



INSTRUCTION MANUAL

IMUX 2000 Intelligent T1 Multiplexer Intelligent Line Switch Mini-DACS

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Note: This product is covered by US Patent number 7,061,905

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WARRANTY

The IMUX 2000 Intelligent T1 Multiplexer comes with a five-year warranty from date of shipment for replacement of any part which fails during normal operation. RFL will repair or, at its option, replace components that prove to be defective at no cost to the Customer. All equipment returned to RFL Electronics Inc. must have an RMA (Return Material Authorization) number, obtained by calling the RFL Customer Service Department. A defective part should be returned to the factory, shipping charges prepaid, for repair or replacement FOB Boonton, N.J.

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NOTE

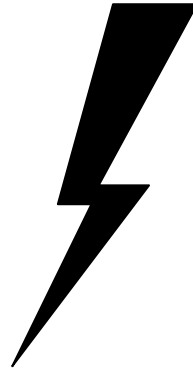
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CAUTION

FOR YOUR SAFETY

THE INSTALLATION, OPERATION, AND
MAINTENANCE OF THIS EQUIPMENT
SHOULD ONLY BE PERFORMED
BY QUALIFIED PERSONS.



WARNING!

The equipment described in this manual contains high voltage. Exercise due care during operation and servicing. Read the safety summary on the reverse of this page

WARNING!

YOUR IMUX 2000 TERMINAL MAY BE EQUIPPED WITH FIBER OPTIC INPUT/OUTPUT MODULES THAT HAVE FIBER OPTIC EMITTER HEADS. FIBER OPTIC EMITTER HEADS USE A LASER LIGHT SOURCE THAT PRODUCE INVISIBLE RADIATION. FIBER OPTIC COMMUNICATION SYSTEMS ARE INHERENTLY SAFE IN NORMAL OPERATION BECAUSE ALL RADIATION IS CONTAINED IN THE SYSTEM. IT IS POSSIBLE DURING MAINTENANCE TO EXPOSE THE RADIATION BY REMOVING OR BREAKING THE FIBER. STARING DIRECTLY INTO THE LIGHT BEAM MAY RESULT IN PERMANENT EYE DAMAGE AND/OR BLINDNESS. NEVER LOOK DIRECTLY INTO THE LIGHT BEAM AND BE CAREFUL NOT TO SHINE THE LIGHT AGAINST ANY REFLECTIVE SURFACE.

THE LASER SOURCE IS A CLASS I LASER PRODUCT WHICH COMPLIES WITH APPLICABLE FDA, OSHA AND ANSI STANDARDS.

SAFETY SUMMARY

The following safety precautions must be observed at all times during operation, service, and repair of this equipment. Failure to comply with these precautions, or with specific warnings elsewhere in this manual, violates safety standards of design, manufacture, and intended use of this product. RFL Electronics Inc. assumes no liability for failure to comply with these requirements.

GROUND THE CHASSIS



The chassis must be grounded to reduce shock hazard and allow the equipment to perform properly. Equipment supplied with three-wire ac power cables must be plugged into an approved three-contact electric outlet. All other equipment is provided with a rear-panel ground terminal, which must be connected to a proper electrical ground by suitable cabling. Refer to the wiring diagram for the chassis or cabinet for the location of the ground terminal.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE OR IN WET OR DAMP AREAS

Do not operate the product in the presence of flammable gases or fumes, or in any area that is wet or damp. Operating any electrical equipment under these conditions can result in a definite safety hazard.

KEEP AWAY FROM LIVE CIRCUITS



Operating personnel should never remove covers. Component replacement and internal adjustments must be done by qualified service personnel. Before attempting any work inside the product, disconnect it from the power source and discharge the circuit by temporarily grounding it. This will remove any dangerous voltages that may still be present after power is removed.

NOTICE

RFL products are not designed for safety critical direct control of nuclear reactors and should not be used as such.

DO NOT SUBSTITUTE PARTS OR MODIFY EQUIPMENT

Because of the danger of introducing additional hazards, do not install substitute parts or make unauthorized modifications to the equipment. The product may be returned to RFL for service and repair, to ensure that all safety features are maintained.

READ THE MANUAL



Operators should read this manual before attempting to use the equipment, to learn how to use it properly and safely. Service personnel must be properly trained and have the proper tools and equipment before attempting to make adjustments or repairs.

Service personnel must recognize that whenever work is being done on the product, there is a potential electrical shock hazard and appropriate protection measures must be taken. Electrical shock can result in serious injury, because it can cause unconsciousness, cardiac arrest, and brain damage.

Throughout this manual, warnings appear before procedures that are potentially dangerous, and cautions appear before procedures that may result in equipment damage if not performed properly. The instructions contained in these warnings and cautions must be followed exactly.

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LIST OF EFFECTIVE PAGES

When revisions are made to the IMUX 2000 Instruction Manual, the entire section where revisions were made is replaced. For the edition of this manual dated August 7, 2012, the sections are dated as follows:

SECTION	EFFECTIVE DATE	SECTION	EFFECTIVE DATE
Front Matter	August 7, 2012	Section 18	August 7, 2012
Section 1	November 2003	DS-TT	January 31, 2008
Section 2	June 1, 2010	Status Module	July 15, 2007
Section 3	May 1, 2010	TMX/TMR	January 25, 2012
Section 4	May 1, 2010	Section 19	October 4, 2000
Section 5	September 15, 2000	Variable Video System	October 4, 2000
Section 6	March 1, 2008	Section 20	August 7, 2012
Section 7	June 1, 2010	MA-490-Telnet I/O	March 6, 2007
Section 8	February 28, 2006	NCM	July 14, 2010
Section 9	May 1, 2010	SNMP Access (SAG)	August 10, 2009
Section 10	May 19, 2003	Section 21	March 1, 2008
Section 11	August 7, 2012	Application Note 3	April 17, 1997
Section 12	May 1, 2010	Application Note 4	July 22, 1996
Section 13	March 17, 1998	Application Note 5	August 14, 1996
Section 14	September 15, 2000	Application Note 6	February 27, 1997
Section 15	May 1, 2010	Application Note 7	February 27, 1997
DA-91I	March 6, 2002	Application Note 8	April 10, 1997
DA-121I	February 10, 2000	Application Note 9	April 10, 1997
DA-291B	April 13, 2010	Application Note 10	February 4, 1999
Section 16	August 7, 2012	Application Note 11	February 8, 1999
DS-562I	June 14, 2007	Application Note 12	September 21, 2000
DS-562NC	July 5, 2012	Application Note 13	October 31, 2000
DS-961D	October 14, 2004	Application Note 19	May 10, 2007
OCUDP	July 15, 2010	Section 22	October 28, 1999
Section 17	August 7, 2012	Section 23	August 20, 2004
VF-5A	June 28, 2005		
VF-5C	March 1, 2010		
VF-6I	December 15, 2011		
VF-8A	August 6, 2010		
VF-10B/VF-11B	April 1, 2009		
VF-15/VF-16	April 1, 2009		
VF-15C	August 7, 2012		
VF-16B	January 17, 2007		
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REVISION RECORD

Rev	Description	Date	Approval
9-15-00	New Release – IMUX 2000 Instruction Manual (2000T1) updated to IMUX 2000R Instruction Manual (MC2000R) with extensive revisions to incorporate CM3R module. (Derived from 2000T1, 3-31-00)	9-29-00	CS
4-10-01	Revised Sections: 0, 2, 6, 7, 8, 16, 17 & 18 in accordance with ECO No. 2000-315, 2000-316 and RFA No. 5782, 6862, 7419, 7420, 7435, 7436 & 7725. Added new 2000R Product Information Sheet. Added new DS5621 (dated 4-8-01). Added new VF5A (dated 4-10-01). Added new DSTT (dated 4-10-01) Added new Status Module (dated 4-2-01) Added new TMX/TMR (dated 4-3-01) Added: MTS local/remote operation MTS alarm reporting over SCB DS562I alarm reporting over SCB CM3R storage of settings in FLASH DSO squelching	4-10-01	CS
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5-17-01	Revised DS-TT in accordance with ECO No. 2000-323 and RFA No. 8008. Created electronic file formats for the following Instruction Data Sheets: DS-64NC, VF10B/11B, VF15/16, and DS-961D. Revised Section 6 as follows: Added Figure 6-4 for setting jumpers for Cm-3R external clock source. Revised Section 8 in accordance with RFA No. 7637 as follows: Changed dash “-“ to underscore “_” on NEXT command. Revised Section 12 in accordance with RFA No. 7645 as follows: Added Table 12-2.	5-17-01	CS
6-26-01	Added module adapters to VF10B/11B, VF10D, VF15/16, VF15C, VF17/18 and DA191A. Created electronic file format for the VF17/18.	6-26-01	CS
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Rev	Description	Date	Approval
12-19-01	Revised VF-5A (4-10-01 to 10-23-01). Revised VF-6I (2-21-00 to 10-15-01) in accordance with CAR No. C2000-0027. Revised DS-562I (4-8-01 to 12-17-01) in accordance with CAR No. C2000-0047. Revised DSTT (5-15-01 to 12-19-01) in accordance with CAR No. C2000-0017, and ECO No. 2000-337. Deleted VF-7A and VF-17/18. Added VF-16B (11-16-01).	12-19-01	CS
3-6-02	Revised in accordance with: CAR No. C2000-0049 (3kV caps) CAR No. C2000-0054 (pinouts) CAR No. C2000-0055 (OCUDP) CAR No. C2000-0067 (DA-91I) ECO No. 2000-340 (3kV caps) ECO No. Misc-488 (3kV caps)	3-6-02	CS
4-12-02	Revised in accordance with: CAR No. C2000-0071 (revised TMX/TMR) ECO No. 2000-343 (revised DS-TT) Added MA-620 to DS-562I	4-12-02	CS
5-19-03	Revised in accordance with: CAR No. C2000-0141 (revised use of SW1-4 on OIAs) Section 6 ECO No. 2000-344 (revised use of SW1-4 on OIAs) Section 6 CAR No. C2000-0166 [revised the function of item 13, Jumper J2 on page 6 of DSTT, from “RUN” (UP) to “RUN” (DOWN)] CAR No. C2000-0185 (added MA-322 & MA-324 to VF-5A, added MA-324 to VF-6I) Revised Section 2 as follows: (revised OIA part numbers) Revised Section 10 as follows: (added troubleshooting Tip #001) Revised Section 12 as follows: (revised OIA part numbers) Revised Section 15 as follows: (added new DA-191B [6-19-02]) Revised Section 16 as follows: Added new DS-562I (2-10-03) & OCUDP (4-2-03) Revised Section 17 as follows: Added new VF-5A (5-14-03), VF-6I (5-16-03), VF-8A (4-16-02), VF-15C (11-26-02) & VF-16B (11-25-02) Revised in accordance with ECO No. 2000-389 (swap time) Sections 2, 6 and 8	5-19-03	CS

Rev	Description	Date	Approval
8-20-04	Revised Section 8 in accordance with CAR# C2000-0241 (See errata sheet MC2000R-001) Revised Status Module in accordance with CAR# C2000-0268 (See errata sheet MC2000R-003) Revised DS-562I in accordance with CAR # C2000-0289 (See errata sheet MC2000R-004) Revised VF16B in accordance with CAR # C2000-0272 (See errata sheet MC2000R-001) Revised DS-64NC in accordance with CAR # C2000-0272 in accordance with ECO No. 2000-444 Added new DS961D dated 7-29-03 to Section 16 Added new VF-5C dated 7-8-04 to Section 17 Added new VF-15C dated 7-28-03 to Section 17 Added new DSTT dated 1-20-04 to Section 18 Added new Section 20 containing MA-490 Telnet I/O and MCM Moved existing Section 20 (Accessory Equipment) to Section 23 Added RFL SAG.MIB file to CD version of this instruction manual in accordance with CAR# C2000-0309	8-20-04	CS
11-3-05	Revised Section 2 in accordance with CAR# C2000-348 (See errata sheet MC2000R-007) Revised Section 16 in accordance with ECO No. 2000-503 (See errata sheet MC2000R-006) Revised Section 16 in accordance with CAR# C2000-0400 (See errata sheet MC2000R-008) Revised Section 17 in accordance with ECO No. 2000-500 (See errata sheet MC2000R-005) Revised Section 17 in accordance with CAR# C2000-0399 (See errata sheet MC2000R-009) Note: This Revision never archived	11-3-05	TG
5-22-06	Manual revised in accordance with CAR #2000-0456 (See errata sheet MC2000R-010. Section 2 revised in accordance with ECO No. 2000-561 and CAR #2000-0421. Data Sheets updated.	5-22-06	TG
6-1-07	Data Sheet DS-562I updated in accordance with CAR # 2000-0568 and 0583. Section 11 updated with the inclusion of new power supplies (HP) as per ECO No. 2000-598 and 628. Section 2 updated with changes to OIA	6-1-07	TG
3-1-08	Data Sheets DA-291B and DS-562NC added. Changes to Section 11 as per ECO 2000-666.Changes to section 6 as per ECO 2000-662. Warranty extended to five years.	3-1-08	TG

Rev	Description	Date	Approval
8-1-10	The following Data Sheets are now obsolete and have been removed from the Instruction Manual with this release. Section 15 – DA-191A, DA-191B Section 16 – DS-64NC Section 17 – VF-10D Minor updates to Section 3, 4, 7, 9, 11,12. OCUDP Data Sheet extensively revised.	8-1-10	TG
8-7-12	Section 11 updated, data sheets updated.	8-31-12	TG

SECTION 1. PRODUCT INFORMATION

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IMUX 2000

T1/E1 Multiplexer

with Common Logic Redundancy



The Fifth Generation Multiplexer designed to meet the needs of your Telecommunications Network

Designed for harsh environments, the new IMUX 2000 T1/E1 Multiplexer creates a new class of Intelligent Multiplexer with features such as *Redundant Common Logic Module*, *built in CSU functionality*, *DS0 squelching capability* and *Fast Reframing Channel*.

The unit provides full featured, Drop-and-Insert capability for each voice frequency circuit or any signal that can be transmitted in a DS0 channel. The multiplexer has electrical and a wide variety of optical fiber (both singlemode and multimode) interfaces to simplify system configuration. Channel cards are available for voice, data, telemetry, teleprotection, video and ethernet applications. When combined with our IMUX 2000 8-Port DACS-R, the IMUX 2000

T1/E1 Multiplexer supports many types of network layouts such as Spur, Hot Standby and Ring topologies. The IMUX 2000 is both hardware and software configurable. The unit offers the ultimate network management system. It operates in a Windows™ point-and-click environment and provides network visibility from any node which allows for remote provisioning, monitoring and alarm reporting.

The IMUX 2000 T1/E1 Multiplexer is compact, modular in design and compatible with previous generations of RFL Multiplexers. For a product that meets and exceeds your telecommunication needs, advance into this new class of hardened multiplexer and make the Intelligent choice, the IMUX 2000 Intelligent T1/E1 Multiplexer.



Key Features and Benefits

- **Substation Hardened**

The IMUX 2000 T1/E1 Multiplexer is designed for harsh environments and has a wide temperature range of -20°C to +65°C (-4°F to +149°F). It meets the IEEE/ANSI standards C.37.90-1989, C.37.90.1 and C.37.90.2 for SWC, fast transient and EMI. It is CE approved and has been tested to BS EN 5002:1995. It is also FCC part 15 Class A approved.

- **Reliability**

The IMUX 2000 provides enhanced reliability by offering optional redundant power supplies and common logic modules.

- **Speed**

The IMUX 2000 is designed to handle time sensitive applications such as Protective Relaying. The Drop-and-Insert through-channel delay is less than 25 microseconds. The IMUX 2000 has an average reframe time of less than 25 milliseconds and also has the ability to enable a Fast Reframing Channel (FRC) for less than 1 millisecond reframing.

- **DS0 Squelching**

The IMUX 2000 T1/E1 Multiplexer has the ability to squelch (turn off) the output of a channel module in the Multiplexer upon loss of synchronization. This feature provides security against false tripping on 4-wire analog transfer trip channels and older digital equipment (with limited error checking) during loss of sync and protects against 'pink' noise conditions, which result from cross-talk or the frame search. This feature is ideal for preventing false tripping due to system malfunction.

- **CSU Functionality**

The IMUX 2000 offers a built in CSU functionality that meets applicable standards for protection including FCC Part 68 approval for direct connection into the Public Switched Telephone Network (PSTN). When enabled, the unit will respond to generated loopback codes compliant to either ANSI T1.403 or AT&T TR 54016. It will also maintain and allow local and remote retrieval of performance measurements in accordance with either ANSI T1.403 or AT&T TR 54016.

- **Modular Design**

The IMUX 2000 incorporates a midplane motherboard design. Channel modules plug into the front of the unit, and matching module adapter for I/O connections plug into the rear. This eliminates the need for internal chassis wiring when adding new channel cards, simplifying the upgrade.

- **Fiber Optic or Electric Interfaces**

The IMUX 2000 can be equipped with either electrical T1/E1 interfaces or Optical Interface Adapters (OIA's). The electrical T1 interface is equipped with Line Build-Out (LBO) networks for operation of up to 6,000 feet from the DSX. The OIA's are available in a wide range of multimode, single-mode, LED or laser combinations to accommodate 1300nm and 1550nm wavelengths.

- **Channel Interfaces**

A wide range of interfaces unique to the utility and the transportation market is offered. It also offers a wide range of Voice and Data, Status, Telemetry, Ethernet, Transfer Trip and Video channel interfaces to meet most communications requirements.

- **Fast Restoration**

When applied to diverse communication routes, such as Ring or Hot-Standby networks, the IMUX 2000 is capable of switch times programmable down to 1 millisecond.

- **Diverse Networks**

The IMUX 2000 supports many types of network layouts such as Linear, Spurs, Hot-Standby and Ring topologies. It is also designed for operation over SONET/SDH networks taking into consideration the critical time-delay issues associated with Protective Relaying.

- **SONET and SDH Applications**

Protective Relaying can finally be applied over non-proprietary SONET/SDH equipment. With emphasis placed on rapid break healing, the IMUX 2000 addresses the critical time issues associated with Protective Relaying making it the ideal and Intelligent choice when interfacing to SONET/SDH networks. The IMUX 2000 bridges the gap between SONET and substations providing DS0 gateways onto the network. Also, through its own switching techniques, can overcome the longer switch times and unequal channel delay issues associated with SONET.

- **Automation**

The IMUX 2000 offers the ultimate GUI Network Management system which operates in a Windows™ point-and-click environment. The optional SNMP based management reporting software can be used when integrated as part of a larger enterprise system. Network visibility is available from any node which allows remote provisioning, monitoring and alarm reporting.



Telecommunication Solutions

Electric Power Utilities

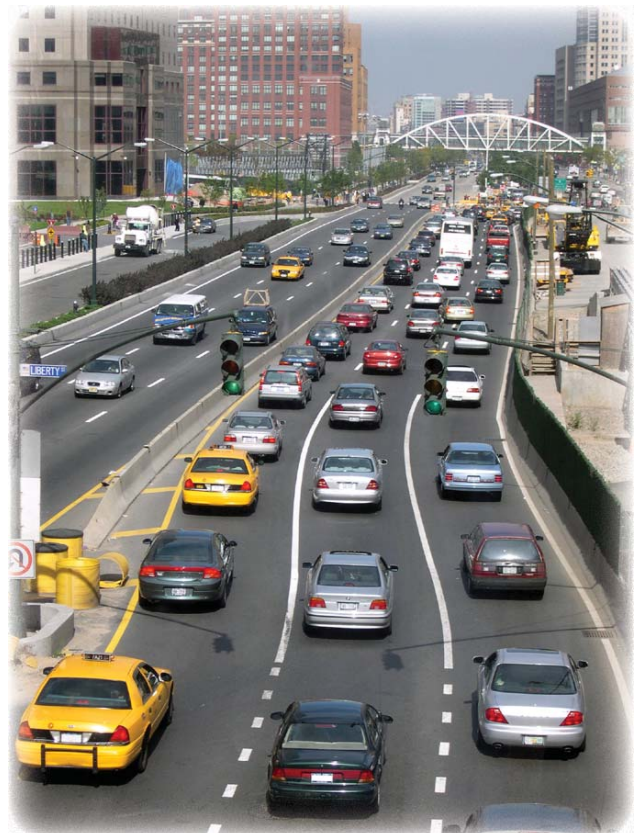


Designed specifically for the unique need of the harsh substation environments, the IMUX 2000 T1/E1 Multiplexer incorporates special design characteristics which allow it to meet ANSI / IEEE / IEC standards for operation in harsh environments (RFI, SWC, EMI and Fast Transient). The Drop-and-Insert through delay is less than 25 microseconds, including the fiber heads (excluding the communications medium). Along with the minimal through delay, a software programmable Fast Reframing channel is available to allow the multiplexer to reframe in less than 1 millisecond. The DS0 squelching (patent pending) capability allows the Common Logic Module to squelch (turn off) the output of a channel module in the Multiplexer upon loss of synchronization. This feature provides security against false tripping on 4-wire analog transfer trip channels and older digital equipment (with limited error checking). These features in the IMUX 2000 T1/E1 Multiplexer, address the critical time issues associated with protective relaying, making it ideal to be used in the electric power utilities industry. In addition, the multiplexer has the Transfer Trip and Current Differential interfaces required for the utility market.

Transportation Industry

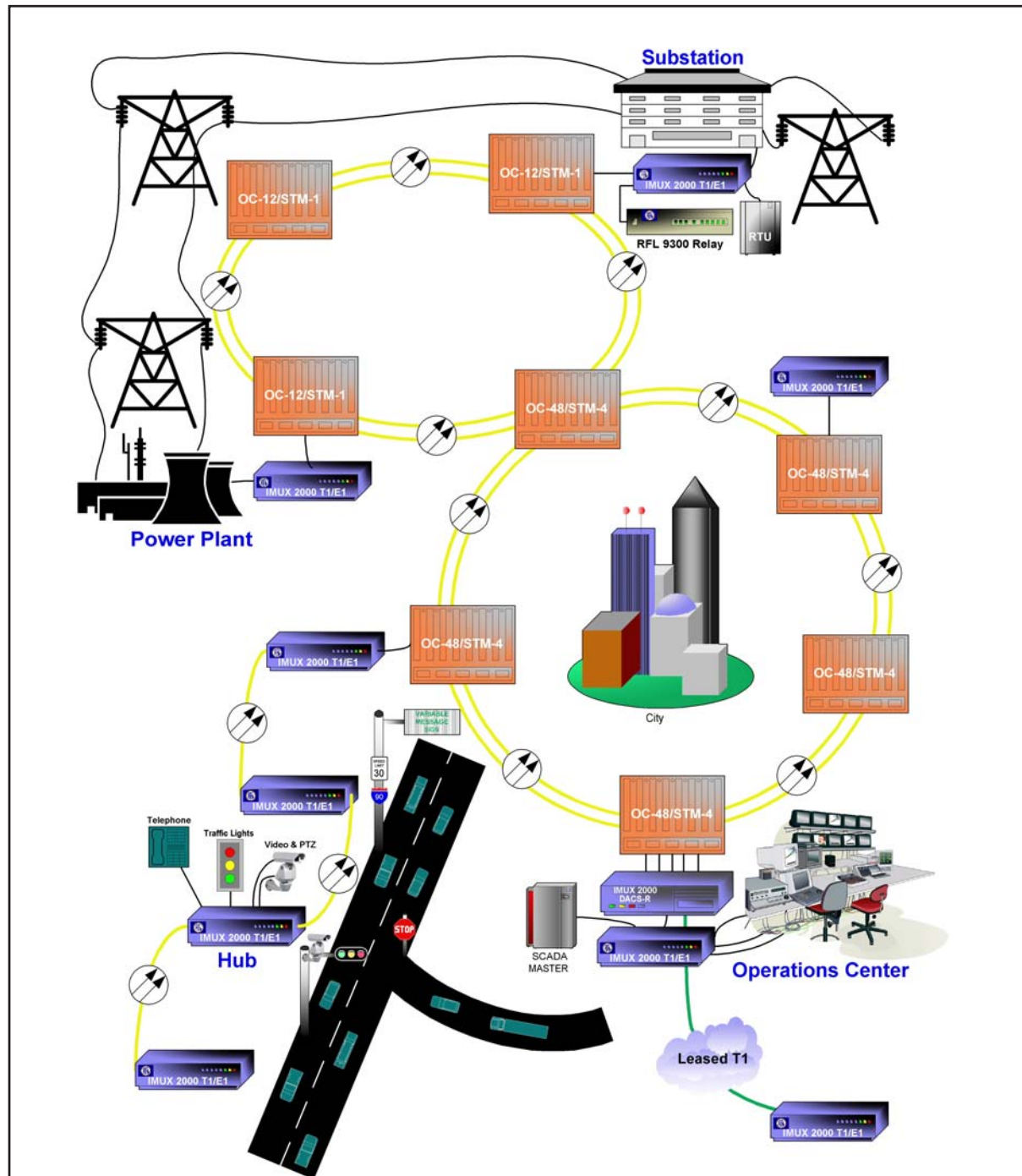
With the increasing demand for faster, more efficient ways to manage the flow of traffic, customers need a communication infrastructure that allows the system to advance as the technology develops. That is why the IMUX 2000 T1/E1 Multiplexer, with its unique harsh environments design, is the preferred choice of communication for the Transportation Industry. The IMUX 2000 T1/E1 multiplexer is designed to be used as part of a large traffic management system working in conjunction with higher bandwidth SONET/SDH networks or in stand-alone T1/E1 networks.

Applications for the product include: roadside signal acquisition and transmission from vehicle loop detectors, compressed digital video, camera control, toll collection, status and alarm reporting, tunnel ventilation control, and voice and data traffic signal control systems. The compact and robust design and the ability to work under harsh conditions makes the IMUX 2000 T1/E1 multiplexer the best multiplexer for transportation applications. The network management software provides ease of maintenance with Windows™ based GUI software. The optional SNMP based management reporting software can be used when integrated as part of a larger enterprise system.





Application Solutions



Above is an example of a typical utility / traffic system solution. It is made up of two SONET/SDH rings as the communications backbone. The IMUX 2000 T1/E1 Multiplexers are configured to work in a Point-to-Point, Star and Stand-Alone Linear topology over the SONET/SDH system.

The IMUX 2000 carries RTU and phone circuits from several substations to the operations center. It also carries current differential relay data between substations.

The IMUX 2000 carries roadside signals, transmission data from vehicle loop detectors, compressed digital video, camera control, toll collection information, status and alarm reporting, voice and data traffic signal controls back to the operations center.



Technical Specifications

T1 INTERFACE

Interface:

DSX-1 interface per ANSI T1.102-1993

Rate:

1.544 Mbps per ANSI T1.102-1993
(Transmit ± 30 PPM using internal timing)

Transmit Pulse Shape:

Per ANSI T1.102-1993

Formats:

Extended Superframe (ESF) per AT&T 62411, D4/
Superframe (SF) per AT&T 43801

Line Codes:

Bipolar with 8 Zero Substitution (B8ZS) & Alternate
Mark Inversion (AMI)

Output Impedance:

100 Ohms nominal per ANSI-T1.102-1993

Reframe Time:

Without Fast Reframing Channel (FRC) enabled: Less
than 25 milliseconds. With Fast Reframing channel
(FRC) enabled: Less than 1ms.

TIMING

Primary Timing:

Internal, External, Loop or Through

Fallback:

Automatically enabled in case of primary timing failure.

Timing Output:

T1: 1.544 Mbps, (RJ11 connector)
E1: 2.048 Mbps, G.703 (RJ11 connector)

ENVIRONMENTAL

Temperature:

-20°C to +65°C (-4°F to +149°F) operating

SWC & Fast Transient:

Power supply, alarm contacts, pilot wire interface &
transfer trip interface meet the requirements of ANSI
C.37.90-1989 & ANSI C.37.90.1. IEC 1000-4-2:1995,
IEC 1000-4-3:1997, IEC 1000-4-4:1995, IEC 1000-4-
6:1996, IEC 1000-4-8:1994, DD ENV 50204:1996.

EMI:

The chassis & modules meet ANSI C.37.90.2.

FCC Compliance:

FCC Part 15 class A

Humidity:

0-95% Non-condensing

Shock & Vibration:

The chassis and channel modules shall meet require-
ments of IEC 255-21-2 and IEC 255-21-1.

E1 INTERFACE

Interface:

Conforms to ITU G.703

Rate:

2.048 Mbps ± 50 PPM input and output

Jitter Tolerance:

Exceeds ITU G.823

Attenuation:

Greater than 18 dB at 40Hz

Formats:

Frame format per ITU G.704 in 30-channel and 31-
channel modes.

Line Codes:

HDB3 (High Density Bipolar, Order 3) per ITU
G.703, or AMI (Alternate Mark Inversion)

Connection:

75/100 ohm BNC connector or DB-15 connector
for twisted pair.

Frame Synchronization:

Average reframe time non-signaling DS0's:
0.3 ms with fast reframe
0.6 ms without fast reframe
Multi-frame based signals (Signaling): 5ms

PHYSICAL

Dimensions:

Height: 5.25" (144 mm)
Width: 19" (483 mm per EIA RS-310)
Depth: 14.50" (370 mm)
Available in 23" width mounting.

Weight:

15 lbs (6.8 kg). for typical fully loaded shelf.

USER INTERFACE

Functionality:

Remote monitoring, configuration and alarm reporting.

Local access:

Switch settings

Remote Access:

RS-232C port
Optional 10 BaseT Ethernet Interface



Technical Specifications

POWER REQUIREMENTS

All shelves can be equipped with a secondary plug-in power supply for redundancy.

Input Voltage:

24 Vdc
48/125 Vdc
250 Vdc
120 Vac
220 Vac

Range:

19 to 29.0 Vdc
38 to 150 Vdc
200 to 300 Vdc
90 to 130 Vac
180 to 265 Vac

OPTICAL INTERFACE ADAPTERS (OIA)

Emitter	Wavelength	Fiber	System Gain
LED	1300 nm	MM	25dB (12mi; 19km)
LED	1300 nm	SM	18dB (17mi; 27km)
Laser	1300 nm	SM	36dB (37mi; 62km)
Laser	1550 nm	SM	30dB (56mi; 90km)
Laser 2mw	1550nm	SM	39d (70mi; 113km)

ALARMS AND DIAGNOSTICS

Status Monitoring:

- Constant monitoring of equipment with alarm reporting.

Alarm Types:

- Alert, cautionary conditions that do not prevent multiplexer operation.
- Alarm, conditions that directly affect multiplexer operation.

Interface:

- Front panel indicators and alphanumeric display
- RS-232 port for remote access and interrogation
- Form C relays for shelf alarm and alert

Loopbacks:

- T1: Line, Equipment and Payload
- E1: Line and Equipment

DS0 CHANNEL MODULE FUNCTIONALITY

Voice Units:

2W VF

- Type I, II, III & V E & M signaling

2W Foreign Exchange

- Loop or ground start signaling
- Automatic ring down option

4W VF

- Type I, II, III & V E & M signaling
- Point-to-point and multi-point
- 4W FXO and FXS
- Channel addressing for added protection
- 2713Hz detection loop-back mode
- Optional SWC rated connection for analog teleprotection

Orderwire:

- 2W party line voice circuit over a 64 kbps channel
- DTMF signaling
- Uses a regular 2W phone

Data Units:

Low Speed Data

- RS-232 interface Async. and Synchronous
- RS-422 interface
- RS-485 interface 2 or 4 wire
- Sub-rate multiplexing
- Point-to-point and multi-point

High Speed Data (56/64 kbps rates)

- RS-449, V.35, X.21 and G.703
- Channel addressing for added protection
- ANSI C37.94 optical interface

High Speed Data (N x 64 kbps Rates)

- N = 1 to 24 64 kbps
- RS-449 & V.35 interfaces
- ANSI C37.94 optical interface

Office Channel Unit Data Port (OCUDP)

- ANSI T1.410



Technical Specifications

DSO CHANNEL MODULE FUNCTIONALITY

Status:

Contact Input/Output

- 16 input
- 16 output
- 8 input / 8 output

Teleprotection Units:

Modular Teleprotection System

- Application: DTT, POTT, PUTT, DCB & DCU
- Four independent bidirectional function
- Solid state or relay output
- Channel delay measurements
- Sequence of events log
- Channel addressing for added protection
- Optional I-RIG B synchronization module

Current Differential

- Pilot wire relay interfaces
- HCB, HCB-1, MBCI & CPD

Analog Telemetry

- Transport of telemetry voltage or current
- Bus voltage remote synchronizing application

Ethernet:

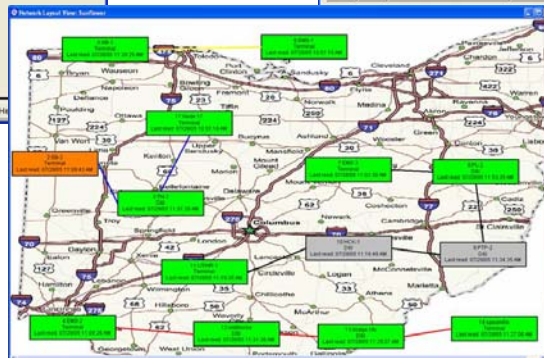
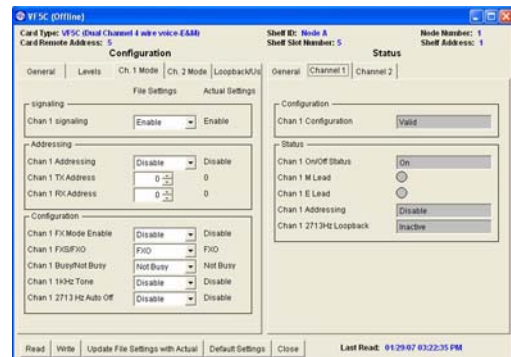
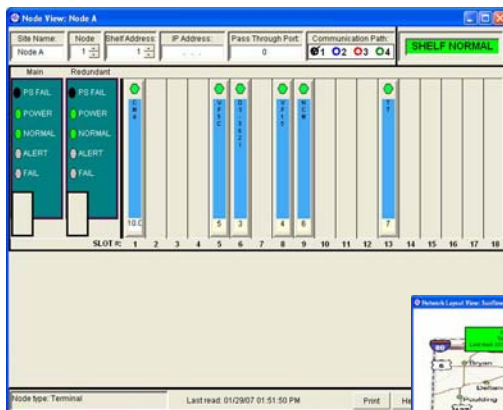
- IP connectivity
- LAN / WAN interconnect
- 10 BaseT Ethernet learning bridge
- Support half or full duplex
- IEEE 802.3

Video:

- NTSC or PAL analog video signal transport
- ITU H.261 compression algorithm
- 1-20 frames/second
- 64 to 1536 Kbps bandwidth
- 352 x 288 resolution

NETWORK MANAGEMENT

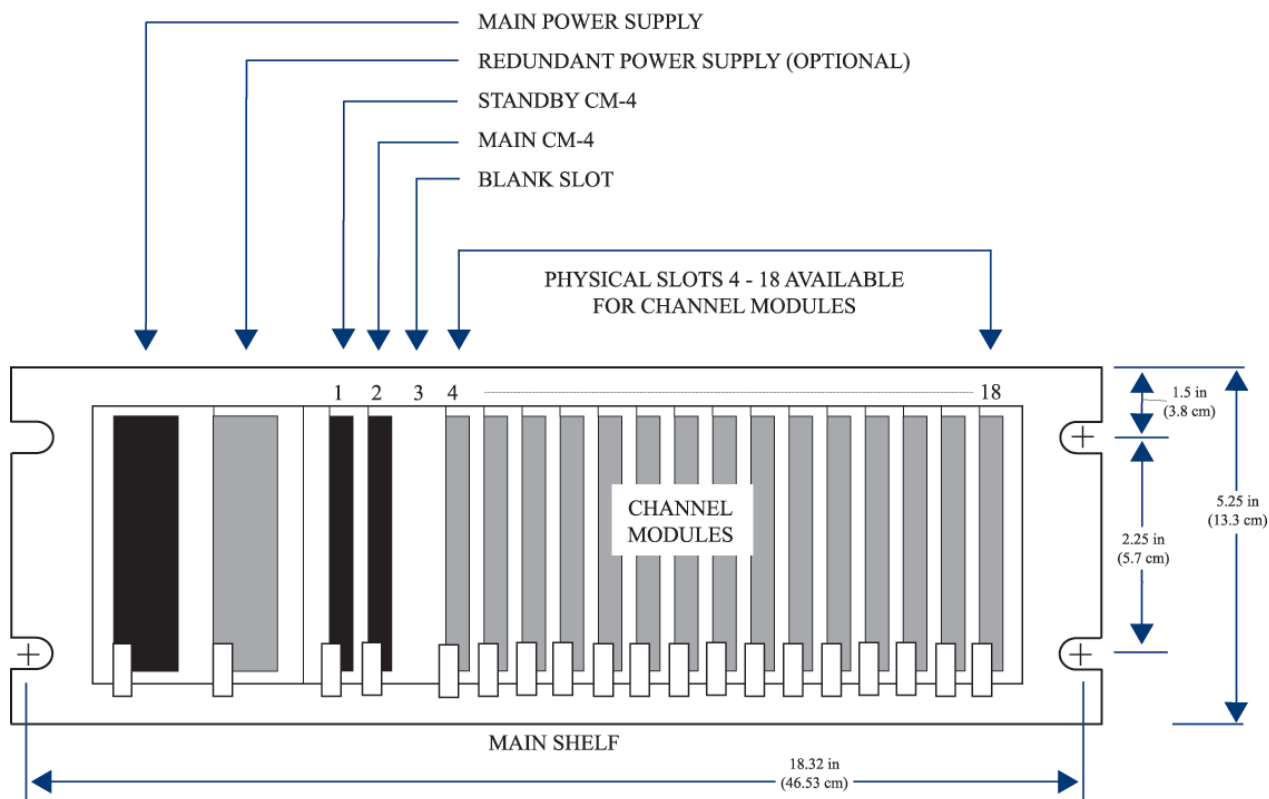
- Windows™ based PC NMS
- 3 User Level Password
- Access from any node for full system provisioning, monitoring and diagnostics
- Alarm logging and time stamping
- RS-232 craft interface
- Optional faster NMS communication using a single 64 kbps channel
- Optional 10 BaseT Ethernet Interface
- Optional interface for SNMP manager
- Network password protection for added security



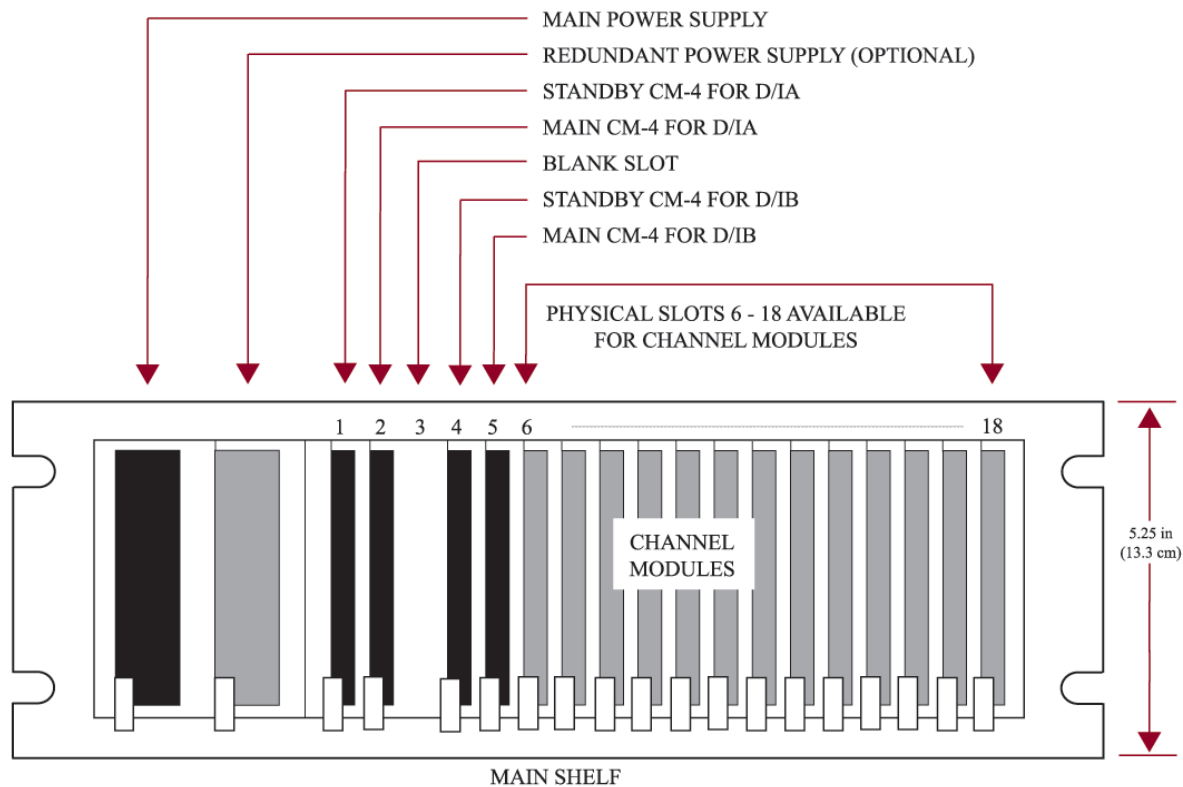
Typical Network Management Screens



Layout and Dimensions



a. Terminal



b. Drop and Insert

SECTION 2. FUNCTIONAL DESCRIPTION OF THE IMUX 2000 INTELLIGENT T1 MULTIPLEXER

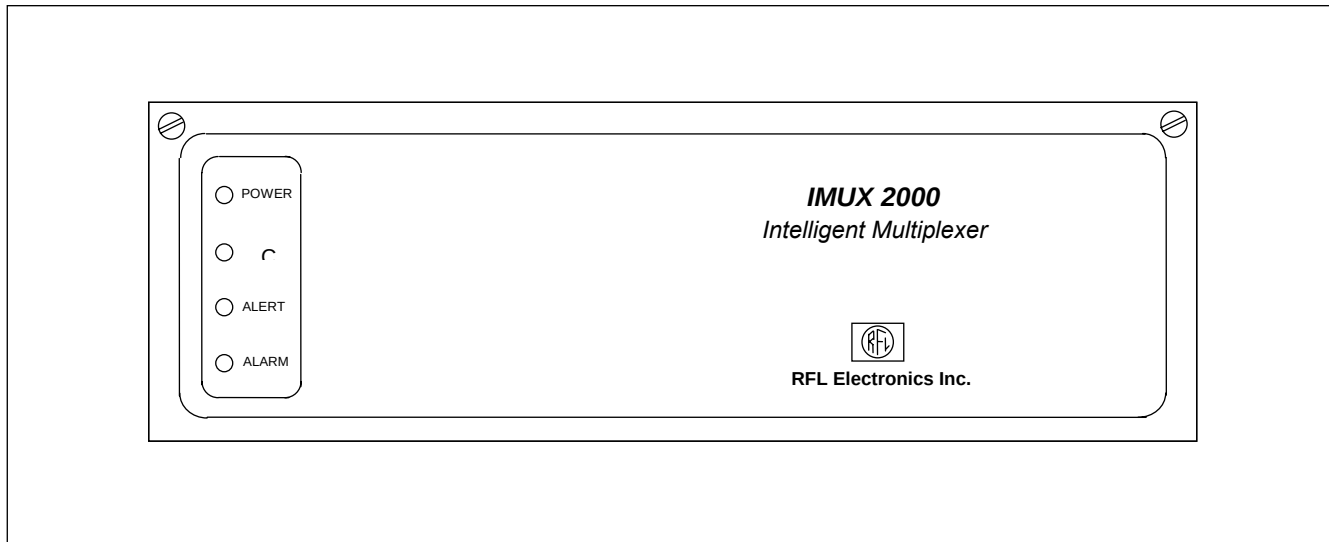


Figure 2-1. Front panel of IMUX 2000 Intelligent T1 Multiplexer

2.1 INTRODUCTION

This section gives a functional description of the IMUX 2000 Intelligent T1 Multiplexer, including how the unit can be configured for both point-to-point and drop/insert electrical and fiber T1 systems. This section also defines all common equipment connectors, switches, and indicators used in the IMUX 2000 Intelligent T1 Multiplexer.

2.2 MULTIPLEXER CONFIGURATIONS AND SYSTEMS

The IMUX 2000 Intelligent T1 multiplexer can be configured as a terminal multiplexer or as a drop/insert multiplexer. Both of these configurations can be fitted with an electrical T1 interface or an optical T1 interface using a variety of interface adapters. The optical interface adapters permit the T1 circuit to operate over a fiber optic cable and are available in both multimode and single-mode configurations at several different wavelengths.

2.2.1 TERMINAL MULTIPLEXER

The terminal multiplexer serves as an interface between a single T1 "high-speed" circuit and multiple voice and data "low-speed" circuits (See Figure 2-2). Channel modules convert voice and data signals into a single or multiple 64,000-bit/second (64-kbps) digital signals. These 64-kbps signals or "time slots" are then combined by time division multiplexing (TDM) into a 1,544,000-bit/second (1.544-Mbps) T1 signal. The multiplexed voice and data circuit becomes payloads within the T1 circuit.

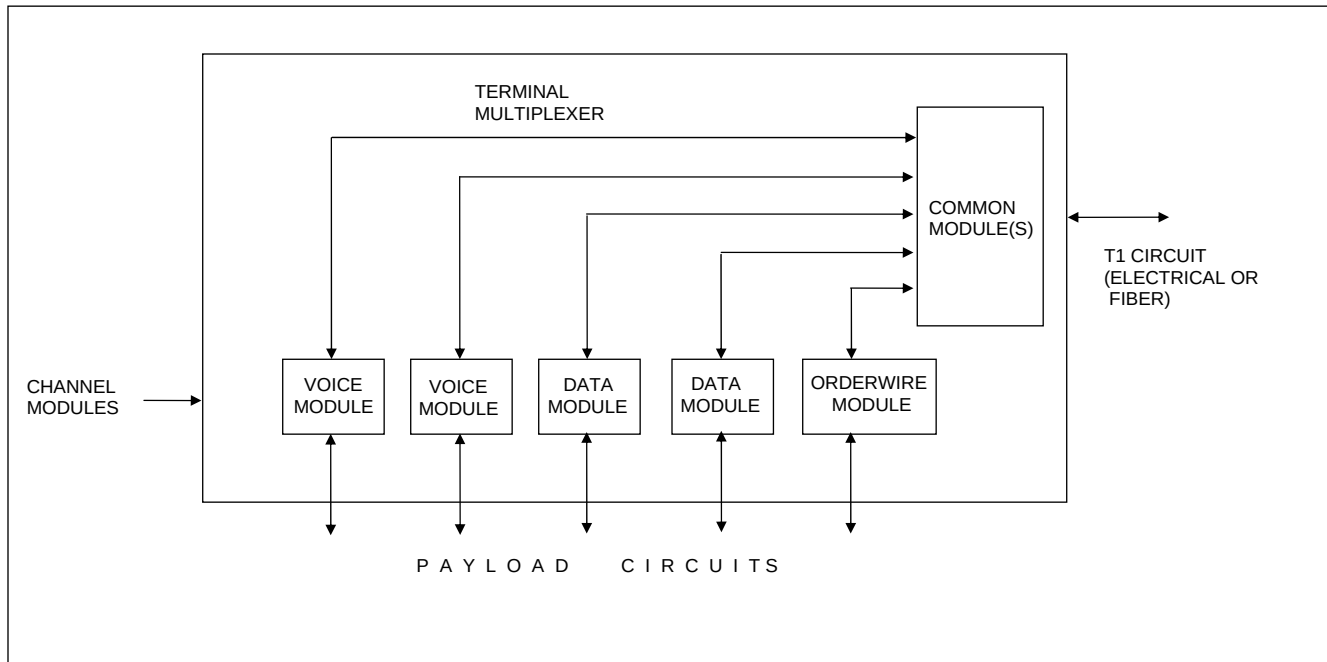


Figure 2-2. Terminal multiplexer (sample configuration)

A single T1 circuit provides 24 full-duplex, 64-kbps time slots for an aggregate payload capacity of 1.536 Mbps in each direction. Because the T1 signal format includes an 8-kbps overhead channel for frame synchronization, error detection, and other functions, the actual T1 interface rate is 1.544 Mbps. (See Section 10 for more information on SF and ESF formats.)

2.2.2 DROP/INSERT MULTIPLEXER

A drop/insert multiplexer is essentially a multiplexer configured as two back-to-back terminals, in which some circuits terminate while others pass through. A drop/insert multiplexer can terminate payload circuits from either of two different T1 circuits; that is, from either of two different locations. (See Figure 2-3.)

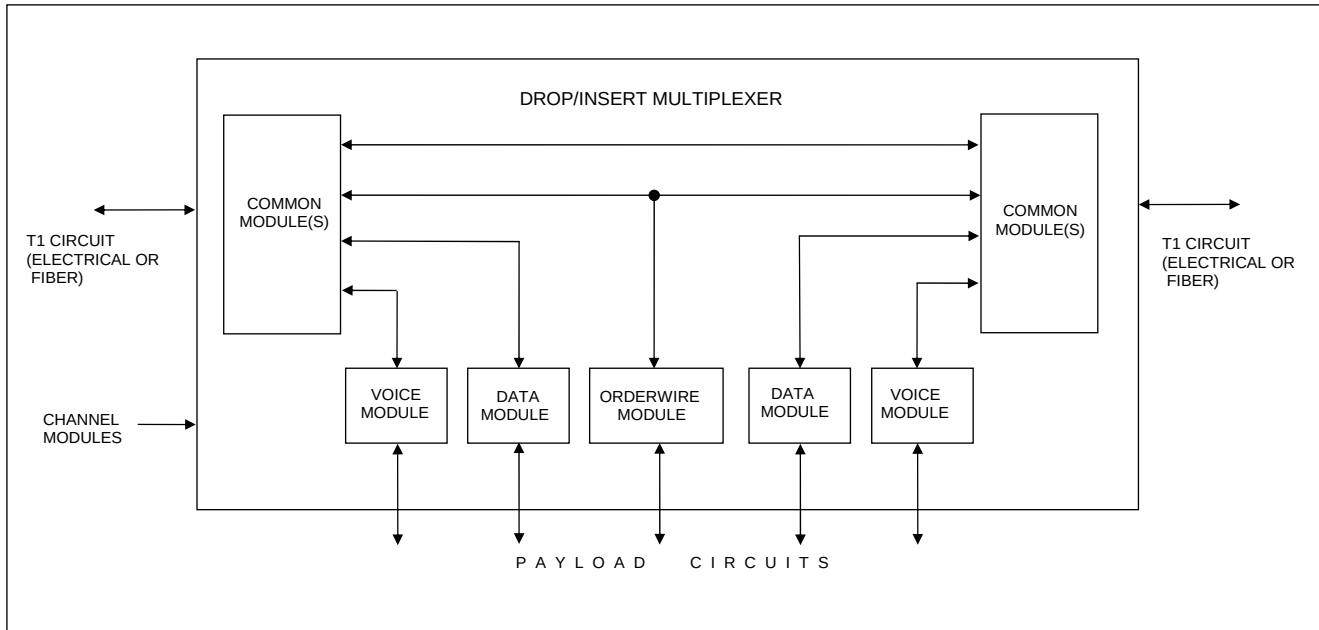


Figure 2-3. Drop/insert multiplexer (sample configuration)

2.2.3 POINT-TO-POINT SYSTEMS

The simplest type of IMUX 2000 system configuration is a point-to-point system. A point-to-point system consists of two terminal multiplexers connected by a single T1 electrical or fiber optic circuit. (See Figure 2-4.) As the figure illustrates, the same payload circuits will appear at both ends of a point-to-point system. Most payload types (such as voice and full-duplex data circuits) are bi-directional, and will have both an input and an output at each terminal multiplexer.

2.2.4 DROP/INSERT SYSTEMS

The addition of one or more drop/insert multiplexers converts a simple point-to-point system into a drop/insert system. (See Figure 2-5.) Data, voice, and orderwire (multiple drop voice) circuits can be established between any two locations in a T1 drop/insert system. As shown in Figure 2-5, a three-location system can provide circuits between Locations 1 and 2, Locations 2 and 3, and Locations 1 and 3. The only limiting factor is the capacity of the T1 circuit between any two adjacent locations, which is 24 time slots. Drop/insert systems are not limited to a single drop/insert multiplexer, and may contain more than three locations.

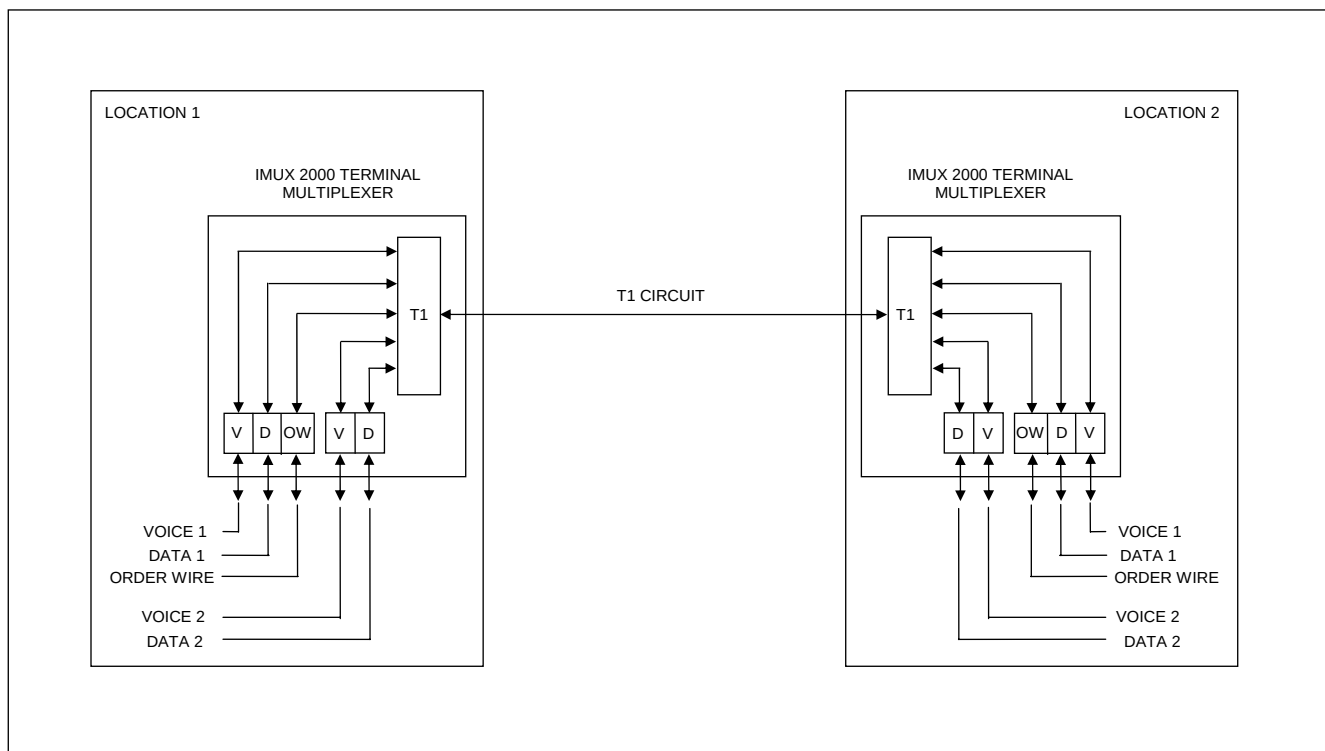


Figure 2-4. Point-to-point system (example)

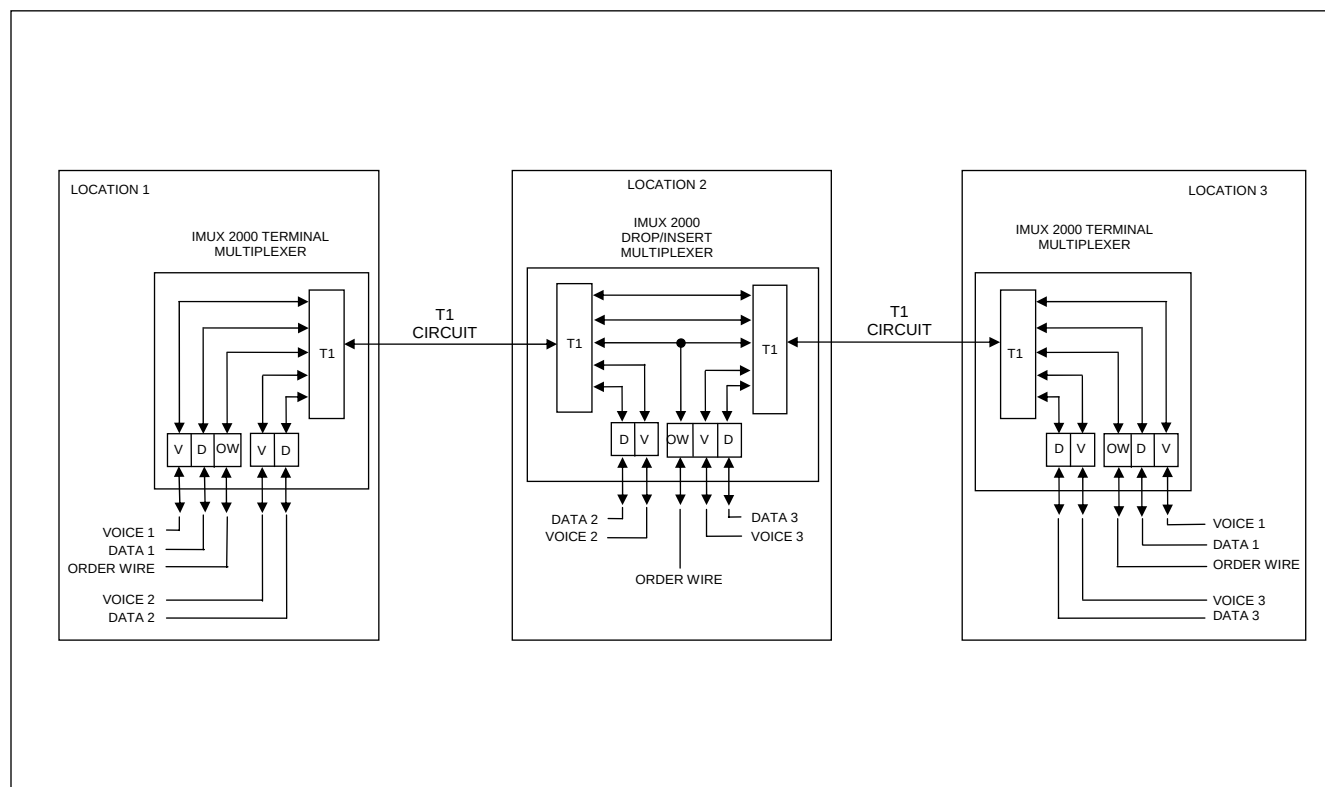


Figure 2-5. Drop/insert system (example)

2.3 MULTIPLEXER COMPONENTS

Each IMUX 2000 multiplexer contains the following components:

<u>Component</u>	<u>See Paragraph</u>
1. Main Shelf	2.3.1
2. Repeater Shelf (optional)	2.3.2
3. T1 Common Modules (CM-3R)	2.3.3
4. Common Module Interface Adapters	2.3.4
5. Power Supply Module(s)	2.3.5
6. Power Supply Alarm I/O Module	2.3.6
7. Channel Modules	2.3.7
8. Module Adapters	2.3.8

Each of these components is described in the paragraphs that follow.

2.3.1 MAIN SHELF

The Main Shelf is the enclosure for the IMUX 2000 multiplexer. It has plug-in slots in the front for one main power supply and one optional redundant power supply. It also provides 18 physical slots for T1 common modules and channel modules. Plug-in slots at the rear accommodate module adapters (MAs) and optical interface adapters (OIA's). (See Figure 2-6.)

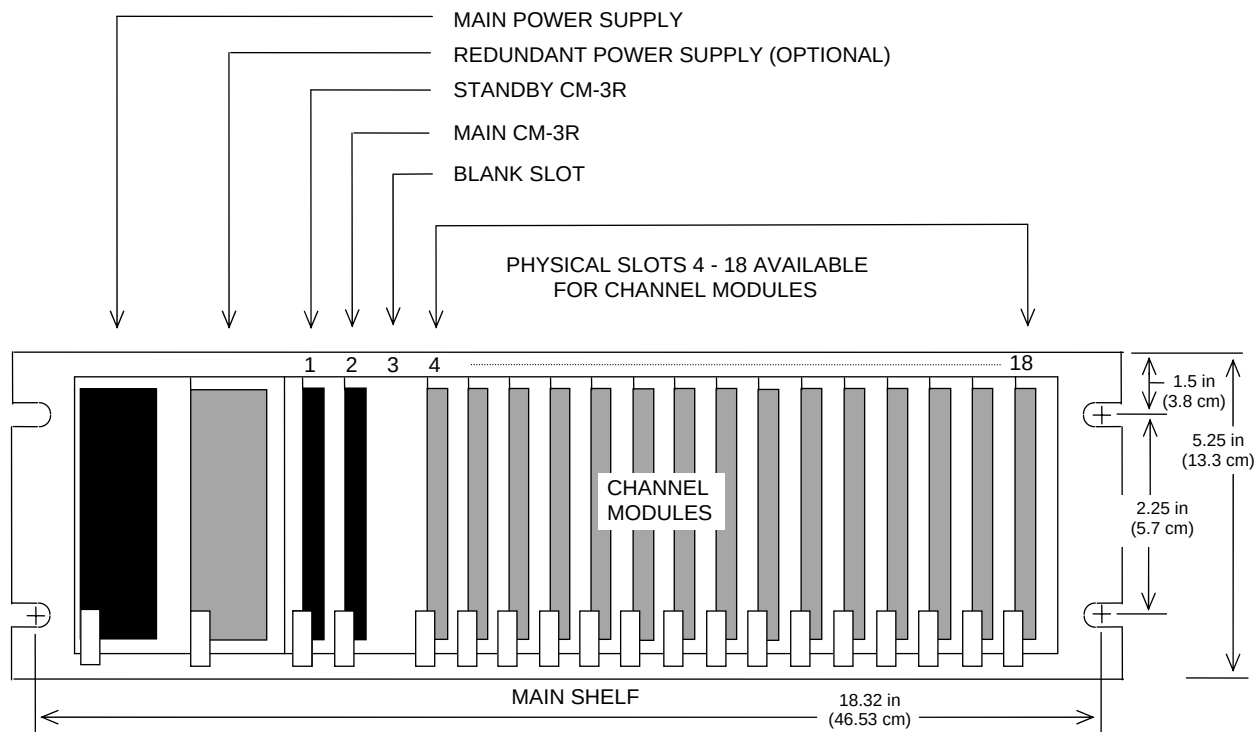
Each IMUX 2000 multiplexer (terminal or drop/insert) includes one Main Shelf which can be installed in a standard 19-inch equipment rack. The Main Shelf is 5.25 inches (13.3 cm) high, and occupies three rack units of cabinet space (3RU).

The following are recommended slot assignments in the Main Shelf for systems with redundancy:

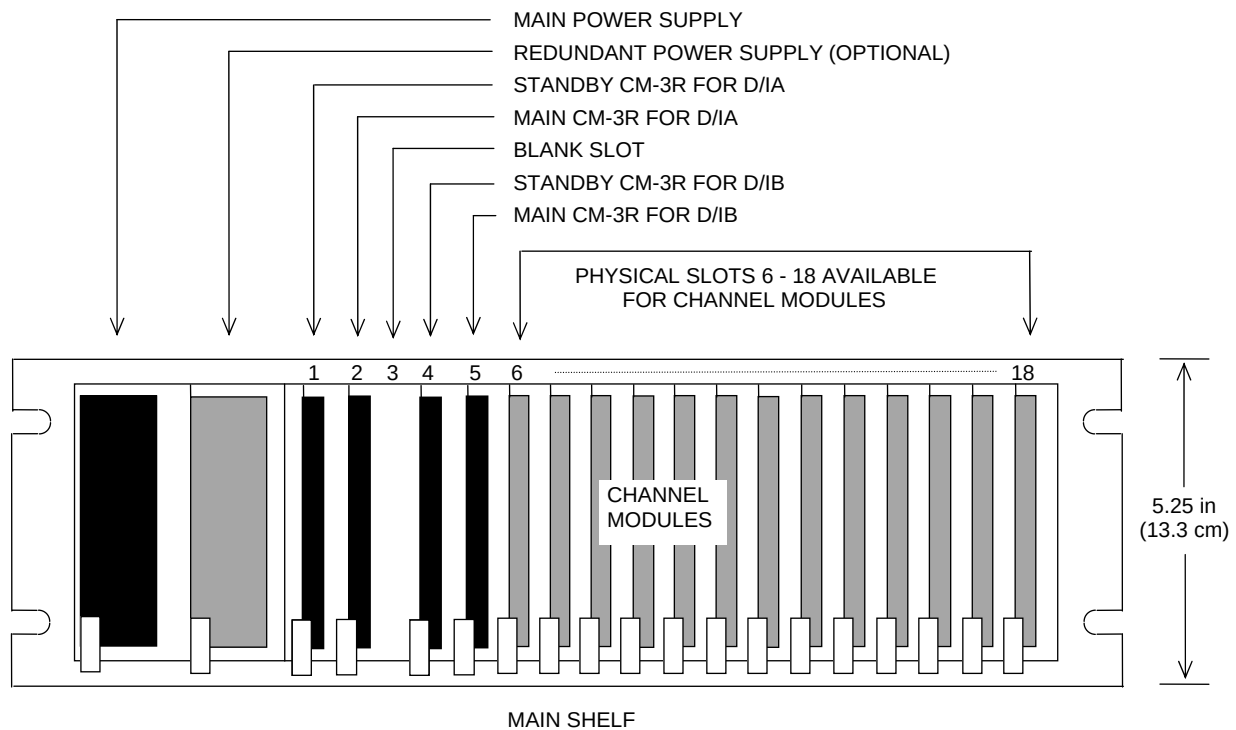
1. In terminal multiplexers with T1 electrical interfaces or fiber optic interfaces, the standby CM-3R should be installed in Slot 1, the main CM-3R should be installed in Slot 2, and slot 3 should be left blank. Slots 4 through 18 are available for channel modules.
2. In drop/insert multiplexers with T1 electrical interfaces or fiber optic interfaces, the standby D/IA CM-3R should be installed in Slot 1, the main D/IA CM-3R should be installed in Slot 2, slot 3 should be left blank, the standby D/IB CM-3R should be installed in Slot 4, and the main D/IA CM-3R should be installed in Slot 5. Slots 6 through 18 are available for channel modules.

The following are recommended slot assignments in the Main Shelf for systems without redundancy:

1. In terminal multiplexers with T1 electrical interfaces or fiber optic interfaces, slot 1 should be left blank, the main CM-3R should be installed in slot 2, and slot 3 should be left blank. Slots 4 through 18 are available for channel modules.
2. In drop/insert multiplexers with T1 electrical interfaces or fiber optic interfaces, slot 1 should be left blank, the main D/IA CM-3R should be installed in Slot 2, slots 3 and 4 should be left blank, and the main D/IA CM-3R should be installed in Slot 5. Slots 6 through 18 are available for channel modules.



a. Terminal



b. Drop and Insert

Figure 2-6. Front view of main shelf

2.3.2 REPEATER SHELF

The Repeater Shelf is an enclosure that provides space for additional channel modules if the system requires more modules than the Main Shelf can accommodate. (See Figures 2-7 and 2-8)

The Repeater Shelf is the same size as the Main Shelf but contains no T1 Common Modules. The Repeater Shelf is connected to the Main Shelf by a signal cable between bus repeater modules. In most cases, the Repeater Shelf can be powered by the Main Shelf power supply through a separate power cable. The Repeater Shelf can be equipped with its own supplies, however, if the Main Shelf power supply does not have sufficient excess capacity. (See Section 5 to determine the power requirements of your system.)

Note that physical slots on the Main and Repeater Shelves do not have a one-to-one correspondence with 64 kbps time slots. For example, a wideband data channel module that occupies one physical slot could be set up to operate at 64 kbps and requires one time slot, or it could be set up to operate at 384 kbps and requires six time slots. Conversely, a channel module may use only one time slot but may require multiple physical slots, usually to accommodate interface connectors and circuits in the I/O module.

Installations containing multiple shelves are connected together with Bus Repeater Modules and signal cables. Refer to paragraph 5.5.2 for more information on the Bus Repeater Module.

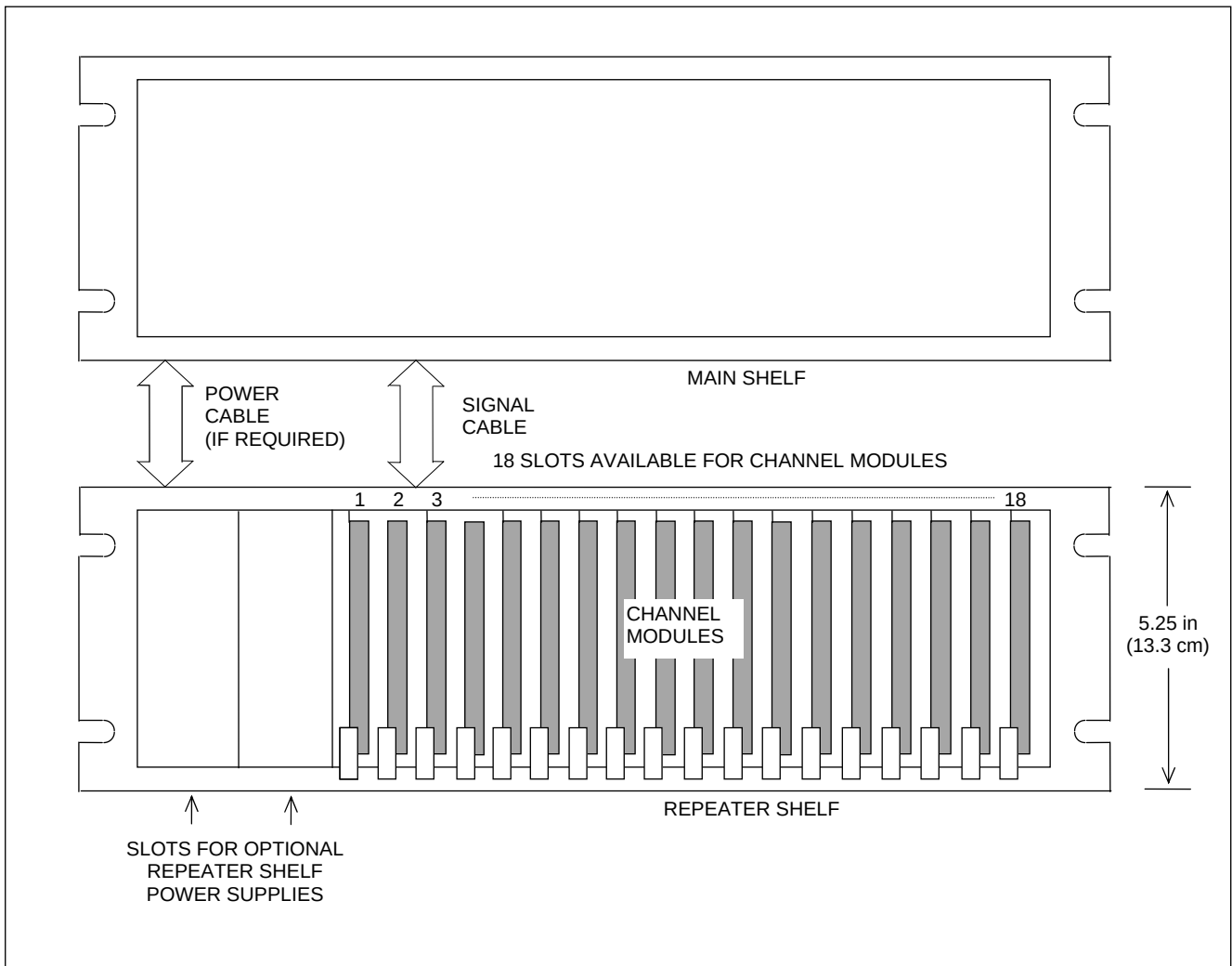


Figure 2-7. Front view of repeater shelf

All T1 Common Modules, channel modules, and power supplies plug into the front of the Main or Repeater Shelf. All power and signal input and output connections are on the rear of the shelf. All common module and channel module input/output connectors are on easy-to-install, rear-access Module Adapters. (See paragraph 2.3.8 for more information.)

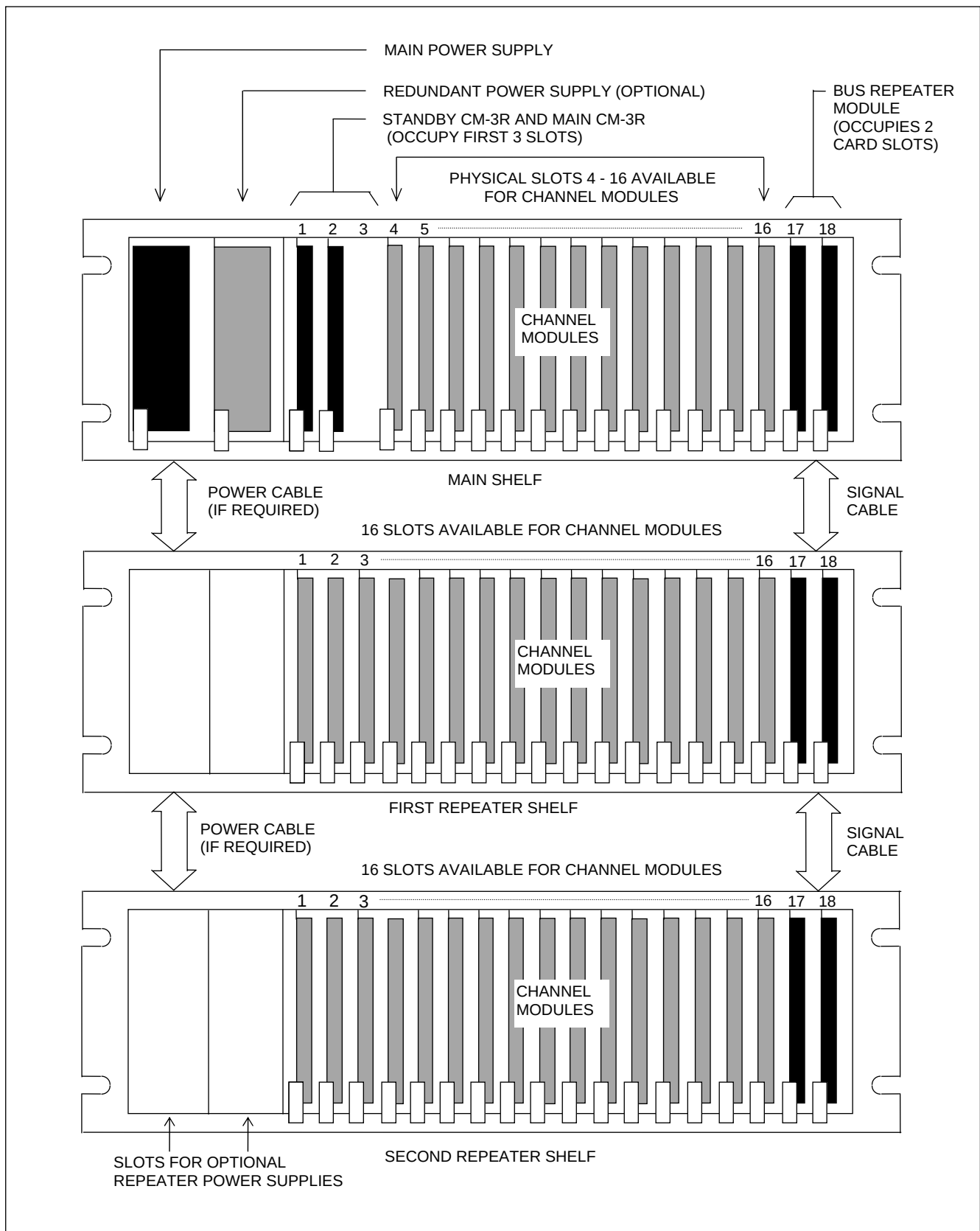


Figure 2-8. Front view of multiple repeater shelves

2.3.3 T1 COMMON MODULES

The T1 Common Module (CM-3R) is a microprocessor-controlled module that performs all of the T1 multiplexing and demultiplexing functions. It also provides the user interface, and may optionally provide other functions, such as an additional timing source. In non-redundant applications, each IMUX 2000 terminal multiplexer contains one CM-3R Common Module, while a drop/insert multiplexer contains two CM-3R Common Modules. In redundant applications, each IMUX 2000 terminal multiplexer contains two CM-3R Common Modules, while a drop/insert multiplexer contains four CM-3R Common Modules.

The CM-3R is the standard T1 Common Module for the IMUX 2000. It provides the following fifteen operational functions:

<u>CM-3R Operational Functions</u>	<u>See Paragraph</u>
1. T1 line receiver (input).	2.3.3.1
2. T1 line driver (output).	2.3.3.2
3. Demultiplexing of the T1 aggregate to individual channels.	2.3.3.3
4. Multiplexing of channels to form T1 aggregate.	2.3.3.4
5. Multiplexer/demultiplexer bus interface to channels.	2.3.3.5
6. Transmit timing functions.	2.3.3.6
7. Loopback configurations.	2.3.3.7
8. Microprocessor control	2.3.3.8
9. User interface.	2.3.3.9
10. Fast reframing channel.	2.3.3.10
11. ILS and DACS operation.	2.3.3.11
12. Sequence of events	2.3.3.12
13. Time and Date Settings	2.3.3.13
14. Download function	2.3.3.14
15. Network Management Communications	Section 7

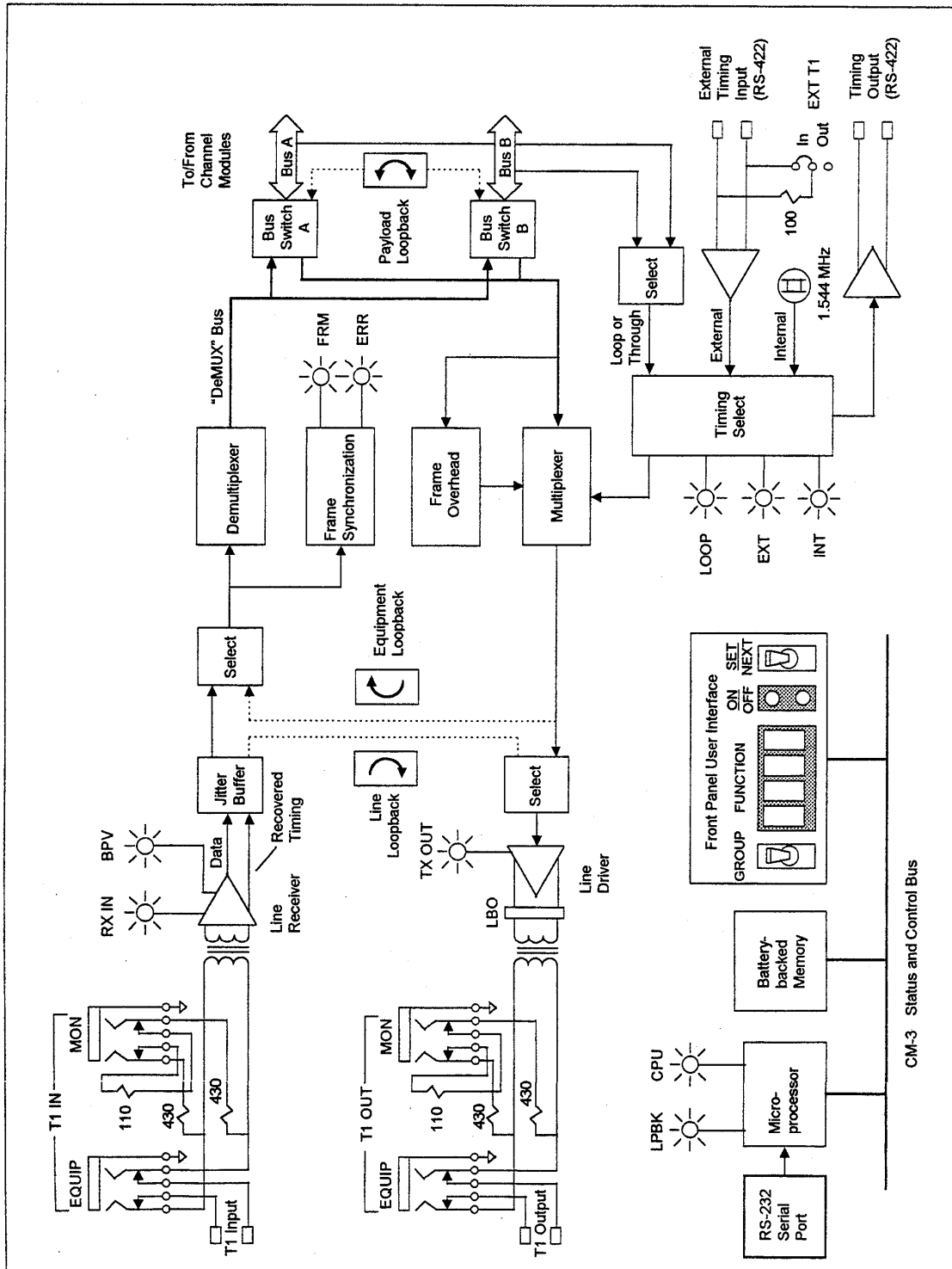


Figure 2-9. Functional diagram, CM-3R T1 Common Module

2.3.3.1 T1 Line Receiver

The CM-3R receives its T1 line input from a Module Adapter in multiplexers with electrical T1 interfaces, or from an OIA (optical interface adapter) in multiplexers with fiber optic T1 interfaces. The T1 format can be either ESF (Extended Superframe) or SF (D4 Superframe). (See Section 10 for more information on formats.) The line code can be either B8ZS (Bipolar with 8 Zero Substitution) or AMI (Alternate Mark Inversion).

Equipment and monitor test jacks on the front of the Common Module accept miniature bantam plugs. Plugging a T1 transmission test set or the output of another multiplexer into the "T1 EQUIP IN" jack breaks the connection to the incoming T1 line. The terminating impedance should be 100 ohms (balanced). The "T1 MON IN" jack permits test access to the line input without breaking the T1 line connection. Equipment connected to this jack should also provide a 100 ohm termination impedance. The signal level at this point is approximately 20 dB below the input.

The test jacks handle the T1 signal originating or terminating at the module on which they are located. In redundant applications, test equipment should be plugged into the jacks on the currently active CM-3R module in order to access the external signal. The inactive CM-3R module is looped onto itself, and therefore, its test jacks permit access only to the transmitter/receiver of that module.

The line receiver accepts the input signal, recovers receive timing, and decodes the bipolar signal. A jitter buffer follows, to smooth out the timing jitter usually present on an incoming signal.

2.3.3.2 T1 Line Driver

The T1 line output connection is made through a Module Adapter in multiplexers with electrical T1 interfaces, or from the OIA in multiplexers with fiber optic interfaces. The "T1 EQUIP OUT" and "T1 MON OUT" jacks function like the input test jacks described above. All equipment connected to them should provide 100 ohms of termination. The "T1 EQUIP OUT" jack breaks the connection to the T1 line output. The "T1 MON OUT" jack does not break the connection, but the signal level at this jack is about 20 dB below the output level.

In redundant applications, the test equipment should be attached to the currently active CM-3R module in order to observe the output of the shelf.

2.3.3.3 Demultiplexing Of The T1 Aggregate To Individual Channels

The decoded line receive signal feeds the demultiplexer circuitry where it achieves frame synchronization. The mean time to lose frame in the presence of a high random bit error rate (10^{-3}) exceeds several hours.

Once frame synchronization is achieved, the demultiplexer develops the proper demultiplexer bus signals and feeds them to all the channels cards plugged into the shelf. Bus signals include demultiplexed channel data, demultiplexer synchronization status, and synchronization signals necessary for proper decoding by the channel modules.

2.3.3.4 Multiplexing Of Channels To Form T1 Aggregate

The multiplexer develops backplane bus synchronization signals. The transmit section of each channel module synchronizes to these signals, and places its data onto the selected bus. The multiplexer then forms the aggregate signal, using the selected framing format (SF or ESF).

2.3.3.5 Multiplexer/Demultiplexer Bus Interface To Channels

The CM-3R uses tri-state bus drivers and receivers to permit routing the demultiplexer and multiplexer bus signals to either of two backplane buses (Bus A or Bus B). This versatile bus capability enables simple configuration of a multiplexer as either "terminal" or "drop/insert."

Bus A/B nomenclature is used to set channel modules to transmit and receive through a desired drop-and-insert port. In order to transmit out of drop-and-insert A, or out of a terminal shelf, a channel module is set to operate on Bus A. In order to transmit out of drop-and-insert B, a channel module is set to operate on Bus B. This can be seen in Figure 2-10.

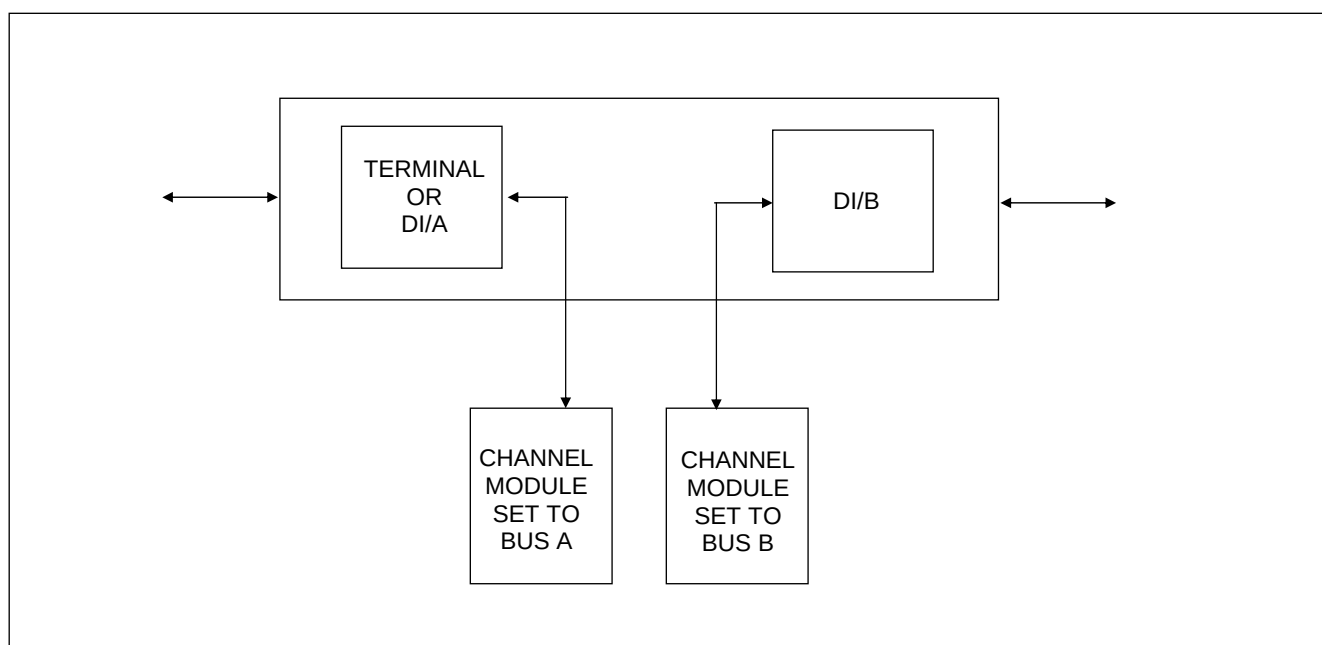


Figure 2-10. The meaning of Bus A and Bus B channel module settings.

2.3.3.6 Transmit Timing Functions

The CM-3R enables the selection of LOOP, INTERNAL, EXTERNAL, or THRU timing. In addition to primary timing, the CM-3R provides a fallback timing setting. Fallback timing takes effect automatically when conditions cause a loss of primary timing; for example, in case of frame loss when LOOP is the primary timing setting. Refer to Application Notes (Section 21) for suggested settings of fallback timing.

2.3.3.7 Loopback Configurations

The CM-3R provides three loopback options: Line, Payload, and Equipment.

LINE LOOPBACK

Line loopback is useful for testing the integrity of the transmission path and the T1 connections to the multiplexer. It takes the decoded T1 receive signal coming from the line receiver/jitter buffer, and loops it back to the T1 line driver input. Receive data also passes on to the demultiplexer.

PAYLOAD LOOPBACK

Payload loopback is useful for verifying the operation of the CM-3R up to the bus interface to the channel modules. Data also passes on to the receive side of the channel modules.

EQUIPMENT LOOPBACK

Equipment loopback is useful for testing individual channel modules in the multiplexer. It loops the transmit signals at the multiplexer output back to the demultiplexer input. During Equipment Loopback, the T1 output of the CM-3R is an ALL ONES signal.

2.3.3.8 Microprocessor Control

The CM-3R uses an 8-bit 80C320 microprocessor which controls the front-panel operator interface, remote interface, T1 communications and other system level functions. The microprocessor is supported by several peripheral chips which include nonvolatile RAM, a T1 transceiver chip, EEPROM, and an ACTEL custom programmable gate array.

2.3.3.9 User Interface

The CM-3R provides the user with the following two types of user interfaces: Front Panel Interface and RS-232 Interface. Each of these interfaces is described below.

Front Panel Interface - The CM-3R has switches and a four-character alphanumeric display on its front edge to enable the user to enter settings and display status information. Details on the operation of the Front Panel Interface appear in Section 4 of this manual.

RS-232 Interface - The IMUX 2000 multiplexer can be set up and monitored from a data terminal connected to its RS-232 port. This connection can be made locally at the controlled multiplexer shelf, or remotely at any other node of the T1 network. The remote connection utilizes a Facility Data Link (FDL) channel and is not available if the T1 link passes through a CSU interface. Details on the operation of the RS-232 Interface appear in Section 5 of this manual.

2.3.3.10 Fast Reframe Channel

Fast Reframe Channel is a function that can be selected by the user via toggle switches on the front panel of the CM-3R module, or via the NMS. This function can be either “on” or “off”. When off, the reframe time in SF mode is approximately 5 ms, and in ESF mode is approximately 10 ms. Reframe times given are for conditions going from AIS to valid data. When on, the reframe time is less than 500µs in both SF and ESF modes.

When Fast Reframe Channel is on, channel 24 of the T1 stream is devoted to monitoring the synchronization of the T1 data and that the data is being received correctly. It does this by sending a repetitive 8-bit pattern. If this pattern is not received correctly, loss of framing is indicated. The CM-3R module is able to detect this pattern and reframe the T1 data within the times specified in Table 2-1.

When Fast Reframe is set to off, the system is in normal reframing mode. Normal reframing mode is usually used for voice communications, however with data communications fast reframing is usually used.

Table 2-1. Reframe times in SF and ESF modes

Fast Reframe	Mode	
	SF	ESF
ON	< 500µs	< 500µs
OFF	≤ 10 ms	≤ 20 ms

2.3.3.11 ILS & DACS Operation

The CM-3R allows the user to configure ILS and/or DACS setup parameters and to monitor ILS and/or DACS operation. This is done by using the Network Management Software (NMS). The NMS is a software tool that must be loaded into the users PC which is then connected to the CM-3R via an RS-232 bus. The PC can be connected locally, or remotely via a modem.

See Section 3 for more information regarding the ILS, Section 4 for more information regarding the DACS and Section 8 for more information regarding the NMS.

2.3.3.12 Sequence of Events

The CM-3R module has an events buffer which maintains a log of the last forty events that have occurred. Event No.1 is always the most recent to occur. When the CM-3R logs an event, the event is stored in the events buffer. When the events buffer is full (40 events), the oldest events are deleted to make room for new events.

DACS and ILS diagnostic information will also be recorded for each event if a DACS or ILS is present in the system. The CM-3R software stores one event at the beginning of an alert or alarm, and a second event at the end. Each event is time tagged to milli-second resolution, and contains year, month, date, hour, minute, second and millisecond.

The Sequence of Events log records the following events:

Alarms:

- Receiver Out of Sync
- Channel Card Fail
- DACS Card Fail
- ILS Card Fail

Alerts:

- Power Supply/Redundant Power Supply
- Channel Card
- DACS Card
- ILS Card
- Line Loopback
- Payload Loopback
- Equipment Loopback
- Transmitter in Fallback Timing
- Receive Blue Alarm
- Receive Yellow Alarm
- Jitter Attenuator Limit Trip
- Receive Carrier Loss
- Transmit Yellow Alarm
- Redundant Alert
- Redundant Switch

T1 Clock Status:

- Transmitter Clock and Receiver Clock, Lock Status

Diagnostic Information:

CM-3R Diagnostics:

- Count of received blue alarm
- Count of received yellow alarm
- Count of received carrier loss
- Count of received loss of sync
- Count of received bipolar violation

Count of received bit error
Count of received multiframe out of sync

DACS/ILS Diagnostics:

DACS/ILS count of received blue alarm
DACS/ILS count of received yellow alarm
DACS/ILS count of received carrier loss
DACS/ILS count of received loss of sync
DACS/ILS count of received bipolar violation
DACS/ILS count of received elastic store slips
DACS/ILS count of received bit error
DACS/ILS count of received multiframe out of sync

The Sequence of Events log can be accessed by the user via the Network Management Software (See Section 6) or via the Simple Command Language (See Section 7).

2.3.3.13 Time and Date Settings

This function allows a user to set or read the time and date set in the CM-3R using the NMS or SCL commands. The CM-3R uses the time and date settings to time stamp events as they occur. See paragraph 2.3.3.12 and Section 7 for more information.

2.3.3.14 Download Function

The download function allows a user to update CM-3R application code by using PC2000.EXE application software. The application software must first be loaded into the PC. Run the application software by entering: C2000 /Cn, where n=port 1 or port 2. Then press F1 to display the help menu. Follow the instructions in the help menu to complete the download. Make sure that the CM-3R serial port is set to 19.2k baud, parity = space, and unlock, before initiating the download. Contact RFL customer service for more information.

2.3.4 COMMON MODULE INTERFACE ADAPTERS

Each CM-3R must be equipped with an interface adapter to connect it to the T1 network. There are two basic types of interface adapters; electrical interface adapters and optical interface adapters.

2.3.4.1 ELECTRICAL INTERFACE ADAPTERS

Electrical interface adapters are used to connect the IMUX 2000 electrically to a T1 network. There are six types of electrical interface adapters available. These are the MA-210, MA-215, MA-218, MA-210R and MA-215R. These are also referred to as module adapters, and are listed in Table 2-2. Also refer to Figures 2-11 through 2-16.

Table 2-2. Characteristics of IMUX 2000 Module Adapters

Connector	Module Adapter Application				
	MA-210 (non-redundant basic interface)	MA-215 (non-redundant with DACS/ILS interface)	MA-218 (non-redundant with CSU interface)	MA-210R ⁶ (redundant basic interface)	MA-215R ⁶ (redundant with DACS/ILS interface)
T1 I/O ¹	X	X		X	X
RS-232 ² or REMOTE	X	X	X	X	X
SCB ³		X			X
T1/CSU ⁴			X	X	X
EXT TMG ⁵			X	X	X

Notes:

1. T1/I/O connector is used for an electrical T1 interface.
2. RS-232 or Remote connector is used to configure the network or do performance monitoring of the network using a PC.
3. SCB connector is an external control port used to connect an ILS or DACS to the multiplexer.
4. T1/CSU connector is used to connect the multiplexer to a central office via a T1 line. It is used to send data through a telephone network.
5. EXT TMG connector is used to synchronize IMUX clocks with external equipment clocks.
6. These module adapters are used for redundant applications.

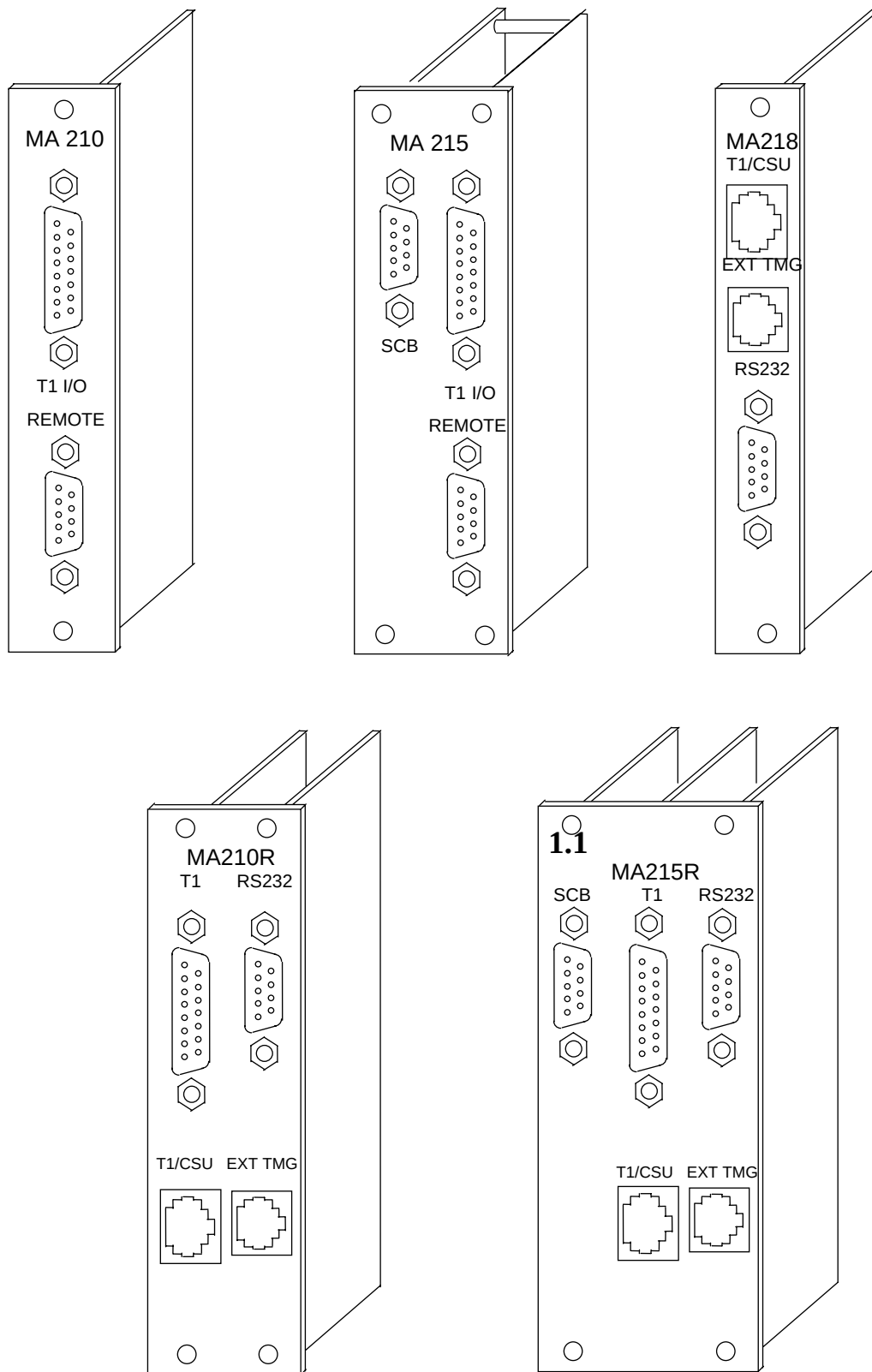
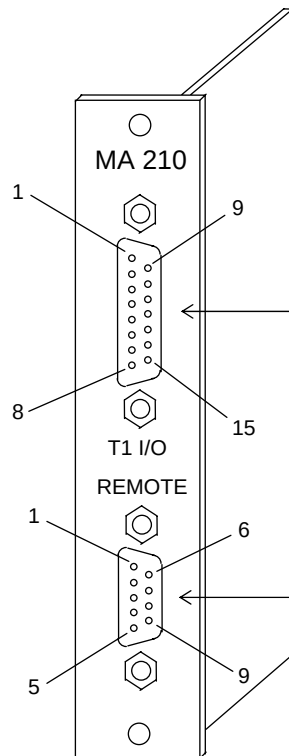


Figure 2-11. MA-210, MA-215, MA218, MA-210R and MA-215R Module Adapters, rear panel views.

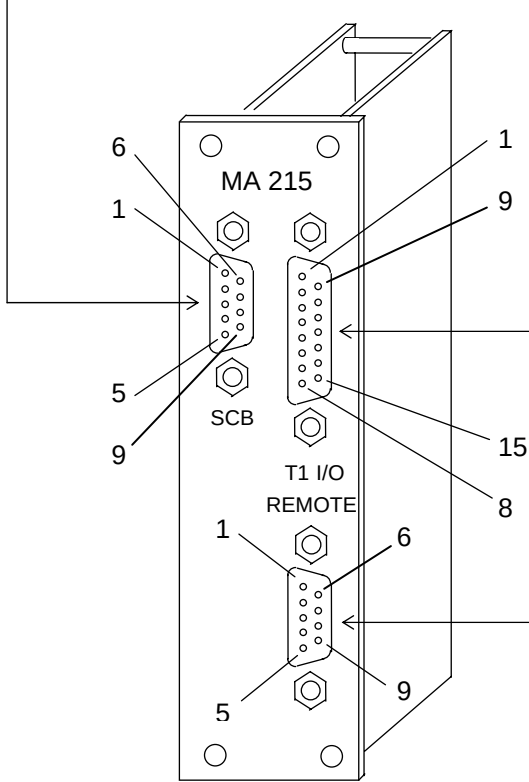


Pin	Function
1	T1 OUT-
2	AG3
3	T1 IN-
4	AG2
5	TIMOUT+
6	T1TIM IN+
7	GND
8	AG2
9	T1 OUT+
10	AG3
11	T1 IN+
12	TIMOUT-
13	T1TIM IN-
14	VRMTIM-
15	VRMTIM+

Pin	Function
1	-
2	RS232TXD
3	RS232RXD
4	-
5	GND
6	-
7	-
8	-
9	-

Figure 2-12. MA-210 pinouts

Pin	Function
1	GND
2	SCB DATA B
3	SCB CLOCK B
4	SCB STROBE B
5	GND
6	SCB DATA A
7	SCB CLOCK A
8	SCB STROBE A
9	SHIELD



Pin	Function
1	T1 OUT-
2	AG3
3	T1 IN-
4	AG2
5	TIMOUT+
6	T1TIM IN+
7	GND
8	AG2
9	T1 OUT+
10	AG3
11	T1 IN+
12	TIMOUT-
13	T1TIM IN-
14	VRMTIM-
15	VRMTIM+

Pin	Function
1	-
2	RS232TXD
3	RS232RXD
4	-
5	GND
6	-
7	-
8	-
9	-

Figure 2-13. MA-215 pinouts

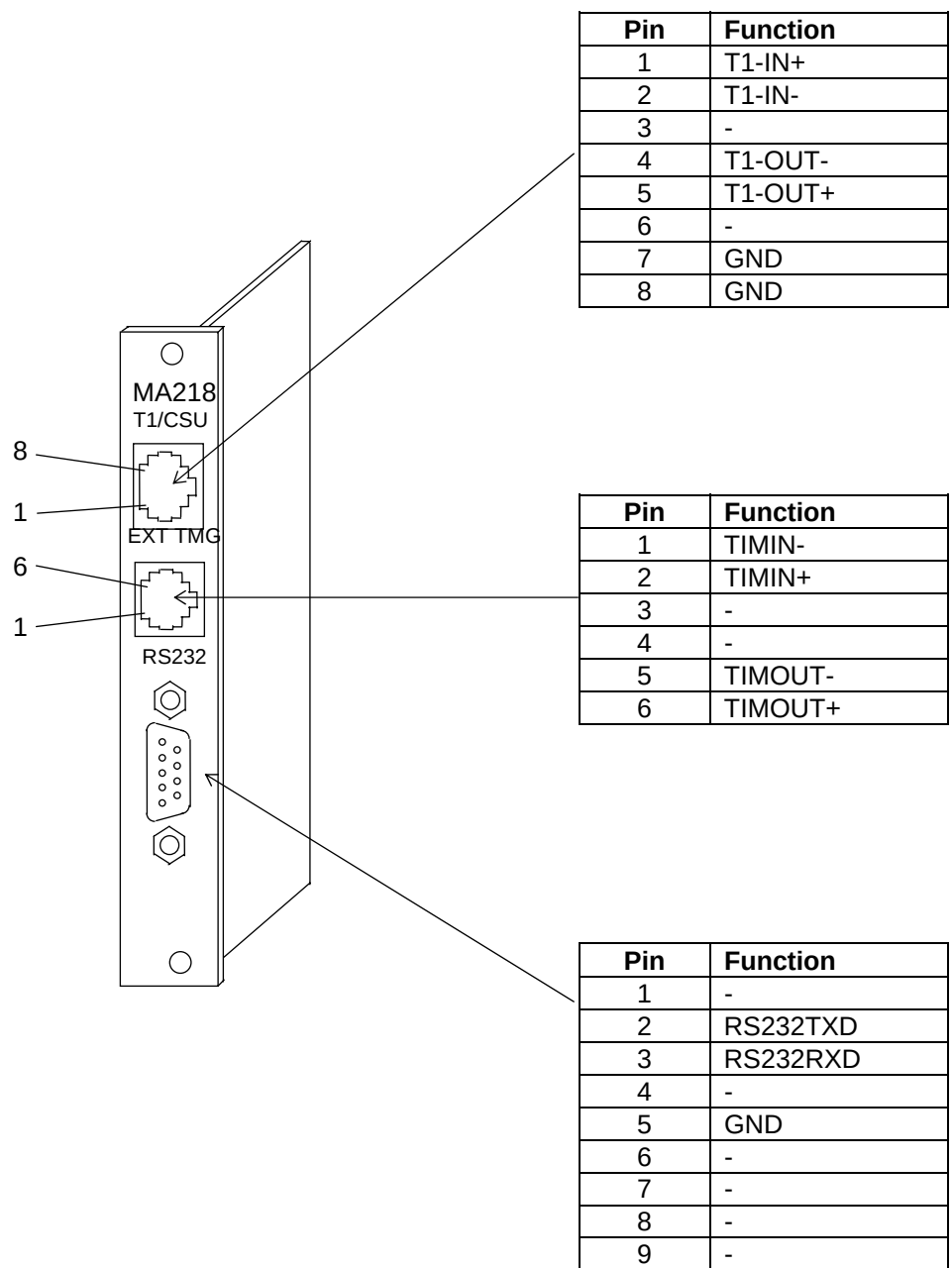


Figure 2-14. MA-218 pinouts

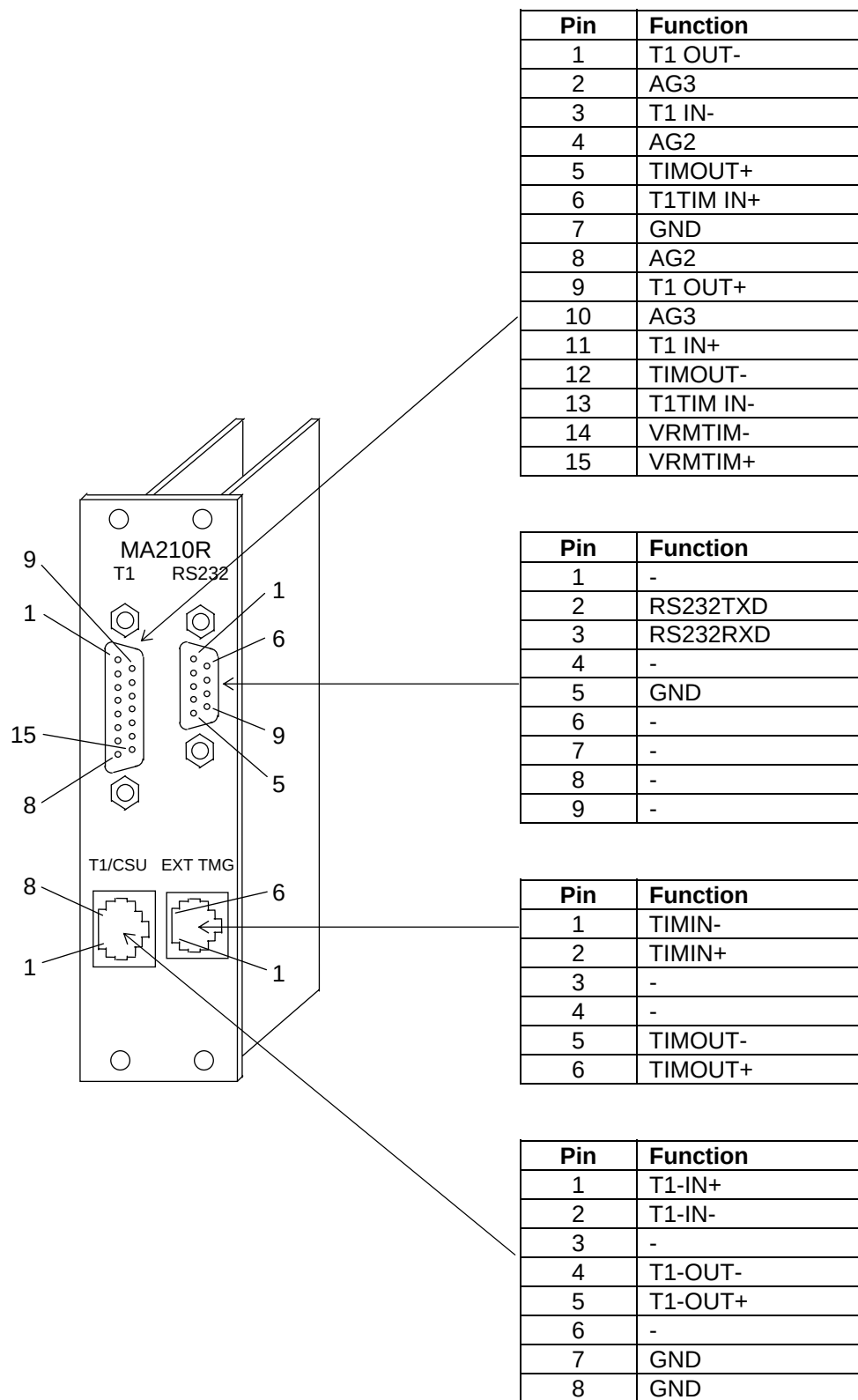


Figure 2-15. MA-210R pinouts

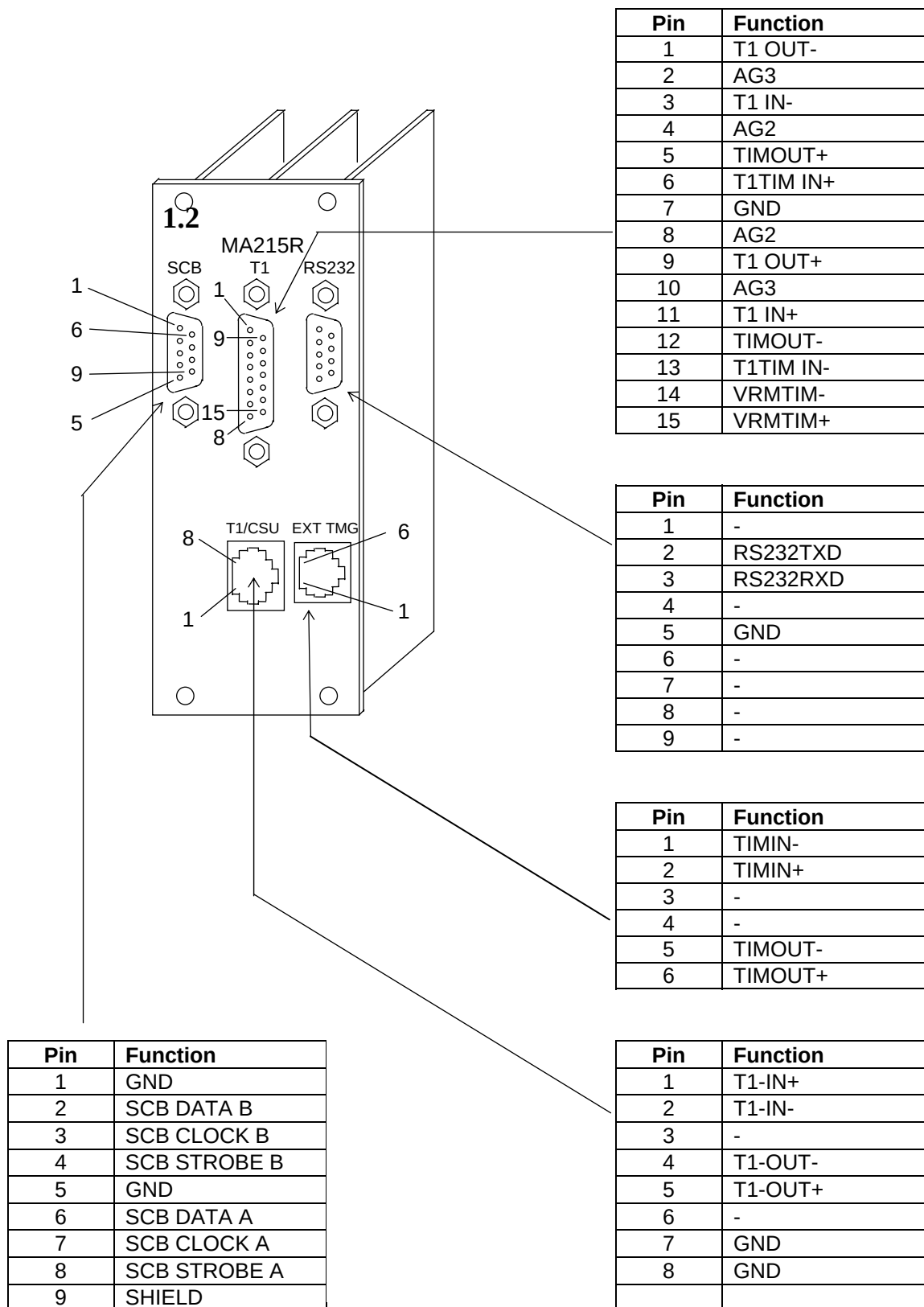


Figure 2-16. MA-215R pinouts

2.3.4.2 OPTICAL INTERFACE ADAPTERS (OIAs)

Optical interface adapters are used to connect the IMUX 2000 to a T1 network using fiber optic cables. There are ten types of optical interface adapters available. Five of them are used for non-redundant applications, and five are used for redundant applications as shown in Table 2-3. Also refer to Figures 2-17 and 2-18.

Table 2-3. Characteristics of IMUX 2000 Optical Interface Adapters

Model Designation	Part Number	Wavelength	Fiber Type	Light Source	Application
850-nm MM OIA	9547 1001	850 nm	Multimode	LED	Non-redundant
1300-nm SM OIA	9547 2001	1300 nm	Singlemode	LED	Non-redundant
1300-nm MM OIA	9547 3001	1300 nm	Multimode	LED	Non-redundant
1300-nm Laser OIA	9547 4001	1300 nm	Singlemode	Laser	Non-redundant
1550-nm Laser OIA	9547 5001	1550 nm	Singlemode	Laser	Non-redundant
850-nm MM OIA-R	9547 1011	850 nm	Multimode	LED	Redundant
1300-nm SM OIA-R	9547 2011	1300 nm	Singlemode	LED	Redundant
1300-nm MM OIA-R	9547 3011	1300 nm	Multimode	LED	Redundant
1300-nm Laser OIA-R	9547 4011	1300 nm	Singlemode	Laser	Redundant
1550-nm Laser OIA-R	9547 5011	1550 nm	Singlemode	Laser	Redundant

The non-redundant OIAs consist of two sub-assemblies; an Electronic Interface Board (EIB) and a Light Interface Board (LIB) which are mounted together to form one module as shown in Figure 2-17. Each board has a thirty pin female connector which mates with a corresponding connector on the chassis motherboard. The EIB has two customer interface connections; an RS-232 connector for remote configuration, and an external timing connector for external timing inputs. The (LIB) has fiber optic connectors for transmit and receive fiber optic cables. The (EIB) has a red “Alert” LED visible from the rear panel.

The redundant OIAs consist of three sub-assemblies; an Electronic Interface Board (EIB), a Light Interface Board (LIB), and a Redundant I/O Board (RI/O) which are mounted together to form one module as shown in Figure 2-18. Each board has a thirty pin female connector which mates with a corresponding connector on the chassis motherboard. The RI/O has two customer interface connections; an RS-232 connector for remote configuration, and an external timing connector for external timing inputs. The (LIB) has fiber optic connectors for transmit and receive fiber optic cables. The (EIB) has a red “Alert” LED visible from the rear panel.

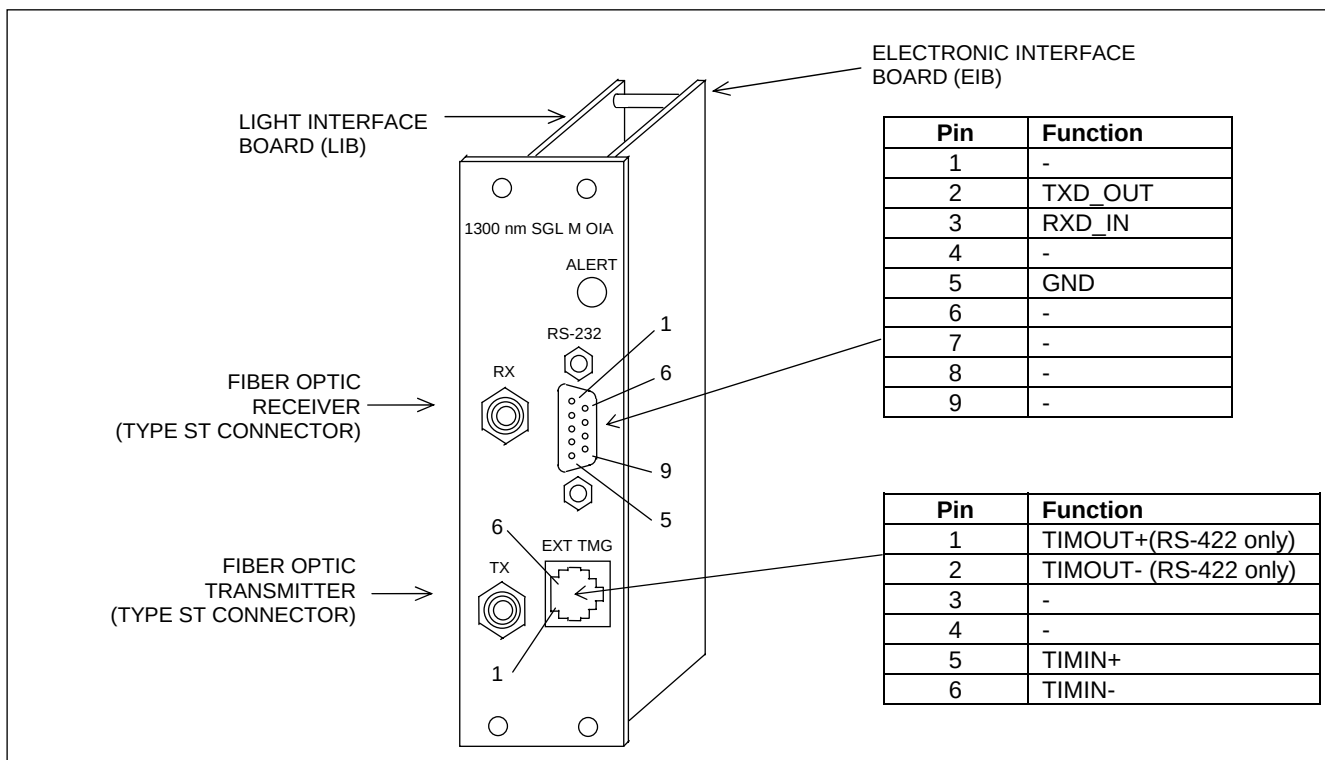


Figure 2-17. Typical Non-redundant Optical Interface Adapter (OIA), rear panel view

Notes:

1. The pinouts shown above are correct for early versions of OIA's
2. Newer non-redundant OIA's have pinouts as shown below, which are the same for redundant and non-redundant adapters

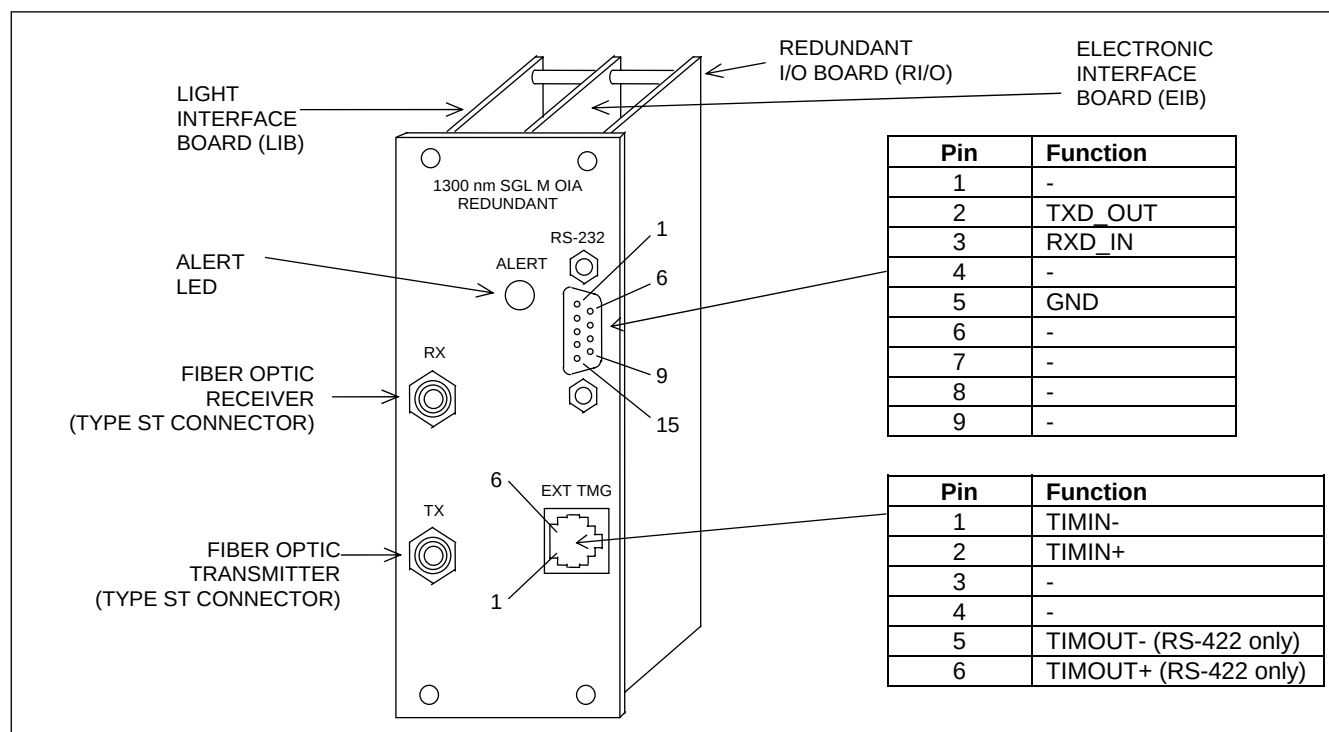


Figure 2-18. Typical Redundant Optical Interface Adapter (OIA), rear panel view

2.3.4.2.1 Electronic Interface Board (EIB)

The Electronic Interface Board (EIB) is an active module that connects to the IMUX 2000 Common Module through the chassis motherboard. Electrical connections to the LIB and RI/O are made through interlocking headers.

The transmit side of the EIB accepts the balanced T1 signal produced by the Common Module. It uses this signal to produce TTL data for modulating the light source on the LIB.

The receive side of the EIB accepts incoming data from the LIB. It recovers the timing, and then retimes and descrambles the data. The receive side also encodes the data with either B8ZS or AMI coding, and produces a balanced T1 signal that is fed to the receive side of the IMUX 2000 Common Module through the chassis motherboard.

2.3.4.2.2 Light Interface Board (LIB)

The Light Interface Board (LIB) contains an emitter section and a detector section. The emitter section accepts the TTL data produced by the EIB and uses it to modulate the light source. This modulated light output is then fed to a fiber optic cable for transmission to a remote IMUX 2000 multiplexer.

The detector section accepts a modulated light signal from an incoming fiber optic cable, and converts it to an electrical signal. This signal is then demodulated and converted into a TTL data signal. This signal is fed to the EIB for further processing to transform it into a replica of the T1 signal at the remote multiplexer.

During system operation, the LIB can generate the following alarms and pass them to the logic circuits on the EIB:

TXACT	TXACT is the activity monitored at the TTL data output at the point where the data is sent to the LIB.
TXALM	TXALM is an alarm generated by the LIB if the outgoing light level falls below a set limit.
LOCK	LOCK is an indication that the VCO has locked onto the incoming data. When this alarm is active, the data output to the Common Module is set to all zeroes. This occurs in both the B8ZS and AMI modes.

If any of these alarms is active, the ALERT indicator on the EIB will light.

2.3.4.2.3 Redundant I/O Board (RI/O)

The Redundant I/O Board has a miniature RJ-11C 6-position jack which provides an EXTERNAL TIMING interface at the rear panel. The external timing input can either be a 1.544MHz T1 or EIA-422 signal. Jumpers J10-13 on the CM-3R module determine the type of input required. External output timing is always present at the connector as an EIA-422 signal. Note that only the active CM-3R can receive input or provide output timing. The external input and output signals are surge protected.

A male DB9 connector provides an RS-232 interface at the rear panel. The RS-232 input signal makes a direct connection to both the Main and Standby CM-3R modules at all times. The RS-232 output signal is only possible by the active CM-3R.

2.3.5 POWER SUPPLY MODULES

IMUX 2000 multiplexers can be configured with five different power supplies that can operate with the following input voltages: 120 Vac, 220 Vac, 24 Vdc, 48 to 125 Vdc, or 250 Vdc. (The specifications listed in Section 11 of this manual provide more information on power supply input voltage ranges, input fuse requirements, and output power ratings.) The Main Shelf can contain one or two power supplies with the same capacity. A functional block diagram of the IMUX 2000 Power Supply and the Power Supply Alarm I/O module appears in Figure 2-19.

The first power supply inserts into the "P.S. MAIN" slot. The second optional power supply inserts into the "P.S. REDUNDANT" slot. As configured at the factory, all Main Shelves can be powered by one power supply module. The second power module, if installed, provides power supply redundancy; if the main power supply fails, the redundant supply automatically comes on-line, with no loss of transmission.

If you are adding modules to an existing system equipped with dual power supplies, always verify that total power consumption does not exceed the capacity of a single supply. This will insure power supply redundancy. (See Section 5 for more information.)

Channel modules on the optional Repeater Shelf receive power from the Main Shelf supply through the Repeater Shelf Power Cable. However, if the Main Shelf supply does not have sufficient excess capacity, the Repeater Shelf can contain its own power supply. Like the Main Shelf, the Repeater Shelf can contain a second supply with equal capacity for power supply redundancy.

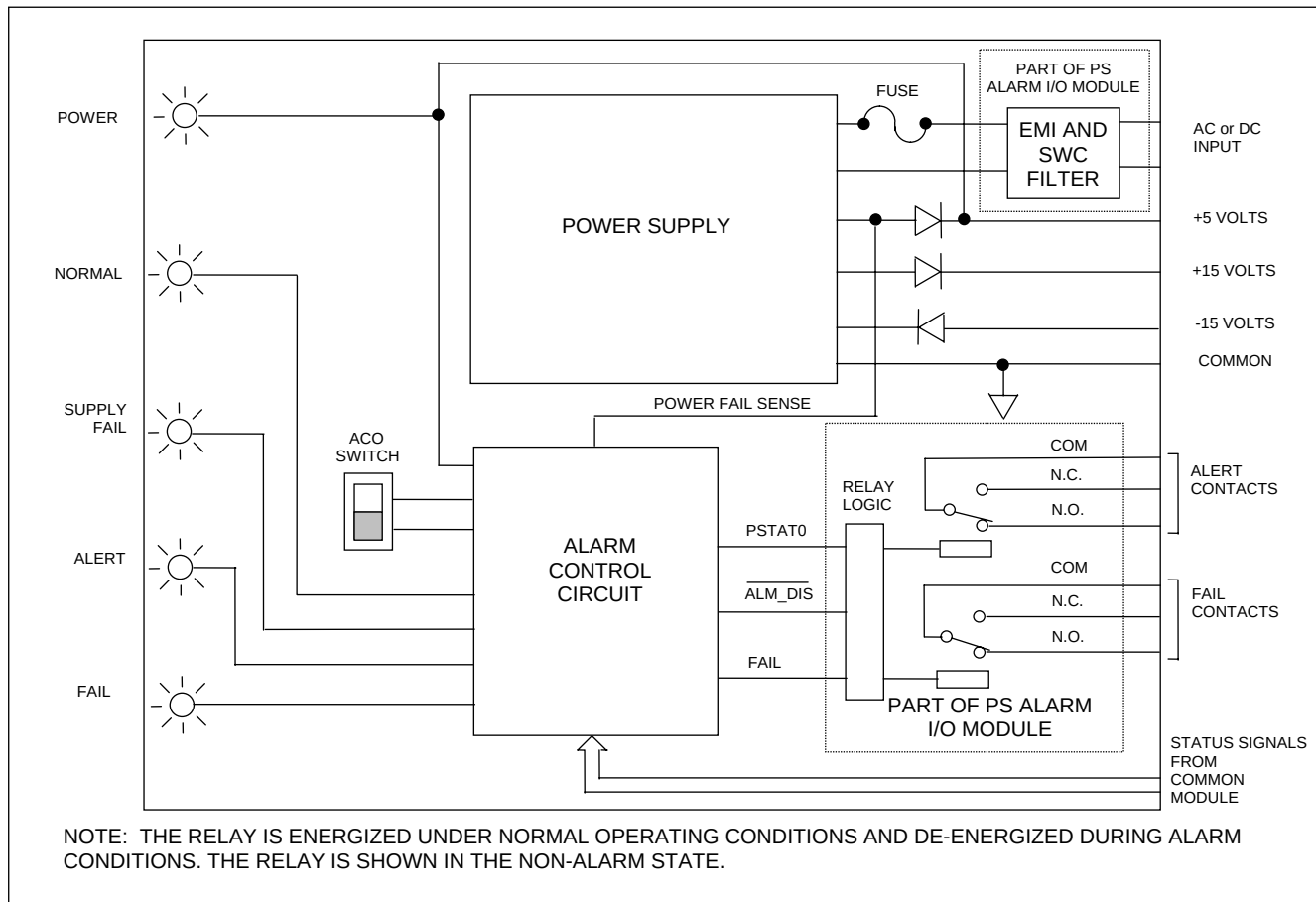


Figure 2-19. Functional diagram, IMUX 2000 Power Supply and Power Supply Alarm I/O module

2.3.6 POWER SUPPLY ALARM I/O MODULE

There are six types of Power Supply Alarm I/O modules that can be used with the IMUX 2000 Multiplexer chassis. These modules can also be used in the ILS and DACS chassis if required. Some of the characteristics of these modules are listed in Table 2-4. A rear panel view of the 9547-18801 Power Supply Alarm I/O module is shown in Figure 2-20.

Table 2-4. Characteristics of Power Supply Alarm I/O modules

Nomenclature	RFL Part No.	Application⁽¹⁾
PS Alarm I/O DC	9547-18801	Used in MUX, ILS or DACS chassis equipped with 250 Vdc power supplies.
PS Alarm I/O AC	9547-18802	Used in MUX, ILS or DACS chassis equipped with 120 Vac power supplies.
PS Alarm I/O 48/125DC	9547-18804	Used in MUX, ILS or DACS chassis equipped with 48/125 Vdc power supplies.
PS Alarm I/O 88/265DC	9547-18805	Used in MUX, ILS or DACS chassis equipped with 220 Vac power supplies.
PS Alarm I/O Hybrid	9547-18806	Used in MUX, ILS or DACS chassis equipped with a mix of ac and dc power supplies.
PS Alarm I/O 24DC	9547-18807	Used in MUX, ILS or DACS chassis equipped with 24 Vdc, power supplies.

NOTE 1. Only one Power Supply Alarm I/O module is used per chassis, and only when power supplies are used.

The Power Supply Alarm I/O module consists of an EMI filter, an SWC filter, relay logic, an alert relay and a fail relay. These components can be seen in Figure 2-19, which also includes the power supply module and the system status indicators that are associated with the IMUX 2000. These indicators and relays respond to fault conditions on Common Modules, channel modules, or the power supply module itself.

When a Main Shelf is equipped with a main power supply and a redundant power supply it will have only one Power Supply Alarm I/O module. The relays on the Power Supply Alarm I/O module will respond to alarm and alert conditions from both power supply modules. This insures that Fail and/or Alert monitoring continues even if one or the other supply is removed. Note that because the corresponding relay contacts on the Main and Redundant supplies are connected in parallel, the ACO switches on both must be switched “on” to activate the alarm cut-off, and both must be switched “off” to de-activate the alarm cut-off.

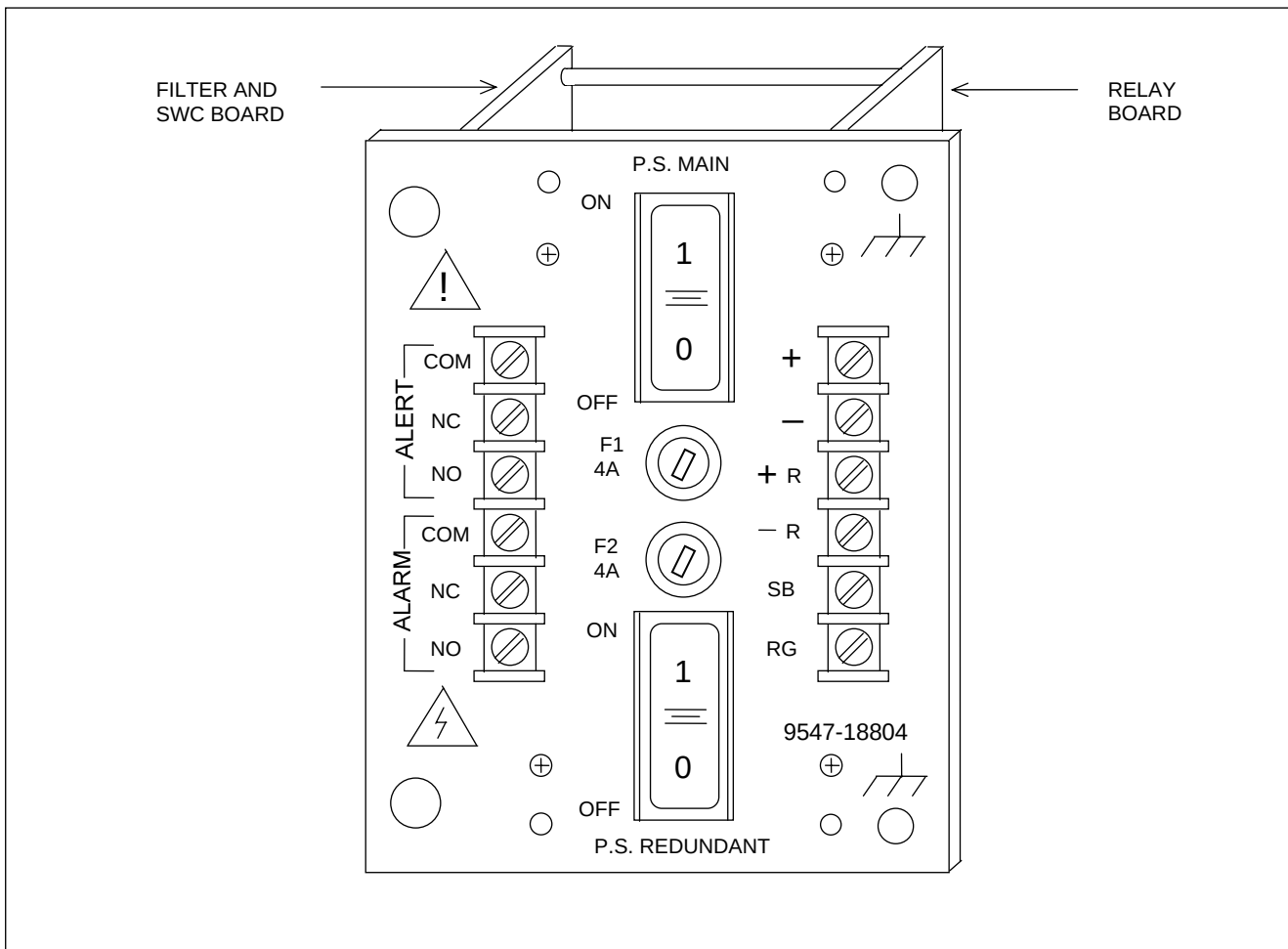


Figure 2-20. Typical Power Supply Alarm I/O module, rear panel view

2.3.7 CHANNEL MODULES

All payload circuits connect to IMUX 2000 multiplexers through channel modules. RFL offers a family of channel modules that support a wide range of circuit types: voice, synchronous and asynchronous data, polling data, office-end/station end, and time slot access. A more detailed discussion of channel module features and a summary of IMUX 2000 channel module configuration guidelines appear in Section 5 of this manual. Instruction Data sheets for all IMUX 2000 channel modules appear in Sections 15 through 18 of this manual.

2.3.8 MODULE ADAPTERS

Each channel module must be used with a Module Adapter, either its own or one that is shared with another channel module. Both the Main and Repeater shelves provide 18 rear-access Module Adapter slots, one corresponding to each of the 18 front-access module slots. All IMUX 2000 Module Adapters have the same connector on their front edge to mate with the back plane. However, different Module Adapters have different rear edge connectors, providing a variety of interfaces. (See Figure 2-21.)

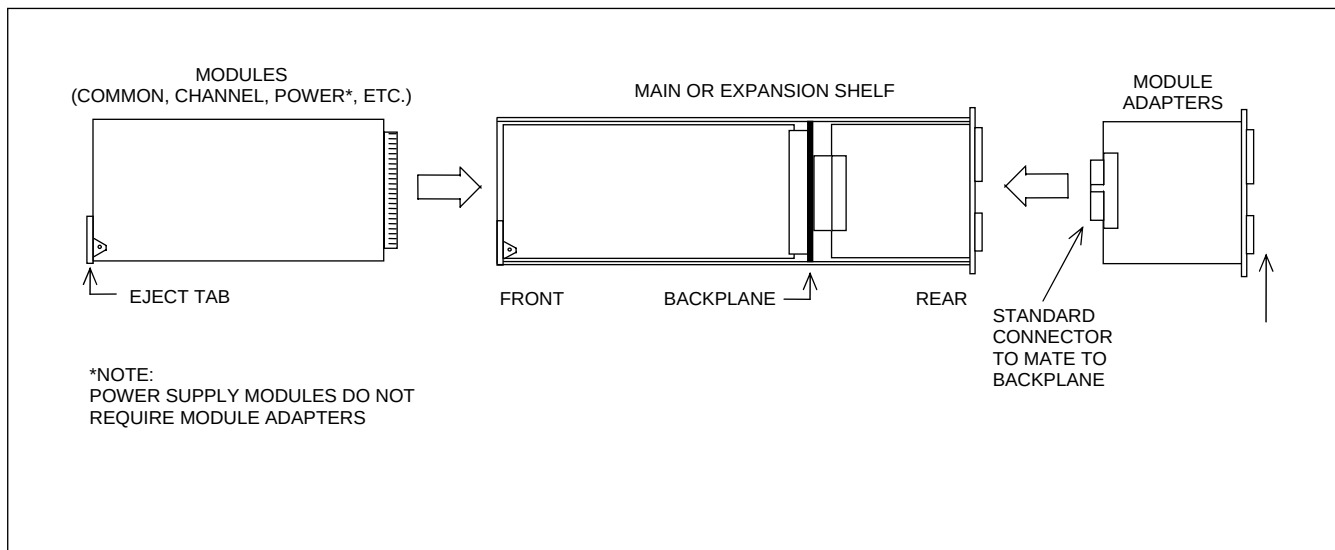


Figure 2-21. Side view of Main or Repeater shelf, showing insertion of modules and Module Adapters

2.4 MULTIPLEXER, FRONT-PANEL SWITCHES, INDICATORS, AND JACKS

Figure 2-22 is a front view of the IMUX 2000 terminal multiplexer with its front door open. A drop/insert multiplexer will look the same, except for the addition of a second CM-3R Common Module. The main power supply module and the T1 common module are expanded to show the location of all front panel switches, indicators, and jacks. Functional descriptions of these switches, indicators, and jacks appear in Tables 2-5 through 2-14. The numbers in the call-out columns of these tables refer to the call-outs shown in Figure 2-22.

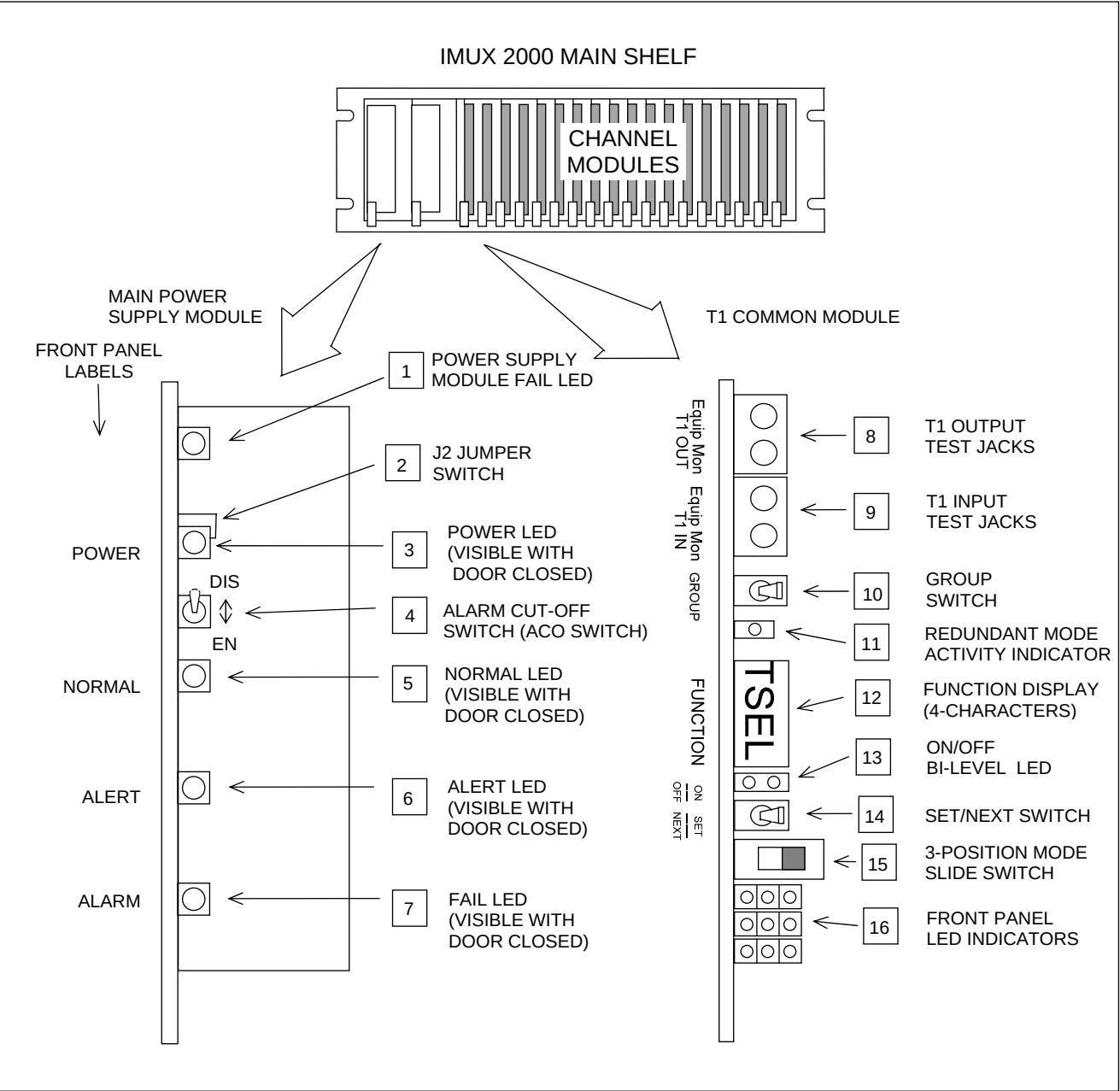


Figure 2-22. Multiplexer Front-panel switches, indicators, and jacks

2.4.1 SYSTEM STATUS INDICATORS AND THE ACO SWITCH

When the IMUX 2000 Main Shelf front door is closed, four LED indicators are visible. These LEDs are labeled: POWER, NORMAL, ALERT, and ALARM, as shown in Figure 2-23, and indicate the operational status of the multiplexer at a glance. Table 2-5 gives a description of these indicators and also includes a description of the power supply fail indicator and the alarm cutoff switch.

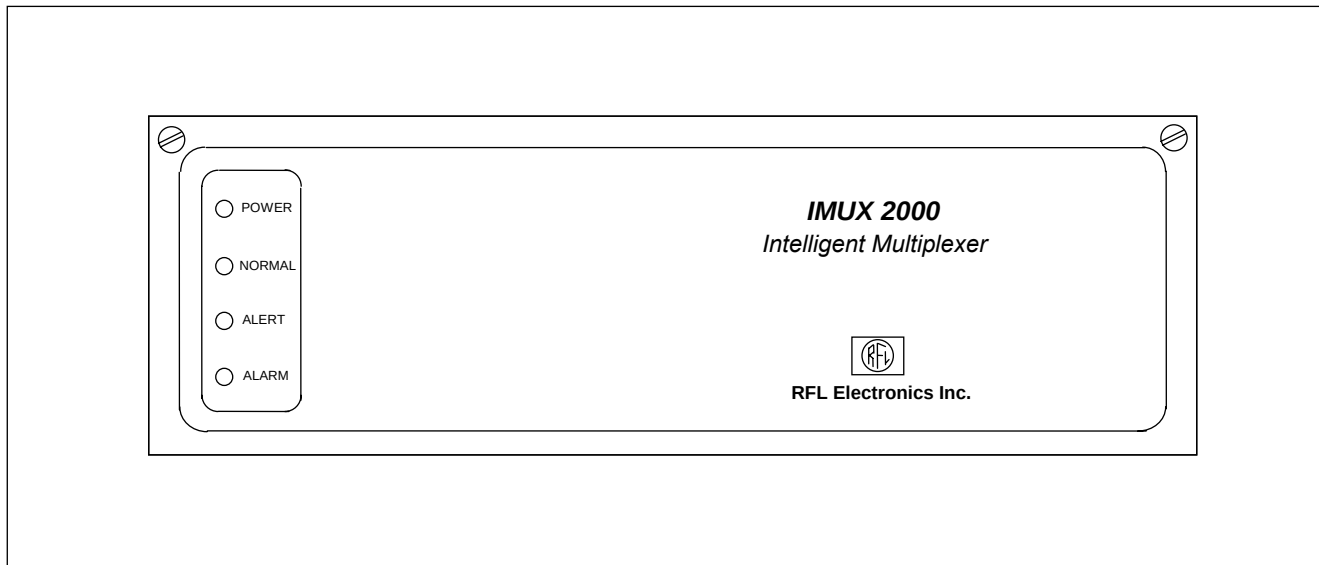


Figure 2-23. Front view of main shelf with door closed, showing the system status indicators

Table 2-5. System status indicators and the ACO switch

Item (Fig. 2-22)	Module	Module Label	Multiplexer Front Panel Label	Description
1	Power supply	PS	- - -	Power Supply Module Fail LED. Lights when power supply module has failed.
2	Power supply	J2	- - -	2-Position Jumper Switch J2 ⁽³⁾ A = Down: Normal factory setting. B = Up: Set this position to enable Alarm when Common Module is removed or not engaged correctly.
3	Power supply	PWR	POWER	Power LED. Lights when the multiplexer is powered. If the multiplexer is equipped with a redundant power supply, this indicator will remain on if one of the power supplies has failed and the remaining supply has enough capacity to power the multiplexer by itself.
4	Power supply	DIS/EN	- - -	Alarm Cut-Off Switch (Disable/Enable). When this switch is in the Disabled position and no alarms are active, the alert indicator will light. When this switch is in the Enabled position the ALERT and ALARM relays are on line and will activate in response to system fault conditions. NOTE: If the multiplexer contains two power supply modules, the ACO switches on <u>both</u> power supply modules must be placed in the DIS position to disable the ALERT and FAIL relays.
5	Power supply	NORM	NORMAL	Normal LED. Lights when neither an ALERT or an ALARM condition exists.
6	Power supply	ALERT	ALERT	Alert LED. Lights when one or more of the following conditions exists: ⁽¹⁾ EXCESSIVELY LOW RECEIVE SIGNAL (RX IN indicator off) REC YELLOW ALARM (RX IN indicator blinking) LOOPBACK ACTIVATED (LPBK indicator on) FALLBACK TIMING ACTIVATED (The TIMING indicator for the programmed timing mode will be blinking) SINGLE POWER SUPPLY FAILURE (when two power supplies are installed) ACO ON
7	Power supply	FAIL	ALARM	Fail LED. Lights when one or more of the following conditions exists: ⁽²⁾ CPU FAILED (CPU indicator on) SIGNAL PRESENT BUT OUT-OF-FRAME (RX IN and FRM indicators on) NO TRANSMIT OUTPUT (TX OUT indicator off)

1. An unframed "all ones" is a T1 Alarm Indication Signal (AIS).
2. This indicator also lights briefly at power-on.
3. Effective March 06 for Motherboard 105590-1 Rev H and up.

2.4.2 T1 TEST JACKS

Each CM-3R has two pairs of bantam jacks (**T1 IN** and **T1 OUT**) to provide test access to the T1 input and output signals. Each pair consists of one equipment (**EQUIP**) jack and one monitor (**MON**) jack.

The two **EQUIP** jacks are used for out-of-service testing. The two **MON** jacks are designed for in-service testing, so they are equipped with isolation resistors. Because of these resistors, the T1 signals received and transmitted by the multiplexer can be monitored without significantly affecting their levels. When terminated by 100 ohms, the signal level at the output of each **MON** jack, is about 20 dB below that of the corresponding T1 input or output signal. T1 test sets are designed to automatically adjust for this attenuation when operated in their monitor (MON) mode.

Table 2-6 summarizes the functions of these jacks.

Table 2-6. T1 test and monitor bantam jacks

Item (Fig. 2-22)	Module	Label	Description
8	CM-3R	T1 OUT EQUIP	Provides out-of-service test access to the CM-3R's T1 output. When in use, this jack disconnects the CM-3R's T1 transmitter from the T1 I/O connector on its MA-210R Module Adapter.
		T1 OUT MON	Used for in-service, non-intrusive (resistor-isolated) monitoring of the CM-3R's T1 output.
9	CM-3R	T1 IN EQUIP	Provides out-of-service test access to the T1 signal received by the CM-3R. When in use, this jack disconnects the CM-3R's T1 receiver from the T1 I/O connector on its MA-210R Module Adapter.
		T1 IN MON	Used for in-service, non-intrusive (resistor-isolated) monitoring of the T1 signal received by the CM-3R.

NOTE

In redundant applications, test equipment should be connected to the jacks of the currently active common module. The inactive module is looped onto itself and its test jacks provide access only to that looped-back signal.

2.4.3 INDICATORS AND TOGGLE SWITCHES USED TO DISPLAY AND SET T1 COMMON MODULE FUNCTIONS

Table 2-7 describes the controls and indicators which display and set CM-3R setup and status functions. Table 2-8 lists CM-3R functions, organized by group. Table 2-9 lists CM-3R Supplementary Functions, organized by group. Figure 2-24 is an overview of all CM-3R groups and functions. (Section 6 of this manual contains detailed instructions on using CM-3R functions.)

Table 2-7. Indicators and toggle switches used to display and set T1 Common Module functions

Item (Fig. 2-22)	Module	Label	Description
10	CM-3R	GROUP	This toggle switch selects a CM-3R function group . (See Section 6.)
11	CM-3R	- - -	Redundant mode activity indicator
12	CM-3R	FUNCTION	This four-character alphanumeric display lists CM-3R function group names and individual function names. (See Tables 2-8 and 2-9)
13	CM-3R	ON/OFF	This bi-level indicator shows the status of the currently-displayed function. The green portion will light if the function is on or has been set. The red portion will light if the function is off or has not been set.
14	CM-3R	SET/NEXT	This toggle switch displays and sets CM-3R function groups .
15	CM-3R	- - -	3-position "MODE" slide switch

NOTE: When you are facing the front of the multiplexer, each toggle switch's "up" position is to the right, and its "down" position is to the left.

Table 2-8. T1 Common Module Standard groups and functions

Group Name	Group Description	Function Name	Function Description
TIME	Transmitter timing mode set-up functions	Loop (1)	Loop timing.
		Int (1)	Internal timing.
		Ext (1) (2)	External timing.
		Thru (2)	Through timing.
TSEL	T1 Set-up functions	SF	Superframe format.
		ESF	Extended Superframe format.
		AMI	Alternate Mark Inversion.
		B8ZS	Bipolar with 8-Zero Substitution.
		RFL	Not CSU mode
		ANSI	ANSI CSU mode
		ATT	AT&T CSU mode
LPBK	T1 loopback setup functions.	LnLB	Line loopback.
		PaLB	Payload loopback.
		EqLB	Equipment loopback.
BLNK	Blink status functions (Reasons for blinking RX IN LED or transmit timing LEDs) (See Tables 2-9 & 2-10 for more details)	RxYl	Receiving yellow alarm.
		Rx1l	Receiving all unframed ones.
		FTIM	Fallback timing is in effect.
		XsJt	Excessive jitter (buffer depth exceeded).
RVU1	Review 1 status functions (See Tables 2-9 & 2-10 for more details)	TxRx	Transmit and receive bus clock lock status.
		RcLs	Receiver carrier loss.
		XsJt	Excessive jitter.
DIAG	Diagnostic functions.	T1	Current T1 mode.
		#.##	Common module firmware revision.
		Fcty	When set, returns Common Module to factory-default setup (Int, ESF, B8ZS).
ADDR	Multiplexer address	ddd	A three-digit number (001 to 500). Note: Node address 0 and 78 are reserved for system use.
SIO	Remote port serial parameters	BAUD	Baud rate; 110 bps to 57.6 kbps.
		PAR	Parity; Mark, Space, Even, or Odd.
		Lock	Lock Locks/unlocks the remote port.
		Univ	Universal addressing
FAST	Fast Reframing	Disa	Disable fast reframe
		Enab	Enable fast reframe
MAIN	Main module forced-switch configuration parameters	Off	Force to report an on-board trouble
		On	Do not force to report an on-board trouble
SWCH	Standby module forced-switch configuration parameters	Auto	Allow automatic switch operation
		Main	Activate main module
		Stby	Activate standby module
SQEL	RDATA Squelch setup function	PRSQ	Pre-squelch timer (0ms, 0.66ms, 1.3ms, 2.0ms, 2.7ms, 3.3ms, 4.0ms, 4.6ms, 5.3ms, 6.0ms, 6.6ms, 7.3ms, 8.0ms, 8.6ms, 9.3ms) or DISA
		POSQ	Post-squelch timer (0ms, 0.66ms, 1.3ms, 2.0ms, 2.7ms, 3.3ms, 4.0ms, 4.6ms, 5.3ms, 6.0ms, 6.6ms, 7.3ms, 8.0ms, 8.6ms, 9.3ms) or DISA
SAVE	Configuration parameters storage options	NRAM	Stores configuration parameters into non-volatile RAM
		FLSH	Stores configuration parameters into FLASH memory

Notes: (1) Active on terminal multiplexers only. (2) Active on drop/insert multiplexers only.

Table 2-9. T1 Common Module Supplementary groups and functions

Group Name	Group Description	Function Name	Function Description
FTIM	Fallback Timing	FLoo	Set fallback timing Loop
		FInt	Set fallback timing to Internal
		FExt	Set fallback timing to External
		FThru	Set fallback timing to Through
		exit	exit
JBUF	Jitter Buffer	Joff	No jitter buffer
		J32	Set jitter buffer to 32 bits
		J128	Set jitter buffer to 128 bits
		exit	exit
TLBO	T1 Line Build Out	DSX	DSX standard (0 to 133 feet)
		200'	133 to 266 feet
		333'	266 to 399 feet
		467'	399 to 533 feet
		595'	533 to 655 feet
		-7.5	-7.5 dB
		-15	-15 dB
		-22	-22.5 dB
		exit	exit
TXYL	T1 Yellow Alarm	off	Yellow alarm off
		on	Yellow alarm on
		Auto	Automatic activate
		exit	exit
Rfrm	Reset framer chip	NA	NA
Rcht	Reset channel configuration table	NA	NA
Rcpu	Reset cpu	NA	NA

Table 2-10. T1 receive status functions

Group	Function	Description
BLNK	RxYl	Received Yellow. When included in the BLNK group, indicates that a Yellow Alarm Signal is detected at the T1 input.
	Rx1l	Received All Ones. When included in the BLNK group, indicates that an All-Ones Signal (framed or unframed) is detected at the T1 input.
	XsJt	Excessive Jitter. When included in the BLNK group, indicates that the receiver jitter buffer has overflowed. This may indicate that the receive signal contains excessive jitter.
RVU1	RcLs	Receiver Carrier Loss. When the Receiver Carrier Loss function is displayed, the bi-level ON/OFF indicator will light to indicate the status of the T1 receiver carrier: GREEN (top lit): The receiver has not lost carrier. RED (bottom lit): The receiver has lost carrier.

Table 2-11. T1 timing status functions

Group	Function	Description
BLNK	FTIM	Fallback Timing. When included in the BLNK group, indicates that the transmitter is in its fallback timing mode.
RVU1	TxRx	Transmit/Receive Lock. When the Transmit/Receive Lock function is displayed, the bi-level ON/OFF indicator will show whether the transmitter timing is synchronized to the incoming T1 signal timing: GREEN (top lit): The transmitter and receiver timing clocks are locked. RED (bottom lit): The transmitter and receiver timing clocks are not locked. If the two halves of the ON/OFF indicator are toggling on and off, the clocks are not locked, but their frequencies are close. Each flash of the bottom half of the ON/OFF indicator corresponds to a relative phase change of one T1 Unit Interval (UI), or 648 ns. (Some T1 test set manufacturers refer to a relative phase change of 1 UI as a "bit slip.") this function to be off. However, when any other timing mode is in use (Ext, Thru, or Loop), it is normal for the TxLk function to be on and a fault condition is indicated when it is off.

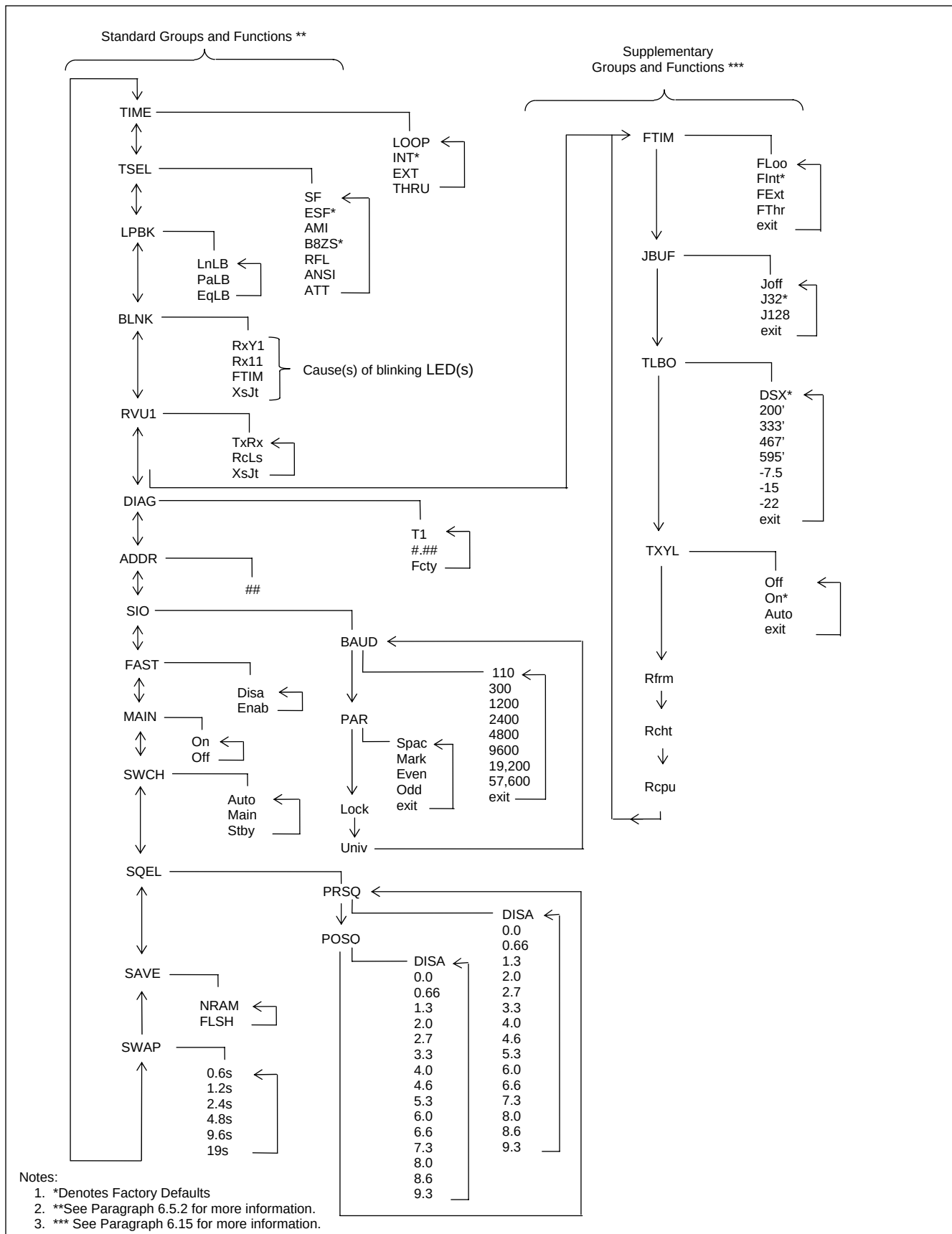


Figure 2-24. Overview of CM-3R Groups and Functions

2.4.4 FRONT PANEL LED INDICATORS

2.4.4.1 LOOP, INT and EXT INDICATORS

The CM-3R timing source selected by the user is called the **primary** timing source. Common modules set up for External, Looped, or Through timing also have a **fallback** timing mode. Upon loss of primary timing, they undergo a smooth, carefully controlled switch to Internal timing. (For more information, see the "**SETTING T1 TRANSMITTER TIMING**" paragraph in Section 6 of this manual).

Three LED indicators on the CM-3R (LOOP, INT, and EXT) indicate the current T1 transmitter timing configuration. Table 2-12 explains the function of each of these indicators. If the CM-3R is in its fallback timing mode, one of these three indicators will be on, while another will be blinking. The blinking indicator shows the primary timing mode set by the user. The indicator that is on continuously indicates the fallback timing mode, which is now in effect.

The meaning of the LOOP indicator depends on the multiplexer type. In terminal multiplexers, the LOOP indicator indicates loop timing. In drop/insert multiplexers, the LOOP indicator indicates through (THRU) timing.

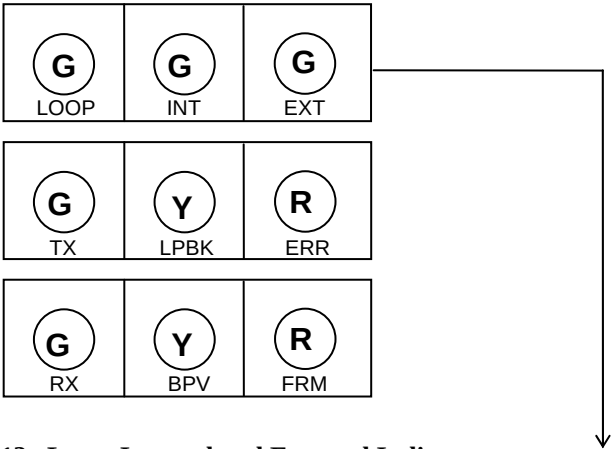


Table 2-12. Loop, Internal and External Indicators

Item (Fig. 2-22)	Module	Label	Description
16	CM-3R	LOOP	Loop or Through Timing Mode indicator (green). Its actions will depend upon the multiplexer configuration: Terminal Multiplexers: ON: The CM-3R transmitter is loop timed. BLINKING: Loop is the primary timing mode, but the CM-3R module is currently in fallback timing mode. Drop/Insert Multiplexers: ON: The CM-3R transmitter is through timed. BLINKING: Thru is the primary timing mode, but the CM-3R module is currently in fallback timing mode.
		INT	Internal Timing Mode indicator (green). Lights when the CM-3R E1 transmitter is internally timed.
		EXT	External Timing Mode indicator (green). Lights when the CM-3R E1 transmitter is externally timed. Blinks when EXT is the primary timing mode, but the CM-3R module is in fallback timing mode.

2.4.4.2 TX, LPBK and ERR INDICATORS

Three LED indicators on the CM-3R module (TX, LPBK and ERR) indicate transmitter output status, loopback status, and error status. The meaning of each of these indicators appears in Table 2-13.

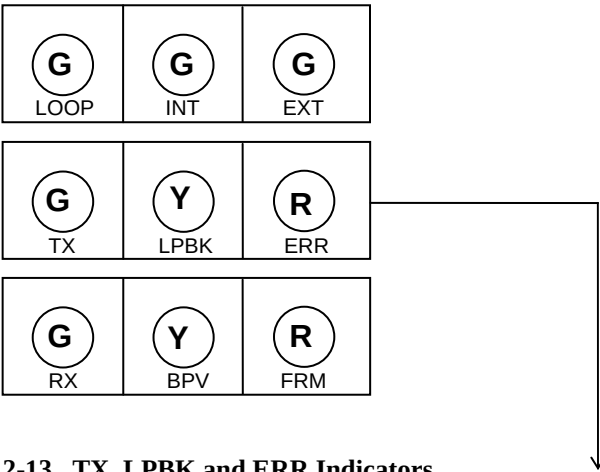


Table 2-13. TX, LPBK and ERR Indicators

Item (Fig. 2-22)	Module	Label	Description
16	CM-3R	TX	Transmit Output indicator (green); indicates transmit status: ON: Transmission signal is normal. It can be either data, or all ones if the shelf is idle. OFF: No signal is being transmitted, indicating a hardware failure.
		LPBK	Loopback indicator (yellow). Lights when one or more of the CM-3R's three T1 loopbacks have been activated. View the LPBK group to determine The active loopback(s): LNLB: Line Loopback PaLB: Payload Loopback EqLB: Equipment Loopback
		ERR	Error indicator (red). When frame format is set to ESF, this indicator flashes once each time a CRC-6 error is detected, and remains on continuously above a random bit error ratio of about 10 ⁻⁵ . When frame format is set to SF, this indicator flashes once each time a frame error is detected, and remains on continuously above a random bit error ratio of about 10 ⁻³ .

2.4.4.3 RX, BPV and FRM INDICATORS

Three LED indicators on the CM-3R module (RX, BPV and FRM) indicate the status of the received T1 signal. The meaning of each of these indicators appears in Table 2-14.

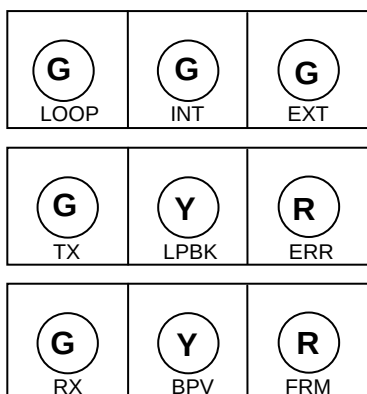


Table 2-14. RX, BPV and FRM Indicators

Item (Fig. 2-22)	Module	Label	Description
16	CM-3R	RX	Receive Input indicator (green); indicates receive status: ON: A valid T1 data signal is detected at the CM-3R T1 receiver input. OFF: Excessively low receive signal is detected. BLINKING: One of the following signals or conditions is detected. (View the BLNK group to determine which one.) Rx11: All ones produced by an idle shelf at the far end, framed or unframed. RxY1: Yellow alarm, indicating a loss of receive signal at the far end, if the equipment at the far end is set up to generate a yellow alarm. XsJt: Excessive jitter, indicating that the jitter buffer depth has been exceeded.
		BPV	Bipolar Variations indicator (yellow). Flashes once each time a bipolar violation is detected, and remains on continuously above a random BPV (bipolar variations) error ratio of about 10^{-5} .
		FRM	Out-Of-Frame indicator (red). Lights when the CM-3R T1 receiver is not in frame synchronization. This can indicate either a high bit error ratio, or improper CM-3R configuration.

2.5 MULTIPLEXER, REAR PANEL CONNECTIONS

Figure 2-20 shows the power and signal connectors located on the rear panel of the Main Shelf of a Multiplexer Terminal using an MA-215R Module Adapter. Figure 2-21 is similar to Figure 2-20, but it shows the Optical Interface Adapter (OIA) used when interfacing to fiber optic cables.

All T1 signal and timing connections to a CM-3R are made through its corresponding MA-215R Module Adapter or Optical Interface Adapter (OIA). A terminal multiplexer contains one MA-215R or OIA, while a drop/insert multiplexer contains two.

Table 2-15 lists the terminal assignments for the input power terminal strip on the rear of the Main Shelf. Table 2-16 lists the terminal assignments for the ALARMS terminal strip that is directly below the input power terminal strip. Table 2-17 provides the pin assignments for the T1 I/O connector on the MA-210R. Table 2-18 lists the pin assignments for the REMOTE connector on the MA-210R; these assignments are that same as for the RS-232 connector on the OIA.

Table 2-15. Terminal assignments, main shelf input power terminal strip

Terminal Label	Description (Refer to Figures 9-2 and 9-3)
RG (RING GEN)	For connection to an external ring generator referenced to SIG BAT. Connect one side of the ring generator to the RING GEN terminal, and the other side to the SIG BAT terminal. ⁽¹⁾
SB (SIG BAT)	For connection to an external signaling voltage source when signaling voltage is required by one or more channel modules. SIG BAT is normally jumpered to NEGATIVE BAT when the dc power voltage is the same as the desired signaling voltage. The SIG BAT input may also be connected to an external loop current generator. ⁽¹⁾
+R (+BAT R)	Redundant station battery positive. ⁽²⁾
-R (-BAT R)	Redundant station battery negative. ⁽²⁾
+ (+BAT)	Station battery positive. Voltage must match input requirements of power supply module.
- (-BAT)	Station battery negative. Voltage must match input requirements of power supply module.

1. To prevent damage to the equipment, the source connected to this input must be externally fused or current-limited.
2. Redundant station battery connections are only used when the shelf is equipped with a redundant power supply. The voltage must match the input requirements of the redundant power supply module.

Table 2-16. Terminal assignments, main shelf rear-panel ALARMS terminal strip

Terminal Label	Description
ALERT NO	ALERT relay N.O. contact (normally-open).
ALERT COM	ALERT relay COM contact (common).
ALERT NC	ALERT relay N.C. contact (normally-closed).
ALARM NO	ALARM relay N.O. contact (normally-open).
ALARM COM	ALARM relay COM contact (common).
ALARM NC	ALARM relay N.C. contact (normally-closed).

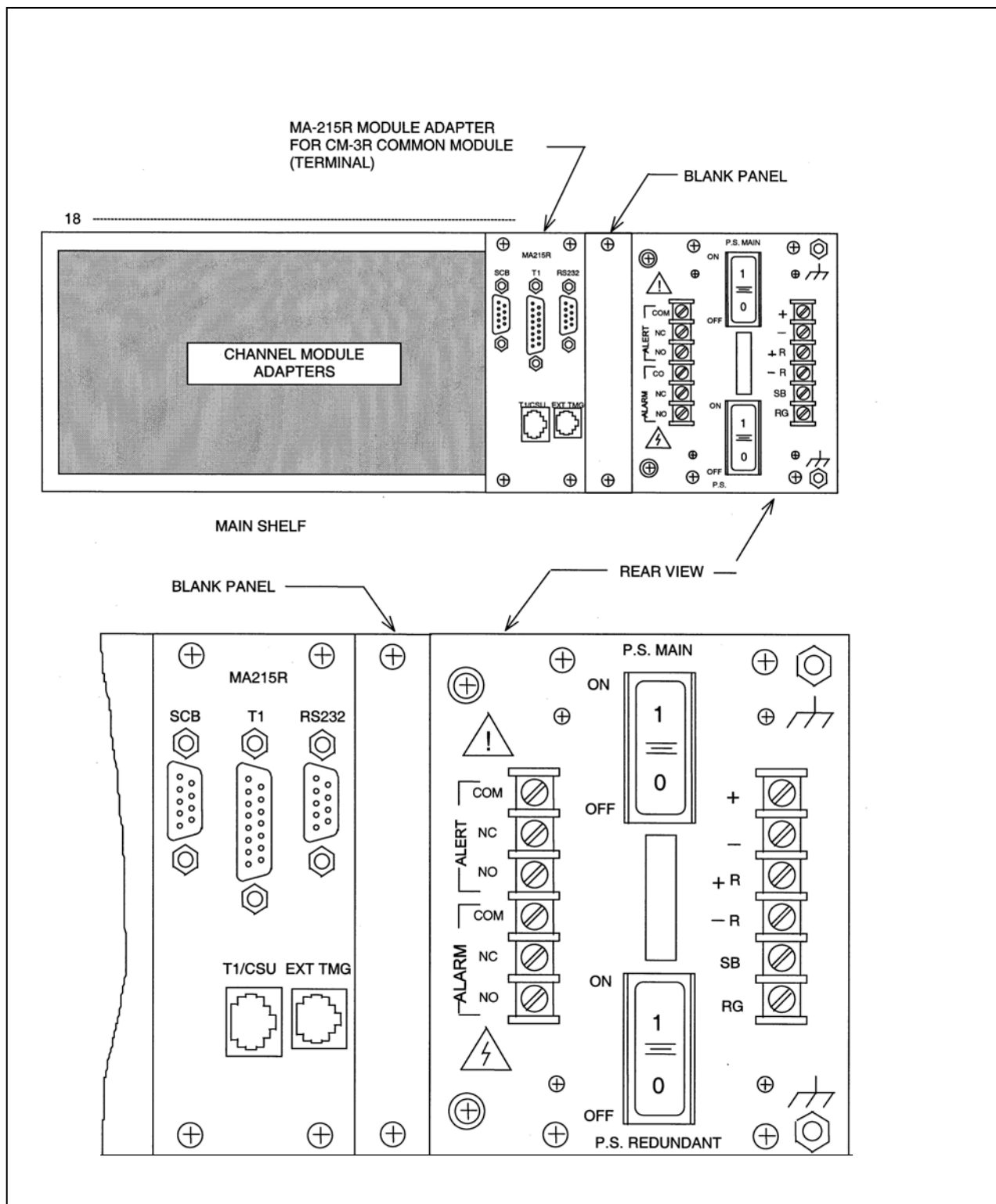


Figure 2-25. Rear panel connectors, Main Shelf equipped with MA-210R Module Adapter

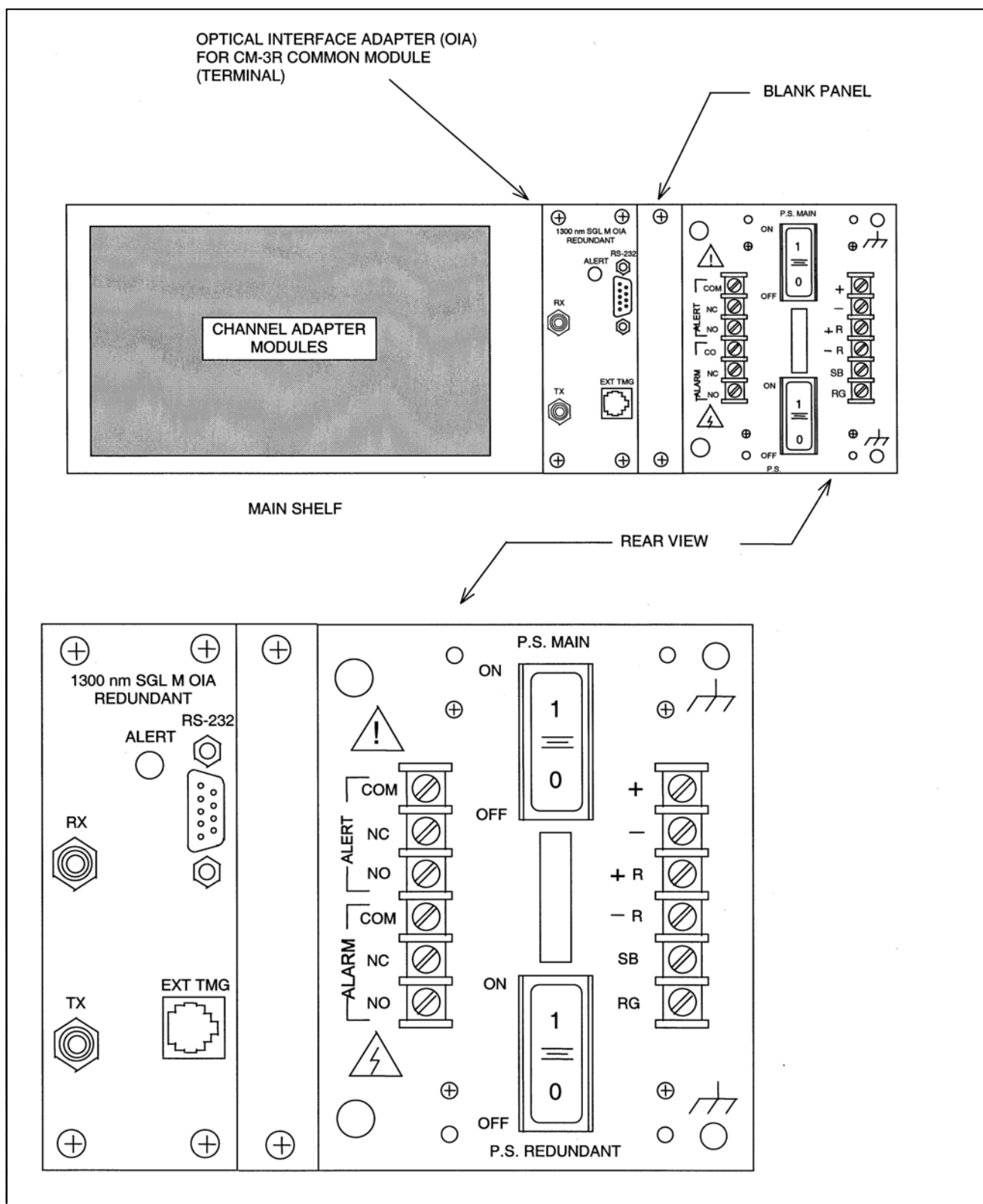


Figure 2-26. Rear panel connectors, Main Shelf equipped with Optical Interface Adapter

Table 2-17. Pin assignments, T1 I/O connector on the MA-210R/MA-215R Module Adapter

Pin Numbers	Designation	Description
1 (tip) and 9 (ring)	T, R	T1 Out; the balanced T1 output of the corresponding CM-3R.
3 (tip) and 11 (ring)	T1, R1	T1 In; the balanced T1 input for the corresponding CM-3R.
5 and 12	...	Timing Out; a balanced RS-422 output from the corresponding CM-3R that may be used as an external T1 timing source by other IMUX 2000 multiplexers.
6 and 13	...	Timing In; a balanced 1.544-mHz RS-422 input to the corresponding CM-3R that may be connected to an external T1 timing source. The CM-3R cannot synchronize to this input unless TIMING is set to EXT.
2 and 4	...	T1 signal grounds. These pins may be used to provide a signal ground for external DTE, such as a T1 CSU.

Table 2-18. Pin assignments, REMOTE connector on the MA-210R/MA-215R Module Adapter or RS-232 connector on the Optical Interface Assembly

Pin Number	Description
1	No connection
2	RS-232 transmit data (output)
3	RS-232 receive data (input)
4	No connection
5	RS-232 ground
6 thru 9	No connection

2.6 MULTIPLEXER, SETUP JUMPERS AND DIP SWITCHES

Setup jumpers are located on most Module Adapters, OIA Optical Interface Adapters and on the CM-3R Common Module. Table 2-19 briefly describes the use of the setup jumpers. A complete discussion of the location and function of each setup jumper appears in Section 6 of this manual.

Table 2-19. Setup jumpers and DIP switches

Module	Labels	Description
MA-210	J1 and J2 (upper board)	Used to set CM-3R mode (TERM, D/I A or D/I B).
MA-215	J1 and J2 (lower board)	Used to set CM-3R mode (TERM, D/I A or D/I B).
	J3 and J4 (upper board)	Used to select SCB clock source. SCB used for master clock SCBT used for timed clock (slave)
MA-218	J1 and J2	Used to set CM-3R mode (TERM, D/I A or D/I B).
MA-210R	J1 and J2 (upper board)	Used to set CM-3R mode (TERM, D/I A or D/I B).
	J4 (upper board)	Used to select T1 or CSU mode.
MA-215R	J1 and J2 (middle board)	Used to set CM-3R mode (TERM, D/I A or D/I B).
	J4 (middle board)	Used to select T1 or CSU mode.
	J3 and J4 (upper board)	Used to select SCB clock source. SCB used for master clock SCBT used for timed clock (slave)
CM-3R	J1	Used to select run or test modes (for factory use only)
	J6, J7, J8, J9	For factory use only
	J10, J11, J12, J13	Used to select external timing input format. Set J10-J13 to T1 position for T1 format Set J10-J13 to 422 position for RS422 format Note: The external timing output is always in 422 format.
OIA	DIP switch SW1	Used to set fiber optic interface configuration: SW1-1 and SW1-2 Mode selection: Both ON (down): Terminal S1-1 OFF (up), Drop/Insert Direction A S1-2 ON (down) (DI-A) S1-1 ON (down), Drop/Insert Direction B S1-2 OFF (up) (DI-B) Both OFF (up): Spare. SW1-3 Coding selection: ⁽¹⁾ ON (down): B8ZS/HDB3 coding. OFF (up): AMI coding. SW1-4 Selects CMI mode or Legacy mode: ON (down): Enable CMI mode. ⁽¹⁾ OFF (up): Enable Legacy mode. ⁽²⁾

1. CMI (Code Mark Inversion).
2. Legacy mode will allow communication with “older versions” of OIA’s that do not support CMI.

2.7 MULTIPLEXER, INTERNAL CONNECTIONS ON THE MOTHERBOARD

Figure 2-27 is a simplified functional diagram of the internal connections of an IMUX 2000 Multiplexer using an electrical T1 interface. Figure 2-28 shows the connections of an IMUX 2000 Multiplexer using an fiber optic interface.

All modules, Module Adapters, and rear panel connectors communicate with each other through the signal and power buses on the motherboard. Input power enters at the rear-panel terminal block and passes to the power supply module. The power supply output goes to the power bus, from which the Common Module and each channel module draw current as needed. Power supplies from the signaling battery and ring generator, if used, also connect to the power bus.

The signal bus is actually comprised of four buses: "TX A," "RX A," "TX B," and "RX B." In a terminal multiplexer, the channel modules place their transmit signals on the TX A bus. The T1 Common Module takes these signals and multiplexes them together for transmission on the T1 line. It also takes the incoming T1 signal, demultiplexes it, and places the resulting channel signals on the RX B bus, from which the channel modules take their individual receive data.

In a drop/insert multiplexer, the channel modules set to transmit in direction A and the CM-3R designated as DI-A work together in a terminal multiplexer. However, the channel modules set to transmit in the B direction work together with the CM-3R designated as DI-B, using the TX-B bus and the RX-A bus.

This topic is discussed further in Section 5 of this manual.

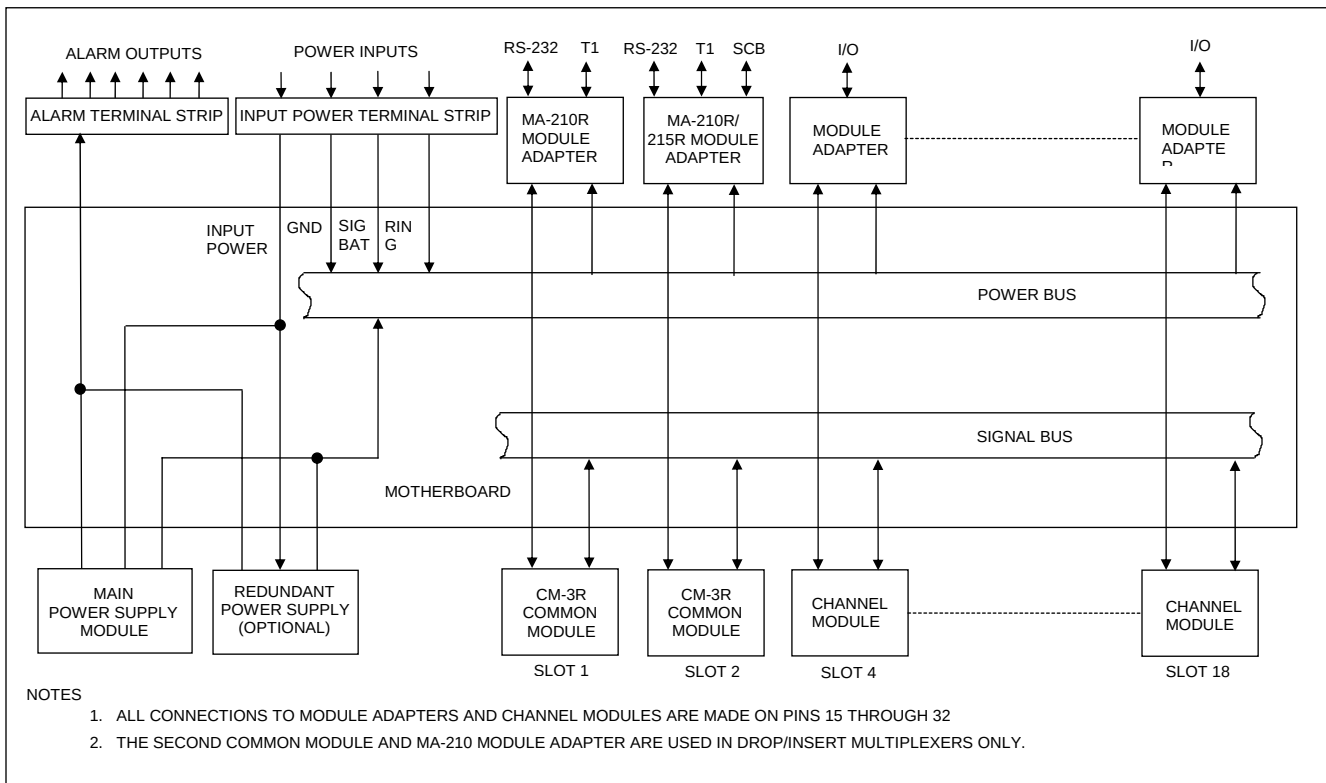


Figure 2-27. Internal connections on the IMUX 2000 motherboard (electrical T1 interface)

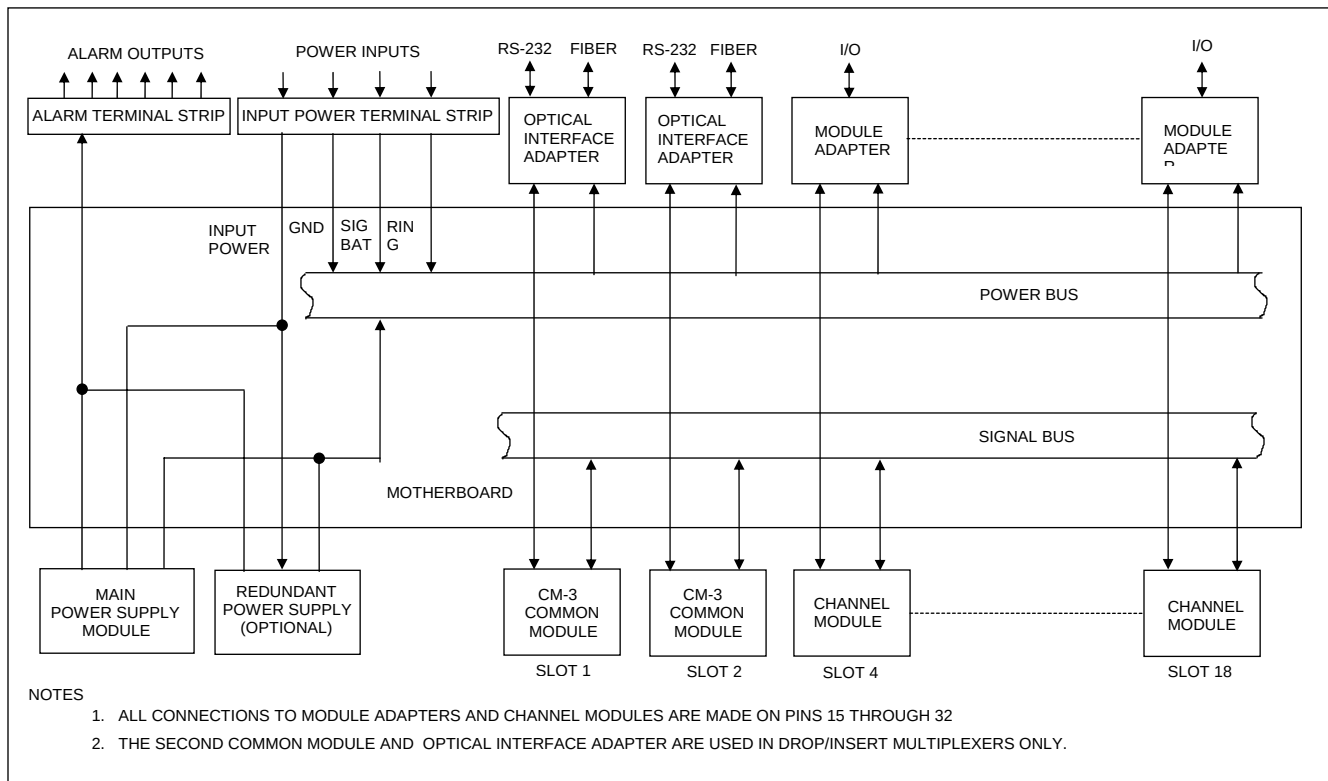


Figure 2-28. Internal connections on the IMUX 2000 motherboard (fiber optic interface)

SECTION 3. FUNCTIONAL DESCRIPTION OF THE IMUX 2000 INTELLIGENT LINE SWITCH

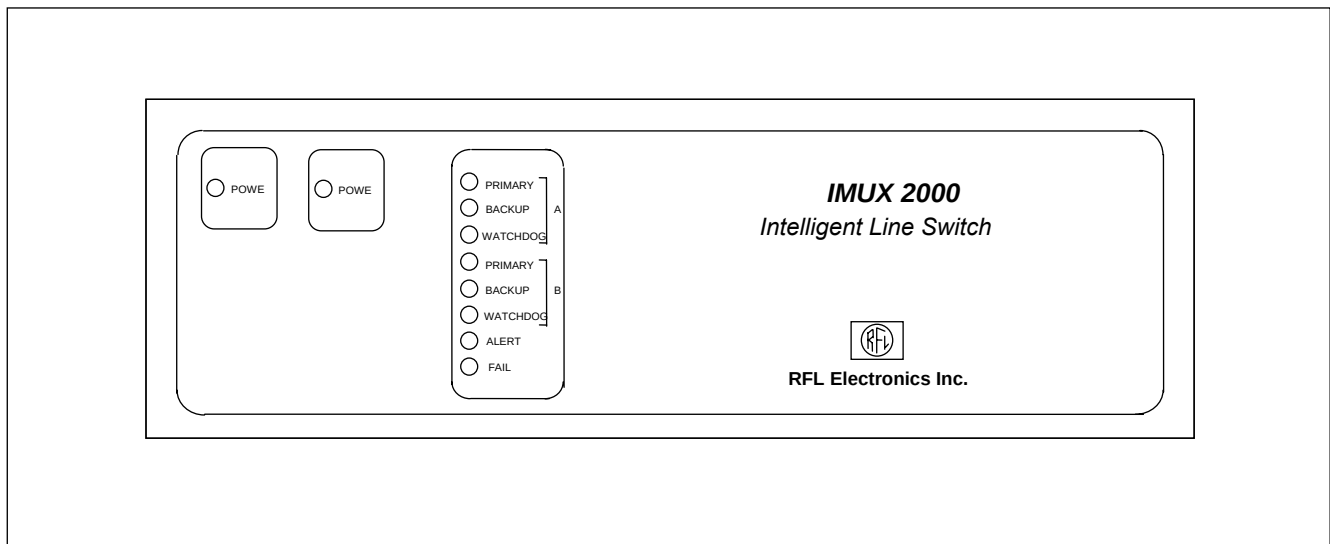


Figure 3-1. Front panel of IMUX 2000 Intelligent Line Switch

3.1 INTRODUCTION

This section gives a functional description of the IMUX 2000 Intelligent Line Switch, and shows how the unit can be configured with an IMUX 2000 Intelligent T1 Multiplexer for both point-to-point and drop/insert T1 systems. This section also defines all common equipment connectors, switches, and indicators used in the IMUX 2000 Intelligent Line Switch. The front panel of the IMUX 2000 Intelligent Line Switch is shown in Figure 3-1.

3.1.1 INTELLIGENT LINE SWITCH DESCRIPTION

The IMUX 2000 Intelligent Line Switch (ILS) is a six port device which is used to switch DS1 channels between primary and backup paths. When the primary path is selected two of the incoming DS1s are connected to two outgoing DS1s. Port 5 is connected to port 1, and port 6 is connected to port 4. When the backup path is selected port 5 is connected to port 2, and port 6 is connected to port 3. A schematic representation of the Intelligent Line Switch is shown in Figure 3-2.

During normal operation the ILS monitors the status of the backup path. If a failure is detected on one of the primary ports (1 or 4), the T1 signal is routed through the backup path. When the failure is restored, the T1 signal is automatically re-routed back to the normal primary path. The switch back to the primary path has an added delay to prevent oscillation.

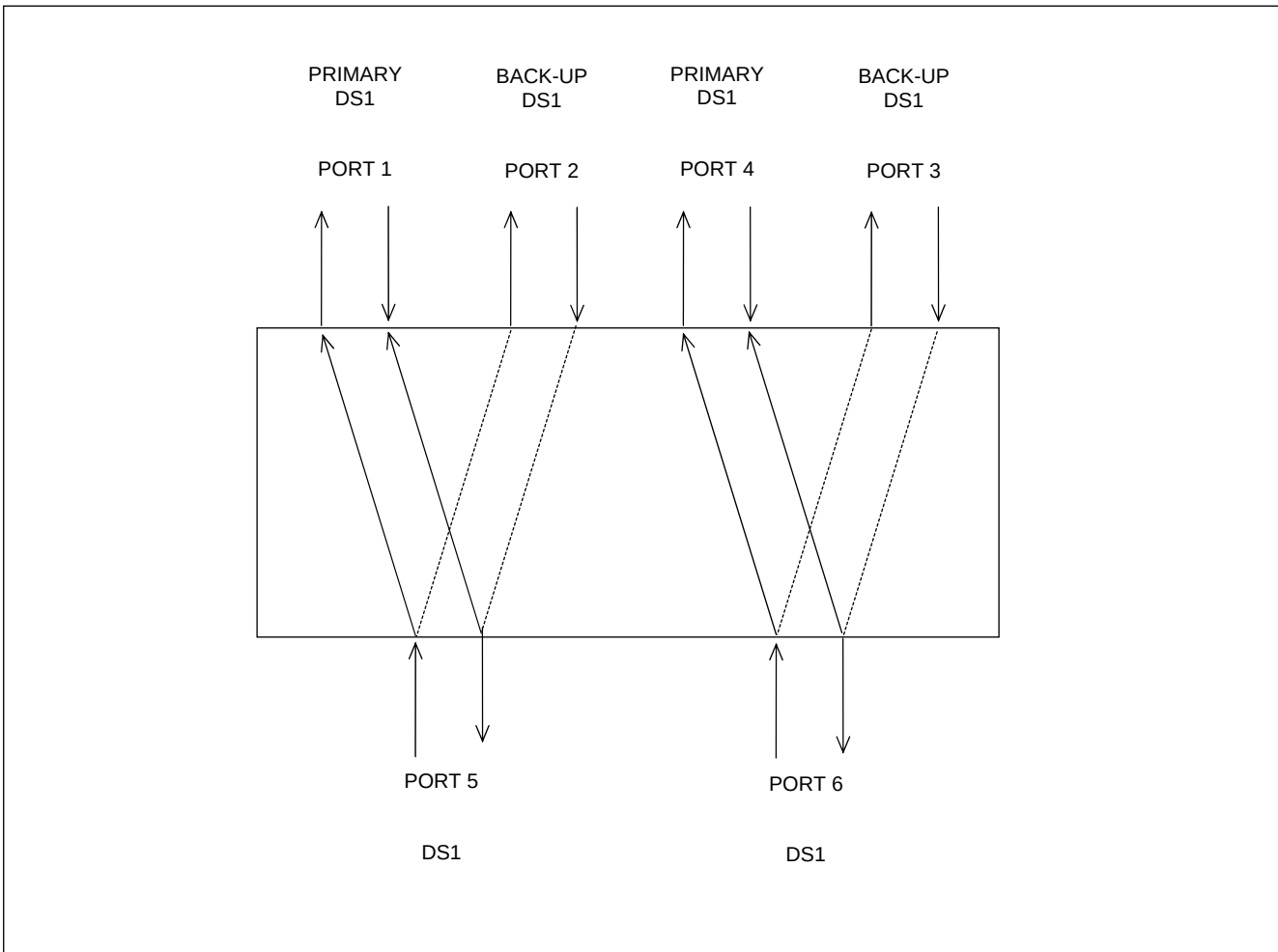


Figure 3-2. Schematic representation of the IMUX 2000 Intelligent Line Switch.

3.2 INTELLIGENT LINE SWITCH CONFIGURATIONS

The IMUX 2000 Intelligent Line Switch is normally used with an IMUX 2000 Intelligent T1 Multiplexer configured as a terminal multiplexer or as a drop/insert multiplexer. Both of these configurations can be fitted with an electrical interface using the MA-230 Module Adapter, or with an optical interface using a variety of Optical Interface Adapters (OIAs). The OIAs permit the T1 circuit to operate over fiber optic cables and are available in both multimode and single-mode configurations at several different wavelengths.

3.2.1 TERMINAL MULTIPLEXER WITH INTELLIGENT LINE SWITCH

The IMUX 2000 Intelligent Line Switch serves as an interface between a single T1 "high-speed" circuit and multiple voice and data "low-speed" circuits (Figure 3-3). Channel modules convert voice and data signals into single or multiple 64,000-bit/second (64-kbps) digital signals. These 64-kbps signals or "time slots" are then combined by time division multiplexing (TDM) into a 1,544,000-bit/second (1.544-Mbps) T1 signal. The multiplexed voice and data circuits become payloads within the T1 circuit.

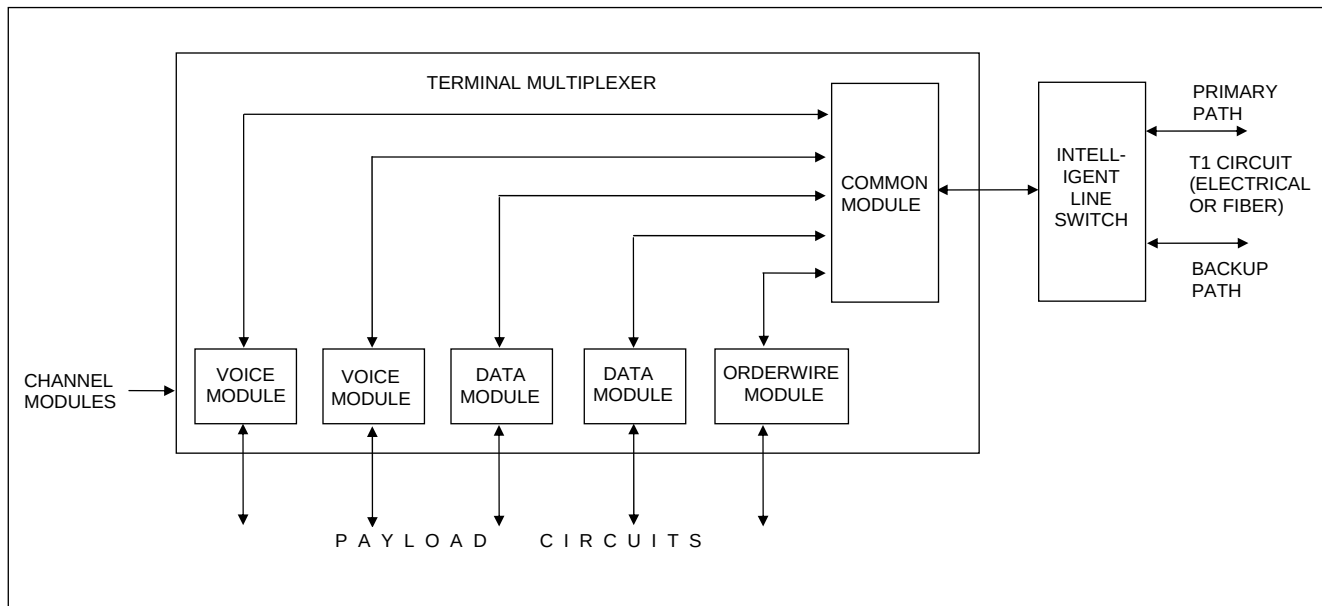
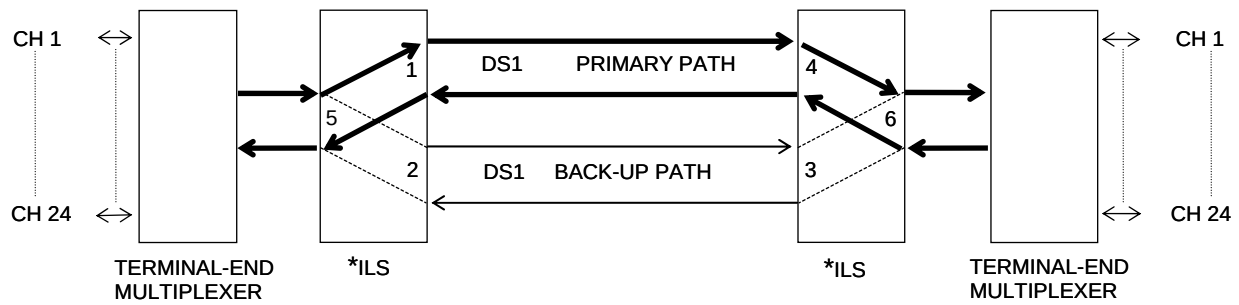


Figure 3-3. Terminal multiplexer with Intelligent Line Switch (sample configuration)

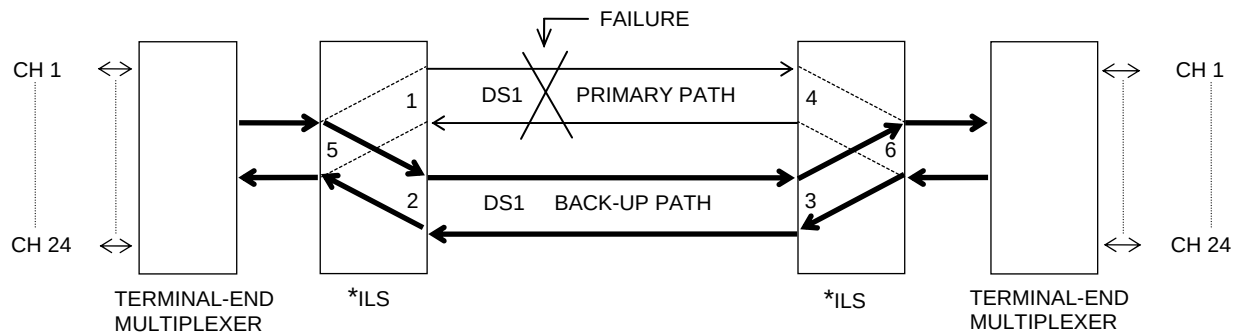
A single T1 circuit provides 24 full-duplex, 64-kbps time slots for an aggregate payload capacity of 1.536 Mbps in each direction. Because the T1 signal format includes an 8-kbps overhead channel for frame synchronization, error detection, and other functions, the actual T1 interface rate is 1.544 Mbps. (See Section 13 for more information on SF and ESF formats.)

3.2.2 POINT-TO-POINT SYSTEM WITH INTELLIGENT LINE SWITCH

Figure 3-4 shows two terminal-end multiplexers, each with an ILS, configured as a point-to-point system. As the figure illustrates, the same payload circuits will appear at both ends of a point-to-point system. Most payload types (such as voice and full-duplex data circuits) are bi-directional, and will have both an input and an output at each terminal multiplexer. Figure 3a shows the system before a failure and Figure 3b shows the system after a failure. The DS1 data is switched automatically upon detection of a DS1 failure on the primary path. After a switch to the back-up occurs, data will be automatically switched back to the primary path after the ILS detects that the primary path is available. The time to switch upon detection of a failure is programmable by the user. Note that in this configuration, only 3 out of 6 ILS ports are being used.



a. Before Failure



b. After Failure

* Only 3 out of 6 ports are being used in this configuration.

Figure 3-4. Point-to-point System with ILS (sample configuration)

3.2.3 DROP/INSERT MULTIPLEXER WITH INTELLIGENT LINE SWITCH

A drop/insert multiplexer is essentially a pair of back-to-back terminal multiplexers, in which some circuits terminate while others pass through. (See Figure 3-5.) A drop/insert multiplexer can terminate payload circuits from either of two different T1 circuits; that is, from either of two different locations.

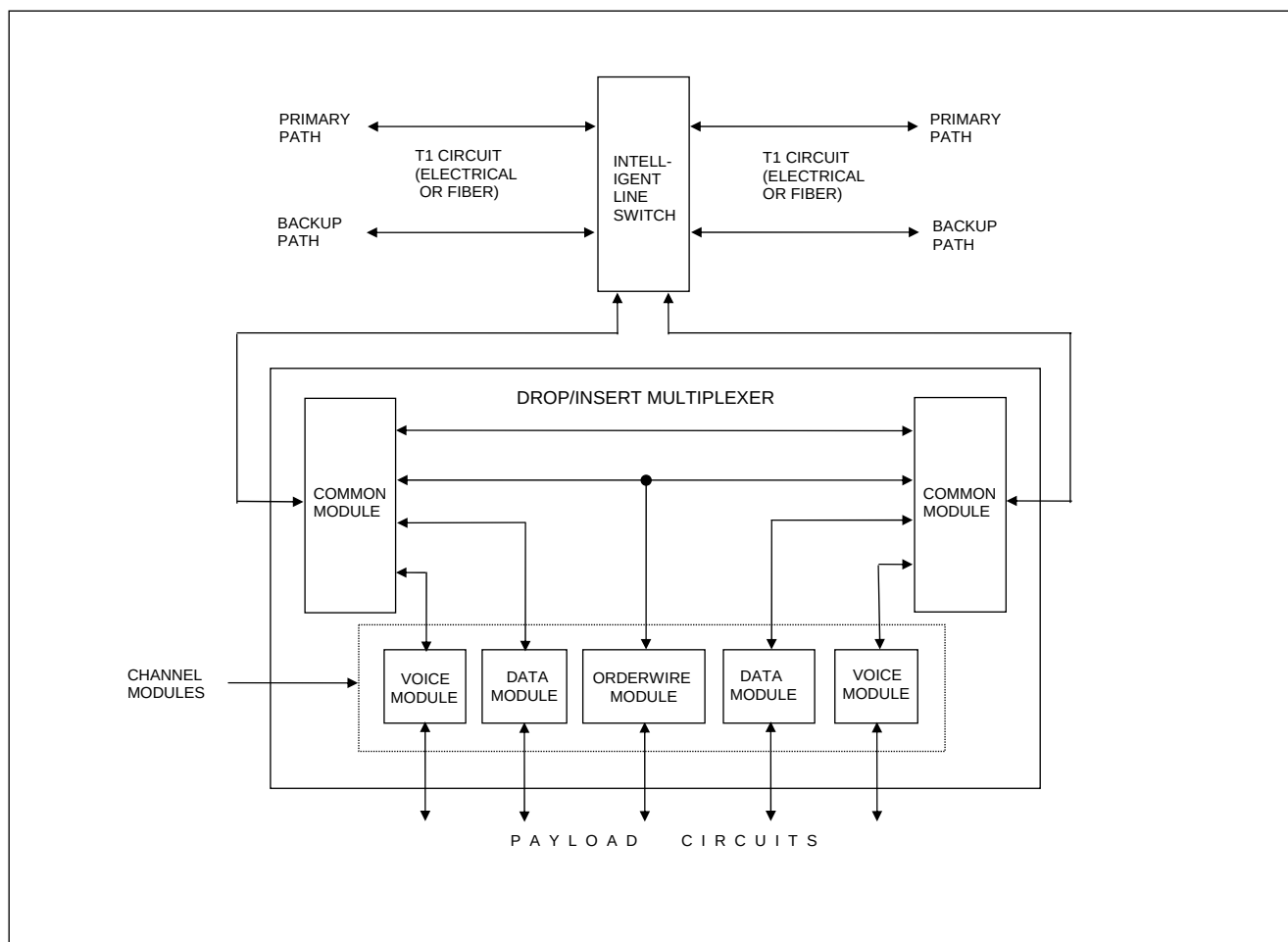


Figure 3-5. Drop/insert multiplexer with Intelligent Line Switch (sample configuration)

3.2.4 DROP/INSERT SYSTEM WITH INTELLIGENT LINE SWITCH

The addition of one or more drop/insert multiplexers converts a simple point-to-point system into a drop/insert system. (See Figure 3-6.) Data, voice, and orderwire (multiple drop) circuits can be established between any two locations in a T1 drop/insert system. As shown in Figure 3-6, a three-location system can provide circuits between Locations 1 and 2, Locations 2 and 3, and Locations 1 and 3. The only limiting factor is the capacity of the T1 circuit between any two adjacent locations, which is 24 time slots. Drop/insert systems are not limited to a single drop/insert multiplexer, and may contain more than three locations.

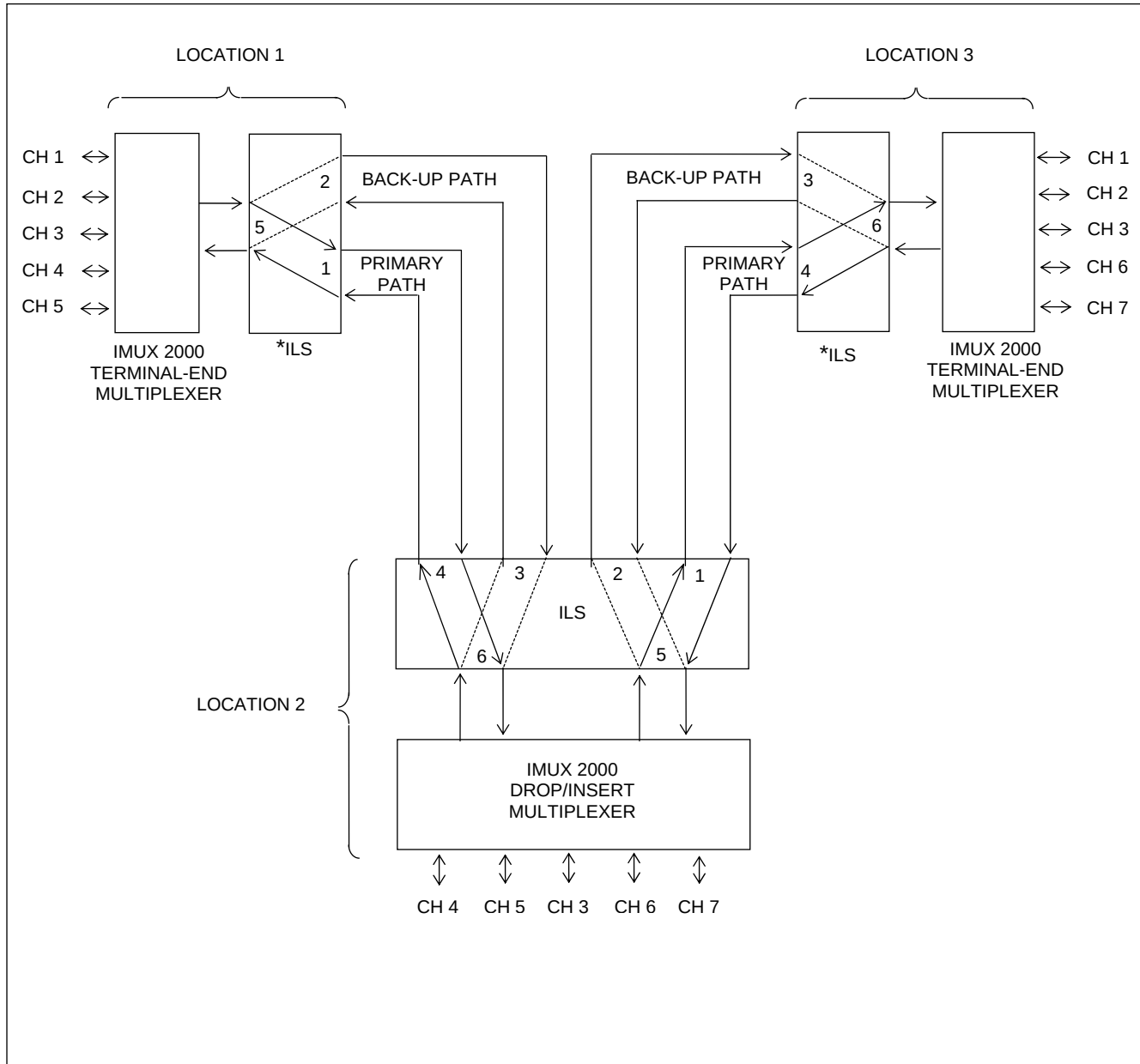


Figure 3-6. Drop/Insert system with ILS (sample configuration)

3.2.5 ILS USED IN A RING CONFIGURATION

Self-healing ring operation of the IMUX 2000 is accomplished using several six-port IMUX 2000 ILS units. Four T1 signals are brought into each location from adjacent nodes to form a ring. (See Figure 3-7). Two terminal-end multiplexers are head and tailed at a central location (Location 1) using a common DACS. All other units around the ring (Locations 2, 3 and 4) are drop/insert units, each utilizing an ILS.

Each of the 24 channels within the T1 data stream may be reused within the loop for maximum T1 utilization. Under normal operation each channel is mapped between nodes through the ILS with a primary T1 path. An alternate or back-up T1 path is circulating around the ring with no data on it. Each ILS monitors this back-up path for its availability. If a failure is detected in an adjacent node, the ILS will redirect the effected T1 signal in the opposite direction around the ring on the back-up path. (See Figure 3-8).

When the failure is restored, the T1 signal is automatically re-routed back to the normal primary path.

The ring configuration shown in Figure 3-7 can be implemented with either an electrical interface utilizing 4 shielded twisted pairs between nodes, or an optical interface utilizing 4 optical fibers between nodes. This configuration is referred to as a 4 fiber ring.

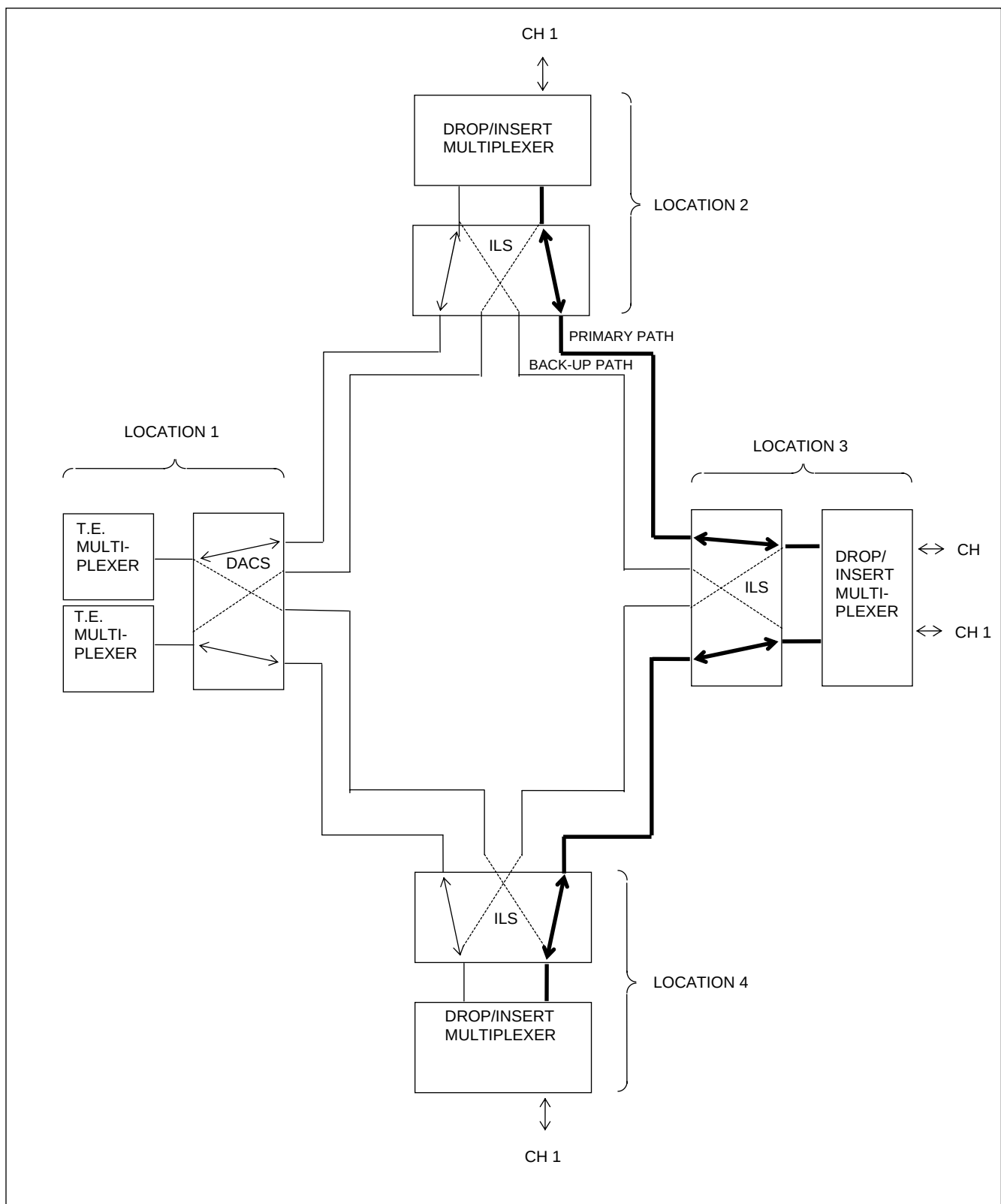


Figure 3-7. ILS ring configuration before a failure (sample configuration)

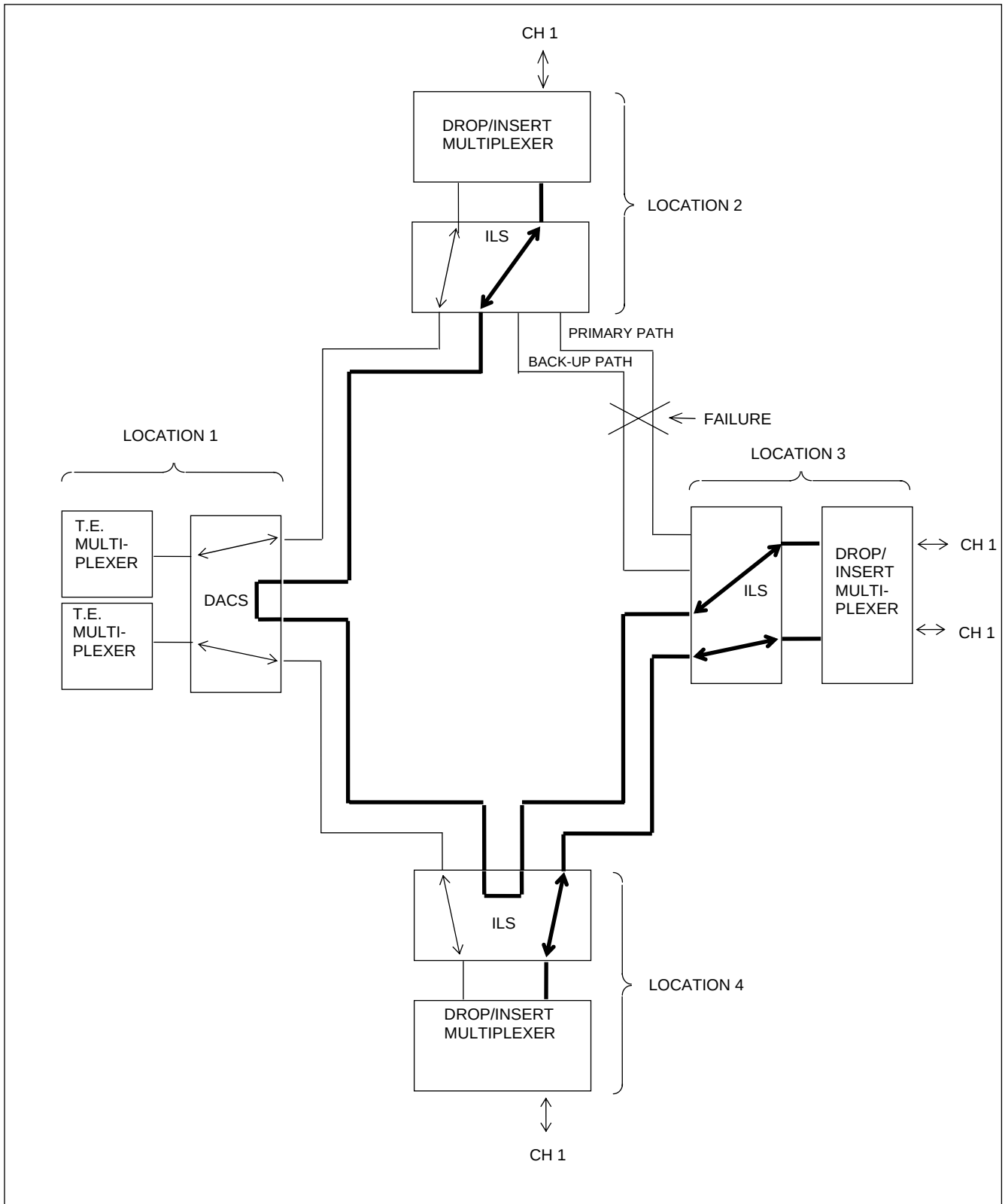


Figure 3-8. ILS ring configuration after a failure (sample configuration)

3.3 INTELLIGENT LINE SWITCH COMPONENTS

Each IMUX 2000 Intelligent Line Switch contains the following components:

<u>Nomenclature</u>	<u>RFL Part No.</u>	<u>See Paragraph</u>
1. ILS Chassis	9597-158510	3.3.1
2. ILS Processor Module	9547-1860	3.3.2
3. ILS Module	9547-1800	3.3.3
4. Power Supply Module(s)	9547-840, 910, 920, 930, 950	3.3.4
5. Power Supply Alarm I/O Module	105490	3.3.5
6. Module Adapters	various	3.3.6
7. OIAs	various	3.3.7

Each of these components is described in the paragraphs that follow.

3.3.1 ILS CHASSIS

The ILS Chassis is the enclosure for the IMUX 2000 Intelligent Line Switch. It has plug-in slots in the front for the main power supply, an optional redundant power supply, an ILS processor module and an ILS module. These are the only four modules that plug into the front of the ILS chassis. Plug-in slots at the rear accommodate the power supply alarm I/O module, and module adapters (MAs) and optical interface adapters (OIAs) as required. (See Figure 3-10.)

Each IMUX 2000 ILS Chassis can be installed in a standard 19-inch equipment rack. The Chassis is 5.25 inches (13.3 cm) high, and occupies three rack units of cabinet space (3RU).

The following rules control slot assignments in the ILS chassis:

1. The main power supply (when used), optional redundant power supply (when used), ILS processor module and ILS module must be plugged into the locations shown in Figure 3-10.
2. At the rear of the chassis the Power Supply Alarm I/O module (when used) must be plugged into the location shown in Figure 3-10.
3. At the rear of the chassis the SCB/TIM I/O module (MA-225) must be plugged into slot 5.
4. At the rear of the chassis the DD I/O module (MA-220) must be plugged into slot 6.

5. At the rear of the chassis OIAs can be plugged into slot pairs 7 and 8, 9 and 10, 11 and 12, or 13 and 14. Note that the OIAs take up two adjacent slot positions.
6. If a Dual DS1 I/O module (MA-230) is used it must be plugged into slot 7 or slot 11. If an MA-230 is plugged into slot 7, then slot 8 must be left blank. If an MA-230 is plugged into slot 11, then slot 12 must be left blank.
7. Slots 1 through 4 and slots 15 through 18 are always blank.

3.3.2 ILS PROCESSOR MODULE

The ILS Processor module resides in the DACS/ILS chassis and is responsible for controlling all ILS or DACS functions. The module contains an Intel 80C196 16 bit embedded controller as its processing unit. The module also contains the usual embedded hardware support devices, which include RAM, EPROM, and EEROM. The processor communicates with all six framer chips on the ILS module or the DACS module and sets their operating parameters. Any DACS mapping or ILS switching is also handled by this processor. In the DACS the processor is responsible for receiving and remapping the robbed bit signaling information. The processor constantly polls the framer chips for the status of T1 links and makes routing decisions based on this information.

The normal user interface with the processor module is through the IMUX CM3R via the SCB interface. A secondary RS232 port has been provided for factory debug purposes.

3.3.3 ILS MODULE

This module is used to reroute DS1 traffic from one port to another. The module has 6 integrated T1 framer chips on it. The six incoming T1 signals are framed and decoded by these framer chips. They are then routed to an FPGA (Field Programmable Gate Array) where they are directed toward the appropriate framers for retransmission. All user interface with this module is controlled by the processor board.

3.3.4 POWER SUPPLY MODULES

The IMUX 2000 Intelligent Line Switch can be configured with eight different power supplies that can operate with the following input voltages: 24 Vdc, 48 Vdc, 120 Vac, 125 Vdc, 220 Vac, 250 Vdc. The High Power versions will give 75 watts of output power. (The specifications listed in Section 11 of this manual provide more information on power supply input voltage ranges, input fuse requirements, and output power ratings). The ILS chassis can contain one or two power supplies with the same capacity. The power supplies used in the ILS chassis are identical to those used in the IMUX 2000 Multiplexer chassis. A functional diagram of the IMUX 2000 power supply appears in Figure 2-11.

If used, the first power supply inserts into the optional main power supply slot, and if used, the redundant power supply inserts into the optional redundant power supply slot as shown in figure 3-10. In some applications, the ILS chassis may receive all of its main power and backup power from the power supply(s) mounted in the IMUX 2000 Multiplexer chassis or the IMUX 2000 expansion shelf. In this case both of these slots will be blank in the ILS chassis. The ILS chassis will receive all of its power from the IMUX 2000 Multiplexer chassis or expansion chassis via an auxiliary power cable. See Section 9 for more information.

Regardless of the number of power supplies used in a given setup or in which chassis they are installed, the second power module, if installed, provides power supply redundancy if the main power supply fails. The redundant supply automatically comes on-line with no loss of transmission.

If you are adding modules to an existing system equipped with dual power supplies, always verify that the total power consumption does not exceed the capacity of a single supply. This will insure power supply redundancy.

3.3.5 POWER SUPPLY ALARM I/O MODULE

The Power Supply Alarm I/O module used in the ILS/DACS Chassis is identical to the one used in the IMUX 2000 Multiplexer Chassis. Refer to paragraph 2.3.6 for more information.

3.3.6 MODULE ADAPTERS

There are three types of module adapters that can be used in the ILS/DACS chassis. Some of the characteristics of these module adapters are listed below.

<u>Nomenclature</u>	<u>Module Adapter Type</u>	<u>RFL Part No.</u>
Direct Digital I/O	MA-220	9547-1830
Serial Control Bus/Timing I/O	MA-225	9547-1840
Dual DS1 I/O	MA-230	9547-1850

3.3.6.1 Direct Digital I/O (MA-220)

The Direct Digital I/O module (MA-220) serves two purposes. First, it routes two DS1 data streams between the ILS/DACS processor and the DS1 medium. The second function is to translate the digital external timing signal into RS-422 format. Only one MA-220 is required per system since this module supports two DS1 channels.

The MA-220 rear panel has two male 15-pin, D-subminiature connectors for T1 connections on ports 5 and 6 as shown in Figure 3-9. The pin descriptions are listed in Table 3-1.

The MA-220 is always plugged into slot 6 at the rear of the ILS/DACS chassis as shown in Figures 3-10 and 4-10.

Table 3-1. Direct Digital I/O (MA-220) pin assignments

PORT 5		PORT 6	
Signal Name	Pin Number	Signal Name	Pin Number
T5_OUT-	1	T6_OUT-	1
T5_OUT+	9	T6_OUT+	9
GND	2, 4, 7, 8, 10	GND	2, 4, 7, 8, 10
T5_IN-	3	T6_IN-	3
T5_IN+	11	T6_IN+	11
T1_TIM_IN - A	13	T1_TIM_IN- B	13
T1_TIM_IN + A	6	T1_TIM_IN+ B	6
CTL_3	14	CTL_4	14
no connection	5, 12, 15	no connection	5, 12, 15

3.3.6.2 Serial Control Bus/Timing I/O (MA-225)

The SCB/Timing I/O module (MA-225) provides the SCB interface and receives an external timing input. The SCB facilitates communications between the ILS/DACS and the IMUX 2000 Multiplexer. The external timing input can be optionally used to synchronize the transmitter timing. This timing signal can also be sent to the Direct Digital I/O module.

The external timing input signal is received through a male 9-pin, D-subminiature connector in T1.102 format. The SCB/Timing I/O module converts this signal into digital format. This digital signal is used internally by the ILS and is also sent to the Direct Digital I/O module to be converted to RS-422 format. The rear panel view of this module can be seen in Figure 3-9. The External Timing pin assignments are listed in Table 3-2.

The MA-225 is always plugged into slot 5 at the rear of the ILS chassis as shown in Figure 3-10.

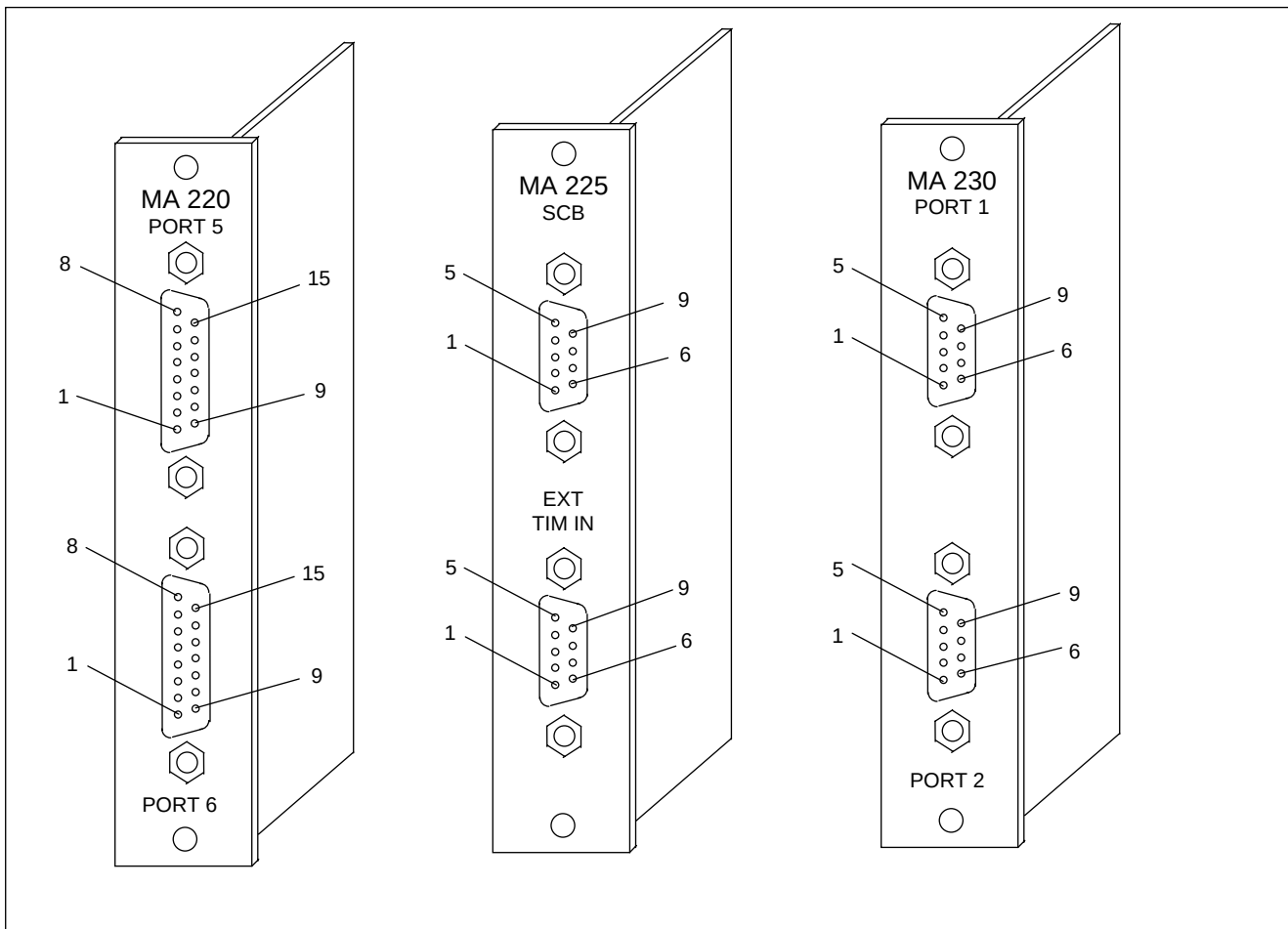


Figure 3-9. MA-220, MA-225, MA-230 Module Adapters, rear panel views.

Table 3-2. Serial Control Bus/Timing I/O (MA-225) pin assignments

EXTERNAL TIMING INPUT		SCB INTERFACE	
Signal Name	Pin Number	Signal Name	Pin Number
GND	5	GND	1
EXT TIMING IN A	6 (TIP)	SCB DATA A	6
EXT TIMING IN B	1 (RING)	SCB DATA B	2
		SCB CLOCK B	3
		SCB STROBE B	4
		SCB CLOCK A	7
		SCB STROBE A	8

3.3.6.3 Dual DS1 I/O (MA-230)

The function of the Dual DS1 I/O module is to route two DS1 data streams from one ILS processor module to another ILS/DACS processor module. One or two modules will be required when the ILS is configured as an End Terminal or as a Drop/Insert unit.

The MA-230 rear panel has two 9-pin, D-subminiature connectors for the DS1 data streams which are labeled Port 1 and Port 2 as shown in Figure 3-9. Port 1 is a male connector and Port 2 is a female connector. The pin assignments are listed in Table 3-3.

The MA-230 can be plugged into slots 7 or 11 at the rear of the ILS/DACS chassis as shown in Figures 3-10 and 4-10.

Table 3-3. Dual DS1 I/O (MA-230) pin assignments

PORT 1		PORT 2	
Signal Name	Pin Number	Signal Name	Pin Number
T1A_OUT-	4	T1B_OUT-	4
T1A_OUT+	3	T1B_OUT+	3
T1A_IN-	2	T1B_IN-	2
T1A_IN+	1	T1B_IN+	1
GND	5, 9	GND	5, 9

3.3.7 OPTICAL INTERFACE ADAPTERS (OIAS)

The OIAs used in the IMUX 2000 ILS chassis are identical to those used in the IMUX 2000 Multiplexer chassis. Refer to paragraph 2.3.4.2 for more information.

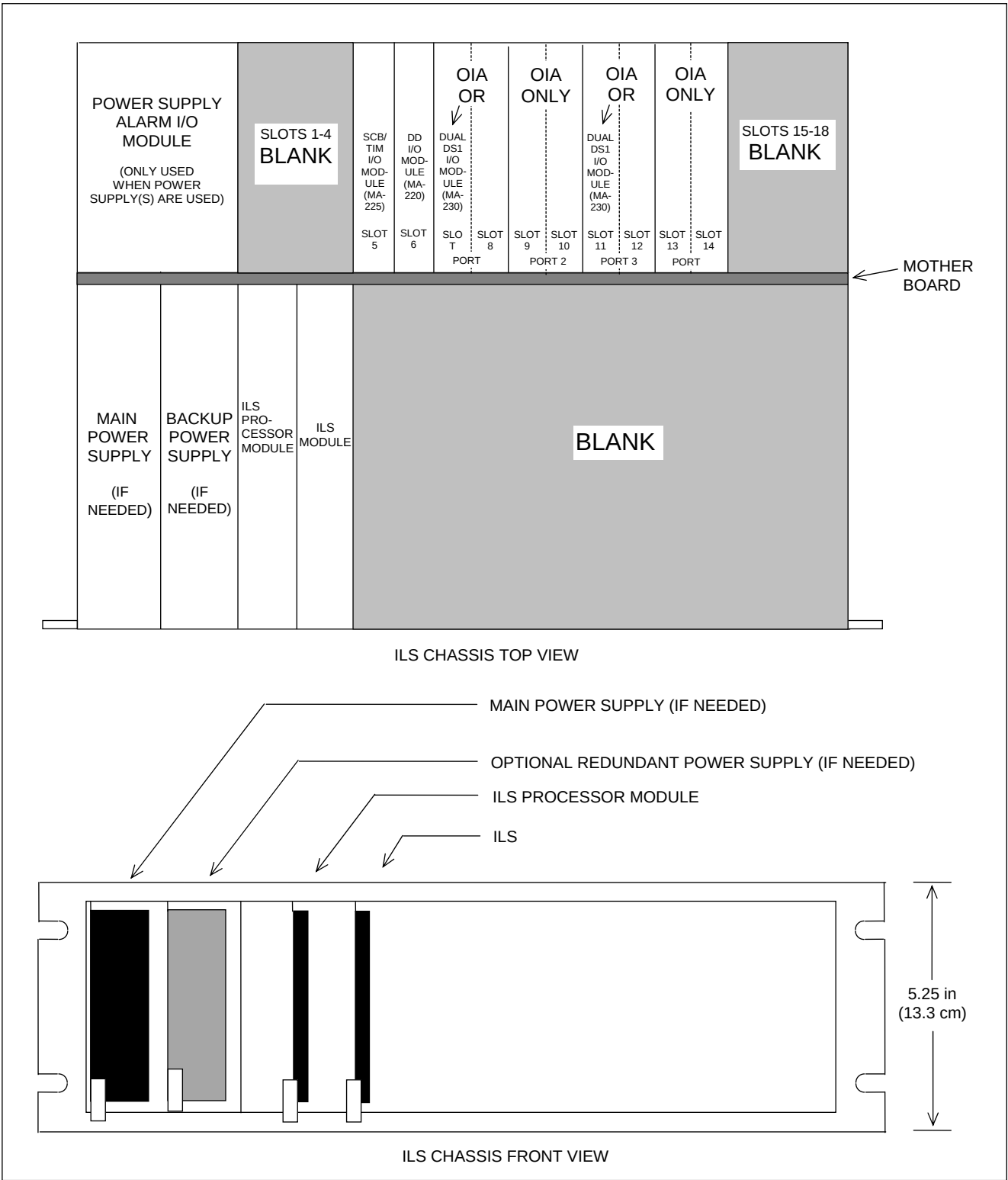


Figure 3-10. Front and top views of ILS chassis

3.4 INTELLIGENT LINE SWITCH, FRONT-PANEL SWITCHES AND INDICATORS

Figure 3-11 is a front view of the IMUX 2000 ILS with its front door open. The main power supply module and the ILS Processor module are expanded to show the location of all front panel switches and indicators. Functional descriptions of these switches and indicators appear in Tables 3-4 and 3-5. The numbers in the call-out columns of these tables refer to the call-outs shown in Figure 3-11.

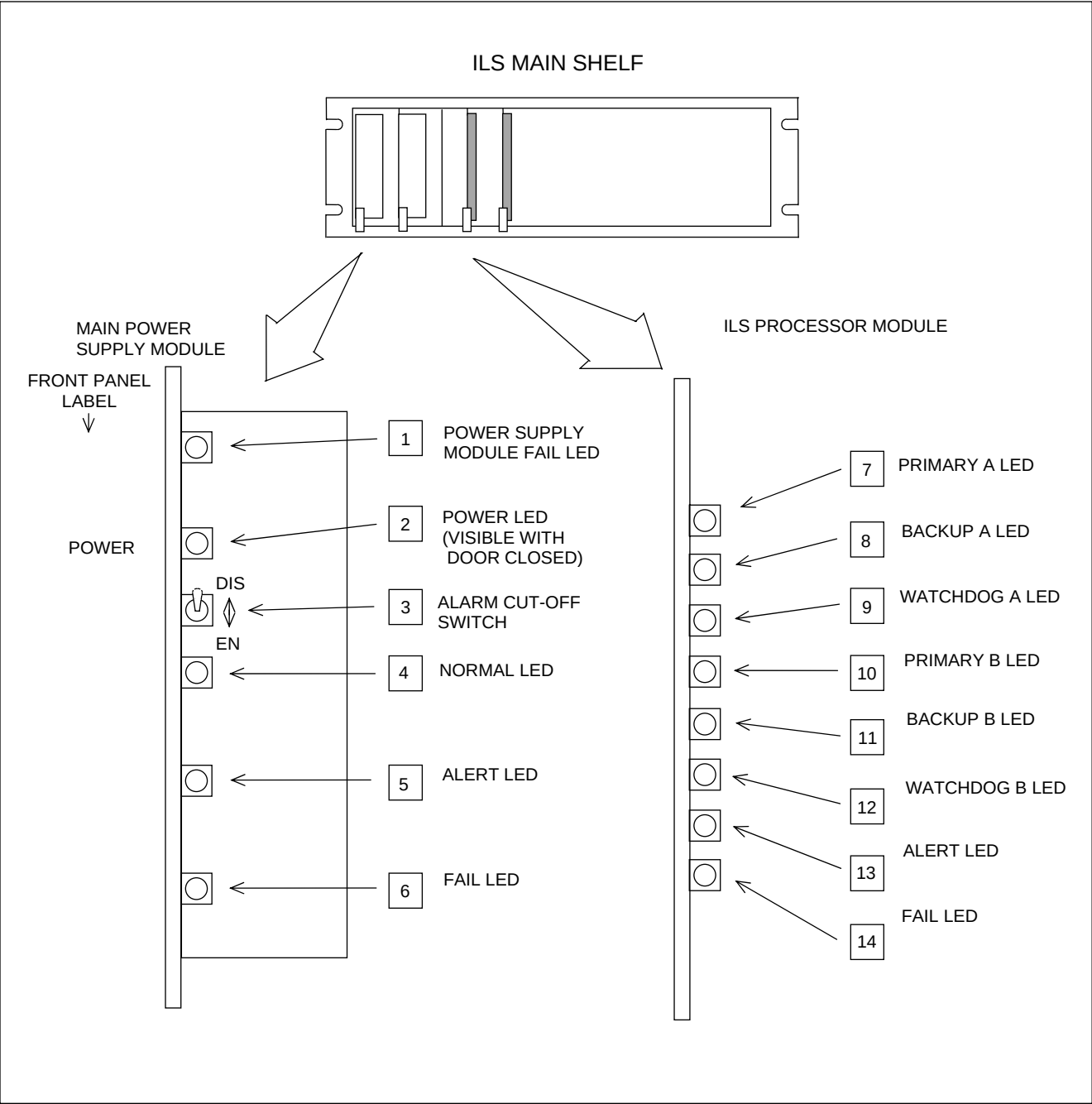


Figure 3-11. ILS Front-panel switches and indicators

3.4.1 SYSTEM STATUS INDICATORS AND THE ACO SWITCH

When the IMUX 2000 ILS front door is closed, one LED indicator on its main power supply is visible, one LED indicator on its backup power supply is visible, and eight LED indicators on the ILS processor module are visible. (See Figure 3-12.) These indicators show the status of the Intelligent Line Switch at a glance. Tables 3-4 and 3-5 give a description of these indicators which includes a description of the power supply module indicators and the alarm cutoff switch.

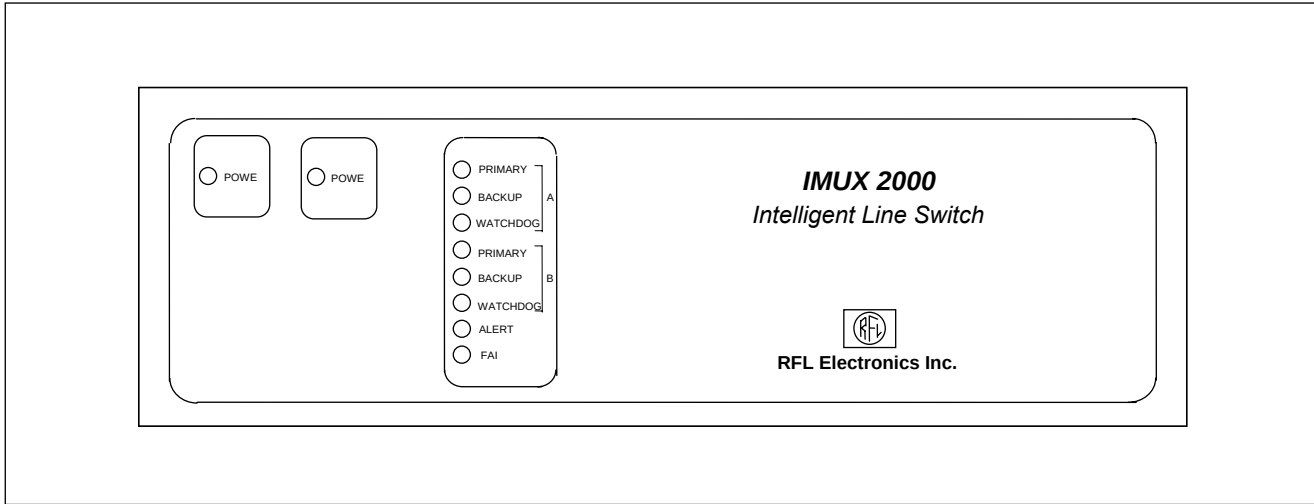


Figure 3-12. Front view of ILS Chassis with door closed, showing the system status indicators

Table 3-4. System status indicators and the ACO switch

Item (Fig. 3-11)	Module	Module Label	ILS Front Panel Label	Description
1	Power supply	PS		Power Supply Module Fail LED. Lights when the power supply module has failed.
2	Power supply	PWR	POWER	Power LED. Lights when the ILS is powered. If the ILS is equipped with a redundant power supply, this indicator will remain on if one of the power supplies has failed and the remaining supply has enough capacity to power the ILS by itself.
3	Power supply	DIS/EN		Alarm Cut-Off Switch (Disable/Enable). When this switch is in the Disabled position and no alarms are active, the alert indicator will light. When this switch is in the Enabled position the ALERT and ALARM relays are on line and will activate in response to system fault conditions. NOTE: If the ILS contains two power supply modules, the ACO switches on <u>both</u> power supply modules must be placed in the disabled position to disable the ALERT and FAIL relays.
4	Power supply	NORM		Normal LED. Lights when neither an ALERT or a FAIL condition exists.
5	Power supply	ALERT		Alert LED. Lights when the following condition exists: Loss of primary path
6	Power supply	FAIL		Fail LED. Lights when the following condition exists: Loss of both primary paths

3.4.2 ILS PROCESSOR MODULE, STATUS INDICATORS

There are eight LED indicators on the ILS processor module that indicate the status of the ILS Processor. Table 3-5 explains the function of each of these indicators.

Table 3-5. ILS Processor status indicators

Item (Fig. 3-11)	Module	Module Label	ILS Front Panel Label	Description
7	ILS processor	DS1	PRIMARY A	Lights when the Primary A active flag has been set “on” and no errors have been detected on Port 1. (1)
8	ILS processor	DS2	BACKUP A	Lights when no errors have been detected on Port 2.
9	ILS processor	DS3	WATCHDOG A	Lights when Port 2 is receiving the watchdog signal.
10	ILS processor	DS4	PRIMARY B	Lights when the Primary B active flag has been set “on” and no errors have been detected on Port 4. (1)
11	ILS processor	DS5	BACKUP B	Lights when no errors have been detected on Port 3.
12	ILS processor	DS6	WATCHDOG B	Lights when Port 3 is receiving the watchdog signal.
13	ILS processor	DS7	ALERT	Lights when an error has been detected on Ports 1 or 4 and the port has been switched to its backup; 1 to 2 or 4 to 3.
14	ILS processor	DS8	FAIL	Lights when Ports 1 and 4 have failed.

Notes: 1. Only Primary A and Primary B have active flags that can be set “on” or “off” by the user via the user interface. This can be done with a dumb terminal using Remote Configuration commands (See Section 7 of this manual), or with a PC equipped with the Network Management Software (See Section 8 of this manual).

NOTE

Remote configuration and status commands for the ILS are described in Section 8.6

3.5 DETERMINING ILS CHASSIS POWER REQUIREMENTS

To determine how much power the modules in an ILS chassis will draw, refer to Table 3-6. The power consumption of all ILS modules is given in this table.

To use the table, write down the number of modules of each type in the ILS chassis in the "Quantity" column. Multiply the quantity by power consumption value to determine the total power consumption for all modules of that type. When you are finished, add up all the totals to determine the total power consumption for the chassis.

Table 3-6. Determining power requirements for the ILS Chassis

Module Designation/Description	Input Power (watts)	Quantity	Total
MA-220 Module Adapter	(1)		
MA-225 Module Adapter	0.5		
MA-230 Module Adapter	0.0 (2)	1	0.0
ILS Processor Module	1.0	1	1.0
ILS Module	2.5	1	2.5
Optical Interface Adapter (OIA)	2.6		
TOTAL POWER CONSUMPTION (3)			

1. Included in the input power requirement for the CM-3 Common Module.
2. The MA-230 module has no active components and therefore draws no power.
3. If total power consumption exceeds 50 watts, additional power supply capacity is required.

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SECTION 4. FUNCTIONAL DESCRIPTION OF THE IMUX 2000 MINI-DACS

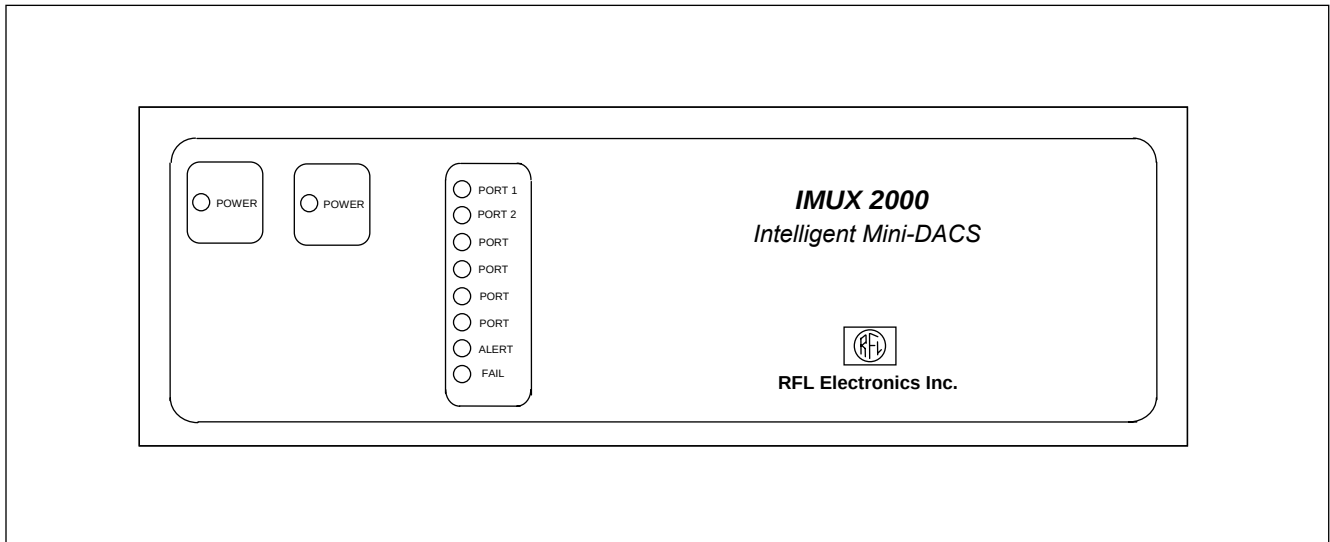


Figure 4-1. Front panel of IMUX 2000 Intelligent Mini-DACS

4.1 INTRODUCTION

This section gives a functional description of the IMUX 2000 Mini-Digital Access Cross connect System (Mini-DACS), and shows how the unit can be configured with an IMUX 2000 Intelligent T1 Multiplexer for both point-to-point and drop/insert T1 and fiber T1 systems. This section also defines all common equipment connectors, switches, and indicators used in the IMUX 2000 Mini-DACS.

4.1.1 DACS DESCRIPTION

The IMUX 2000 DACS has six DS1 input ports and six DS1 output ports arranged as six bi-directional ports. The DACS allows any DS0 on any input port to be connected to any DS0 on any output port.

The DS0 grooming takes place by time slot interchanging. Each incoming DS1 is captured and then disassembled into DS0s. Then each DS0 is stored in memory. When the DS0 is ready to be transmitted it is retrieved from storage and then re-transmitted. The DACS processor follows the instructions in a time slot interchange map which determines which incoming DS0s will be aligned with which outgoing DS0s. Each DACS processor contains 5 time slot interchange maps, one normal map and four backup maps. The DACS maps are normally programmed at the factory to customer specifications, however, the maps can be re-programmed by the user via the RS-232 Remote Port using Simple Command Language (SCL) as shown in the “DSO Remapping Function” in Table 8-6, or via the Network Management Software as shown in Section 7. A detailed discussion of the DACS mapping can be found in paragraph 4.6. A schematic representation of the DACS can be seen in Figure 4-2 showing time slot interchange, pass-thru, and hair pinning modes.

During normal operation the DACS monitors the status of the backup channel. This is accomplished by periodically transmitting a coded message into the backup path. All nodes look for the message and if it does not arrive in a preset time an alarm is generated. The DACS processor contains one normal time slot interchange map (map 0), and four back-up time slot interchange maps (maps 1-4). If there is a loss of frame or if an Alarm Indication Signal (AIS) is detected on the primary path, one of the four back-up maps can be used.

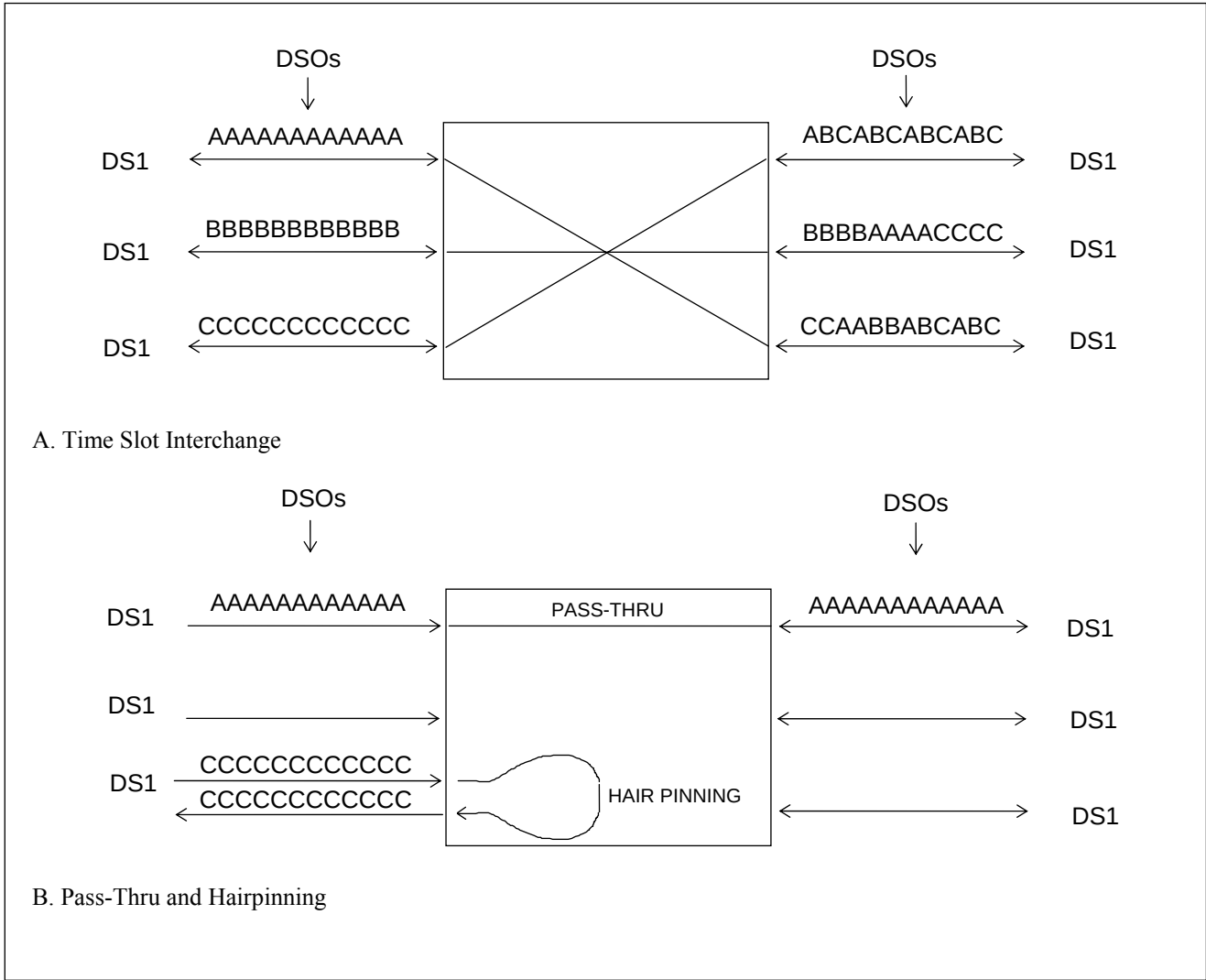


Figure 4-2. Schematic representation of the IMUX 2000 DACS

4.2 MINI-DACS CONFIGURATIONS

The IMUX 2000 Mini-DACS can be used with an IMUX 2000 Intelligent T1 Multiplexer configured as a terminal multiplexer or as a drop/insert multiplexer. Both of these configurations can be fitted with an electrical interface using the MA-230 Module Adapter, or with an optical interface using a variety of Optical Interface Adapters (OIAs). The OIAs permit the T1 circuit to operate over a fiber optic cable and are available in both multimode and single-mode configurations at several different wavelengths.

4.2.1 TERMINAL MULTIPLEXER WITH MINI-DACS

The terminal multiplexer and Mini-DACS serve as an interface between a single T1 "high-speed" circuit and multiple voice and data "low-speed" circuits (Figure 4-3). Channel modules convert voice and data signals into a single or multiple 64,000-bit/second (64-Kbps) digital signals. These 64-Kbps signals or "time slots" are then combined by time division multiplexing (TDM) into a 1,544,000-bit/second (1.544-Mbps) T1 signal. The multiplexed voice and data circuit becomes payloads within the T1 circuit.

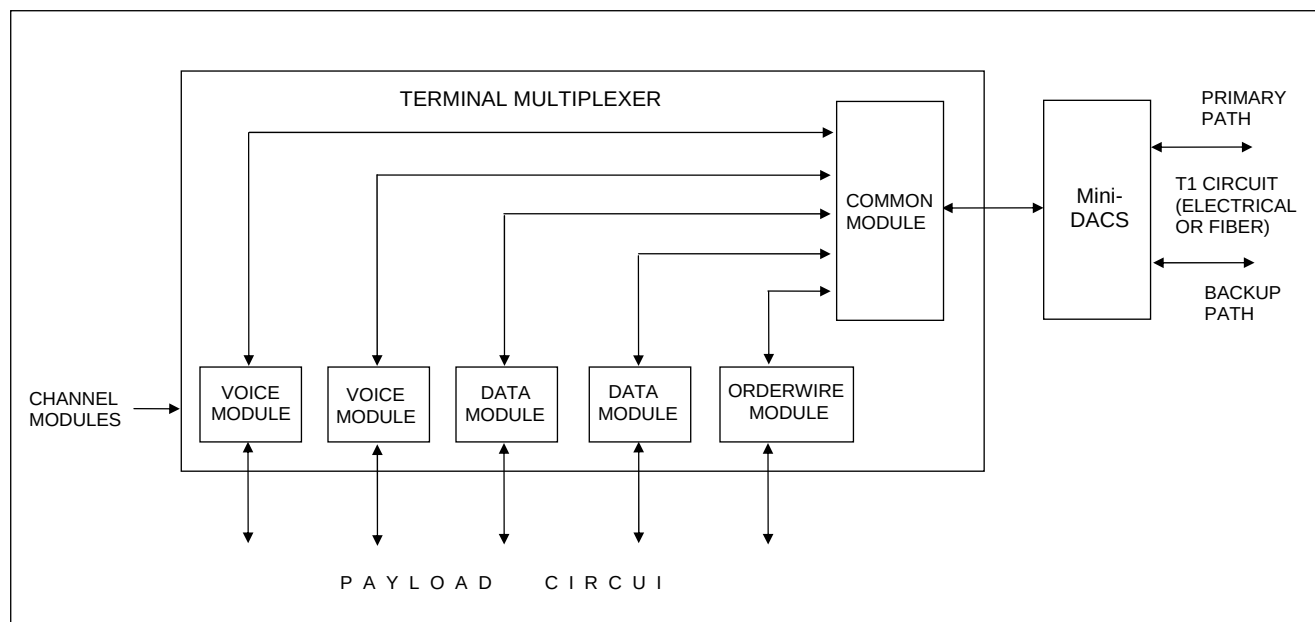
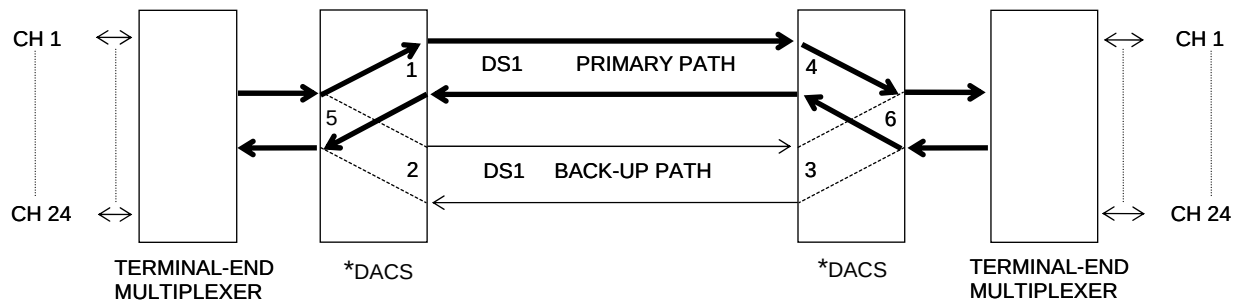


Figure 4-3. Terminal multiplexer with Mini-DACS (sample configuration)

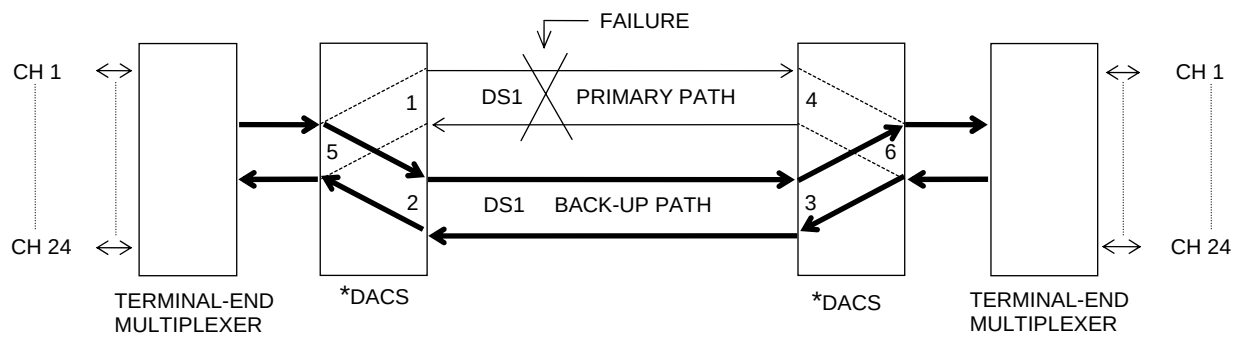
A single T1 circuit provides 24 full-duplex, 64-kbps time slots for an aggregate payload capacity of 1.536 Mbps in each direction. Because the T1 signal format includes an 8-kbps overhead channel for frame synchronization, error detection, and other functions, the actual T1 interface rate is 1.544 Mbps. (See Section 10 for more information on SF and ESF formats.)

4.2.2 POINT-TO-POINT SYSTEM WITH MINI-DACS

Figure 4-4 shows two terminal-end multiplexers, each with a DACS, configured as a point-to-point system. As the figure illustrates, the same payload circuits will appear at both ends of a point-to-point system. Most payload types (such as voice and full-duplex data circuits) are bi-directional, and will have both an input and an output at each terminal multiplexer. Figure 4a shows the system before a failure and Figure 4b shows the system after a failure. The DS1 data is switched automatically upon detection of a DS1 failure on the primary path. After a switch to the back-up path occurs, data will be automatically switched back to the primary path after the DACS detects that the primary path is available. The time to switch upon detection of a failure is programmable by the user. Note that in this configuration, only 3 out of 6 DACS ports are being used.



a. Before Failure



b. After Failure

* Only 3 out of 6 ports are being used in this configuration.

Figure 4-4. Point-to-point System with DACS (sample configuration)

4.2.3 DROP/INSERT MULTIPLEXER WITH MINI-DACS

A drop/insert multiplexer is essentially a pair of back-to-back terminal multiplexers, in which some circuits terminate while others pass through. (See Figure 4-5.) A drop/insert multiplexer can terminate payload circuits from either of two different T1 circuits; that is, from either of two different locations.

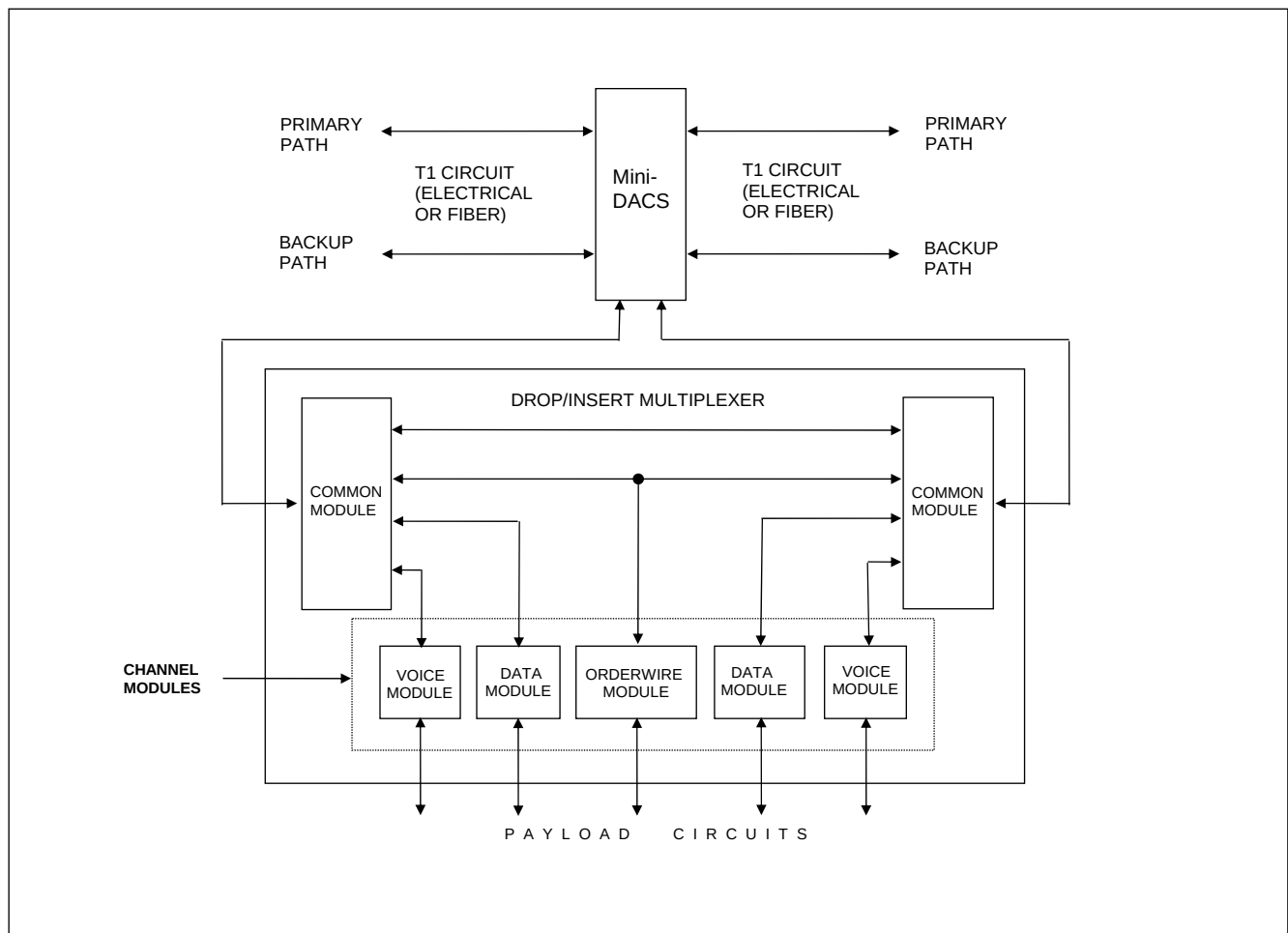


Figure 4-5. Drop/insert multiplexer with Mini-DACS(sample configuration)

4.2.4 DROP/INSERT SYSTEM WITH MINI-DACS

The addition of one or more drop/insert multiplexers converts a simple point-to-point system into a drop/insert system. Data, voice, and orderwire (multiple drop) circuits can be established between any two locations in a T1 drop/insert system. As shown in Figure 4-6, a three-location system can provide circuits between Locations 1 and 2, Locations 2 and 3, and Locations 1 and 3. The only limiting factor is the capacity of the T1 circuit between any two adjacent locations, which is 24 time slots. Drop/insert systems are not limited to a single drop/insert multiplexer, and may contain more than three locations.

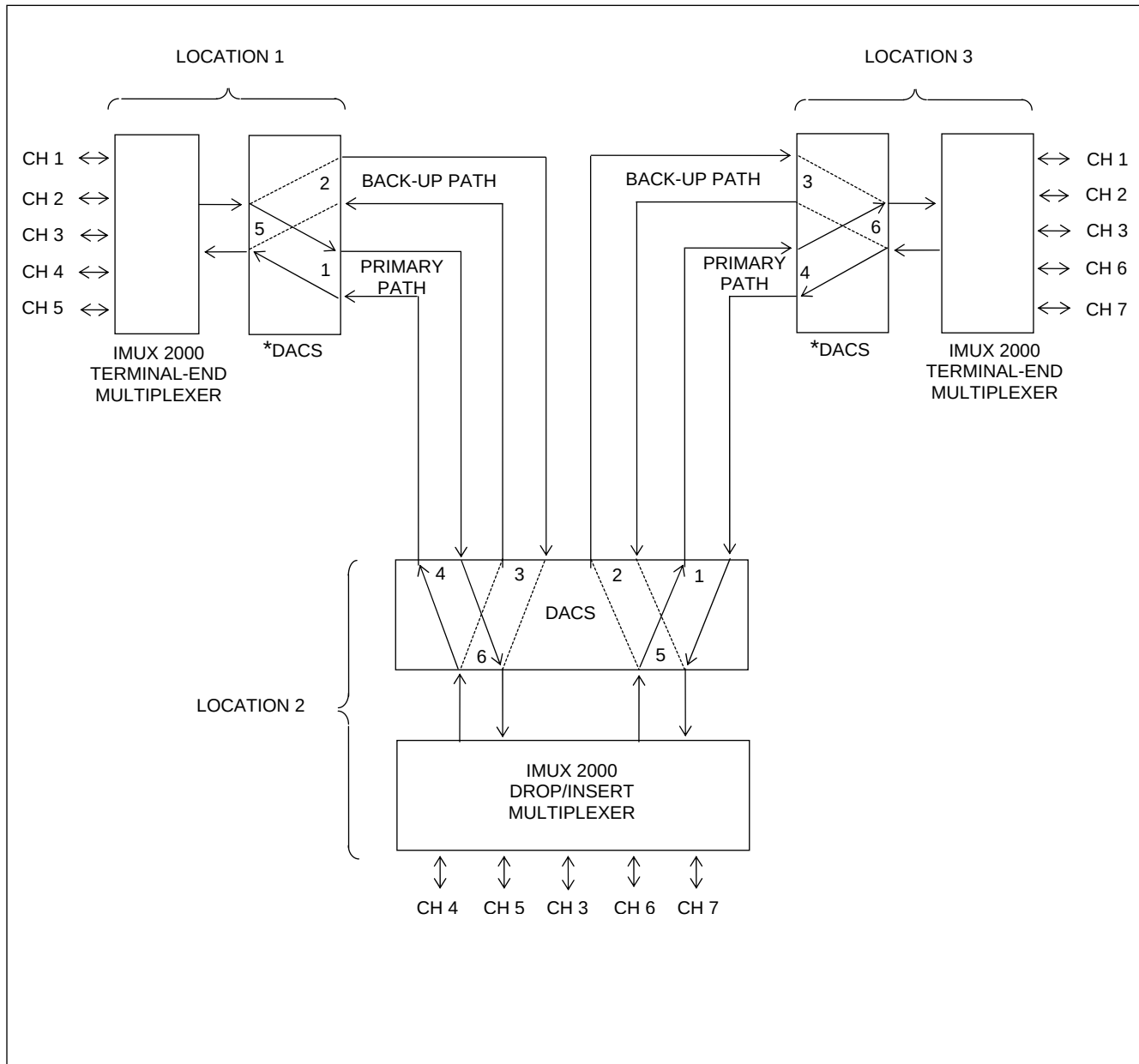


Figure 4-6. Drop/Insert system with DACS (sample configuration)

4.2.5 DACS USED IN A RING CONFIGURATION

Self-healing ring operation of the IMUX 2000 is accomplished using several six-port IMUX 2000 DACS units. Four T1 signals are brought into each location from adjacent nodes to form a ring. (See Figure 4-7). Two terminal-end multiplexers are head and tailed at a central location (Location 1) using a common DACS. All other units around the ring (Locations 2, 3 and 4) are drop/insert units, each utilizing an DACS.

Under normal operation each channel is mapped between nodes through the DACS with a primary T1 path. An alternate or back-up T1 path is circulating around the ring with no data on it. The DACS monitors this back-up path for its availability. If a failure is detected in an adjacent node, the DACS will redirect the effected T1 signal in the opposite direction around the ring on the back-up path. (See Figure 4-8). When the failure is restored, the T1 signal is automatically re-routed back to the normal primary path.

The ring configuration shown in Figure 4-7 can be implemented with either an electrical interface utilizing 2 shielded twisted pairs between nodes, or an optical interface utilizing 2 optical fiber pairs between nodes. This configuration is referred to as a 2 fiber ring. In the two fiber ring configuration, each of the 24 channels within the T1 data stream may not be reused within the loop.

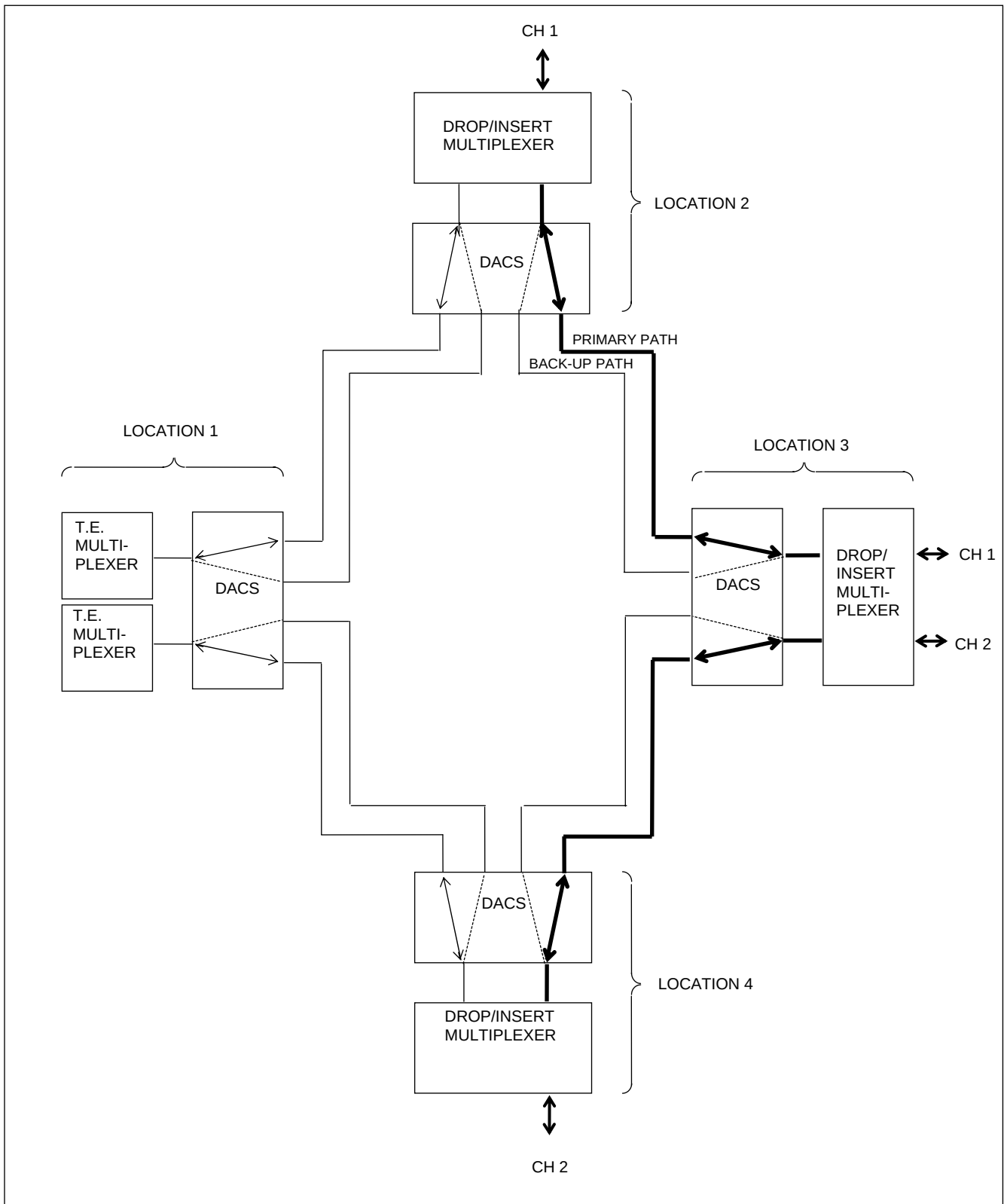


Figure 4-7. DACS 2 fiber ring configuration before a failure (sample configuration)

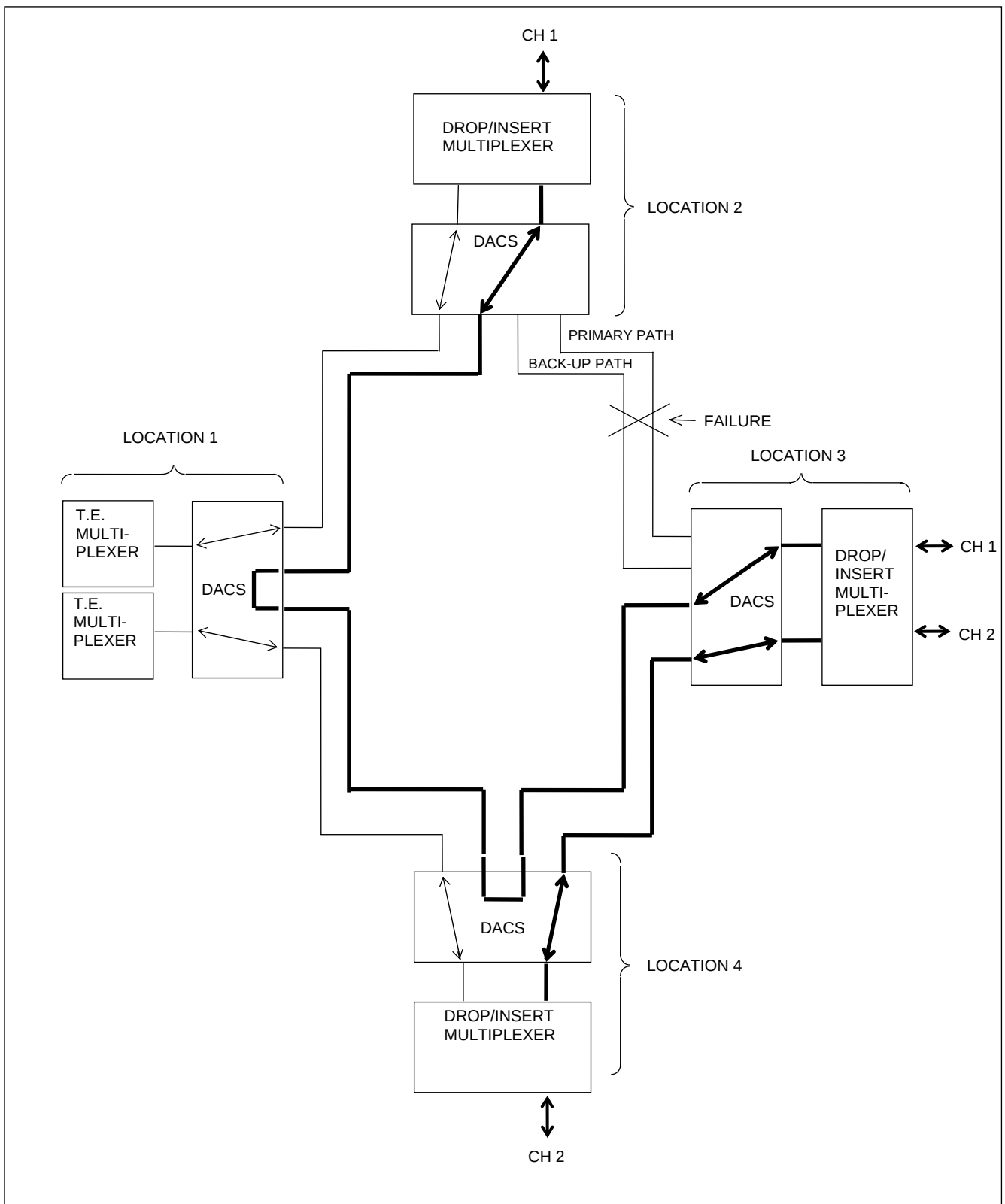


Figure 4-8. DACS 2 fiber ring configuration after a failure (sample configuration)

4.3 MINI-DACS COMPONENTS

Each IMUX 2000 Mini-DACS contains the following components:

<u>Nomenclature</u>	<u>RFL Part No.</u>	<u>See Paragraph</u>
1. DACS Chassis	9597-158515	4.3.1
2. DACS Processor Module	9547-1860	4.3.2
3. DACS Module	9547-1810	4.3.3
4. Power Supply Modules	9547-720,730,740,750	4.3.4
5. Power Supply I/O Module	105490	4.3.5
6. Module Adapters	various	4.3.6
7. OIAs	various	4.3.7

Each of these components is described in the paragraphs that follow.

4.3.1 DACS CHASSIS

The DACS Chassis is the enclosure for the IMUX 2000 Mini-DACS. It has plug-in slots in the front for the main power supply, an optional redundant power supply, the DACS Processor module, and the DACS module. These are the only four modules that plug into the front of the DACS chassis. Plug-in slots at the rear accommodate the power supply I/O module, the SCB/TIM I/O module, the direct digital I/O module, and module adapters (MAs) and optical interface adapters (OIAs) as required. (See Figure 4-5.)

Each IMUX 2000 Mini-DACS Chassis can be installed in a standard 19-inch equipment rack. The Chassis is 5.25 inches (13.3 cm) high, and occupies three rack units of cabinet space (3RU).

The following rules control slot assignments in the DACS chassis:

1. The main power supply (when used), optional redundant power supply (when used), DACS processor module and DACS module must be plugged into the locations shown in Figure 4-10.
2. At the rear of the chassis the Power Supply Alarm I/O module (when used) must be plugged into the location shown in Figure 4-10.
3. At the rear of the chassis the SCB/TIM I/O module (MA-225) must be plugged into slot 5.
4. At the rear of the chassis the Direct Digital I/O module (MA-220) must be plugged into slot 6.

5. At the rear of the chassis OIAs can be plugged into slot pairs 7 and 8, 9 and 10, 11 and 12, or 13 and 14 as required. Note that the OIAs take up two adjacent slot positions.
6. If a Dual DS1 I/O module (MA-230) is used it must be plugged into slot 7 or slot 11. If an MA-230 is plugged into slot 7, then slot 8 must be left blank. If an MA-230 is plugged into slot 11, then slot 12 must be left blank.
7. Slots 1 through 4 and slots 15 through 18 are always blank.

4.3.2 DACS PROCESSOR MODULE

The DACS Processor module is the same module that is used in the ILS chassis. See paragraph 3.3.2 for more information.

4.3.3 DACS MODULE

The DACS module is similar to the ILS module with one added capability. It can reroute incoming DS0 traffic to any outgoing DS0. The module has six integrated T1 framer chips to frame and decode the incoming T1 signals. The DS0 traffic is sent to an FPGA (Field Programmable Gate Array) which breaks down the frame and stores the DS0 bytes in a dual port RAM. The location in which the data is stored determines when and where it is transmitted. A second FPGA reads the dual port RAM and directs the data to the framer chips for retransmission. The mapping of the DS0 traffic is stored in a second dual port RAM. The receiving FPGA reads that RAM to determine where to store the received DS0 traffic.

The robbed bit signal data does not follow this path, but instead is sent to the processor. The processor redirects these bits as needed. The FDL bits are also redirected by the processor. All user interface with this module is controlled by the processor board.

4.3.4 POWER SUPPLY MODULES

The IMUX 2000 DACS can be configured with eight different power supplies that can operate with the following input voltages: 24 Vdc, 48 Vdc, 120 Vac, 125 Vdc, 220 Vac, 250 Vdc. The High Power versions will give 75 watts of output power. (The specifications listed in Section 11 of this manual provide more information on power supply input voltage ranges, input fuse requirements, and output power ratings). The DACS chassis can contain one or two power supplies with the same capacity. The power supplies used in the DACS chassis are identical to those used in the IMUX 2000 Multiplexer chassis. A functional diagram of the IMUX 2000 power supply appears in Figure 2-11.

If used, the first power supply inserts into the optional main power supply slot, and if used, the redundant power supply inserts into the optional redundant power supply slot as shown in figure 4-9. In some applications, the DACS chassis may receive all of its main power and backup power from the power supply(s) mounted in the IMUX 2000 Multiplexer chassis or the IMUX 2000 Expansion shelf. In this case both of these slots will be blank in the DACS chassis. The DACS chassis will receive all of its power from the IMUX 2000 Multiplexer chassis or expansion chassis via an auxiliary power cable. See Section 9 for more information.

Regardless of the number of power supplies used in a given setup or in which chassis they are installed, the second power module, if installed, provides power supply redundancy if the main power supply fails. The redundant supply automatically comes on-line with no loss of transmission.

If you are adding modules to an existing system equipped with dual power supplies, always verify that the total power consumption does not exceed the capacity of a single supply. This will insure power supply redundancy.

4.3.5 POWER SUPPLY ALARM I/O MODULE

The power supply alarm I/O module used in the DACS chassis is identical to the one used in the IMUX 2000 Multiplexer chassis. Refer to paragraph 2.3.6 for more information.

4.3.6 MODULE ADAPTERS

This information is covered in Section 3. Refer to paragraph 3.3.6.

4.3.6.1 MA-220 Module Adapter

This information is covered in Section 3. Refer to paragraph 3.3.6.1.

4.3.6.2 MA-225 Module Adapter

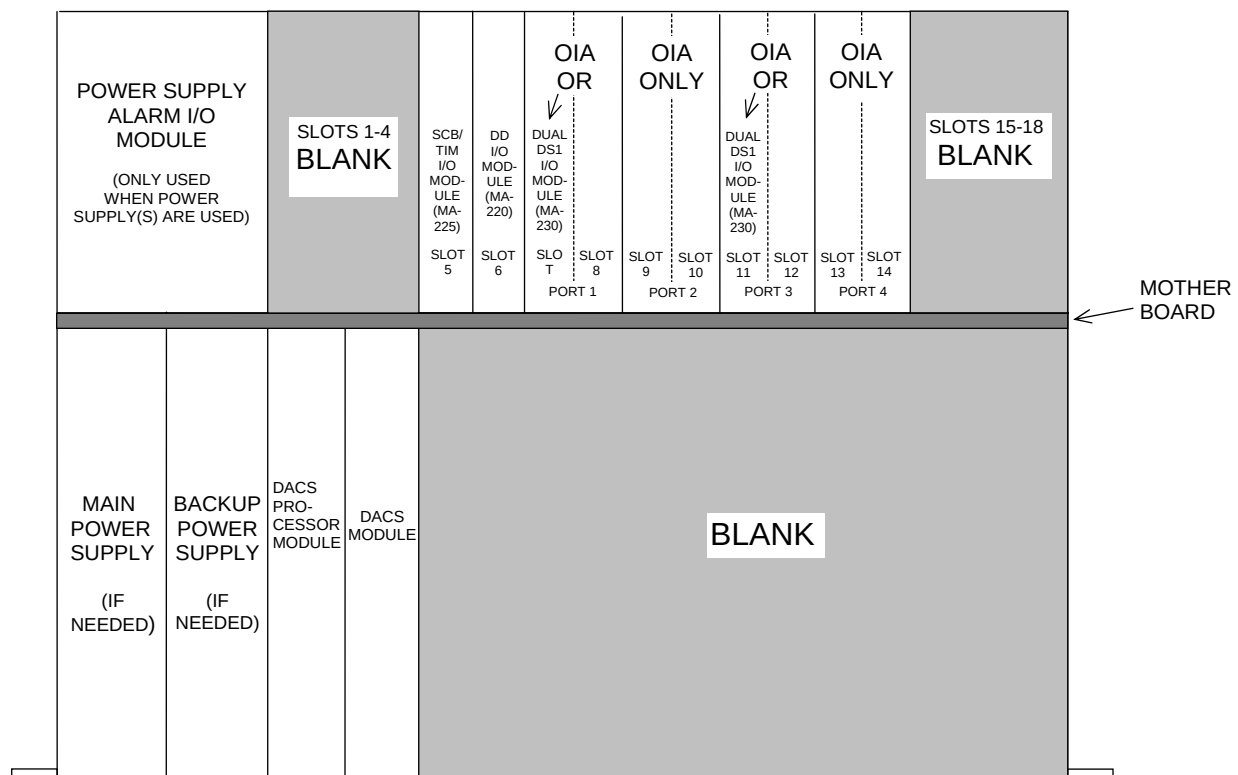
This information is covered in Section 3. Refer to paragraph 3.3.6.2.

4.3.6.3 MA-230 Module Adapter

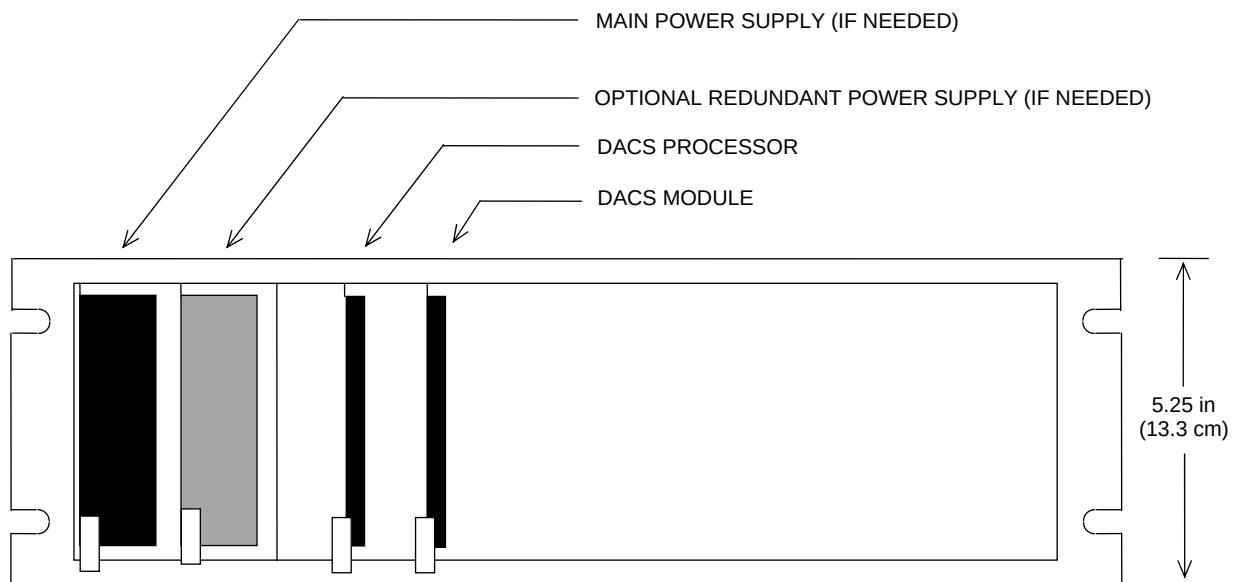
This information is covered in Section 3. Refer to paragraph 3.3.6.3.

4.3.7 OPTICAL INTERFACE ADAPTERS

The Optical Interface Adapters used in the IMUX 200 DACS chassis are identical to those used in the IMUX 2000 Multiplexer chassis. Refer to paragraph 2.3.4.2 for more information.



DACS CHASSIS TOP VIEW



DACS CHASSIS FRONT VIEW

Figure 4-9. Front and top views of DACs chassis

4.4 MINI-DACS FRONT-PANEL SWITCHES AND INDICATORS

Figure 4-10 is a front view of the IMUX 2000 Mini-DACS with its front door open. The main power supply module and the DACS processor module are expanded to show the locations of all front panel switches and indicators. Functional descriptions of these switches and indicators appear in Tables 4-1 and 4-2. The numbers in the call-out columns of these tables refer to the call-outs shown in Figure 4-10.

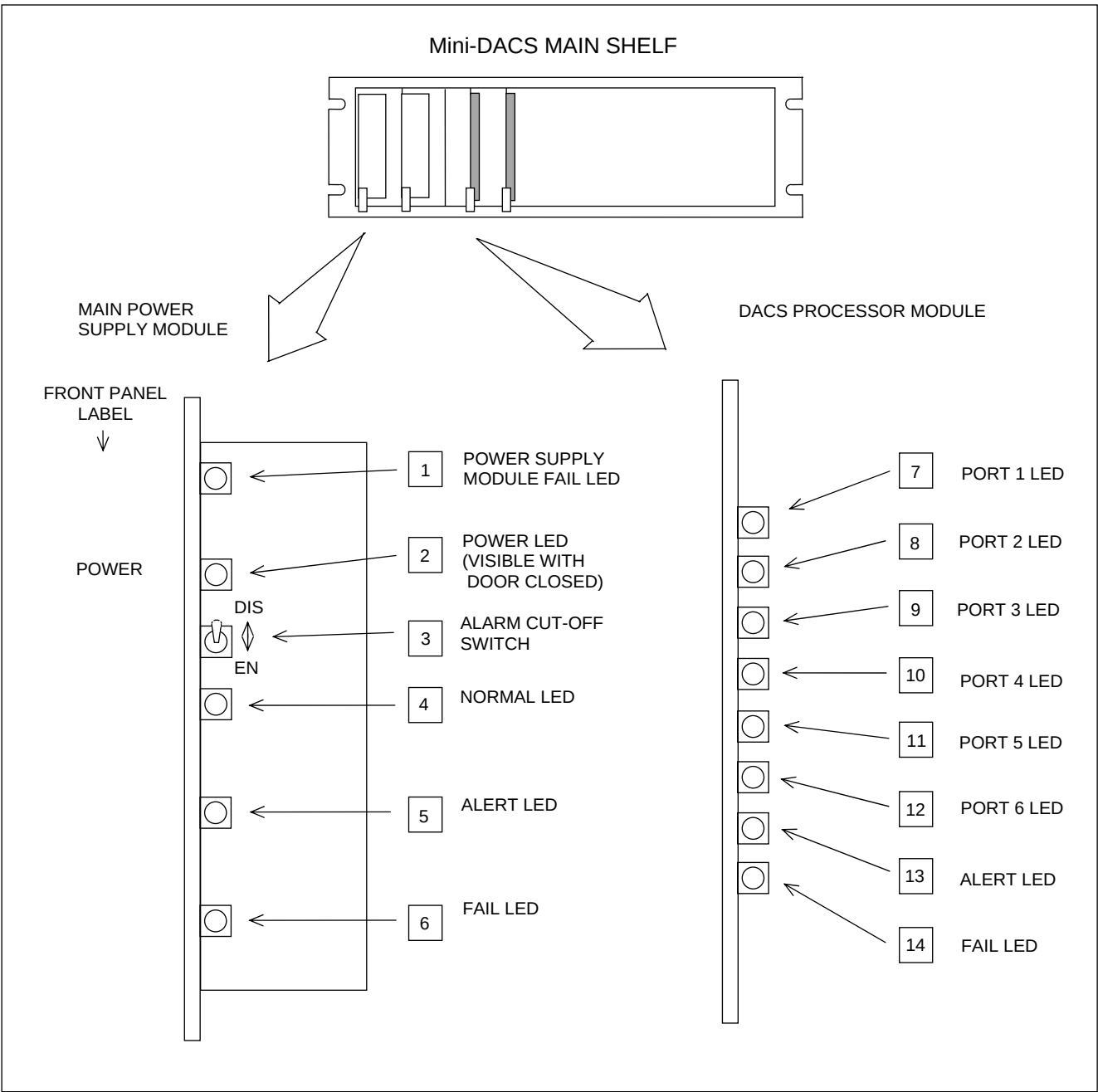


Figure 4-10. DACS Front-panel switches and indicators

4.4.1 SYSTEM STATUS INDICATORS AND THE ACO SWITCH

When the IMUX 2000 DACS front door is closed, one LED indicator on its main power supply is visible, one LED indicator on its backup power supply is visible, and eight LED indicators on the DACS processor module are visible. (See Figure 4-11.) These indicators show the status of the DACS at a glance. (See Table 4-2.)

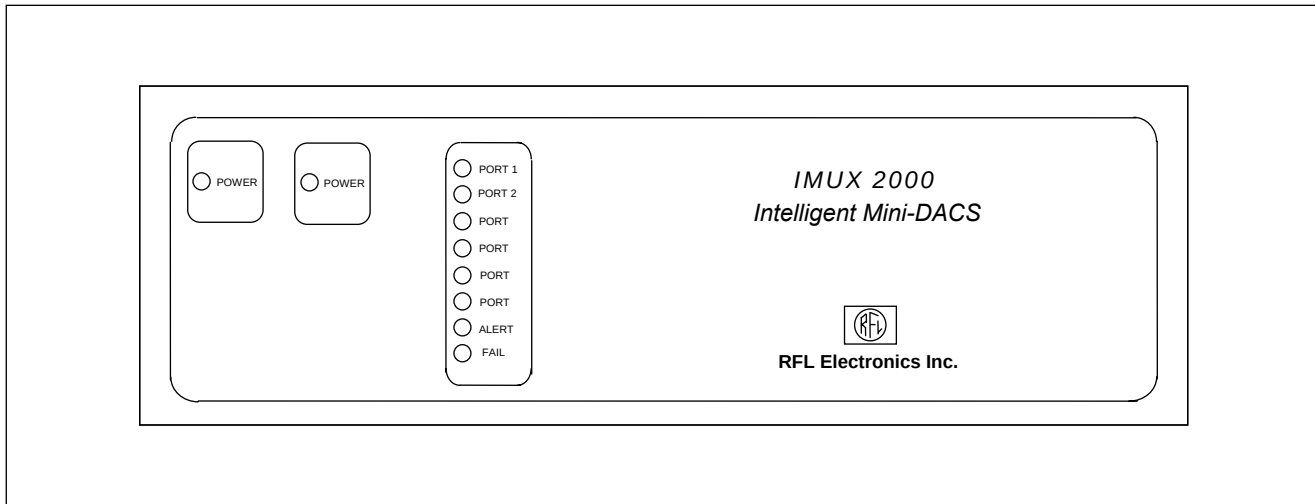


Figure 4-11. Front view of DACS with door closed, showing the system status indicators

Table 4-1. System status indicators and the ACO switch

Item (Fig. 4-10)	Module	Module Label	DACS Front Panel Label	Description
1	Power supply	PS		Power Supply Module Fail LED. Lights when the power supply module has failed.
2	Power supply	PWR	POWER	Power LED. Lights when the DACS is powered. If the DACS is equipped with a redundant power supply, this indicator will remain on if one of the power supplies has failed and the remaining supply has enough capacity to power the DACS by itself.
3	Power supply	DIS/EN		Alarm Cut-Off Switch (Disable/Enable). When this switch is in the Disabled position and no alarms are active, the alert indicator will light. When this switch is in the Enabled position the ALERT and ALARM relays are on line and will activate in response to system fault conditions. NOTE: If the DACS contains two power supply modules, the ACO switches on <u>both</u> power supply modules must be placed in the disabled position to disable the ALERT and FAIL relays.
4	Power supply	NORM		Normal LED. Lights when neither an ALERT or FAIL condition exists.
5	Power supply	ALERT		Alert LED. Lights when the following condition exists: Loss of one port
6	Power supply	FAIL		Fail LED. Lights when the following condition exists: Loss of more than one port

4.4.2 DACS PROCESSOR MODULE, STATUS INDICATORS

There are eight LED indicators on the DACS processor module that indicate the status of the DACS Processor. Table 4-2 explains the function of each of these indicators.

Table 4-2. DACS Processor status indicators

Item (Fig. 4-10)	Module	Module Label	DACS Front Panel Label	Description
7	DACS processor	DS1	PORT 1	Lights when the Port 1 active flag has been set “on” and no errors have been detected. (See note 1)
8	DACS processor	DS2	PORT 2	Lights when the Port 2 active flag has been set “on” and no errors have been detected. (See note 1)
9	DACS processor	DS3	PORT 3	Lights when the Port 3 active flag has been set “on” and no errors have been detected. (See note 1)
10	DACS processor	DS4	PORT 4	Lights when the Port 4 active flag has been set “on” and no errors have been detected. (See note 1)
11	DACS processor	DS5	PORT 5	Lights when the Port 5 active flag has been set “on” and no errors have been detected. (See note 1)
12	DACS processor	DS6	PORT 6	Lights when the Port 6 active flag has been set “on” and no errors have been detected. (See note 1)
13	DACS processor	DS7	ALERT	Lights when an error has been detected on one port and an alternate map is in use.
14	DACS processor	DS8	FAIL	Lights when an error has been detected on two or more ports and an alternate map is in use.

Notes: 1. Ports 1 through 6 can have their active flags set “on” or “off” by the user via the user interface. This can be done with a dumb terminal using Remote Configuration commands (See Section 7 of this manual), or a PC equipped with the Network Management Software (See Section 8 of this manual).

NOTE

Remote configuration and Status commands for the DACS are described in Section 8.7

4.5 DETERMINING DACS CHASSIS POWER REQUIREMENTS

To determine how much power the modules in a DACS chassis will draw, refer to Table 4-3. The power consumption of all DACS modules is given in this table.

To use the table, write down the number of modules of each type in the DACS chassis in the "Quantity" column. Multiply the quantity by power consumption value to determine the total power consumption for all modules of that type. When you are finished, add up all the totals to determine the total power consumption for the chassis.

Table 4-3. Determining power requirements for the DACS Chassis

Module Designation/Description	Input Power (watts)	Quantity	Total
MA-220 Module Adapter	(1)		
MA-225 Module Adapter	0.5		
MA-230 Module Adapter	0.0 (2)	1	0.0
DACS Processor Module	1.0	1	1.0
DACS Module	2.75	1	2.75
Optical Interface Adapter (OIA)	2.6		
TOTAL POWER CONSUMPTION ⁽³⁾			

1. Included in the input power requirement for the CM-3B Common Module.
2. The MA-230 module has no active components and therefore draws no power.
3. If total power consumption exceeds 50 watts, additional power supply capacity is required.

4.6 DACS MAPPING

4.6.1 INTRODUCTION

The function of the DACS is to “groom” or break down the DSO elements in six DS1 frames and then recombine them as specified in a map. Each DACS has five DSO grooming maps labeled map 0, and maps 1-4. Map 0 is the primary DACS map for no detected failures in the network path.

Each DACS has two sets of paths: four network paths which are connected either to another T1 system or to a higher order multiplexer, and two paths connected to an IMUX 2000 Multiplexer. These paths are shown in Figure 4-12. The DACS monitors T1 data passing through it on its four network paths and uses an alternate map if an error is detected on one of these network paths. The DACS will switch from map 0 to map 1 if a failure has been detected in the network path connected to port 1, to map 2 if a failure has been detected in the network path connected to port 2, to map 3 if a failure has been detected in the network path connected to port 3, and to map 4 if a failure has been detected in the network path connected to port 4. The DACS uses programmable and non-programmable criteria for error detection. The DACS can also detect a recovery from an error and will switch back to the primary map.

To perform these functions, the DACS uses a microprocessor that monitors its internal circuitry. It is programmable and can be monitored via the IMUX Serial Control Bus. The DACS also contains LEDs and alarm contacts.

The DACS can operate in one of two modes: Super Frame (SF) and Extended Super Frame (ESF). See Section 13 for SF and ESF formats.

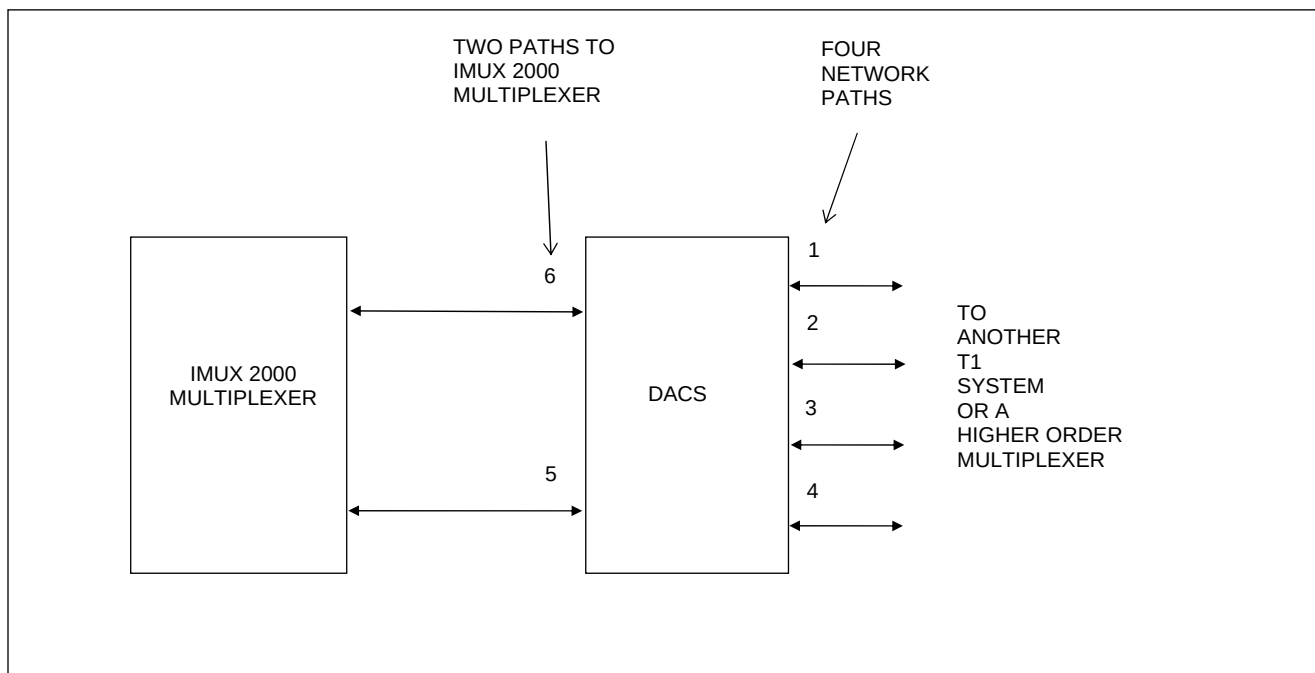


Figure 4-12. DACS paths and port numbers

4.6.2 DSO GROOMING

The configuration for DSO grooming is contained in the active map. There are five maps: one for no network path failure and one each for each network path failure. The transmitted DSO data is mapped to the received DSO data. Each transmitted DSO has a coded index in the map referred to as the DSO time slot. The content of the DSO time slot is the address of the received DSO data. Figure 4-13 shows a typical DACS and its active DACS map. This map is described in detail in paragraph 4.6.5.

4.6.3 ERROR DETECTION AND SWITCHING

The DACS constantly monitors its network paths for the following errors: bit error rate exceeded, all ones signal, loss of data, and loss of frame. Any one of these errors can cause an alarm condition, but only if the enable for each has been selected via programming. In addition, any combination of the four paths can go unused. If unused, a failure in a path will not cause an alarm or a change in operation. Before switching, the DACS will wait a selected time delay. If the error is removed during this period, the DACS will not switch.

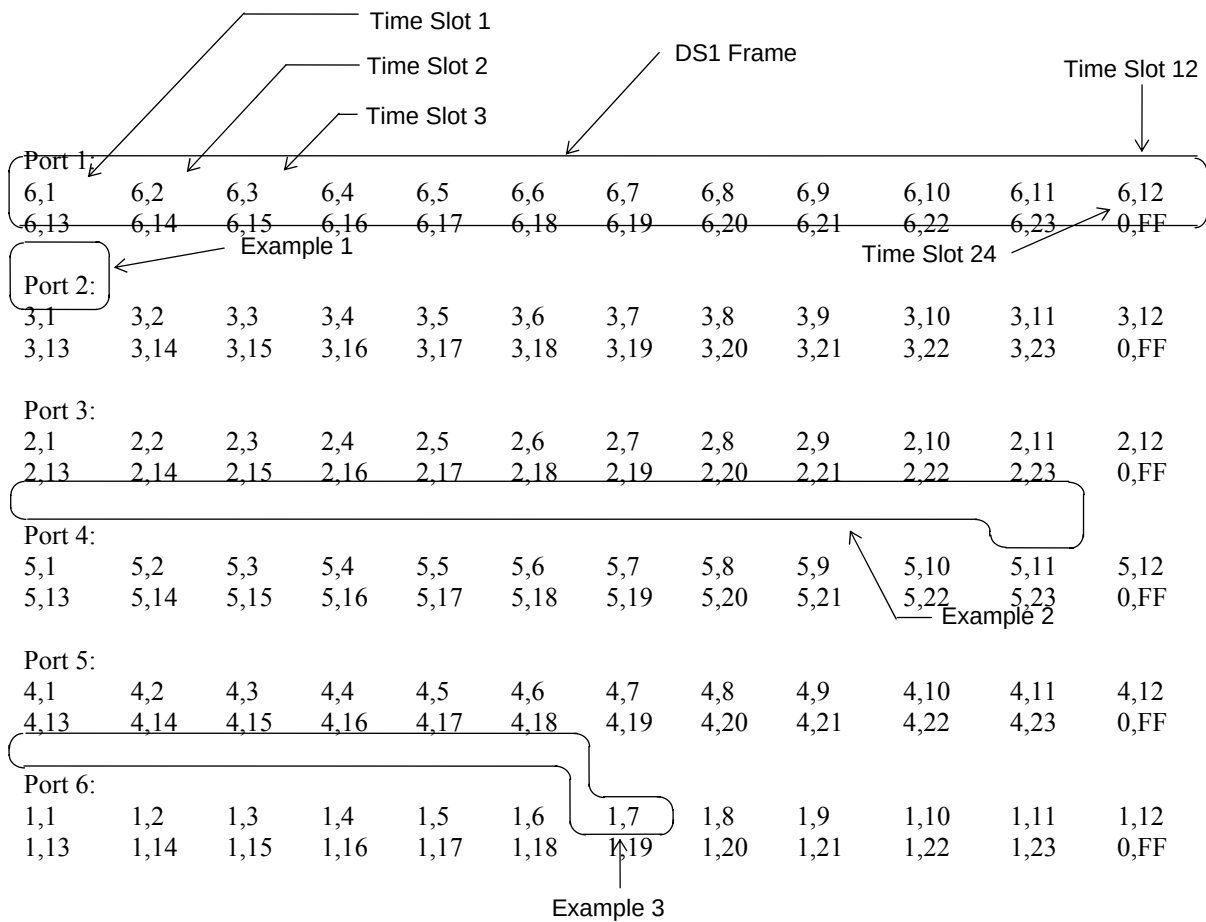
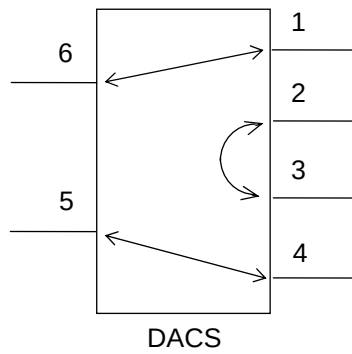
The bit error rate is determined by periodically sampling the CRC failures and comparing them against a programmed value. The other error conditions are read directly from the internal circuitry of the Dallas transceiver chip. The loss of frame error is either the severely erred framing event (SEFE) or the loss of sync (RLOS) signal. The loss of data signal is receive carrier loss (RCL). The all ones signal is the blue alarm (RBL).

The DACS can only change to one other map, upon the first failure. Subsequent failures on other channels will not cause it to change to another map.

4.6.4 ERROR RECOVERY

Although a DACS has switched, it will still transmit DSOs along the failed network path as directed by the new map. Any transceiver affected by an error will undergo recovery, even if it has not caused a switch.

Since a transceiver can only monitor receive errors, it insures that its fellow transceiver gets an error by sending an all ones signal for 10 ms. After this, the transceiver waits until all errors are cleared. It allows an extra 50 ms period after errors are cleared to allow the fellow transceiver to fully reframe. Then it waits an extra recovery time before going fully on line.



Note: The above examples are referenced in paragraph 4.6.5.

Figure 4-13. A typical DACS and its active DACS map

4.6.5 DESCRIPTION OF A TYPICAL DACS MAP

Figure 4-13 represents a typical DACS and its active DACS map. Each DACS has six receive ports and six transmit ports labeled Port 1 through Port 6. Each port has a DS1 frame, and each frame has 24 DSO time slots labeled Time Slot 1 through Time Slot 24. The contents of each time slot has two numbers separated by a comma. The first number is the Port number, and the second number is the Time Slot number.

The map shows where the DSO data is coming from and where it is going to. The position in the map, which is the DSO time slot, and its corresponding port number, is where the data is going to and the content of that DSO time slot is where the data is coming from. This can be better understood by referring to the following examples.

- Example 1: 3,1 under the heading Port 2 is located in time slot 1. This indicates that the data coming from Port 3 time slot 1 is going to Port 2 time slot 1.
- Example 2: 5,11 under the heading Port 4 is located in time slot 11. This indicates that the data coming from Port 5 time slot 11 is going to Port 4 time slot 11.
- Example 3: 1,19 under the heading Port 6 is located in time slot 19. This indicates that the data coming from Port 1 time slot 19 is going to Port 6 time slot 19.

If a time slot has no data in it, it will be labeled 0,FF. This can be seen in time slot 24 for all six ports.

4.6.6 MAPPING OF A DACS RING

Figure 4-14 shows an example of a fiber optic DACS ring consisting of four DACS units labeled DACS A, DACS B, DACS C, and DACS D. In this example no failures are detected in any of the network paths. Therefore, each DACS unit is using map 0. The outer heavy line represents the primary path and the inner light line represents the backup path.

Figure 4-15 shows the same DACS ring with a break in the network path between DACS A and DACS B. The break can be in any one of the four fiber optic cables between DACS A and DACS B. Let's assume in this example that the break occurred between DACS A port 1 and DACS B port 4. This will be detected by DACS A and DACS B and will cause DACS A to switch to map 1 and DACS B to switch to map 4. DACS C and D will be unaffected and therefore will still use map 0. The remapping will cause data to be re-routed away from all direct connections between DACS A and DACS B, and will now follow the backup path as shown by the heavy line in the figure.

Tables 4-4 through 4-23 show all five maps for each of the four DACS units.

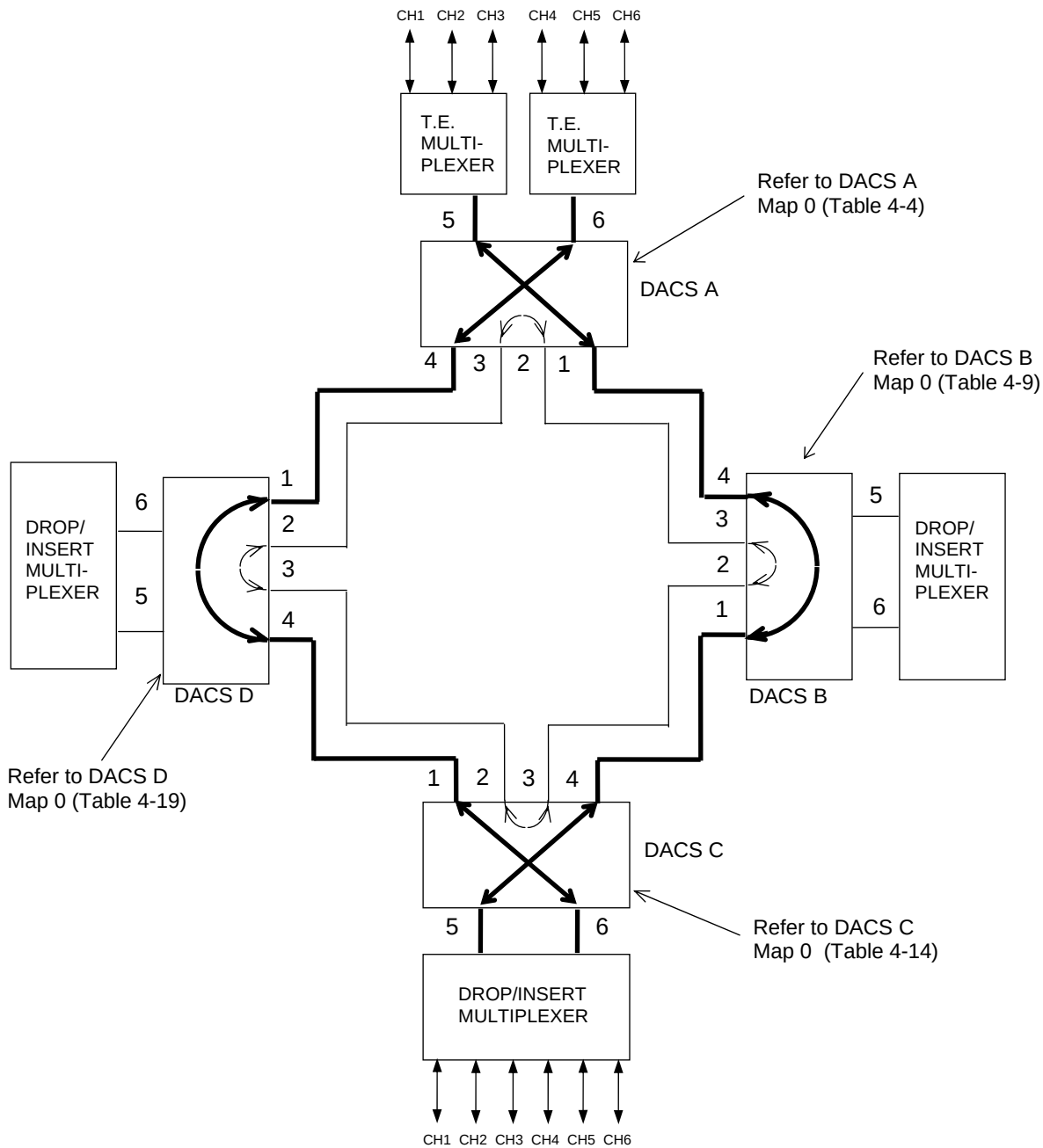


Figure 4-14. DACS fiber ring configuration before a failure (sample configuration)

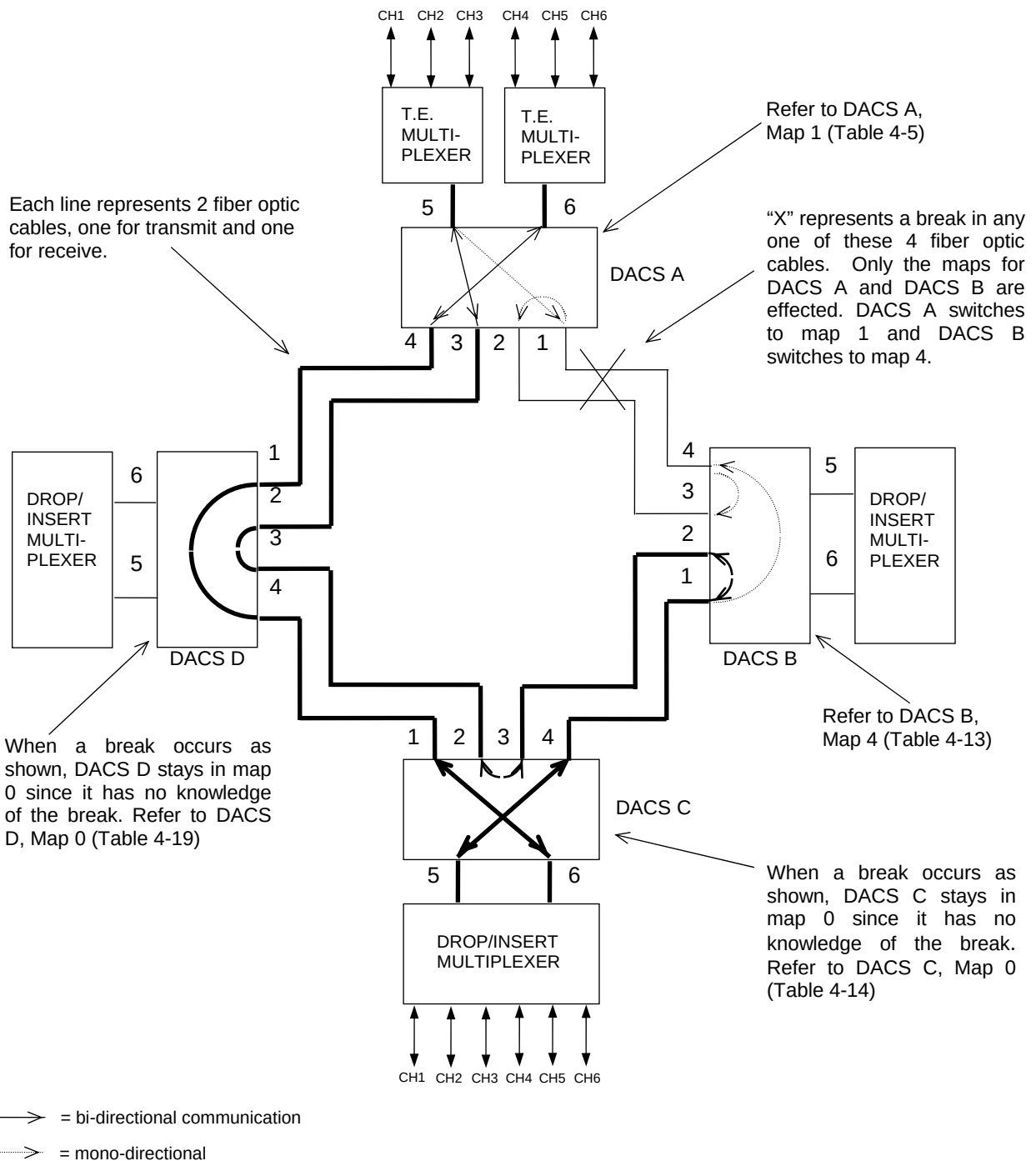


Figure 4-15. DACS fiber ring configuration after a failure (sample configuration)

Table 4-4, DACS A, Map 0

Port 1												
5,1	5,2	5,3	5,4	5,5	5,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 2												
3,1	3,2	3,3	3,4	3,5	3,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 3												
2,1	2,2	2,3	2,4	2,5	2,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 4												
6,1	6,2	6,3	6,4	6,5	6,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 5												
1,1	1,2	1,3	1,4	1,5	1,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 6												
4,1	4,2	4,3	4,4	4,5	4,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF

Table 4-5. DACS A, Map 1

Port 1												
5,1	5,2	5,3	5,4	5,5	5,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 2												
1,1	1,2	1,3	1,4	1,5	1,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 3												
5,1	5,2	5,3	5,4	5,5	5,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 4												
6,1	6,2	6,3	6,4	6,5	6,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 5												
3,1	3,2	3,3	3,4	3,5	3,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 6												
4,1	4,2	4,3	4,4	4,5	4,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF

Table 4-6. DACS A, Map 2

Port 1												
5,1	5,2	5,3	5,4	5,5	5,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 2												
1,1	1,2	1,3	1,4	1,5	1,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 3												
5,1	5,2	5,3	5,4	5,5	5,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 4												
6,1	6,2	6,3	6,4	6,5	6,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 5												
3,1	3,2	3,3	3,4	3,5	3,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 6												
4,1	4,2	4,3	4,4	4,5	4,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF

Table 4-7. DACS A, Map 3

Port 1												
5,1	5,2	5,3	5,4	5,5	5,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 2												
6,1	6,2	6,3	6,4	6,5	6,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 3												
4,1	4,2	4,3	4,4	4,5	4,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 4												
6,1	6,2	6,3	6,4	6,5	6,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 5												
1,1	1,2	1,3	1,4	1,5	1,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 6												
2,1	2,2	2,3	2,4	2,5	2,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF

Table 4-8. DACS A, Map 4

Port 1											
5,1	5,2	5,3	5,4	5,5	5,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 2											
6,1	6,2	6,3	6,4	6,5	6,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 3											
4,1	4,2	4,3	4,4	4,5	4,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 4											
6,1	6,2	6,3	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 5											
1,1	1,2	1,3	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 6											
2,1	2,2	2,3	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF

Table 4-9. DACS B, Map 0

Port 1											
4,1	4,2	4,3	4,4	4,5	4,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 2											
3,1	3,2	3,3	3,4	3,5	3,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 3											
2,1	2,2	2,3	2,4	2,5	2,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 4											
1,1	1,2	1,3	1,4	1,5	1,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 5											
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 6											
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF

Table 4-10. DACS B, Map 1

Port 1												
4,1	4,2	4,3	4,4	4,5	4,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 2												
1,1	1,2	1,3	1,4	1,5	1,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 3												
4,1	4,2	4,3	4,4	4,5	4,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 4												
3,1	3,2	3,3	3,4	3,5	3,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 5												
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 6												
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF

Table 4-11. DACS B, Map 2

Port 1												
4,1	4,2	4,3	4,4	4,5	4,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 2												
1,1	1,2	1,3	1,4	1,5	1,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 3												
4,1	4,2	4,3	4,4	4,5	4,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 4												
3,1	3,2	3,3	3,4	3,5	3,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 5												
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 6												
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF

Table 4-12. DACS B, Map 3

Port 1												
2,1	2,2	2,3	2,4	2,5	2,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 2												
1,1	1,2	1,3	1,4	1,5	1,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 3												
4,1	4,2	4,3	4,4	4,5	4,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 4												
1,1	1,2	1,3	1,4	1,5	1,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 5												
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 6												
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF

Table 4-13. DACS B, Map 4

Port 1												
2,1	2,2	2,3	2,4	2,5	2,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 2												
1,1	1,2	1,3	1,4	1,5	1,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 3												
4,1	4,2	4,3	4,4	4,5	4,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 4												
1,1	1,2	1,3	1,4	1,5	1,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 5												
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 6												
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF

Table 4-14. DACS C, Map 0

Port 1												
6,1	6,2	6,3	6,4	6,5	6,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 2												
3,1	3,2	3,3	3,4	3,5	3,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 3												
2,1	2,2	2,3	2,4	2,5	2,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 4												
5,1	5,2	5,3	5,4	5,5	5,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 5												
4,1	4,2	4,3	4,4	4,5	4,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 6												
1,1	1,2	1,3	1,4	1,5	1,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF

Table 4-15. DACS C, Map 1

Port 1												
6,1	6,2	6,3	6,4	6,5	6,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 2												
1,1	1,2	1,3	1,4	1,5	1,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 3												
6,1	6,2	6,3	6,4	6,5	6,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 4												
5,1	5,2	5,3	5,4	5,5	5,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 5												
4,1	4,2	4,3	4,4	4,5	4,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 6												
3,1	3,2	3,3	3,4	3,5	3,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF

Table 4-16. DACS C, Map 2

Port 1												
6,1	6,2	6,3	6,4	6,5	6,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 2												
1,1	1,2	1,3	1,4	1,5	1,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 3												
6,1	6,2	6,3	6,4	6,5	6,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 4												
5,1	5,2	5,3	5,4	5,5	5,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 5												
4,1	4,2	4,3	4,4	4,5	4,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 6												
3,1	3,2	3,3	3,4	3,5	3,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF

Table 4-17. DACS C, Map 3

Port 1												
6,1	6,2	6,3	6,4	6,5	6,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 2												
5,1	5,2	5,3	5,4	5,5	5,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 3												
4,1	4,2	4,3	4,4	4,5	4,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 4												
5,1	5,2	5,3	5,4	5,5	5,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 5												
2,1	2,2	2,3	2,3	2,5	2,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 6												
1,1	1,2	1,3	1,4	1,5	1,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF

Table 4-18. DACS C, Map 4

Port 1												
6,1	6,2	6,3	6,4	6,5	6,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 2												
5,1	5,2	5,3	5,4	5,5	5,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 3												
4,1	4,2	4,3	4,4	4,5	4,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 4												
5,1	5,2	5,3	5,4	5,5	5,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 5												
2,1	2,2	2,3	2,4	2,5	2,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 6												
1,1	1,2	1,3	1,4	1,5	1,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF

Table 4-19. DACS D, Map 0

Port 1												
4,1	4,2	4,3	4,4	4,5	4,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 2												
3,1	3,2	3,3	3,4	3,5	3,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 3												
2,1	2,2	2,3	2,4	2,5	2,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 4												
1,1	1,2	1,3	1,4	1,5	1,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 5												
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 6												
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF

Table 4-20. DACS D, Map 1

Port 1												
4,1	4,2	4,3	4,4	4,5	4,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 2												
1,1	1,2	1,3	1,4	1,5	1,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 3												
4,1	4,2	4,3	4,4	4,5	4,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 4												
3,1	3,2	3,3	3,4	3,5	3,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 5												
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 6												
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF

Table 4-21. DACS D, Map 2

Port 1												
4,1	4,2	4,3	4,4	4,5	4,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 2												
1,1	1,2	1,3	1,4	1,5	1,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 3												
4,1	4,2	4,3	4,4	4,5	4,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 4												
3,1	3,2	3,3	3,4	3,5	3,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 5												
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 6												
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF

Table 4-22. DACS D, Map 3

Port 1												
2,1	2,2	2,3	2,4	2,5	2,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 2												
1,1	1,2	1,3	1,4	1,5	1,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 3												
4,1	4,2	4,3	4,4	4,5	4,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 4												
1,1	1,2	1,3	1,4	1,5	1,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 5												
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 6												
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF

Table 4-23. DACS D, Map 4

Port 1												
2,1	2,2	2,3	2,4	2,5	2,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 2												
1,1	1,2	1,3	1,4	1,5	1,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 3												
4,1	4,2	4,3	4,4	4,5	4,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 4												
1,1	1,2	1,3	1,4	1,5	1,6	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 5												
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
Port 6												
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF
0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF	0,FF

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SECTION 5. CHANNEL MODULES OVERVIEW

5.1 CHANNEL MODULE TYPES

There are several types of channel modules which can be used with the IMUX 2000 Multiplexer. Detailed information on each channel module type appears in the following sections of this manual:

<u>Module Type</u>	<u>Additional Information</u>
Asynchronous Data	Section 15
Synchronous Data	Section 16
Voice	Section 17
Protection and Control	Section 18
Video	Section 19

Sections 15 through 19 of this manual contain Instruction Data Sheets for all channel modules available as of the date this manual was printed. Contact the factory or an RFL Sales Representative for the latest listing of available channel modules.

5.2 CHANNEL MODULE CHARACTERISTICS

5.2.1 RELATIONSHIP BETWEEN CIRCUITS AND TIME SLOTS

Some channel modules provide one or several circuits over a single 64-Kbps time slot. For example, a single-port RS-449 module can support one synchronous data circuit operating at bit rates up to 64 Kbps. On the other hand, a seven-port RS-232 channel module can support up to seven asynchronous data circuits, each operating at a bit rate of up to 1.2 Kbps. Both of these channel module types require only one 64-Kbps time slot in each direction of transmission.

Other channel module types require multiple time slots per circuit. For example, an RFL DS-64NC Wideband Synchronous Data Module may be configured to operate from 64 Kbps to 1.536 Mbps. It may use one time slot within a given T1 circuit, or all twenty-four.

5.2.2 POINT-TO-POINT AND POINT-TO-MULTIPOINT CIRCUITS

Most circuits provided by IMUX 2000 systems are point-to-point. However, several types of channel modules can be configured for point-to-multipoint operation. For example, a data polling channel module can be used to communicate with several locations over a single DS0 for point-to-multipoint operation. Orderwire voice modules communicate using a similar arrangement.

5.3 PHYSICAL SLOTS AND TIME SLOTS

As discussed above, a given channel module (depending on its function) may use one **or more** of the twenty-four 64-Kbps time slots provided by each direction of a T1 circuit. In addition, a given channel module may be assigned to any available time slot (or group of time slots) within a T1 circuit, regardless of its physical location (slot) on an IMUX 2000 equipment shelf. This makes it important to distinguish **physical slots** on IMUX 2000 multiplexer shelves from **time slots** within the T1 circuit. In most cases, they are **not** directly related.

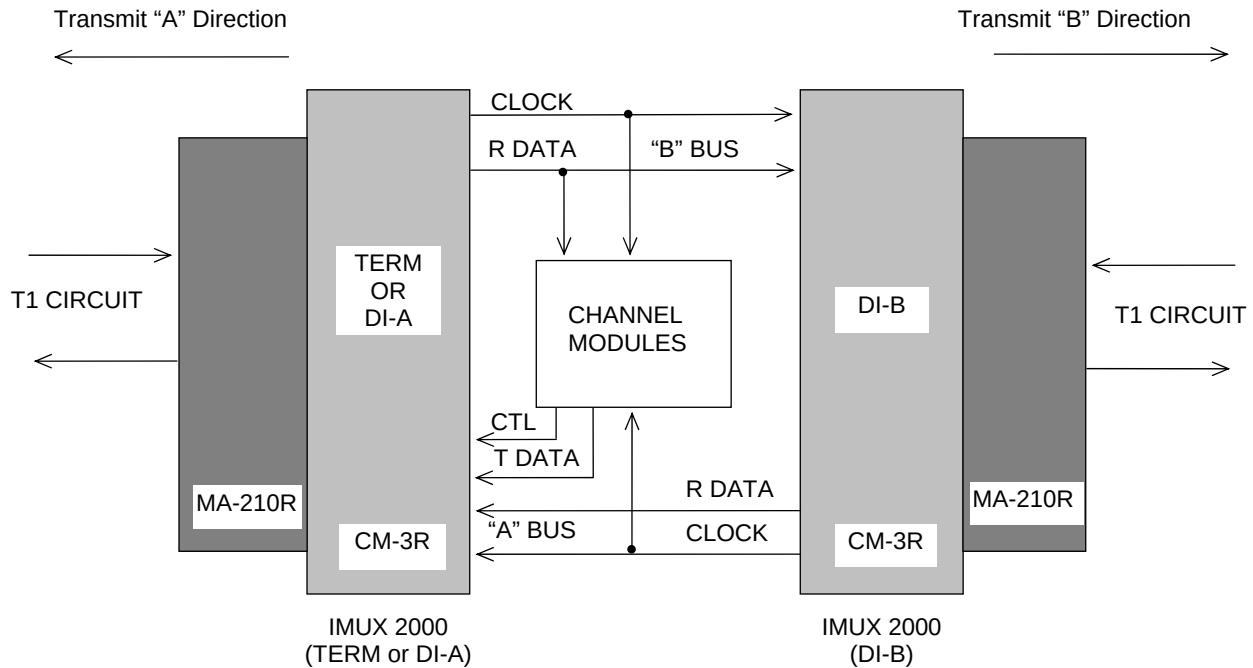
5.3.1 CHANNEL DIRECTION AND RELATIONSHIP TO CM-3R MODE

Channel modules can be set to transmit in either "Direction A" or "Direction B". The transmit and receive directions are always opposite from one another. This means that a channel module set to transmit in Direction A will receive from Direction B. If the channel module is set to transmit in Direction B, it will receive from Direction A. Every channel module has a switch that sets its transmit/receive direction. Consult the Instruction Data Sheets in Sections 15 through 19 of this manual to determine the location and labeling of this switch on any given module.

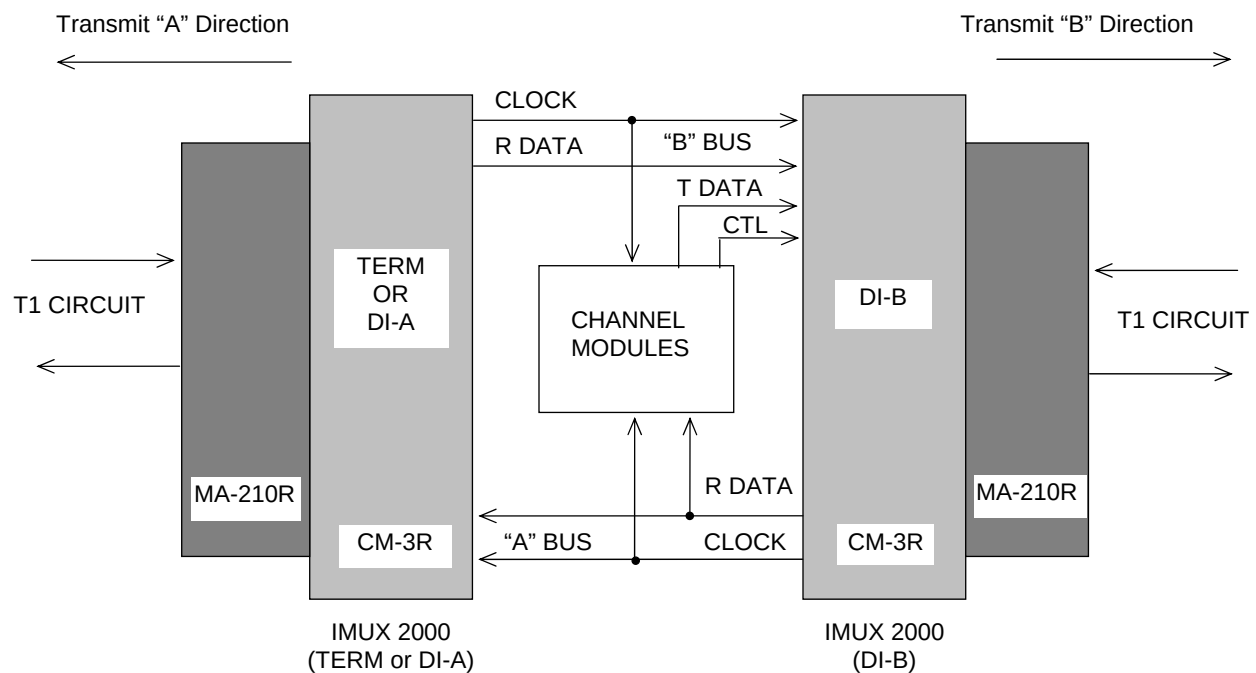
Each CM-3R Common Module operates in one of three modes: TERM, DI-A or DI-B (See Section 6 of this manual for more information on CM-3R modes). CM-3R modules operating in either the DI-A or TERM mode take the transmit data from channel modules set to transmit in Direction A, and multiplex it together for transmission on the outgoing T1 line in Direction A. CM-3R modules operating in the DI-B mode take the transmit data from channel modules set to transmit in Direction B, and multiplex it together for transmission on the outgoing T1 line in Direction B.

Figure 5-1 illustrates this process. In terminal multiplexers, only Figure 5-1a applies; all channel modules in a terminal multiplexer **must** be set to transmit in Direction A and receive from Direction B. In drop/insert multiplexers, channel modules can be set to transmit in either direction. The channel modules set to transmit in Direction A and receive from Direction B will work according to Figure 5-1a; Figure 5-1b shows how the channel modules set to transmit in Direction B and receive from Direction A will work.

Note the "CTL" connection on Figure 5-1. This is a control wire. When a channel module set to time slot N is active in a drop/insert multiplexer, the control wire carries a signal that tells the CM-3R to place local data (from the channel module) instead of through data (from the incoming T1 signal) into time slot N of the outgoing T1 signal.



a. Channel modules set to transmit in Direction A, receive from Direction B.



b. Channel modules set to transmit in Direction B, receive from Direction A.

Figure 5-1. Effect of direction settings on channel modules

Figure 5-2 further illustrates this subject by showing multiple channel modules of various types in a three-node system, using both terminal and drop/insert multiplexers. It is important to note that **channel module direction does not correspond to a particular geographic direction (such as east or west), or to a particular topological direction (such as towards Location 1 or towards Location 2).**

For example, in Figure 5-2, the transmit-receive (T/R) and transmit-only (T) channel modules in multiplexers #1 and #2 that are configured to transmit in the “A” direction, actually transmit in opposite directions over the same T1 facility.

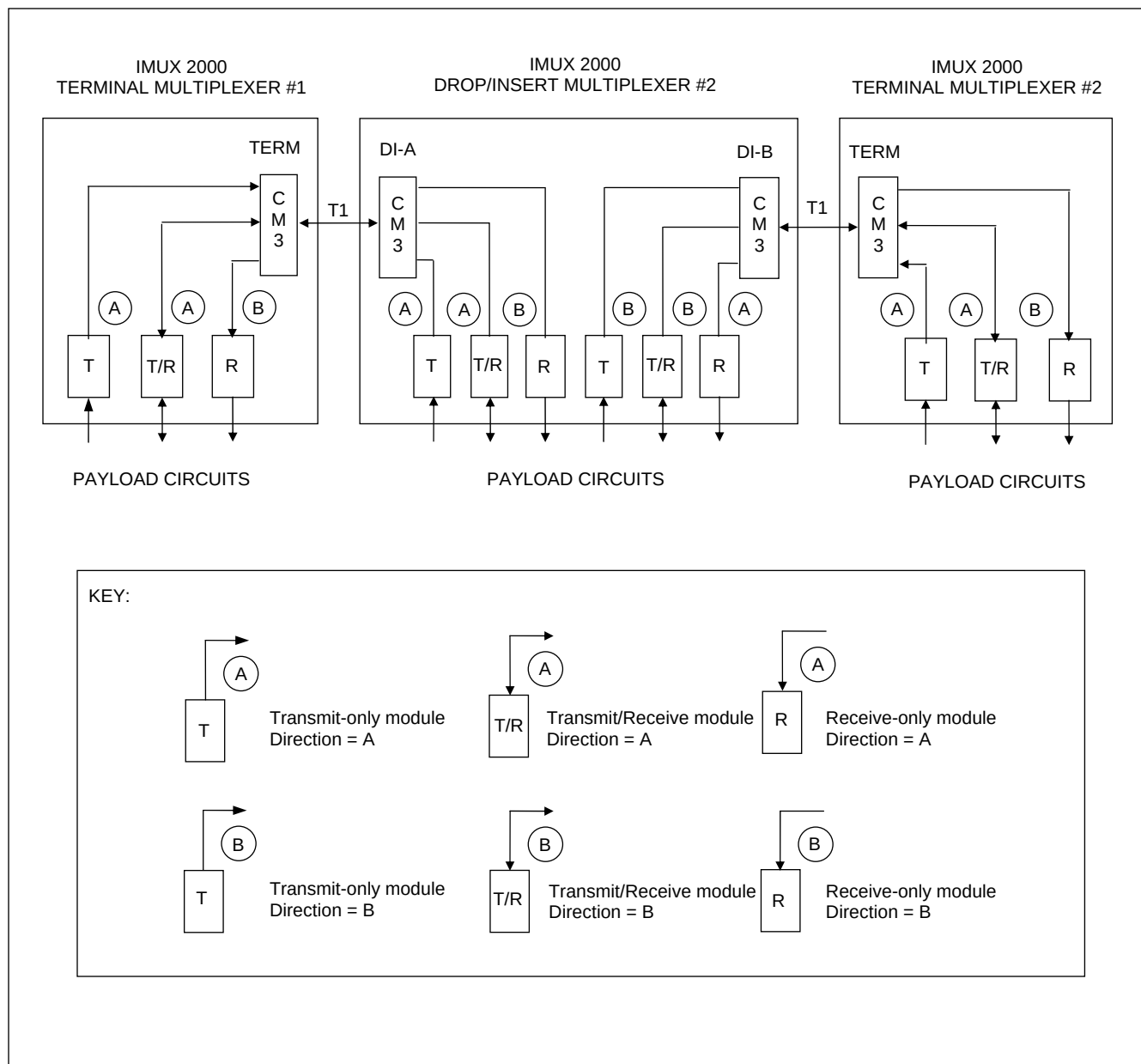


Figure 5-2. Channel direction setup for transmit-only, transmit/receive, and receive-only channel modules

5.4 CHANNEL MODULE CONFIGURATION GUIDELINES

5.4.1 PHYSICAL SLOTS

The first two slots in an IMUX 2000 T1 multiplexer equipped with MA-210R Module Adapters (electrical T1 interface) are reserved for Common Modules. The remaining 16 physical slots (Slots 3 through 18), are available for channel modules.

If the shelf is equipped with OIAs (fiber optic interface), the first four slots are reserved for Common Modules. The next 14 physical slots (Slots 5 through 18) are available for channel modules.

One Expansion Shelf may be added to each IMUX 2000 Main Shelf. An Expansion Shelf provides physical slots for up to 18 additional channel modules.

5.4.2 TIME SLOTS

5.4.2.1 Terminal Multiplexers

Each terminal multiplexer terminates one T1 circuit, which has 24 time slots. Because of this, the total number of 64-Kbps time slots occupied by the channel modules in a terminal multiplexer cannot exceed 24, regardless of the number of physical slots available.

5.4.2.2 Drop/Insert Multiplexers

Each drop/insert multiplexer terminates two T1 facilities: one in the A direction and one in the B direction. Because of this, the total number of times slots occupied by channels set up to transmit in the "A" Direction (that is, through Drop/Insert Module A) is limited to 24 **minus the number of through time slots**, regardless of the total number of physical slots available. Similarly, the total number of times slots that can be occupied by channel modules set up to transmit in the "B" direction (that is, through Drop/Insert Module B) is limited to 24 **minus the number of through time slots**, regardless of the total number of physical slots available.

The A and B direction time slot capacities of a drop/insert multiplexer are independent of one another. The total capacity in each direction is 24 time slots. Unused time slots in one direction cannot be added to the time slot capacity in the other direction.

5.5 POWER AVAILABLE FOR CHANNEL MODULES

5.5.1 MAIN SHELF

Each shelf's power supply must provide sufficient power for the Common Modules, channel modules, and Optical Interface Adapters (OIAs) in that shelf. The power requirement for each Common Module is 2 watts. This means a terminal multiplexer Main Shelf equipped with a 50-watt supply and an electrical T1 interface has 48 watts available for channel modules (50 watts minus 2 watts for the Common Module). A terminal multiplexer Main Shelf with a 50-watt supply and a fiber optic interface has 45.4 watts available for channel modules (50 watts minus 2 watts for the Common Module and 2.6 watts for the OIA).

A drop/insert multiplexer Main Shelf has two Common Modules, one for each direction. This means a drop/insert multiplexer Main Shelf equipped with a 50-watt supply and an electrical T1 interface has 46 watts available for channel modules (50 watts minus 4 watts for the Common Modules). A drop/insert multiplexer Main Shelf with a 50-watt supply and a fiber optic interface has 40.8 watts available for channel modules (50 watts minus 4 watts for the Common Modules and 5.2 watts for the OIAs).

5.5.2 BUS REPEATER MODULE

The Bus Repeater Module (BRM) and its associated Module Adapter, the MA-500, allow multiple physical chassis to function as one large chassis. The system is configured with a single master chassis or Main Shelf which contains the Common Module, channel modules, etc. and one or more slave chassis or Repeater Shelves. Power can be applied to each chassis either by a local power supply or through a power jumper cable. A single bus repeater system is designed to work with up to five chassis total.

The BRM is a double card module which appears to the Main Shelf bus as a channel card. The BRM takes signals from the backplane and drives them onto a connector on the I/O Adapter. From there the signals are daisy-chained from chassis to chassis. The Main Shelf and furthest Repeater Shelf add termination to the signal lines to preserve signal integrity.

In the Repeater Shelf, the BRM appears essentially as a common logic card, receiving signals from the cable, buffering them, and placing them on the backplane. The TxAddr and TxData lines are generated by the channel cards, and thus by the Repeater Shelf, and are transferred back to the Main Shelf in a similar way.

The SCB Data line is a bi-directional signal with no independent handshaking lines. This signal runs at no more than half of the basic E1 rate, and has special waveshaping circuitry on the common logic. As such, it is not manipulated by the BRM, but is simply passed from backplane to backplane.

Refer to paragraph 2.3.2 for more information on the Repeater Shelf.

5.6 DETERMINING CHANNEL MODULE POWER REQUIREMENTS

To determine how much power the channel modules in a multiplexer shelf will draw, refer to Tables 5-1 and 5-2. The power consumptions for all IMUX 2000 channel modules, Common Modules, OIAs and MA-210R and MA-215R Module Adapters are given in these tables.

To use the tables, write down the number of modules of each type in the multiplexer shelf in the "Quantity" column. (If the multiplexer has a Repeater Shelf with no power supply modules, be sure to include the channel modules in the Repeater Shelf. If the Repeater Shelf has its own power supply modules, use Table 5-2 to determine its power requirements.) Multiply the quantity by power consumption value to determine the total power consumption for all modules of that type. When you are finished, add up all the totals to determine the total power consumption for the shelf.

Table 5-1. Determining power requirements for Main Shelf

Module Designation/Description	Input Power (watts)	Quantity (1)	Total
MA-210R or MA-215R Module Adapter	(2)		
MA-412			
MA-800			
RFL Bus Repeater Module	0.35		
MA-500 Bus Repeater Module Adapter (passive device)	0.0		
Optical Interface Adapter (OIA)	2.6		
CM-3R Common Module	2.0		
RFL DA-91 Asynchronous Data Polling	1.25		
RFL DA-91I			
RFL DA-121 Asynchronous Data Polling	2.4		
RFL DA-121I			
RFL DA-191A Asynchronous Data	2.2		
RFL DS-64NC Wideband Synchronous Data	2.0		
RFL DS-562I			
RFL DS-961D Synchronous Data	2.0		
RFL VF-5A Dual-Channel E&M	1.0		
RFL VF-6I Orderwire Voice Frequency Channel Module	1.25		
RFL VF-7A Dual ADPCM Four-Wire E&M	1.0		
RFL VF-8A			
RFL VF-10B Office-End Foreign Exchange	0.75		
RFL VF-10D			
RFL VF-11B Station-End Foreign Exchange	0.75		
RFL VF-15 Dual-Channel ADPCM Office-End Foreign Exchange	0.75		
RFL VF-15C			
RFL VF-16 Dual-Channel ADPCM Station-End Foreign Exchange	0.75		
RFL VF-17 Dual-Channel ADPCM Office-End Foreign Exchange	1.2		
RFL VF-18 Dual-Channel ADPCM Station-End Foreign Exchange	1.2		
RFL DS-TT Transfer Trip Module	2.0		
RFL TMX/TMR			
RFL Status Module	2.0		
TOTAL POWER CONSUMPTION (3)			

1. Include all channel modules installed in Repeater Shelf (if present), unless Repeater Shelf is equipped with its own power supply modules. In that case, use Table 5-2 to determine the power requirements for the Repeater Shelf.
2. Included in the input power requirement for the CM-3R Common Module.
3. If total power consumption exceeds 50 watts, additional power supply capacity is required.

Table 5-2. Determining power requirements for Repeater Shelf

Module Designation/Description	Input Power (watts)	Quantity	Total
RFL Bus Repeater Module	0.35		
MA-500 Bus Repeater Module Adapter (passive device)	0.0		
RFL DA-91 Asynchronous Data Polling	1.25		
RFL DA-91I			
RFL DA-121 Asynchronous Data Polling	2.4		
RFL DA-121I			
RFL DA-191A Asynchronous Data	2.2		
RFL DS-64NC Wideband Synchronous Data	2.0		
RFL DS-562I			
RFL DS-961D Synchronous Data	2.0		
RFL VF-5A Dual-Channel E&M	1.0		
RFL VF-6I Orderwire Voice Frequency Channel Module	1.25		
RFL VF-7A Dual ADPCM Four-Wire E&M	1.0		
RFL VF-8A			
RFL VF-10B Office-End Foreign Exchange	0.75		
RFL VF-10D			
RFL VF-11B Station-End Foreign Exchange	0.75		
RFL VF-15 Dual-Channel ADPCM Office-End Foreign Exchange	0.75		
RFL VF-15C			
RFL VF-16 Dual-Channel ADPCM Station-End Foreign Exchange	0.75		
RFL VF-17 Dual-Channel ADPCM Office-End Foreign Exchange	1.2		
RFL VF-18 Dual-Channel ADPCM Station-End Foreign Exchange	1.2		
RFL DS-TT Transfer Trip Module	2.0		
RFL Status Module	2.0		
RFL TMX/TMR			
TOTAL POWER CONSUMPTION (1)			

1. If total power consumption exceeds 50 watts, additional power supply capacity is required.

5.7 POWER SUPPLY REDUNDANCY

IMUX 2000 Main Shelves and Repeater Shelves may be equipped with two power supply modules for redundancy. If the primary supply fails, the redundant supply is automatically switched in to provide uninterrupted multiplexer operation.

Note that the second supply is strictly a backup to the first, not an increase in available power. The total shelf power is the individual capacity of either supply, not their sum. For example, a terminal multiplexer Main Shelf equipped with two 50-watt power supplies would have a total of 48 watts available for channel modules - not 98 watts.

If additional power supply capacity is needed in multiplexers equipped with Repeater Shelves, power supply modules may be installed in the Repeater Shelves to power the channel modules located there.

SECTION 6. SETUP AND CONFIGURATION

6.1 INTRODUCTION

This section contains information on how to set up the IMUX 2000 and operate it under local control.

6.2 CM-3R MODES

A CM-3R module can operate in one of three modes:

TERM	Terminal (terminal multiplexer only)
DI-A	Drop/Insert Direction A (drop/insert multiplexer only)
DI-B	Drop/Insert Direction B (drop/insert multiplexer only)

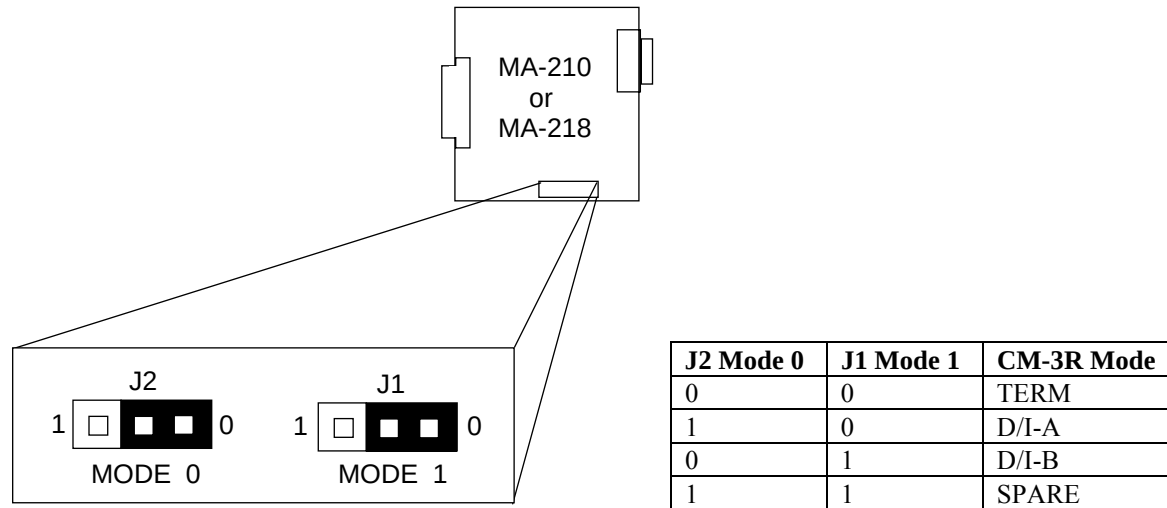
The CM-3R displays its mode for several seconds immediately after it is powered, either by plugging it into a powered Main Shelf or by applying power to the Main Shelf. If the CM-3R is not set to operate in one of the three available modes, it displays **SPAR**, meaning "spare".

6.2.1 HOW TO SET THE CM-3R MODE

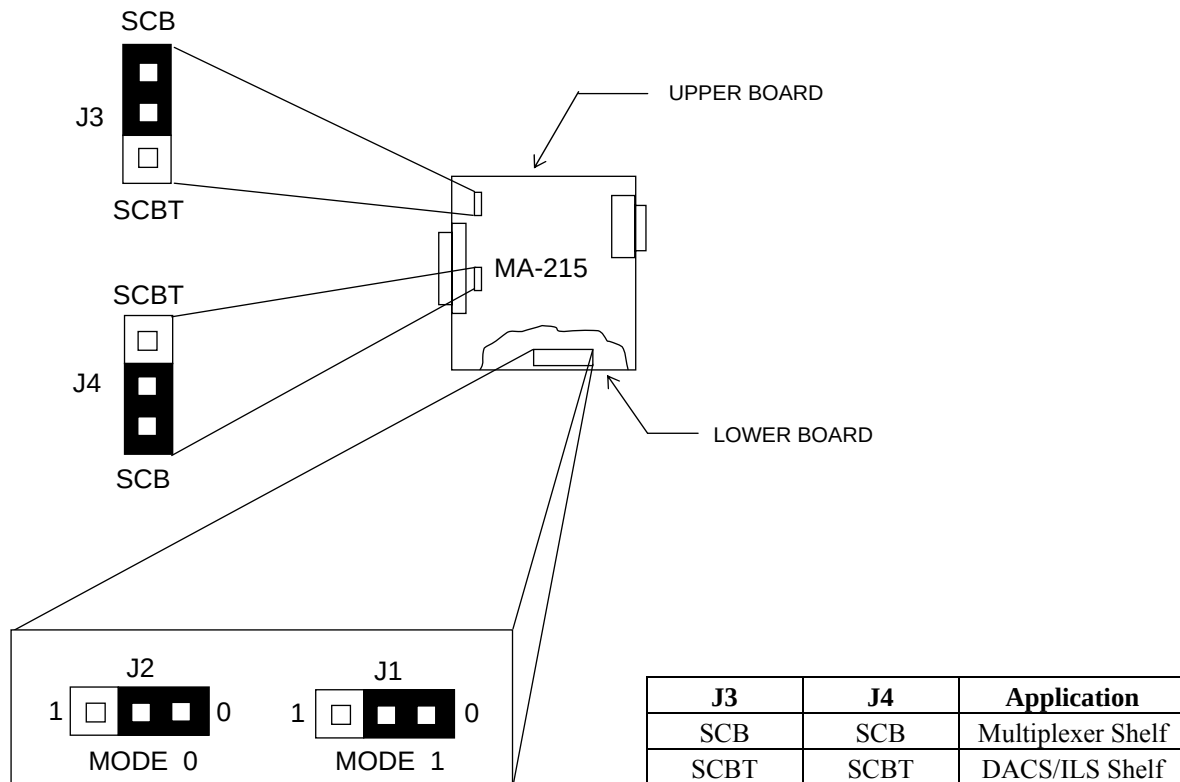
When the IMUX 2000 is equipped with an electrical T1 interface, the CM-3R mode is selected by the placement of jumpers on the applicable Module Adapter as shown in Figures 6-1 and 6-2, and Table 2-19. When the IMUX 2000 is equipped with an optical fiber interface, the CM-3R mode is selected by setting DIP switch SW1 on the applicable Optical Interface Adapter (OIA) as shown in Figure 6-3 and Table 6-1.

Each CM-3R module determines its mode by "reading" these jumper settings. As a result, any CM-3R module can be replaced by a spare (or the two CM-3R modules in a drop/insert multiplexer can be swapped) without affecting mode setup. Other settings that affect system operation are made on the CM-3R module itself. (See paragraph 6-5 for more information.)

Refer to Table 2-2 to determine which module adapter to use for your application. Refer to Table 2-3 to determine which OIA to use for your application.

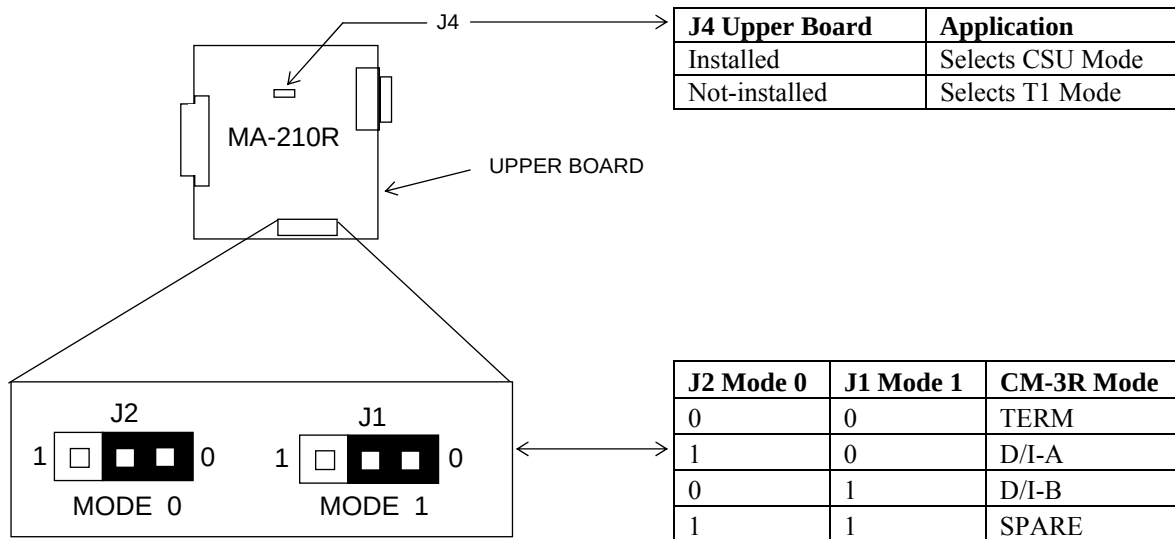


a. MA-210 and MA-218 Setup Jumpers.

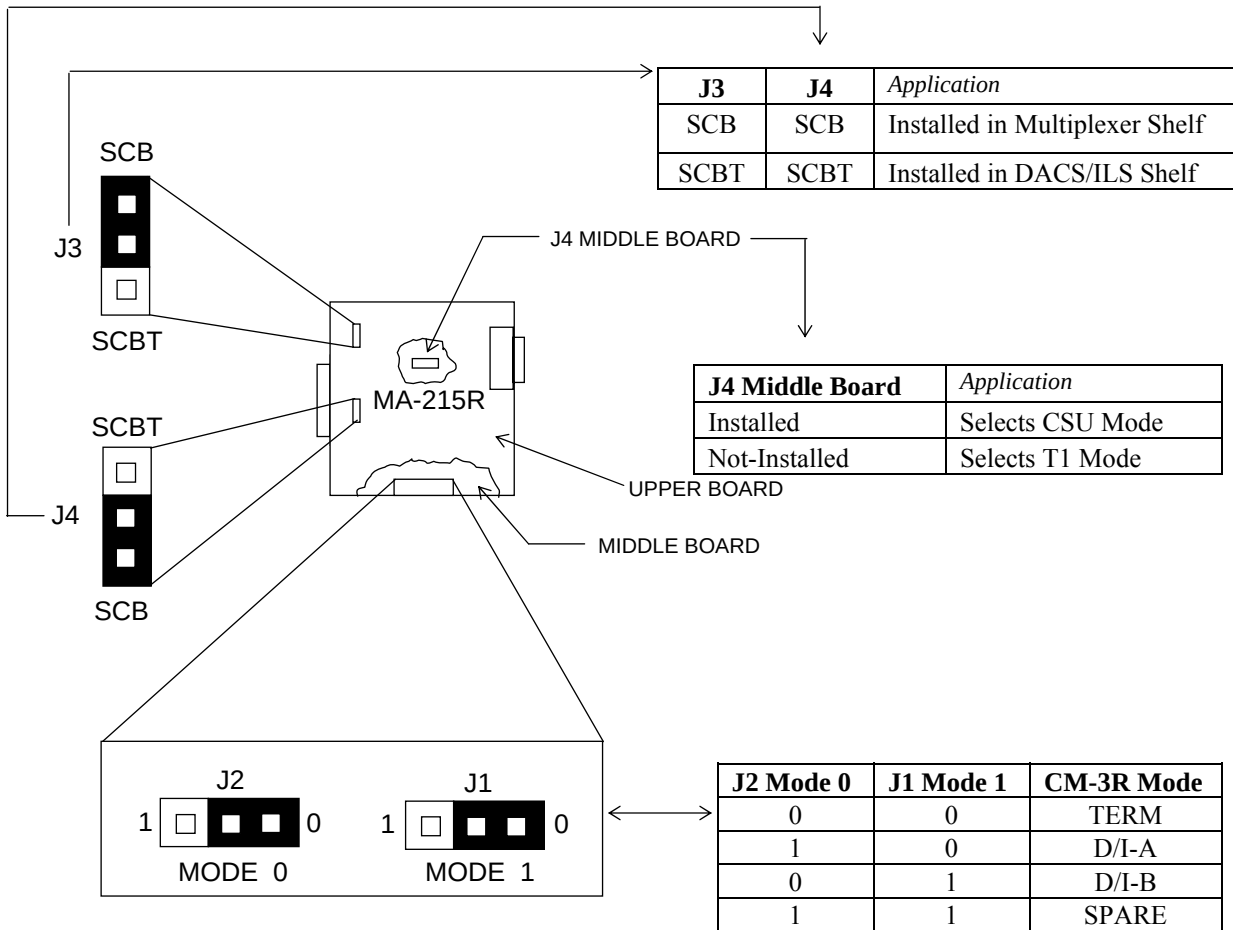


b. MA-215 Setup

Figure 6-1. Location and use of setup jumpers on the MA-210, MA-215 and MA-218 Module Adapters.



a. MA-210R Setup



b. MA-215R Setup

Figure 6-2. Location and use of setup jumpers on the MA-210R and MA-215R Module Adapters.

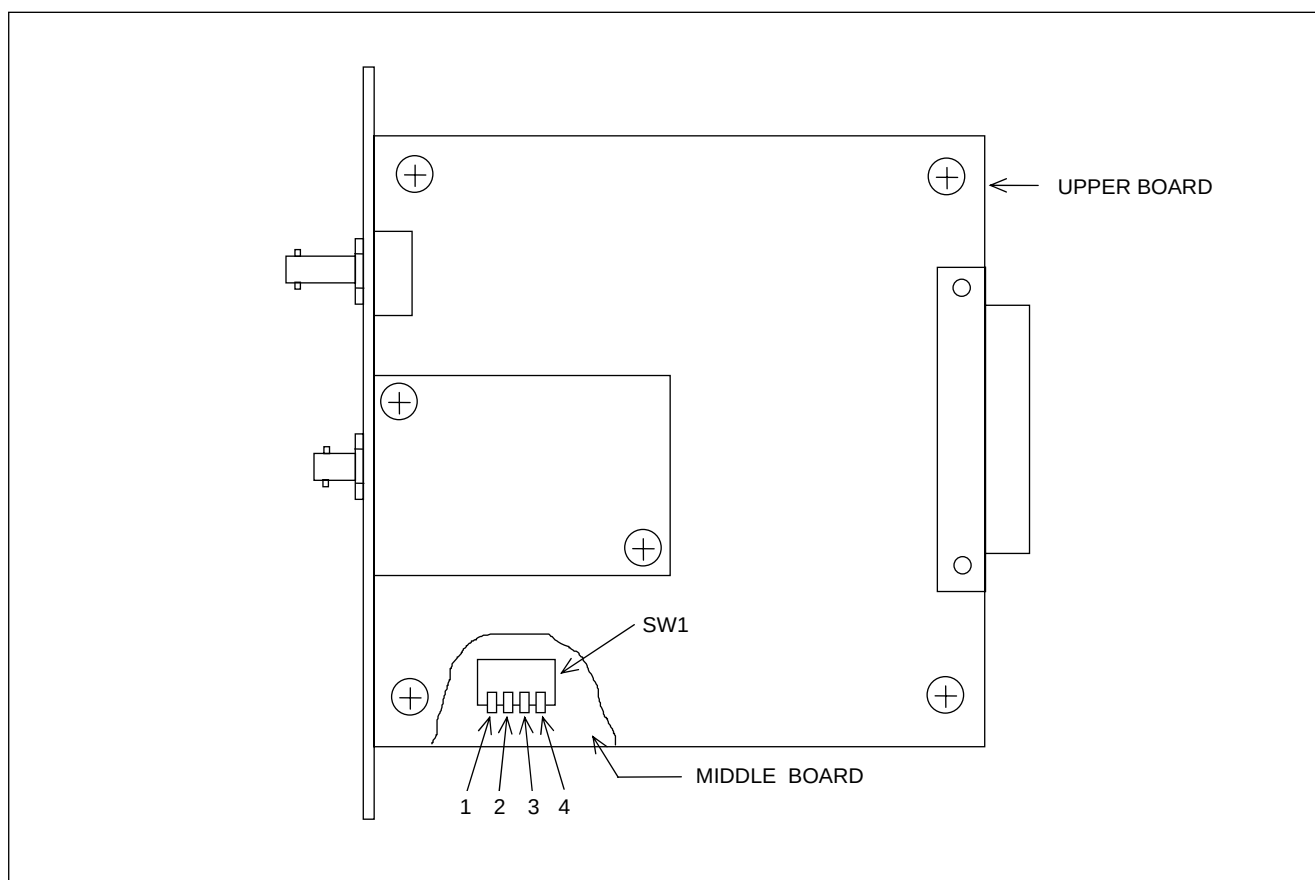


Figure 6-3. Location of DIP switch SW1 on the middle board of the Optical Interface Adapter

Table 6-1. Switch settings, DIP switch SW1 on the Optical Interface Adapter

Switch Section(s)	Function	Setting	Meaning
SW1-1 and SW1-2	CM-3R mode selection	Both ON (down)	Terminal
		S1-1 OFF (up), S1-2 ON (down)	Drop/Insert Direction A (DI-A)
		S1-1 ON (down), S1-2 OFF (up)	Drop/Insert Direction B (DI-B)
		Both OFF (up)	Spare
SW1-3	Coding selection: (1)	ON (down)	B8ZS coding
		OFF (up)	AMI coding
SW1-4	Configuration mode:	ON (down)	Enable CMI Mode ⁽¹⁾
		OFF (up)	Enable Legacy Mode ⁽²⁾

1. CMI (Code Mark Inversion)

2. Legacy Mode will allow communication with “older” versions of OIAs that do not support CMI.

6.2.2 WHEN TO USE EACH CM-3R MODE

CM-3R modules used in terminal multiplexers must be configured to operate in the TERM mode. In drop/insert multiplexers, one CM-3R module (or main/standby module pair) must be configured to operate in the DI-A mode while the other is configured to operate in the DI-B mode.

Which CM-3R module is set to DI-A and which is set to DI-B depends only on which T1 facility is associated with channel module Direction A and which T1 facility is associated with channel module Direction B. (See Section 5 of this manual for more information.)

NOTE

The terms DI-A and DI-B are sometimes referred to as D/I-1 and D/I-2.

6.3 SETTING THE MASTER AND TIMED SCB CLOCKS

Jumpers J3 and J4 on the MA-215R Module Adapter allow the user to select the master SCB clock when set to the “SCB” position, or the timed SCB clock when set to the “SCBT” position. The location of these jumpers is shown in Figure 6-1b.

The MA-215R located in the shelf containing the CM-3R must have jumpers J3 and J4 set to the “SCB” position. The MA-215R located in the shelf containing the ILS/DACS processor must have jumpers J3 and J4 set to the “SCBT” position. The shelf containing the CM-3R is the master clock. The shelf containing the ILS/DACS processor is the timed or slave clock.

6.4 SETTING THE CM-3R EXTERNAL CLOCK SOURCE

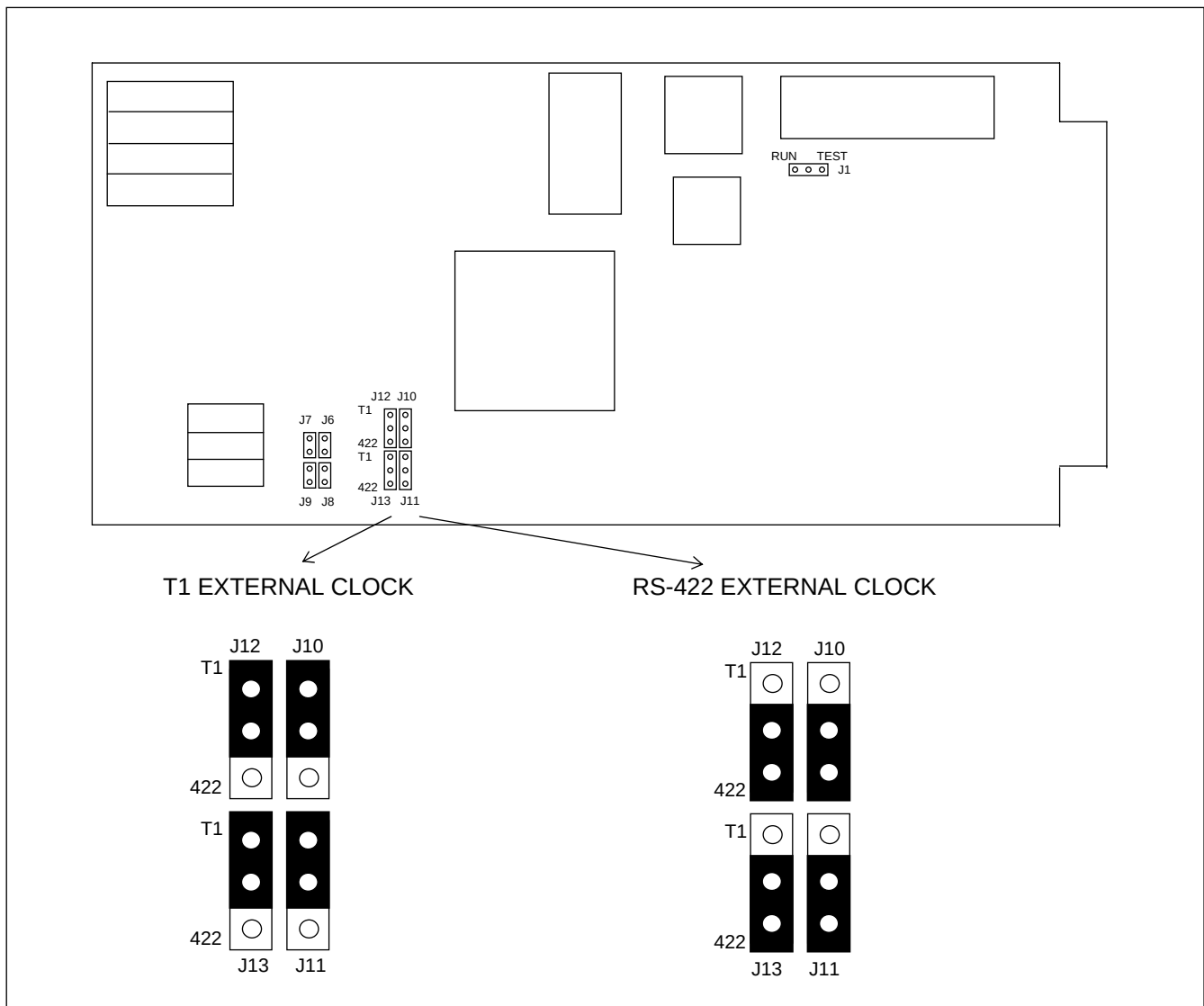


Figure 6-4. Location and settings of T1/422 clock jumpers on CM-3R common module.

If your system is connected to a T1 external clock, set jumpers J10 through J13 to the T1 position. If your system is connected to an RS-422 external clock, set jumpers J10 through J13 to the 422 position. If your system is not connected to an external clock, all four jumpers, J10 through J13, must be set to either the T1 position or the 422 position.

<u>Jumper</u>	<u>Function</u>
J1	Place jumper in RUN position for normal operation. Place jumper in TEST position for factory testing only.
J6, J7, J8, J9	Used for FACTORY TESTING only.
J10, J11, J12, J13	Place all four jumpers in T1 position for T1 clock format. Place all four jumpers in 422 position for RS-422 clock format.

6.5 USING THE GROUP AND SET/NEXT SWITCHES

Use the GROUP and SET/NEXT switches to view and, when applicable, to set various CM-3R functions. CM-3R functions include the following:

1. Setup options, such as SF and ESF (frame formats).
2. Current status conditions, such as RxY1 (yellow alarm).
3. Informational items, such as CM-3R firmware revision.

CM-3R functions are organized into groups. As shown in Figure 6-5, the GROUP switch selects a particular group of functions. The SET/NEXT switch lets you view and set functions within the currently selected group. The four-character alphanumeric function display shows both group and function names. Tables 2-8, 2-9 list all CM-3R functions, organized by group. Detailed explanations of CM-3R functions appear in the paragraphs that follow.

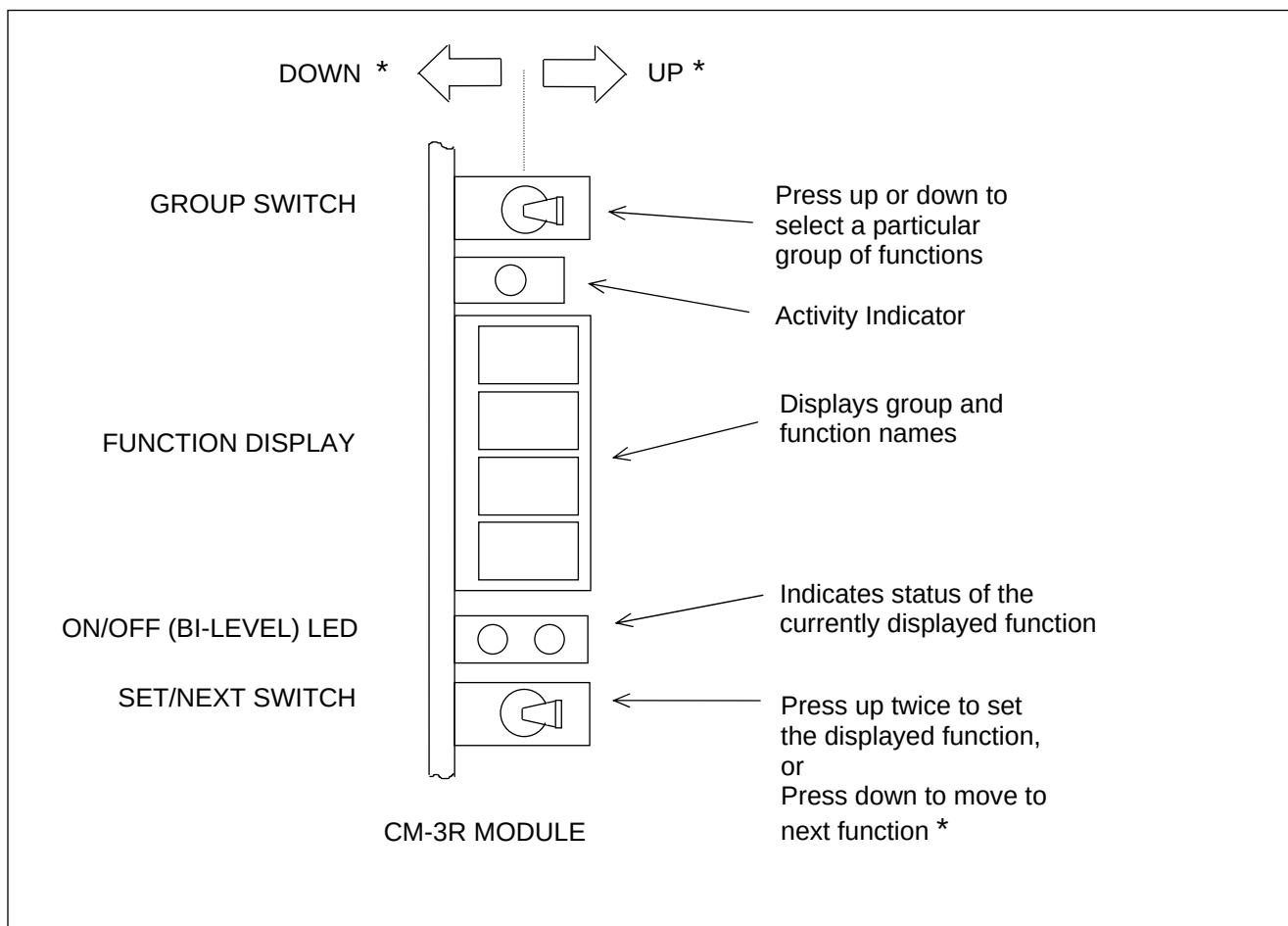


Figure 6-5. CM-3R switches and indicators used to display and set functions

*Note: This module is installed vertically in the multiplexer. Therefore, "up" means to the right, or away from the circuit board, and "down" means to the left, or towards the circuit board.

6.5.1 SELECTING A GROUP

When the CM-3R display is blank or when a function is displayed, press down on the GROUP toggle switch to view the name of the currently selected group. Once the current group name is displayed, press down on the GROUP switch again to select the "next" group or press up to select "previous" group.

6.5.2 DISPLAYING AND SETTING STANDARD FUNCTIONS

If the display is blank or shows a Group name, press down on the SET/NEXT Switch to display the first function in the currently selected group. Once a function appears, press down on the SET/NEXT switch again to display the next function in the group.

If the green part of the ON/OFF indicator to the right of the FUNCTION display is on, the currently displayed function is ON. Pressing up on the SET/NEXT switch causes no status or setup changes. However, if the red part of the ON/OFF indicator is on, pressing up on the SET/NEXT switch twice turns that function on. Pressing up once causes the green part of the ON/OFF indicator to blink, meaning that a setup change will take place if the SET/NEXT switch is pressed up again. Pressing up on the SET/NEXT switch a second time causes the green part of the ON/OFF indicator to light continuously. This means that the setup parameter has been changed to the currently-displayed setting.

For example, if the display shows ESF while frame format is set to SF, then pressing up on the SET/NEXT switch once will cause the green part of the ON/OFF indicator to blink. Pressing up on the SET/NEXT switch a second time will actually change the current T1 framing format from SF to ESF.

It is important to note that some setup functions are "mutually exclusive". That is, setting one function will automatically "un-set" another. Examples include line code (you may set line code to AMI or B8ZS but not both) and frame format (you may set frame format to SF or ESF but not both). Other functions are not mutually exclusive. For example, CM-3R Line and Equipment loopbacks in the LPBK group can be active at the same time.

NOTE

As shown in Figure 6-5, when a CM-3R module is installed in a chassis, the "down" position of the GROUP and SET/NEXT toggle switches corresponds to the user's left, while the "up" position corresponds to the user's right.

6.6 SETTING T1 TRANSMITTER TIMING (TIME GROUP)

Depending on which multiplexer it is in, a CM-3R module can operate in one of four T1 transmitter timing modes:

Loop	Looped
Int	Internal
Ext	External
Thru	Through

In terminal multiplexers, the T1 transmitter timing mode can be set to Internal, External, or Looped by setting the appropriate function in the TIME group. (See Table 6-2.) In drop/insert multiplexers, the T1 transmitter timing mode is automatically set to Through. No user setup is necessary or allowed.

Table 6-2. TIME group

Function	Available On	Description
LOOP	Terminal multiplexers only	Looped. The T1 transmitter of a loop-timed terminal multiplexer derives its timing from the received T1 signal; the multiplexer's T1 output is synchronized to its T1 input.
INT	Terminal multiplexers only	Internal. The T1 transmitter of an internally-timed IMUX 2000 terminal multiplexer derives its timing from the multiplexer's own internal 1.544-mHz oscillator. INT is the default primary timing mode in IMUX 2000 terminal multiplexers, where CM-3R mode is set to TERM.
EXT	Use on terminal multiplexers only. Available on D/I multiplexers for test purposes.	External. The T1 transmitter of an externally-timed IMUX 2000 terminal multiplexer derives its timing from the external source connected to the External Timing Input pins on the T1 I/O connector. (See Section 2.) External timing may cause framing errors in D/I multiplexers.
THRU	Drop/insert multiplexers only	Through. Both CM-3R modules derive their transmitter timing from the T1 signal received by the other CM-3R module. The T1 output of the DI-A module is synchronized to the T1 input of the DI-B module. The T1 output of the DI-B module is synchronized to the T1 input of the DI-A module. (See Figures 6-6 and 6-7.) THRU is the only available primary timing mode in IMUX 2000 drop/insert multiplexers, where CM-3R mode is set to DI-A or DI-B.

The timing mode selected by the user is called the primary timing mode. IMUX 2000 multiplexers may also operate in a fallback timing mode. Specifically, when configured for External, Loop, or Through timing, if the primary timing source becomes unavailable, an IMUX 2000 multiplexer performs an automatic fallback to an alternate source of timing. For example, the internal oscillator may be selected as the fallback source.

Appropriate uses of each of the four T1 transmitter timing modes are illustrated in Figures 6-6 through 6-10. Note that in IMUX 2000 systems synchronized to the digital network, both terminal multiplexers will normally be loop timed (Figures 6-6 and 6-8). In IMUX 2000 systems timed from one end and **not** synchronized to the carrier's network, one terminal multiplexer will be internally (or externally) timed while the other is loop timed (Figures 6-7, 6-9, and 6-10). Figure 6-10 shows how an IMUX 2000 system can use an external timing source.

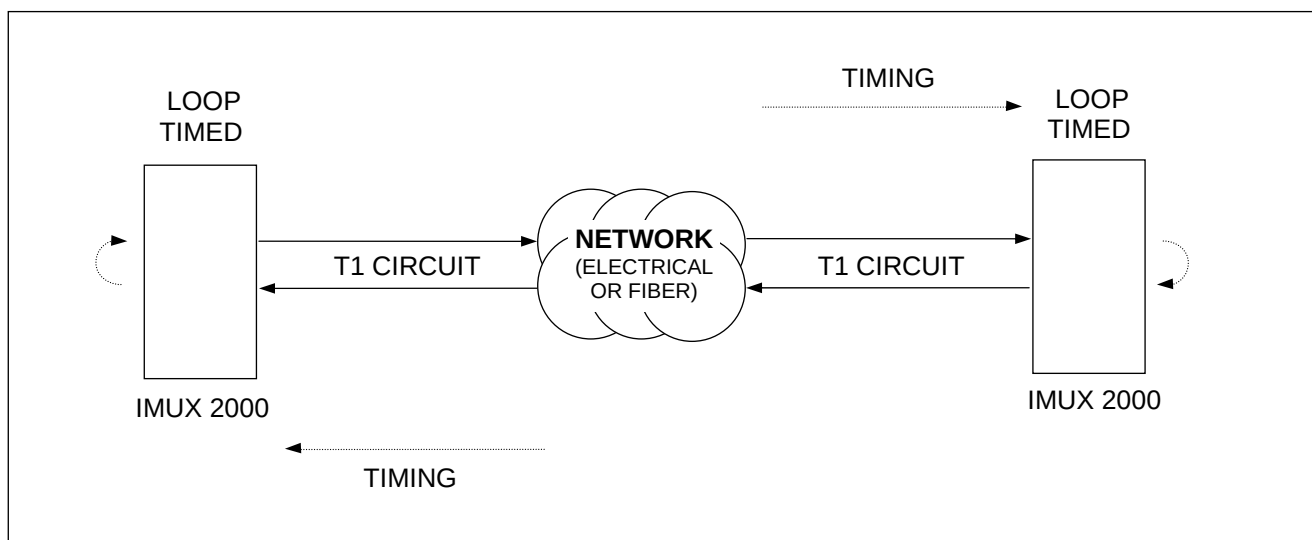


Figure 6-6. Point-to-point system synchronized to the network which forces timing onto T1 signal

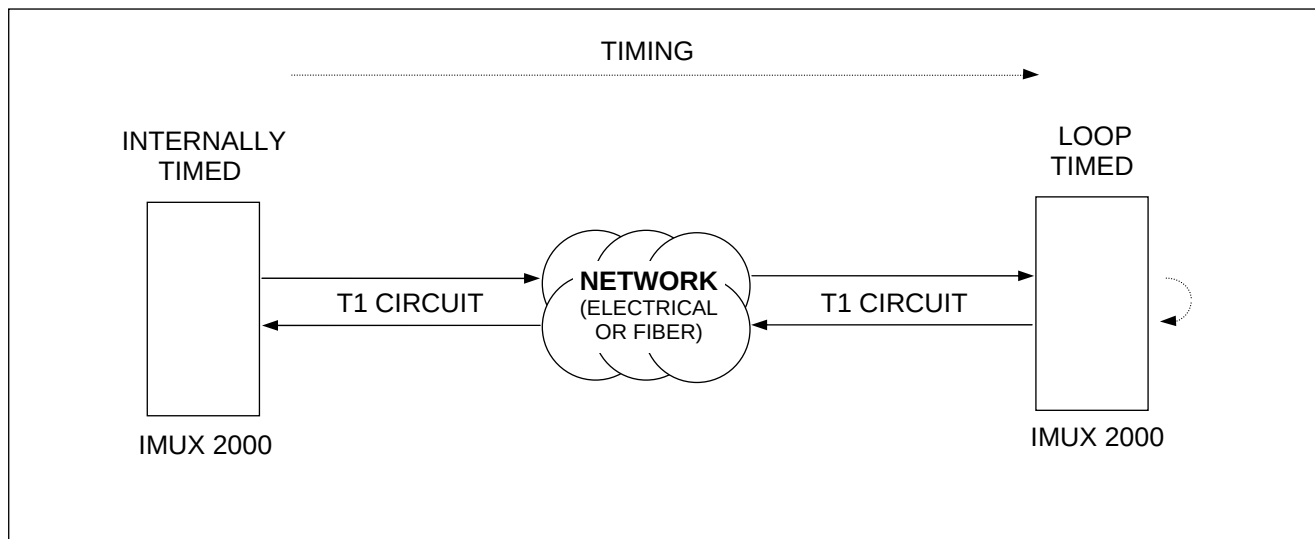


Figure 6-7. Point-to-point system internally timed from one end (not synchronized to the network)

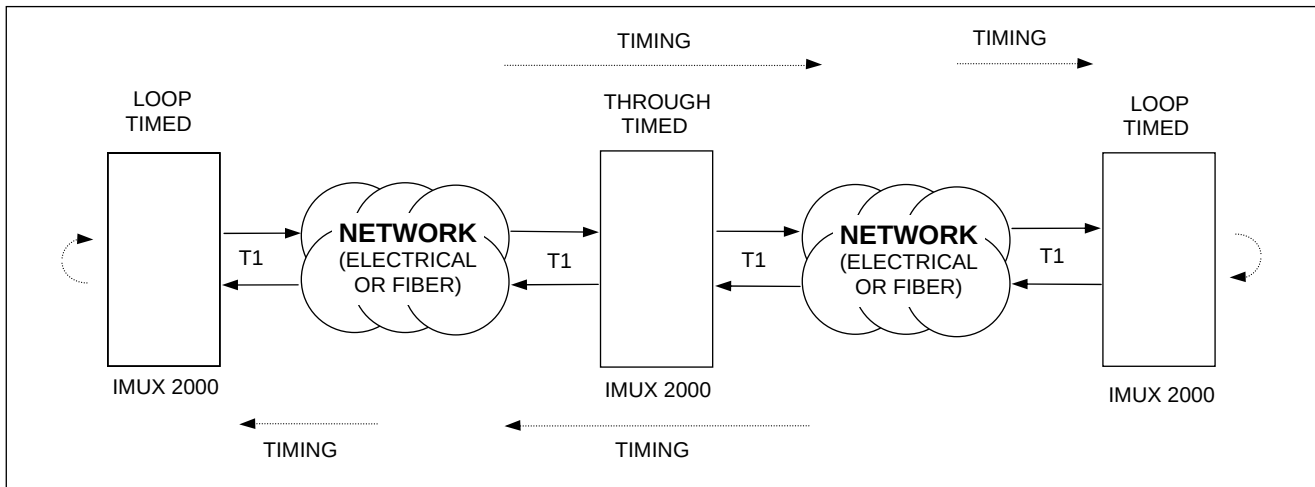


Figure 6-8. Drop/insert system synchronized to the network

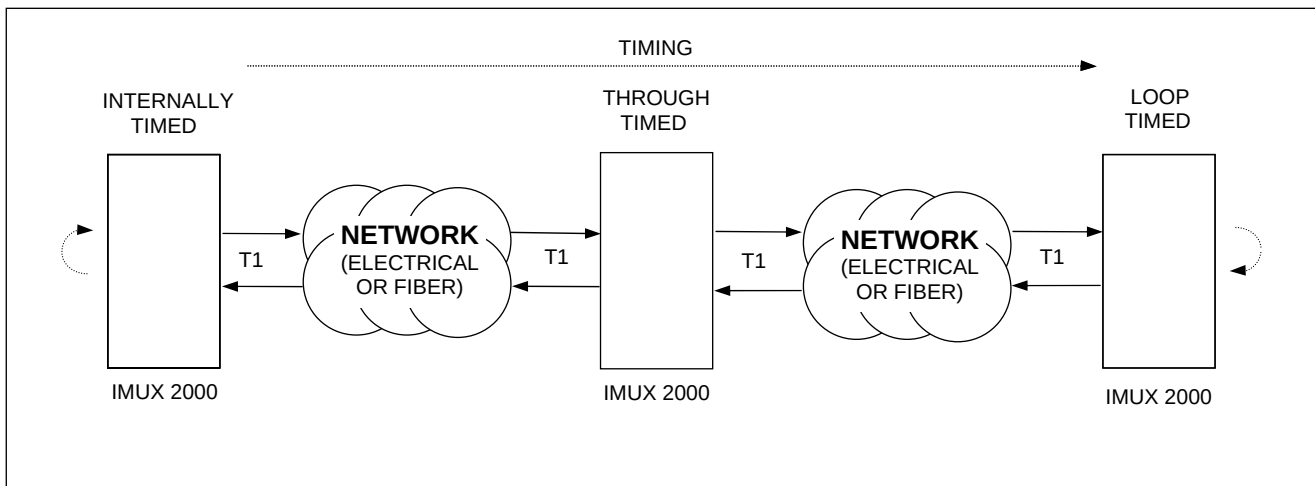


Figure 6-9. Drop/insert system internally timed from one end (not synchronized to the network)

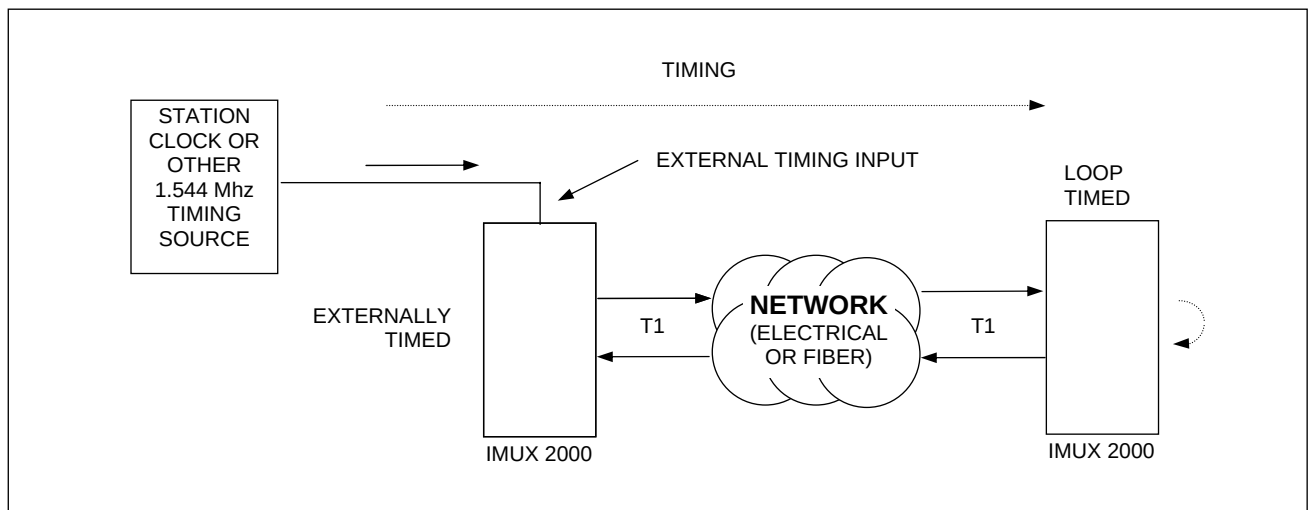


Figure 6-10. Point-to-point system externally timed from one end (not synchronized to the network)

6.6.1 SYNCHRONIZED T1 SYSTEMS

Multiple IMUX 2000 systems can be synchronized by deriving their timing from the same timing source. One way to accomplish this is to daisy-chain the external timing outputs and inputs of several head-end terminal multiplexers (Figure 6-11). Note that multiple IMUX 2000 systems loop-timed to the same network are also synchronized, both to each other and to the network. T1 systems are synchronized to prevent buffer overflows or underflows, generally called "slips", in the network switching systems such as digital central offices, PBXs, and digital cross-connect systems.

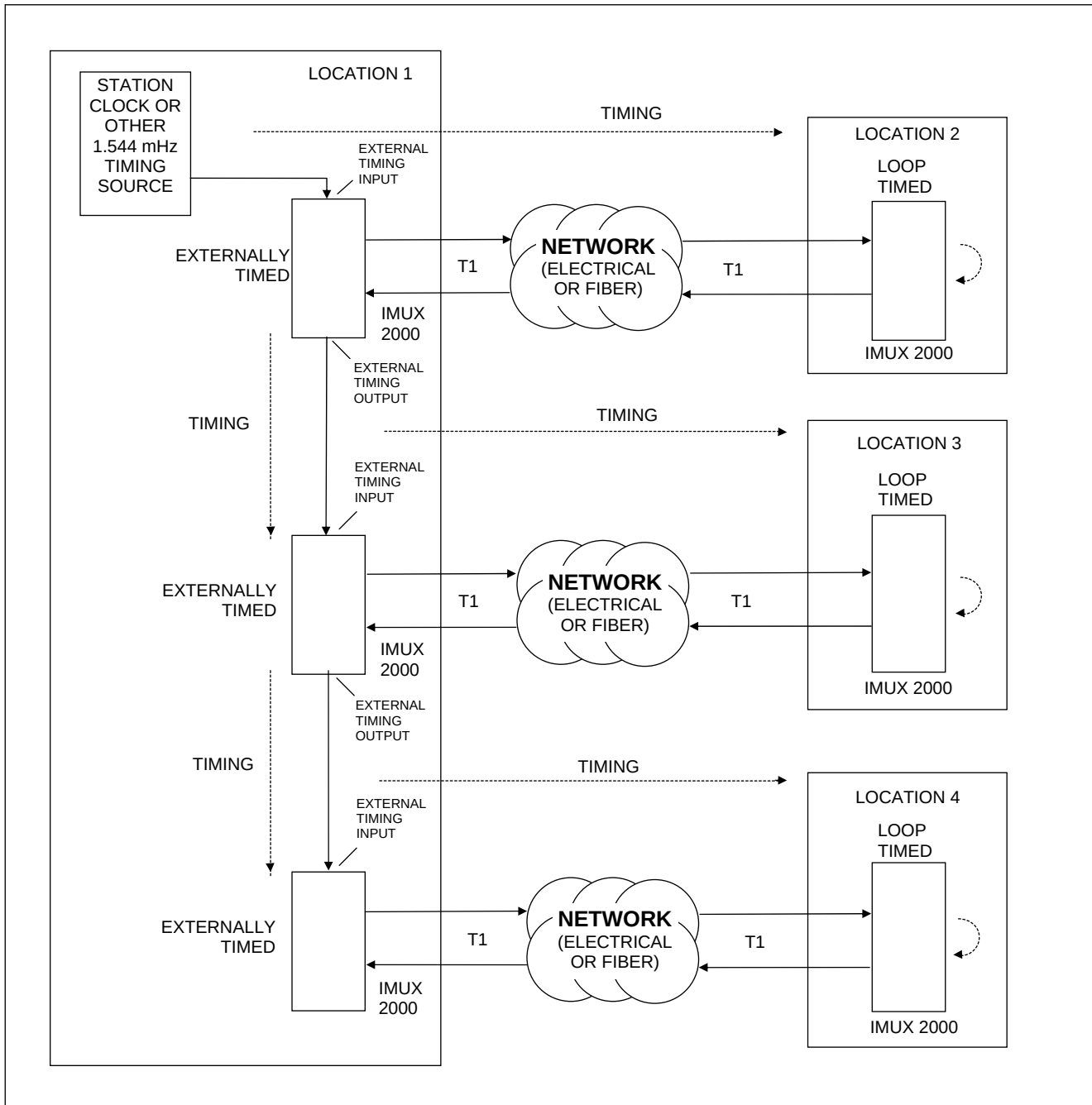


Figure 6-11. Multiple systems synchronized to a common timing source

6.6.2 FRAME-SYNCHRONIZED T1 SYSTEMS

By definition, synchronized T1 systems have equal bit rates (frequencies). Except for a limited amount of jitter and wander, synchronized T1 systems are phase-locked. In general, synchronized T1 systems are not frame-synchronized. This means that systems in a synchronized network may transmit a given time slot at different times. This is not a problem for switching systems because they are equipped with buffers to realign time slots. However, frame synchronization is generally required whenever it is necessary to equalize transmission time delay over multiple T1 circuits.

For example, frame synchronization can help to equalize transmission delays in a multiple transmitter site radio broadcast system. Note that frame synchronization by itself does not guarantee equalized transmission delay. Rather, it allows fixed time delays to be added to individual circuits in order to achieve equal transmission delays.

Several IMUX 2000 systems can be frame-synchronized by substituting drop/insert multiplexers in place of the usual "head-end" terminal multiplexers in each system (Figure 6-12). In this application, the second CM-3R module in each drop/insert is used to frame synchronization rather than drop/insert multiplexing.

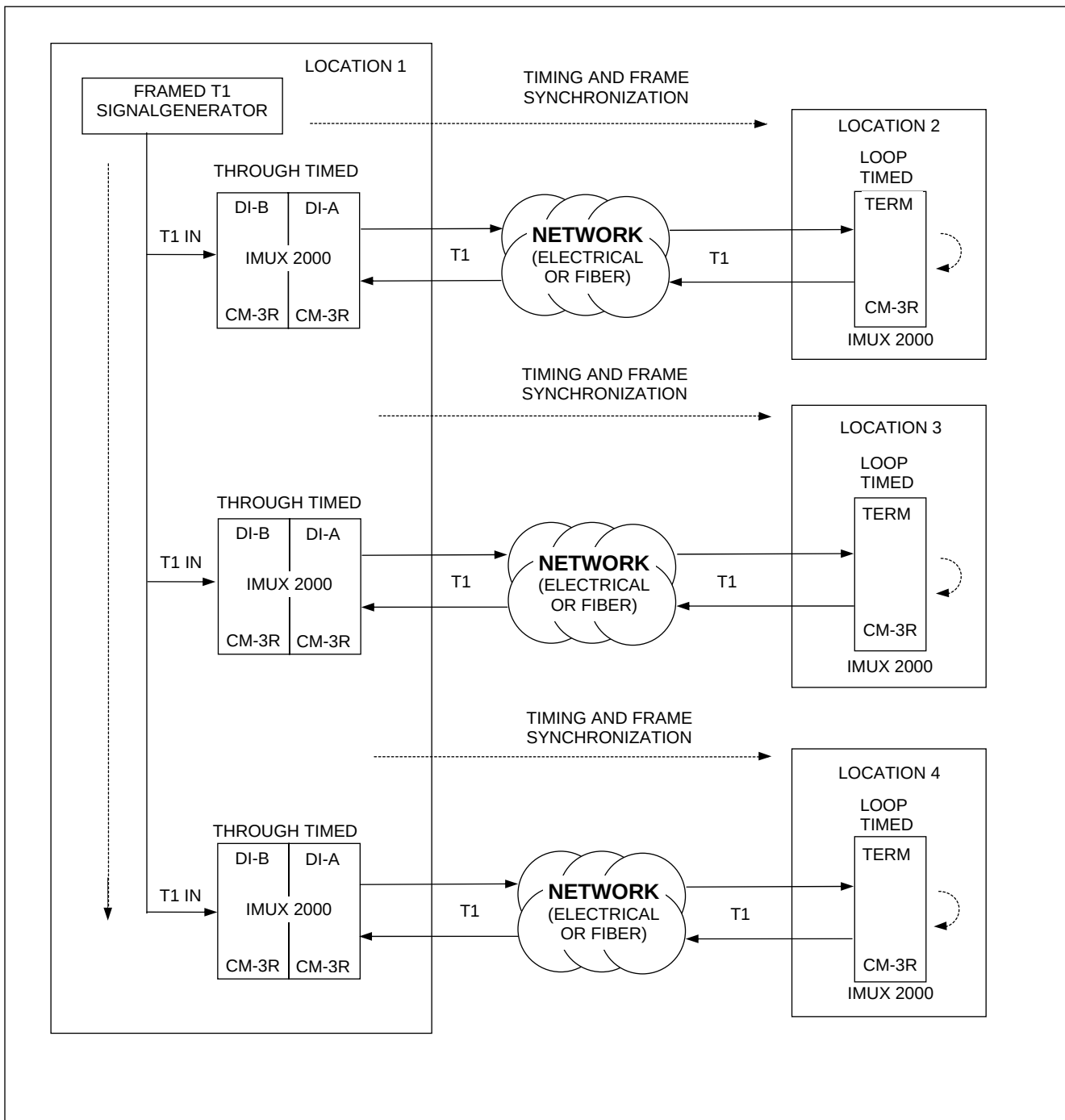


Figure 6-12. Multiple frame-synchronized systems

6.7 SETTING T1 FRAME FORMAT AND LINE CODE (TSEL GROUP)

The TSEL (T1 Select) Group is used to set T1 frame format and line code. The functions available in the TSEL group are explained in Table 6-3.

Table 6-3. TSEL group

Function	Description
SF	Superframe Format. An older format in which 193-bit T1 frames are grouped into 12-frame superframes. Also referred to as "D4." Generally, SF is only used in applications where the carrier's network cannot support ESF.
ESF	Extended Superframe Format. A frame format in which T1 frames are grouped into 24-frame extended superframes. The ESF format provides better error detection than SF, and is generally recommended over SF. The only limitation to ESF is that some older carrier networks cannot support it. Note: The SF and ESF frame formats are mutually exclusive functions. ESF is the factory-default framing format.
AMI	Alternate Mark Inversion. A bipolar line code composed of positive pulses, negative pulses, and zeroes. In an AMI-encoded signal, every pulse has the opposite polarity of the pulse that preceded it, regardless of the number of zeroes between them. The major limitation of AMI is that it cannot support 64-Kbps clear-channel capability, due to the possibility of an excessive number of zeros.
B8ZS	Bipolar With Eight-Zero Substitution. A modified bipolar line code in which strings of eight zeroes are replaced by zero substitution code. This allows T1 signals using the B8ZS line code to maintain a sufficient ones density, regardless of the number of zeroes in the data. B8ZS supports unrestricted 64-Kbps clear-channel capability. The only limitation of B8ZS is that some older carrier networks cannot support it. Note 1: The AMI and B8ZS line codes are mutually exclusive functions. B8ZS is the factory-default line code. Note 2: If a fiber optic interface is used, the AMI/B8ZS coding of the OIA must be set to match the Common Module. OIA line coding is set by SW1-3 on the OIA. See Table 6-1 for more information.
RFL	This is the standard FDL mode which allows remote configuration, status inquiries, and diagnostics. This mode does not provide CSU functionality.
ANSI	ANSI CSU standard T1.403 is followed If framing is SF, the CM-3R can respond to line loop-up and loop-down commands.
ATT	AT&T CSU standard TR54016 is followed. If framing is SF, the CM-3R can respond to line loop-up and loop-down commands. Note: The RFL, ANSI and ATT line codes are mutually exclusive functions. RFL is the factory-default line code.

6.8 ACTIVATING AND DEACTIVATING T1 LOOPBACKS (LPBK GROUP)

The LPBK group activates or deactivates the three T1 loopback modes provided by the CM-3R module: equipment, line, and payload. (See Table 6-4.) In most cases, only one loopback will be active at a time. However, the CM-3R loopbacks are independent of each other, so it is possible for two loopbacks (such as Line and Equipment) to be active at the same time. See Figure 6-13.

CAUTION

Do not activate the Payload and Equipment Loopbacks simultaneously. This sets up a feedback condition that will send the multiplexer into an alarm state.

Table 6-4. LPBK group

Function	Description
LnLB	Line Loopback. When active, the entire T1 signal received by the CM-3R module is looped, or passed through to its T1 output. Line code and frame format are passed from input to output without modification. This means that all line code violations (bipolar violations), frame bit errors, and CRC-6 errors received by the CM-3R module are re-transmitted without correction. Line Loopback forces the re-transmitted signal to be synchronized to the received signal. Since the Line Loopback is located behind the CM-3R Jitter Buffer, any received jitter is attenuated. (See Section 2 of this manual for more information.) A CM-3R module is essentially loop-timed when its Line Loopback is active.
PaLB	Payload Loopback. When active, the payload portion of the received T1 signal is looped, or inserted into the payload portion of the transmitted signal. The transmitted signal's line code and overhead bits (frame format) are generated by the CM-3R module itself. This means that all line code violations, frame bit errors, and CRC-6 errors received by the CM-3R module are not passed through. When Payload Loopback is active, the CM-3R module is automatically forced into the loop-timed mode. Once the Payload Loopback is de-activated, the CM-3R module will return to its primary timing mode (the timing mode set by the user).
EqLB	Equipment Loopback. When active, the payload portion of the transmitted T1 signal is looped into the payload portion of the received signal. Equipment Loopback may be used to perform a local loopback test on all the payload circuits terminated by a CM-3R module. When Equipment Loopback is active, the CM-3R module will transmit an unframed all-ones signal; this is called the Alarm Indication Signal (AIS).

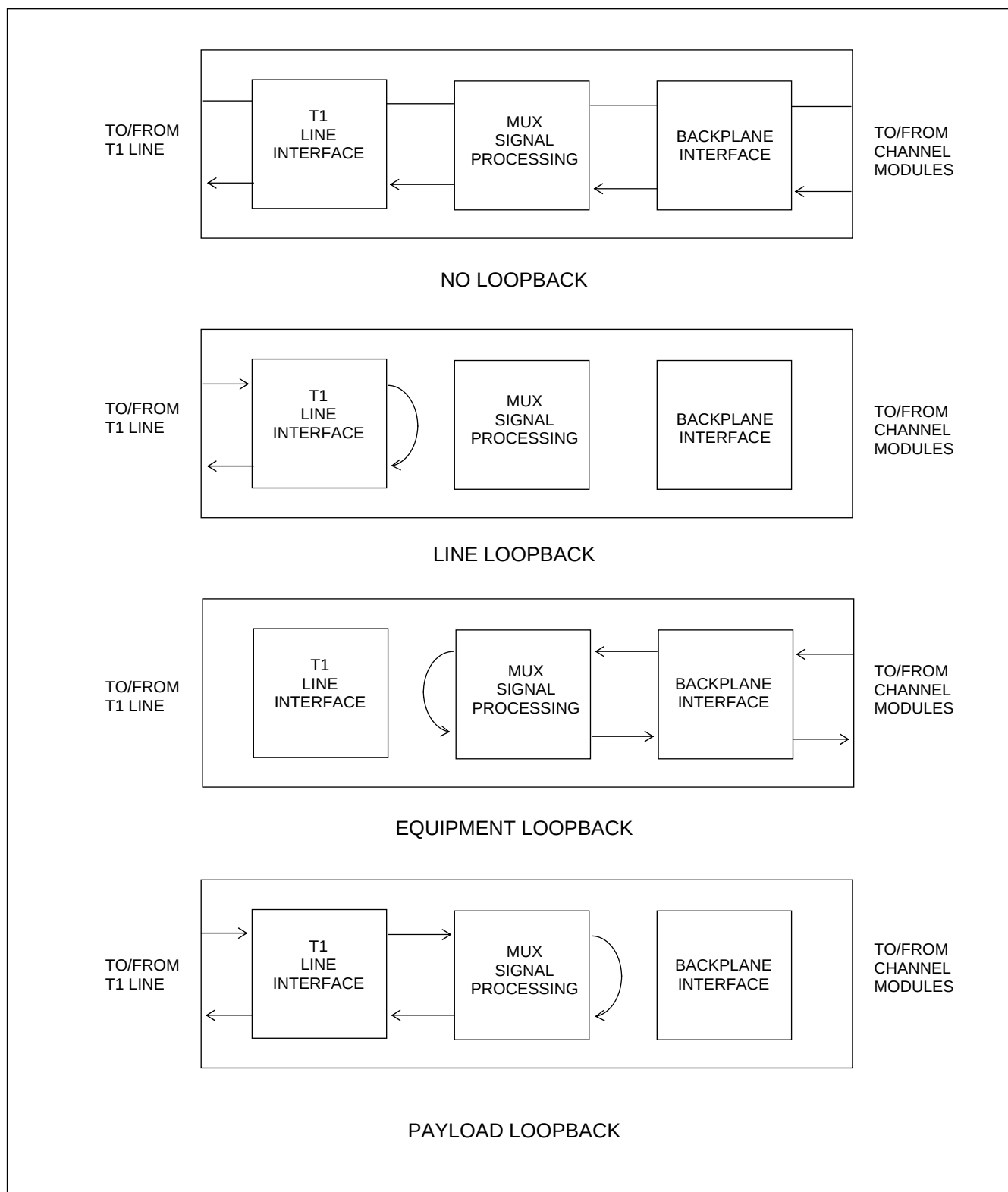


Figure 6-13. Signal flow in Common Module for various loopbacks

If the LPBK (loopback) indicator on a CM-3R module is on, then one or more of its T1 loopbacks is active. To review the state of the loopbacks on a given CM-3R module, proceed as follows:

1. Press up or down on the GROUP switch to display the LPBK group.
2. Press down on the SET/NEXT switch one or more times to display the desired loopback function. The green part of the ON/OFF indicator next to the FUNCTION display will light if the displayed loopback is active; the red part will light if it is not active.
3. If you want to change the state of the displayed loopback, press up twice on the SET/NEXT switch. The ON/OFF indicator will change state to indicate that the desired setup change has taken place.

If you do not want to change the state of the displayed loopback, press down on the SET/NEXT switch to display a different loopback, or press up or down on the GROUP switch to leave the LPBK group altogether.

6.9 THE MEANING OF BLINKING INDICATORS (BLNK GROUP)

BLNK (Blink) group functions explain what is happening when the RX IN, RX OUT, or any of the CM-3R timing indicators are blinking (Table 6-5). BLNK functions will appear in the BLNK group only when they are applicable; when no indicators are blinking, the BLNK group is empty. When one or more indicators are blinking, one or more functions appear in the BLNK group to indicate why. For example, if a T1 yellow alarm is detected by a CM-3R receiver, the RX IN indicator on the CM-3R module will blink, and the function "RxY1" will appear in its BLNK group.

Table 6-5. BLNK group

Function	Description
FTIM	Fallback Timing. FTIM appears in the BLNK group when one of the timing indicators is blinking. It means that the CM-3R transmitter is in its fallback internal timing mode. This occurs when the CM-3R module is configured to operate in the Looped, Through, or External timing modes, but cannot do so. This is usually caused by one of the following: 1. A T1 facility failure. 2. A CM-3R module failure. 3. An external timing source failure. The INT indicator will light continuously when the CM-3R module is in the fallback internal timing mode.
RxY1	Receive Yellow. When included in the BLNK group, the CM-3R receiver detects a T1 Yellow Alarm signal. A Yellow Alarm is produced by some types of T1 equipment, and indicates a loss of frame at the far end. IMUX 2000 multiplexers do not generate a Yellow Alarm upon loss of frame.
Rx11	Receive All Ones. When included in the BLNK group, the CM-3R receiver detects a framed or unframed all-ones signal. This indicates that the far end shelf is idle or set to Equipment Loopback.
XsJt	Excessive Jitter. When included in the BLNK group, the CM-3R T1 receiver jitter buffer has overflowed. This normally indicates that the received T1 signal contains excessive timing jitter.

6.10 PERFORMANCE DATA (RVU1 GROUP)

The RVU1 (Review 1) group functions indicate certain status information (Table 6-6). RVU1 status functions, unlike BLNK group status functions, will always appear in the group. As explained in Table 6-6, the state of each RVU1 function is indicated by the ON/OFF indicator next to the the four-character FUNCTION display on the CM-3R module.

Table 6-6. RVU1 group

Function	Description
TxLk	Transmit Lock. When TxLk is displayed, the ON/OFF indicator shows the status of the T1 transmitter's PLL: Green For looped or external timing, this means the PLL is locked. This indicator should be on at all times when internal timing is being used. Red This means the PLL is <u>not</u> locked.
RcLs	Receiver Carrier Loss. When the Receiver Carrier Loss function is displayed, the bi-level ON/OFF indicator will light to indicate the status of the T1 receiver carrier: Green(top lit) The receiver <i>has</i> lost carrier. Red(bottom lit) The receiver <i>has not</i> lost carrier.
TxRx	Transmit/Receive Lock. When TxRx is displayed, the ON/OFF indicator shows whether the transmit and receive bus clocks are locked: Green This means the transmit and receive bus clocks are locked. Red This means the transmit and receive bus clocks are <u>not</u> locked. This indication is the result of an approximate measurement. Proper test equipment should be used to verify lock of bus clocks, if necessary.
XsJt	Excess Jitter. When XsJt is displayed, the ON/OFF indicator shows whether the receiver jitter buffer depth has been exceeded. The factory-default buffer depth is 32 UI_{p-p}, or about 20.7 ms. ON (green lit) This means the jitter buffer depth has been exceeded. OFF (red lit) This means the jitter buffer depth has not been exceeded.

6.11 DIAGNOSTIC DATA (DIAG GROUP)

The DIAG (diagnostic) group displays some basic T1 Common Module information, and enables a reset to factory default settings. (See Table 6-7).

Table 6-7. DIAG group

Function	Description
T1	Indicates the module's operating mode. On a CM-3R module, this is always "T1".
#.##	Indicates the module's firmware revision.
Fcty	Return to factory default configuration: Framing ESF Line Code B8ZS Timing Internal (terminal multiplexers) or Through (drop/insert multiplexers) Line Loopback OFF Payload Loopback OFF Equipment Loopback OFF Fast Reframe OFF To set this function, push up twice on the SET/NEXT switch

6.12 SETTING MULTIPLEXER NETWORK ADDRESS (ADDR GROUP)

NOTE

If the remote access feature is not in use, or if a terminal is connected directly to a single IMUX 2000 multiplexer, it is not necessary to set up and use the network address.

Each IMUX 2000 multiplexer can be assigned a three-digit network address. This can be any number from "001" to "500" (excluding 078 which is reserved for system use). Network addresses are used to distinguish the multiplexers connected by a common network to a central controller. The central controller can be a human operator using a PC or dumb terminal with a basic communications program, or, when available, a computerized network management system which is compatible with the IMUX 2000 Series.

In such a network, all IMUX 2000 multiplexers may receive every command issued by the central controller. However, including the target multiplexer's network address in the command format allows selection of only one multiplexer to respond to that command, if universal addressing is OFF (See paragraph 6.13.5). Section 8 of this manual provides a detailed explanation of remote access and control for the IMUX 2000 multiplexers.

To view and, if desired, change the current network address of an IMUX 2000 multiplexer:

1. Press up or down on the GROUP switch one or more times until the display shows "ADDR."
2. Press down on the SET/NEXT switch one time. The FUNCTION display shows the current three-digit address of the multiplexer (for example, "001"). Also, the green part of the ON/OFF indicator next to the FUNCTION display lights to indicate that the displayed address is the current address.
3. If you **do not** want to change the current address, either do nothing, or press down on the GROUP switch to exit the ADDR group and perform some other setup operation.

If you **do** want to change the current address, press down on the SET/NEXT switch a second time to begin the address editing process. The display changes to show two digits slightly reduced in size, with one digit underscored. For example, if the current multiplexer address is 001, then the display now shows "001."

At this point, each press **down** on the SET/NEXT switch causes the underscore to move one digit to the right, and each press **up** on the SET/NEXT switch increments the currently underscored digit by one. Using this process, change any or all digits to obtain the desired address. (Address 000 and 078 are reserved; choose any other number from 001 to 500).

Once the display is edited to the desired value, do the following:

1. Press down the SET/NEXT switch until the underscore disappears and the digits are again displayed full size. For example, if the displayed address was changed to 040, the display now reads **040**. The red part of the ON/OFF indicator lights to show that the address displayed is **not** the current address.
2. To change the multiplexer's network address to the number on the display, press up **twice** on the SET/NEXT switch.

Pressing up once on the SET/NEXT switch causes the green part of the ON/OFF indicator to blink; this shows that a change is about to be made. At this point you can abort the change by pressing down on the SET/NEXT switch. Pressing up on the SET/NEXT switch a second time actually makes the change. The green part of the ON/OFF indicator now stays on and the red part turns off. This shows that the displayed number is the currently-set address.

This procedure is illustrated in Table 6-8.

Table 6-8. Changing multiplexer network address from 001 to 040

Step	Action	Function* Display	ON/OFF Indicator Status
1	Press up or down on the GROUP switch until "ADDR" is displayed.	ADDR	Both parts OFF.
2	Press down on the SET/NEXT switch once to display the current address. The green part of the ON/OFF indicator will light to indicate that the number on display is the current address setting.	001	Green (ON) part lit.
3	Press down on the SET/NEXT switch again to begin address editing. The first digit will be blinking.	<u>0</u> 01	Green (ON) part lit.
4	Press down on the SET/NEXT switch to move the blinking to the second digit.	0 <u>0</u> 1	Green (ON) part lit.
5	Press up four times on the SET/NEXT switch to change the center digit from "0" to "4."	04 <u>1</u>	Green (ON) part lit.
6	Press down on the SET/NEXT switch once to move the blinking to the last digit.	04 <u>1</u>	Green (ON) part lit.
7	Press up nine times on the SET/NEXT switch to change the last digit from "1" to "0."	04 <u>0</u>	Green (ON) part lit.
8	Press down on the SET/NEXT switch once to restore the full-size display. The red part of the ON/OFF indicator will light to indicate that the number on display is <u>not</u> the current address setting.	040	Red (OFF) part lit.
9	Press up twice on the SET/NEXT switch to change the current address to match the display. After the second switch press, the red part of the ON/OFF indicator will turn off, and the green part will light. This means that the address on the display is the current address.	040	Green (ON) part lit.

Note: The underscored digit indicates that it is blinking

6.13 SETTING REMOTE PORT PARAMETERS (SIO GROUP)

The IMUX 2000 remote port is an RS-232-compatible serial interface. The Serial Input/Output (SIO) group contains settings for the remote port's baud rate and parity. It also contains settings for locking and unlocking the remote access lock. This can be used to unlock the remote port locally if the remote access password is lost.

The IMUX 2000 SIO group functions are summarized in Table 6-9. Refer to Section 8 of this manual for details on the remote access and control features available.

Table 6-9. SIO group

Subgroup Or Function	Setting	Description
<u>BAUD</u> (baud rate)	100	The baud rate is set to 100 bps.
	300	The baud rate is set to 300 bps.
	1200	The baud rate is set to 1200 bps.
	2400	The baud rate is set to 2400 bps.
	4800	The baud rate is set to 4800 bps.
	9600	The baud rate is set to 9600 bps.
	19,200	The baud rate is set to 19.2 Kbps.
	57,600	The baud rate is set to 57.6 Kbps.
	exit	When exit is displayed, press up on the SET/NEXT switch to exit the BAUD subgroup and display the PAR function.
<u>PAR</u>	Spac	Space: no parity, all parity bits set to zero.
	Mark	Mark; no parity, all parity bits set to one.
	Even	Even parity; each parity bit set so that the total number of ones in each data byte (including the parity bit) is even.
	Odd	Odd parity; each parity bit set so that the total number of ones in each data byte (including the parity bit) is odd.
	exit	When exit is displayed, press up on the SET/NEXT switch to exit the BAUD subgroup and display the PAR function.
Lock	- - -	When the Lock function is displayed, press up twice on the SET/NEXT switch to toggle the state of the remote port between locked and unlocked. The green part of the ON/OFF indicator will light when the port is locked; the red part will light when the port is unlocked. To exit the Lock function and display the Baud subgroup, press down on the SET/NEXT switch. To exit the SIO group entirely, press up or down on the GROUP switch.
Univ	- - -	(Univ = universal addressing) When the Univ function is displayed, press up twice on the SET/NEXT switch to toggle the state of the remote port between Univ "ON" and Univ "OFF". The green part of the ON/OFF indicator will light when Univ is "ON"; the red part will light when Univ is "OFF". To exit the Univ function and display the Baud subgroup, press down on the SET/NEXT switch. To exit the SIO group entirely, press up or down on the GROUP switch.

NOTE: The remote port always operates using **seven data bits**, **one parity bit**, and **one stop bit**. These parameters **cannot** be changed by the user.

6.13.1 SELECTING THE SIO GROUP

To select the SIO group, press up or down on the GROUP switch one or more times until "SIO" appears in the display. At this point each time the SET/NEXT switch is pressed down, the next SIO function will be displayed. The four functions in the SIO group are:

1. BAUD
2. PAR
3. Lock
4. Univ

The BAUD and PAR functions each has an additional menu layer beneath them containing more functions. BAUD and PAR may be thought of as subgroups within the SIO function group. The Lock and Univ functions, on the other hand do not have additional menu layers beneath them.

6.13.2 SETTING BAUD RATE

To display and change the current remote port baud rate, proceed as follows:

1. Use the GROUP switch to display the SIO group.
2. Press down on the SET/NEXT switch to display BAUD.
3. Press up once on the SET/NEXT switch.
The display will now show "110," which is the first available baud rate (110 bps).
4. Press down on the SET/NEXT switch additional times to see the other available baud rates
As the baud rate values are being displayed, the green part of the ON/OFF indicator lights when the display shows the currently-set baud rate, and the red part lights when the display shows any other baud rate.
5. To change the current baud rate, press down on the SET/NEXT switch until the display shows the desired baud rate, and then press up twice on the SET/NEXT switch.
After the first press, the green part of the ON/OFF indicator flashes; this means that a change is about to be made. After the second press, the green part lights continuously; this means that the baud rate is now set to the displayed value.

The last function in the BAUD subgroup is **exit**. When the exit function is displayed, you can press up on the SET/NEXT switch to leave the **BAUD** subgroup and display **PAR**, the next SIO function. To exit the **SIO** group altogether, press up or down on the GROUP switch.

6.13.3 SELECTING PARITY MODE

To display and change the current parity mode, proceed as follows:

1. Use the GROUP switch to display the SIO group.
2. Press down on the SET/NEXT switch to display **PAR**.
3. Press up once on the SET/NEXT switch. The display now shows **Spac**, which is the first of four available parity modes.
4. Press down on the SET/NEXT switch additional times to see the other available modes.
The other available modes are Mark, Even, and Odd. If parity mode is set to Space, then every parity bit is set to zero. If parity mode is set to Mark, then every parity bit is set to one. If parity mode is set to Odd or Even then parity bits will be set to create odd or even parity for each data byte.
The green part of the ON/OFF indicator lights when the current parity setting is being displayed. If any other parity setting is displayed, the red part of the ON/OFF indicator lights.
5. To change the current parity setting, advance the display to the desired setting and press up twice on the SET/NEXT switch.
After the first press, the green part of the ON/OFF indicator flashes, meaning that a change is about to be made. After the second press, the green part lights continuously, showing that the parity setting has been changed to the displayed value.

The fifth function in the PAR subgroup is **exit**. When the exit function is displayed, you can press up on the SET/NEXT switch to leave the **PAR** subgroup and display **Lock**, the next SIO function. To exit the **SIO** group, press up or down on the GROUP switch.

6.13.4 USING THE LOCK FUNCTION

The **LOCK** function is used to unlock or lock the remote port. When the remote port is locked, setup changes cannot be made remotely. This prevents accidental or unauthorized system setup changes through the remote port.

To unlock a multiplexer through the remote port, the user must send the proper command and **password**. The user selects a password during setup; it can be any combination of letters and numbers up to 16 characters in length. Section 7 of this manual describes how to set up and use passwords.

The lock function has no effect on local operation. This allows a multiplexer to be unlocked locally (using the GROUP and SET/NEXT toggle switches), even if its password has been lost.

To access the Lock function directly, proceed as follows:

1. Select the SIO group using the GROUP switch.
2. Press down on the SET/NEXT switch until **Lock** is displayed.
As mentioned above, the Lock function can also be accessed from the PAR subgroup by displaying its "exit" function and pressing up on the SET/ NEXT switch.
3. When the display shows **Lock**, the green part of the ON/OFF indicator lights if the multiplexer remote port is locked, and the red part lights if it is unlocked. To toggle the remote port from locked to unlocked (or unlocked to locked), press up twice on the SET/NEXT switch.

To exit the Lock function and display the **BAUD** subgroup, press down on the SET/NEXT switch. To exit the SIO group entirely, press up or down on the GROUP switch.

6.13.5 USING THE UNIV FUNCTION

The **UNIV** function allows for universal addressing. If universal addressing is enabled, any multiplexer receiving through its local RS-232 port a command not containing a node address, will respond to that command. This is the most typical operating mode. It allows the operator to control and query the locally connected multiplexer without knowing its node address.

In some system configurations, several multiplexers may be bridged (parallel-connected) onto the RS-232 link to the controlling terminal as shown in Figure 6-14. A command or inquiry not containing a node address would elicit a response from all nodes simultaneously, resulting in message collisions or unwanted operation. To prevent this, universal addressing should be disabled.

If **UNIV** is **OFF**, the unit will only respond to commands which have its correct address. This parameter is accessed via the front panel only, under the **SIO** menu. Universal addressing pertains only to communications over a local port. To access a remote node over FDL, the desired node address must be present in the command or inquiry.

To access the Univ function, proceed as follows:

1. Select the SIO group using the GROUP switch.
2. Press down on the SET/NEXT switch until **Univ** is displayed.
3. When the display shows **Univ**, the green part of the ON/OFF indicator lights if Univ is ON, and the red part lights if Univ is OFF. To toggle from Univ ON to Univ OFF (or OFF to ON), press up twice on the SET/NEXT switch.

To exit the Univ function and display the **BAUD** subgroup, press down on the SET/NEXT switch. To exit the SIO group entirely, press up or down on the GROUP switch.

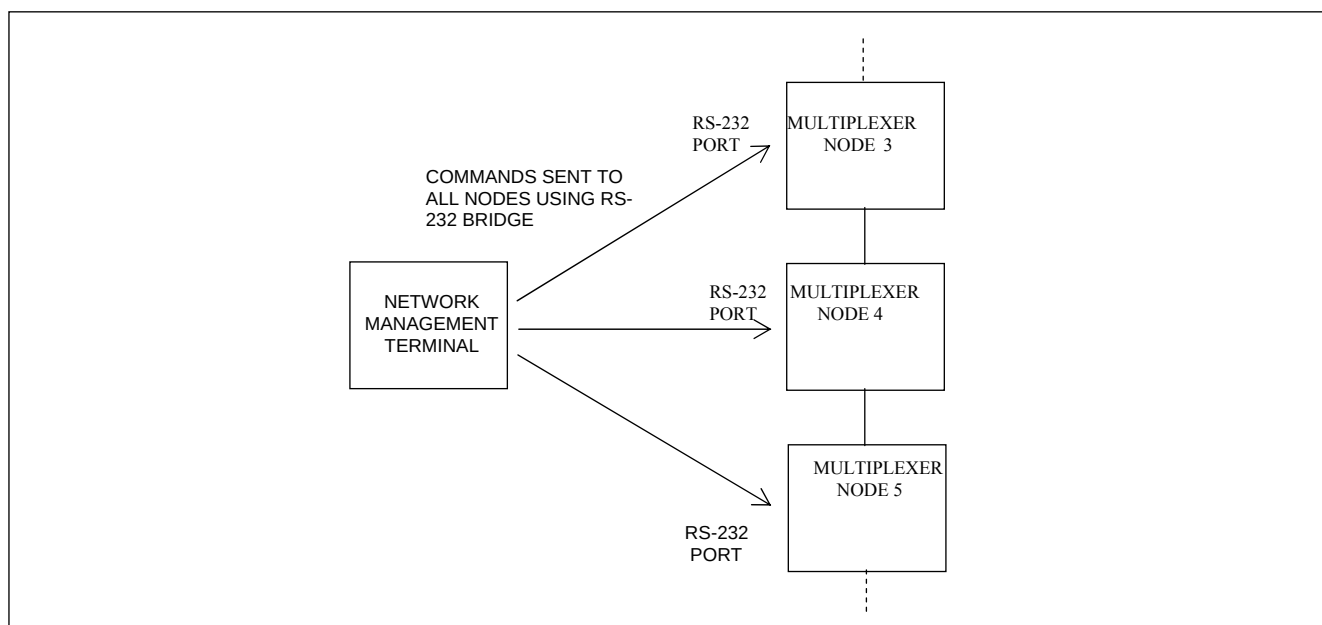


Figure 6-14. Network management terminal simultaneously connected to multiple IMUX multiplexers

6.14 SETTING THE FAST FUNCTION

The **FAST** function is used to enable or disable the T1 Fast Reframe function.

To access the **FAST** function, proceed as follows:

1. Use the GROUP switch to display the **FAST** group.
2. Press down on the SET/NEXT switch to display **Disa** (disable) or **Enab** (enable) as required.
3. When the display shows **Disa** or **Enab**, the green part of the ON/OFF indicator lights when the function is selected.
4. To change the current setting, advance the display to the desired setting (**Disa** or **Enab**) and press up twice on the Set/next switch.
After the first press, the green part of the ON/OFF indicator flashes, meaning that a change is about to be made. After the second press, the green part lights continuously, showing that the parity setting has been changed to the displayed value.

6.15 SETTING THE MAIN FUNCTION

The **MAIN** function can be turned ON or OFF. When the MAIN function is set to ON, the CM3R main module works normally. When the MAIN function is set to OFF, the CM3R main module is turned OFF and is forced to report an on-board trouble. This simulates a problem with the CM3R main module.

To access the **MAIN** function, proceed as follows:

1. Use the GROUP switch to display the **MAIN** group.
2. Press down on the SET/NEXT switch to display **On** or **Off** as required.
3. When the display shows **On** or **Off**, the green part of the ON/OFF indicator lights when the function is selected.
4. To change the current setting, advance the display to the desired setting (**On** or **Off**) and press up twice on the Set/next switch.
After the first press, the green part of the ON/OFF indicator flashes, meaning that a change is about to be made. After the second press, the green part lights continuously, showing that the parity setting has been changed to the displayed value.

6.16 SETTING THE SWCH FUNCTION

The **SWCH** function can be set to **Auto**, **Main** or **Stby**, and is only used when you have a redundant IMUX. The Auto setting allows automatic switch operation from the main CM3R to the standby CM3R when the main module has a problem. The Main setting activates the Main CM3R module. The Stby setting activates the standby CM3R module

To access the **SWCH** function, proceed as follows:

1. Use the GROUP switch to display the **SWCH** group.
2. Press down on the SET/NEXT switch to display Auto, Main or Stby as required.
3. When the display shows Auto, Main or Stby, the green part of the ON/OFF indicator lights when the function is selected.
4. To change the current setting, advance the display to the desired setting (Auto, Main or Stby) and press up twice on the Set/next switch.
After the first press, the green part of the ON/OFF indicator flashes, meaning that a change is about to be made. After the second press, the green part lights continuously, showing that the parity setting has been changed to the displayed value.

6.17 SETTING THE SQEL FUNCTION

SQEL (Squelch) function is used to control data traffic on the multiplexer backplane and to control fallback behavior in the event of loss of sync with the received DS1 data stream.

6.17.1 EFFECT OF SQUELCH ON DATA

The receiving Common Module drives received data onto the backplane, where it is used by channel modules. It is also used by the other common module in the shelf in Drop-and-Insert configurations.

Without squelch enabled, when sync is lost, data driven onto the backplane may contain random or unrelated data fragments. For some applications the system operator may elect to invoke **SQEL** to substitute that random backplane data with All-Ones, in order to prevent random output of channel modules or to prevent emitting of that data by the other side of a Drop-and-Insert configuration.

Squelch, when activated, will block data on the backplane during loss-of-sync.

6.17.2 EFFECT OF SQUELCH ON FALLBACK

Another issue addressed by the **SQEL** setting is that the loss-of-sync condition may not be stable. This is more likely to happen with optical interfaces, as the detector increases its gain while attempting to recover faint signals from a broken fiber and occasionally regains sync for a brief moment.

A loss-of-sync condition controls the fallback mode of the other common module in a Drop-and-Insert application; if the receiving Common Module momentarily regains and loses sync, it may be forcing the other Common Module out of and into fallback just as briefly. Since the fallback condition blocks pass-through data traffic and uses fallback timing, these spurious switchovers may be undesirable.

To prevent this, the system operator may elect to stretch or debounce the signal on the backplane that carries loss-of-sync condition to the other Common Module in a Drop-and-Insert shelf. This is also accomplished by the use of Squelch, in the manner described below.

Squelch, when activated, will debounce (stretch) loss-of-sync signal on the backplane.

6.17.3 SQUELCH FUNCTION TIMERS

The **SQEL** function has two separate timers and corresponding settings. These are the Pre-Squelch (**PRSQ**) timer and the Post-Squelch (**POSQ**) timer.

The Pre-Squelch timer determines how long the Common Module waits after encountering a loss-of-sync condition before substituting backplane data with All-Ones. The Post-Squelch timer determines how long the Common Module waits after recovery of sync before restoring data onto the backplane.

Post-Squelch also determines how long the signal announcing loss-of-sync to the other Common Module in Drop-and-Insert is extended during recovery, thus delaying the return to normal conditions. Note that this extension takes place only during recovery; loss-of-sync signal is always activated instantly to ensure the fastest transition into a fallback condition. Each of these timers can be independently set to be disabled (**DISA**) or can be set to any of the following values: 0ms, 0.66ms,

1.3ms, 2.0ms, 2.7ms, 3.3ms, 4.0ms, 4.6ms, 5.3ms, 6.0ms, 6.6ms, 7.3ms, 8.0ms, 8.6ms and 9.3ms. Setting of 0ms denotes instant activation of timer (minimum delay).

To program the desired values of timers for data squelching, both pre- and post-squelch timers must be set to a value that is not **DISA** (disabled). **If either value is DISA, data squelch will not take place.**

Debouncing of loss-of-sync and fallback is controlled only by post-squelch control; the same value pertains to both data squelch and loss-of-sync debouncing. Pre-squelch setting has no effect on loss-of-sync debouncing and may be left disabled if not needed for data squelch.

The interaction of both settings is shown in the chart below.

Table 6-10. Squelch Settings

Squelch Settings		Data Squelch Functionality	Debouncing loss-of-sync
PRSQ Pre-Squelch	POSQ Post-Squelch		
DISA (disabled)	DISA (disabled)	No data squelch	No debouncing
DISA (disabled)	Set to a value 0ms or higher	No data squelch	Signal debounced (extended)
Set to a value 0ms or higher	Set to a value 0ms or higher	Data squelched	Signal debounced (extended)
Set to a value 0ms or higher	DISA (disabled)	No data squelch	No debouncing

RFL recommends a value of 2ms as an initial setting for both pre- and post-squelch timers for multiplexers operating in terminal shelf configuration. Drop-and-Insert shelves require more attention to debouncing of loss-of-sync and thus RFL recommends 2ms pre-squelch and 9.3ms post-squelch as initial settings in Drop and Insert configurations.

The system engineer should review these settings with care, as they control the effect of disturbances on system behavior.

In applications that check their own data integrity, such as digital data traffic, squelch timer values can be shortened or even eliminated. In applications that use received data without any further checks, such as voice traffic, delays should be extended to prevent noise from appearing as valid transmissions.

6.18 SETTING THE SAVE FUNCTION

The **SAVE** function is used to save the CM3R configuration parameters. The configuration parameters can be saved to a nonvolatile RAM chip (**NRAM**) or to a FLASH memory chip (**FLSH**).

To access the **SAVE** function, proceed as follows:

1. Use the GROUP switch to display the **SAVE** group.
2. Press down on the SET/NEXT switch to display **NRAM** or **FLSH** as required.
3. When the display shows **NRAM** or **FLSH**, the green part of the ON/OFF indicator lights when the function is selected.
4. To change the current setting, advance the display to the desired setting (**NRAM** or **FLSH**) and then press up twice on the Set/next switch.
After the first press, the green part of the ON/OFF indicator flashes, meaning that a change is about to be made. After the second press, the green part lights continuously, showing that the parity setting has been changed to the displayed setting.

6.19 SETTING THE SWAP FUNCTION

The SWAP function is only used when the system has a redundant CM3R. The SWAP function enables the user to select swap times from 0.6 seconds to 19 seconds in six steps. The steps are as follows: 0.6 seconds, 1.2 seconds, 2.4 seconds, 4.8 seconds, 9.6 seconds and 19 seconds. The swap time is the amount of time that the primary CM3R will remain in service before it switches to the redundant CM3R when a DS1 disturbance occurs or an active module does not function correctly.

To access the **SWAP** function, proceed as follows:

1. Use the GROUP switch to display the **SWAP** group.
2. Press down on the SET/NEXT switch to display 0.6s, 1.2s, 2.4s, 4.8s, 9.6s or 19s as required.
3. When the display shows the selected swap time, the green part of the ON/OFF indicator lights.
4. To change the current setting, advance the display to the desired setting (0.6s, 1.2s, 2.4s, 4.8s, 9.6s or 19s) and then press up twice on the Set/next switch.
After the first press, the green part of the ON/OFF indicator flashes, meaning that a change is about to be made. After the second press, the green part lights continuously, showing that the parity setting has been changed to the displayed setting.

6.20 USING THE ALARM CUT-OFF SWITCH

The IMUX 2000 Alarm Cut-Off (ACO) switch is located on the power supply module (Figure 6-15). When the ACO switch is in the EN position, the main shelf ALARM and ALERT relays located on the Power Supply Alarm I/O module will respond to detected alarm and alert conditions. However, when the ACO switch is in the DIS position, these relays are disabled. That is, they are forced into their normal (non-alarm) state. (See Table 6-10.)

The ACO switch on an IMUX 2000 multiplexer may be used to silence a local alarm once this multiplexer has been identified as the source of the alarm. After the alarm or alert producing condition has been fixed, be sure to return the ACO switch to its EN position to re-enable the ALARM and ALERT relays.

NOTE

In multiplexers equipped with two power supplies, both ACO switches must be placed in the DIS position to disable the ALARM and ALERT relays located on the Power Supply Alarm I/O module

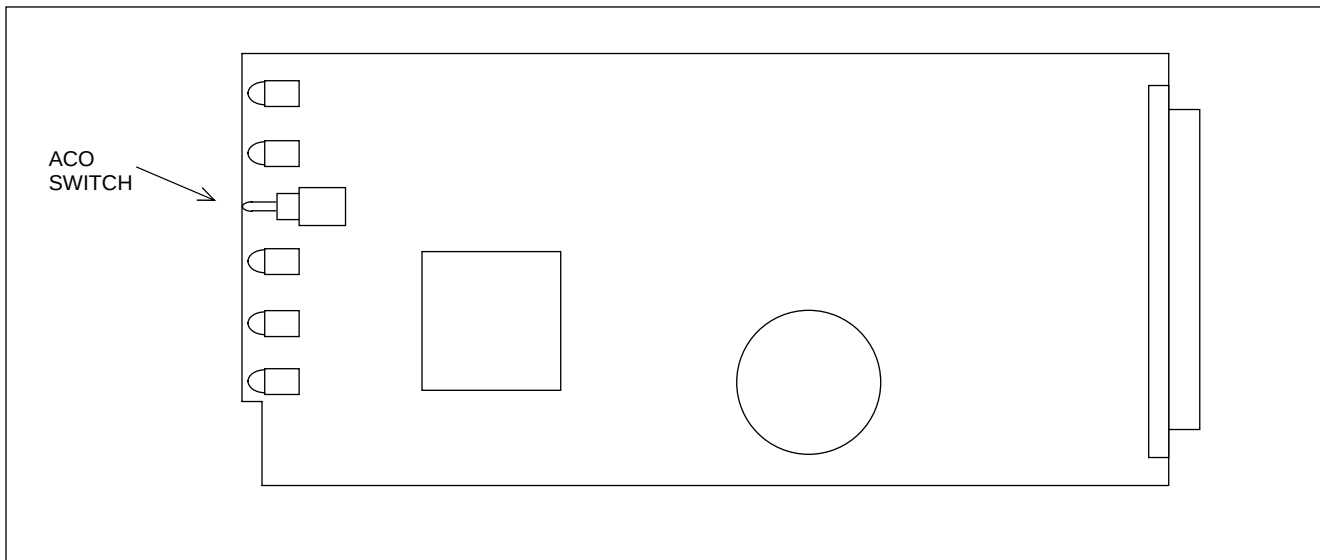


Figure 6-15. Location of the alarm cut-off (ACO) switch on the Power Supply module

Table 6-11. Using the ACO switch

Switch Position	Description
EN	The ALARM and ALERT relays located on the Power Supply Alarm I/O module are enabled. If an alarm or alert condition is detected, they will change position accordingly. When the condition ceases, the relays will return to normal.
DIS	The ALARM and ALERT relays located on the Power Supply Alarm I/O module are disabled. They will stay in their normal positions, even if an alert or alarm condition occurs. If the shelf is equipped with a second (redundant) power supply, the ACO switches on <u>BOTH</u> power supplies must be in the DIS position to disable the ALARM and ALERT relays.

6.21 DISPLAYING AND SETTING SUPPLEMENTARY FUNCTIONS

6.21.1 GENERAL

In addition to the standard groups and functions listed in Table 2-8, the CM-3R Common Modules contain supplementary groups for controlling functions that rarely need adjustment in most systems. These supplementary groups and functions are listed in Table 2-9, Figure 2-19, Table 6-11, and Figure 6-16.

This section describes the functions found in the supplementary configuration group, and explains how to make changes to them. It assumes a basic familiarity with the operation of the CM-3R, particularly the use of the GROUP and SET/NEXT switches, the four-character alphanumeric display, and the bi-level ON/OFF LED. Users not familiar with changing the CM-3R configuration should first read paragraphs 6.5, 6.5.1, and 6.5.2.

6.21.2 ENTERING THE SUPPLEMENTARY CONFIGURATION GROUP

Press down repeatedly on the GROUP switch until RVU1 is displayed, and then release the switch. Press down on the group switch one more time and hold the switch down - do not release it.

While holding the GROUP switch down (the display will now read DIAG), press up once on the SET/NEXT switch. The display will change to read FTIM. You are now in the supplementary group. Release both switches.

NOTE

Although you can cycle through the CM-3R groups by pressing repeatedly either up or down on the GROUP switch, you can only enter the supplementary group by pressing down on the switch to reach DIAG; that is, as the display cycles from RVU1 to DIAG.

6.21.3 INSPECTING AND MAKING CHANGES IN THE SUPPLEMENTARY GROUP

To cycle the subgroups of the supplementary configuration group, press down repeatedly on the SET/NEXT switch. Table 6-11 lists the subgroups and their contents. As Table 6-11 shows, most members of the supplementary group are actually subgroups containing several functions. Paragraph 6.21.3.1 shows how to gain access to subgroup functions, using the example of changing the T1 line build-out (TLBO).

Three members of the supplementary configuration group (Rfrm, Richt, and Rcpu) are functions themselves. Paragraph 6.21.3.2 shows how to set these, taking the Framer Chip Reset (Rfrm) as an example.

Table 6-12. Contents of the Supplementary Configuration Group

Group	Group Description	Function	Function Description
FTIM	Sets the fallback timing mode. The module automatically reverts to fallback timing on the loss of primary timing. This group contains:	FLoo	Set fallback timing to Loop
		FInt*	Set fallback timing to Internal
		FExt	Set fallback timing to External
		FThru	Set fallback timing to Through
		exit	Leave the FTIM group, move on to JBUF group
JBUF	Sets the jitter buffer depth. Increasing the jitter buffer depth increases jitter tolerance, but also increases circuit delay. This group contains:	Joff	No jitter buffer
		J32*	Set jitter buffer depth to 32 bits
		J128	Set jitter buffer depth to 128 bits
		exit	Leave the JBUF group, move on to TLBO group
TLBO	Sets the T1 line build-out range for the T1 port on the card. The display shows the midpoint of the range. This group contains:	DSX*	Set line build-out for DSX standard (0 to 133 feet)
		200'	Set line build-out for 133 to 266 feet
		333'	Set linebuild-out for 266 to 399 feet
		467'	Set line build-out for 399 to 533 feet
		595'	Set line build-out for 533 to 655 feet
		-7.5	Set line build-out for -7.5 dB
		-15	Set line build-out for -15 dB
		-22	Set line build-out for -22.5 dB
		exit	Leave the TLBO group, move on to TXYL group
TXYL	Sets the condition on which the card generates a T1 yellow alarm signal. Note that the exact form of yellow alarm depends on whether SF or ESF is selected. This group contains:	Off*	Yellow alarm off (never active)
		On	Yellow alarm on (always active)
		Auto	Yellow alarm activated on loss of T1 receive signal
		exit	Leave the TXYL group, move on to TYPE group
Rfrm	Resets the receive side of the card by forcing it out of frame and allowing it to resynchronize.	NA	Push down on the SET/NEXT switch to move on to Rcht
Rcht	Resets channel configuration table	NA	Push down on the SET/NEXT switch to move on to Rcpu
Rcpu	Resets the central processing unit (CPU) on the card. The effect is equivalent to removing power from the card and then restoring it. This reset does not change the configuration settings of the card.	NA	Push down on the SET/NEXT switch to move on to the FTIM group

* Indicates factory default settings for these parameters.

6.21.3.1 Example 1: Changing the T1 Line Build-Out from DSX to 333 Feet

1. Enter the supplementary configuration group as shown in paragraph 6.21.2 and then press down on the SET/NEXT switch until the desired subgroup (in this case, TLBO) appears on the display.
2. Press up once on the SET/NEXT switch. The display changes to show the first function in the group, DSX. Because this is the currently selected function, the green portion of the adjacent bi-level LED lights up.
3. Press down repeatedly on the SET/NEXT switch. The display cycles through the functions of the TLBO group. When the display reaches the desired setting (333'), release the switch. The red portion of the bi-level LED lights, indicating that this function is not currently selected.
4. Press up twice on the SET/NEXT switch. After the first press, the green portion of the bi-level LED begins to blink; after the second press, the green LED stays on steadily, indicating that this setting is now active.
5. To reach the next subgroup, press down repeatedly on the SET/NEXT switch until the display shows exit, then press up once on the SET/NEXT switch. You may now cycle through the supplementary configuration subgroups by pressing down repeatedly on the SET/NEXT switch. To leave the supplementary configuration group altogether and return to the main menu, press down once on the GROUP switch.

6.21.3.2 Example 2: Invoking the Frammer Chip Reset

1. Enter the supplementary configuration group as shown in paragraph 6.21.2 and then press down on the SET/NEXT switch until the desired subgroup (in this case, Rfrm) appears on the display.
2. Press up twice on the SET/NEXT switch. After the first press, the green portion of the bi-level LED begins to blink; at the second press, the reset is activated.

NOTE: This is the same for Rcht and Rcpu; Rfrm, Rcht and Rcpu are functionally equivalent to momentary contact switches.

3. To reach the next subgroup, press down once on the SET/NEXT switch. You may now cycle through the supplementary configuration subgroups by pressing down repeatedly on the SET/NEXT switch. To leave the supplementary configuration group altogether and return to the main menu, press down once on the GROUP switch.

NOTE: See Figures 2-19 and 6-16 for flow charts showing all available CM-3R standard and supplementary groups and functions.

6.22 RESET-CHART PROCEDURE FOR CM-3R MODULE

1. This procedure will reset the “channel configuration table” on the CM-3R module.
2. Toggle the GROUP switch toward the board (left) until the display shows Function Group “RVU1”.
3. Toggle the GROUP switch toward the board (left) once and hold it. At the same time toggle SET/NEXT switch away from the board (right) in order to get into the Supplementary Group.
4. The first Function Group in the Supplementary Group is “FTIM”.
5. Toggle the SET/NEXT switch toward the board (left) until the display shows Function “RCHT” (Reset Chart).
6. At this point ON/OFF LED should be RED.
7. Toggle the SET/NEXT switch TWICE away from the board (right).

Caution: *Performing this procedure will delete all channel configurations.*

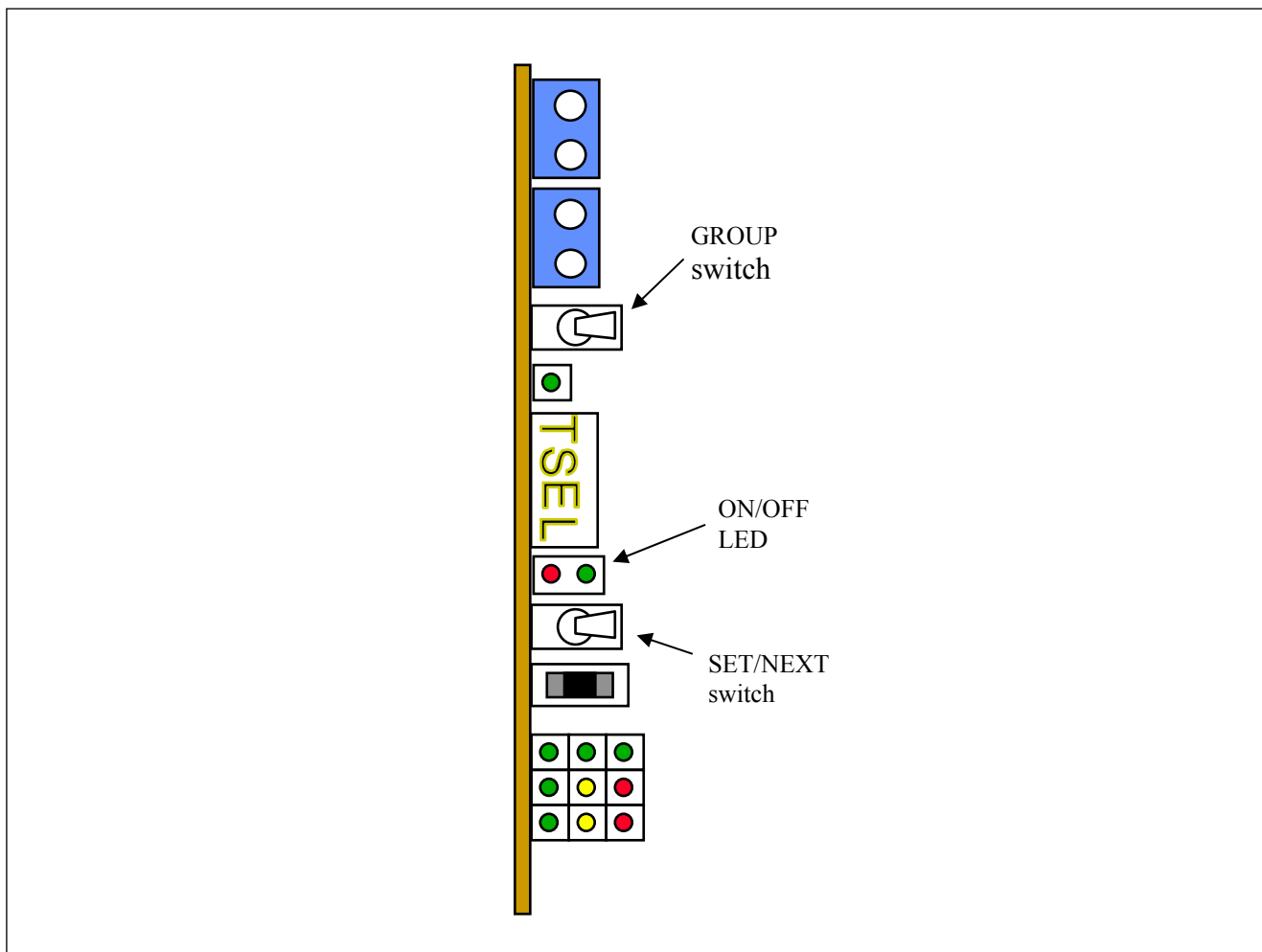


Figure 6-16. View of CM-3R showing switches used in Reset-Chart procedure

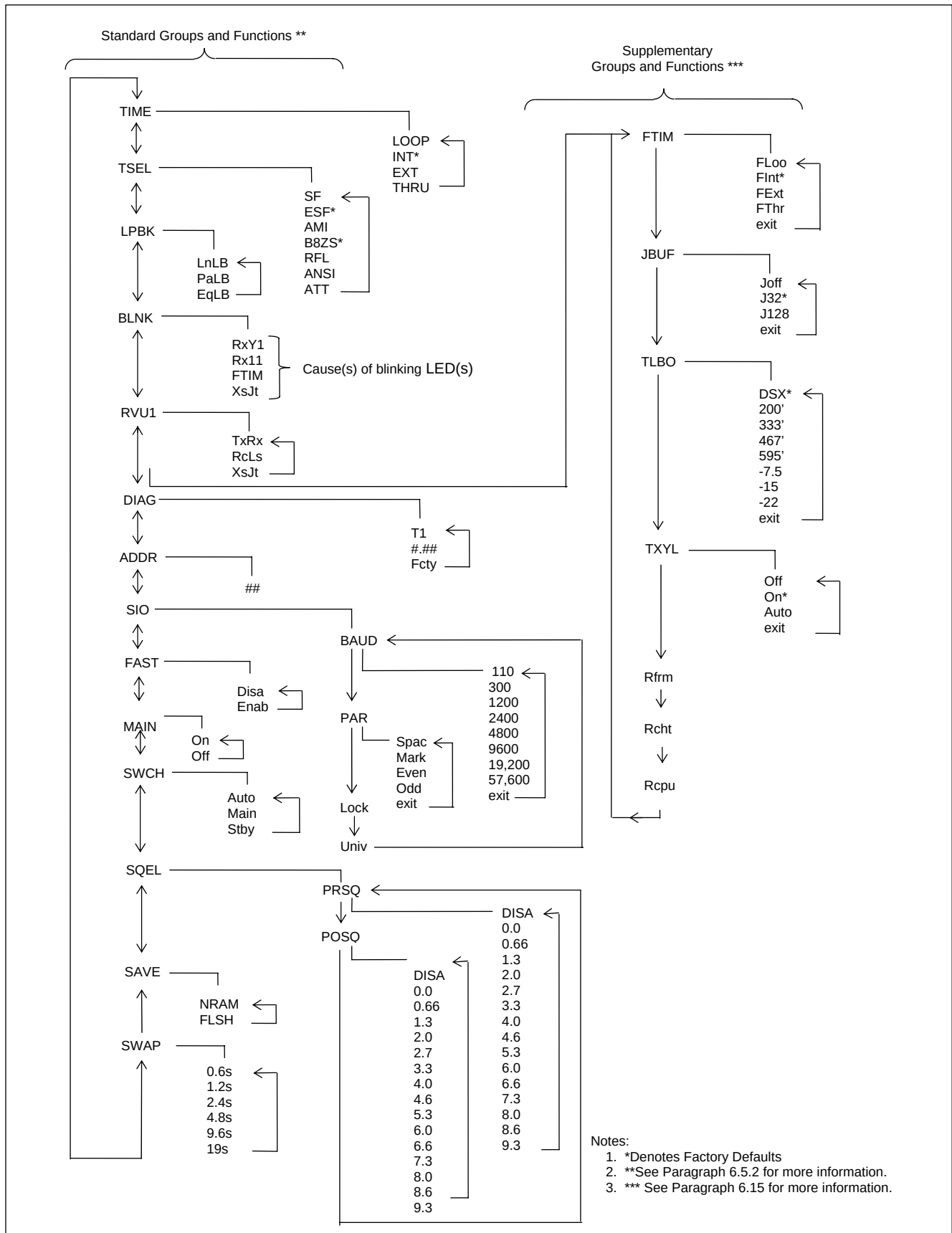


Figure 6-17. Overview of CM-3R Groups and Function

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SECTION 7. NETWORK MANAGEMENT SOFTWARE

7.1 GENERAL INFORMATION

The IMUX 2000 Network Management Software is a software program which uses the Microsoft Windows operating system. It enables the user to perform several different tasks related to the IMUX 2000 Multiplexer, Intelligent Line Switch and DACS when in a system configuration. A brief description of these tasks is listed below. A more detailed description of how these tasks can be implemented is discussed later in this section.

1. Enables the user to communicate with all IMUX 2000 units located in a network.
2. Enables the user to communicate with all intelligent channel cards located in each multiplexer.
3. Enables the user to view a graphical picture of the system from any node.
4. Enables the user to access information regarding the configuration of any node in the network.
5. Enables the user to customize the software for specific requirements.
6. Enables the user to change card parameters in real time.
7. Enables the user to perform network troubleshooting and maintenance.

7.1.1 SYSTEM REQUIREMENTS

In order to use the Network Management Software your PC must meet the following minimum requirements:

1. The PC must be IBM compatible with a hard disk drive and a high density 3.5 inch floppy disk drive.
2. The PC must use an Intel 386 microprocessor or higher.
3. The PC must have a minimum of 4MB of RAM (8MB of RAM preferred).
4. The PC must have Windows version 3.1, Windows 95, or Windows NT.
5. The hard disk must have at least 10 megabytes of free disk space for the IMUX 2000 Network Management Software.

7.2 SOFTWARE INSTALLATION

This section describes how the IMUX 2000 Network Management Software (NMS) is installed into your PC. The following procedure can also be used to install updated NMS programs into your PC as they are released.

Before attempting to install the software into your PC, there are some important facts that must be considered:

1. The software is shipped from the factory on four 3.5 inch diskettes labeled “Disk 1, SW2000NM0XX” , “Disk 2, SW2000NM0XX” , “Disk 3, SW2000NM0XX”, and “Disk 4, SW2000NM0XX”.
2. Before loading the software make a working copy of each diskette. Store the original diskettes in a safe place, and use the working copies to load the software into the PC.
3. Before installing the software, it is recommended that you run CHKDSK or SCANDISK to verify that no problems exist on your hard disk, and to verify available disk space. You will need about 10 megabytes free for a complete installation.
4. As you are installing the software, several lists of choices will appear on the screen; the exact lists displayed will depend on whether you are installing the software for the first time or replacing an existing version. Read the instructions below each list carefully before making your choice.
5. If this is a new installation, proceed as described in paragraph 7.2.1. If you are upgrading to a new NMS version, un-install the old NMS version as described in paragraph 7.2.2, install the new NMS version as described in paragraph 7.2.1, and then use the “Update Config in Memory to New Version” option as described in Help.

7.2.1 INSTALLING THE SOFTWARE

1. Insert Disk 1 into drive A.
2. From the Start Menu, select Run.
3. The Run window will appear on the screen.
4. Type the following in the command line: a:\setup
5. Then click on OK.
6. A setup window will appear on the screen.
7. Click on Next to continue with the setup.
8. From this point on the Installation Software will prompt you to enter the information it needs to install the software into your system. When the installation is complete, the Network Management Icon will be displayed in the Program Manager window.
9. This completes the installation of the Network Management Software.

After the installation is complete, your desktop will be similar to the one shown in Figure 7-1. This window is the starting point for running the Network Management Software. To run the Network Management Software double click on the NMS 9.3 Icon on your desktop, or go to the Start menu and select Programs/RFL IMUX 2000/NMS 9.3. Refer to paragraph 7.4 for information on how to use the Network Management Software. Refer to paragraph 7.5 for an example showing how to configure a typical network using the Network Management Software. Refer to paragraph 7.6 for information on the Network Management Software help screens.

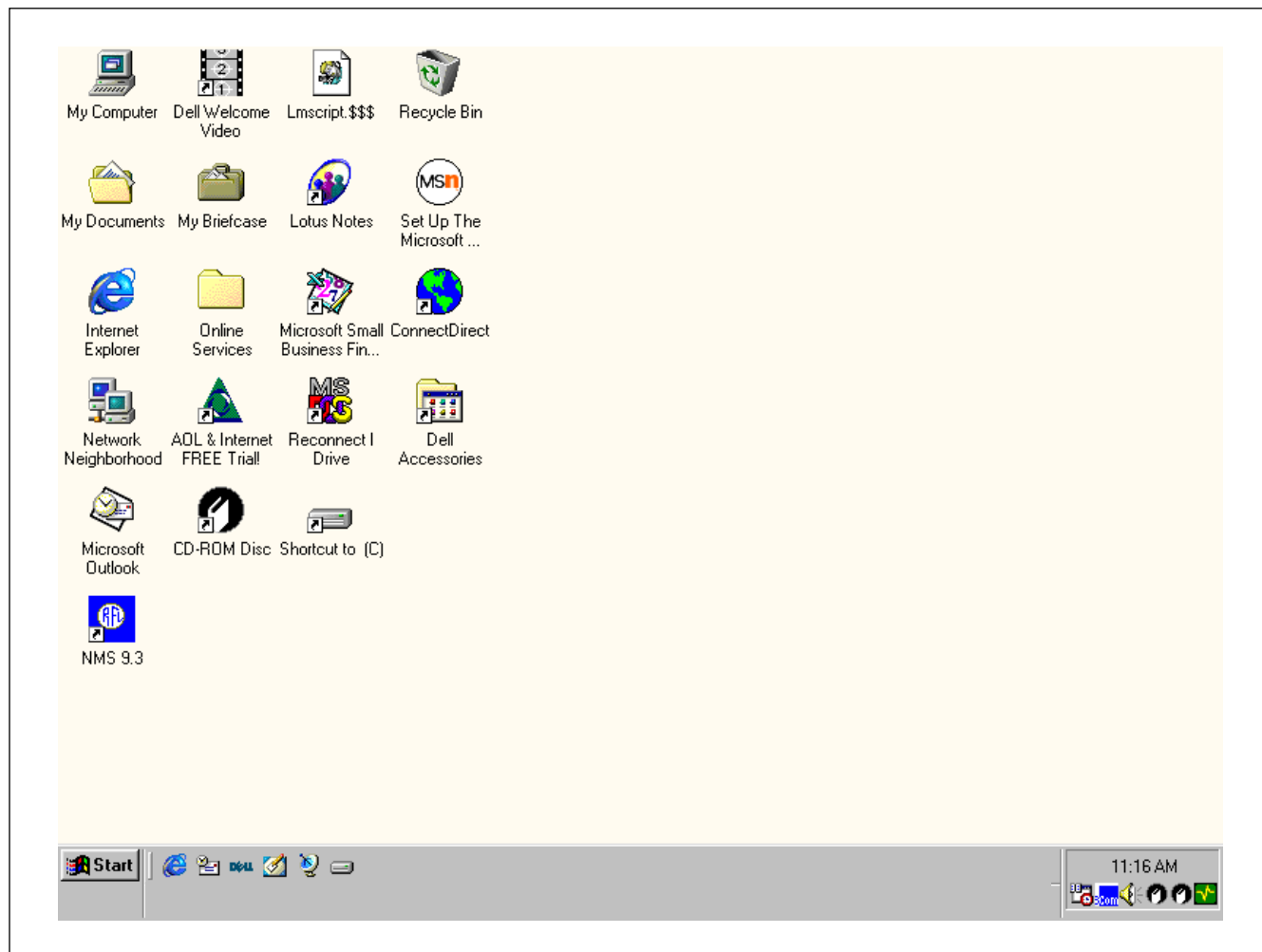


Figure 7-1. Typical desktop showing the RFL NMS version 9.3 Icon.

7.2.2 UN-INSTALLING THE SOFTWARE

If for any reason you want to remove the IMUX 2000 Network Management Software from your computer system, go to the start menu and select Programs/RFL IMUX 2000/Uninstall RFL IMUX 2000. This will cause the Uninstall program to permanently erase all of the programs, icons, directories and files related to the IMUX 2000 Network Management Software from your hard drive.

NOTE

If you want to save the existing nine network configuration files which are listed below, copy these files to a diskette prior to using the un-install program. Otherwise they will be lost. Then copy the diskette files to the new network management directory after installing the new version of the Network Management Software.

name.ALR	The log of alarms for that network
name.DAC	Information on each DACS in the network
name.NET	Network information (name, date, communication path)
name.NOD	Information on each node in the network
name.SLT	The cards in each node
name.VAL	The settings of each card
name.EVT	The log of sequence of events for that network
name.TSC	The settings of ethernet port
name.FPT	The table memo file

7.3 CONNECTING YOUR PC TO THE NETWORK

In order to use the Network Management Software your PC must be connected to a node in the network. There are two ways a user can do this. A direct connection can be made using an RS-232 cable as shown in Figure 7-2, or a remote connection can be made over a public or private phone line as shown in Figure 7-3. The user activates a Com Port connection and sets the baud rates of the PC and the CM3R to the same value. The minimum suggested baud rate is 9600. The construction of a typical RS-232 cable can be seen in Figure 7-4.

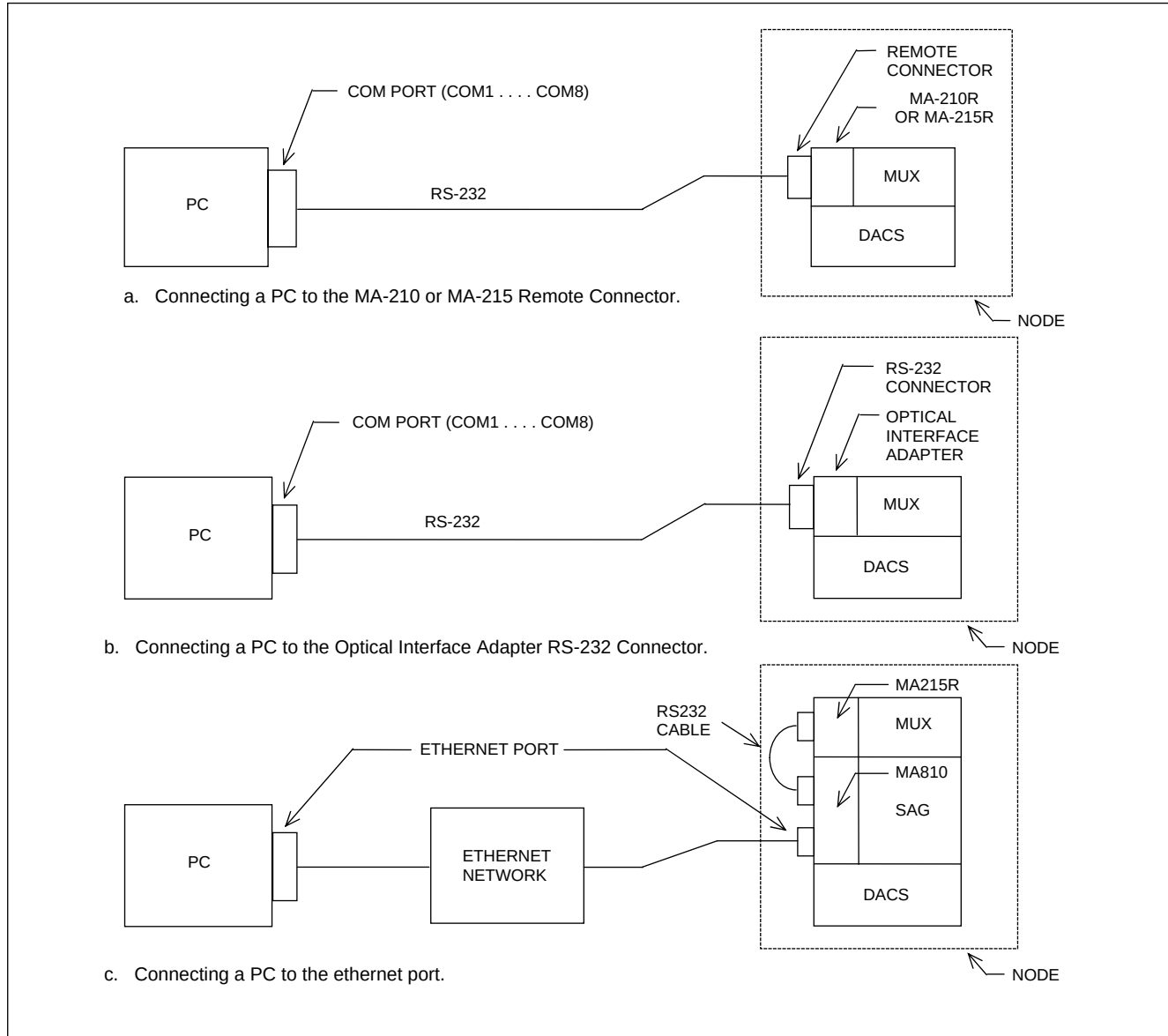


Figure 7-2. PC directly connected to a node using an RS-232 cable.

Figure 7-5 shows a PC at a remote location connected to 4 nodes, where each node is in a different network. Phone line #1 through phone line #4 each represent a different communication path.

Figure 7-6 shows a PC at a remote location connected to 4 nodes, where all nodes are in the same network. The nodes communicate Network Management configuration information via the Facility Data Link.

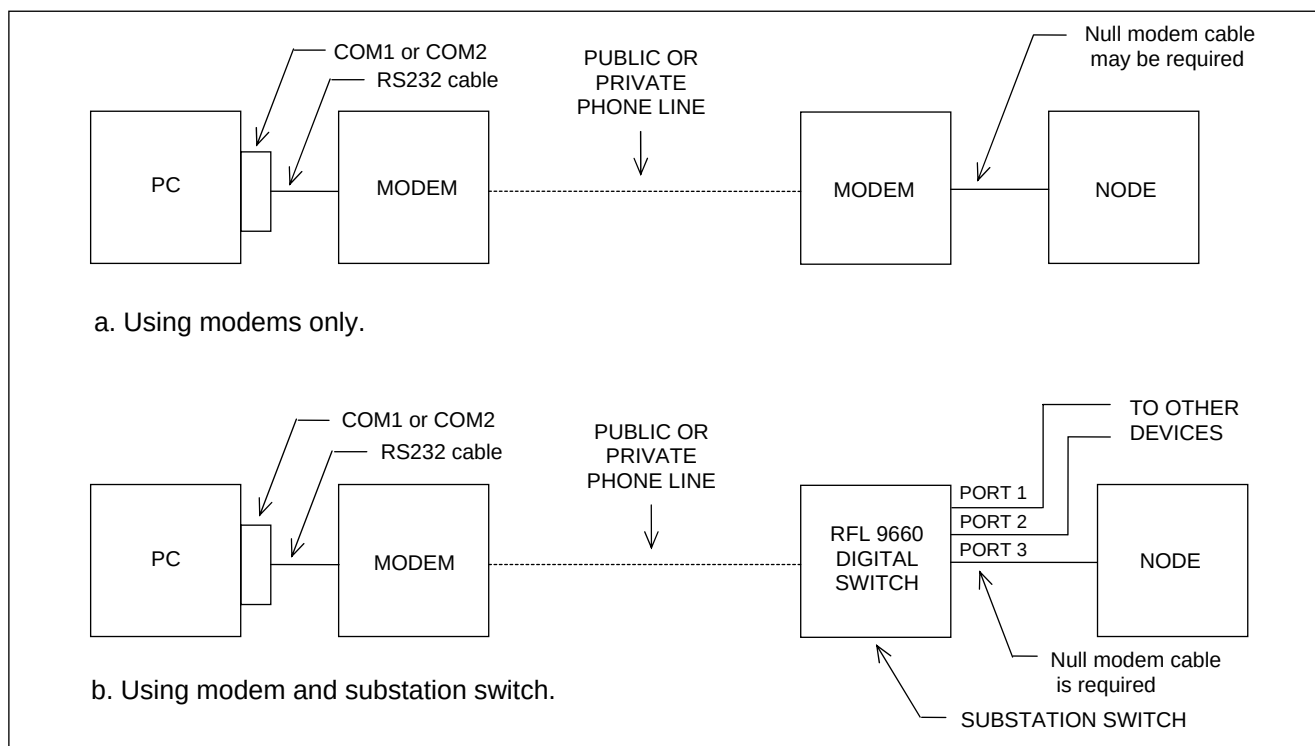


Figure 7-3. PC connected to a node from a remote location.

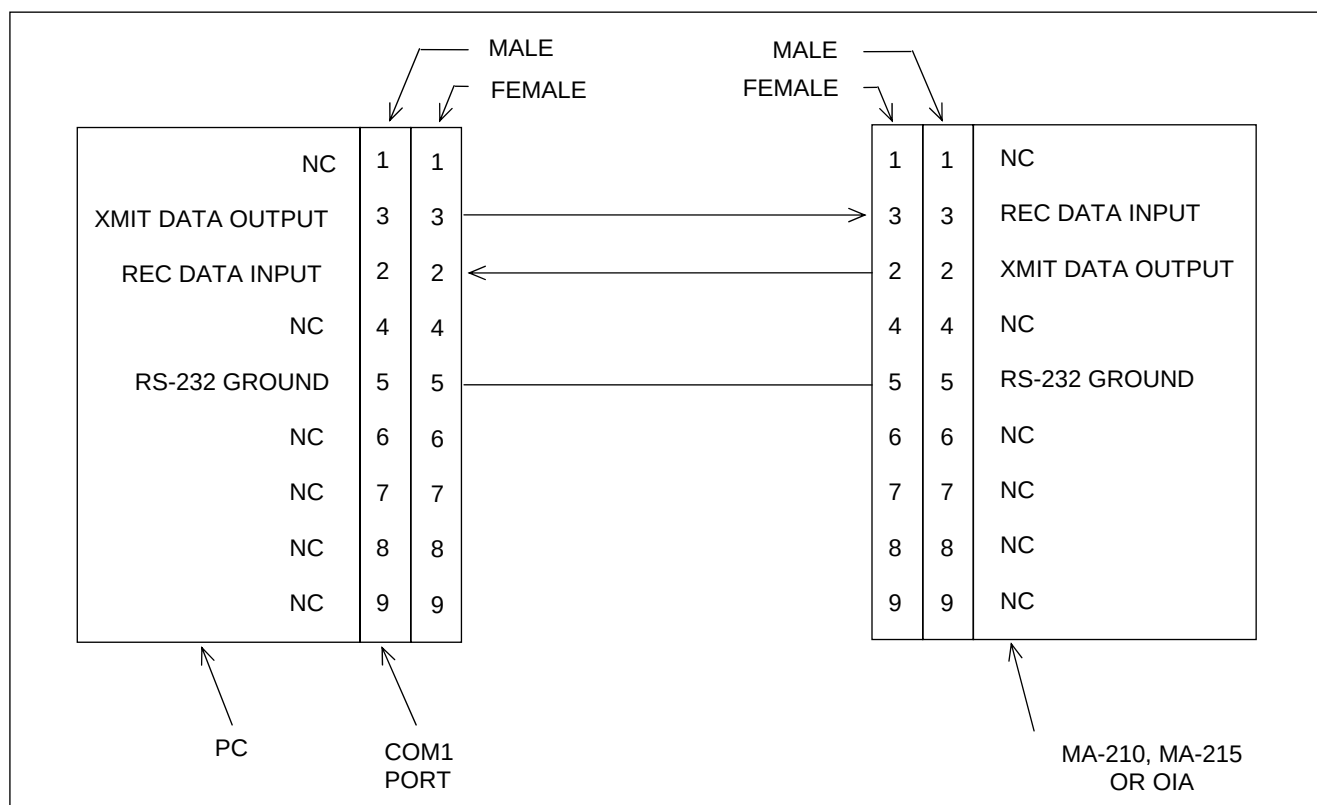
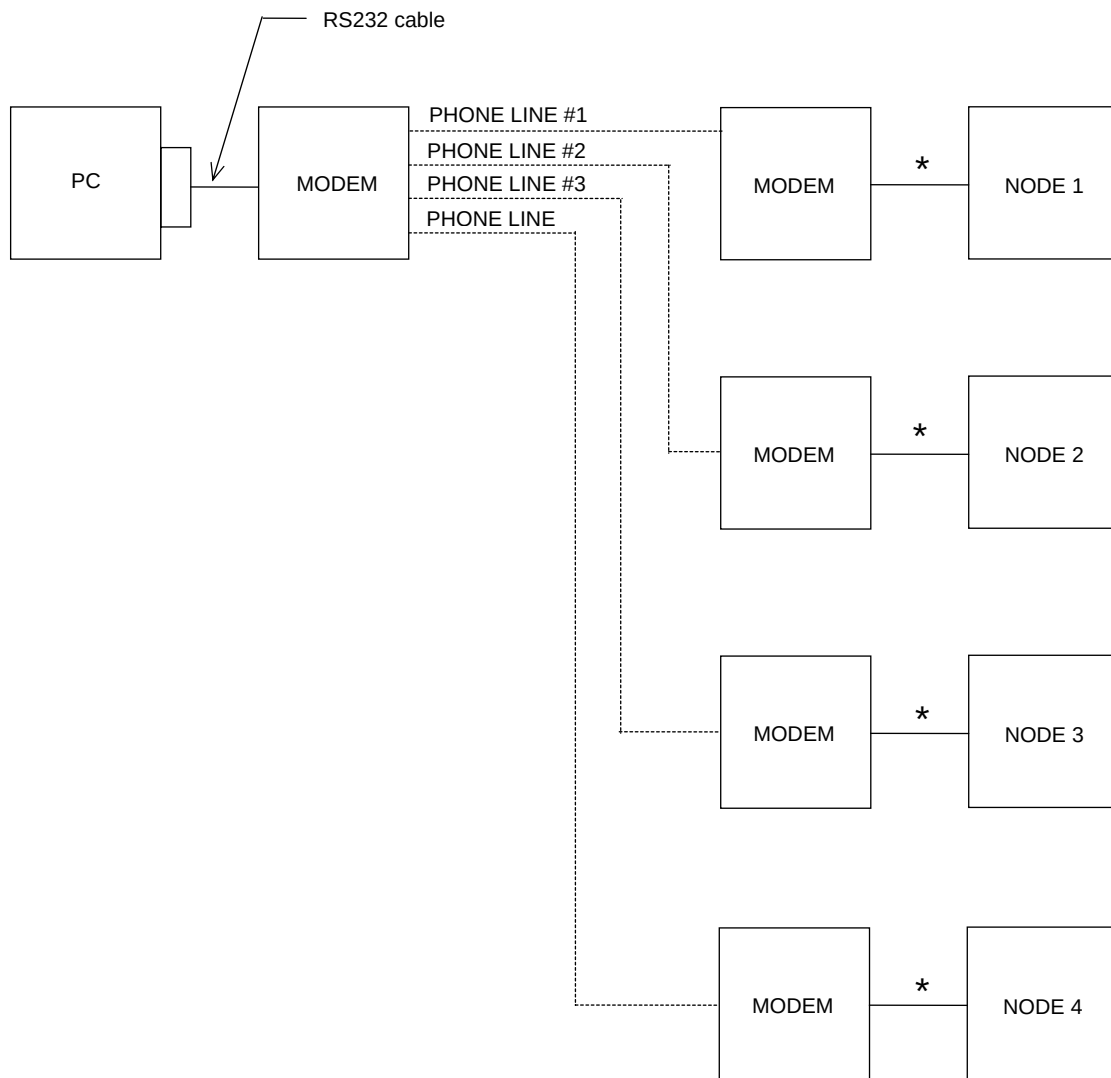
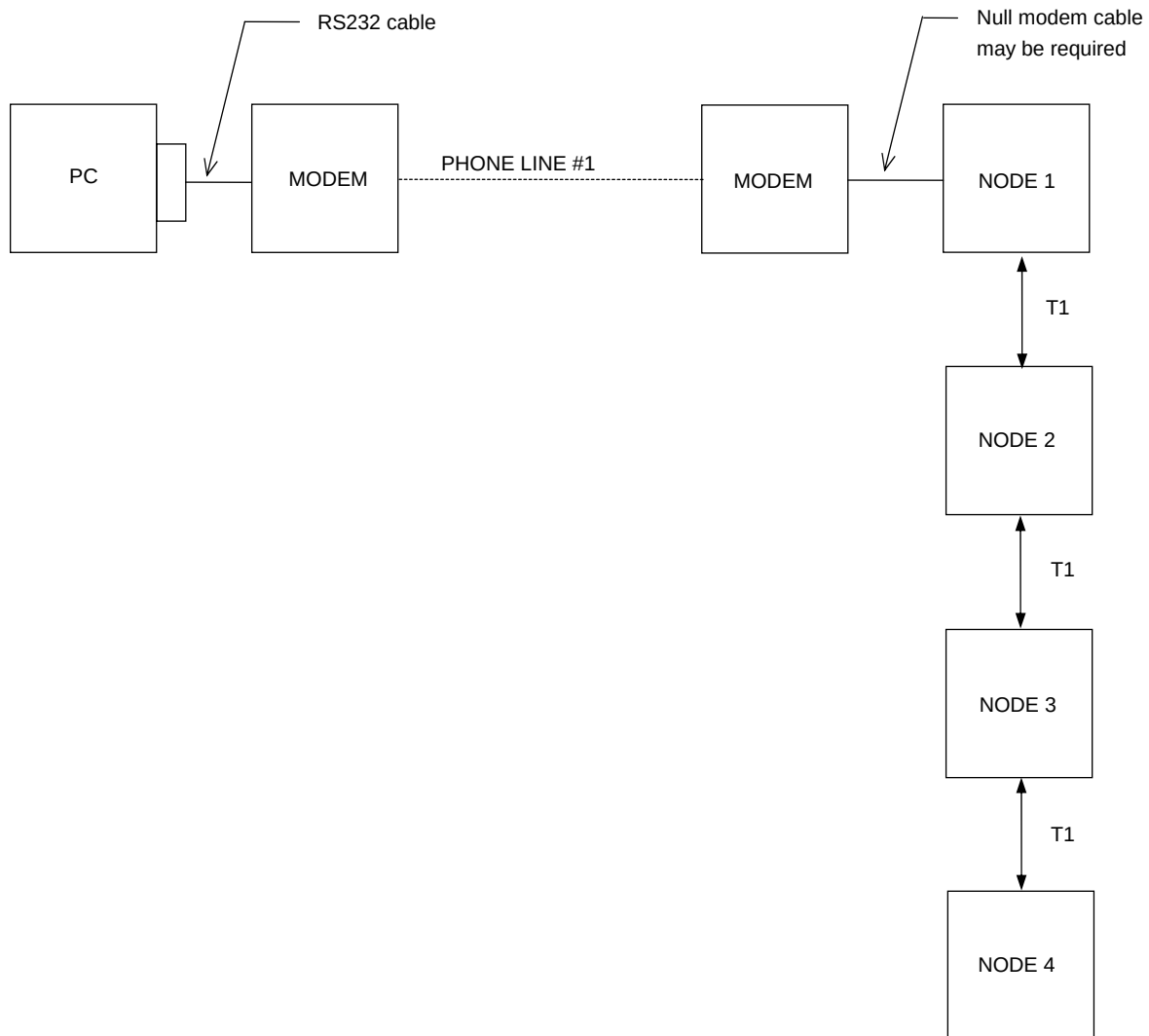


Figure 7-4. Construction of a typical RS-232 cable between the PC and an MA-210, MA-215 or OIA.



* Null modem cable may be required.

Figure 7-5. PC at a remote location connected to 4 nodes, where each node is in a different network.



- Notes:
1. The nodes communicate Network Management configuration information on T1 via the Facility Data Link.
 2. The network must be in Extended Superframe mode for the Facility Data Link to operate.

Figure 7-6. PC at a remote location connected to 4 nodes, where all nodes are in the same network.

7.3.1 NETWORK COMMUNICATION PATHS

Each node in a network is connected to another node, allowing communication to pass from one node to another. Each communication path must have a beginning and an end as shown in the Figures below. Each box represents a node in the network. When using the Network Management Software, the PC can be connected to any node in the network.

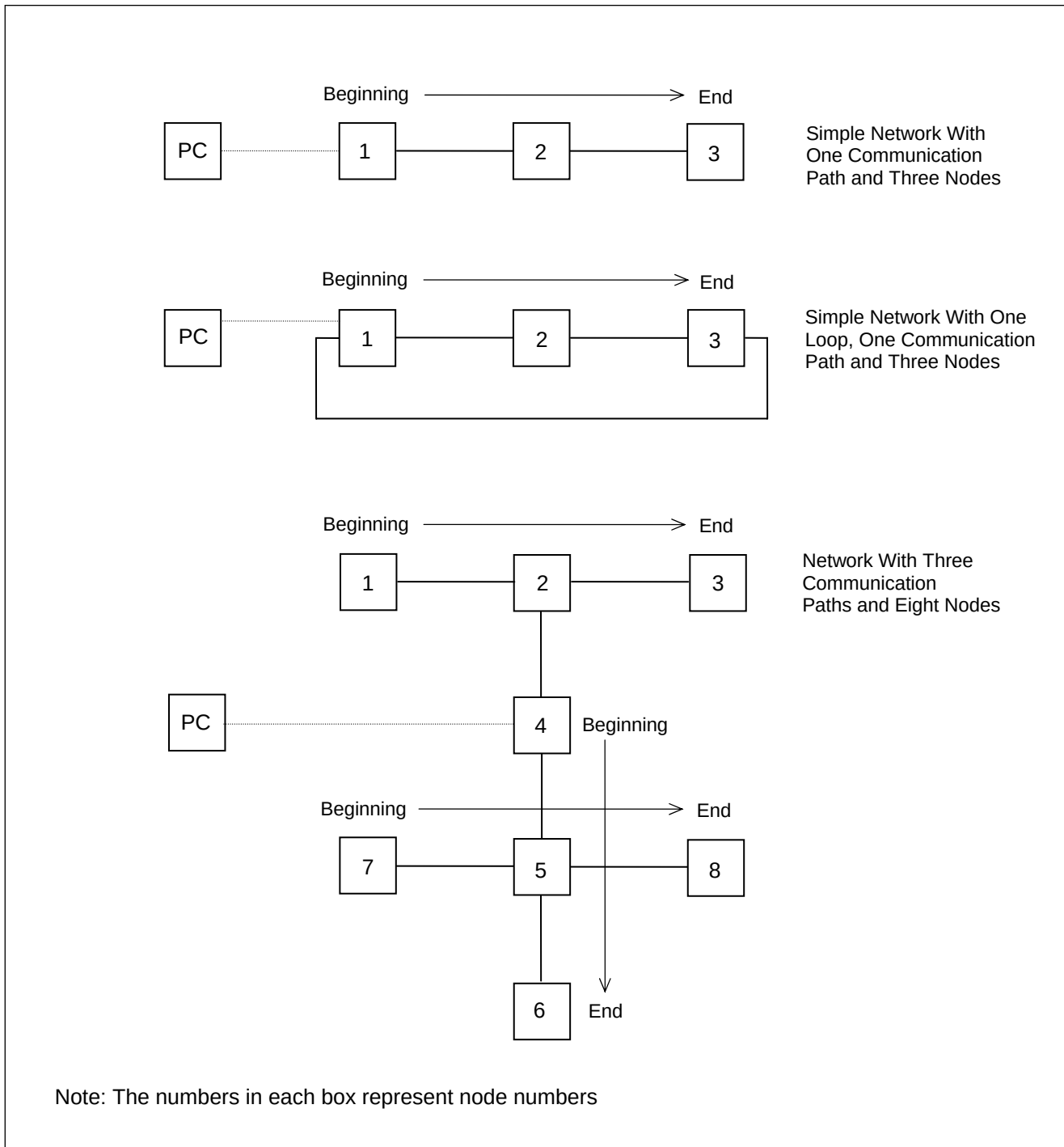


Figure 7-7. Typical networks and communication paths

7.4 USING THE NETWORK MANAGEMENT SOFTWARE ICONS

To enter the Network Management Software, double click on the NMS 9.3 Icon on your desktop. Then enter your user ID and password in accordance with paragraph 7.8.1. This will bring you to the Main window as shown in Figure 7-8. This window has eighteen functions which correspond to the Icons listed below.

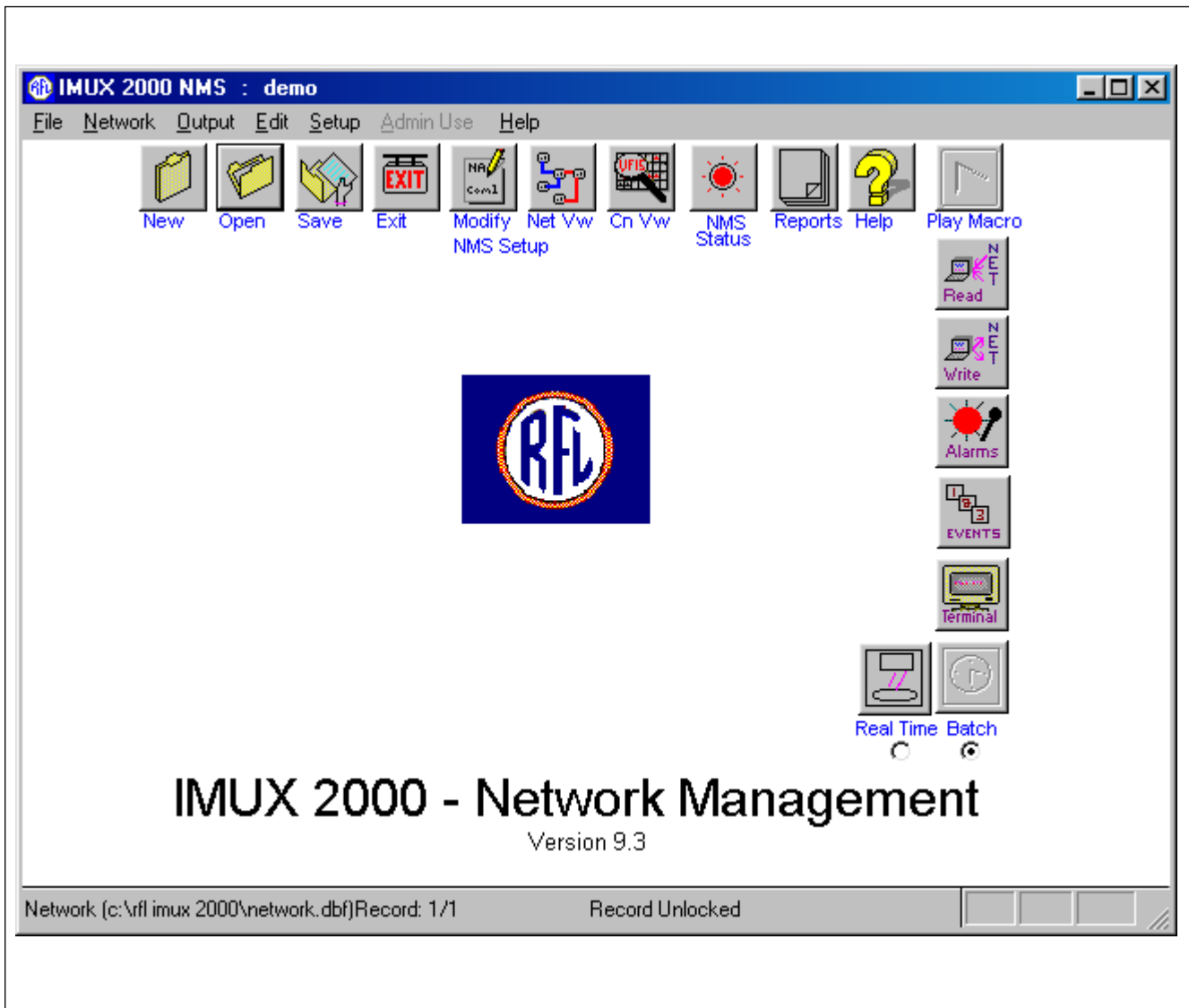


Figure 7-8. Network Management Software Main window

<u>Icon</u>	<u>Function</u>
1. New	Allows the user to create a new network file to enable the configuration of a network yet to be installed.
2. Open	Allows the user to open an existing network file for the purpose of altering the file or to download the file to a network.
3. Save	Allows the user to save a network file.
4. Exit	Allows the user to exit the Network Management Software.
5. Modify NMS Setup	Allows the user to select the communication path(s), parity, baud rate, and connection type (direct or phone)
6. Net Vw	Network View provides the user with a graphical representation of the network. The nodes are shown as boxes and the connections are shown as lines. Each node has a site name and address which are also displayed.
7. Cn Vw	Connection View provides a table view of all possible connections in a network. It provides the user with the information required to assign time slots to channel cards and modules.
8. NMS Status	Provides the user with information about the network file setup.
9. Reports	Allows the user to view seven types of network reports.
10. Help	Provides the user with Network Management Software help.
11. Play Macro	Allows a user to play a macro which has been previously recorded and edited. To play a macro the user selects the Play Macro icon on the main screen then selects the macro by name, and it runs. This function can only be used in real time mode. More information on Play Macro can be found later in this section.
12. Read Net	Read Network causes the network to be read to a file. This function can only be used in batch mode.
13. Write Net	Write Network causes a file to be written to the network. This function can only be used in batch mode.
14. Alarms	Allows the user to gather alarm data and then go to Reports to view the alarm data. This function can only be used in batch mode, however, an autopolling option is available in real time mode. More information on auto polling can be found later in this section.

15. Events	Causes the Sequence Of Events buffer to be read by the Network Management Software and allows the user to view or print the Sequence Of Events buffer.
16. Terminal	Causes the software to enter Terminal Emulation mode. Refer to Section 8 on Remote Configuration for more information.
17. Real Time	Allows a user to change the configuration parameters of any card in the network in real time which means that any change that is made will be written to the network immediately. Real time mode is used when you have only a few (1 or 2) changes to make in the network.
18. Batch	Allows a user to change the configuration parameters of all nodes in the network or of just one node in the network in one operation. The change does not take place immediately. The user must select either a network write or an individual node write in order to implement the change. (NOTE: Batch is the default mode. The red dot indicates which mode is selected)

7.5 EXAMPLE OF CONFIGURING A NETWORK

7.5.1 INTRODUCTION

This section contains an example of how to configure a new network using the Network Management Software. The example gives step by step instructions showing all windows and settings. The information provided here will enable you to configure more advanced networks to suit your own requirements.

7.5.2 STEPS REQUIRED TO CONFIGURE A NETWORK

	<u>See paragraph</u>
1. Setup the hardware at each node including all cards, modems and cables as required.	7.5.3.1
2. Connect the PC or laptop to the network either directly or remotely using a modem or an ethernet module.	7.5.3.2
3. Start the IMUX 2000 Network Management Software from the desktop.	7.5.3.3
4. Select NEW to start a new configuration. Complete the network setup screen. Enter all communication path information.	7.5.3.4
5. Select the READ option. Then select Auto-configuration Method 3.	7.5.3.5
6. Select Network View.	7.5.3.6
7. Enter Display/Change Node window. For each node, add dumb cards, settings for all cards, and program the DACS maps as required.	7.5.3.7
8. Enter Network View window. Connect lines to nodes.	7.5.3.8
9. Use Network Write to configure the cards. When the writing is done the program will return to the main menu.	7.5.3.9
10. Look at Difference Report	7.5.3.10
11. Use Poll For Alarms to look for errors.	7.5.3.11
12. Save Settings in a file	7.5.3.12

7.5.3 GETTING STARTED

Figure 7-9 shows a simplified drawing of the network that will be used for this example. Figure 7-10 shows a more detailed drawing of the network showing all IMUX 2000 components, modules, cards and cables used in the network example.

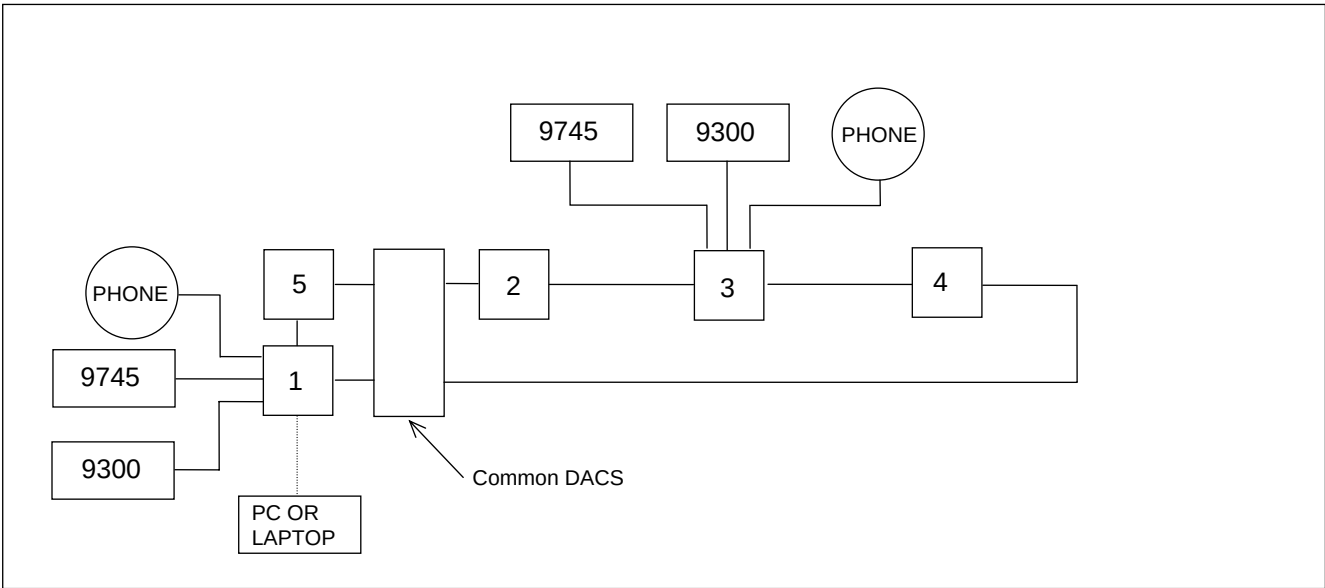


Figure 7-9. Basic drawing of the network used in the example.

The network used in this example has 5 nodes. Nodes 1 and 5 each have one terminal end multiplexer head and tailed at one location to form a ring using a common DACS. All other nodes around the ring have Drop and Insert multiplexers, each utilizing a DACS. Data and voice circuits are established between node 1 and node 3, which consist of one phone line, one RFL 9300 charge comparison system data link, and one RFL 9745 teleprotection data link. Table 7-1. lists the modules and cards in each node that must be configured into the network.

Table 7-1. List of modules and cards used in the example that must be configured into the network

Node 1 (Terminal)	Node 2 (Drop/Insert)	Node 3 (Drop/Insert)	Node 4 (Drop/Insert)	Node 5 (Terminal)
DACS CM3R-1 VF5A VF11B DS562I	DACS CM3R-1 CM3R-2	DACS CM3R-1 CM3R-2 VF5A VF11B DS562I	DACS CM3R-1 CM3R-2	CM3R-1



7.5.3.1 SETTING UP THE HARDWARE

Since this is an example, we will not be setting up actual hardware. However, you should study Figure 7-10 carefully to familiarize yourself with which modules plug into which chassis, with the cabling at each node, and with the settings of the cards at each node. Set up all intelligent cards for “remote” mode. Refer to Sections 15 through 18 for Instruction Data sheets for these cards.

Note that each common module and each channel module that plugs into the front of a multiplexer chassis has a module adapter associated with it which plugs into the rear of the chassis. For example, the Drop and Insert Multiplexer at node three has the following five modules plugged into the front of the chassis: 2 CM3Rs, a DS562I, a VF5A and a VF11B. The following 5 module adapters are plugged into the rear of the chassis: The MA215R is the module adapter for CM3R-1. The MA210R is the module adapter for CM3R-2. The MA406 is the module adapter for the DS562I. The MA301 is the module adapter for the VF5A. The MA304 is the module adapter for the VF11B.

7.5.3.2 CONNECTING THE PC TO THE NETWORK

The next step is to connect your PC to the network. It can be connected to any node, and can be either directly connected with an RS-232 cable, or remotely connected over a public or private phone line using a modem or ethernet module. In this example we will connect the PC directly to node 1. Connect one end of the RS-232 cable to the communication port at the rear of your PC and connect the other end of the cable to the Remote Connector of the MA215R module adapter at the rear of the multiplexer at node 1. See Paragraph 7.3 for more information related to the RS-232 cable.

7.5.3.3 STARTING THE NETWORK MANAGEMENT SOFTWARE

To start the Network Management Software, click on the NMS 9.3 Icon on your desktop. Then enter your user ID and password in accordance with paragraph 7.8.1. This will bring you to the Main window as shown in Figure 7-11. See paragraph 7.4 for information regarding this window.

7.5.3.4 STARTING A NEW NETWORK CONFIGURATION

Since this is a new network configuration, you should click on the NEW Icon. This will bring you to the Edit Network Information window as shown in Figure 7-12. Enter the network name, created by, and comments at the top of the window. This information is optional and does not have to be entered.

Note that this window has the following default values entered for communication path 1: baud rate = 9600, data bits = 7, parity = 2, stop bits = 1, connection type = direct. All of these default values can be used for this example with the exception of the parity bit. You must change the parity bit shown in the window from 2 to 1, since the values shown in the window must match the values that the Remote Port operates at (See paragraph 6-9). Also make sure that the CM3R at node 1 is set to 9600 baud, and that its parity is odd.

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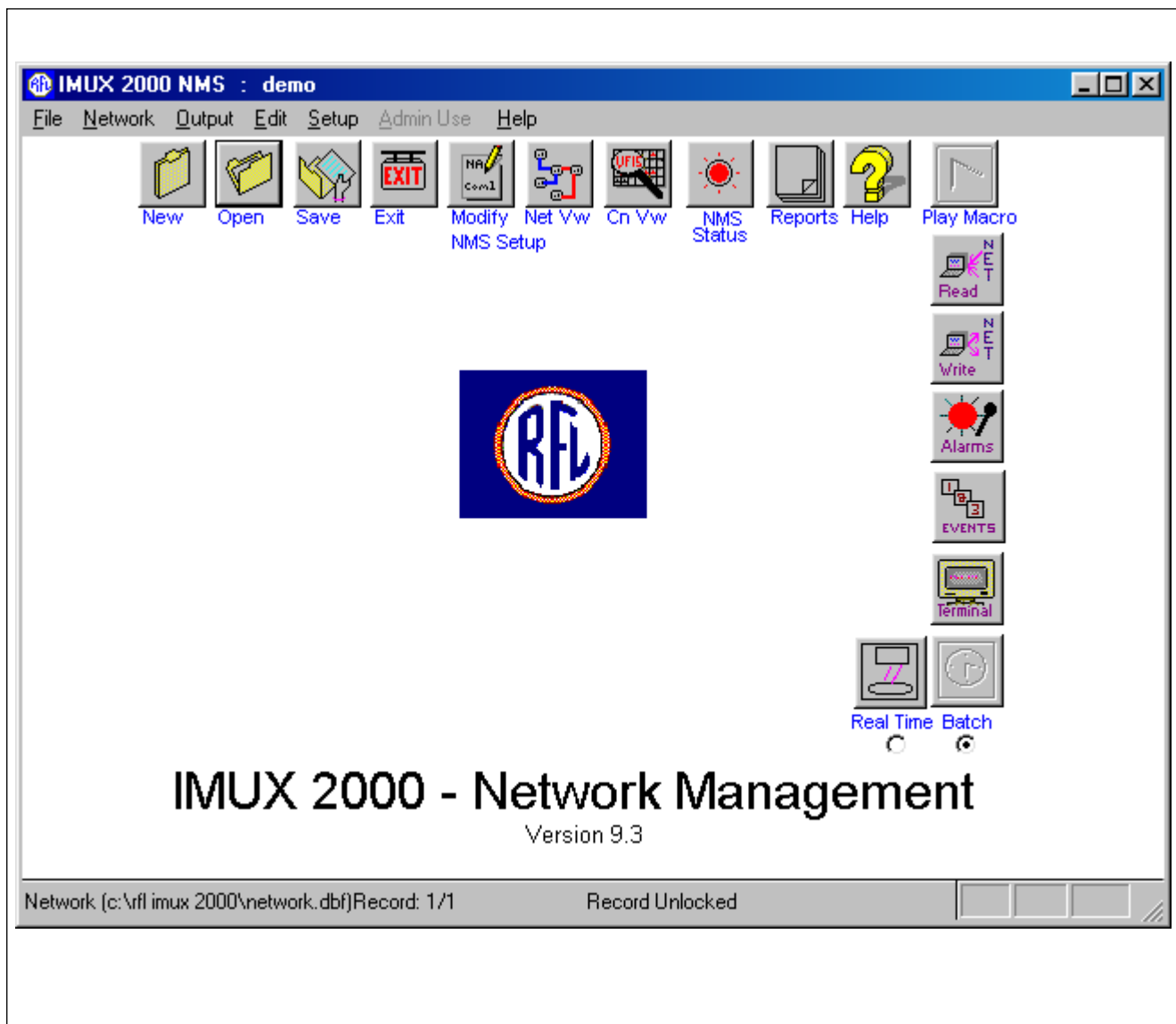


Figure 7-11. Network Management Software Main window

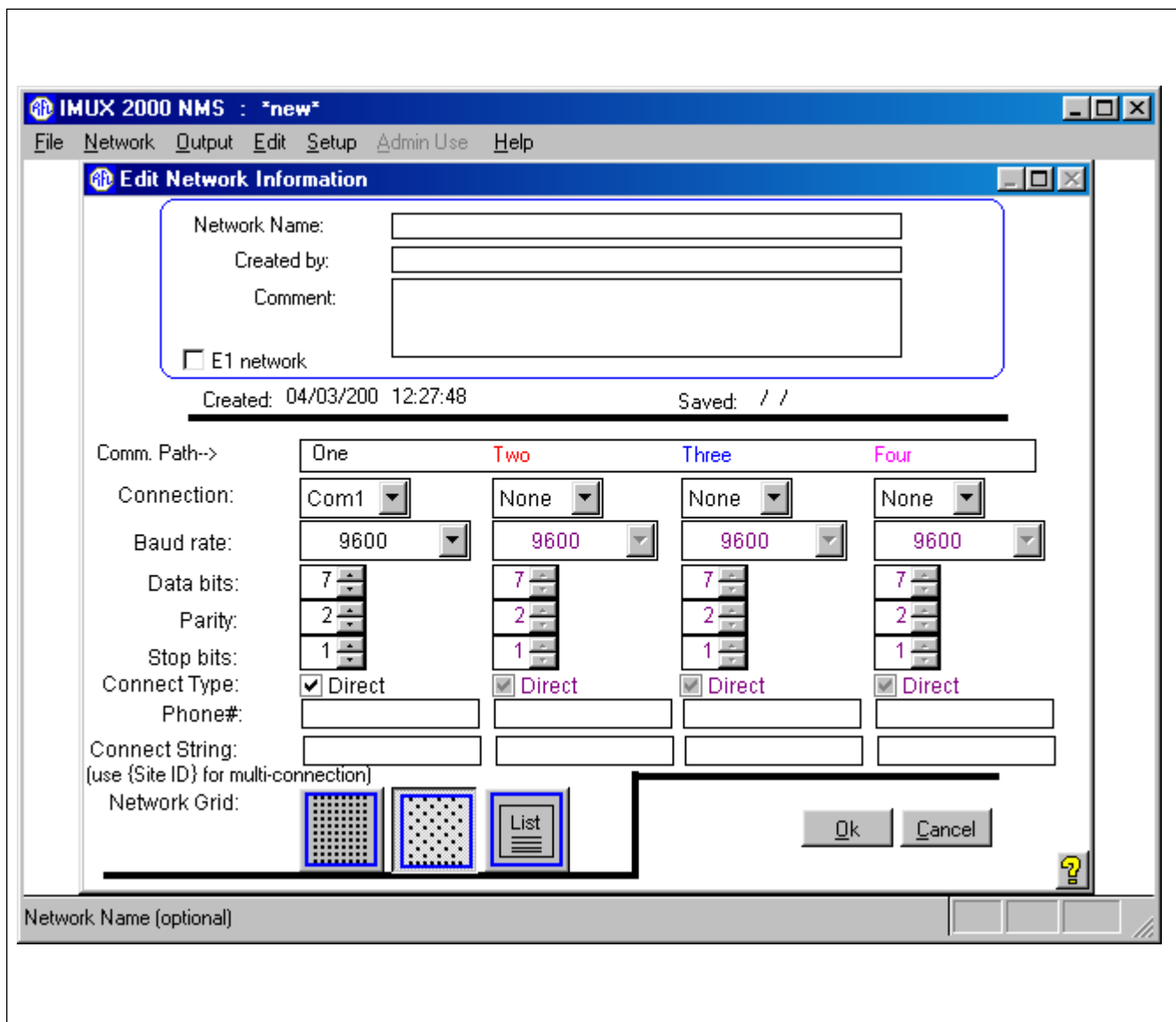


Figure 7-12. Edit Network Information window.

There are two network grids and a network list available. The 8 x 11 grid has more spaces available, but screen updates take time. The 4 x 10 grid has less spaces available, but screen updates are quicker. You can switch from the 4 x 10 grid to the 8 x 11 grid at any time.

Since this example has only 5 nodes, you can select the 4 x 10 network grid at the bottom of the window. The grid that is selected will be highlighted light gray. A phone number is not required in this example since we are directly connected to node 1. A connect string is not required in this example since we are not using a substation switch (such as an RFL 9660). You can now click on OK to return to the main window.

NOTE

In this example the PC is directly connected to Node 1 as shown in Figure 7-10. This connection is shown in more detail in Figure 7-2a. Since this is a direct connection, “Direct” is selected in Figure 7-12, and the Phone# and Connect String boxes are left blank. However, if the PC was connected to Node 1 through a modem with a substation switch as shown in Figure 7-3b, the following selections would be made in the Edit Network Information window (Figure 7-12): “Direct” would not be selected, a phone number would be entered, and “{3}” would be entered in the connect string box to indicate that port 3 of the RFL 9660 Digital Switch is connected to the node.

7.5.3.5 SELECTING NETWORK READ

From the Main window, select the Network Read Icon. This will open a sub-window asking you which communication path(s) to read from, as shown in Figure 7-13. This window has a default for communication path 1, which is correct for this example. Click on Auto-configuration. This will bring you to the Auto-Configure Options window as shown in Figure 7-14. The Auto-Config Option, Method 3 will allow the user to “build” a new network. It will automatically read the current network setup which consists of the nodes, the cards and modules at each node, and either the factory default or user assigned configuration settings of each card and module. Click on Method 3. Then click on OK to read the network.

NOTE

Method 1 only works when there is a configuration already installed. Since this is a new network, a configuration is not yet installed. Therefore if you select Method 1 there is nothing to be read.

Selecting Method 2 will delete information about the cards in each node, and then it will read all the information of the network.

Selecting Method 3 will delete information about the cards in each node, and the nodes , and then it will read all the information of the network.

At 57.6K baud it takes about two and one-half minutes to read each node in the network, if the node does not have a DACS installed. To read a node with a DACS installed takes about an additional five minutes per node. In this example, if we were actually reading the network, it would take about thirty minutes to read the network. While the network is being read, two pop-up windows will get superimposed over the window shown in Figure 7-13. One of these will be a Communications window and the other will be an Auto Cfg/Nodes window.

The network is read into a temporary file which contains the following information:

1. The shelf address of each node in the network (1-500 for CM3Rs, excluding 078 which is reserved for system use).
2. The cards that are in each node
3. The card configuration settings (either default settings, or user assigned settings at the time of hardware installation)

Before the user leaves the Network Management Software, the network configuration information must be saved in a network file with a .NET extension in the form of netname.NET, where netname is selected by the user. If this is not done, the network configuration information will be lost. A description of how to do this will be described later in this Section.

After the network read is complete you will be returned to the main window.

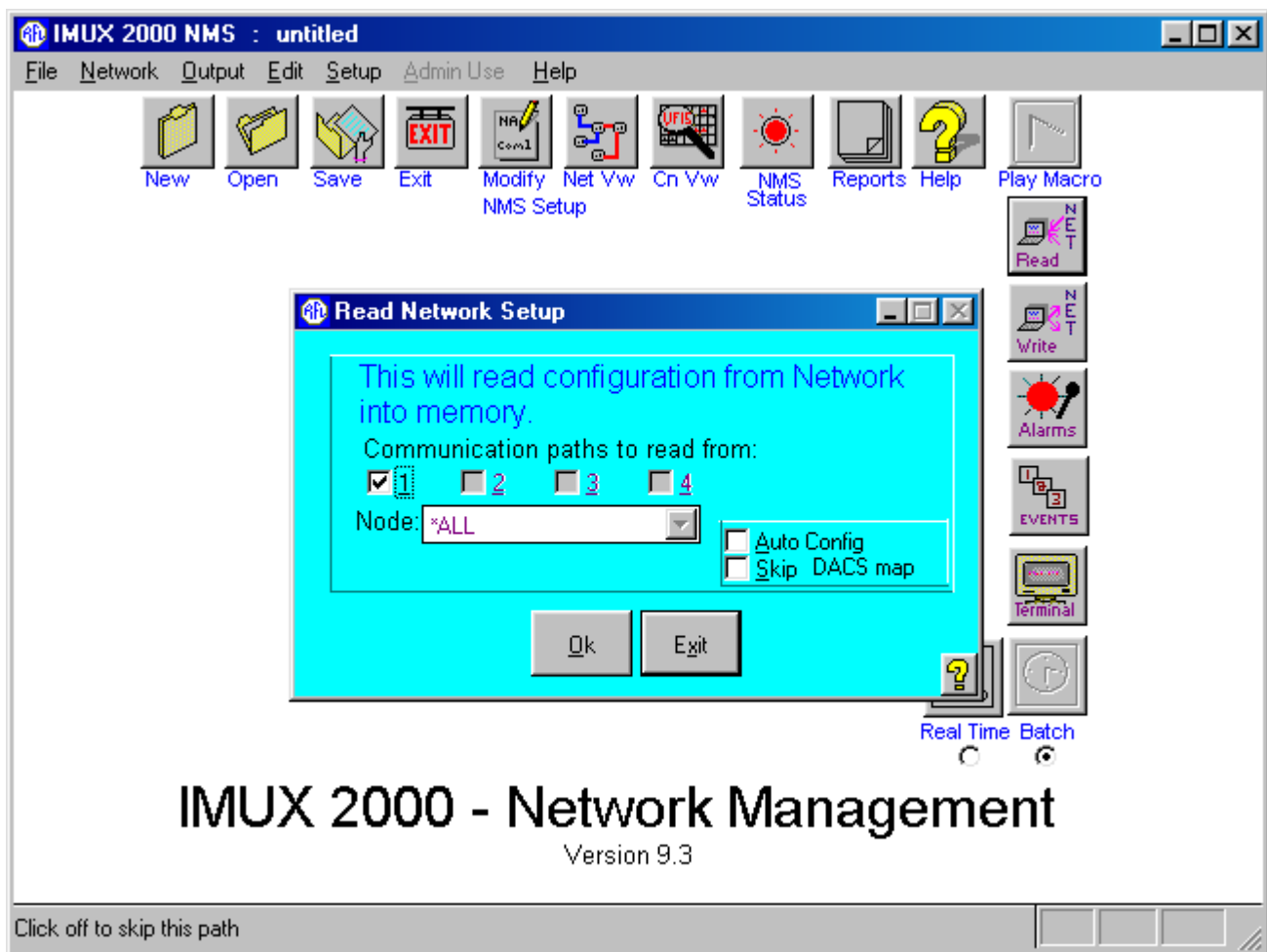


Figure 7-13. Read Network Setup Window

NOTE

When reading a new network configuration into memory the Network Management Software should be in batch mode since all settings must be read for all nodes. After the network has been read you can change the setting to real time mode. This will allow you to change the configuration parameters of any card in the network in real time which will nominally take under 30 seconds.

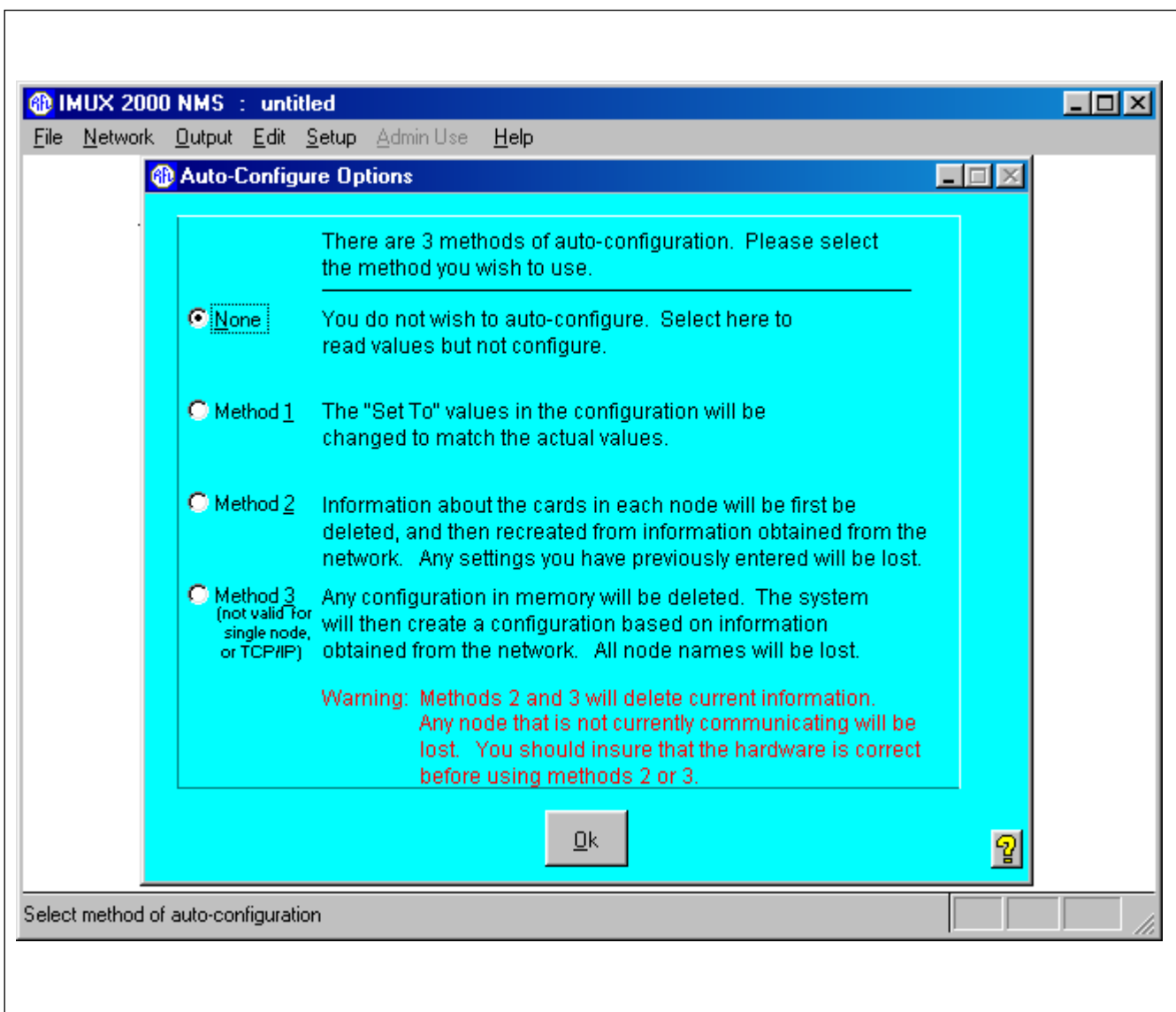


Figure 7-14. Auto-Configure Options Window

7.5.3.6 SELECTING NETWORK VIEW

The Network View window is the first window in a set of several windows that tells the user what nodes are in the network. The information in these windows was read from the network and stored in a temporary file. The Network View window is where the user can configure card and module settings and program the DACS maps. You get to the Network View window by clicking on the Network View Icon. If this network example actually existed, and the network was read as described in paragraph 7.5.3.5, a Network View window similar to the one shown in Figure 7-15 would be seen. To make changes to the card settings, first click on the Change button at the bottom left of the window and then click on the node that you want to change. For this example click on the Change button, and then click on node 1 which is located at the upper left of the Network View window. This will bring you to the Display/Change Node window for node 1 as shown in Figure 7-16.

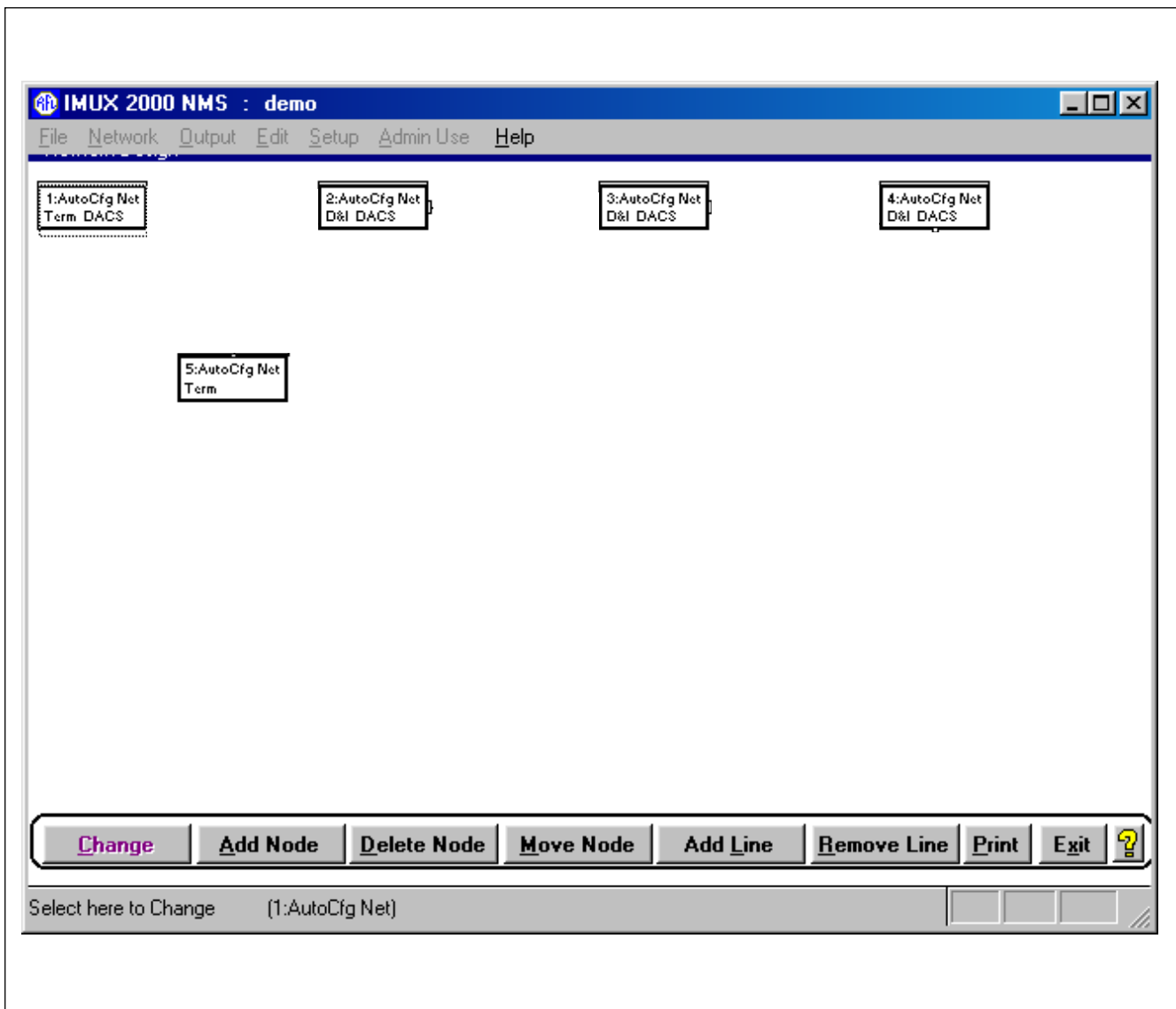


Figure 7-15. Network View window

7.5.3.7 THE DISPLAY/CHANGE NODE WINDOW

The Display/Change Node window shown in Figure 7-16 is entered from the Network View window as described in the previous paragraph. As its name implies, the Display/Change Node window has two main functions. First, it displays the node number, the node address, the communication path used, the node type, the presence of a DACS or ILS, and a list of all cards and modules at the node. In addition to this the user can enter a Site ID name at the top of the window. Its second function is to allow the user to change card settings by going into a sub-window for each card or module.

To view the settings of the DACS, click on the DACS button. This will bring you to the View or Change a Card window for the DACS as shown in Figure 7-17.

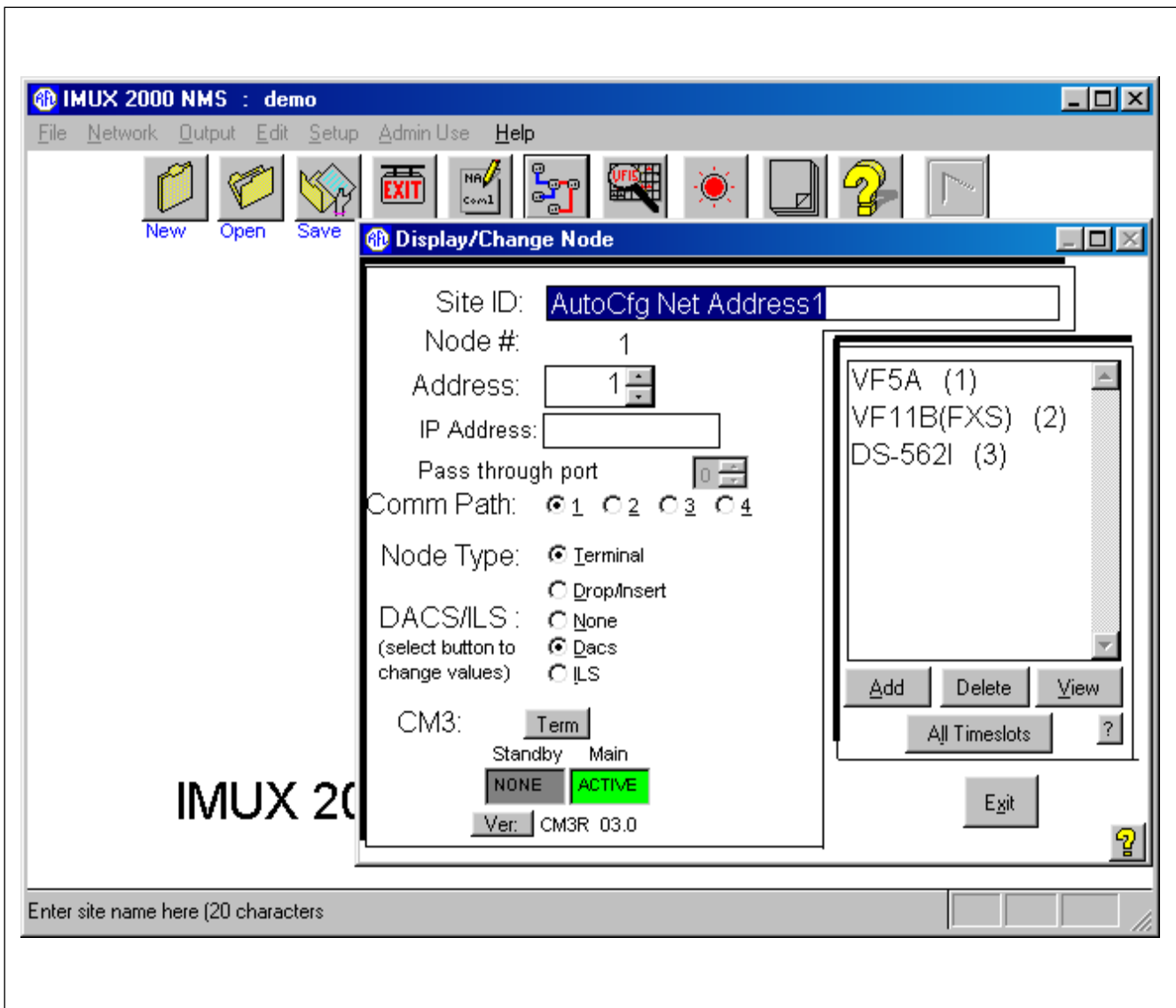


Figure 7-16 Display/Change Node window for node 1

7.5.3.7.1 VIEW OR CHANGE A CARD WINDOW FOR THE DACS

The View or Change a Card window for the DACS is shown in Figure 7-17. This is where the user can view or change the DACS settings. The “Actual” column is what the DACS is actually set to, and the “Set to” column contains settings the user can change. Refer to Table 7-3 in paragraph 7.7 for a list of DACS parameters. Use the down arrow at the lower right of the window to scroll down to view the other settings. For this example scroll down the window until Channel 1 Failure Map is visible and then double click on that line. This will bring you to the Input Value window for the Channel 1 Failure Map as shown in Figure 7-18.

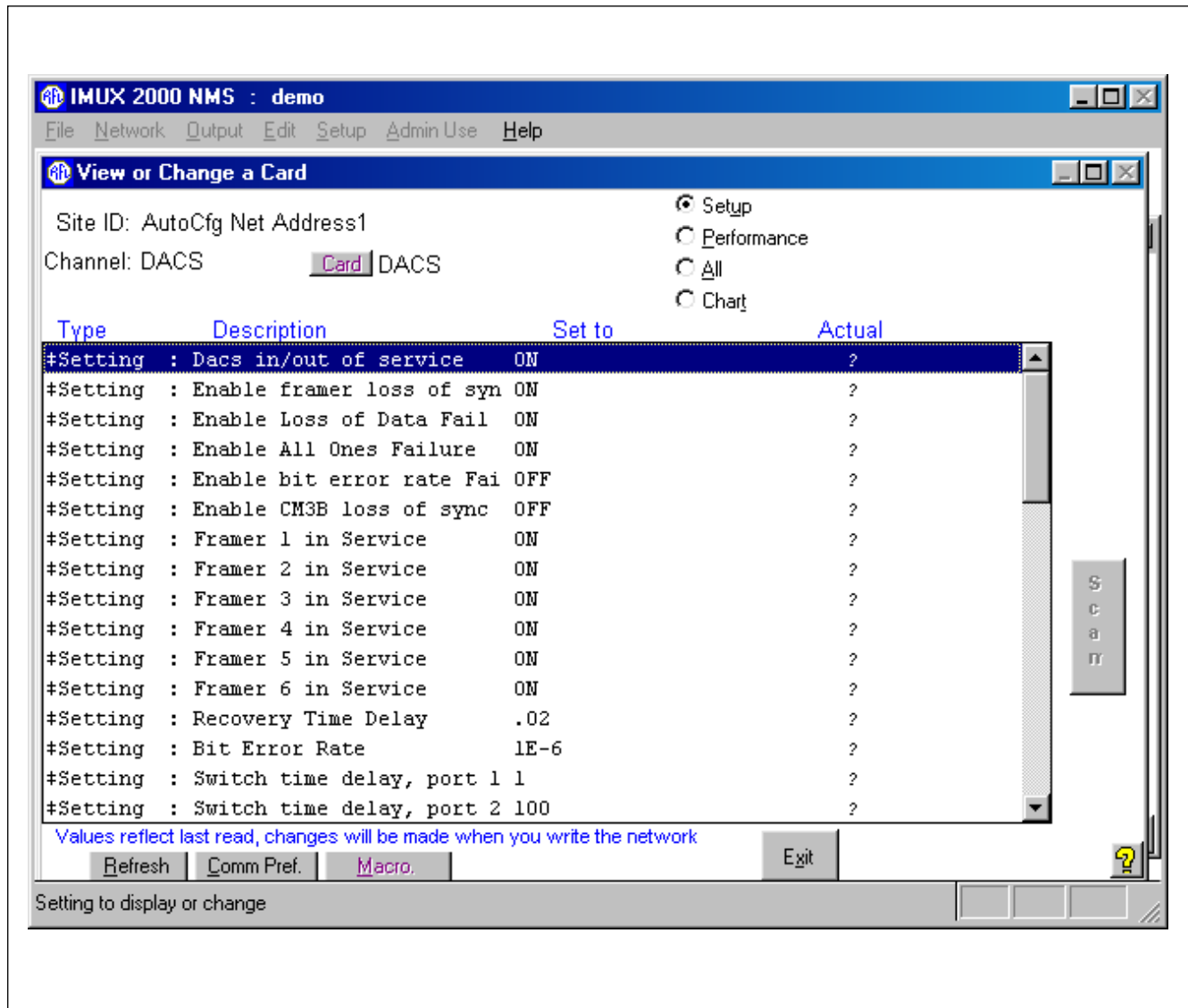


Figure 7-17 View or Change a Card window for the DACS

7.5.3.7.1.1 INPUT VALUE WINDOW FOR DACS MAP 1

The DACS maps can be programmed using windows similar to the one shown in Figure 7-18. Refer to Paragraph 4.6 for instructions on DACS mapping. When finished entering map values, click on Ook to return to the View or Change a Card window for the DACS. When finished with either viewing or changing the other DACS settings, click on Exit. This will return you to the Display/Change Node window where you can select the next card. Go back to the Display/Change Node window and click on CM3B-1. This will bring you to the View or Change a Card window for CM3B-1 as shown in Figure 7-19.

IMUX 2000 NMS : demo

File Network Output Edit Setup Admin Use Help

View Input Value

Site ID:
Channel:

Channel 1 Failure Map

- Time Slots -

	01	02	03	04	05	06	07	08	09	10	11	12	FDL
	13	14	15	16	17	18	19	20	21	22	23	24	
01													
02													
03													
04													
05													
06													

☒ Setting ☐ Actual
 Blank value indicates 0xFF (all ones)
☐ indicates diff/change

Zero Revert Reset Ok Cancel

set values to actual

Assignment for Port, Timeslot 1, 01

Scan

Figure 7-18. DACS Channel 1 Failure Map

7.5.3.7.2 VIEW OR CHANGE A CARD WINDOW FOR THE CM3B

The View or Change a Card window for the CM3R is shown in Figure 7-19. This is where the user can view or change CM3R settings. The “Actual” column is what the CM3R module is actually set to, and the “Set to” column contains settings the user can change. Refer to Table 7-2 in paragraph 7-7 for a list of CM3R parameters. When finished with either viewing or changing the CM3R settings, click on Exit to return to the Display/Change Node window as shown in Figure 7-16. To view the settings of the VF5A card, first click on VF5A and then click on View. This will bring you to the View or Change a Card window for the VF5A card as shown in Figure 7-20.

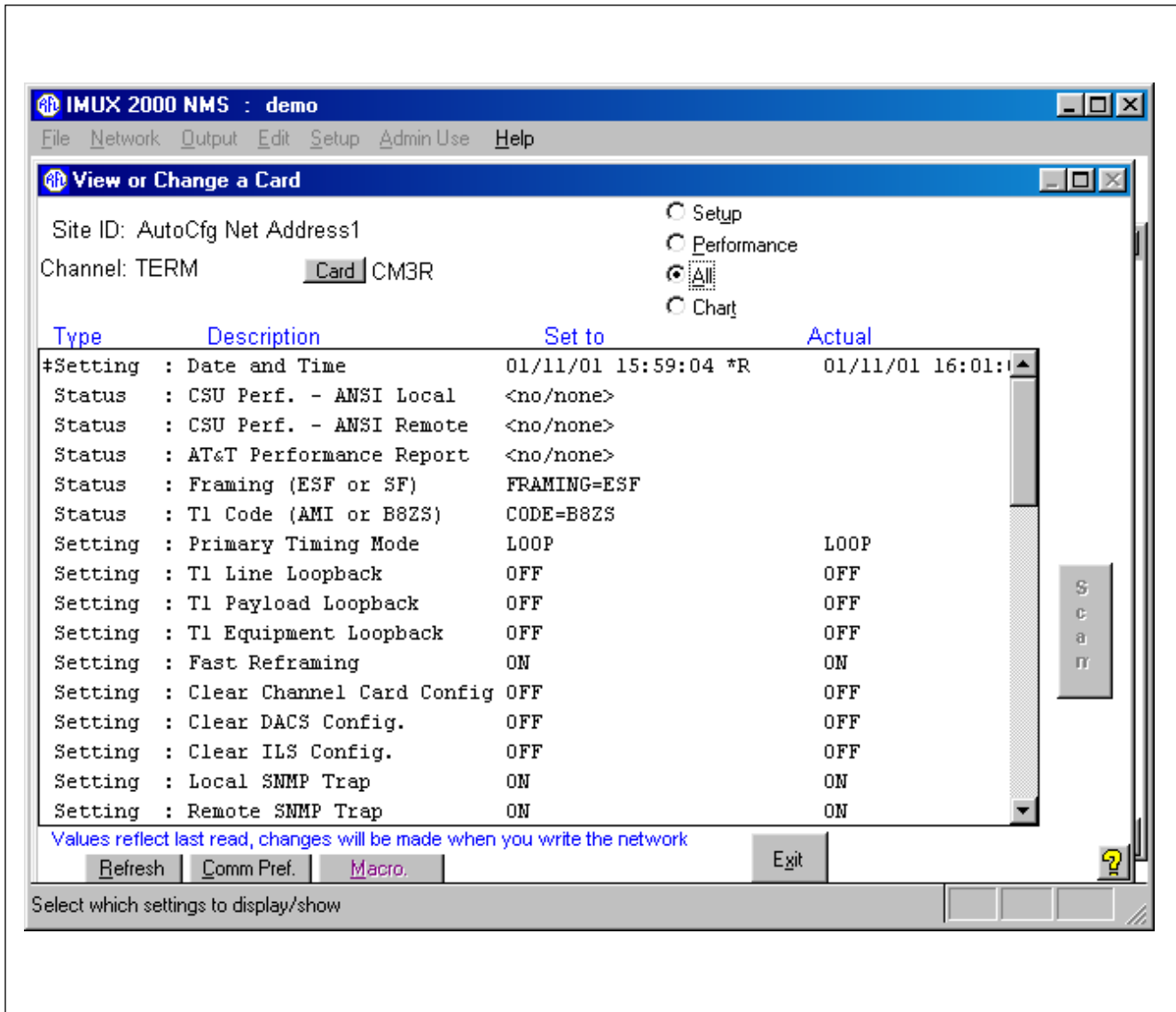


Figure 7-19. View or Change a Card window for the CM3B

7.5.3.7.3 VIEW OR CHANGE A CARD WINDOW FOR THE VF5A

The View or Change a Card window for the VF5A is shown in Figure 7-20. This is where the user can view or change VF5A settings. The “Actual” column is what the VF5A card is actually set to, and the “Set to” column contains settings the user can change. Refer to Table 7-11 in paragraph 7-7 for a list of VF5A parameters. When finished with either viewing or changing the VF5A settings, click on Exit to return to the Display/Change Node window as shown in Figure 7-16. To view the settings of the VF11B card, first click on VF11B and then click on View. This will bring you to the View or Change a Card window for the VF11B card as shown in Figure 7-21.

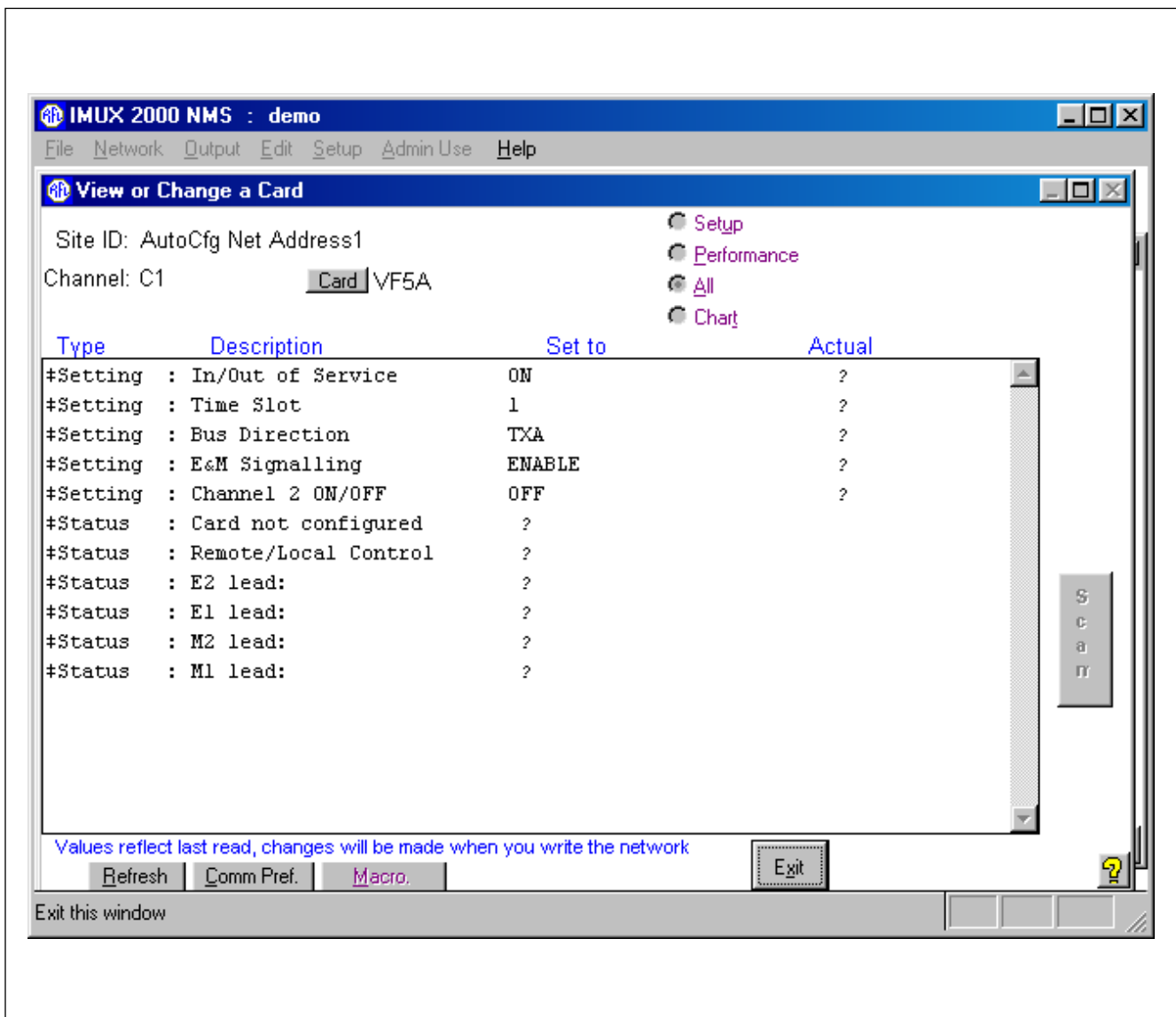


Figure 7-20. View or Change a Card window for the VF5A

7.5.3.7.4 VIEW OR CHANGE A CARD WINDOW FOR THE VF11B

The View or Change a Card window for the VF11B is shown in Figure 7-21. This is where the user can view or change VF11B settings. The “Actual” column is what the VF11B module is actually set to, and the “Set to” column contains settings the user can change. Refer to Table 7-14 in paragraph 7-7 for a list of VF11B parameters. When finished with either viewing or changing the VF11B settings, click on Exit to return to the Display/Change Node window as shown in Figure 7-16. To view the settings of the DS562I card, first click on DS562I and then click on View. This will bring you to the View or Change a Card window for the DS562I card as shown in Figure 7-22.

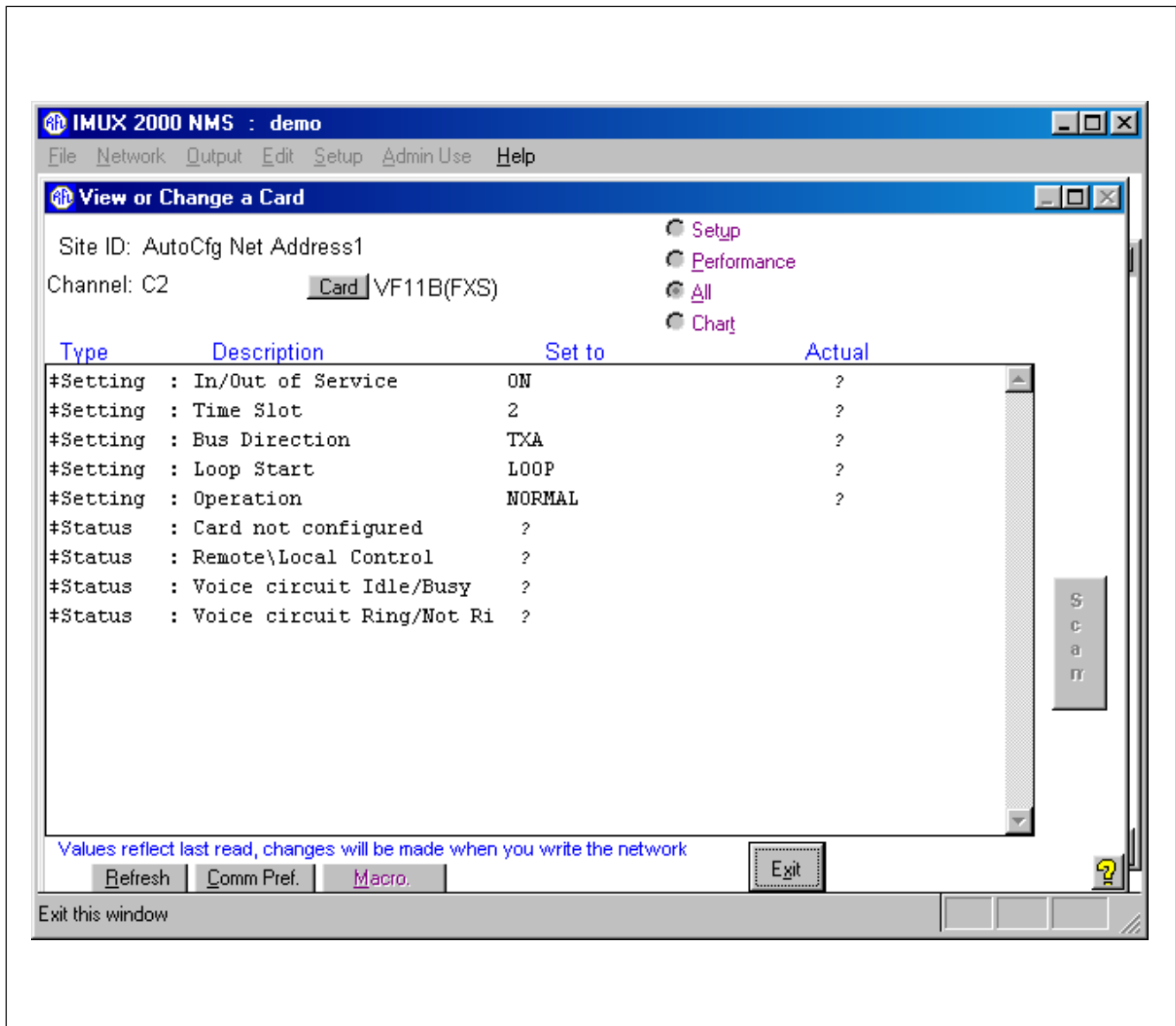


Figure 7-21. View or Change a Card window for the VF11B

7.5.3.7.5 VIEW OR CHANGE A CARD WINDOW FOR THE DS562I

The View or Change a Card window for the DS562I is shown in Figure 7-22. The “Actual” and “Set to” columns are blank since this card has no settings that the user can change at this window. The user must configure this card on site by setting dip switches on the card. When finished with viewing this window, click on Exit to return to the Display/Change Node window as shown in Figure 7-16. This completes the configuration of all cards and modules for Node 1.

From the Display/Change Node window click on Exit. This will return you to the Network View window shown in Figure 7-15. To complete this example, proceed to configure all cards, modules and DACS maps for Nodes 2, 3, 4 and 5. The list of modules and cards that must be configured for each node are listed in Table 7-1.

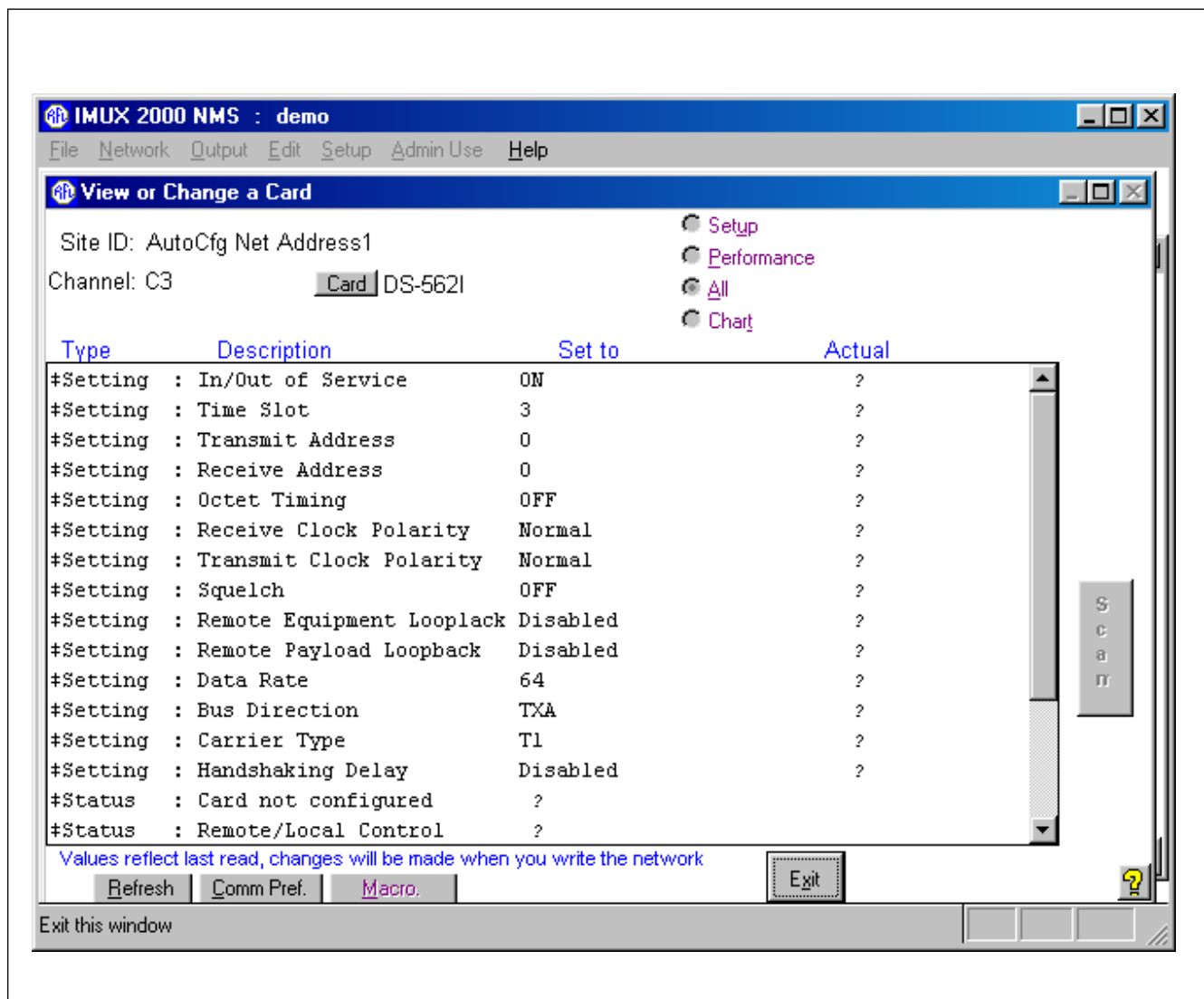


Figure 7-22. View or Change a Card window for the DS562

7.5.3.8 CONNECTING LINES TO NODES

After the entire network has been configured return to the Network View window shown in Figure 7-15. Connect the lines between nodes in accordance with Figure 7-9. To make the Network View more readable the nodes can be moved to different locations by using the Move Node button. Then use the Add Line button to add connecting lines between nodes. When you are finished connecting lines to nodes, your Network View window should be similar to the one shown below in Figure 7-23.

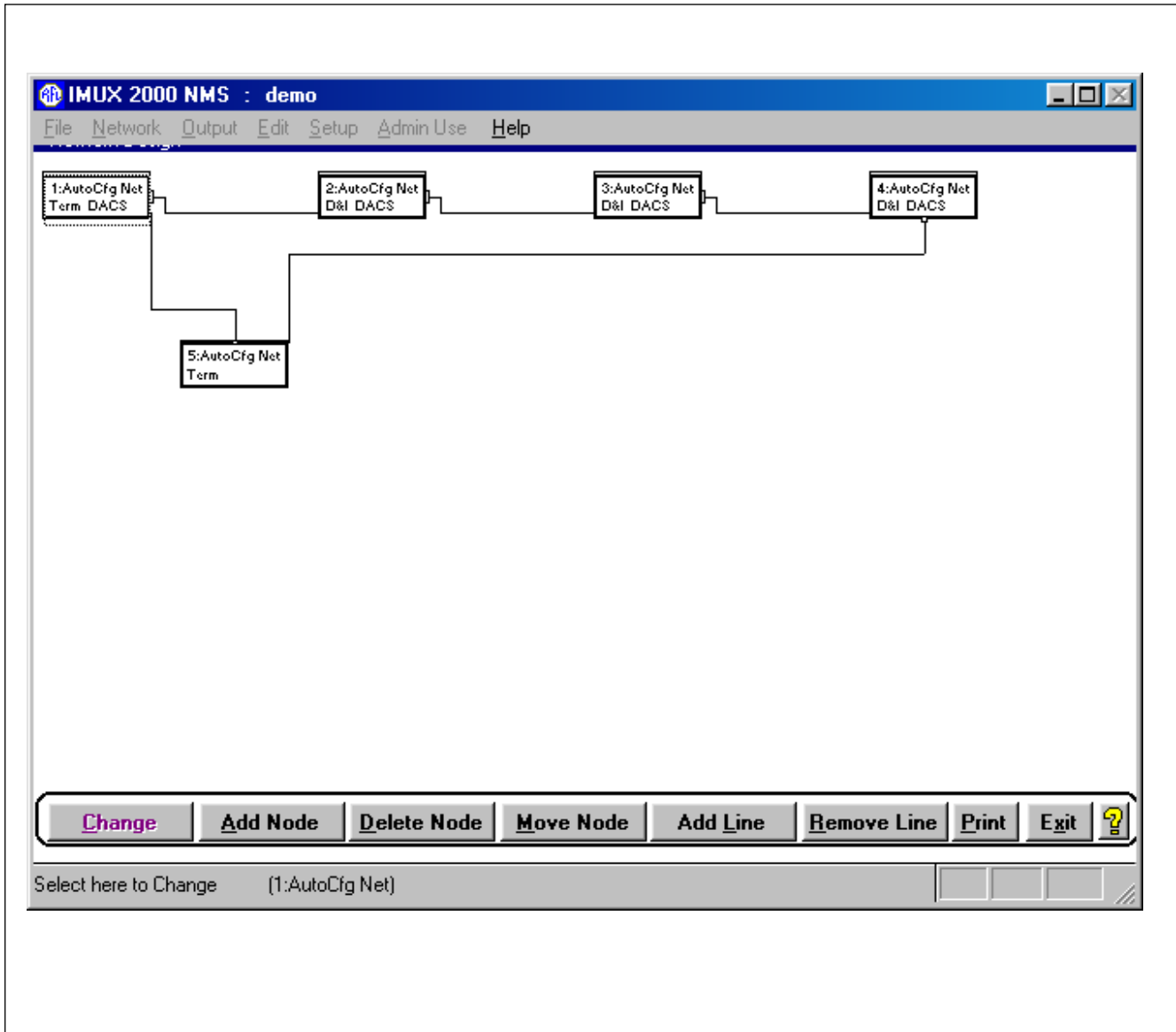


Figure 7-23. Network View window after connecting lines to nodes

7.5.3.9 WRITING TO THE NETWORK

The next step in this example is to write the network configuration to the network. Up to this point in time, all of the network configuration data has been saved in a temporary file in the Network Management Software. To write this data to the network you must return to the main window shown in Figure 7-11, and then click on the Write NET Icon. Writing to the network takes approximately six minutes per node and an additional twenty four minutes per DACS. For this example the writing will take approximately 126 minutes. The Network Management Software first writes to the network and then reads it back to verify any errors that might have occurred. The user can look at a difference report to verify that all settings were written correctly, and then read back correctly. While the data is being written a window will appear similar to the one shown in Figure 7-13 with two additional pop-up windows at the bottom. After the network writing is complete you will be returned to the main window. The network is now operating.

7.5.3.10 VIEWING REPORTS

The Network Management Software provides the user with seven different reports which are made up of information from various sources. These reports and a description of each is listed below. An example of what these reports look like is shown in figures 7-24 through 7-30. Note that these reports are not related to the network example shown earlier in this section.

<u>Report Name</u>	<u>Description</u>	<u>See Figure</u>
Alarm Log Report	Lists all alarms found in the network	7-24
Complete Network Information Report	Lists all settings of all cards in the network	7-25
Connection View Report	Lists which cards are in which time slots for each node	7-26
DACS Map Report	Displays all DACS maps for all nodes in the network	7-27
Difference Report	Lists the actual versus the configured setup	7-28
Event Log (This does not appear as a report)	Lists the Sequence Of Events for each node in the network.	7-29
Network Diagram Report	Lists the nodes and the cards in each node	7-30

Note that the Difference Report compares the “Set to” column to the “Actual” column for all cards and modules in the network. It then displays only the ones that are different. To see the Difference Report click on the Reports Icon in the Main window. A Report Description window will be displayed. Click on Difference Report and then click on Ok. The Difference Report will then be displayed.

Alarm Log

Alarms logged from 03/01/01 15:24:01 to 03/01/01 15:25:05

Report Name	AlarmLog
Page	1
Date/Time	03/01/01 15:31:30

Date	Time	Node				
03/01/01	15:24:01	2: AutoCfg Net	DI-A	CM3R	New Common logic module	Shelf status (alert)
	15:24:08		DI-B			Shelf status (alert)
	15:24:16		DAC	DACS	Digital Access Cross Connect	Loss of frame on framer 2
	15:24:16					Bit error rate exceeded fram4
	15:24:16					Loss of data on framer 4
	15:24:16					Alert on the dacs
	15:24:16					Bit error rate exceeded fram2
	15:24:16					Loss of frame on framer 4
	15:24:16					Loss of data on framer 4
	15:24:58	3: AutoCfg Net	TER	CM3R	New Common logic module	Shelf status (alert)
	15:25:05		C11	DS-64NC	Wide band data channel card	Configuration Error

Comment	Version 14, 3 nodes with dacs & 9 ch cards	
Create Date	03/01/01	11:28:00
Last Saved	03/01/01	15:26:59

Figure 7-24. Typical Alarm Log report

Complete Listing

Report Name	NetList
Page	1
Date/Time	03/20/02 10:09:25

Type	Address	Node	DACS	ILS	CM3-1	CM3-2	Channel	Card/Description	Set To	Actual			
Term	1	1	●	○	R	-	AutoCfg Net Address1						
								TERM	CM3R	New Common Logic module			
								Date and Time		01/11/01 15:59:04		01/11/01 16:01:04	
								CSU Perf. – ANSI Local		<no/none>			
								CSU Perf. – ANSI Remote		<no/none>			
								AT&T Performance Report		<no/none>			
								Framing (ESF or SF)		FRAMING = ESF			
								T1 Code (AMI or B8ZS)		CODE = B8ZS			
								Primary Timing Mode		LOOP		LOOP	
								T1 Line Loopback		OFF		OFF	
								T1 Payload Loopback		OFF		OFF	
								T1 Equipment Loopback		OFF		OFF	
								Fast Reframing		ON		ON	
								Clear Channel Card Config.		OFF		OFF	
								Clear DACS Config.		OFF		OFF	
								Clear ILS Config.		OFF		OFF	
								Local SNMP Trap		ON		ON	
								Remote SNMP Trap		ON		ON	
								Force Main ON or OFF		ON		ON	
								Redundant Switch Control		AUTO		AUTO	
								CSU Mode Control		RFL		RFL	
								Reset CSU		OFF		OFF	
								Report Alert at Stby		OFF		OFF	
								Pre-Squelch Timer (ms)		DISA		DISA	
								Post-Squelch Timer (ms)		DISA		DISA	
								Shelf is Normal		SHELF NORMAL			
								Fallback timing		FTIME= INT (FALLBACK TIMING)			
								Payload loopback status		<no/none>			
								Line loopback status		<no/none>			
								Equipment loopback status		<no/none>			
								Curr rcv blue alarm cnt		0			
Curr rcv yellow alarm cnt		0											

Network Name	Demo T1 network
Author's Name	Frank Luo
Comment	* Created by Auto Cfg
Create Date	3/19/02 11:59:07
Last Saved	03/20/02 10:09:15

Figure 7-25. Page 1 of a typical Complete Network Information Report

Connection View

Report Name	ConnView
Page	1
Date/Time	03/06/01 15:31:18

Site ID	AutoCfg Net	AutoCfg Net	AutoCfg Net	AutoCfg Net	AutoCfg Net
Shelf Addr	1	2	3	4	5
Term / D&I	Term	D & I	D & I	D & I	Term
DACS / ILS	DACS	DACS	DACS	DACS	
Direction	TXA >	<TXB TXA>	<TXB TXA>	<TXB TXA>	< TXA
Tslot. 1	VF5A		VF5A		
2			VF11B		
3	DS-562I		DS-562I		
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					

Network Name	Demo T1 network
Author's Name	Frank Luo
Comment	Created by Auto Cfg
Create Date	03/06/01 12:30:51
Last Saved	03/06/01 15:00:54

Figure 7-26. Typical Connection View Report

DACS Map

Type Address Node DACS ILS CM3-1 CM3-2

D&I	18	18	●	○	R	R	SUB 1

- Timeslots -

Map	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	FDL
1		5,01	5,02	5,03	5,04	5,05	5,06	5,07	5,08	5,09	5,10	5,11	5,12	5,13	5,14	5,15	5,16	5,17	5,18	5,19	5,20	5,21	5,22	5,23	5,24	5
2		3,01	3,02	3,03	3,04	3,05	3,06	3,07	3,08	3,09	3,10	3,11	3,12	3,13	3,14	3,15	3,16	3,17	3,18	3,19	3,20	3,21	3,22	3,23	3,24	3
3		2,01	2,02	2,03	2,04	2,05	2,06	2,07	2,08	2,09	2,10	2,11	2,12	2,13	2,14	2,15	2,16	2,17	2,18	2,19	2,20	2,21	2,22	2,23	2,24	2
4		6,01	6,02	6,03	6,04	6,05	6,06	6,07	6,08	6,09	6,10	6,11	6,12	6,13	6,14	6,15	6,16	6,17	6,18	6,19	6,20	6,21	6,22	6,23	6,24	6
5		1,01	1,02	1,03	1,04	1,05	1,06	1,07	1,08	1,09	1,10	1,11	1,12	1,13	1,14	1,15	1,16	1,17	1,18	1,19	1,20	1,21	1,22	1,23	1,24	1
6		4,01	4,02	4,03	4,04	4,05	4,06	4,07	4,08	4,09	4,10	4,11	4,12	4,13	4,14	4,15	4,16	4,17	4,18	4,19	4,20	4,21	4,22	4,23	4,24	4
Map	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	FDL
1		5,01	5,02	5,03	5,04	5,05	5,06	5,07	5,08	5,09	5,10	5,11	5,12	5,13	5,14	5,15	5,16	5,17	5,18	5,19	5,20	5,21	5,22	5,23	5,24	5
2		5,01	5,02	5,03	5,04	5,05	5,06	5,07	5,08	5,09	5,10	5,11	5,12	5,13	5,14	5,15	5,16	5,17	5,18	5,19	5,20	5,21	5,22	5,23	5,24	5
3		5,01	5,02	5,03	5,04	5,05	5,06	5,07	5,08	5,09	5,10	5,11	5,12	5,13	5,14	5,15	5,16	5,17	5,18	5,19	5,20	5,21	5,22	5,23	5,24	5
4		6,01	6,02	6,03	6,04	6,05	6,06	6,07	6,08	6,09	6,10	6,11	6,12	6,13	6,14	6,15	6,16	6,17	6,18	6,19	6,20	6,21	6,22	6,23	6,24	6
5		2,01	2,02	2,03	2,04	2,05	2,06	2,07	2,08	2,09	2,10	2,11	2,12	2,13	2,14	2,15	2,16	2,17	2,18	2,19	2,20	2,21	2,22	2,23	2,24	2
6		4,01	4,02	4,03	4,04	4,05	4,06	4,07	4,08	4,09	4,10	4,11	4,12	4,13	4,14	4,15	4,16	4,17	4,18	4,19	4,20	4,21	4,22	4,23	4,24	4

Values printed below "set to" values indicate actual values, when different than settings

Figure 7-27. Page 1 of a typical DACS Map Report

Difference Report

Report Name	NetList
Page	1
Date/Time	03/01/01 13:13:10

Type	Address	Node	DACS	ILS	CM3-1	CM3-2	Channel	Card/Description	Set To	Actual
D&I	2	2	●	○	●	●	AutoCfg Net Address2			
								C14	VF16	Dual Channel 2 wire F. E.
								Time	10	5
								C15	VF11B	2 Wire Foreign Exch. Stat. End
								Time Slot	11	7

Comment	Version 14, 3 nodes with dacs & 9 ch cards	
Create Date	03/01/01	11:28:00
Last Saved	03/01/01	12:10:07

Figure 7-28. Typical Difference Report

Event Log

Events logged from 03/01/01 15:24:01 to 03/01/01 15:25:05

Report Name	EventLog
Page	1
Date/Time	03/01/01 15:31:30

Date Time Node

03/02/01	15:24:01	2:AutoCfgNet	END OF EVENT	03/02/01	15:31:49

CM3C DI-A:
RECEIVER OUT OF FRAME
TRANSMITTER TIMING NOT CORRECT
TRANSMITTER CLOCK DOES NOT LOCK RECEIVER CLOCK

CM3C DI-B:
TRANSMITTER USING FALLBACK TIMING
TRANSMITTER TIMING NOT CORRECT
TRANSMITTER CLOCK DOES NOT LOCK RECEIVER CLOCK

CM3C DI-A DIAG:
CRBL=00000 CRYEL=00000
CRCL=00000 CRLOS=00016
CBPV=00000 CBER=00000
CMFOS=00000

CM3C DI-B DIAG:
CRBL=00000 CRYEL=00000
CRCL=00000 CRLOS=00000
CBPV=00000 CBERS=00000
CMFOS=00000

ILS DIAG:

Port	1	2	3	4
CRBL	00000	00000	00000	00000
CRYEL	00000	00000	00000	00000
CRCL	00000	00000	00000	00000
CRLOS	00000	00000	00000	00000
CRESS	00000	00000	00000	00000
CBPV	00000	00000	00000	00000
CBERS	00000	00000	00000	00000
CMFOS	00000	00000	00000	00000

Date Time Node

03/02/01	15:22:01	2:AutoCfgNet	END OF EVENT	03/02/01	15:21:44

CPU POWER UP
CM3C DI-A DIAG:
CRBL=00000 CRYEL=00000
CRCL=00000 CRLOS=00016
CBPV=00000 CBER=00000
CMFOS=00000

CM3C DI-B DIAG:
CRBL=00000 CRYEL=00000
CRCL=00000 CRLOS=00000

Network Name	CM3C3NS.net
Author's Name	Frank Luo
Comment	02/28/01 4CM3C nodes
Create Date	03/01/01 15:26:59

Figure 7-29. Page 1 of a typical Event Log Report

Network View

								Report Name	NetView	
								Page	1	
								Date/Time	03/01/01 13:13:10	
Type	Address	Node	DACS	ILS	CM3-1	CM3-2	Channel	Card	Card Description	

Term	1	1	●	○	R	-	AutoCfg Net Address1			
							TERM	CM3R	New Common Logic module	
							DACS	DACS	Digital Access Cross Connect	
							C1	VF5A	Dual Channel 4 wire voice – E&M	
							C2	VF11B(FXS)	2 Wire Foreign Exch. Stat. End	
							C3	DS-562I	Synchronous Data Module	

D&I	2	2	○	●	R	R	AutoCfg Net Address2			
							DI-A	CM3R	New Common logic module	
							DI-B	CM3R	New Common logic module	
							DACS	DACS	Digital Access Cross Connect	

D&I	3	3	●	○	R	R	AutoCfg Net Address3			
							TERM	CM3R	New Common Logic module	
							DACS	DACS	Digital Access Cross Connect	
							C1	VF5A	Dual Channel 4 wire voice – E&M	
							C2	VF11B(FXS)	2 Wire Foreign Exch. Stat. End	
							C3	DS-562I	Synchronous Data Module	

D&I	4	4	●	○	R	-	AutoCfg Net Address4			
							DI-A	CM3R	New Common logic module	
							DACS	DACS	Digital Access Cross Connect	

Term	5	5	○	○	R	-	AutoCfa Net Address5			
							TERM	CM3R	New Common logic module	

Network Name	Demo T1 network	
Author's Name	Frank Luo	
Comment	* Created by Auto Cfg	
Create Date	03/01/01	11:28:00
Last Saved	03/01/01	12:10:07

Figure 7-30. Typical Network Diagram Report

7.5.3.11 POLLING FOR ALARMS IN BATCH MODE

The next step in this example is to poll the network for alarms, which causes the Network Management Software to look for network failures. It polls every card in every node in the network. You can then look at an alarm report for a list of failures. To activate this feature, click on the Alarms Icon in the Main window. A sub-window will be displayed called Poll The Network For Alarms. Click on Com Path 1 and then click on Start. If failures are detected they can be viewed by clicking on the Reports Icon in the Main window and then selecting Alarm Log Report. After polling is completed you will be returned to the Main window.

7.5.3.12 AUTO POLLING

Auto polling is an option selected from the Communications Preferences window which determines whether or not the network will be polled for alarms while in Real Time mode. This feature is normally selected when a user is troubleshooting a network and is looking for alarms. To select this option click on Auto polling ON.

7.5.3.13 SAVE SETTINGS IN A FILE

The last step in this example is to save the settings in a file. Click on the Save Icon in the Main window.

An Open window will be displayed which contains a file directory. The file will be saved with a .NET extension in the form of filename.NET. Type the filename in the box under the words "Save Untitled As". Then click on the Save button. The file is now saved. To exit the Network Management Software click on the Exit button.

7.5.3.14 SEQUENCE OF EVENTS

The Sequence Of Events feature of the Network Management Software allows a user to view network events (alerts or alarms) in the order in which they have occurred. Each event has a date and time stamp associated with it. There is one icon on the main screen for accessing Sequence Of Events. This causes the sequence of events buffer to be read by the Network Management Software, and allows the user to view or print the sequence of events buffer.

Page one of a typical Event Log Printout can be seen in Figure 7-29.

7.5.3.15 USING MACROS

The macro feature of the Network Management Software will enable a user to make multiple settings on several cards for a specific network. To play a macro the user simply hits the PLAY icon on the main screen (or selects PLAY from the MACROS menu under SETUP). The user then selects the macro by name and it runs. You can only run macros in Real Time mode. To set up macros (a feature that will be used only by RFL or advance users) perform the following steps:

1. Go into Real Time mode.
2. Start macro recording: From SETUP select MACROS and then RECORD.
3. Give the macro a name, up to twenty characters (including spaces) are allowed.
4. Make the required settings. Each setting will be recorded.
5. At any time you can pause and then resume the recording, use the options in the MACRO menu under SETUP.
6. At the conclusion of recording, select the STOP RECORDING option from the MACRO MENU.
7. You can edit the macro, including merging two macros together by selecting the EDIT option under MACROS.

To merge two macros, edit the second one, and copy the commands, then edit the first macro and paste the commands at the end.

There is a MACRO button on the View or Change Card screen that allows you to start recording a macro, stop it, or pause/resume it. You can not play a macro from this screen. Also, after recording a macro you can remove some redundant lines (caused by Pn=settings that repeat over and over). Also, you can add comments to the macro by adding a /* */ at the end of any line. For example, you can have a macro line that reads:

```
1:TERM:SET:EQPT-LB=OFF;      /* Turn Equip off */
```

7.5.3.16 EMERGENCY EXIT

The Network Management Software has an Emergency Exit key sequence. If for some reason the user gets “stuck” or a screen freezes, hit <CTRL> <PgDn> then X, and the NMS session will terminate.

7.6 NETWORK MANAGEMENT SOFTWARE HELP

7.6.1 INTRODUCTION

The Network Management Software has a help system that is common to all other programs using the Microsoft Windows operating system. A description of how it is used is explained below.

7.6.2 USING NETWORK MANAGEMENT SOFTWARE HELP

Network Management Software Help is activated by clicking on Help in the Network Management Software main menu bar, or by clicking on the Help Icon. This will get you into a sub-window giving you the following four choices:

1. Contents
2. Search
3. How
4. About

Clicking on Contents will give you a list of the Network Management Software Help Topics. Clicking on Search will give you an alphabetized list of Help Topics to choose from. Clicking on How will give you an alphabetized list of how to use Help. Clicking on About will give you the nomenclature and version number of the Network Management Software, and a telephone number and fax number for Network Management Software support.

The most useful of the four choices is Contents, which will display a list of all topics relevant to Network Management Software help. When you are in the Help contents, and when you move the mouse pointer to any of the “green underlined” topics shown, the mouse pointer will change into a hand with a pointing finger. Click once to select help for that topic.

When you are finished using help, you can close the help window by double-clicking on the Icon in the upper left of the help window, or by clicking on File and then Exit. As a reference to the user, para. 7.6.3 has been included which contains the Network Management Software Help Topics as it actually appears on the PC terminal.

Network Management Software Help can also be activated by pressing F1 twice from any sub-menu. This feature will take you to a help screen that is associated with the sub-menu that you were in immediately before F1 was pressed.

7.6.3 NETWORK MANAGEMENT SOFTWARE HELP TOPICS

The following is a list of Help Topics contained in this section. Click on the desired topic for more information.

- What is the IMUX 2000?
- Hardware Required
- Description of Cards
- IMUX 2000 Program Group
- Learning to use the Menu Options
- Communication Paths
- Using the IMUX 2000 Network Management Software
- Answers to Common Questions

7.7 MODULES SUPPORTED BY THE NETWORK MANAGEMENT SOFTWARE

The following modules are supported by the Network Management Software. The settings, alarms, readings and commands for each of these modules are listed in Tables 7-2 through 7-32.

<u>Module</u>	<u>Description</u>	<u>Table</u>
CM3B	Common Logic Module	7-2
CM3C	Common Logic Module (with enhancements)	7-3
CM3R	Common Logic Module (with redundancy)	7-4
DACS	Digital Access Cross-Connect System Module	7-5
DA-91I	Asynchronous Data Polling Channel Module *	7-6
DA-121I	Asynchronous Data Channel Module *	7-7
DA291B	Asynchronous Data Channel Module	7-8
DS-562I	Synchronous Data Module (RS-449/CCITT V.35/G.703 Interface)	7-9
DS-562NC	Multi-Baud Synchronous Data Module	7-10
DS-961D	Five-Port Multi-Rate Synchronous Data Module	7-11
DS-TT	Transfer Trip Module	7-12
ILS	Intelligent Line Switch Module	7-13
OCUDP	Office Channel Unit Data Port Module	7-14
OIA	Optical Interface Adapters	7-15
TMX/TMR	Telemetry Transmitter Module/Telemetry Receiver Module	7-16
TT	Transfer Trip Module	7-17
VF-5A	Dual-Channel Four-Wire E&M Voice Module	7-18
VF-5C	Dual-Channel Four-Wire E&M Voice Module	7-19
VF-6I	Orderwire Voice Frequency Channel Module	7-20
VF-8A	Selective Calling Unit	7-21
VF-10B	Foreign Exchange Voice Module (office end)	7-22
VF-11B	Foreign Exchange Voice Module (station end)	7-23
VF-15	Dual-Channel Foreign Exchange Voice Module (office end)	7-24
VF-16	Dual-Channel Foreign Exchange Voice Module (station end)	7-25
VF-15C	Dual-Channel Foreign Exchange Voice Module (office end)	7-26
VF-16B	Dual-Channel Foreign Exchange Voice Module (station end)	7-27
VF-25	Four-Port PCM, Four-Wire E&M Voice Module	7-28
Status Module	Transmits and receives data via the T1 serial link	7-29

* These modules are not presently remotely configurable and their settings must be manually entered into the network by the user. All other modules can be configured remotely, and their presence can be verified by the Network Read menu option.

Table 7-2. CM3B module parameters

CM3B Module				
Group	Parameter	Description	Legal Values	Default
Settings	PASSWORD	Shelf security (N/A for DI-B)	16-character string	none
	FRAMING	Frame type	SF, ESF	ESF
	CODE	T1 line code	B8ZS, AMI	B8ZS
	PTIME	Primary timing mode (TERM)	INT, EXT, LOOP	INT
	PTIME	Primary timing mode (DI-A, DI-B)	THRU, EXT	THRU
	LINE-LB	T1 line loopback	ON, OFF	OFF
	PAYLD-LB	T1 payload loopback	ON, OFF	OFF
	EQPT-LB	T1 equipment loopback	ON, OFF	OFF
	FAST	Fast Reframing via Timeslot 24	ON, OFF	ON
	RESET	Resets CM3B factory default	DFLT	not used
Alarms	REDUNDANT POWER SUPPLY FAILURE TRANSMITTER TIMING NOT CORRECT RECEIVER CARRIER LOSS EXCESS JITTER RECEIVER OUT OF FRAME OTHER SIDE (DI-A) IS OUT OF FRAME OTHER SIDE (DI-B) IS OUT OF FRAME RECEIVING ALL ONES RECEIVING REMOTE ALARM TRANSMITTER CLOCK FREE RUNNING CHANNEL CARD ALERT			
Readings	SHELF NORMAL TRANSMITTER USING FTIME = <fallback timing> (FALLBACK TIMING) PAYLD-LB = ON (PAYLOAD LOOPBACK ON) LINE-LB = ON (LINE LOOPBACK ON) EQPT-LB = ON (EQUIPMENT LOOPBACK ON)			
Commands	UNLOCK LOCK SET CONFIG STATUS WHO NEXT UPDATE			

Table 7-3. CM3C module parameters

CM3C Module				
Group	Parameter	Description	Legal Values	Default
Settings	PASSWORD	Shelf security (N/A for DI-B)	16-character string	none
	PTIME	Primary timing mode (TERM)	INT, EXT, LOOP	INT
	PTIME	Primary timing mode (DI-A, DI-B)	THRU, EXT	THRU
	LINE-LB	T1 line loopback	ON, OFF	OFF
	PAYLD-LB	T1 payload loopback	ON, OFF	OFF
	EQPT-LB	T1 equipment loopback	ON, OFF	OFF
	FAST	Fast Reframing via Timeslot 24	ON, OFF	ON
	CLRCHAN	Clear channel card configuration table	ON, OFF	OFF
	CLRDACS	Clear DACS card configuration table	ON, OFF	OFF
	CLRILS	Clear ILS card configuration table	ON, OFF	OFF
	TIME	Real time clock (hours, minutes, seconds)	HH, MM, SS	not used
	DATE	Current date (month, day, year)	MM, DD, YY	not used
Alarms	REDUNDANT POWER SUPPLY FAILURE TRANSMITTER TIMING NOT CORRECT RECEIVER CARRIER LOSS EXCESS JITTER RECEIVER OUT OF FRAME OTHER SIDE (DI-A) IS OUT OF FRAME OTHER SIDE (DI-B) IS OUT OF FRAME RECEIVING ALL ONES RECEIVING REMOTE ALARM TRANSMITTER CLOCK FREE RUNNING CHANNEL CARD ALERT DI-B CONFIG ALERT			
Readings	SHELF NORMAL TRANSMITTER USING FTIME = <fallback timing> (FALLBACK TIMING) PAYLD-LB = ON (PAYLOAD LOOPBACK ON) LINE-LB = ON (LINE LOOPBACK ON) EQPT-LB = ON (EQUIPMENT LOOPBACK ON)			
Commands	UNLOCK LOCK SET CONFIG STATUS WHO NEXT UPDATE TIME EVENT VERSION			

Table 7-4. CM3R module parameters

CM3R Module				
Group	Parameter	Description	Legal Values	Default
Settings	PASSWORD	Shelf security (N/A for DI-B)	16-character string	none
	PTIME	Primary timing mode (TERM)	INT, EXT, LOOP	INT
	PTIME	Primary timing mode (DI-A, DI-B)	THRU, EXT	THRU
	LINE-LB	T1 line loopback	ON, OFF	OFF
	PAYLD-LB	T1 payload loopback	ON, OFF	OFF
	EQPT-LB	T1 equipment loopback	ON, OFF	OFF
	FAST	Fast Reframing via Timeslot 24	ON, OFF	ON
	CLRCHAN	Clear channel card configuration table	ON, OFF	OFF
	CLRDACS	Clear DACS card configuration table	ON, OFF	OFF
	CLRILS	Clear ILS card configuration table	ON, OFF	OFF
	TIME	Real time clock (hours, minutes, seconds)	HH, MM, SS	not used
	DATE	Current date (month, day, year)	MM, DD, YY	not used
	SIO TRAP	Local SNMP trap	ON, OFF	OFF
	FDL TRAP	Remote SNMP trap	ON, OFF	OFF
	MAIN	Force main ON or OFF	ON, OFF	ON
	SWITCH	Redundant switch control	AUTO, MAIN, STANDBY	AUTO
	CSU	CSU mode control	RFL, ANSI, ATT	RFL
	PM RESET	Reset CSU counters	ON, OFF	OFF
	PRSQ*	Pre-squelch timer (ms)	DISA, 0, 0.66, 1.3, 2.0, 2.7, 3.3, 4.0, 4.6, 5.3, 6.0, 6.6, 7.3, 8.0, 8.6, 9.3 (ms)	DISA
	POSQ*	Post-squelch timer (ms)	DISA, 0, 0.66, 1.3, 2.0, 2.7, 3.3, 4.0, 4.6, 5.3, 6.0, 6.6, 7.3, 8.0, 8.6, 9.3 (ms)	DISA
	SAVE*	Save configuration parameters into nonvolatile RAM or Flash	NRAM, FLSH	NRAM
Alarms/Readings	REDUNDANT POWER SUPPLY FAILURE TRANSMITTER TIMING NOT CORRECT RECEIVER CARRIER LOSS EXCESS JITTER RECEIVER OUT OF FRAME OTHER SIDE (DI-A) IS OUT OF FRAME OTHER SIDE (DI-B) IS OUT OF FRAME RECEIVING ALL ONES RECEIVING REMOTE ALARM TRANSMITTER CLOCK FREE RUNNING TRANSMITTER USING FALLBACK TIMING CHANNEL CARD ALERT DI-B CONFIG ALERT ALERT AT CHANNEL STANDBY COMMON MODULE ACTIVE BUS TROUBLE MAIN COMMON MODULE TROUBLE			

*Version 3 and above

Table 7-4. (continued) CM3R module parameters

CM3R Module				
Group	Parameter	Description	Legal Values	Default
Alarms/Readings (continued)		STANDBY COMMON MODULE TROUBLE MAIN COMMON MODULE OFF VIA FIRMWARE TO MAIN COMMON MODULE VIA MODE SWITCH TO STANDBY COMMON MODULE VIA MODE SWITCH TO MAIN COMMON MODULE VIA FIRMWARE TO STANDBY COMMON MODULE VIA FIRMWARE TRANSMITTER USING FTIME = <fallback timing> (FALLBACK TIMING) PAYLD-LB = ON (PAYLOAD LOOPBACK ON) LINE-LB = ON (LINE LOOPBACK ON) EQPT-LB = ON (EQUIPMENT LOOPBACK ON) SHELF NORMAL (Reading only)		
Commands		UNLOCK LOCK SET CONFIG CONFIG2 STATUS STATUS2 WHO NEXT UPDATE TIME EVENT VERSION		

Table 7-5. DACS module parameters

DACS Module				
Group	Parameter	Description	Legal Values	Default
Settings	SRVC	DACS in/out of service	ON, OFF	OFF
	ELOS	Enable Loss of Synch	ON, OFF	ON
	ELOD	Enable loss of Data failure	ON, OFF	ON
	EAIS	Enable All Ones failure	ON, OFF	ON
	EBER	Enable Bit Error Rate failure	ON, OFF	ON
	EFLOF	Enable fast loss of frame	ON, OFF	OFF
	ACT1	Port 1 in service	ON, OFF	ON
	ACT2	Port 2 in service	ON, OFF	ON
	ACT3	Port 3 in service	ON, OFF	ON
	ACT4	Port 4 in service	ON, OFF	ON
	ACT5	Port 5 in service	ON, OFF	ON
	ACT6	Port 6 in service	ON, OFF	ON
	FTYP5	Frame type	SF, ESF	ESF
	CODE5	T1 line code	B8ZS, AMI	B8ZS
	FTYP6	Frame type	SF, ESF	ESF
	CODE6	T1 line code	B8ZS, AMI	B8ZS
	FTYP, P	Frame type	SF, ESF	ESF
	CODE, P	T1 line code	B8ZS, AMI	B8ZS
	EFAST, P	Fast switching	ON, OFF	OFF
	LOSDLY, P	Loss of synch switch delay	5 to 999 (ms)	85
	RESET	Reset counters (stored as OFF)	ON, OFF	not used
	DLY1	Switch time delay, port 1	1 to 100 (ms)	1
	DLY2	Switch time delay, port 2	1 to 100 (ms)	100
	DLY3	Switch time delay, port 3	1 to 100 (ms)	100
	DLY4	Switch time delay, port 4	1 to 100 (ms)	1
	REC	Recovery time delay, all ports	0 to 60 (sec)	2.0
	BER	Bit Error Rate	0..9E-7..-4	1E-6
	LEVEL	Rx Low Level	-7.5, -15, N	-7.5
	CLOCK	Clock Sources		
		Alt1 = Alternate Clock 1 (I = internal, E = external, 1 to 6)	Alt1,Alt2	5, NOT USED
		Alt2 (optional) = Alternate Clock 2 (1 to 6)		
	RBS,RxF	Robbed Bit Signal Enable where: RxF = Rx Framer number (1 to 6) n1, n2, n3 = 3 enable variables	n1, n2, n3	0, 0, 0
	DSO, M, TxF, TxC	DS0 re-mapping parameter where: M = Map(0 = normal, 1 to 4 = Framer failure) TxF = Tx Framer number (1 to 6) TxC = Tx Framer Channel (timeslot) number (1 to 24) RxF = Rx Framer number (1 to 6, 0=constant) RxC = Rx Framer Channel number (1 to 24, or constant)	RxF, RxC	0, 0xFF
	FDL,M,TxF	FDL re-mapping parameter where: M= Map (0- normal, 1 to 4 = Framer failure) TxF = Tx Framer number (1 to 6) RxF = Rx Framer number (1 to 6)	RxF	note 1

Table 7-5. (continued) DACS module parameters

DACS Module				
Group	Parameter	Description	Legal Values	Default
Settings (continued)	FDL, M, 0	FDL Direct Data Entry Remap where: M=Map(0=normal, 1 to 4 = Port failure) Rx21 = Rx Ports for Tx Ports 2 & 1 Rx43 = Rx Ports for Tx Ports 4 & 3 Rx65 = Rx Ports for Tx Ports 6 & 5	Rx21, Rx43, Rx65	
Alarms	LOF1 LOD1 AIS1 BER1 LOF2 LOD2 AIS2 BER2 LOF3 LOD3 AIS3 BER3 LOF4 LOD4 AIS4 BER4 ALERT = ON ALARM = ON	Loss of Frame on Framer 1 Loss of Data on Framer 1 All Ones Signal on Framer 1 Bit Error Rate Exceeded on Framer 1 Loss of Frame on Framer 2 Loss of Data on Framer 2 All Ones Signal on Framer 2 Bit Error Rate Exceeded on Framer 2 Loss of Frame on Framer 3 Loss of Data on Framer 3 All Ones Signal on Framer 3 Bit Error Rate Exceeded on Framer 3 Loss of Frame on Framer 4 Loss of Data on Framer 4 All Ones Signal on Framer 4 Bit Error Rate Exceeded on Framer 4		
Readings	ALERT = OFF ALARM = OFF MAP = <n> <LOOP TEST ON <port>> MAP 1 COUNT = <n> MAP 2 COUNT = <n> MAP 3 COUNT = <n> MAP 4 COUNT = <n> PORT 1 BER = <nEn> PORT 2 BER = <nEn> PORT 3 BER = <nEn> PORT 4 BER = <nEn> CLOCK SOURCE = <n> CLOCK CHANGES = <n> CLOCK IN USE = <n>			
Commands	SET CONFIG STATUS			

Note 1: The default FDL mapping is as follows:

Map 0, 2, 3	1<>5, 2<>3, 4<>6
Map 1	1<5, 2<>5, 3<1, 4<>6
Map 4	1<>5, 2<4, 3<>6, 4<6

Table 7-6. DA-91I Module parameters

DA-91I Module	
Mode	Type 126
Settings	Time slot (1 to 24 for T1, 1 to 31 for E1) CAS (on or off) Bus A (disabled or TXA and RXB) Bus B (disabled or TXB and RXA) Local loopback (on or off) Remote loopback (on or off) Mode (dual or single) CTS1 (ON or depends on RTS) CTS2 (ON or depends on RTS) 7BIT (active or inactive)
Alerts/Alarms	None
Readings	System (T1 or E1) Configuration (OK or not OK) Remote loopback (on or off) Local loopback (on or off) Service (on or off) TX activity (TX activity on selected channel, or no TX activity) RX activity (RX activity on selected channel, or no RX activity)

Table 7-7. DA-121I Module parameters

DA-121I Module	
Mode	Type 127
Settings	Time slot (1 to 24 for T1, 1 to 31 for E1) CAS (on or off) Terminal (Terminal, or txa/rxb or txa/rxb) Local loopback (on or off) Remote loopback (on or off)
Alerts/Alarms	None
Readings	T1/E1 (T1 detected or E1 detected) SCB configuration errors (errors detected or errors not detected) Remote loopback (on or off) Local loopback (on or off) Service (on or off)

Table 7-8. DA-291B Module parameters

DA-291B Module	
Mode	Type 245
Settings	Timeslot-T1 (1 to 24) Timeslot-E1 (1 to 31) SCB Address (1 to 36) MUX Type (T1 or E1) Loopback (none, local, remote) Terminal (drop and insert and terminal) Service (Module active/Service off) Control (Local/Remote) CAS (Normal/Time slot 16 reserved for CAS signaling) Data Rate (0.6 kbps, 1.2 kbps, 2.4 kbps, 4.8 kbps, 9.6 kbps, 19.2 kbps, 38.4 kbps) Four independent Data Ports Time slot usage (Single or Double, based on data rate)
Alarms	None
Readings	Receive activity (Detected/Not detected) Transmit activity (Detected/Not detected)

Table 7-9. DS-562I Module parameters

DS-562I Module	
Mode	Type 77
Settings	TX/RX Timeslot (1 to 32) Bus Direction (TXA/TXB) Transmission speed (56/64) Local equipment loopback enable (Enable/Disable) Local payload loopback enable (Enable/Disable) Local Address (0-64, 0 disables addressing) Remote Address (0-64, 0 disables addressing) Squelch RX on address loss (Enable/Disable) Transmit clock polarity (Positive/Negative) Receive clock polarity (Positive/Negative) Octet timing (Enable/Disable) RTS/CTS delay (Enable/Disable) TX timing (Internal/External) Service (On/Off)
Alarms	None
Readings	TX activity (TX data present from DTE) RX activity (RX data present from remote module) Payload loopback (Payload loopback is enabled) Equipment loopback (Equipment loopback is enabled) Address Enabled (TX address is enabled, not set to 0) Address Valid Addressing is enabled and correct) Installed I/O (RS449, V.35, Contra, Co dir.) Mode (Local/Remote)

Table 7-10. DS-562NC Module parameters

DS-562NC Module	
Mode	Type 116
Settings	TX/RX Timeslot (T1 – 1 to 24, E1 – 1 to 31) Bus Direction (TXA/TXB) Data Rate 56 or N x 64 kbps Local equipment loopback enable (Enable/Disable) Local payload loopback enable (Enable/Disable) Local Address (0-64, 0 disables addressing) Remote Address (0-64, 0 disables addressing) Squelch RX on address loss (Enable/Disable – 56K only) Transmit clock polarity (Positive/Negative) Receive clock polarity (Positive/Negative) Octet timing (Enable/Disable – for G.703)) Handshaking delay (Enable/Disable – RS-449, RS-530, V.35) TX timing (Internal/External) Service (On/Off)
Alarms	Module level alert to shelf common module if loopback enabled or loss of addressing detected
Readings	TX activity (TX data present from DTE) RX activity (RX data present from remote module) Payload loopback (Payload loopback is enabled) Equipment loopback (Equipment loopback is enabled) Address Enabled (TX address is enabled, not set to 0) Address Valid Addressing is enabled and correct) Installed I/O (RS-449, RS-530, G.703 contra, co-directional, V.35, X.21, Optical Fiber, C37.94 single, multimode, IEEE 802.3) Mode (Local/Remote)

Table 7-11. DS-961D Module parameters

DS-961D Module	
Mode	Type 68
Settings	Service (on or off) Timeslot (1 to 24) Transmit/Receive direction (0=DI-A, 1=DI-B) Rate select (0=9600bps, 1=2400bps, 2=4800bps, 3=1200bps) Buffer/timing select (0=buffer out/internal timing, 1=buffers in/DTE timing) Channel 1 clock (0=normal, 1=inverted) Channel 2 clock (0=normal, 1=inverted) Channel 3 clock (0=normal, 1=inverted) Channel 4 clock (0=normal, 1=inverted) Channel 5 clock (0=normal, 1=inverted) Loopback (0=on, 1=off)
Alarms	FRM (cannot find framing bit) TX FAULT (transmit fault)
Readings	TX BUSY (LED on or off) RX BUSY (LED on or off)

Table 7-12. DS-TT parameters

DS-TT Module	
Mode	Type 118
Settings	Service (on or off) Output (Relay or Solid-State) SCB Address (1 to 31) Function 1 trip hold timer (2.25 to 192.0 ms) Function 2 trip hold timer (2.25 to 192.0 ms) Function 3 trip hold timer (2.25 to 192.0 ms) Function 4 trip hold timer (2.25 to 192.0 ms) Function 1 pre trip timer (2.25 to 12.0 ms) Function 2 pre trip timer (2.25 to 12.0 ms) Function 3 pre trip timer (2.25 to 12.0 ms) Function 4 pre trip timer (2.25 to 12.0 ms) Function 1 output polarity (0 = normal, 1 = inverted) Function 2 output polarity (0 = normal, 1 = inverted) Function 3 output polarity (0 = normal, 1 = inverted) Function 4 output polarity (0 = normal, 1 = inverted) Function 1 unblock enable (0 = disable, 1 = enable) Function 2 unblock enable (0 = disable, 1 = enable) Function 3 unblock enable (0 = disable, 1 = enable) Function 4 unblock enable (0 = disable, 1 = enable) Alarm timer (delay) (10 - 2550 ms) Ping pong interval (.40 - 25.5 ms) Ping pong time limit (1 - 31 ms) Tx time slot (1 -24) Tx address (0 - 64) Rx time slot (1-24) Path select (0 = D&IB, 1 = Terminal or D&IA) Rx address (0 - 64)
Alarms	Alarm LED
Readings	Function 1 input (0 = inactive, 1 = active) Function 2 input (0 = inactive, 1 = active) Function 3 input (0 = inactive, 1 = active) Function 4 input (0 = inactive, 1 = active) Function 1 output (0 = inactive, 1 = active) Function 2 output (0 = inactive, 1 = active) Function 3 output (0 = inactive, 1 = active) Function 4 output (0 = inactive, 1 = active) Ping pong value (0 to 31 ms) # of new events since last read (0 to 20) Disable switch (0 = disabled, 1 = enabled) CRC status (0 = error, 1= no error) Address (0 = error or disabled, 1 = no error)

Table 7-13. ILS Module parameters

ILS Module				
Group	Parameter	Description	Legal Values	Default
Settings	SRVC	ILS in/out of service	ON, OFF	ON
	FTYPE	Frame type	SF, ESF	ESF
	ELOS	Enable Loss of synch	ON, OFF	ON
	ELOD	Enable loss of Data failure	ON, OFF	ON
	EAIS	Enable All Ones failure	ON, OFF	ON
	EBER	Enable Bit Error Rate failure	ON, OFF	OFF
	EFLOF	Enable fast loss of frame	ON, OFF	OFF
	USE1	Primary Path 1 in service	ON, OFF	ON
	USE4	Primary Path 4 in service	ON, OFF	ON
	CODE	T1 line code	B8ZS, AMI	B8ZS
	MODE	Master generates backup watchdog	MASTER,SLAVE,HOT,THROUGH	SLAVE
	EXCLK	External clock available	H	OFF
	RESET	Reset counters (stored as OFF)	ON, OFF	not used
	DELAY	Switch time delay	ON, OFF	1
	REC	Recovery time delay	0.5 to 100 (ms)	2.0
	BER	Bit Error Rate	0 to 60 (sec)	1E-6
	LEVEL	Rx Low Level	0..9E-7..-4	-7.5
	EFAST	Enable fast switching	-7.5, -15, N	ON
	LOSDLY	Loss of synch switch delay	ON, OFF 5 to 1000 (ms)	85
Alarms	LOF1	Loss of Frame on Framer 1		
	LOD1	Loss of Data on Framer 1		
	AIS1	All Ones Signal on Framer 1		
	BER1	Bit Error Rate Exceeded on Framer 1		
	LOF4	Loss of Frame on Framer 4		
	LOD4	Loss of Data on Framer 4		
	AIS4	All Ones Signal on Framer 4		
	BER4	Bit Error Rate Exceeded on Framer 4		
	ALERT = ON FAILURE = ON			
Readings	BACKUP 2=<OK, NOT OK>, <IN USE, NOT IN USE> WATCHDOG 2 = <OK, NOT OK> BACKUP 3 = <OK, NOT OK>, <IN USE, NOT IN USE> WATCHDOG 3 = <OK, NOT OK> CLOCK = <NONE, EXT, RCLK> <LOOP TEST ON <port>> SWITCH 1 COUNT = <n> SWITCH 4 COUNT = <n> PORT 1 BER = <nEn> PORT 4 BER = <nEn> ALERT = OFF FAILURE = OFF			
Commands	SET			
	CONFIG			
	STATUS			

Table 7-14. OCUDP module parameters

OCUDP Module	
Mode	Type 124
Settings	Baud rate SW56 (disabled) Zero code suppression (enabled or disabled) AB signaling (enabled or disabled) RX time slot (See Table 3 in Instruction Data sheet) A/B direction (txa/rxb or txb/rxa) Quality monitor (not used) TX time slot (See Table 3 in Instruction Data sheet) Digital loopback (enabled or disabled) Latching loopback (enabled or disabled) Reset (0 to 1 transition resets latching status)
Alerts/Alarms	None
Readings	Equipment detected (T1 detected or not detected) Sealing current (detected or not detected) Excessive errors (not used) Loop length (See Table 7 in Instruction Data sheet) Receiver converging (converging or not converging) Full operation (Full operation or NOT full operation) Level detection (Level detection or NO level detection) Receive loss of signal (Receive loss of signal or NO receive loss of signal) RX signal magnitude (See data sheet) Test code (code detected or code NOT detected) Unassigned MUX channel (code detected or code NOT detected) MUX out-of-sync (code detected or code NOT detected) Abnormal station (code detected or code NOT detected) OCU loopback (code detected or code NOT detected) DSU loopback (code detected or code NOT detected) Channel loopback (code detected or code NOT detected) Receiving idle code (code detected or code NOT detected) Release code (code detected or code NOT detected) Block code (code detected or code NOT detected) Transition in progress (code detected or code NOT detected) Far-end voice (code detected or code NOT detected) Loopback enable (code detected or code NOT detected) Multiple junction unit alert (code detected or code NOT detected) Test alert (code detected or code NOT detected) Transmitting idle (code detected or code NOT detected) TX loopback (code detected or code NOT detected) Transmitting abnormal station (code detected or code NOT detected)

Table 7-15. OIA parameters

Optical Interface Adapters	
Mode	Type 11
Settings	Service (on or off) T1 Line code (B8ZS or AMI)
Alerts/Alarms	None
Readings	Transmit Alarm (alarm or normal) Transmit Activity (alarm or normal) Lock (alarm or normal) Receive Alarm (alarm or normal)

Table 7-16. TMX/TMR parameters

TMX	
Mode	Type 122
Settings	Time slot select TX address Terminal Calibrator select Analog channel 1 input gain select Analog channel 1 offset polarity Analog channel 2 input gain select Analog channel 2 offset polarity Analog channel 3 input gain select Analog channel 3 offset polarity Analog channel 4 input gain select Analog channel 4 offset polarity Analog channel 1 fixed data level selector Analog channel 1 fixed level switch Analog channel 2 fixed data level selector Analog channel 2 fixed level switch Analog channel 3 fixed data level selector Analog channel 3 fixed level switch Analog channel 4 fixed data level selector Analog channel 4 fixed level switch Analog channel 1 offset magnitude after gain Analog channel 2 offset magnitude after gain Analog channel 3 offset magnitude after gain Analog channel 4 offset magnitude after gain
Alerts/Alarms	None
Readings	T1/E1 auto detect SCB configuration Analog channel 1 LSB Analog channel 1 MSB Analog channel 2 LSB Analog channel 2 MSB Analog channel 3 LSB Analog channel 3 MSB Analog channel 4 LSB Analog channel 4 MSB

>> Table 7-18 continues on next page <<

Table 7-16. continued - TMX/TMR parameters

TMR	
Mode	Type 123
Settings	Time slot select TX address Terminal Analog channel 1 fixed data level selector Analog channel 1 fixed level switch Analog channel 1 loss of signal output selector Analog channel 1 output gain selector Analog channel 1 LS byte of transfer ratio Analog channel 1 MS byte of transfer ratio Analog channel 1 polarity of output reset Analog channel 1 magnitude of output reset Analog channel 2 fixed data level selector Analog channel 2 fixed level switch Analog channel 2 loss of signal output selector Analog channel 2 output gain selector Analog channel 2 LS byte of transfer ratio Analog channel 2 MS byte of transfer ratio Analog channel 2 polarity of output reset Analog channel 2 magnitude of output reset Analog channel 3 fixed data level selector Analog channel 3 fixed level switch Analog channel 3 loss of signal output selector Analog channel 3 output gain selector Analog channel 3 LS byte of transfer ratio Analog channel 3 MS byte of transfer ratio Analog channel 3 polarity of output reset Analog channel 3 magnitude of output reset Analog channel 4 fixed data level selector Analog channel 4 fixed level switch Analog channel 4 loss of signal output selector Analog channel 4 output gain selector Analog channel 4 LS byte of transfer ratio Analog channel 4 MS byte of transfer ratio Analog channel 4 polarity of output reset Analog channel 4 magnitude of output reset
Alerts/Alarms	Loss of telemetry frame synchronization Non-matching TMX/TMR addresses TPU alert (loss of communication)
Readings	T1/E1 auto detect SCB configuration Address test result Telemetry frame sync TPU signal MS byte of received analog channel 1 TX data MS byte of received analog channel 2 TX data MS byte of received analog channel 3 TX data MS byte of received analog channel 4 TX data

Table 7-17. Transfer Trip module parameters

Transfer Trip	
Mode	Type 118
Settings	Function 1 trip hold timer Function 2 trip hold timer Function 3 trip hold timer Function 4 trip hold timer Function 1 pretrip timer Function 2 pretrip timer Function 3 pretrip timer Function 4 pretrip timer Function 1 output polarity/start input polarity Function 2 output polarity/stop input polarity Function 3 output polarity Function 4 output polarity Function 1 unblock enable Function 2 unblock enable Function 3 unblock enable Function 4 unblock enable Alarm timer delay Ping-pong interval Ping-pong time limit Tx time slot Tx address Rx time slot Path select Normal mode/DCB mode Rx address
Alerts/Alarms	Loss of CRC or addressing
Readings	Function 1 input Function 2 input Function 3 input Function 4 input Function 1 output Function 2 output Function 3 output Function 4 output Ping-pong value in ms Number of new events since last read Module enable/disable CRC status Address error/no error

Table 7-18. VF-5A parameters

VF-5A Module	
Mode	Type 64
Settings	Service (on or off) Time slot (T1 - 1 to 24, E1 - 1 to 31) Direction (txa/rxb or txb/rxa) E&M signalling (enabled or disabled) Channel 2 operation (on or off)
Alerts/Alarms	None
Readings	E2 lead (idle or active) E1 lead (idle or active) M2 lead (idle or active) M1 lead (idle or active)

Table 7-19. VF-5C parameters

VF-5C Module	
Mode	Type 183
Settings	Service (on or off) Time slot (1 to 31 for E1, 1 to 24 for T1) Addressing ((enabled or disabled) FXS/FXO (enabled or disabled) Transmit polarity (positive or negative) Receive polarity (positive or negative) 1 kHz test tone (enabled or disabled) Magnitude of TX level (settable between +10dBm and -23dBm) Magnitude of RX level (settable between +10dBm and -31.5dBm) Direction (txa/rxb or txb/rxa) E&M signalling (enabled or disabled) E&M signaling type (selectable for type I, II, III or V) Off-hook force (on or off) Channel 1 or 2 operation (on or off) Loopback (None, local, remote)
Alerts/Alarms	None
Readings	E2 lead (idle or active) E1 lead (idle or active) M2 lead (idle or active) M1 lead (idle or active)

Table 7-20. VF-6I Module parameters

VF-6I Module	
Mode	Type 121
Settings	Time slot (1 to 31 for E1, 1 to 24 for T1) System type (T1 or E1) Bus A (enabled or disabled) Bus B (enabled or disabled) Voice activate setting (min to max) Signaling (enabled: CAS for E1, RBS for T12, or disabled) Transmit control modes (Receive only, Voice activate, Hook-switch, or Continuous)
Alerts/Alarms	None
Readings	Signaling/M-lead (M-lead inactive/Signaling on and M-lead active) Signaling/E-lead (E-lead inactive/Signaling on and E-lead active) Transmit activity (transmitting/not transmitting) Receive activity (Receiving/not receiving) Configuration (Valid/invalid)

Table 7-21. VF-8A parameters

VF-8A Module	
Mode	Type 125
Settings	Time slot select Bus B enable Bus A enable Number of rings Group number of 3-digit station ID MSD of 3-digit station ID/LSD of 3-digit station ID Signaling delay Busy circuit mode TX level Rx level
Alerts/Alarms	None
Readings	Configuration valid/invalid Local ringing/not-ringing Remote connected/not-connected Local connected/not-connected Remote ringing/not-ringing Timeout active/ not active

Table 7-22. VF-10B parameters

VF-10B Module	
Mode	Type 75
Settings	Time slot (1 to 24) Loop start (ground or loop) Mux type (DI or term) Operation
Alerts/Alarms	None
Readings	Voice circuit (idle or busy) Ring circuit (ring or no ring)

Table 7-23. VF-11B parameters

VF-11B Module	
Mode	Type 76
Settings	Time slot (1 to 24) Loop start (ground or loop) Mux type (DI or term) Operation (normal or ARD)
Alerts/Alarms	None
Readings	Voice circuit (idle or busy) Ring circuit (ring or no ring)

Table 7-24. VF-15 parameters

VF-15 Module	
Mode	Type 69
Settings	Time slot (1 to 24) Mux type (D/I or term) Channel 2 (on or off) Channel 1 loop start (ground or loop) Channel 1 operation Channel 2 loop start (ground or loop) Channel 2 operation
Alerts/Alarms	None
Readings	Channel 1 voice circuit (idle or busy) Channel 1 ring circuit (ring or no ring) Channel 2 voice circuit (idle or busy) Channel 2 ring circuit (ring or no ring)

Table 7-25. VF-16 parameters

VF-16 Module	
Mode	Type 70
Settings	Time slot (1 to 24) Mux type (D/I or term) Channel 2 (on or off) Channel 1 loop start (ground or loop) Channel 1 operation (normal or ARD) Channel 2 loop start (ground or loop) Channel 2 operation (normal or ARD)
Alerts/Alarms	None
Readings	Channel 1 voice circuit (idle or busy) Channel 1 ring circuit (ring or no ring) Channel 2 voice circuit (idle or busy) Channel 2 ring circuit (ring or no ring)

Table 7-26. VF-15C parameters

VF-15C Module	
Mode	Type 69 when installed in a T1 system, type 78 when installed in a E1 system
Settings	Time slot (1 to 31 for E1, 1 to 24 for T1) Service (on or off) Channel 2 (enable or disable) Bus transmit direction (set 'A' for terminal, 'B' for D &I) Channel 1 or 2 (set to loop start) Channel 1 or 2 signalling delay (enable or disable – T1 only) Channel 1 or 2 (set RX audio level) Channel 1 or 2 (set TX audio level) Control (local or remote)
Alerts/Alarms	None
Readings	Module (enabled /disabled) Channel 1 voice circuit (idle or busy) Channel 1 ring circuit (ring or no ring) Channel 2 voice circuit (idle or busy) Channel 2 ring circuit (ring or no ring)

Table 7-27. VF-16B parameters

VF-16B Module	
Mode	Type 182
Settings	Time slot (1 to 31 for E1, 1 to 24 for T1) Channel 1 or 2 (enable or disable) Bus transmit direction (A – terminal, B – drop & insert) Channel 1 or 2 loopback (enable or disable) Channel 1 or 2 (set RX audio level) Channel 1 or 2 (set TX audio level) Channel 1 or 2 (set ring voltage) Channel 1 or 2 set ring DC offset (enable or disable) Channel 1 or 2 set ARD (enable or disable) Channel 1 or 2 (set loop current, 41 or 20mA)
Alerts/Alarms	None
Readings	Module service (on or off) Channel 1 or 2 (enabled or disabled) Channel 1 voice circuit (idle or busy) Channel 1 ring circuit (ring or no ring) Channel 2 voice circuit (idle or busy) Channel 2 ring circuit (ring or no ring)

Table 7-28. VF-25 parameters

VF-25 Module	
Mode	Type 182
Settings	Time slot select Signaling on/off Number of active channels Terminal DI-A/DI-B Local loopback Channel 1 remote loopback on/off Channel 2 remote loopback on/off Channel 3 remote loopback on/off Channel 4 remote loopback on/off Channel 1 Tx level Channel 1 Rx level Channel 2 Tx level Channel 2 Rx level Channel 3 Tx level Channel 3 Rx level Channel 4 Tx level Channel 4 Rx level
Alerts/Alarms	None
Readings	M-lead for channel 1 idle/busy M-lead for channel 2 idle/busy M-lead for channel 3 idle/busy M-lead for channel 4 idle/busy E-lead for channel 1 idle/busy E-lead for channel 2 idle/busy E-lead for channel 3 idle/busy E-lead for channel 4 idle/busy

Table 7-29. Status Module

Status Module	
Mode	Type 120
Settings	Rx timeslot Tx timeslot Receive direction (A or B) Rx address Tx address Scan speed (10ms or 100ms) I/O 0-7 type (input or output) I/O 8-15 type (input or output) System type (T1 or E1) Output polarity 0-7 (normal or inverted) Output polarity 8-15 (normal or inverted)
Alerts/Alarms	Alarm LED
Readings	Point 1 status (active or inactive) Point 2 status (active or inactive) Point 3 status (active or inactive) Point 4 status (active or inactive) Point 5 status (active or inactive) Point 6 status (active or inactive) Point 7 status (active or inactive) Point 8 status (active or inactive) Point 9 status (active or inactive) Point 10 status (active or inactive) Point 11 status (active or inactive) Point 12 status (active or inactive) Point 13 status (active or inactive) Point 14 status (active or inactive) Point 15 status (active or inactive) Point 16 status (active or inactive) Address (valid or invalid) Data (valid or invalid) Outputs (locked or unlocked)

7.8 PASSWORD PROTECTION

NOTE

This is the only page where the user ID and password are discussed. This page can be removed from the Instruction Manual for added security.

Password protection is used in this system to prevent unauthorized persons from gaining access to the Network Management Software settings and parameters.

7.8.1 ENTERING THE NETWORK MANAGEMENT SOFTWARE

Upon starting the Network Management Software the user will be presented with a sign on screen. The user must enter a user ID and a password to continue. Enter the word “control” for the user ID, then hit the “enter” key. Enter the word “password” for the password, then click on “OK”. This will allow the main window to be displayed.

7.8.2 CHANGING THE PASSWORD

The user ID or password can be changed by entering the security file window. This window is entered from the main window by clicking on Setup and then clicking on Setup User ID. In this window, other user ID's can be setup as “Master” which means they can setup or change other users (including other “masters” or “users”). A “user” class can not set up other users or see other passwords.

7.8.3 BYPASSING THE SIGN ON SCREEN

Two keywords in the INI file are used in conjunction with security. If the user enters the INI file and then enters a value for USERID and for PASSWORD, and these are valid values the sign on screen will be bypassed. A user that is not interested in security can change their INI file after the first sign on and then not have to enter the sign on screen to get into the main Network Management Software window. At a later date the security can be reactivated.

From the main window click on Setup, and then click on Edit INI. This will bring you to the software settings window. Click on the Expert Mode button. This will bring you to the rfl.ini file. Scroll down to the [SECURITY] section and type in the following two lines:

```
USERID=CONTROL  
PASSWORD=PASSWORD
```

Then exit the rfl.ini window and click on the Yes buttons to get back to the main window. The sign on screen will now be bypassed.

SECTION 8. REMOTE CONFIGURATION

NOTE

If the IMUX 2000 multiplexer is equipped with a fiber optic interface, DIP switch SW1-4 on the Optical Interface Adapter (OIA) controls the remote configuration of the multiplexer. If SW1-4 is set to the LOCAL (up) position, the multiplexer cannot be configured remotely. This is the preferred setting. (Refer to Section 6 of this manual for more information on setting this DIP switch.)

8.1 INTRODUCTION

An IMUX 2000 multiplexer can be set up and monitored from a controller connected to its RS-232 remote port. The controller, which may be a simple video display terminal, a personal computer (PC), or another type of computer system, can be connected locally using a cable or remotely using dial-up modems over a data network. The terminal or computer used for this purpose must contain a basic communications program which provides call setup and terminal emulation functions.

IMUX 2000 multiplexers operate strictly in the command-response mode. That is, a multiplexer generates a message only in response to a received command.

The Simple Command Language (SCL) provides the basis for communication between the user and the multiplexer. The operator types SCL commands at the keyboard and views the responses on the terminal screen. The design of the SCL command structure also allows IMUX 2000 multiplexers to be integrated into a multi-node, multi-vendor network controlled by an automated Network Management System (NMS).

8.2 HARDWARE AND PROTOCOL ISSUES

8.2.1 REMOTE PORT

Each CM-3R Common Module has one remote port. A terminal multiplexer therefore has one remote port while a drop/insert multiplexer has two remote ports. IMUX 2000 remote ports are RS-232C compatible, asynchronous, serial interfaces which can operate at baud rates from 110 bps to 57.6 Kbps.

The remote port on each CM-3R module is equipped with a 9-pin male DB-9 connector, which is located on the MA-210R Module Adapter or Optical Interface Adapter (OIA) associated with that module. Instructions on setting remote port baud rate and parity appear in Section 6 of this manual. The pin assignments for the remote connector appear in Section 2 of this manual.

NOTE

In a Drop/Insert multiplexer if a user wants to change the configuration of a DI-A or DI-B common module, or determine the configuration of a DI-A or DI-B common module, the PC or modem must be plugged into the remote port of the DI-A common module. The reason for this is as follows:

In a Drop/Insert Multiplexer the DI-A common module is the master and the DI-B common module is the slave; that is, the DI-B module configuration is stored in the DI-A module. The DI-A module gets the configuration of the DI-B module via the SCB bus on power turn on only, and as long as power remains on it does not “look at” DI-Bs configuration again. If the configuration of DI-B is changed at the DI-B remote port, the DI-A module will have no knowledge of this.

However, if the configuration of the DI-B module is changed locally via the DI-B front panel switches, this information will automatically be transferred to the DI-A module and no further action is required.

FDL messages (remote IMUX access) is handled only by the DI-A.

8.2.2 DATA CIRCUITS

For local operation, connect a video terminal or PC directly to the remote port on an IMUX 2000 Series multiplexer (Figure 8-1) using an RS-232 cable. Or, using modems, establish a remote connection over a dial-up voice circuit (Figure 8-2).

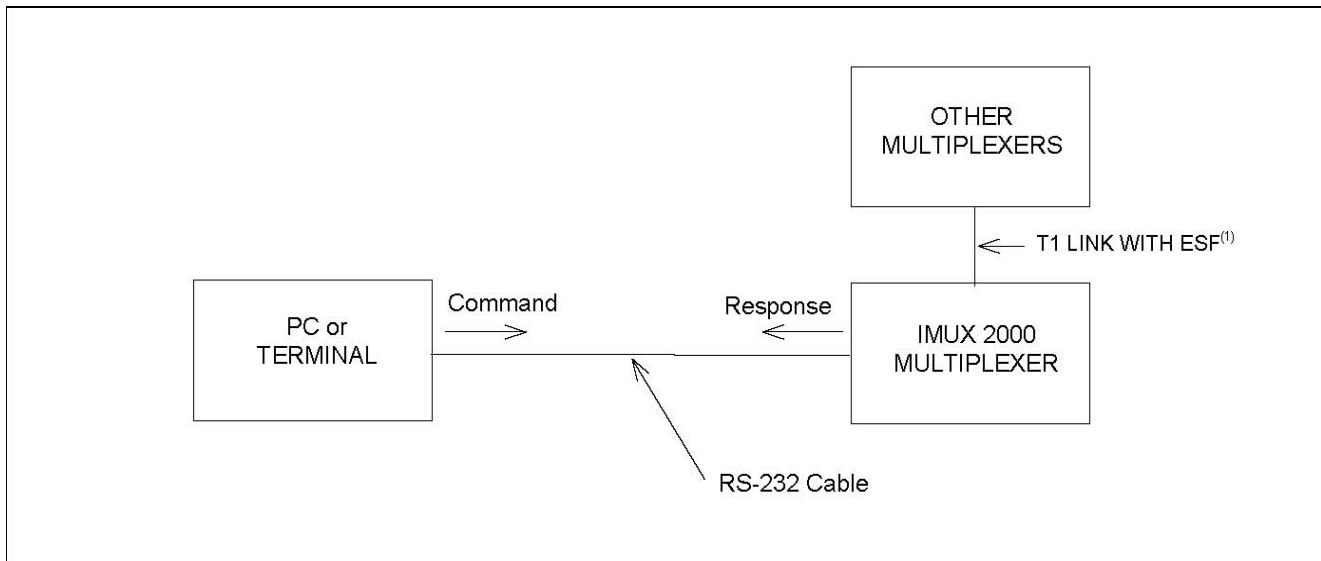


Figure 8-1. Local connection

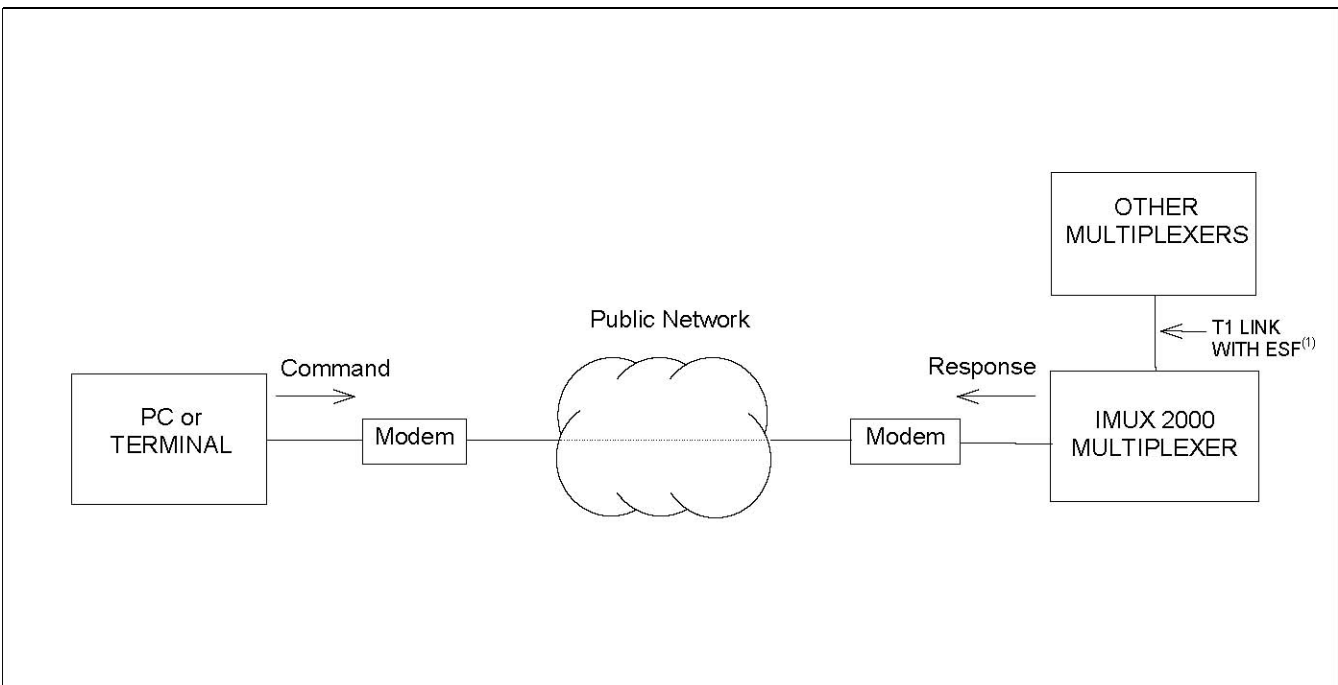


Figure 8-2. Remote connection over a dial-up circuit

Note 1: Remote control communication with a multiplexer over a T1 link is possible over a network providing FDL facilities. Note that some interfaces such as CSU, block FDL traffic.

IMUX 2000 Series multiplexers can also be connected to a controller over a public switched network (Figure 8-3). This can be DDS, X.25, or any type of data network capable of providing asynchronous RS-232 interfaces for the IMUX 2000 remote ports. SCL commands issued over switched network circuits may include the network address of the "target" multiplexer to facilitate record keeping and network management.

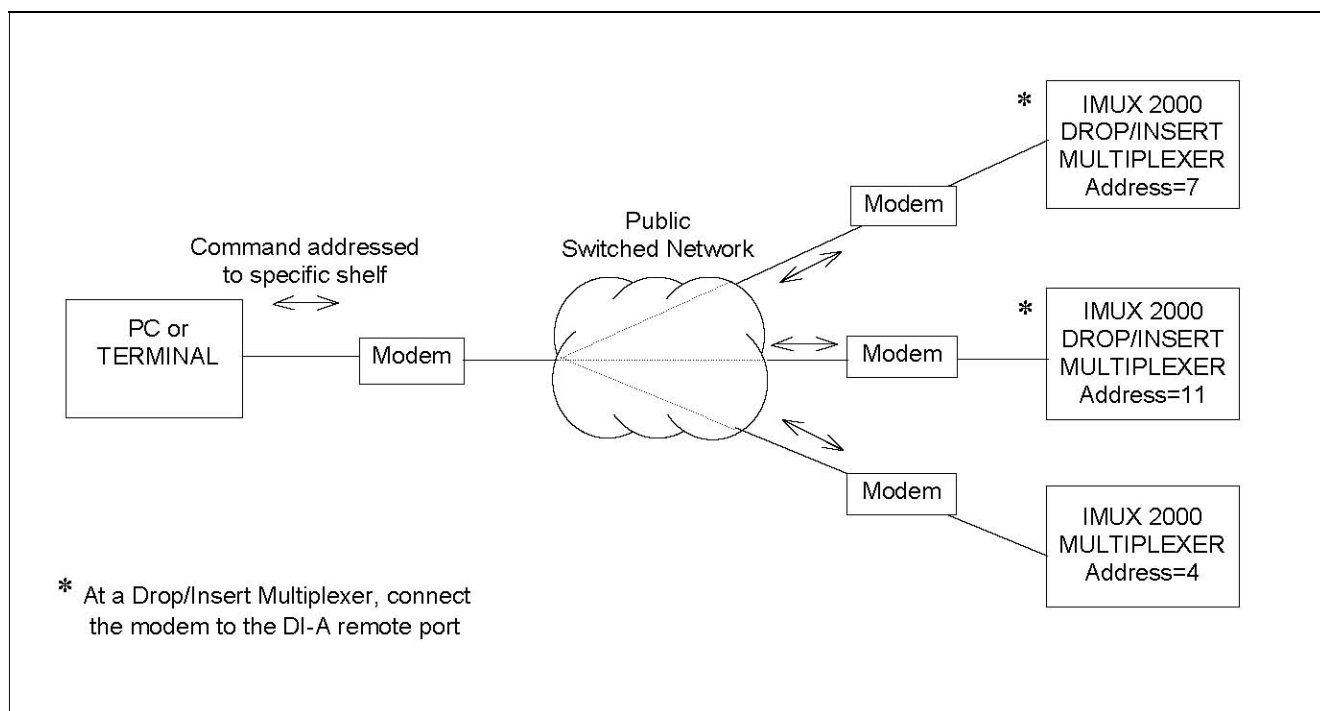


Figure 8-3. Remote connection over a public switched network

8.2.3 HANDSHAKING

Current IMUX 2000 software does not support hardware or software flow control or "handshaking". This is not an issue when entering SCL commands manually from a terminal or PC keyboard. However, if you plan to download IMUX 2000 setup information, or poll IMUX 2000 multiplexers for status information using a PC or any other type of automated controller, be aware that flow control must be handled by the controller itself. Generally, this means that controller software must be designed to wait until it has received a response to the last command sent to a given IMUX 2000 Series multiplexer before issuing another command to the same multiplexer.

8.3 SCL COMMAND LINE FORMAT

An SCL command line contains four fields, separated by three colons. The command line is terminated by a semicolon and carriage return:

<Address>:<Subaddress>:<Command>:<Parameter=Value>;<CR>

For example, to set primary timing to EXTERNAL in a terminal multiplexer whose network address is 3, type:

3:TERM:SET:PTIME=EXT;

and then press the **[ENTER]** key on your terminal or PC keyboard.

In the example above, "3" is the target multiplexer's address; "TERM" is the subaddress (also known as the card address); "SET" is the command; "PTIME" is the parameter being set; and "EXT" is the desired parameter value. Note that colons (:) terminate the address, subaddress, and command field while a semicolon (;) terminates the parameter field, the last field in an SCL command line.

In the sample SCL commands shown in this manual, the carriage return character required at the end of every SCL command line will not be shown explicitly. However, remember that in all cases, **SCL commands must end with a carriage return character (hex 0D)**. When typing commands manually, simply press the ENTER key at the end of every command line.

8.3.1 ADDRESS FIELD

The first field in an SCL command line is the **address** field. Valid SCL network addresses are the integers from 1 to 500. Leading zeros are not required. Zero "0" and 78 are not valid SCL addresses and should not be used.

The address field is optional when sending SCL commands, but can be useful when two or more multiplexers (or other RFL remote controllable devices) are connected to a central controller. It provides a means of identifying which multiplexer command was addressed to when reviewing records of such commands.

If the address field in an SCL command contains a number, only the multiplexer which is set to that address will respond. If the address field is left blank, any multiplexer receiving the command through its local RS-232 port will respond as long as it is valid, and the UNIVersal parameter is OFF. (See Paragraph 6.12.5).

If a multiplexer is in ESF framing mode, SCL commands which are not addressed to it are sent on the FDL link to other multiplexers until one matches the address. These remote accesses will take longer to respond, but in all other respects are equal to local SCL commands and replies.

In a system involving a single remote control link, the address field is generally left blank at all times. For example, if you are entering SCL commands from a modem-equipped PC, which is connected over a dialed voice circuit to a single modem-equipped IMUX 2000 multiplexer, then the SET command discussed above could be entered as follows:

:TERM:SET:PTIME=EXT;

Note that the colon terminating the network address field is required, even when the address field itself is left blank.

The two CM-3R Common Modules in a drop/insert multiplexer can have the same or different addresses. However, we recommend that both CM-3R modules in any given drop/insert multiplexer always be assigned the same network address. This practice will be assumed throughout this document. As discussed below, commands can still be targeted to one CM-3R module or the other in a drop/insert multiplexer by including the appropriate subaddress - that is, either DI-A or DI-B.

To prevent unauthorized or accidental changes, multiplexer addresses cannot be changed remotely. Rather, each multiplexer's address must be entered locally, usually at installation time, using the GROUP and SET/ NEXT switches. (For more information, see Section 6 of this manual.)

8.3.2 SUBADDRESS FIELD

The second field in an SCL command line is the **subaddress** field. This field is used to identify a specific common module, channel module, ILS, or DACS within a given IMUX 2000 multiplexer. Valid IMUX 2000 multiplexer subaddresses are shown in Table 8-1.

In drop/insert multiplexers, only the DI-A module will accept and process commands targeted for channel modules (commands with a subaddress of the form **Cn**, where **n** is a number from 1 to 36). When using either a local controller or a remote controller to perform channel module operations on a drop/insert multiplexer, always establish the connection through the remote port on the DI-A module. If both CM-3R modules in a drop/insert multiplexer are connected to a controller via a data network, commands issued with the proper multiplexer address and channel module subaddress will automatically be processed by the multiplexer's DI-A module and ignored by its DI-B module.

If the subaddress field is left blank, the default subaddress is TERM. This is a convenience feature for human operators when addressing the CM-3R module in a terminal multiplexer. The default cannot be used with a drop/insert multiplexer. When using the default, the colon terminating the subaddress field must still be present. The following command uses the default subaddress to send a configuration inquiry to a terminal multiplexer:

::CONFIG?;

Table 8-1. Valid subaddress field entries

Subaddress	Description
TERM	Use this subaddress in commands issued to the CM-3R module in an IMUX 2000 terminal multiplexer.
DI-A	Use this subaddress in commands issued to the CM-3R module configured to operate in the DI-A mode in IMUX 2000 drop/insert multiplexers.
DI-B	Use this subaddress in commands issued to the CM-3R module configured to operate in the DI-B mode in IMUX 2000 drop/insert multiplexers.
Cn (n = 1, 2, 36)	Use this subaddress format in commands sent to remotely-controllable channel modules in IMUX 2000 terminal or drop/insert multiplexers. Note that "n" is the subaddress number or "card address" of the target channel module within the multiplexer. This should not be confused with the multiplexer network address. Channel module subaddresses are set by switches on the channel modules themselves. The card address is generally set to the same number as the physical slot the card occupies; for modules in an Expansion Shelf, to that number plus 18. This is not a requirement, but following this method will simplify system maintenance. Each channel module within a given multiplexer must be assigned a different number. Valid channel numbers are the integers 1 through 36. Consult the individual channel module Instruction Data Sheets in Sections 15 through 18 for details on setting the card address.
DACS	Use this subaddress in commands issued to the DACS chassis
ILS	Use this subaddress in commands issued to the ILS chassis

8.3.3 COMMAND FIELD

The third field in the SCL command line is the **command** field. There are fourteen SCL commands: "SET", "CONFIG?", "STATUS?", "LOCK", "UNLOCK", "WHO", "NEXT", "NEXT_A", "NEXT_B", "EVENT", "TIME?", "TRAP?", "CONFIG2?", and "STATUS2?". The last two commands apply only to redundant multiplexers.

The first three commands ("SET," "CONFIG?," and "STATUS?") can be addressed either to Common Modules or to channel modules. When issued to a Common Module, these commands must include an appropriate address -**TERM**, **DI-A**, or **DI-B**. When issued to channel modules, they must include a subaddress of the form **Cn**, where **n** = 1 to 36. The commands ("LOCK" , "UNLOCK" , etc.) refer to the remote port itself, and can be issued only to Common Modules.

"STATUS?" is the default command if the command field is left blank. This is a convenience feature, providing a quick method for checking the status of a multiplexer, particularly a terminal multiplexer. The colon terminating the field, however, must always be present. As noted earlier, if the address field is left blank, any multiplexer will respond, and if the subaddress field is left blank, its default is TERM. Combining these with the default for the command field means that a “ <local node> :TERM:STATUS?; ” command can be issued to a terminal multiplexer simply by typing three colons and a semicolon:

;;;

The SCL commands are listed and described in Table 8-2.

Table 8-2. Valid command field entries

Command	Description
SET	Used to set a particular parameter on the common module, channel module, ILS, or DACS identified in the subaddress field. Every SET command must include a valid parameter name and value in the parameter field. Command example: 1:TERM:SET:CODE=B8ZS; Response: *OK;
CONFIG?	Lists the configuration settings for the module named in the subaddress field. The parameter field in a "CONFIG?" command should be left blank. Command example: 99DI-A:CONFIG?;; Response: *OK FROM NET ADDRESS=99 PTIME=THRU FTIME= FRAMING=SF CODE=AMI FAST REFRAME=ON;
STATUS?	When addressed to a Channel Module, lists the state of all "S" (status) parameters associated with that module. Command example: 34:C5:STATUS?;; Response: *OK FROM NET ADDRESS=46 CHANNEL CARD 11,TYPE 79; When addressed to a CM-3R module, lists the T1 interface and timing status information associated with that module. Command example: 34:TERM:STATUS?;; Response: *OK FROM NET ADDRESS=5; In all cases, the "STATUS?" command's parameter field should be left blank.

<<Table continues on next page>>

Table 8-2 – continued. Valid command field entries

Command	Description
LOCK	Locks the remote port of the addressed CM-3R module. When the port is locked, it will not accept SET commands, so setup changes cannot be made. (If the password is lost, a module's remote port can still be unlocked locally.) The parameter field of a "LOCK" command should be left blank. Command example: 4:DI-B:LOCK;; Response: *OK FROM NET ADDRESS=4 CM3R LOCKED
UNLOCK	Unlock the remote port of the addressed CM-3R module. This command must be accompanied by a valid password in the parameter field. However, because every CM-3R module is given a null password at the factory, the parameter field of UNLOCK commands issued to a new CM-3R module must be left blank (null) until its password is set. (For information, see paragraph 8.5.2) Command examples: Null Password:55TERM:UNLOCK;; Password = "GREEN":55:TERM:UNLOCK:GREEN Response: *OK FROM NET ADDRESS=55 CM3R UNLOCKED
WHO	Used to determine which modules are present in a node. Command example: ::WHO;; Response: *OK FROM NET ADDRESS=2 CM3R CONFIGURED AS TERM CHANNEL=14, TYPE 79 DACS PRESENT;

<<table continues on next page>>

Table 8-2 – continued. Valid command field entries

Command	Description
NEXT	The NEXT command sends a WHO inquiry to the next node after the one addressed. The NEXT command should be used when the PC is connected to a Terminal node and is searching for the next node after the See Figure 8-4. Before using the NEXT command, the user has to know the type of node (terminal or drop/insert) to which the PC is connected. This must be determined by first using the WHO command. The NEXT command should also be used when searching “behind” some remote node regardless of its type. By then the direction of search is already determined to be “away” from the interrogating location. Command example: 1:TERM:NEXT;; Response: *OK FROM NET ADDRESS=2 CM3R CONFIGURED AS DI-A
NEXT_A	The NEXT_A command sends a WHO inquiry to the next node in the A-Direction after the one addressed. The NEXT_A command should be used when the PC is connected to a Drop/Insert node. See Figure 8-4. Before using the NEXT_A command, the user has to know the type of node (terminal or drop/insert) to which the PC is connected. This must be determined by first using the WHO command. The NEXT_A command is only issued to the drop/insert to which the PC is connected. It initializes a node search in the A-Direction. No further remote nodes will be interrogated since the search always continues away from the local node. Command example: 3:DI-A:NEXT_A;; Response: *OK FROM NET ADDRESS=4 CM3R CONFIGURED AS DI-A;
NEXT_B	The NEXT_B command sends a WHO inquiry to the next node in the B-Direction after the one addressed. The NEXT_B command should be used when the PC is connected to a Drop/Insert node. See Figure 8-4. Before using the NEXT_B command, the user has to know the type of node (terminal or drop/insert) to which the PC is connected. This must be determined by first using the WHO command. The NEXT_B command is only issued to the drop/insert to which the PC is connected. It initializes a node search in the A-Direction. No further remote nodes will be interrogated since the search always continues away from the local node. Command example: 3:DI-A:NEXT_B;; Response: *OK FROM NET ADDRESS=2 CM3R CONFIGURED AS DI-B;

Note: NEXT command for a drop-and-insert are always issued to the DI/A regardless of the direction of search, since the configuration controller resides in DI/A.

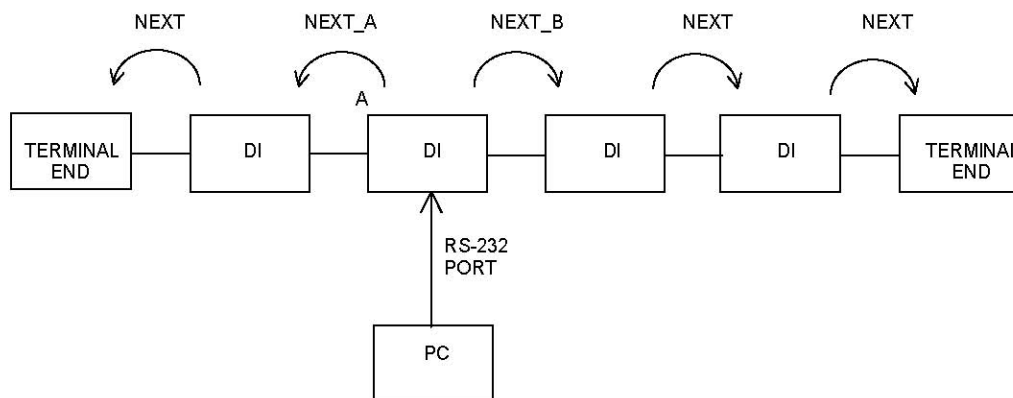
<<table continues on next page>>

Table 8-2 – continued. Valid command field entries

Command	Description
EVENT	Lists Sequence Of Events information for a given node. Command example: 3:TERM:EVENT:1,BLOCK1; Response: *OK FROM NET ADDRESS=3 EVENT NUMBER 1 DATE=05:11:97 TIME=11Hrs.:32Mins.:03Secs. ALARM ACTIVE 05/11/1997 11:32:03:147 CM3R TERM RECEIVER OUT OF FRAME;
TIME?	Used to determine the time set in the common module identified in the address field. Command example: 1:DI-A:TIME?;; Response: *OK FROM NET ADDRESS=1 DATE=03-25-1997 TIME=11Hrs.:49Mins.:21Secs.;
TRAP?	Used to determine the SNMP trap settings in the common module identified in the address field. Command example: 1:TERM:TRAP?;; Response: *OK FROM NET ADDRESS=1 SIO TRAP=OFF FDL TRAP=OFF;

Table 8-2 – continued. Valid command field entries

Command	Description
STATUS2?	Used to determine the redundancy status information in the common module identified in the address field. Command example: 4:DI-A:EVENT:1,STATUS2?;; Response: *OK FROM NET ADDRESS=4 >>>ALERT AT SHELF<<< STANDBY COMMON MODULE ACTIVE;
CONFIG2?	Used to determine the redundancy configuration settings in the common module identified in the address field. Command example: 1:TERM:CONFIG2?;; Response: *OK FROM NET ADDRESS=1 MAIN=ON SWITCH=AUTO CSU=RFL PRSQ=DISA POSQ=NRAM SWAP=0.6s (MODE SWITCH=AUTO);



NEXT_A and NEXT_B commands set the initial direction of the node search from a drop-and-insert when the interrogating PC is connected to that node's local port. The NEXT command is used for any other node to continue the search away from the local node. When the local node is a TERMINAL, only the NEXT command is used throughout.

Figure 8-4. Usage of NEXT commands

8.3.4 PARAMETER FIELD

The fourth field in an SCL command line is the **parameter** field. As noted above, the parameter field should be left blank for STATUS?, CONFIG?, and LOCK commands.

For UNLOCK commands, the parameter field must contain the correct password of the addressed multiplexer. For example, to unlock the remote port on the DI-A module in a drop/insert multiplexer with an address of 12 and a password of "GREEN", issue the following command:

12:DI-A:UNLOCK:GREEN;

For SET commands, the parameter field must include a valid parameter name, followed by an equal sign (=), followed by a valid parameter value. For example, to activate the payload loopback in a terminal multiplexer with an address of 17, issue the following command:

17:TERM:SET:PAYLD-LB=ON;

The valid parameter names and values for SET commands issued to CM-3R modules are listed in Table 8-5 in this section.

The valid parameter names and values for SET commands issued to an ILS chassis are listed in Table 8-6 in this section.

The valid parameter names and values for SET commands issued to a DACS chassis are listed in Table 8-7 in this section.

SET commands can also be issued to remotely controllable channel modules. Each channel module type has its own valid parameter names and values, listed in the individual channel module manual sections.

8.3.5 COMMENT FIELD

The SCL command line format also allows a free-form comment to be included after the command, between the semicolon and the carriage return. For example:

3:TERM:SET:PTIME=EXT; Sets #3 primary timing to external

Anything typed in the comment field, that is, anything **after** the semicolon but **before** the carriage return, is ignored by the multiplexer. Comments may be used when SCL commands are embedded in batch files or data files accessed by an automated controller, to make the commands more readable later. The comment field is optional at all times.

8.3.6 ALLOWABLE CHARACTERS

SCL command line fields may contain valid addresses, subaddresses, commands, parameters and space characters.

Space characters are ignored, so they can be used to make command lines more readable. For example, the following three SCL commands are perceived as identical by the multiplexer:

3:TERM:SET:PTIME=EXT;

3:TERM:SET:PTIME = EXT;

3: TERM: SET: PTIME = EXT;

Line feed <LF> characters are also ignored. A terminal or PC may be configured to generate either a single carriage return <CR> character or a <CR><LF> pair when its **[ENTER]** (or **[RETURN]**) key is pressed.

The comment field may contain any printable ASCII characters.

SCL commands are not case-sensitive. Subaddresses, commands, and parameters may be entered in upper or lower case, or a combination of both.

8.4 GENERAL FORMAT OF SCL RESPONSES

Upon receiving a valid command, an IMUX 2000 multiplexer, or to be precise the addressed CM-3R Common Module, always responds initially with the line:

***OK**
FROM NET ADDRESS=XX

This line indicates only that a valid command was received, and not necessarily that the multiplexer itself is "OK".

If the received command is SET, UNLOCK, or LOCK, which do not require explicit responses, then no additional response lines are generated. However, if the received command is CONFIG? or STATUS?, then the "* OK" line is followed by one or more lines contain the requested information. Examples of CONFIG? and STATUS? responses are included in the following sections.

If the received command is invalid (if, for example, it contains an unrecognizable command or an invalid subaddress, or the user attempts to send a SET command while the remote port is locked), then the addressed multiplexer responds with one of three invalid command response formats:

***WHAT?;**

or

***WHAT? <descriptive message>;**

or

***WHAT? <descriptive message> (rest of descriptive message);**

In all cases, the last line of an SCL response, and only the last line, terminates with a semicolon (;). All responses are immediately followed by a carriage return and line feed <CR> <LF>.

8.5 SHELF-LEVEL AND COMMON MODULE REMOTE ACCESS

8.5.1 USING THE LOCK AND UNLOCK COMMANDS

Each CM-3R module can be remotely locked or unlocked using the LOCK/ UNLOCK command pair. When a CM-3R module is locked, then no setup changes can be made via the module's remote port. The LOCK feature prevents accidental or unauthorized remote setup changes to IMUX 2000 multiplexers that are permanently connected to dial-up phone lines or dedicated data lines. The LOCK feature has no effect on local operation; setup changes, including locking and unlocking the remote port, can always be done locally.

The LOCK command has the following format:

<Address>:<Subaddress>:LOCK;;

Note that the parameter field is left blank.

The UNLOCK command has a slightly different format in that its parameter field must include the password of the addressed multiplexer, as shown below:

<Address>:<Subaddress>:UNLOCK:<Password>;

For example, assume that a drop/insert multiplexer has been set up with an address of 8 and a password of "BLUE". Then, to unlock the remote port on its DI-A module, make setup changes, and then re-lock this module, you would issue the following command sequence:

8:DI-A:UNLOCK:BLUE;

(Include one or more SET commands here)

8:DI-A:LOCK;;

8.5.2 CHANGING THE PASSWORD

In addition to its address, each multiplexer may be assigned a password. The password of a multiplexer must be known in order to make any remote setup changes once its remote port(s) have been locked. All of the multiplexers in a given network may be assigned the same password or different passwords, depending on the user's requirements.

Valid passwords consist of any string of letters and numbers up to 16 characters long.

Like the network address setting, the **password** is actually a CM-3R parameter rather than a multiplexer parameter. The password is normally used on a one-per-multiplexer basis; that is, both CM-3R modules in a given drop/insert multiplexer are generally assigned the same password. However, this is not a requirement.

When shipped from the factory, each IMUX 2000 multiplexer is assigned a "null" password - that is, the parameter field of an UNLOCK command must be left blank to unlock the remote port. To change the password of a given CM-3R module, issue a SET command of the following general form:

<Address>:<Subaddress>:SET:PASSWORD=xyz;

where "xyz" is the new password.

For example, to set the password of a CM-3R module to "GREEN" in a terminal multiplexer with an address of 7, issue the command:

7:TERM:SET:PASSWORD=GREEN;

Or, to set the password of both CM-3R modules to "BLUE" in a drop/insert multiplexer with an address of 8, issue two commands:

8:DI-A:SET:PASSWORD=BLUE;

8:DI-B:SET:PASSWORD=BLUE; If the password is lost or forgotten, the multiplexer can still be unlocked locally using the **Lock** function in the SIO Group.

8.5.3 DETERMINING THE ALERT/ALARM STATUS

You can determine the overall alarm and alert status of an IMUX 2000 multiplexer by issuing a STATUS? command to its TERM or DI-A module. For example, to determine the overall status of a terminal multiplexer, issue a command of the form:

<Address>:TERM:STATUS?;;

The response to this command shows the status of the multiplexer's T1 interface and indicate whether any channel modules are in an alarm or alert state. Similarly, to determine the overall status of a drop/insert multiplexer, issue a command of the form:

<Address>:DI-A:STATUS?;;

The response to this command shows the status of the A-direction T1 interface - that is, the T1 interface on the DI-A module.

To determine the status of the T1 interface on the DI-B module in a drop/insert multiplexer, issue a command of the form:

<Address>:DI-B:STATUS?;;

The response to this command shows the status of the B-direction T1 interface and indicates whether there is an alert or alarm condition in the shelf.

If an IMUX 2000 multiplexer is not in an alarm or alert state, then it responds as follows to a STATUS? command issued to its TERM or DI-A module:

***OK
FROM NET ADDRESS=XX
SHELF NORMAL;**

This response indicates that no power, timing, or T1 alarms or alerts are detected, the ACO switch is not on, and that no channel module on either the Main or Expansion shelf (if provided) is in an alarm or alert state. This "SHELF NORMAL" response may also include the line "RECEIVING ALL ONES" if the far end multiplexer is idle.

If, however, the queried multiplexer is in an alarm or alert state, then it generates a response with the following format:

***OK
FROM NET ADDRESS=XX
>>>ALARM (or ALERT) AT SHELF<<<
(message describing the alarm or alert condition[s])**

Note that the "* OK" in the first line of the response indicates that the received command was valid, not that the multiplexer is "all right".

For example, if a STATUS? command is issued to a CM-3R module that is receiving a T1 Yellow Alarm signal, it responds:

```
*OK  
FROM NET ADDRESS=XX  
>>>ALERT TO SHELF<<<  
RECEIVING YELLOW ALARM;
```

There are two basic types of conditions that a CM-3R module reports in response to a STATUS? command: alerts and alarms originating elsewhere in the multiplexer shelf, and alerts and alarms originating on the Common Module itself or its associated T1 link. A single status response may contain reports on one or more of these conditions. Table 8-3 provides a list of possible alert and alarm messages.

You can determine the status of an IMUX 2000 multiplexer, with respect to redundant operating modes, by issuing a STATUS2? command to its TERM or DI-A module. For example, to determine the redundant mode status of a terminal redundant multiplexer, issue a command of the form:

```
<Address>:TERM:STATUS2?;;
```

The response to this command shows the redundant controller status of the multiplexer. Similarly, to determine the redundant controller status of a drop/insert multiplexer, issue a command of the form:

```
<Address>:DI-A:STATUS2?;;
```

Table 8-3. Possible alert and alarm messages

Message	Meaning
TRANSMITTER USING FTIME = INT	The addressed CM-3R module's T1 transmitter is in its internal fallback timing mode.
TRANSMITTER CLOCK FREE RUNNING	The addressed CM-3R module's T1 transmitter has dropped out of its primary timing mode, but cannot operate in its fallback timing mode.
NO OUTPUT FROM TRANSMITTER	The addressed CM-3R module's T1 output is not generating a signal.
RECEIVE SIGNAL LOSS	No signal is detected at the addressed CM-3R module's T1 input.
EXCESS JITTER	Excessive jitter is detected at the addressed CM-3R module's T1 input.
RECEIVER OUT OF FRAME	The addressed CM-3R module's T1 receiver has lost frame synchronization.
OTHER SIDE (DI-B) IS OUT OF FRAME	The T1 receiver in the DI-B module has lost frame synchronization. Only reported by a Common Module set to DI-A mode.
OTHER SIDE (DI-A) IS OUT OF FRAME	The T1 receiver in the DI-A module has lost frame synchronization. Only reported by a Common Module set to DI-B mode.
RECEIVING ALL ONES	A framed or unframed all-ones signal is detected at the addressed CM-3R module's T1 input.
RECEIVING YELLOW ALARM	A Yellow Alarm signal is detected at the addressed CM-3R module's T1 input.
PAYLD-LB = ON	The addressed CM-3R module's T1 Payload Loopback is active.
LINE-LB = ON	The addressed CM-3R module's T1 Line Loopback is active.
EQUIP-LB = ON	The addressed CM-3R module's T1 Equipment Loopback is active.
REDUNDANT POWER SUPPLY FAILURE	One of the two power supplies on the Main Shelf or one of the two power supplies on the Expansion Shelf (if so equipped) has failed.
STANDBY COMMON MODULE ACTIVE	Standby common module active
BUS TROUBLE	Backplane bus trouble
MAIN COMMON MODULE OFF VIA FIRMWARE	Main common module forced via software command to report on-board trouble. Standby module will take over if so enabled.
FORCED TO MAIN COMMON MODULE VIA MODE SWITCH	Forced to main common module via mode switch on front panel
FORCED TO STANDBY COMMON MODULE VIA MODE SWITCH	Forced to standby common module via mode switch on front panel
MAIN COMMON MODULE TROUBLE	Main common module detecting on-board trouble
STANDBY COMMON MODULE TROUBLE	Standby common module detecting on-board trouble
FORCED TO MAIN COMMON MODULE VIA FIRMWARE	Forced to main common module via software command
FORCED TO STANDBY COMMON MODULE VIA FIRMWARE	Forced to standby common module via software command

8.5.4 “WHO” & “NEXT” FAMILY OF COMMANDS

The WHO command allows a user to determine which modules are present in a node. The WHO command has the following format:

<Address>:<Subaddress>:WHO;;

An example of a WHO command is as follows:

::WHO;;

An example of a WHO command response is as follows:

***OK FROM NET ADDRESS=2 CM3R CONFIGURED AS TERM CHANNEL=14, TYPE 79
DACS PRESENT;**

The NEXT family of commands is used to determine the type and content of the nodes in a network. Refer to Table 8-2 and Figure 8-4 for the application of NEXT, NEXT-A and NEXT-B commands.

The user propagates the NEXT command through the network by using the last returned address to address the following NEXT command. For example, if the PC is connected to a terminal in node 1, the following sequence would result:

user	→	::WHO;;	
		FROM ADDRESS 1	← common module
		...;	
user	→	1:TERM;NEXT;;	
		FROM ADDRESS 2	← common module
		...;	
user	→	2:DI-A:NEXT;;	
		etc.	

The NEXT commands for a drop-and-insert are always issued to DI-A since this is where the multiplexer controller resides.

8.5.5 EVENT COMMANDS

The EVENT command allows a user to list Sequence Of Events information for a given node. The EVENT command has the following format:

<Address>:<Subaddress>:EVENT:<event number>,BLOCK<block number>;

The event number is a sequence event number that ranges from 1 to 40. A block number is a number that ranges from 1 to 4, where BLOCK 1 = alerts and alarms, BLOCK 2 = Diagnostic information for the common module, BLOCK 3 = Diagnostic information for the DACS if present at the node, and BLOCK 4 = Redundancy status information.

An example of an EVENT command is as follows:

3:TERM:EVENT:1,BLOCK1;

An example of an EVENT command response is as follows:

***OK
FROM NET ADDRESS=3
EVENT NUMBER 1
DATE=05:11:97
TIME=11Hrs.:32Mins.:03Secs.**

ALARM ACTIVE 05/11/1997 11:32:03:147

**CM6R TERM
RECEIVER OUT OF FRAME;**

8.5.6 TIME? COMMANDS

The TIME? command allows a user to determine the time set in the common module identified in the address field.

The TIME? command has the following format:

<Address>:<Subaddress>:TIME?;;

An example of a TIME command is as follows:

1:DI-A:TIME?;;

An example of a TIME command response is as follows:

***OK
FROM NET ADDRESS=1
DATE=03-25-1997
TIME=11Hrs.:49Mins.:21Secs.:**

8.5.7 DETERMINING THE CONFIGURATION OF A COMMON MODULE

The configuration (setup) of a CM-3R Common Module can be determined by issuing a CONFIG? command of the general form:

<Address>:<Subaddress>:<CONFIG?>;

For example, to determine the current setup of the DI-A module in a drop/insert multiplexer with an address of 9, issue the follow command:

9:DI-A:CONFIG?;;

The response to a CONFIG? command always contains the following setup information about the addressed CM-3R module:

- 1 Primary timing mode
- 2 Fallback timing mode
- 3 T1 framing format

4. T1 line code A

typical response might be:

***OK
FROM NET ADDRESS=XX
PTIME = THRU (PRIMARY TIMING)
FTIME = INT (FALLBACK TIMING)
FRAMING = ESF
CODE = AMI;**

In addition, the response may contain one or more of the following messages:

**PAYLD-LB = ON (PAYLOAD LOOPBACK ON)
(USING LOOP TIMING FOR PAYLOAD LOOPBACK)**

LINE-LB = ON (LINE LOOPBACK ON)

EQPT-LB = ON (EQUIPMENT LOOPBACK ON)

The configuration (setup) of a CM-3R Common Module in a redundant multiplexer can be determined by issuing a CONFIG2? command of the general form:

<Address>:<Subaddress>:<CONFIG2?>;

For example, to determine the current setup of the DI-A module in a redundant drop/insert multiplexer with an address of 7, issue the follow command:

7:DI-A:CONFIG2?;;

A typical response might be:

***OK
FROM NET ADDRESS=7
MAIN=ON
SWITCH=AUTO
CSU=RFL
PRSQ=DISA
POSQ=DISA
SAVE=NRAM
SWAP=0.6s
(MODE SWITCH=AUTO);**

8.5.8 CHANGING COMMON MODULE SETUP PARAMETERS

The setup of a CM-3R Common Module can be changed by issuing SET commands with the appropriate parameter names and values. For example, to set line code to AMI in a terminal multiplexer with an address of 11, issue the following command:

11:TERM:SET:FAST=ON;

Table 8-4 lists the CM-3R setup parameters that can be changed remotely.

Table 8-4. Valid parameter names and values for SET commands issued to CM-3R modules

Name	Description	Legal Value	Sets Parameter To:	Default
PASSWORD	Shelf Security (N/A for DI-B)	16-character string	Password	none
FRAMING*	Frame Type	ESF	Extended Superframe Format	ESF
		SF	Superframe format. Also known as "D4".	
CODE*	T1 Line Code	B8ZS	Bipolar with Eight-Zero Substitution.	B8ZS
		AMI	Alternate Mark Inversion	
PTIME	Primary timing mode (TERM)	INT	Internal (terminal multiplexers only).	INT
		EXT	External (terminal multiplexers only).	
		LOOP	Loop (terminal multiplexers only).	
PTIME	Primary timing mode (DI-A, DI-B)	EXT	External (drop/insert multiplexers only).	THRU
		THRU	Through (drop/insert multiplexers only).	
LINE-LB	T1 line loopback	ON	Activate the line loopback of the target CM-3R module.	OFF
		OFF	Deactivate the line loopback of the target CM-3R module.	
PAYLD-LB	T1 payload loopback	ON	Activate the payload loopback of the target CM-3R module. CAUTION: To avoid system misoperation, do not activate the payload and equipment loopbacks simultaneously.	OFF
		OFF	Deactivate the payload loopback of the target CM-3R module.	
EQPT-LB	T1 equipment loopback	ON	Activate the equipment loopback of the target CM-3R module. CAUTION: To avoid system misoperation, do not activate the payload and equipment loopbacks simultaneously.	OFF
		OFF	Deactivate the equipment loopback of the target CM-3R module.	
FAST	Fast Reframing via Time Slot 24	ON	Activate Fast Reframing	ON
		OFF	Deactivate Fast Reframing	
CSU	CSU mode	RFL	Not CSU mode	RFL
		ANSI	ANSI CSU mode	
		ATT	AT&T CSU mode	
MAIN	Main module forced-switch config. parameters	ON	Force to report an on-board trouble	ON
		OFF	Do not force to report an on-board trouble	
SWITCH	Standby module forced-switch config. parameters	AUTO	Allow automatic switch operation	AUTO
		MAIN	Activate main module	
		STANDBY	Activate standby module	
PMRESET	Reset CSU counters	ON	Reset CSU counters	OFF
		OFF	Do not reset CSU counters	
PRSQ	Pre-squelch timer	0,0.66,1.3,2.0,2.7,3.3,4.0,4.6,5.3,6.0,6.6,7.3,8.0,8.6,9.3, DISA	0ms, 0.66ms, 1.3ms, 2.0ms, 2.7ms, 3.3ms, 4.0ms, 4.6ms, 5.3ms, 6.0ms, 6.6ms, 7.3ms, 8.0ms, 8.6ms, 9.3ms DISA = disable squelch function	DISA
POSQ	Post-squelch timer	0,0.66,1.3,2.0,2.7,3.3,4.0,4.6,5.3,6.0,6.6,7.3,8.0,8.6,9.3, DISA	0ms, 0.66ms, 1.3ms, 2.0ms, 2.7ms, 3.3ms, 4.0ms, 4.6ms, 5.3ms, 6.0ms, 6.6ms, 7.3ms, 8.0ms, 8.6ms, 9.3ms DISA = disable squelch function	DISA
SAVE	Configuration parameters storage options	NRAM	Store configuration parameters into nonvolatile SRAM	NRAM
		FLSH	Store configuration parameters into FLASH memory	
SWAP	Swap delay in seconds	0.6, 1.2, 2.4, 4.8, 9.6, 19	0.6s, 1.2s, 2.4s, 4.8s, 9.6s, 19s	0.6s

*NOTE: These parameters cannot be set via SCL, but can be set via the front panel switches and can be viewed in a "CONFIG?" response.

8.5.9 CSU PERFORMANCE REPORT

The CSU performance reports are special parameter requests of the STATUS? Command. The parameter of the command reports which type of performance report is requested. The accepted parameters for ANSI CSU and LOCAL (default for ANSI) and REMOTE. The accepted parameter for ATT CSU is HOUR followed by a comma and the starting 15 minute interval requested. If no interval is requested, the last four intervals are returned.

8.5.9.1 ANSI PERFORMANCE REPORT

The user can request an ANSI performance report for either the local or remote unit:

<Address>:<term>:[STATUS?]:ANSI[,<R,L>];

***OK**

FROM NET ADDRESS=<adr>

<LOCAL,REMOTE>ANSI PERFORMANCE REPORT

	G1	G2	G3	G4	G5	S6	SE	FE	LV	SL	LB
T1	0	0	0	0	0	0	0	0	0	0	0
T2	0	0	0	0	0	0	0	0	0	0	0
T3	0	0	0	0	0	0	0	0	0	0	0
T4	0	0	0	0	0	0	0	0	0	0	0
COUNT	1	0	0	0	0	0	5	48	0	0	5;

The “count” is the number of erred seconds since the last performance monitor reset and is not part of the ANSI standard. T1 through T4 contain the last four seconds worth of performance data sent or received. The local data is the default for the command.

8.5.9.2 AT&T PERFORMANCE REPORT

The user can request an AT&T performance report for the local unit:

<Address>:<term>:[STATUS?]:ATT[,<1st interval>[,<2nd interval>]];

***OK**

FROM NET ADDRESS=<adr>

AT&T PERFORMANCE REPORT

NUMBER INTERVALS W/DATA=<n>

	ES	UAS	BES	SES	CSS	LOF
CURRENT	0	0	0	0	0	0
24 HOUR	0	0	0	0	0	0
INT 1	0	0	0	0	0	0
...	0	0	0	0	0	0
INT 96	0	0	0	0	0	0;

The default interval is interval 1 which is the 15 minute interval just prior to the current interval. If no second interval is requested, only one interval is shown.

8.6 ILS COMMANDS

8.6.1 CHANGING ILS SETUP PARAMETERS

The setup of an ILS chassis can be changed by issuing SET commands with the appropriate parameter names and values. For example, to set the time delay to 40 ms of an ILS connected to a multiplexer at address 46, issue the following command:

46:ILS:SET:DELAY=40;

Table 8-5 lists ILS setup parameters that can be changed remotely.

Table 8-5. Valid parameter names and values for set commands issued to an ILS chassis

Name	Function	Legal Value	Sets parameter to:	Default
SRVC	Service	ON	ILS in service	OFF
		OFF	ILS out of service	
FTYPE	Frame Type	SF	Superframe Format	ESF
		ESF	Extended Superframe Format	
ELOS	Loss of Synch	ON	Enable loss of synch failure	ON
		OFF	Disable loss of synch failure	
ELOD	Loss of Data	ON	Enable loss of data failure	ON
		OFF	Disable loss of data failure	
EAIS	All Ones Failure	ON	Enable all ones failure	ON
		OFF	Disable all ones failure	
EBER	Bit Error Rate	ON	Enable bit error rate failure	OFF
		OFF	Disable bit error rate failure	
EFLOF	Enable fast loss of frame	ON	Enable fast (CM3) loss of frame	OFF
		OFF	Disable fast (CM3) loss of frame	
USE1	Primary Path 1	ON	Primary path 1 in service	ON
		OFF	Primary path 1 out of service	
USE4	Primary Path 4	ON	Primary path 4 in service	ON
		OFF	Primary path 4 out of service	
CODE	T1 Line Code	B8ZS	Bipolar with eight-zero substitution	B8ZS
		AMI	Alternate mark inversion	
MODE	Mode	Master	Originates timing on backup path	SLAVE
		Slave	Passes thru timing on backup path	
		Hot	Used on 2 terminal 2 port system	
		Thru	Passes thru framing & timing on all paths	
EXCLK	External Clock	ON	Enable external clock	OFF
		OFF	Disable external clock	
RESET	Reset Counters	ON	Reset ILS status counters	not used
		OFF	Do not reset ILS status counters	
DELAY	Switch Time Delay	1 to 100 (ms)	Switch time delay	1
REC	Recovery Time Delay	0 to 60 sec	Recovery time delay	2
BER	Bit Error Rate	0 to 9E -7 to -4	Bit error rate	1E-6
LEVEL	Rx Low Level	-7.5, -15, N (N=not used)	Rx Low Level	-7.5
EFAST	Enable Fast Switching	ON	Enable Fast Switching	ON
		OFF	Disable Fast Switching	
LOSDLY	Loss of synch switch delay	5 to 1000 (ms)	Loss of synch switch delay	85
DEBUG	Diagnostics and Hidden Parameters	1-16	See paragraph 8.10	none

8.7 DACS COMMANDS

8.7.1 CHANGING DACS SETUP PARAMETERS

The setup of a DACS chassis can be changed by issuing SET commands with the appropriate parameter names and values. For example, to set the recovery time to 0.1 second of a DACS connected to a multiplexer at address 32, issue the following command:

32:DACS:SET:REC=0.10;

Table 8-6 lists DACS setup parameters that can be changed remotely

Table 8-6. Valid parameter names and values for set commands issued to a DACS chassis.

Name	Function	Legal Value	Sets parameter to:	Default
SRVC	Service	ON	DACS in service	OFF
		OFF	DACS out of service	
ELOS	Loss of Synch	ON	Enable loss of synch failure	ON
		OFF	Disable loss of synch failure	
ELOD	Loss of Data	ON	Enable loss of data failure	ON
		OFF	Disable loss of data failure	
EAIS	All Ones Failure	ON	Enable all ones failure	ON
		OFF	Disable all ones failure	
EBER	Bit Error Rate	ON	Enable bit error rate failure	ON
		OFF	Disable bit error rate failure	
EFLOF	Fast loss of frame	ON	Enable fast (CM3) loss of frame	OFF
		OFF	Disable fast (CM3) loss of frame	
ACT1	Port 1 active/not active	ON	Port 1 in Service	ON
		OFF	Port 1 not in Service	
ACT2	Port 2 active/not active	ON	Port 2 in Service	ON
		OFF	Port 2 not in Service	
ACT3	Port 3 active/not active	ON	Port 3 in Service	ON
		OFF	Port 3 not in Service	
ACT4	Port 4 active/not active	ON	Port 4 in Service	ON
		OFF	Port 4 not in Service	
ACT5	Port 5 active/not active	ON	Port 5 in Service	ON
		OFF	Port 5 not in Service	
ACT6	Port 6 active/not active	ON	Port 6 in Service	ON
		OFF	Port 6 not in Service	
FTYP5	Frame type	SF	Superframe Format	ESF
		ESF	Extended Superframe Format	
CODE5	T1 Line Code	B8ZS	Bipolar with eight-zero substitution	B8ZS
		AMI	Alternate Mark Inversion	
FTYP6	Frame type	SF	Superframe Format	ESF
		ESF	Extended Superframe Format	
CODE6	T1 Line Code	B8ZS	Bipolar with eight-zero substitution	B8ZS
		AMI	Alternate Mark Inversion	
FTYPE, P P = port number (1 to 4)	Frame type	SF	Superframe Format	ESF
		ESF	Extended Superframe Format	
CODE, P P = port number (1 to 4)	T1 line code	B8ZS	Bipolar with eight-zero substitution	B8ZS
		AMI	Alternate Mark Inversion	
EFAST, P P = port number (1 to 4)	Fast switching	ON	Enable fast switching	OFF
		OFF	Disable fast switching	
LOSDLY, P P = port number (1 to 4)	Loss of synch switch delay	5 to 999 (ms)*	Loss of synch switch delay	85

*When set = 1000, means do not switch on this port. 2=1000 means table 2 will be disabled. The DACS will never go to table 2.

Table 8-6 – continued. Valid parameter names and values for set commands issued to a DACS chassis

Name	Function	Legal Value	Sets parameter to:	Default
RESET	Reset counters	ON	Reset DACS status counters	not used
		OFF	Do not reset DACS status counters	
DLY1	Delay	0 to 100 (ms)	Switch time delay, port 1	1
DLY2	Delay	0 to 100 (ms)	Switch time delay, port 2	100
DLY3	Delay	0 to 100 (ms)	Switch time delay, port 3	100
DLY4	Delay	0 to 100 (ms)	Switch time delay, port 4	1
REC	Recovery time	0 to 60 sec	Recovery time delay	all ports 2 sec
BER	Bit error rate	0 ..9E-7 ..-4	Bit error rate	1E-6
LEVEL	Rx Low Level	-7.5, -15, N	Rx Low Level (N = not used)	-7.5
CLOCK	Clock source	Alt1, Alt2	Alt1 = Alternate Clock 1 (I(ternal), E(xternal), 1 to 6) (optional)Alt2 = Alternate Clock 2 (1 to 6)	5, NOT USED
RBS,RxF	Robbed Bit Signal	n1,n2,n3	Robbed Bit Signal enable where: RxF=Rx Framer Number (1 to 6) n1, n2, n3= 3 enable variables	0, 0, 0
DSO,M,TxF,TxC	DSO Remapping	RxF, RxC	DSO remapping parameter where: M=Map (0=normal, 1 to 4 = Framer Failure) TxF=Tx Framer Number (1 to 6) TxC= Tx Framer (time slot) number (1 to 24) RxF= Rx Framer Number (1 to 6, 0=constant) RxC= Rx Framer Channel Number (1 to 24, if RxF=0 then RxC=the constant value) Note: A constant can be entered in decimal or hexadecimal format as shown in the following example: decimal 255 hexidecimal FFH or 0XFF if a constant FFH is selected, enter it as follows: 0,FFH	0, 0 x FF
FDL,M,TxF	Facility Data Link	RxF	FDL remapping parameter where :M=Map (0=normal, 1 to 4 = Framer Failure) TxF=Tx Framer Number (1 to 6) RxF=Rx Framer Number (1 to 6)	*see below
FDL, M, 0	Facility Data Link	Rx21, Rx43, Rx65	FDL Direct Data Entry Remap where: M=Map (0=normal, 1 to 4=port failure) Rx21=Rx Ports for Tx Ports 2 & 1 Rx43=Rx Ports for Tx Ports 4 & 3 Rx65=Rx Ports for Tx Ports 6 & 5	* see below
DEBUG	Diagnostics and Hidden Parameters	1-16	See paragraph 8.10	none

*The default FDL mapping should be:

Map 0, 2, 3 1<>5, 2<>3, 4<>6

Map 1 1<5, 2<>5, 3<1, 4<>6

Map 4 1<>5, 2<4, 3<>6, 4<6

8.7.2 “STATUS?” PARAMETERS FOR DACS

8.7.2.1 “FLAGS1” (default)

Response:

*** OK**

FROM NET ADDRESS = <net_addr>

ALERT = <ON, OFF>

FAILURE = <ON, OFF>

<list of active alarms>

MAP = <n> (table in use)

<LOOP TEST ON <port>>; (if active)

List of potential alarms:

LOF1 Loss of Frame on Framer 1

LOD1 Loss of Data on Framer 1

AIS1 All Ones Signal on Framer 1

BER1 Bit Error Rate Exceeded on Framer 1

LOF2 Loss of Frame on Framer 2

LOD2 Loss of Data on Framer 2

AIS2 All Ones Signal on Framer 2

BER2 Bit Error Rate Exceeded on Framer 2

LOF3 Loss of Frame on Framer 3

LOD3 Loss of Data on Framer 3

AIS3 All Ones Signal on Framer 3

BER3 Bit Error Rate Exceeded on Framer 3

LOF4 Loss of Frame on Framer 4

LOD4 Loss of Data on Framer 4

AIS4 All Ones Signal on Framer 4

BER4 Bit Error Rate Exceeded on Framer 4

EXTA External Clock Alarm (Requested external clock no longer in use)

8.7.2.2 “COUNT1”

Response:

*** OK**

FROM NET ADDRESS = <net_addr>

ALERT = <ON, OFF>

FAILURE = <ON, OFF>

MAP 1 COUNT = <n>

MAP 2 COUNT = <n>

MAP 3 COUNT = <n>;

8.7.2.3 “COUNT2”

Response:

*** OK**

FROM NET ADDRESS = <net_addr>

ALERT = <ON, OFF>

FAILURE = <ON, OFF>

MAP 4 COUNT = <n>

PORT 1 BER = <nEn>

PORT 2 BER = <nEn>;

8.7.2.4 “COUNT3”

Response:

*** OK**

FROM NET ADDRESS = <net_addr>

ALERT = <ON, OFF>

FAILURE = <ON, OFF>

PORT 3 BER = <nEn>

PORT 4 BER = <nEn>;

8.7.2.5 “COUNT4”

Response:

*** OK**

FROM NET ADDRESS = <net_addr>

ALERT = <ON, OFF>

FAILURE = <ON, OFF>

CLOCK SOURCE = <n>

CLOCK IN USE = <n>

CLOCK CHANGES =<n>;

The “CLOCK SOURCE” is the desired clock source based upon user configured clock sources (“FLAGS5”) and clock source status. The “CLOCK IN USE” is the actual timing clock used by the DACS board at this point. The clock in use will be updated to the clock source when the two sources go into phase. If the two sources are running at the same frequency (i.e. the sources are both connected to the same system master clock), the clock in use will not update.

8.7.2.6 “FLAGS2” (Miscellaneous Flags)

Response:

*** OK**

ALERT = <ON, OFF>

FAILURE = <ON, OFF>

<list of alarms covered by FLAGS2 SCB status>

...;

List of potential alarms:

CHKSM Configuration checksum failed, configuration in doubt

8.7.3 “CONFIG?” SCL PARAMETERS FOR DACS

8.7.3.1 “FLAGS1” (default)

Response:

*** OK**

SRVC = <ON, OFF>
ELOF = <ON, OFF>
ELOD = <ON, OFF>
EAIS = <ON, OFF>
EBER = <ON, OFF>
ACT1 = <ON, OFF>
ACT2 = <ON, OFF>
ACT3 = <ON, OFF>
ACT4 = <ON, OFF>
ACT5 = <ON, OFF>
ACT6 = <ON, OFF>;

8.7.3.2 “FLAGS2”

Response:

*** OK**

SRVC = <ON, OFF>
RECOVERY = < n>
BER = <nE-e>;

8.7.3.3 “FLAGS3”

Response:

*** OK**

SRVC = <ON, OFF>
DLY1 = < n>
DLY2 = < n>

8.7.3.4 “FLAGS4”

Response:

*** OK**

SRVC = <ON, OFF>

DLY3 = <n>

DLY4 = <n>

8.7.3.5 “FLAGS5”

Response:

*** OK**

SRVC = <ON, OFF>

CLOCK = <n>,<n>

FTYP5 = <SF, ESF>

CODE5 = <AMI, B8ZS >

FTYP6 = <CCS, CAS>

CRC45 = <ON, OFF>

CODE6 = <AMI, B8ZS>

CRC46 = <ON, OFF>;

8.7.3.6 “FLAGS6, < Port(Framer)>”

Response to “**FLAGS6,1**” :

*** OK**

SRVC = <ON, OFF>

FTYPE,1 = <SF, ESF>

CODE,1 = <AMI, B8ZS>

EFAST,1 = <ON, OFF>

CRC4,1 = <ON, OFF>

LOSDLY,1 = <n>;

Response to “**FLAGS6**” :

*** OK**

SRVC = <ON, OFF>
FTYPE,1 = <SF, ESF>
CODE,1 = <AMI, B8ZS>
EFAST,1 = <ON, OFF>
CRC4,1 = <ON, OFF>
LOSDLY,1 = <n>
FTYPE,2 = <SF, ESF>
CODE,2 = <AMI, B8ZS>
EFAST,2 = <ON, OFF>
CRC4,2 = <ON, OFF>
LOSDLY,2 = <n>
FTYPE,3 = <SF, ESF>
CODE,3 = <AMI, B8ZS>
EFAST,3 = <ON, OFF>
CRC4,3 = <ON, OFF>
LOSDLY,3 = <n>
FTYPE,4 = <SF, ESF>
CODE,4 = <AMI, B8ZS>
EFAST,4 = <ON, OFF>
CRC4,4 = <ON, OFF>
LOSDLY,4 = <n>;

8.7.3.7 “DS0<,Map><,<Port(Framer)><,Channel>”

The DS0 request configuration parameter can be modified by adding a comma and then map number, another comma and then port or framer number, and another comma and finally channel number. The response to the command will be lengthened when many individual SCB accesses are made to retrieve more than one re-mapping. When used by the networking software, that is, over the FDL link, all modifiers should be used.

Response to “**DS0,0,1,1**” :

*** OK**

DS0,0,1,1 = <Port n>, <Channel n>
DS0,0,1,2 = <Port n>, <Channel n>;

Response to “DS0,0,1” :

*** OK**

Port 1

f1,c1	f2,c2	f3,c3	f4,c4	f5,c5	f6,c6	f7,c7	f8,c8	f9,c9	f10,c10	f11,c11	f12,c12
f13,c13	f14,c14	f15,c15	f16,c16	f17,c17	f18,c18	f19,c19	f20,c20	f21,c21	f22,c22	f23,c23	f24,c24

;

Response to “DS0,0” :

*** OK**

Port 1:

f1,c1	f2,c2	f3,c3	f4,c4	f5,c5	f6,c6	f7,c7	f8,c8	f9,c9	f10,c10	f11,c11	f12,c12
f13,c13	f14,c14	f15,c15	f16,c16	f17,c17	f18,c18	f19,c19	f20,c20	f21,c21	f22,c22	f23,c23	f24,c24

Port 2:

f1,c1	f2,c2	f3,c3	f4,c4	f5,c5	f6,c6	f7,c7	f8,c8	f9,c9	f10,c10	f11,c11	f12,c12
f13,c13	f14,c14	f15,c15	f16,c16	f17,c17	f18,c18	f19,c19	f20,c20	f21,c21	f22,c22	f23,c23	f24,c24

Port 3:

f1,c1	f2,c2	f3,c3	f4,c4	f5,c5	f6,c6	f7,c7	f8,c8	f9,c9	f10,c10	f11,c11	f12,c12
f13,c13	f14,c14	f15,c15	f16,c16	f17,c17	f18,c18	f19,c19	f20,c20	f21,c21	f22,c22	f23,c23	f24,c24

Port 4:

f1,c1	f2,c2	f3,c3	f4,c4	f5,c5	f6,c6	f7,c7	f8,c8	f9,c9	f10,c10	f11,c11	f12,c12
f13,c13	f14,c14	f15,c15	f16,c16	f17,c17	f18,c18	f19,c19	f20,c20	f21,c21	f22,c22	f23,c23	f24,c24

Port 5:

f1,c1	f2,c2	f3,c3	f4,c4	f5,c5	f6,c6	f7,c7	f8,c8	f9,c9	f10,c10	f11,c11	f12,c12
f13,c13	f14,c14	f15,c15	f16,c16	f17,c17	f18,c18	f19,c19	f20,c20	f21,c21	f22,c22	f23,c23	f24,c24

Port 6

f1,c1	f2,c2	f3,c3	f4,c4	f5,c5	f6,c6	f7,c7	f8,c8	f9,c9	f10,c10	f11,c11	f12,c12
f13,c13	f14,c14	f15,c15	f16,c16	f17,c17	f18,c18	f19,c19	f20,c20	f21,c21	f22,c22	f23,c23	f24,c24

;

Response to “DS0” :

*** OK**

Map 0:

Port 1:

f1,c1	f2,c2	f3,c3	f4,c4	f5,c5	f6.c6	f7,c7	f8,c8	f9,c9	f10,c10	f11,c11	f12,c12
f13,c13	f14,c14	f15,c15	f16,c16	f17,c17	f18.c18	f19,c19	f20,c20	f21,c21	f22,c22	f23,c23	f24,c24

Port 2:

f1,c1	f2,c2	f3,c3	f4,c4	f5,c5	f6.c6	f7,c7	f8,c8	f9,c9	f10,c10	f11,c11	f12,c12
f13,c13	f14,c14	f15,c15	f16,c16	f17,c17	f18.c18	f19,c19	f20,c20	f21,c21	f22,c22	f23,c23	f24,c24

Port 3:

f1,c1	f2,c2	f3,c3	f4,c4	f5,c5	f6.c6	f7,c7	f8,c8	f9,c9	f10,c10	f11,c11	f12,c12
f13,c13	f14,c14	f15,c15	f16,c16	f17,c17	f18.c18	f19,c19	f20,c20	f21,c21	f22,c22	f23,c23	f24,c24

Port 4:

f1,c1	f2,c2	f3,c3	f4,c4	f5,c5	f6.c6	f7,c7	f8,c8	f9,c9	f10,c10	f11,c11	f12,c12
f13,c13	f14,c14	f15,c15	f16,c16	f17,c17	f18.c18	f19,c19	f20,c20	f21,c21	f22,c22	f23,c23	f24,c24

Port 5:

f1,c1	f2,c2	f3,c3	f4,c4	f5,c5	f6.c6	f7,c7	f8,c8	f9,c9	f10,c10	f11,c11	f12,c12
f13,c13	f14,c14	f15,c15	f16,c16	f17,c17	f18.c18	f19,c19	f20,c20	f21,c21	f22,c22	f23,c23	f24,c24

Port 6:

f1,c1	f2,c2	f3,c3	f4,c4	f5,c5	f6.c6	f7,c7	f8,c8	f9,c9	f10,c10	f11,c11	f12,c12
f13,c13	f14,c14	f15,c15	f16,c16	f17,c17	f18.c18	f19,c19	f20,c20	f21,c21	f22,c22	f23,c23	f24,c24

Map 1:

Port 1:

f1,c1	f2,c2	f3,c3	f4,c4	f5,c5	f6.c6	f7,c7	f8,c8	f9,c9	f10,c10	f11,c11	f12,c12
f13,c13	f14,c14	f15,c15	f16,c16	f17,c17	f18.c18	f19,c19	f20,c20	f21,c21	f22,c22	f23,c23	f24,c24

Port 2:

f1,c1	f2,c2	f3,c3	f4,c4	f5,c5	f6.c6	f7,c7	f8,c8	f9,c9	f10,c10	f11,c11	f12,c12
f13,c13	f14,c14	f15,c15	f16,c16	f17,c17	f18.c18	f19,c19	f20,c20	f21,c21	f22,c22	f23,c23	f24,c24

Port 3:

f1,c1	f2,c2	f3,c3	f4,c4	f5,c5	f6.c6	f7,c7	f8,c8	f9,c9	f10,c10	f11,c11	f12,c12
f13,c13	f14,c14	f15,c15	f16,c16	f17,c17	f18.c18	f19,c19	f20,c20	f21,c21	f22,c22	f23,c23	f24,c24

Port 4:

f1,c1	f2,c2	f3,c3	f4,c4	f5,c5	f6.c6	f7,c7	f8,c8	f9,c9	f10,c10	f11,c11	f12,c12
f13,c13	f14,c14	f15,c15	f16,c16	f17,c17	f18.c18	f19,c19	f20,c20	f21,c21	f22,c22	f23,c23	f24,c24

Port 5:

f1,c1	f2,c2	f3,c3	f4,c4	f5,c5	f6.c6	f7,c7	f8,c8	f9,c9	f10,c10	f11,c11	f12,c12
f13,c13	f14,c14	f15,c15	f16,c16	f17,c17	f18.c18	f19,c19	f20,c20	f21,c21	f22,c22	f23,c23	f24,c24

Port 6:

f1,c1	f2,c2	f3,c3	f4,c4	f5,c5	f6.c6	f7,c7	f8,c8	f9,c9	f10,c10	f11,c11	f12,c12
f13,c13	f14,c14	f15,c15	f16,c16	f17,c17	f18.c18	f19,c19	f20,c20	f21,c21	f22,c22	f23,c23	f24,c24

Map 2:**Port 1:**

f1,c1	f2,c2	f3,c3	f4,c4	f5,c5	f6.c6	f7,c7	f8,c8	f9,c9	f10,c10	f11,c11	f12,c12
f13,c13	f14,c14	f15,c15	f16,c16	f17,c17	f18.c18	f19,c19	f20,c20	f21,c21	f22,c22	f23,c23	f24,c24

Port 2:

f1,c1	f2,c2	f3,c3	f4,c4	f5,c5	f6.c6	f7,c7	f8,c8	f9,c9	f10,c10	f11,c11	f12,c12
f13,c13	f14,c14	f15,c15	f16,c16	f17,c17	f18.c18	f19,c19	f20,c20	f21,c21	f22,c22	f23,c23	f24,c24

Port 3:

f1,c1	f2,c2	f3,c3	f4,c4	f5,c5	f6.c6	f7,c7	f8,c8	f9,c9	f10,c10	f11,c11	f12,c12
f13,c13	f14,c14	f15,c15	f16,c16	f17,c17	f18.c18	f19,c19	f20,c20	f21,c21	f22,c22	f23,c23	f24,c24

Port 4:

f1,c1	f2,c2	f3,c3	f4,c4	f5,c5	f6.c6	f7,c7	f8,c8	f9,c9	f10,c10	f11,c11	f12,c12
f13,c13	f14,c14	f15,c15	f16,c16	f17,c17	f18.c18	f19,c19	f20,c20	f21,c21	f22,c22	f23,c23	f24,c24

Port 5:

f1,c1	f2,c2	f3,c3	f4,c4	f5,c5	f6.c6	f7,c7	f8,c8	f9,c9	f10,c10	f11,c11	f12,c12
f13,c13	f14,c14	f15,c15	f16,c16	f17,c17	f18.c18	f19,c19	f20,c20	f21,c21	f22,c22	f23,c23	f24,c24

Port 6:

f1,c1	f2,c2	f3,c3	f4,c4	f5,c5	f6.c6	f7,c7	f8,c8	f9,c9	f10,c10	f11,c11	f12,c12
f13,c13	f14,c14	f15,c15	f16,c16	f17,c17	f18.c18	f19,c19	f20,c20	f21,c21	f22,c22	f23,c23	f24,c24

Map 3:**Port 1:**

f1,c1	f2,c2	f3,c3	f4,c4	f5,c5	f6.c6	f7,c7	f8,c8	f9,c9	f10,c10	f11,c11	f12,c12
f13,c13	f14,c14	f15,c15	f16,c16	f17,c17	f18.c18	f19,c19	f20,c20	f21,c21	f22,c22	f23,c23	f24,c24

Port 2:

f1,c1	f2,c2	f3,c3	f4,c4	f5,c5	f6.c6	f7,c7	f8,c8	f9,c9	f10,c10	f11,c11	f12,c12
f13,c13	f14,c14	f15,c15	f16,c16	f17,c17	f18.c18	f19,c19	f20,c20	f21,c21	f22,c22	f23,c23	f24,c24

Port 3:

1,c1	f2,c2	f3,c3	f4,c4	f5,c5	f6.c6	f7,c7	f8,c8	f9,c9	f10,c10	f11,c11	f12,c12
f13,c13	f14,c14	f15,c15	f16,c16	f17,c17	f18.c18	f19,c19	f20,c20	f21,c21	f22,c22	f23,c23	f24,c24

Port 4:

f1,c1	f2,c2	f3,c3	f4,c4	f5,c5	f6.c6	f7,c7	f8,c8	f9,c9	f10,c10	f11,c11	f12,c12
f13,c13	f14,c14	f15,c15	f16,c16	f17,c17	f18.c18	f19,c19	f20,c20	f21,c21	f22,c22	f23,c23	f24,c24

Port 5:

f1,c1	f2,c2	f3,c3	f4,c4	f5,c5	f6.c6	f7,c7	f8,c8	f9,c9	f10,c10	f11,c11	f12,c12
f13,c13	f14,c14	f15,c15	f16,c16	f17,c17	f18.c18	f19,c19	f20,c20	f21,c21	f22,c22	f23,c23	f24,c24

Port 6:

f1,c1	f2,c2	f3,c3	f4,c4	f5,c5	f6.c6	f7,c7	f8,c8	f9,c9	f10,c10	f11,c11	f12,c12
f13,c13	f14,c14	f15,c15	f16,c16	f17,c17	f18.c18	f19,c19	f20,c20	f21,c21	f22,c22	f23,c23	f24,c24

Map 4:**Port 1:**

f1,c1	f2,c2	f3,c3	f4,c4	f5,c5	f6.c6	f7,c7	f8,c8	f9,c9	f10,c10	f11,c11	f12,c12
f13,c13	f14,c14	f15,c15	f16,c16	f17,c17	f18.c18	f19,c19	f20,c20	f21,c21	f22,c22	f23,c23	f24,c24

Port 2:

f1,c1	f2,c2	f3,c3	f4,c4	f5,c5	f6.c6	f7,c7	f8,c8	f9,c9	f10,c10	f11,c11	f12,c12
f13,c13	f14,c14	f15,c15	f16,c16	f17,c17	f18.c18	f19,c19	f20,c20	f21,c21	f22,c22	f23,c23	f24,c24

Port 3:

f1,c1	f2,c2	f3,c3	f4,c4	f5,c5	f6.c6	f7,c7	f8,c8	f9,c9	f10,c10	f11,c11	f12,c12
f13,c13	f14,c14	f15,c15	f16,c16	f17,c17	f18.c18	f19,c19	f20,c20	f21,c21	f22,c22	f23,c23	f24,c24

Port 4:

f1,c1	f2,c2	f3,c3	f4,c4	f5,c5	f6.c6	f7,c7	f8,c8	f9,c9	f10,c10	f11,c11	f12,c12
f13,c13	f14,c14	f15,c15	f16,c16	f17,c17	f18.c18	f19,c19	f20,c20	f21,c21	f22,c22	f23,c23	f24,c24

Port 5:

f1,c1	f2,c2	f3,c3	f4,c4	f5,c5	f6.c6	f7,c7	f8,c8	f9,c9	f10,c10	f11,c11	f12,c12
f13,c13	f14,c14	f15,c15	f16,c16	f17,c17	f18.c18	f19,c19	f20,c20	f21,c21	f22,c22	f23,c23	f24,c24

Port 6

f1,c1	f2,c2	f3,c3	f4,c4	f5,c5	f6.c6	f7,c7	f8,c8	f9,c9	f10,c10	f11,c11	f12,c12
f13,c13	f14,c14	f15,c15	f16,c16	f17,c17	f18.c18	f19,c19	f20,c20	f21,c21	f22,c22	f23,c23	f24,c24

;

8.8 CHANNEL MODULE REMOTE ACCESS

Many of the channel modules available for use with the IMUX 2000 multiplexers can be set up and monitored remotely. Specifically, the SET, CONFIG? and STATUS? commands may be issued to channel modules by using a subaddress of the form "Cn," where "n" is the card address of the target channel module. Valid card (or module) address range from 1 to 36.

As discussed earlier, setting hardware switches on each channel module determines its card address. We recommend setting the card address of each channel module in a Main Shelf to its physical slot number (3 through 18), and the address of each channel module in an Expansion Shelf to its physical slot number plus 18. For example, a channel module located in Slot 4 of an Expansion Shelf should be assigned a card address of 22.

It is important to note again that remote communication with channel modules located in drop/insert multiplexers can only take place through the remote port of the DI-A module. Channel module commands received by the DI-B module will be ignored.

WARNING

In a Terminal multiplexer or in a DI-A multiplexer using fiber, you cannot set any card in the shelf to Address 1. In a DI-B multiplexer using fiber, you cannot set any card in the shelf to Address 3. These addresses are used by the optical interface adapters.

8.8.1 DETERMINING CHANNEL MODULE STATUS

To determine the status of a given channel module in an IMUX 2000 multiplexer, issue a STATUS? command in the following form:

<Address>:Cn:STATUS?;;

where n is the number of the target channel module. For example, to request the status of channel module #4 in multiplexer #15, issue the command:

15:C4:STATUS?;;

Note that the subaddress field in channel module STATUS? command is always of the form Cn, regardless of whether it is located in a terminal or a drop/insert multiplexer.

The response to a valid channel module STATUS? command indicates whether the module is in an alarm or alert state, and may provide other information as well, depending on the specific channel module type. The response always takes this general form.

*** OK CHANNEL CARD nn, TYPE mmm (one or two lines indicating Alert/Alarm conditions, if present, followed by one or more lines stating the values of each "S" [status parameter]);**

8.8.2 DETERMINING CHANNEL MODULE CONFIGURATION

To determine the configuration of a given channel module in an IMUX 2000 Series multiplexer, issue a CONFIG? command in the following form:

<Address>:Cn:CONFIG?;

where **n** is the number of the target channel module. For example, to determine the setup of a channel module #4 in multiplexer #20, issue the following command:

20:C4:CONFIG?;

The response to a valid channel module CONFIG? command has the following general form:

*** OK
CHANNEL CARD nn, TYPE mmm
UNDER REMOTE (or LOCAL) CONTROL
SRVC = ON (or OFF)
(one or more lines stating the values of each "P" [setup] parameter);**

8.8.3 CHANGING CHANNEL MODULE CONFIGURATION

The configuration of a channel module can be changed by issuing SET commands with the appropriate subaddress and parameter. For example, to turn off (disable) channel module #4 in multiplexer #20, you would issue the following command:

20:C4:SET:SRVC = OFF;

8.9 OPTICAL INTERFACE ADAPTER (OIA) REMOTE ACCESS AND STATUS REPORTING

In IMUX 2000 multiplexers equipped with fiber optic interfaces, the Optical Interface Adapter (OIA) plugs in as a Module Adapter behind the CM-3R Common Module. Though it serves the function of a Module Adapter, it acts as a channel module to the SCB (Serial Control Bus).

The OIA will always have a fixed channel address. When DIP switches SW1-1 and SW1-2 on the OIA are set to the TERM or DI-A mode, the address is "C1." When SW1-1 and SW1-2 are set to the DI-B mode, the address is "C3." The OIA reports itself as a "**Type 11**" module.

SRVC service is always on in the local mode, and may be turned off in the remote mode. However, this has no effect on the module.

8.9.1 CHANNEL CARD 1 (OR 3) TYPE 11

There is only one remote configuration setting ("P" code) for the OIA, as listed in Table 8-7. The remote status messages ("S" codes) for the OIA are listed in Table 8-8.

Table 8-7. Remote configuration settings ("P" codes), Optical Interface Adapter

Parameter	Possible Settings	Description
SRVC	ON	Turn service on (enable module).
	OFF	Turn service off (disable module).
P01	0	Select B8ZS line coding.
	1	Select AMI line coding.

Table 8-8. Remote status messages ("S" codes), Optical Interface Adapter

Position	Value	Description
B 0 1 1 1 1 1 1 1 - - - ↑	0	TX ALM (Transmit Alarm) is in its alarm state.
	1	TX ALM (Transmit Alarm) is in its normal state.
B 0 1 1 1 1 1 1 1 - - ↑ -	0	TX ACT (Transmit Activity) is in its alarm state.
	1	TX ACT (Transmit Activity) is in its normal state.
B 0 1 1 1 1 1 1 1 - ↑ - -	0	LOCK is in its alarm state.
	1	LOCK is in its normal state.
B 0 1 1 1 1 1 1 1 ↑ - - -	0	RX ALM (Receive Alarm) is in its alarm state.
	1	RX ALM (Receive Alarm) is in its normal state.

8.10 DACS AND ILS DIAGNOSTIC PARAMETER “DEBUG”

WARNING: This section is to be used only by qualified persons

The DACS and ILS each has the ability to accept debug commands from either the SCB interface or an attached RS232 port connected to a terminal. The commands can run various diagnostic routines.

The RS232 interface accepts ISiCL format commands for configuration and diagnostic routines. These are the same commands accepted by the CM3R and sent along the SCB. If the DACS/ILS receives a command from the terminal, the DACS/ILS (as applicable) will output information or reply to the terminal, in an ISiCL form. Similarly, if a command is received via the SCB, the reply will be put in a status word on the SCB. The CM3R must wait a sufficient amount of time before reading the SCB reply. The CM3R will know that the debug command is performed when it receives a debug reply in the status registers.

The DACS/ILS supports up to sixteen debug commands. Each debug command can be further modified by three data bytes. The first data byte is sent as the auxillary address on the SCB. The second and third data bytes are the other two configuration data bytes on the SCB. In ISiCL, the user specifies a debug request by using the command “SET”. The parameter is “DEBUG”, followed by an equal sign (“=”), followed by the debug command number, followed by a comma and the first data byte, followed by another comma and the second data byte, followed by a comma and the third data byte. The data bytes do not necessarily have to be given; some debug commands have default data associated with each byte or do not use them.

The DEBUG command has the following format:

<Address>:<Subaddress>:SET:DEBUG=X,<optional parameter 1>,<optional parameter 2>,<optional parameter 3>;

Address is the address of the common module that you are talking to.

Subaddress can be either DACS or ILS.

The value of X can be from 1 to 15.

If there is an optional parameter 1, there may be an optional parameter 2.

If there is an optional parameter 1 and 2, there may be an optional parameter 3.

An example of a DEBUG command is as follows:

3:DACS:SET:DEBUG=4,1,0,0;

In this example, 4 is the Hidden Parameter, 1 is Port 1, 0 is Line Buildout, 0 is the value of the Line Buildout. The command means the following: Set Hidden Parameter “Line Buildout” for port 1, to 0-133ft, 0dB (default). See paragraph 8.10.4 for additional information.

8.10.1 LED TEST (SCB=0X41; DEBUG=1)

The DACS/ILS alternates lighting each LED until a stop command is received. The status will be set to echo back the command once it is started, but a user needs to be present at the DACS/ILS to see the activity.

8.10.2 STOP TEST (SCB=0X42; DEBUG=2)

The Stop Test halts whatever test is running. When status is echoed back, testing has halted.

8.10.3 MEMORY CHECK (SCB=0X43; DEBUG=3[,TEST#])

The DACS/ILS runs a context-specific test on whatever memory is specified in the first data byte: no entry or 0 is non-volatile RAM and 1 is EPROM. The range is the full scope of the EPROM memory and the used portion of the non-volatile RAM. Status is returned when the test is finished. The status byte 1 shows whether the test passed or failed. For the non-volatile RAM, status bytes 2 and 3 are zero. For the EPROM test, status bytes 2 and 3 contain the checksum.

8.10.4 SET HIDDEN PARAMETERS (SCB=0X44; DEBUG=4,PORT,PARM#[,VALUE])

The DACS/ILS has several parameters for the framer chip which are not part of the normal setup, such as build-out range. These parameters will be set to factory default, but the user may need to adjust them. The first parameter byte is the framer number, which must be set. The allowed values are 0 to set all framers or the framer number (1 to 6). The hidden parameter number is the second data byte, which must be set. The third parameter byte (optional) is the setting. If the third byte is set to query (0xFF), the DACS/ILS responds with the current setting of the parameter.

	# Parameter	Settings
0	Line Build-Out	0 = 0-133ft, 0 dB (default) 1 = 133-266ft 2 = 266-399ft 3 = 399-533ft 4 = 533-655ft
1	Rx Equalizer Gain	0 = -36dB 1 = -30dB
2	Jitter Attenuator	0 = 128 bits 1 = 32 bits
3	ILS Failure Ratio	0 - 100%
4	NORMx	See paragraph 8.10.4.1

The RATIO parameter is used while determining whether the loss of a master node resulted in a slave-ILS-only ring network. If such a network is created, Loss-of-Sync (LOS) appears as a train of pulses. RATIO sets a limit level for density (duty cycle) of these pulses. If LOS pulses appear more frequently than the RATIO percentage, the processor assumes that a master is lost and therefore reverts back to normal routing. The ILS will then remain in normal routing configuration until all ports recover fully. At that point, the processor will again monitor ports for signs of failure and switch routing accordingly.

Typical RATIO values are:

15% for dedicated (direct-connect) networks.

50% for networks utilizing higher-level carrier, such as SONET.

8.10.4.1 Explanation of “NORMx” flags hidden parameter

Hidden parameter 4 sets the “normal” flags for ports 1 through 6. For clarity, these parameters will be called “NORMx”, where x is 1 through 6, corresponding to the port, even though this parameter name is not used to set the flags. Each NORMx flag has a value of 0 or 1. If the value is 1, the port is assumed to be functioning as a normal DACS/ILS port. The user can set the flag to 0 to turn off certain DACS/ILS functionalities. This flag is used in conjunction with the “ACTx” flags in the DACS and the “USEx” flags in the ILS. The “ACTx” and “USEx” flags have priority. That is, if ACT1 is OFF, the setting for NORM1 is irrelevant. If ACT1 is ON, the setting of NORM1 will decide how the port behaves when it encounters a problem.

In a DACS, usually ports 1 through 4 are connected to ports on other DACSs or ILSs and will use an all ones signal to establish communications and force failures. As well, an enabled problem will cause a switch into an alternative map. Assuming that ACTx is ON, if the value of NORMx, where x is 1 through 4, is set to 0, the DACS will monitor the port and reflect its status on the port LED and will report enabled problems on the SUI and the SCB, but will not transmit an all ones signal or switch to an alternative map. Thus, the new parameter, partly overrides the LOSDLY setting, which is used to turn off switching. If the NORMx flag is 0, the DACS/ILS will not switch because of that port, regardless of the setting of LOSDLY. If the NORMx flag is 1, the LOSDLY setting determines whether the DACS switches or not. An ILS bunches ports 1 and 5 under the USE1 flag, and ports 4 and 6 under the USE4 flag. Ports 2 and 3 are always considered active. The NORMx flag can be used to turn off all ones signaling on ports 1 through 4. That means that ports 1 and 4 will have switching disabled if their respective NORMx flags are 0. The NORMx flag only modifies all ones handshaking on ports 2 and 3. These ports will still be used as alternative paths even if their NORMx flags are 0. On ports 1 and 4, if the NORMx flag is set to 0, the ILS will not switch for problems on these ports.

The NORMx flags have a different meaning for ports 5 and 6 on both the ILS and DACS. Ports 5 and 6 never self-generate an all ones signal, however, under normal usage, a failure (loss of data) on port 5 or 6 is treated as a node failure. This causes all the active outbound ports (1 through 4) to generate all ones so that the adjacent nodes will switch and cut off the malfunctioning node. If NORMx is 0 for ports 5 or 6, the outbound ports will not generate all ones. That is, the flags do not affect the operation of ports 5 and 6 themselves. In system configuration, it might be a good idea to set these flags to 0 even under a normal configuration if the DACS/ILS ring has a “master” node with ties to all the other nodes, such as a control center.

The NORMx flags form a hidden parameter accessed by using the DEBUG command:

<adr>:<DACS/ILS>:SET:DEBUG=4,<Port>,4[Value]);

If the port number is 0, the value is a byte, which sets all the flags: bit 0 is for port 1, bit 1 for port 2, etc. Otherwise, the port value must be 1 through 6, and the value must be 0 or 1. If the value is not given (is set to 0xFF on the SCB bus), the DEBUG command returns the current value in the returned byte DATA3.

8.10.5 FRAMER DUMP (NO SCB; DEBUG=5[,PORT])

The DACS/ILS dumps the register configuration and register reading for the framer specified in the first data byte (default framer 1). This debug command can only be run from the RS232 port as there is too much information for the SCB status bytes.

8.10.6 LOOP TEST (SCB=0X46; DEBUG=6,PORT[,TEST#])

The DACS/ILS runs a loop test until a stop command is received. The framer to use is in the first data byte. There is no default for this test. If no framer is specified, the test does not run. The type of loop test is specified in the second data byte: no entry or 0 is local loopback, 1 is remote loopback, 2 is payload loopback, 3 is framer loopback. This test must be stopped, there is an SCB alarm set if loopback is active on any channel. Also, the alert LED and relay are engaged.

8.10.7 SET MAP (SCB=0X47; DEBUG=7[,MAP])

The DACS/ILS is set to the map number specified in auxiliary byte 1 (default 0). This map number remains the active number until a debug stop command is received. It overrides both the active map as set by switches and any further switches. For this reason, a status bit is set in status flag register 1 when the map has been set with this command.

8.10.8 RESET FRAMER (SCB=0X48; DEBUG=8[,RESET#[,PORT]])

The frames are reset as specified by the auxiliary data byte 1. If 0 (default), the framer programming registers are rewritten. If 1, the framer is requested to resync. If 2, the elastic stores are reset. If 3, the line interface is reset. Auxiliary byte 2 can be used to specify which framers undergo reset. If 0, all framers are reset. If 1 to 6, only the framer specified is reset.

8.10.9 DUMP MEMORY (SCB=0X49; DEBUG=9[,ADR])

This command can only be requested via the RS232 interface. A 256 byte block of memory is shown as specified by the first auxiliary byte, which is the most significant byte of the address (default 0x20). This command can be used to display the RFL copyright and software version number, which are in block 0x20. This command cannot be run from the CM3B.

8.10.10 MODIFY MEMORY (SCB=0X4A; DEBUG=10,VALUE,ADR_LOW,ADR_HIGH)

The order of the debug modifiers is so that an address high byte of 0xFF, which is the same as default, can be used to detect that the command was improperly or not fully written. (The address range of FF00-FFFF is unused in RAM).

SECTION 9. INSTALLATION AND CHECK-OUT

WARNING

FOLLOW ALL OF YOUR COMPANY'S POLICIES AND PROCEDURES REGARDING THE INSTALLATION OF AC-POWERED OR DC-POWERED EQUIPMENT. IF THERE IS A CONFLICT BETWEEN ANY PROCEDURE IN THIS SECTION AND YOUR COMPANY'S SAFETY RULES, THEN YOUR COMPANY'S SAFETY RULES MUST TAKE PRIORITY.

CAUTION

If an external ring generator is being connected to the multiplexer, a 0.5-amp slow-blow fuse must be placed in line to protect the multiplexer.

When using a separate signaling battery, place a slow-blow fuse in line to protect the multiplexer. To determine the value of this fuse, multiply 0.12 amperes by the number of voice circuits supported by the battery.

9.1 INTRODUCTION

This section contains installation instructions for the IMUX 2000, including unpacking, mounting, and interconnection wiring. Check-out procedures are also provided for verifying operation once installation is complete.

9.2 INSTALLATION

IMUX 2000 installation is a five-part process:

1. Unpacking and inspecting the equipment.
2. Mounting the equipment.
3. Wiring the equipment.
4. Checking the power supply input voltage.
5. Applying input power.

Once the IMUX 2000 is installed, you can use the check-out procedures starting in paragraph 9.3 of this section to verify operation before placing the equipment in service.

9.2.1 UNPACKING

IMUX 2000 equipment may be supplied as individual chassis or interconnected with other chassis or assemblies as part of a system. The following paragraphs provides unpacking instructions for individual chassis and interconnected chassis.

9.2.1.1 Individual Shelves

IMUX 2000 multiplexer, ILS or DACS chassis supplied as individual shelves are packed in their own shipping cartons:

1. Open each carton carefully to make sure the equipment is not damaged.
2. After the shelf is removed from the carton, carefully examine all packing material to make sure no items of value are discarded.
3. Carefully remove any packing materials inserted into the shelf to hold modules in place during transit.
4. Make sure all modules are fully seated in the shelf.

If you notice any signs of shipping damage, immediately notify RFL Customer Service at the phone number listed at the bottom of this page. Save all the packing material and the shipping carton, in case a damage claim needs to be filed with the shipping company that delivered the unit.

9.2.1.2 Interconnected Shelves

IMUX 2000 multiplexers ordered as part of a larger system may be interconnected with other equipment and mounted in a relay rack or cabinet, or bolted to shipping rails for installation into a rack or cabinet at the customer's site. In such cases, the entire assembly is enclosed in a wood crate or delivered by air-ride van:

1. If the equipment is crated, carefully open the crate to avoid damaging the equipment.
2. Remove the equipment from the crate and carefully examine all packing materials to make sure no items of value are discarded.
3. Carefully remove any packing materials that were inserted into the equipment to hold modules in place during transit.
4. Make sure all modules are fully seated in the equipment.

If you notice any signs of shipping damage, immediately notify RFL Customer Service at the phone number on the front of this manual. Save all the packing material and the shipping carton, in case a damage claim needs to be filed with the shipping company that delivered the unit.

9.2.2 MOUNTING

After unpacking, IMUX 2000 equipment must be securely mounted. Two different procedures are provided below: one for Main Shelves, and one for Repeater Shelves.

9.2.2.1 Main Shelf

IMUX 2000 Main Shelves are normally shipped pre-configured, with common and channel modules already installed. Except for the power supplies, all modules and Module Adapters can remain installed while the Main Shelf is bolted into its equipment rack.

1. Remove all power supplies from the Main Shelf.
2. Make sure all remaining modules and Module Adapters are seated properly.
3. Bolt the Main Shelf into its 19-inch equipment rack.

9.2.2.2 Repeater Shelf

Normally, install the optional Repeater Shelf just below the Main Shelf in the same equipment rack. No space is required between the two shelves. However, if there is room in the rack, leave one mounting space (1.75 inches) between the two shelves for additional cooling.

1. Remove any power supplies from the Repeater Shelf.
2. Make sure all remaining modules and Module Adapters are seated properly.
3. Bolt the Repeater Shelf into its equipment rack.
4. Connect the Repeater Signal cable between the “BUS OUT” connector on the Main Shelf and the “BUS IN” connector on the Repeater Shelf. These connectors are located on the MA-500 Bus Repeater Module Adapter at the rear left of the shelf. (See Figure 9-1.)

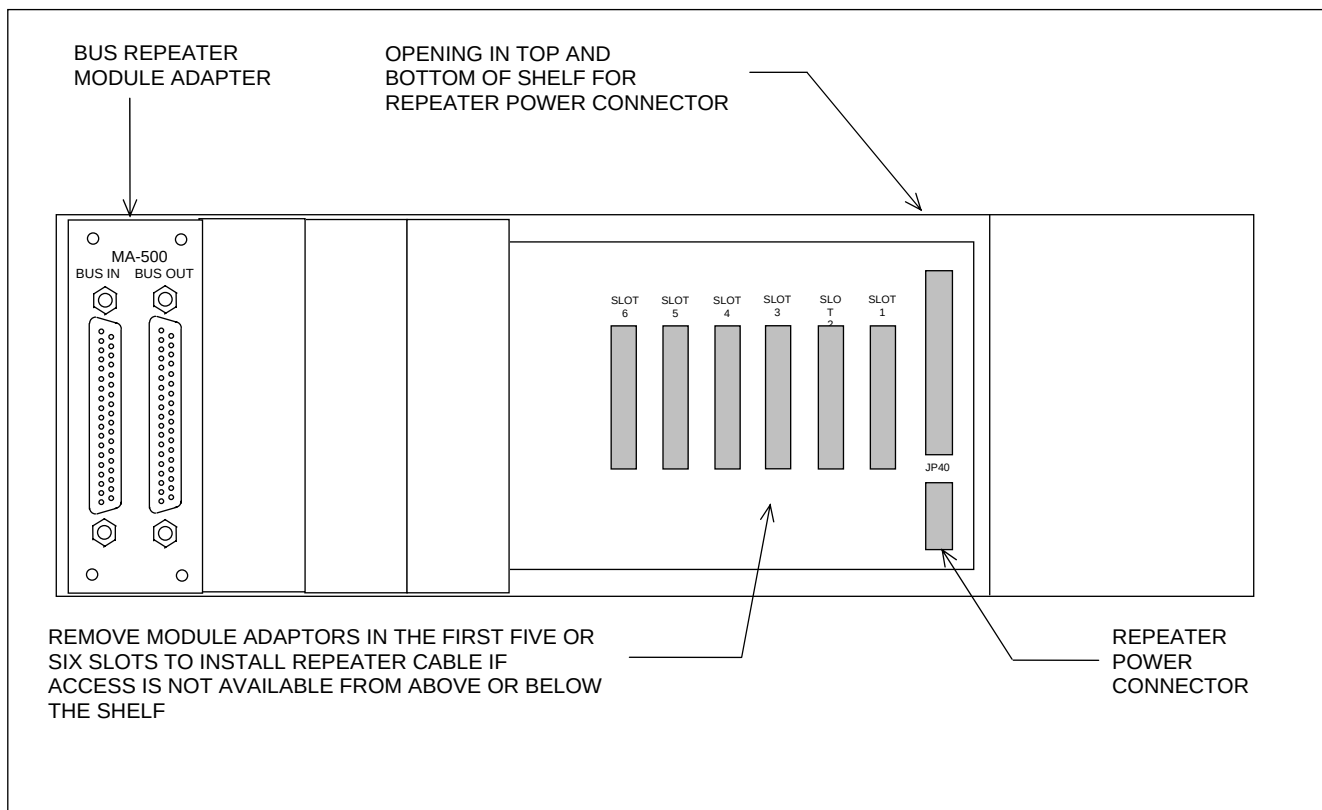


Figure 9-1. Rear view of Main or Repeater Shelf showing Bus Repeater Module and Repeater signal and power connectors.

5. If the Repeater Shelf will be powered by the Main Shelf supply, connect the Repeater Power cable between the Repeater Power connector on the Main Shelf and the Repeater Power connector on the Repeater Shelf.

These connectors are labeled "JP 40", and are located at the lower right rear of the shelves as shown in Figure 9-1. If the Repeater Shelf has its own power supplies, the Repeater Power cable is not needed.

It may be necessary to remove several Module Adapters on both shelves to gain access to the Repeater Signal and Power connectors. Be sure to re-install the adapters after inserting the Repeater cables.

9.2.3 WIRING

The following procedure assumes that the Main and Repeater Shelves will be completely wired before turning up any T1 or payload circuit. Basic wiring diagrams are shown in Figures 9-2 and 9-3. Also refer to the "as supplied" drawings furnished with the equipment and the system drawings placed in Section 15 of this manual at the factory.

1. Connect a ground wire from the GND ground stud on the rear of the Main Shelf to station ground.
This is a required connection.
2. Connect an external ringing generator or loop current source to the RING GEN terminal on the input power terminal block on the rear of the Main Shelf.
This step is optional. It is only necessary if the shelf does not use the MA-304 Module Adapter and contains one or more Foreign Exchange Station End modules, used for Automatic Ring Down or Off Premise Extension).
3. Connect the signaling battery to the SIG BAT terminal on the input power terminal block on the rear of the Main Shelf.
This step is optional. It is only required if the shelf contains more than two Foreign Exchange Station End modules, four-wire E&M voice modules using Type II signaling, or (in some cases) Foreign Exchange Office End modules. Check with RFL Customer Service if you are not sure whether this battery is necessary).

If SIG BAT is the same voltage as the dc power voltage, then SIG BAT may be connected to the -BAT terminal instead.
4. Connect the input power source to the input power terminal block on the rear of the Main Shelf as follows:

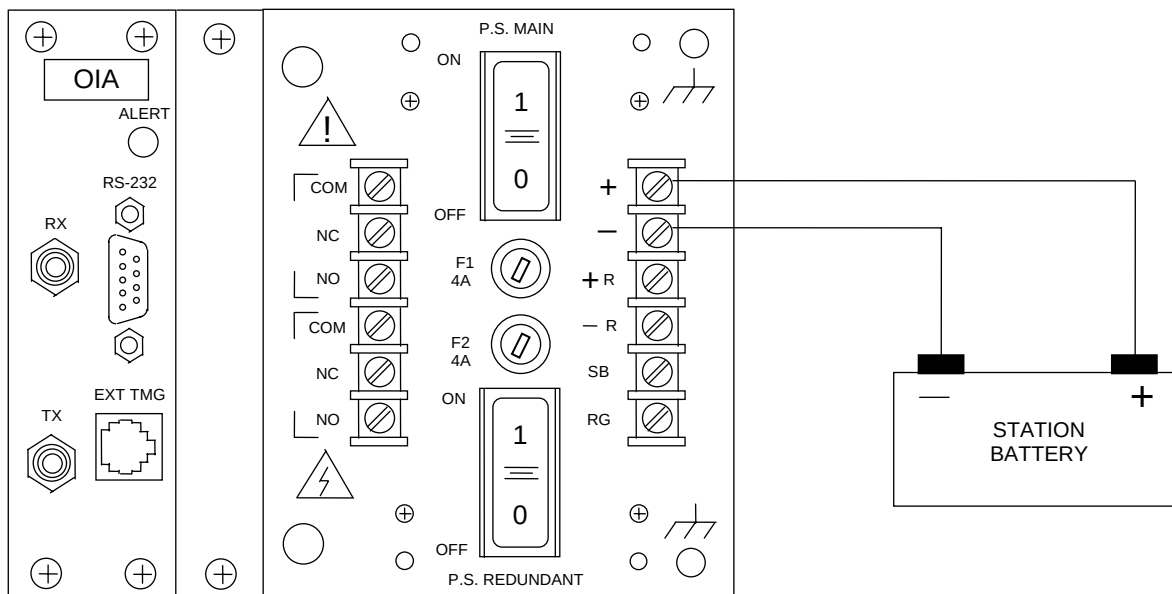
Ac-Powered Multiplexers:

Ac Input (hot)	+BAT terminal
Ac Input (neutral)	-BAT terminal

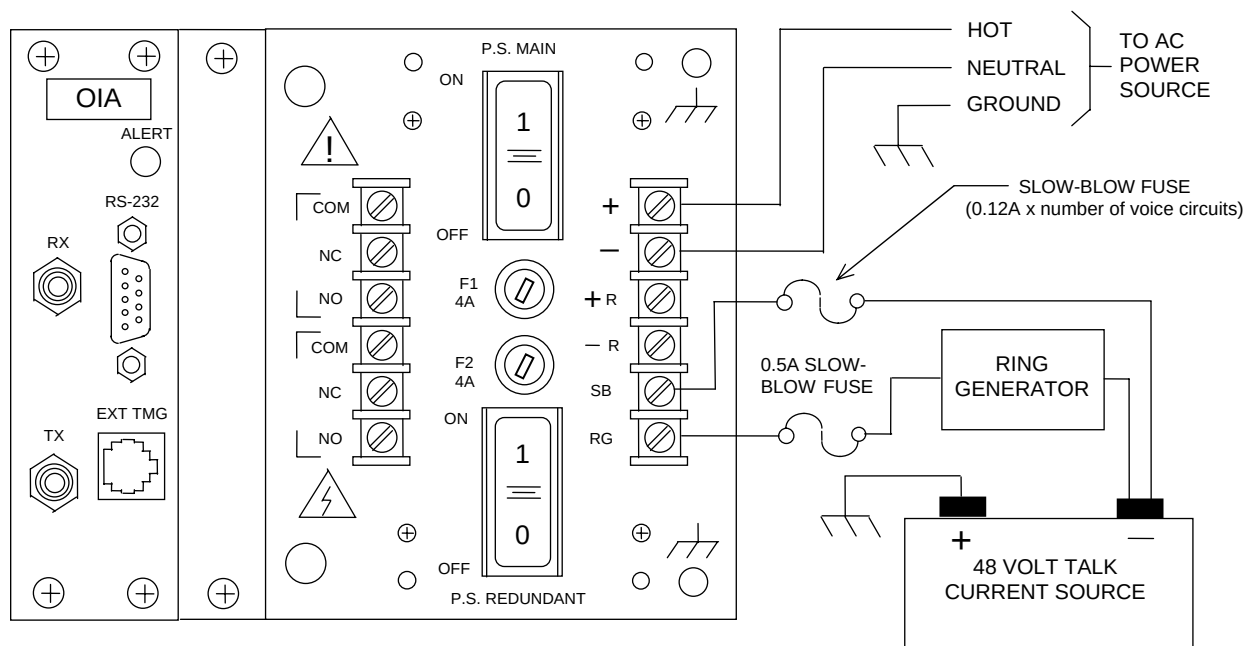
Dc-Powered Multiplexers:

Station Battery +	+BAT terminal
Station Battery -	-BAT terminal

For dc-powered multiplexers, make sure that a 2-amp slow-blow fuse is placed in line with Station Battery + to protect the multiplexer.



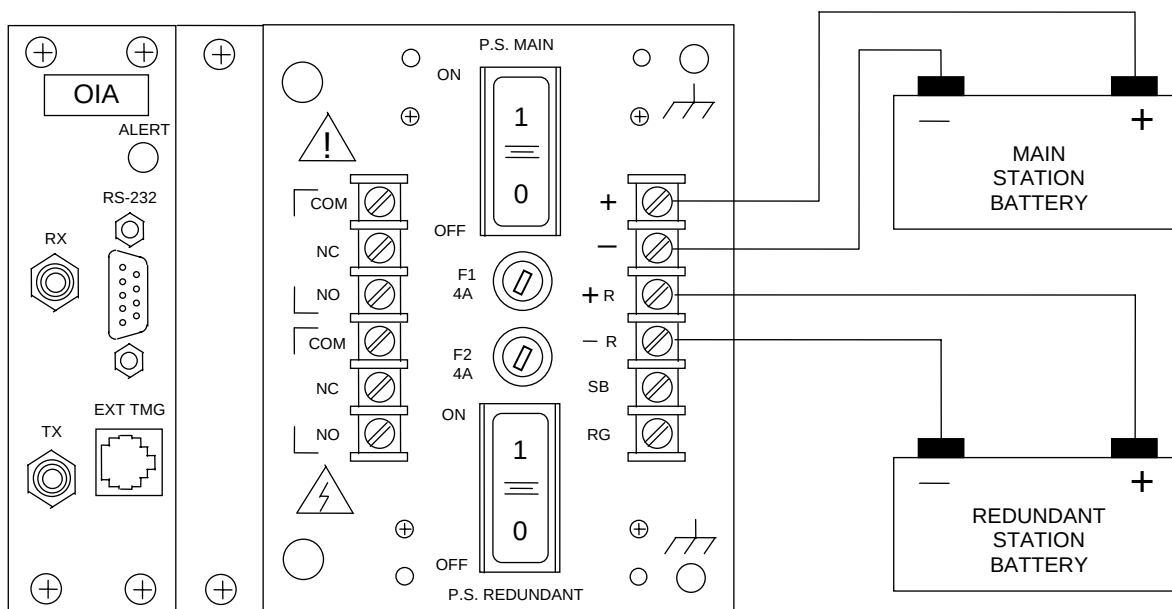
a. Connections for 48-Vdc, 125-Vdc or 250-Vdc operation.



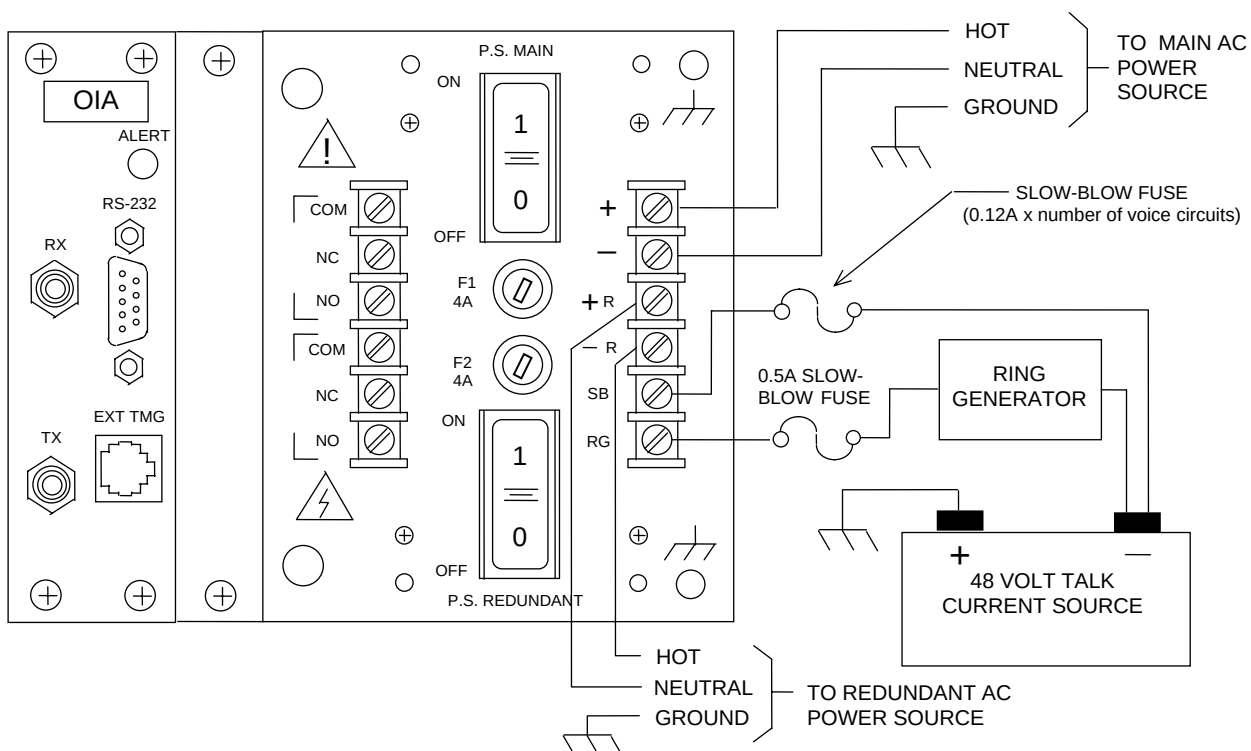
b. Connections for ac operation, and 48-Vdc talk current source for external ring generator, and for voice circuits.

NOTE: This configuration can only be used when the internal -48Vdc source is disabled. Consult RFL technical support personnel for more information.

Figure 9-2. Terminal strip power connections for IMUX 2000 multiplexers with single power supply modules



a. Connections for 48-Vdc, 125-Vdc or 250-Vdc



b. Connections for ac operation, and 48-Vdc talk current source for external ring generator, and for voice circuits.

NOTE: This configuration can only be used when the internal -48Vdc source is disabled. Consult RFL technical support personnel for more information.

Figure 9-3. Terminal strip power connections for IMUX 2000 mux with redundant power supply modules

5. If the multiplexer is equipped with a redundant power supply, connect the redundant input power source to the input power terminal block on the rear of the Main Shelf as follows:

Ac-Powered Multiplexers:

Redundant Ac Input (hot)	+BAT R terminal
Redundant Ac Input (neutral)	-BAT R terminal

Dc-Powered Multiplexers:

Redundant Station Battery +	+BAT R terminal
Redundant Station Battery -	-BAT R terminal

For dc-powered multiplexers, make sure that a 2-amp slow-blow fuse is placed in line with Redundant Station Battery + to protect the multiplexer.

6. Connect the T1 inputs and outputs of each CM-3R T1 Common Module by inserting the cable containing the appropriate T1 input and output pairs into the T1 I/O connector on each MA-210R Module Adapter.
7. Connect all low-speed circuits to their assigned Module Adapters.
8. Connect ALARM and ALERT contacts if used.

CAUTION

Before attempting to apply input power to the IMUX 2000, you must make sure that its power supply module(s) will operate at the available input supply voltage. If an incorrect power supply module is installed, component damage may result.

9.2.4 POWER SUPPLY INPUT VOLTAGE CHECK

Before re-inserting the power supplies into the IMUX 2000, check the model number stamped on the supply to make sure the supply is compatible with the available input power. Eight different power supply modules are used in the IMUX 2000:

<u>Model Designation</u>	<u>Part Number</u>	<u>Input Voltage</u>
2000 PS 250DC	9547-840	250 Vdc
2000 PS 120AC	9547-950	120 Vac
2000 PS 24DC	9547-910	24 Vdc
2000 PS 48/125DC	9547-920-1	48/125 Vdc
2000 PS 220AC	9547-930	220 Vac
2000 PS 48/125DC	9547-965	48/125 Vdc High Power
2000 PS 24DC	9547-975	24 Vdc High Power
2000 PS 120AC	9547-985	120 Vac High Power

NOTE

There is a label on the inside front door of the IMUX 2000. (See Figure 9-4.) This label is marked to indicate which model power supply(s) was installed before it left the factory. If you change the power supply module(s) with a different model, you must change the markings on this label to reflect the change.

A CAUTION label is also located on the inside of the front cover of the IMUX 2000 which alerts the user to keep hands away from the power supply module. (See Figure 9-5.)

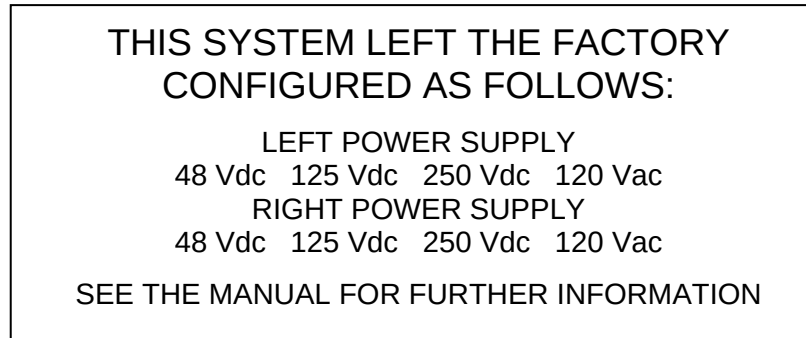


Figure 9-4. Label on front door for recording input voltage configuration



Figure 9-5. Caution Label inside front door of IMUX 2000

9.2.5 APPLYING POWER

After all equipment has been installed and wired, apply power to each shelf by re-installing the power supply modules.

1. Re-insert the main and (if provided) redundant power supply modules into the Main Shelf.
2. If the multiplexer is equipped with a Repeater Shelf using separate Repeater Shelf power supplies, re-insert the main and (if provided) redundant power supply modules into the Repeater Shelf.
3. If a local alarm comes on, activate the IMUX 2000 alarm cut-off by turning on the ACO switch located on the power supply module.
If the shelf is equipped with redundant power supplies, turn on both ACO switches.
4. Check the indicators on each power supply.
On each power supply, the POWER indicator should be lit, and the POWER FAIL indicator should not be lit.

If no indicators are illuminated on any power supply, then both power modules have failed, both fuses have blown, or (most likely) power has not been wired to the shelf. If the POWER indicators turn on, but the POWER FAIL indicator on one power supply is also on, then that power module is not functioning or has a blown fuse.
5. Verify that the mode of each CM-3R module is displayed for several seconds after power is first applied.
Do not be concerned at this point if the mode setup(s) are not correct.

9.3 SYSTEM CHECK-OUT PROCEDURES

The system check-out procedures in this section are general guides. They illustrate how to check out a typical three-location IMUX 2000 drop/insert system. (See Figure 9-6.)

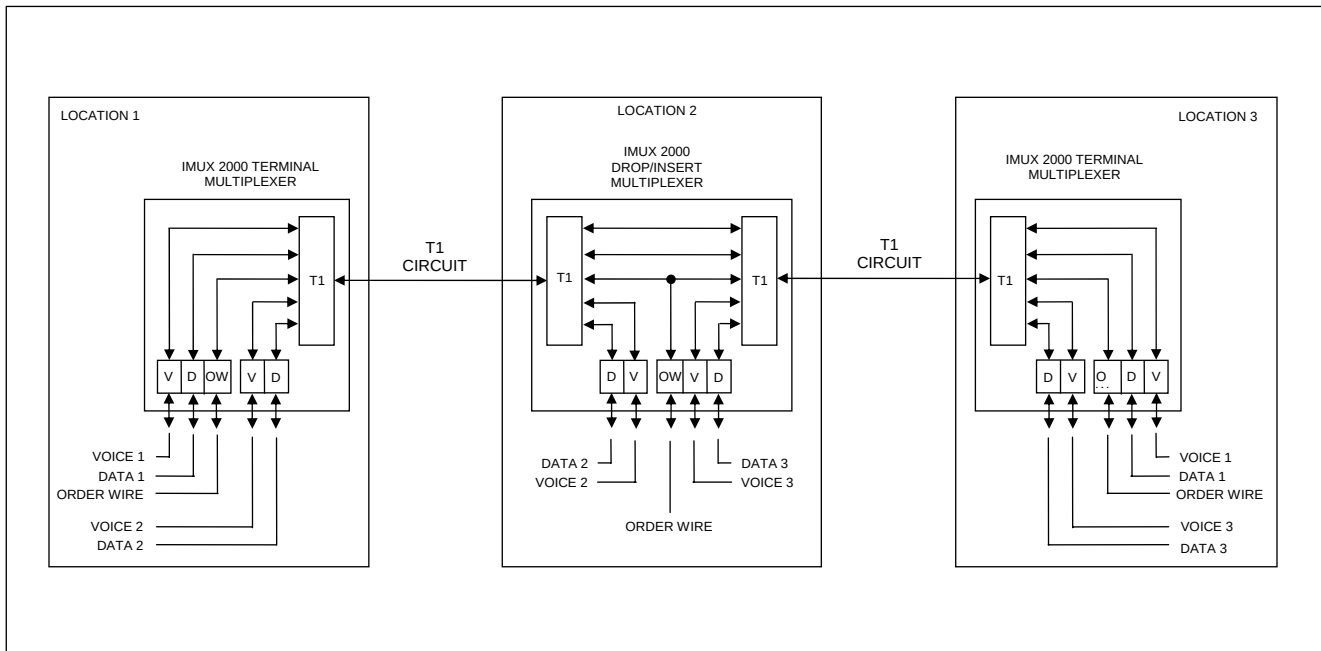


Figure 9-6. Typical three-terminal IMUX 2000 system

When checking out an IMUX 2000 system, follow these overall guidelines:

1. Start at the terminal multiplexer that is internally or externally timed.
If both terminal multiplexers are loop-timed, start at either end.
2. Perform the check-out procedures at locations in the order in which they appear in the system.
3. Test each location locally before performing system tests.
4. After performing the system-level tests described in this section, you may also wish to test the individual circuits formed by the channel modules in the multiplexers. Consult the individual channel module Instruction Data Sheets in Sections 15 through 19 of this manual for recommended test procedures for each type of circuit.

The following procedures do not specify the use of T1 test equipment. However, you may need T1 test sets in some instances, such as to isolate an intermittent trouble in either a T1 facility or a multiplexer.

9.3.1 TERMINAL MULTIPLEXER AT LOCATION 1 (INTERNALLY TIMED)

Use the following procedure to check out the head-end, internally-timed terminal multiplexer and Location 1. It is assumed that this multiplexer is already installed, wired, and powered.

NOTE

When you are facing the front of a Main Shelf, the "up" position of the GROUP and SET/NEXT toggle switches is to the right (away from the circuit board, and the "down" position is to the left (toward the circuit board).

1. Verify that the CM-3R module is in the terminal mode as follows:
 - a. Remove the CM-3R module for a few seconds and then re-insert it.
 - b. Look at the display on the CM-3R module.
The display should read "TERM" if the module is in the terminal mode. If it does, go to step 2.

If the display reads anything else, check the settings of jumpers JMP 1 and JMP 2 on the MA-210R Module Adapter at the rear of the shelf. If the multiplexer uses a fiber optic interface, check the setting of DIP switch SW1 on the OIA at the rear of the shelf. (See Section 6 for more information on jumper and switch settings.)
 - c. Repeat steps 1a and 1b to verify that the CM-3R is now in the terminal mode.
2. Verify that CM-3R T1 transmitter timing is set to INT (internal) as follows:
 - a. Press down on the GROUP switch several times to display the TIME group.
 - b. Press down on the SET/NEXT switch several times to display the INT function.
 - c. Look at the ON/OFF indicator next to the display.
If the green part of the ON/OFF indicator next to the display lights, the module is set for internal timing. Go to step 3. If the red part of the ON/OFF indicator lights, press up on the SET/NEXT switch twice to set timing to internal. The green part of the ON/OFF indicator should now be lit.

3. Perform the following steps to verify that T1 line code and frame format are set up as required:
 - a. Press down on the GROUP switch several times to display the TSEL (T1 select) group.
 - b. Press down on the SET/NEXT switch to display the desired frame format (SF or ESF).
If the green part of the ON/OFF indicator next to the display lights, then frame format is set to the displayed format. If the red part of the ON/OFF indicator lights, press up twice on the SET/NEXT switch to select the displayed format. The green part of the ON/OFF indicator should now be lit.
 - c. Press down on the SET/NEXT switch to display the desired line code (B8ZS or AMI).
If the green part of the ON/OFF indicator next to the display lights, then line code is set to the desired type. If the red part of the ON/OFF indicator lights, press up twice on the SET/NEXT switch to select the displayed line code. The green part of the ON/OFF indicator should now be lit.
4. Use one of the following methods to establish a local T1 loopback:
 - a. Use a Bantam-Bantam patch cord to connect the T1 EQUIP OUT jack to the T1 EQUIP IN jack.
 - b. If the multiplexer has an electrical T1 interface, connect an external looping plug to the 15-pin D-subminiature T1 connector (DA-15) on the MA-210R Module Adapter.
 - c. If the multiplexer has a fiber optic interface, connect a fiber optic patch cord between the fiber optic connectors on the Optical Interface Adapter (OIA).
 - d. Use the Group switch to display the LPBK group and then the SET/NEXT switch to set (activate) the EqLB (equipment loopback).
5. Once the local T1 loopback is established, verify the states of the indicators shown in Table 9-1.
6. With the T1 loopback in place, perform all desired channel tests using available VF, data, and other type test sets. These tests may include, for example, loss tests on voice and program channels, bit error tests on data channels, and so on. (See Section 10 of this manual.)
7. When channel tests are complete, take down the loopback either by removing the patch cord, or by de-activating the Equipment Loopback (EqLB).
8. Go to the drop/insert multiplexer at Location 2 and perform the next procedure.

Table 9-1. Indicator status during terminal multiplexer loopback (internal timing)

Module	LED Indicator	Patch Cord Loopback (1)	EqLB Loopback
CM-3R	RX	ON	(2)
	ERR and BPV	OFF	OFF
	FRM	OFF	OFF
	INT	ON	ON
	LPBK	OFF (3)	OFF (3)
Power supply	NORMAL	ON	OFF
	ALERT	OFF	ON
	ALARM	OFF	OFF

1. Electrical or fiber optic.
2. Depends on T1 input status.
3. The LPBK indicator only responds to loopbacks that are set using the LPBK group, not externally-created loopbacks.

9.3.2 DROP/INSERT MULTIPLEXER AT LOCATION 2

The following procedure may be used to check out a drop/insert multiplexer at the "middle" location of a three-site drop/insert system.

1. Verify that the CM-3R module terminating the T1 facility between Locations 1 and 2 is set to the DI-A mode as follows:
 - a. Remove the CM-3R module for a few seconds and then re-insert it.
 - b. Look at the display on the CM-3R module.
The display should read "DIA" if the module is in the DI-A mode. If it does, go to step 2.

If the display reads anything else, check the settings of jumpers JMP 1 and JMP 2 on the MA-210R Module Adapter at the rear of the shelf. If the multiplexer uses a fiber optic interface, check the setting of DIP switch SW1 on the OIA at the rear of the shelf. (See Section 6 for more information on jumper and switch settings.)
 - c. Repeat steps 1a and 1b to verify that the CM-3R is now in the DI-A mode.
For the rest of this procedure, this module will be referred to as "CM-3R Module A.")
2. Verify that the CM-3R module terminating the T1 facility between Locations 2 and 3 is set to the DI-B mode as follows:
 - a. Remove the CM-3R module for a few seconds and then re-insert it.
 - b. Look at the display on the CM-3R module.
The display should read "DIB" if the module is in the DI-B mode. If it does, go to step 3.

If the display reads anything else, check the settings of jumpers JMP 1 and JMP 2 on the MA-210R Module Adapter at the rear of the shelf. If the multiplexer uses a fiber optic interface, check the setting of DIP switch SW1 on the OIA at the rear of the shelf. (See Section 6 for more information on jumper and switch settings.)
 - c. Repeat steps 2a and 2b to verify that the CM-3R is now in the DI-B mode.
For the rest of this procedure, this module will be referred to as "CM-3R Module B.")
3. Verify that T1 line code and frame format are set up as required (TSEL group).

4. Put one end of a T1 patch cord (or a 100-ohm termination plug) into the T1 EQUIP IN jack on CM-3R Module B.
This establishes a "no signal" condition at the input to CM-3R Module B. CM-3R Module A is automatically forced into its fallback timing mode (Internal).
5. Use one of the following methods to establish a local T1 loopback at CM-3R Module A:
 - a. Use a Bantam-Bantam patch cord to connect the T1 EQUIP OUT jack to the T1 EQUIP IN jack.
 - b. If the multiplexer has an electrical T1 interface, connect an external looping plug to the 15-pin D-subminiature T1 connector (DA-15) on the MA-210R Module Adapter.
 - c. If the multiplexer has a fiber optic interface, connect a fiber optic patch cord between the fiber optic connectors on the Optical Interface Adapter (OIA).
 - d. Use the Group switch to display the LPBK group and then the SET/NEXT switch to set (activate) the EqLB (equipment loopback).
6. Once the loopback is established, verify the states of the following indicators on CM-3R Module A, as shown in Table 9-2.

Table 9-2. Indicator status during drop/insert multiplexer loopback (Module A)

Module	LED Indicator	Patch Cord Loopback ⁽¹⁾	EqLB Loopback
CM-3R	RX	ON	ON
	ERR and BPV	OFF	OFF
	FRM	OFF	OFF
	LOOP	(2)	(2)
	LPBK	OFF	ON
Power supply	NORMAL	OFF	OFF
	ALERT	ON	ON
	ALARM	OFF	OFF

1. Electrical or fiber optic.
2. In a drop/insert multiplexer, the LOOP indicator actually indicates THRU timing. It blinks to show that although this is the primary timing setting, the multiplexer is now using fallback (INT) timing.

7. With CM-3R Module A looped, perform all desired loopback tests on transmit/receive channel modules configured to transmit in the A direction - that is, all channel modules that terminate circuits from Location 1.
These tests may include loss measurements on voice and program channels, bit error tests on data channels, and so on.
8. When channel tests are complete, take down the loopback on CM-3R Module A by removing the patch cord between its T1 EQUIP OUT and T1 EQUIP IN jacks.
If loopback was initiated by activating the module's Equipment Loopback (EqLB), de-activate it.
9. Remove the patch cord or termination plug that was plugged into the T1 EQUIP IN jack on CM-3R Module B.
10. Use one of the following methods to establish a local T1 loopback at CM-3R Module B:
 - a. Use a Bantam-Bantam patch cord to connect the T1 EQUIP OUT jack to the T1 EQUIP IN jack.
 - b. If the multiplexer has an electrical T1 interface, connect an external looping plug to the 15-pin D-subminiature T1 connector (DA-15) on the MA-210R Module Adapter.
 - c. If the multiplexer has a fiber optic interface, connect a fiber optic patch cord between the fiber optic connectors on the Optical Interface Adapter (OIA).
 - d. Use the Group switch to display the LPBK group and then the SET/NEXT switch to set (activate) the EqLB (equipment loopback).
At this point, CM-3R Module B (and CM-3R Module A) should be timed by the signal coming from the terminal multiplexer at Location 1. Because of this, the fallback timing "trick" is not needed to test CM-3R Module B.
11. Once CM-3R Module B is looped, verify the states of the indicators as shown in Table 9-3.
12. With CM-3R Module B looped, perform all desired loopback tests on the transmit/receive channel modules that are configured to transmit in the "B" direction - that is, all channel modules that will be terminating circuits from Location 3.
As before, these tests may include loss measurements on voice and program channels, bit error tests on data channels, and so on.
13. At this point you may also perform end-to-end tests on channels established between Locations 1 and 2; that is, through the channel modules at Location 2 that are configured to transmit in the "A" direction.

Table 9-3. Indicator status during drop/insert multiplexer loopback (Module B)

Module	LED Indicator	Patch Cord Loopback (1)	EqLB Loopback
Both CM-3R modules (A and B)	RX	ON	(2)
	ERR and BPV	OFF	OFF
	FRM	OFF	OFF
	INT	ON	ON
	LPBK	OFF	ON
Power supply	NORMAL	ON	OFF
	ALERT	OFF	ON
	ALARM	OFF	OFF

1. Electrical or fiber optic.
2. RX IN on CM-3R Module A should be on. However, when a patch cord is used to create the loopback, the state of RX IN on CM-3R Module B will depend on the signal coming from Location 3, which has not yet been tested.

9.3.3 TERMINAL MULTIPLEXER AT LOCATION 3 (LOOP-TIMED)

Use this procedure to check out the loop-timed terminal multiplexer at Location 3. The major difference between this procedure, and that used to check-out the terminal multiplexer at Location 1, is that CM-3R timing has to be temporarily changed from Loop to Internal while local loopback tests are performed. Transmitter timing must then be returned to Loop before the terminal multiplexer at Location 3 is put on-line.

1. Verify that the CM-3R module is in the terminal mode as follows:

- a. Remove the CM-3R module for a few seconds and then re-insert it.
- b. Look at the display on the CM-3R module.

The display should read "TERM" if the module is in the terminal mode. If it does, go to step 2.

If the display reads anything else, check the settings of jumpers JMP 1 and JMP 2 on the MA-210R Module Adapter at the rear of the shelf. If the multiplexer uses a fiber optic interface, check the setting of DIP switch SW1 on the OIA at the rear of the shelf. (See Section 6 for more information on jumper and switch settings.)

- c. Repeat steps 1a and 1b to verify that the CM-3R is now in the terminal mode.
2. Change Transmitter Timing to INT (internal).
 - a. Press down on the Group switch several times to display the TIME group.
 - b. Press down on the SET/NEXT switch several times to display the INT function.
 - c. Press up on the SET/NEXT switch twice to set timing to internal.
3. Verify that T1 line code and frame format are setup as required (TSEL Group).
4. Use one of the following methods to establish a local T1 loopback:
 - a. Use a Bantam-Bantam patch cord to connect the T1 EQUIP OUT jack to the T1 EQUIP IN jack.
 - b. If the multiplexer has an electrical T1 interface, connect an external looping plug to the 15-pin D-subminiature T1 connector (DA-15) on the MA-210R Module Adapter.
 - c. If the multiplexer has a fiber optic interface, connect a fiber optic patch cord between the fiber optic connectors on the Optical Interface Adapter (OIA).
 - d. Use the Group switch to display the LPBK group and then the SET/NEXT switch to set (activate) the EqLB (equipment loopback).
5. Once the loopback is established, verify the states of the indicators shown in Table 9-4.

Table 9-4. Indicator status during terminal multiplexer loopback (loop timing)

Module	LED Indicator	Patch Cord Loopback ⁽¹⁾	EqLB Loopback
CM-3R	RX	ON	ON
	ERR and BPV	OFF	OFF
	FRM	OFF	OFF
	INT	ON	ON
	LPBK	OFF	ON
Power supply	NORMAL	ON	OFF
	ALERT	OFF	ON
	ALARM	OFF	OFF

1. Electrical or fiber optic.

6. With the local T1 loopback in place, perform all desired channel tests using available VF, data, and other type test sets. These tests may include loss tests on voice and program channels, bit error tests on data channels, and so on.
7. After completing channel tests, take down the loopback either by removing the patch cord or by deactivating the Equipment Loopback (EqLB).
8. Return timing mode to Loop.
 - a. Press down on the Group switch several times to display the TIME group.
 - b. Press down on the SET/NEXT switch several times to display the LOOP function.
 - c. Press up on the SET/NEXT switch twice to set timing to loop.
9. Again verify the states of the indicators shown in Table 9-4.
10. You can now perform end-to-end or single-ended (far-end loopback) tests on all channels established between any two locations in the system.

Refer to the individual channel module sections for recommended test procedures.

This three-location IMUX 2000 system is now ready for service.

9.4 ADDING CHANNEL MODULES TO EXISTING SYSTEMS

To install new channel modules into existing systems, without affecting other in-service channels, do the following:

1. Make sure there is enough power available in the shelf for the module.
2. Make sure there are enough T1 time slots available for the module.
3. Using the information in the channel module Instruction Data Sheet, set its time slot and channel direction.

Refer to Section 5 for more information on these subjects. Also refer to the Instruction data Sheets in Sections 15 through 19 of this manual.

Use the following setup hints and installation procedures as a general guide when adding new channel modules to existing (in-service) IMUX 2000 systems. (See Figure 9-7.)

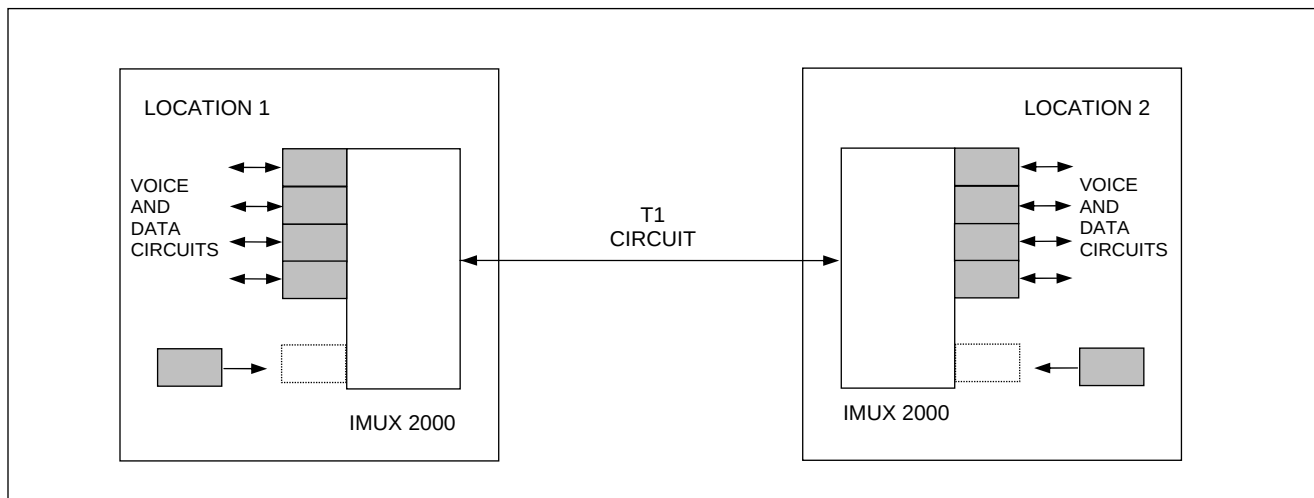


Figure 9-7. Adding a new channel module to an existing system

9.4.1 PHYSICAL SLOT SELECTION

The new channel module can be placed into any available physical slot (Slot 4 through Slot 18) on the Main Shelf, or any available physical slot (Slot 1 through Slot 18) on the Repeater Shelf, if present.

9.4.2 SETTING CHANNEL MODULE DIRECTION

Set the channel module transmit/receive direction, using the guidelines given in Section 3 of this manual.

9.4.3 SETTING CHANNEL MODULE TIME SLOTS

1. In each direction of transmission, always set up the two channel modules at either end of a new channel to the same time slot value(s). That is, on a channel between Locations 1 and 2, the transmit time slot at Location 1 must be the same as the receive time slot at Location 2, and the receive time slot at Location 1 must be the same as the transmit time slot at Location 2.
2. Where possible, use the same time slot in both directions of transmission. This is not a requirement, but should reduce the chance of making record keeping errors.
3. Always select time slots that are not occupied by other channels in any T1 facility traversed by the new channel. In drop/insert systems with four or more locations, be careful not to ignore time slots occupied by channels between intermediate drop/insert multiplexers.

9.4.4 CHANNEL MODULE INSTALLATION PROCEDURE

1. At Location 1, install and wire the Module Adapter provided with the channel module.
2. Install the channel module at Location 1.
If an alarm or alert indicator turns on, remove the channel module immediately.
3. If available, activate the local (equipment) loopback on the channel module itself and perform local loopback tests on this module (See the individual channel module manual for details).
4. Before leaving Location 1, be sure to remove the channel loopback. Also make sure that no alarms or alert indicators are on.
5. At Location 2, install and wire the Module Adapter provided with the second channel module.
6. If available, activate the local (equipment) loopback on the channel module itself and perform local loopback tests on this module (See the individual channel module manual for details).
7. Remove the channel loopback.
8. If desired, perform end-to-end tests or single-ended (far-end loopback) tests with the other site.
9. Make sure no alarm or alert indicators are on.

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SECTION 10. TROUBLESHOOTING

10.1 INTRODUCTION

This section contains a general approach to troubleshooting the IMUX 2000 system, and CM3R Common Module diagnostics. The general troubleshooting section includes an introduction to the use of IMUX 2000 loopbacks, T1 test equipment, and channel test equipment for in-service or out-of-service testing. This information is helpful when troubleshooting an existing system, or when trying to isolate a problem during the check-out phase of a new system installation. For general troubleshooting, refer to paragraph 10.2. The CM3R Common Module diagnostic section contains specific information on troubleshooting certain T1 related problems. For CM3R Common Module diagnostics, refer to paragraph 10.3. No procedure, however, can cover all possible situations. If you have reached what appears to be a dead end, or if the information in this section does not seem to apply to your case, please contact RFL for assistance in troubleshooting your IMUX 2000 system.

10.2 GENERAL TROUBLESHOOTING

10.2.1 TROUBLE TYPES

IMUX 2000 system troubles generally fall into three categories:

1. Setup Errors
2. T1 Network Problems
3. IMUX 2000 Equipment Problems

Details of these three major categories appear in Figure 10-1.

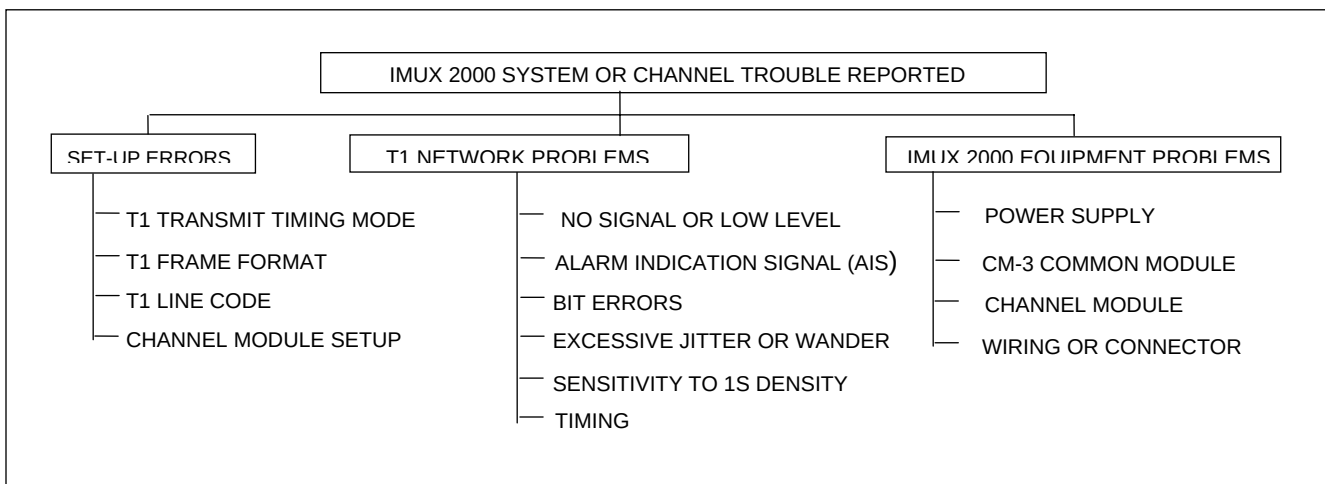


Figure 10-1. Basic troubleshooting categories

The basic objective of any troubleshooting procedure is to determine the **type** and **location** of a problem. Once this is accomplished, taking one of the following actions will usually restore the IMUX 2000 system:

1. For setup problems, re-configure the IMUX 2000 multiplexer or multiplexers that are not set up correctly.
2. For public network problems, work with your Local or Inter-exchange carrier to correct the situation. For private network problems, consult the network manager.
3. For equipment problems, replace the bad module or modules with spares.

10.2.2 GENERAL TROUBLESHOOTING HINTS

Use the following hints as general guides when troubleshooting an IMUX 2000 system:

1. At each location, verify that the POWER LED on the IMUX 2000 Main Shelf is on. If there is an expansion shelf in the location and it has its own power supply, verify that its POWER LED is on as well. If the POWER LED is off, then there is a power-related problem.
2. In general, always check for setup errors before performing in-service or out-of-service tests. This is especially true during the check-out of a new installed system.
Setup problems may not appear immediately. For example, if at installation time both multiplexers in a point-to-point system are incorrectly configured for AMI operation (instead of B8ZS), errors may not occur until later when a data pattern with very low ones density is transmitted.
3. If a trouble occurs on a single channel, always check to see if similar troubles exist on other channels. If troubles exist on multiple channels at the same time, then the source of the channel troubles is probably a T1 circuit or IMUX 2000 Common Module failure, rather than several simultaneous channel module failures.
4. To isolate a "soft" trouble such as a low bit error rate on a data channel, or occasional clicks or pops on audio channels, try in-service T1 circuit monitoring before performing out-of-service testing. This can minimize overall circuit down-time. Use the procedure in paragraph 10.5.
5. To isolate a "hard" trouble, as for example when troubleshooting a system that is unavailable because of a high error rate or loss of frame synchronization, use the loopback procedure below. If a T1 test set is available, perform an out-of-service test using the procedure in paragraph 10.6. Once a system is in hard failure, you incur no additional downtime by using these techniques.

10.2.3 TYPICAL IMUX 2000 LOOPBACK PROCEDURE

The following example shows how to use the loopbacks built into IMUX 2000 multiplexers to isolate a failure on a point-to-point T1 system (Figure 10-2).

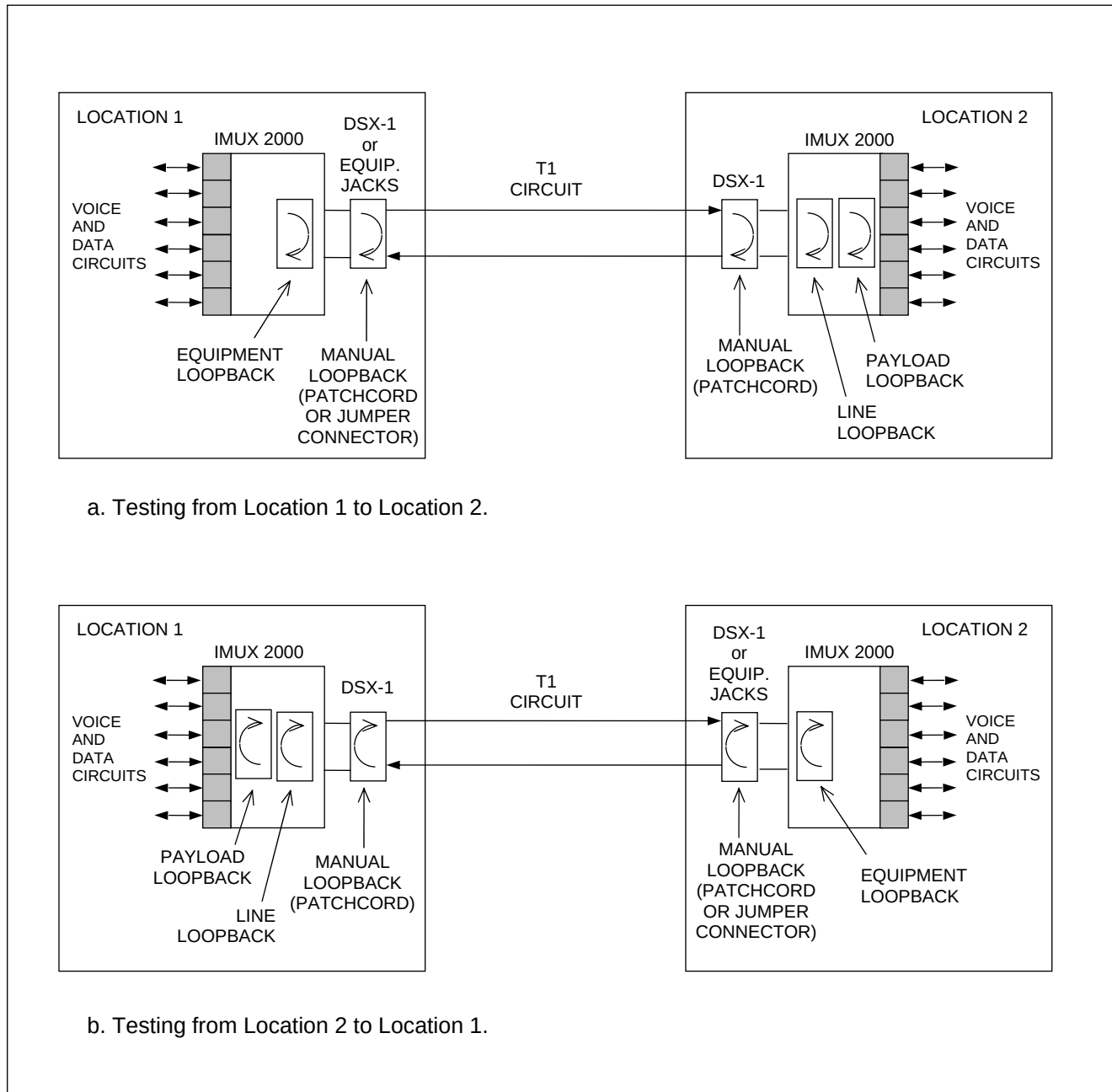


Figure 10-2. Using IMUX 2000 T1 loopbacks

Situation:

The FRM (loss of frame) indicator on the terminal multiplexer at Location 1 comes on. Technicians at Location 1 and Location 2 use successive loopbacks in an attempt to identify the fault as occurring in one of the following:

1. The multiplexer at Location 1.
2. The T1 facility.
3. The multiplexer at Location 2.

Procedure:

1. Activate the Equipment Loopback (EqLB) in the multiplexer at Location 1. (It is assumed in this example that the multiplexer at Location 1 is internally timed.)
If the FRM LED remains on, then this multiplexer has a fault.
If the FRM LED turns off, then this multiplexer is probably fine. Proceed to Step 2.
2. Deactivate the Equipment Loopback in the multiplexer at Location 1. The FRM indicator should turn on again.
3. Activate the Line Loopback in the multiplexer at Location 2.
If the FRM indicator remains on at Location 1, then the T1 facility is probably the source of the fault.
If the FRM indicator turns off, then the T1 facility is probably all right, leaving the multiplexer at Location 2 as the likely source of the fault.
4. To further identify the cause of the fault in the multiplexer at Location 2, deactivate the Line Loopback and activate the Payload Loopback in the Location 2 multiplexer.
If the FRM indicator remains on at Location 1, then the source of the fault is the CM-3 module in the Location 2 multiplexer.
If the FRM indicator turns off, then the fault may be related to the ones density of the signal generated by the multiplexer at Location 2. This can mean either that too many data channels are operating without bandwidth limitation (i.e. operating at N x 64 Kbps rates instead of N x 56 Kbps rates), or that the system is set up to use the AMI line code but should be set up for B8ZS.
5. You can also perform these tests in the opposite direction, from Location 2 towards Location 1, as shown in Figure 10-2.

10.2.4 USING T1 TEST EQUIPMENT TO PERFORM IN-SERVICE TESTS

When intermittent errors occur on one or more data channels, it is often helpful to perform in-service monitoring on the T1 facility. This is primarily useful in determining whether the channel errors are being caused by errors on the T1 facility, rather than by a fault in the channel module or in another section of the low-speed circuit.

Use the following procedure to perform in-service monitoring of a T1 facility between two IMUX 2000 locations (Figure 10-3).

1. To measure performance in the Location 2 to Location 1 direction, connect the DS1/T1 input of a T1 test set (such as a TTC T-BERD 211A or a Tau-tron 5111) to the T1 IN Mon jack on the multiplexer at Location 1.
2. To measure performance in the Location 1 to Location 2 direction, connect the DS1/T1 input of a T1 test set to the T1 IN Mon jack on the multiplexer at Location 2.

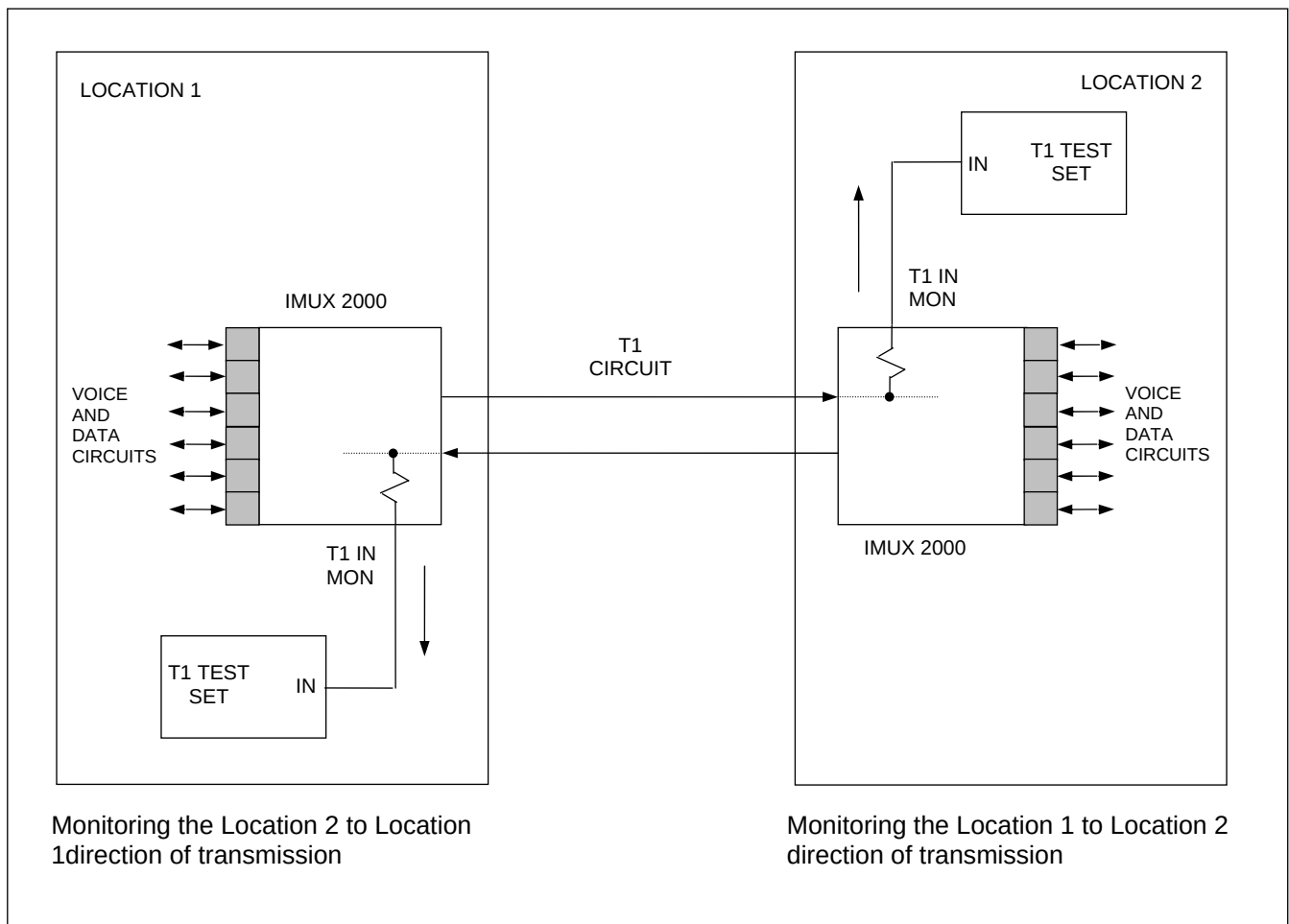


Figure 10-3. In-service monitoring of a T1 circuit

Use the following hints for interpreting test results:

1. On T1 systems using the ESF format, measure total CRC-6 errors, CRC-6 errored seconds, and CRC-6 severely errored seconds to determine overall facility performance.
2. On systems using the SF format, frame bit error counts can indicate the presence of a high bit error rate or severe error bursts. However, frame bit error monitoring cannot usually identify problems with very low error rates.
3. Check with your service provider to determine what level of error performance is guaranteed on your T1 circuit. Compare this with your actual test results.

10.2.5 USING T1 TEST EQUIPMENT TO PERFORM OUT-OF-SERVICE TESTS

Use T1 test equipment to test T1 facilities on an out-of-service basis, as illustrated in Figure 10-4. For compatibility with all carrier networks, we recommend that you use test equipment that is capable of generating framed T1 signals.

In a carrier central office, T1 out-of-service testing generally takes place at a DSX-1 bay. At a customer site, testing can be done using the test jacks at the T1 Channel Service Unit (CSU).

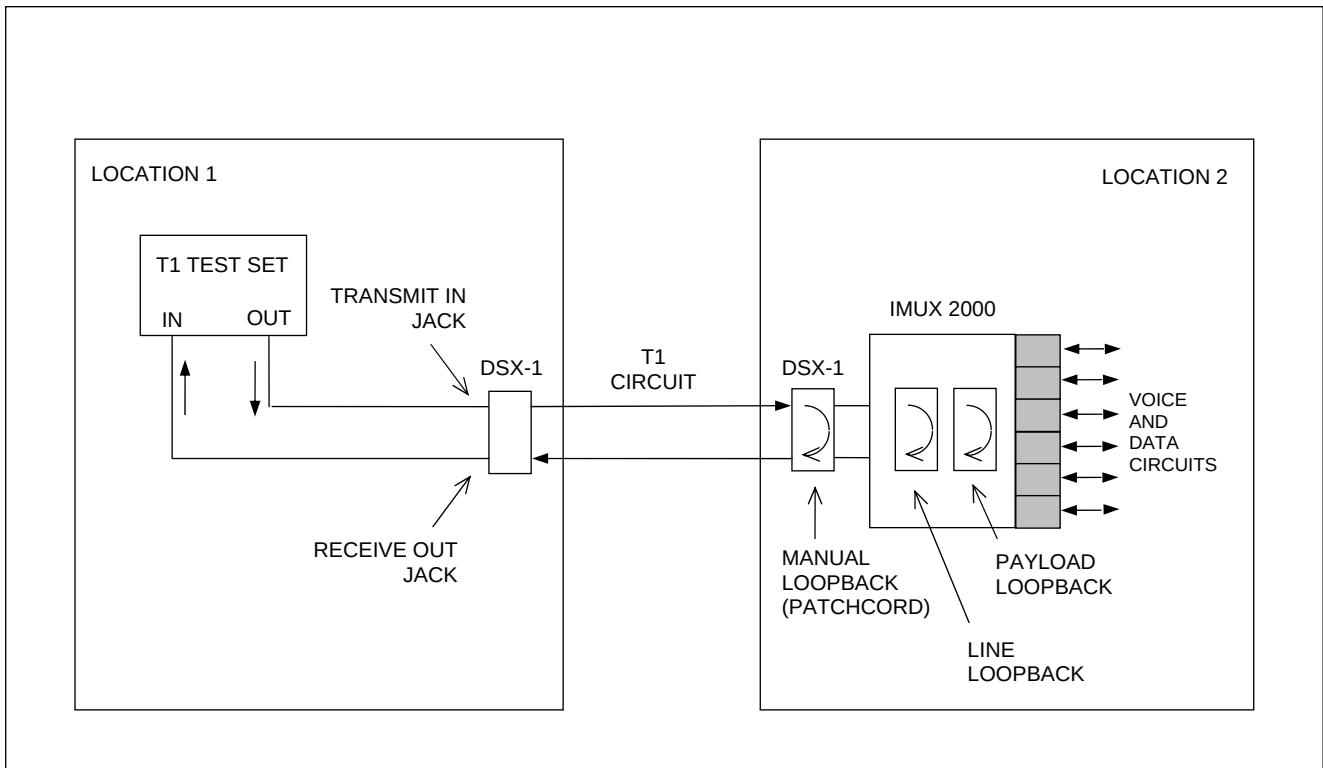


Figure 10-4. Out-of-service testing of a T1 circuit

10.2.6 USING ANALOG OR DATA TEST EQUIPMENT TO PERFORM CHANNEL TESTS

Test individual channels using the appropriate analog transmission measurement sets (TMS), digital Bit Error Rate test sets (BERTS), and other related types of test equipment. As shown in Figure 10-5, you can perform tests on individual channels of in-service T1 systems without affecting the other channels carried in the same system.

As shown in Figure 10-6, you can perform local loopback test on individual channel modules before putting a multiplexer into service by activating its Equipment Loopback, or by establishing a local loopback using a T1 patch cord. However, once a system is in-service, avoid using T1 loopbacks to test individual channels, because all channels on the T1 circuit carrying the channel under test will be out-of-service during the test.

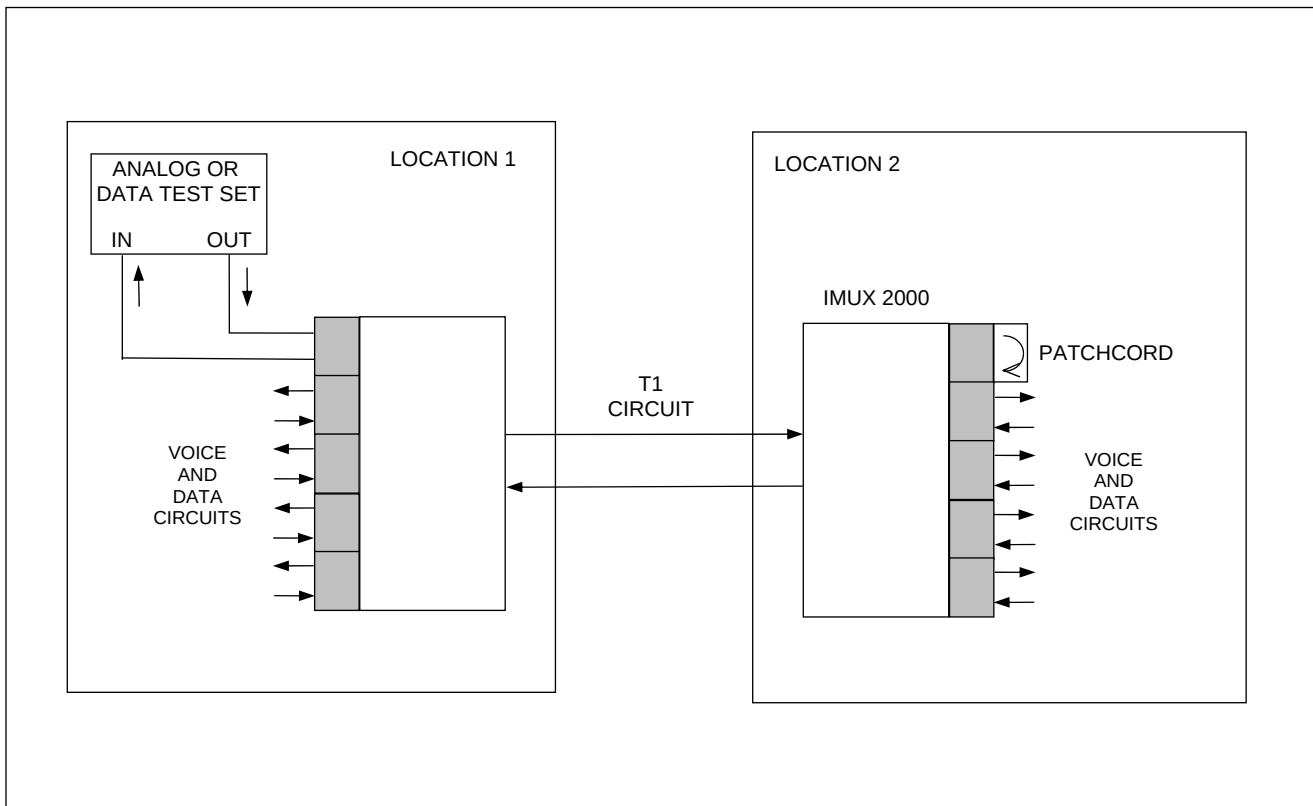


Figure 10-5. Testing an individual channel on an in-service T1 system

IMUX 2000
May 19, 2003

10.3 CM3R COMMON MODULE DIAGNOSTICS

This section contains information which will help the user diagnose certain T1 related problems, and describes the severity and frequency of trapped counter increments. Both the CM3R and DACS/ILS are identical with the error detection performance registers described. These registers are directly read from the T1 Transceiver Framer chips and are stored in memory. This section also provides a brief description of the possible Sequence of Events, which are stored in the CM3R. There are up to 40 events which can be stored in the buffer.

In Table 10-1 below, the *Counter Name* column includes the designation of the counter when read with NMS or with a terminal emulation program using SCL. The *Update Rate* column describes how a given counter is incremented. The *Severity* column classifies the relative importance of given condition.

Table 10-1. CM3R Diagnostic Counters

Counter Name (NMS or SCL)	Update Rate / Method	Severity	Effect on System	Function & Notes
Currently Received Blue Alarms NMS: Curr rcv blue alarm cnt SCL: CRBL	Counter contains result for previous 1s interval. During each second CM3R checks blue alarm every 6ms - if it is present, the counter will increase by one.	Major	When Blue Alarm signal is active, payload traffic is over-written by alarm and several other alarms become active.	Counter reports received Alarm Indication Signal ("Blue Alarm" or "All-Ones"). AIS is a DS1 signal containing only 1's. This is specifically generated by equipment external to MUX (such as SONET) and typically denotes trouble with communication links between nodes.
Currently Received Yellow Alarms NMS: Curr rcv yellow alarm cnt SCL: CRYEL	Counter contains result for previous 1s interval. During each second CM3R checks yellow alarm every 6ms - if it is present, the counter will increase by one.	Minor	When Yellow Alarm signal is active, FDL traffic is over-written by alarm.	Counter reports received Yellow Alarm. Yellow Alarm is a message carried by the overhead of T1. This is specifically generated by equipment external to MUX and typically denote trouble with communication links. Unless forced, MUX does not generate Yellow Alarm, but passes it on.
Currently Received Carrier Losses NMS: Curr carrier loss cnt SCL: CRCL	Counter contains result for previous 1s interval. During each second CM3R checks presence of carrier every 6ms - if carrier is lost, the counter will increase by one.	Major	When Loss of Carrier exists, payload traffic is interrupted.	Counter reports Loss of Carrier at the Common Module. Loss of Carrier is caused by low received signal power level or low 1's density. Typically, this denotes missing T1 signal at the multiplexer port. During Loss of Carrier condition, the content of other counters may be not valid. Due to AGC action of framer input, Carrier Alarm may clear after initial indication even if Loss condition continues.

Table 10-1 - continued. CM3R Diagnostic Counters

Counter Name (NMS or SCL)	Update Rate / Method	Severity	Effect on System	Function & Notes
Currently Received Losses of Sync NMS: Curr rev loss of sync cnt SCL: CRLOS	Counter contains result for previous 1s interval. During each second CM3R checks presence of framing sync every 6ms - if sync is lost, the counter will increase by one.	Major	When Loss of Sync condition exists, payload traffic is corrupted. Disturbance may spread to other nodes.	Counter reports Loss of Sync at the Common Module. Loss of Sync occurs when the multiplexer cannot capture the timing structure of the received signal. Typically, this denotes bad T1 signal at the multiplexer port, high bit error rate, improper single-frame/multi-frame configuration or improper timing configuration. During Loss of Sync condition, the content of other counters may be not valid. When Fast Reframe is On, and Loss of Sync is the only alarm active, it is most likely due to incorrect Fast Enable/Disable configuration in the network.
Currently Received Bipolar Violations NMS: Curr bipolar violation cnt SCL: CBPV	Counter contains result for previous 1s interval.	Minor	Low level of Bipolar Violations has a minimal effect on system if not accompanied by other trouble conditions.	Counter reports Bipolar Violations received at the Common Module. Bipolar Violations are pulses of incorrect polarity in the received signal. Typically, this denotes errors or noise present in the T1 signal at the multiplexer port or improper AMI/B8ZS line code configuration.
Currently Received Path Code Violations NMS: Curr path code violation cnt SCL: CBERS	Counter contains result for previous 1s interval.	Intermediate	Low level of Path Code Violations has a minimal effect on system if not accompanied by other trouble conditions.	Counter reports Path Code Violations received at the Common Module. Path Code Violations are bit errors in received signal. In ESF framing mode this equals to the CRC6-error count. In SF mode, it is the framing bit error count. Typically, this denotes errors or noise in the T1 signal at the multiplexer port or improper SF/ESF line format configuration.
Currently Received Multi-Frames Out of Sync NMS: Curr multiframe out of sync cnt SCL: CMFOS	Counter contains result for previous 1s interval.	Intermediate	When Multi-Frame out of Sync condition exists, payload traffic may be corrupted. Disturbance may spread to other nodes.	Reports Multi-Frame Out of Sync at the Common Module. Multi-Frame Out of Sync is defined as errors in the framing pattern. Typically, this denotes bit errors or bad T1 signal at the multiplexer port, improper SF/ESF line format setting or improper network timing configuration.

Table 10-1 - continued. CM3R Diagnostic Counters

Counter Name (NMS or SCL)	Update Rate / Method	Severity	Effect on System	Function & Notes
Accumulated Received Blue Alarms NMS: Acum rcv blue alarm cnt SCL: ARBL	Accumulated counter is incremented by adding current counter every second.	Major	When Blue Alarm signal is active, payload traffic is over-written by alarm and several other alarms become active.	Counter reports accumulated count of received Alarm Indication Signal ("Blue Alarm" or "All-Ones"). AIS is a DS1 signal containing only 1's. This is specifically generated by equipment external to MUX (such as SONET) and typically denotes trouble with communication links between nodes.
Accumulated Received Yellow Alarms NMS: Acum rcv yellow alarm cnt SCL: ARYEL	Accumulated counter is incremented by adding current counter every second.	Minor	When Yellow Alarm signal is active, FDL traffic is over-written by alarm.	Counter reports accumulated count of received Yellow Alarm. Yellow Alarm is a message carried by the overhead of T1. This is specifically generated by equipment external to MUX and typically denote trouble with communication links. Unless forced, MUX does not generate Yellow Alarm, but passes it on.
Accumulated Received Carrier Losses NMS: Acum rcv carrier loss cnt SCL: ARCL	Accumulated counter is incremented by adding current counter every second.	Major	When Loss of Carrier exists, payload traffic is interrupted.	Counter reports accumulated count of Loss of Carrier at the Common Module. Loss of Carrier is caused by low received signal power level or low 1's density. Typically, this denotes missing T1 signal at the multiplexer port. During Loss of Carrier condition, the content of other counters may be not valid. Due to AGC action of framer input, Carrier Alarm may clear after initial indication even if Loss condition continues
Accumulated Received Losses of Sync NMS: Acum rcv loss of sync cnt SCL: ARLOS	Accumulated counter is incremented by adding current counter every second.	Major	When Loss of Sync condition exists, payload traffic is corrupted. Disturbance may spread to other nodes.	Counter reports accumulated count of Loss of Sync at the Common Module. Loss of Sync occurs when the multiplexer cannot capture the timing structure of the received signal. Typically, this denotes bad T1 signal at the multiplexer port, high bit error rate, improper single-frame/multi-frame configuration or improper timing configuration. During Loss of Sync condition, the content of other counters may be not valid. When Fast Reframe is On, and Loss of Sync is the only alarm active, it is most likely due to incorrect Fast Enable/Disable configuration in the network.

Table 10-1 - continued. CM3R Diagnostic Counters

Counter Name (NMS or SCL)	Update Rate / Method	Severity	Effect on System	Function & Notes
Accumulated Received Bipolar Violations NMS: Acum bipolar violation cnt SCL: ABPV	Accumulated counter is incremented by adding current counter every second.	Minor	Low level of Bipolar Violations has a minimal effect on system if not accompanied by other trouble conditions.	Counter reports accumulated count of Bipolar Violations received at the Common Module. Bipolar Violations are pulses of incorrect polarity in the received signal. Typically, this denotes errors or noise present in the T1 signal at the multiplexer port or improper AMI/B8ZS line code configuration.
Accumulated Received Path Code Violations NMS: Acum path code violation cnt SCL: ABERS	Accumulated counter is incremented by adding current counter every second.	Intermediate	Low level of Path Code Violations has a minimal effect on system if not accompanied by other trouble conditions.	Counter reports accumulated count of Path Code Violations received at the Common Module. Path Code Violations are bit errors in received signal. In ESF framing mode this equals to the CRC6-error count. In SF mode, it is the framing bit error count. Typically, this denotes errors or noise in the T1 signal at the multiplexer port or improper SF/ESF line format configuration.
Accumulated Received Multi-Frames Out of Sync NMS: Acum multiframe out of sync cnt SCL: AMFOS	Accumulated counter is incremented by adding current counter every second.	Intermediate	When Multi-Frame out of Sync condition exists, payload traffic may be corrupted. Disturbance may spread to other nodes.	Reports accumulated count of Multi-Frame Out of Sync at the Common Module. Multi-Frame Out of Sync is defined as errors in the framing pattern. Typically, this denotes bit errors or bad T1 signal at the multiplexer port, improper SF/ESF line format setting or improper network timing configuration.

In Table 10-2 below, the *Status Message* column contains messages displayed by the CM3R Common Modules in response to *Status?* inquiry. The *Severity* column classifies the relative importance of the given condition.

Table 10-2. CM3R Status Messages

Status Message	Severity	Effect on System	Function & Notes
TRANSMITTER USING FTIME = INT	Minor	Section supplied by fallback clock should be operational.	The addressed CM-3 module's T1 transmitter is in its internal fallback timing mode. This is due to bad signal at input to one of drop-and-inserts or to failed primary clock source.
TRANSMITTER CLOCK FREE RUNNING	Minor	Minor data errors possible.	The addressed CM-3 module's T1 transmitter has dropped out of its primary timing mode (as above), but cannot operate in its fallback timing mode. This may be due to failed fallback clock source.
RECEIVE SIGNAL LOSS	Major	Communications interrupted.	No signal is detected at the addressed CM-3 module's T1 input.
EXCESS JITTER	Minor	Minor data errors possible.	Excessive jitter is detected at T1 input of the addressed CM-3 module.
RECEIVER OUT OF FRAME	Major	Data errors exist.	The addressed CM-3 module's T1 receiver has lost frame synchronization.
OTHER SIDE (DI-A) IS OUT OF FRAME	Major	Data errors exist.	The T1 receiver in the DI-A module has lost frame synchronization. Only reported by a Common Module set to DI-B mode.
RECEIVING ALL ONES	Major	Data traffic interrupted.	An All-Ones Alarm (AIS - Alarm Indication Signal, or "Blue Alarm") is detected at the input of the addressed common module. AIS is a DS1 signal containing only 1's. This is specifically generated by equipment external to MUX (such as SONET) and typically denotes trouble with communication links between nodes.
RECEIVING YELLOW ALARM	Minor	Data errors possible elsewhere in the network.	A Yellow Alarm is detected by the addressed common module's input. Yellow Alarm is a message carried by the overhead of T1. This is specifically generated by equipment external to MUX and typically denotes trouble with communication links. Unless forced, MUX does not generate Yellow Alarm, but passes it on.
PAYLD-LB = ON	Information	Data traffic is forced to re-route.	The addressed CM-3 module's T1 Payload Loopback is active.
LINE-LB = ON	Information	Data traffic is forced to re-route.	The addressed CM-3 module's T1 Line Loopback is active.
OTHER SIDE (DI-B) IS OUT OF FRAME	Major	Data errors exist.	The T1 receiver in the DI-B module has lost frame synchronization. Only reported by a Common Module set to DI-A mode.

Table 10-2 - continued. CM3R Status Messages

Status Message	Severity	Effect on System	Function & Notes
EQUIP-LB = ON	Information	Data traffic is forced to re-route.	The addressed CM-3 module's T1 Equipment Loopback is active.
REDUNDANT POWER SUPPLY FAILURE	Minor	System operates normally.	One of the two power supplies on the Main Shelf or one of the two power supplies on the Expansion Shelf (if so equipped) has failed.
DI-B CONFIG ALERT	Minor	Timing or Fast Reframe errors may exist.	Configuration of DI-B does not correspond to the master table maintained by DI-A. An error occurred, possibly due to failed communication between drop-and-inserts over backplane.
ALERT AT (#) CHANNEL CARDS	Information	Affects only specific module(s).	Alert condition detected at (number of) channel module(s).
ALERT AT Cn	Information	Affects only specific module.	Alert condition detected at channel module n.
ALERT AT DACS	Information	Data traffic maintained.	Alert condition at Mini-DACS, most likely due to failed data path. Trouble resolved by DACS switching maps.
ALERT A ILS	Information	Data traffic maintained.	Alert condition at ILS, most likely due to failed data path. Trouble resolved by ILS switching routes.
ALARM AT (#) CHANNEL CARDS	Information	Affects only specific module(s).	Alarm condition detected at (number of) channel module(s).
ALARM AT Cn	Information	Affects only specific module.	Alarm condition detected at channel module n.
ALARM AT DACS	Major	Data traffic may be interrupted.	Alarm at Mini-DACS, most likely due to failed data path. Could not be compensated by DACS switching maps.
ALARM AT ILS	Major	Data traffic may be interrupted.	Alarm at ILS, most likely due to failed data path. Could not be compensated by ILS switching routes.

10.4 TROUBLESHOOTING TIP #001

10.4.1 SYMPTOM

In redundant-configured CM3R nodes, the “UNIV” parameter setting appears to have spontaneously turned off, prohibiting entry into Real-Time mode with the NMS software.

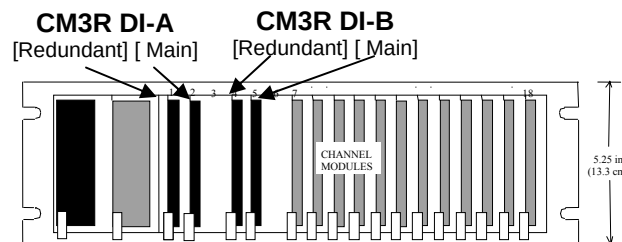
10.4.2 DEFINITION OF THE UNIV SETTING

“UNIV” is a settable parameter that alters the way a CM3R (Redundant Common Module) responds to NMS commands. Specifically, the UNIV function allows for “universal” IMUX node addressing. If universal addressing is enabled, any multiplexer receiving through its local RS-232 port a command *not* containing an actual node address will still respond to that command. This is the most typical operating mode. It allows the NMS software to communicate with the locally-connected multiplexer without knowing its specific node address. However, in some system configurations, there can be several multiplexers bridged (parallel connected) onto the RS-232 link to a main controlling terminal. A command or inquiry not containing a specific node address would elicit a response from all nodes simultaneously, resulting in message collisions. In this case UNIV should be set to off, disabled. Therefore the unit will only respond to commands which have the exact address.

Note: The UNIV parameter is only utilized when connected directly to a node’s local RS232 port, not in “node-to-node”, (FDL) NMS communications.

UNIV = **Green** = Enabled

UNIV = **Red** = Disabled



10.4.3 TECHNICAL DISCUSSION OF SYMPTOM

The above symptom may appear to occur under the following conditions:

1. The user configured a fully redundant Drop & Insert Imux node initially with the UNIV setting enabled for both DI-A (left pair CM3R) and DI-B (right pair CM3R).

2. During a Main-to-Redundant CM3R switch which had taken place on the DI-B side, either because of a T1 disturbance, or because the user “forced” the redundant card to be active, the UNIV parameter will be automatically disabled “Red” regardless of whether or not it was originally set to enabled “Green”. This behavior is witnessed on the DI-B set of CM3R modules only. The UNIV parameter is set to OFF because it is not used for DI-B modules, as NMS connections to Drop-and-Insert nodes are always made to the DI-A side. This, by itself, will not cause any communications problems.
Note: The UNIV parameter will also be disabled during a Redundant-back-to-Main CM3R switch on the DI-B direction side forced by the user resetting the shelf to normal.
3. If, however, the Redundant DI-B is then moved during a troubleshooting session, for example, to either a Terminal node or into the DI-A position, the UNIV=Off condition will disallow NMS from entering into Real Time mode.
4. None of the above conditions will affect T1 or payload service in any way.
5. This symptom will only happen with CM3R Flash Firmware (U5) version SW20003R006 or earlier.

10.4.4 RECOMMENDATION

If the above sequence is encountered (DI-B switch between Main and Redundant, then moving the CM3R to a Terminal or DI-A position), simply set the UNIV parameter via the CM3R front panel to ON.

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SECTION 11. POWER SUPPLY AND POWER SUPPLY ALARM I/O

11.1 INTRODUCTION

This section provides technical information on Power Supply modules, and Power Supply Alarm I/O modules used in IMUX 2000 Intelligent T1 Multiplexers. Refer to Paragraph 11.2 for Power Supply module information, and to paragraph 11.3 for Power Supply Alarm I/O module information. Table 11-1 gives general information on these modules. **For specific component information at the board level please contact the factory with the board part number and revision level.** Power Supply Schematics are provided at the end of this section.

Table 11-1. Power Supply and Power Supply Alarm I/O, General Information

Unit	Model Designation	Part Number	Input Voltage
Power Supply	2000 PS 250DC	9547-840	250 Vdc
Power Supply	2000 PS 220AC	9547-930	220 Vac
Power Supply	2000 PS 48/125DC High Power	9547-965	48 Vdc or 125 Vdc
Power Supply	2000 PS 24DC High Power	9547-975	24 Vdc
Power Supply	2000 PS 120AC High Power	9547-985	120 Vac
Power Supply Alarm I/O	2000 PS ALARM I/O DC	9547-18801	250 Vdc
Power Supply Alarm I/O	2000 PS ALARM I/O 48/125 DC	9547-18804	48 Vdc or 125 Vdc
Power Supply Alarm I/O	2000 PS ALARM I/O 180/265 AC	9547-18805	220 Vac
Power Supply Alarm I/O	2000 PS ALARM I/O HYBRID	9547-18806	48 Vdc or 125 Vdc for power supply 1, and 120Vac for power supply 2.
Power Supply Alarm I/O	2000 PS ALARM I/O 24 DC	9547-18807	24 Vdc
Power Supply Alarm I/O	2000 PS ALARM I/O DC/AC	9547-18808	120 Vac

Note: See Table 11-3 for Power Supply Alarm I/O application information.

11.2 POWER SUPPLY MODULE

11.2.1 DESCRIPTION

The 2000 PS power supply modules are the power source for all logic circuits in the IMUX 2000 Family, which consists of the Multiplexer, ILS and DACS. As listed above, they are available in both dc-input and ac-input versions. 50 watts of output power is available. The High power models will give 75 watts of output power.

Two supplies may be paralleled directly for redundancy, as Schottky steering diodes are provided on the 5-volt and 15-volt outputs. Input fusing and output overcurrent protection are provided as safety features. In addition, the supply is designed to meet the Oscillatory, and Fast-Transient tests specified in IEEE C37.90.1-2002.

11.2.2 SPECIFICATIONS

As of the date this manual was published, the specifications shown in Table 11-2 apply to all 2000 PS power supply modules, except where indicated. Because all RFL products undergo constant refinement and improvement, these specifications are subject to change without notice.

Table 11-2. IMAX 2000 Power Supply Specifications

Power Supply→ Specifications ↓	9547-840 (250Vdc)	9547-930 (220Vac)	High Power		
			9547-965 (48-125Vdc)	9547-975 (24Vdc)	9547-985 (120Vac)
Input Voltage Range	200 to 300 Vdc	180 to 265 Vac	38 to 150 Vdc	19 to 29 Vdc	88 to 132 Vac
Max Output Current: +5V +15V -15V -48V	5.00A 0.75A 0.75A 0.10A	4.00A 1.00A 0.75A 0.10A	6.00A 1.75A 1.00A 0.10A		
Adjustments: R44 R49 R50 R61 R76	NA NA NA Output adjust +5V output adjust	+5 Volt output adjust +15 Volt output adjust -15 Volt output adjust NA NA	NA NA NA Output adjust +5V/+15V/-15V NA		
Test Points: TP1 TP2 TP3 TP4 TP5 TP6 TP7 TP8 TP9 TP10	+15 Volt output Output circuit common -15 Volt output +5 Volt output NA Input circuit common FET gate drive Supply voltage (Vcc) to PWM Input to +15Vdc regulator -48Vdc output	Output circuit common +5Vdc output +15 Volt output -15 Volt output -48Vdc output NA NA NA NA NA			
Indicators	DS1 – Normal (Green) DS2 – Alert (Yellow) DS3 – Fail (Red) DS4 – Power (Green) DS5 – Supply Fail (Red)				
Alarm Disable Switch SW1	Enables “dropout” of relays K51 & K52 on Power Supply Alarm I/O module when in the ENABLE position. Keeps relays K51 & K52 on Power Supply Alarm I/O moduile “pulled in” when in the DISABLED position.				
Operating Temperature	-20°C to +65°C				
Humidity	95% @ +40°C				
Isolation	2500 Vdc isolation from input terminals to ground, output terminals to ground, input terminals to output terminals, relay contacts to ground, and relay contacts to coil.				

11.2.3 THEORY OF OPERATION (9547-840)

The topology used in the front end is that of a "FLYBACK" converter. The method of conversion uses the transformer core for primary energy storage. The energy is transferred to the secondary upon demand. It is a preferred topology due to its simplicity and reduced number of parts. Only one switching device is required, and since the transformer acts as a common mode choke, additional inductors and filtering are not required on the secondary. Another benefit is its ability to regulate from a feedback winding which does not require isolation from the primary circuit. The feedback winding powers the front end for greater efficiency and is monitored by the Pulse Width Modulator (PWM). The PWM varies the duty cycle of the switching device to compensate for changes in line and load. The duty cycle is varied proportionally with load and inversely with line. To provide better cross regulation between outputs, linear regulators are used to provide line and load regulation.

11.2.3.1 INPUT CIRCUIT

Input power is first applied to fuses F1 and F2 which provide primary overcurrent protection. For safety, F2 on the 120VAC unit is replaced with a short so that neutral leg is always connected. For protection against line transients in the transverse mode, CR1 limits the overvoltage to a manageable level. In the case of line transients that are Common Mode, an L-C filter created by L1, L2, C1, & C2 provide immunity. Transverse voltage spikes are limited by C3 and CR2. To prevent power switch and fuse failures, inrush current limiting is provided by thermistor RT1. Reverse line voltage protection is provided by the bridge rectifier circuit CR3 through CR6. Application of any polarity provides normal operation on the 125V & 250V units. To increase efficiency on the 48V supply, CR5 and CR6 are removed and replaced with wire jumpers. Reverse input voltage will force the input fuses to clear on the 48V power supply as a result of removing CR5 and CR6. Lastly, the input voltage is filtered by capacitor C5 which serves as a reservoir for the primary current of the transformer.

11.2.3.2 START-UP CIRCUIT

For increased efficiency, the PWM circuit obtains power from a feedback winding. In order to activate the PWM, current is drawn from the input supply through the startup circuit. When power is first applied, current flows through R2 and zener diode CR7 which pulls Q1's base to 15V. The transistor then turns on and current flows to the V+ bus and starts the PWM controller U1. The peak current is limited by R3 to within the safe operating area of Q1. When the control loop stabilizes, the V+ bus is bootstrapped to approximately 17V, which then applies a reverse bias to the transistor and cuts off the current.

11.2.3.3 PWM CONTROLLER

The duty cycle of the switching element is controlled by the PWM chip (TL494) and associated components. Modulation of the gate drive is performed by comparison of an internal sawtooth waveform created by the internal oscillator of U1, with timing components C9 & R11, and either of two control signals. One signal is provided by an error amplifier for which the feedback voltage is applied to the non-inverting input through an adjustable voltage divider. The inverting input is connected to a 5V reference. The output voltage of the amplifier drives the PWM. The duty cycle is inversely proportional to the amplifier voltage and will adjust the duty cycle to maintain 5V at the

non inverting input. The AC gain of the error amplifier is limited by R9 and C10 to maintain loop stability.

11.2.3.4 FET DRIVE CIRCUIT

Primary current flow is switched by N-Channel FETs Q3 and Q4. Since the gate input of these devices is highly capacitive, special driving techniques are used to obtain fast switching speeds. Control of the gate is performed by the PWM controller U1, whose drive outputs are configured as emitter followers. A Zener regulated supply consisting of CR8, R4, & C11, provides a constant gate voltage and protects against any overvoltages. During the active portion of each switching cycle, the emitters are pulled up to the gate voltage supply. To turn off the FET, the energy stored on the gate must be discharged quickly. This happens when the drive transistors turn off, allowing the base of Q2 to be pulled low through R13. The FETs are protected from overcurrent by current sense transformer T2, Q7 and associated components. The gate drive is shut down when the instantaneous current exceeds approximately 10 amps.

11.2.3.5 SNUBBERS

Flyback power supplies generate very large voltage spikes between power switch turn off and power rectifier turn on. The transformer used in this design includes a *Clamp Winding* to control this self generated voltage spike. The winding is 1:1 with the primary and along with CR12 and C14, limit the voltage spike to twice the input voltage. The clamped energy is returned to the input filter capacitor C5. R19 and C12 shape the voltage spike to reduce conducted and radiated EMI.

11.2.3.6 ± 15 -VOLT OUTPUT CIRCUIT

Since the positive and negative 15V outputs are the same, only the +15V circuitry will be discussed. In addition it should be mentioned that the -15 volt regulator is powered from an isolated transformer winding, has a -15 volt ground reference and its output diode is clamped to circuit common. The secondary winding of T1 is rectified by a fast efficient rectifier CR51, and filtered with a low ESR capacitor C51. This voltage is then applied to the input of the adjustable linear regulator U52. The output voltage of the regulator is determined by the voltage applied to adjustment input pin #1. Regulation is obtained when 1.275V is present at this pin. The voltage divider R57, R58 & R59, develop this voltage while compensating for the "O Ring" diode voltage drop.

11.2.3.7 +5-VOLT OUTPUT CIRCUIT

The +5V output circuitry operates essentially the same as the other outputs. In order to increase the output current capability, a series pass device was employed. The regulator U54 controls the base current to the pass transistor Q5, which varies the collector to emitter voltage and provides a fixed output. To compensate for tolerances of the voltage programming, an adjustment is provided by R76. This eliminates all the fixed tolerances leaving only deviations for temperature, load and line regulation. The 5 volt output is protected from overloads and short circuits via a Hick-Up Mode overcurrent circuit. The circuit consists of a current shunt R60, differential amp U57A, comparator U57B and a one shot U58 and associated components. During overload conditions the output of U58 is triggered high and will disable the 5 volt regulator U54 for 100ms. After the timeout U58 will enable

U54. Within 1 ms the circuit will detect if the overload is still active and trigger the one shot for another 100ms shutdown period. This will continue until the fault is removed. This mode of operation has a 1% duty cycle thereby eliminating any excessive power dissipation of Q5 or U54.

11.2.3.8 -48-VOLT OUTPUT CIRCUIT

Another output of -48V is provided as a reference for local talk battery. The winding of T1 is rectified by CR53, and filtered by C54. The output is protected against short circuits by PTC thermistor RT2. The circuit will open if the current exceeds 100mA at 55 DEG C or 230mA at 0 DEG C.

11.2.3.9 REDUNDANT OPERATION

When two power supplies are installed in the same multiplexer shelf, they operate in a redundant fashion that is transparent to the user. Redundancy occurs automatically, as described below. (Since redundancy works the same for the +15-volt, -15-volt, and +5-volt outputs, only the +15-volt output will be described.)

The two power supply modules do not produce exactly the same +15-volt output; one will be slightly higher than the other. The higher-voltage output will become the dominant (or primary) output, and will bear the entire +15 volt load. This occurs because the feedback voltage present at U3-1 of the redundant output is higher than its internal reference voltage; this will tend to turn the redundant output off. (Resistor R51 is placed in the feedback divider network to prevent the output from turning off completely.)

At this point, Schottky diode CR11 on the redundant output is reverse-biased, preventing current from flowing from the primary output into the redundant output. If the primary output fails, CR11 will become forward-biased, and the redundant output will then bear the entire +15-volt load. Switchover occurs quickly and smoothly, preventing system misoperation.

11.2.4 THEORY OF OPERATION (9547-930)

The RFL IMUX 2000, 50 Watt power supply is a multiple output, forward, dc to dc converter. The 9547-30 power supply operates from a 180 to 265 Vac input. The supply has four outputs: 5 Vdc at 4.0 Adc, + 15 Vdc at 1.0 Adc, -15 Vdc at -0.75 Adc, and -48 Vdc at 100 mAdc. All of the outputs are connected to a common ground. The 5 Vdc output is constantly monitored and signals are provided if the output should exceed lower limits. All outputs contain or'ing diodes for paralleling a second supply for redundancy.

Input power is fed through terminals A23-25. C23-25 and A30-32, C30-32. An external alarm and interface board provides fusing and EMI suppression.

Diode CR1 protects the power supply from reversal of input voltage. Under such conditions, a fuse on the alarm and interface board clears. Inrush limiter TH1 allows charging of capacitor C5 from a stiff ac or dc source, as applicable, without excessive input currents.

The forward converter is designed around PWM integrated circuit U1. The device has an internal clock set by resistor R12 and capacitor C11. Power for the device is initially provided by a series regulator consisting of MOSFET Q3, resistors R2 and R8, and diode CR5. With power applied and internal clock set, pin 11 of U1 goes high causing MOSFETs Q1, Q2, and Q5 to conduct. This causes the dc bus voltage to be applied across windings 1 and 2 of transformer T1 and conduction of output diodes CR7, CR9, CR11, and CR14. Upon conduction of these diodes, power flows from the input to the output of the power supply. The dc bus current, which flows through MOSFETs Q1 and Q2 is detected across resistors R5 and R6 and is monitored at pins 3 and 4 of U1. When the peak increases to a level set at pin 7 of U1, pin 11 of U1 is set low causing transistor Q4 to conduct. This drives MOSFETs Q1 and Q2 to an off state. Transformer T1 voltage reverses and diodes CR8, CR9 (opposite device), CR10, CR14 (opposite device) conduct and circulate current stored in inductor L3. Inductor L3 and capacitors C19, C24, C26, and C34 form a low pass filter producing a dc that is the half cycle average voltage produced by transformer T1. Inductor L3 is a multi-winding inductor that is matched to transformer T1.

The auxiliary winding of transformer T1, terminals 5 and 6, provides a source of power for the supply's control circuit. After the first few cycles, the voltage at capacitor C17 increase rendering MOSFET Q3 non-conductive.

The secondary auxiliary winding of transformer T1, terminals 3 and 4, capacitor C6, and diode CR2, is a clamp to limit voltage transients across MOSFETs Q1 and Q2.

The 5Vdc output is unique because its level is monitored across diode CR6, resistors R42 and R43, and potentiometer R44. The wiper arm of potentiometer R44 is fed to pin 6 of dual error amplifier U3 and is compared against an internal reference set at pin 7 of U3. If the 5Vdc output is greater than the reference, pin 14 of U3 goes high causing optical isolator U2 to conduct. This reduces the voltage applied to pin 5 of integrated circuit U1, reduces the peak current through transformer T1, and lowers the output voltage. The negative feedback path is compensated with resistor R41 and C44.

To protect the 5Vdc output from excessive output currents, the voltage across shunt R26 is monitored between pins 2 and 3 of U3. Like the voltage feedback path, exceeding limits, established by resistors R35 and R36, causes pin 14 to go high and reduces the output voltage.

Integrated circuits U6, U7, and U8 are series regulators, which provide post regulation for the secondary outputs. Post regulation is required to meet the voltage regulation requirements of the supply. Feedback for regulator U7 is provided by resistors R47, R25, potentiometer R49, and CR16. Feedback paths for the other regulators are similarly structured.

All outputs have or'ing diodes. These diodes; CR12, CR15, CR18, CR19, allow two supplies to be connected in parallel. Feedback signals for all outputs are taken before the or'ing diodes. The temperature voltage sensitivities introduced by the or'ing diodes are compensated with diodes CR13, CR16, CR17, and CR6.

11.2.5 THEORY OF OPERATION (9547-965, -975)

The RFL IMUX 2000, 75 Watt power supply is a multiple output, forward, dc to dc converter. The 9547-970 power supply operates from a 19 to 29 Vdc input and the 9547-960 power supply operates from a 38 to 150 Vdc input. Each of these supplies has four outputs: 5 Vdc at 6.0 Adc, + 15 Vdc at 1.75 Adc, -15 Vdc at -1.0 Adc, and -48 Vdc at 100 mAdc. All of the outputs are connected to a common ground. The 5 Vdc output is constantly monitored and signals are provided if the output should exceed lower limits. All outputs contain or'ing diodes for paralleling a second supply for redundancy.

Input power is fed through terminals A23-25. C23-25 and A30-32, C30-32. An external alarm and interface board provides fusing and EMI suppression.

Diode CR1 protects the power supply from reversal of input voltage. Under such conditions, a fuse on the alarm and interface board clears. Inrush limiter TH1 allows charging of capacitor C5 from a stiff ac or dc source, as applicable, without excessive input currents.

The forward converter is designed around PWM integrated circuit U1. The device has an internal clock set by resistor R12 and capacitor C11/C52. Power for the device is initially provided by a series regulator consisting of MOSFET Q3, resistors R2 and R8, and diode CR5. With power applied and internal clock set, pin 11 of U1 goes high causing MOSFETs Q1, Q2, and Q5 to conduct. This causes the dc bus voltage to be applied across windings 1 and 2 of transformer T1 and conduction of output diodes CR7, CR9, CR11, and CR14. Upon conduction of these diodes, power flows from the input to the output of the power supply. The dc bus current, which flows through MOSFETs Q1 and Q2 is detected across resistors R5, R6, R98, and R99 and is monitored at pin 4 of U1. When the peak increases to a level set at pin 7 of U1, pin 11 of U1 is set low causing transistor Q4 to conduct. This drives MOSFETs Q1 and Q2 to an off state. Transformer T1 voltage reverses and diodes CR8, CR9

(opposite device), CR10, CR14 (opposite device) conduct and circulate current stored in inductor L1. Inductor L1 and capacitors C19, C24, C26, and C34 form a low pass filter producing a dc that is the half cycle average voltage produced by transformer T1. Inductor L1 is a multi-winding inductor that is matched to transformer T1.

The auxiliary winding of transformer T1, terminals 5 and 6, provides a source of power for the supply's control circuit. After the first few cycles, the voltage at capacitor C17 increases rendering MOSFET Q3 non-conductive.

The secondary auxiliary winding of transformer T1, terminals 3 and 4, capacitor C6, and diode CR2, is a clamp to limit voltage transients across MOSFETs Q1 and Q2.

The 5Vdc output is unique because its level is monitored and fed back to the PWM controller. The voltage is divided by resistors R32, R72, and R33 and fed into pin 8 of shunt regulator Q6. If the 5Vdc output is greater than the internal reference of Q6, current is drawn into pin 1 causing optical isolator U2 to conduct. This increases the voltage applied to pin 6 of integrated circuit U1, reduces the peak current through transformer T1, and lowers the output voltage. The negative feedback path is compensated with resistor R64 and C22. The +15V rail is AC coupled into the regulation circuit via C14 to improve the transient response on that rail.

To protect the 5Vdc output from excessive output currents, the voltage across shunt R26 is monitored between pins 2 and 3 of U7. Exceeding limits, established by resistors R35 and R36, causes pin 1 to go high and opto-isolator U3 to conduct. This causes the PWM controller to shutdown. Each of the other outputs has short circuit protection in the form of a single transistor (Q8, Q9, or Q10) and shunt resistors (R44, R47, or R50). A short circuit on any of these rails will also shut down the PWM controller.

Integrated circuit U6 is a series regulator, which provides post regulation for the -48V output. Post regulation on the +15V and -15V rails is supplied to meet the voltage regulation requirements of the supply. Q13 and its associated circuitry provides regulation for the +15V rail. Q16 and its circuitry performs the same function for the -15V rail.

All outputs have or'ing diodes. These diodes; CR12, CR15, CR18, CR19, allow two supplies to be connected in parallel. Feedback signals for all outputs are taken before the or'ing diodes.

11.3 ALARM I/O MODULE

11.3.1 DESCRIPTION

The Power Supply Alarm I/O module consists of an EMI filter, an SWC filter, relay logic, an alert relay and a fail relay. These components can be seen in Figure 2-11 which also includes the power supply module and the system status indicators that are associated with the IMUX 2000. These indicators and relays respond to fault conditions on Common Modules, channel modules, or the power supply module itself.

When a Main Shelf is equipped with a main power supply and a redundant power supply it will have only one Power Supply Alarm I/O module. The relays on the Power Supply Alarm I/O module will respond to alarm and alert conditions from both power supply modules. This insures that Fail and/or Alert monitoring continues even if one or the other supply is removed. Note that because the corresponding relay contacts on the Main and Redundant supplies are connected in parallel, the ACO switches on both must be switched “on” to activate the alarm cut-off, and both must be switched “off” to de-activate the alarm cut-off.

Each Alarm I/O module operates with a specific Power Supply module. Refer to Table 11-3 for application information.

Table 11-3. Power Supply Alarm I/O Application Information

Power Supply→ Alarm I/O ↓	9547-840	9547-930	9547-965	9547-975	9547-985
9547-18801	X				
9547-18804			X		
9547-18805		X			
9547-18807				X	
9547-18808					X

11.3.2 THEORY OF OPERATION

U51, U52, K51, K52, and their associated components form the alarm I/O circuitry for the IMUX 2000 multiplexer. Operation of relays K51 and K52, as well as annunciation indicators DS1 through DS5 are described in Section 2 of this manual.

Logic signals controlling the alarm circuitry are interfaced with the chassis motherboard through edge connector terminals (See P2 in Figure 11-5). After processing, normal and alarm conditions are annunciated by LED indicators DS1 through DS5 and relays K51 and K52. The indicators are mounted along the front edge of the power supply board, and can be viewed with the shelf door closed.

The relay contacts are wired to TB2 as shown in Figure 11-5. One Form C contact per relay is provided, rated 100 mA @ 300 Vdc (resistive).

11.4 POWER SUPPLY SCHEMATICS

The following Power Supply and Power Supply Alarm I/O Schematics are included in this section.

Table 11-4. Power Supply and Power Supply Alarm I/O Schematics

Schematic	Drawing Number	Revision	Page Number
Figure 11-1, IMUX 2000 Power Supply, 250 Vdc (2-Sheets)	D-105499-1	G	11-11
Figure 11-2, IMUX 2000 Power Supply, High Power 24Vdc, 48/125 Vdc and 120 Vac. (3-Sheets)	B-107454-4	H	11-15
Figure 11-3, IMUX 2000 Power Supply, 220 Vac	D-106824	E	11-21
Figure 11-4, IMUX 2000 Power Supply Alarm I/O	D-105494	C	11-23
Figure 11-5, IMUX 2000 Power Supply Alarm I/O, 24 Vdc	D-106984-1	C	11-25

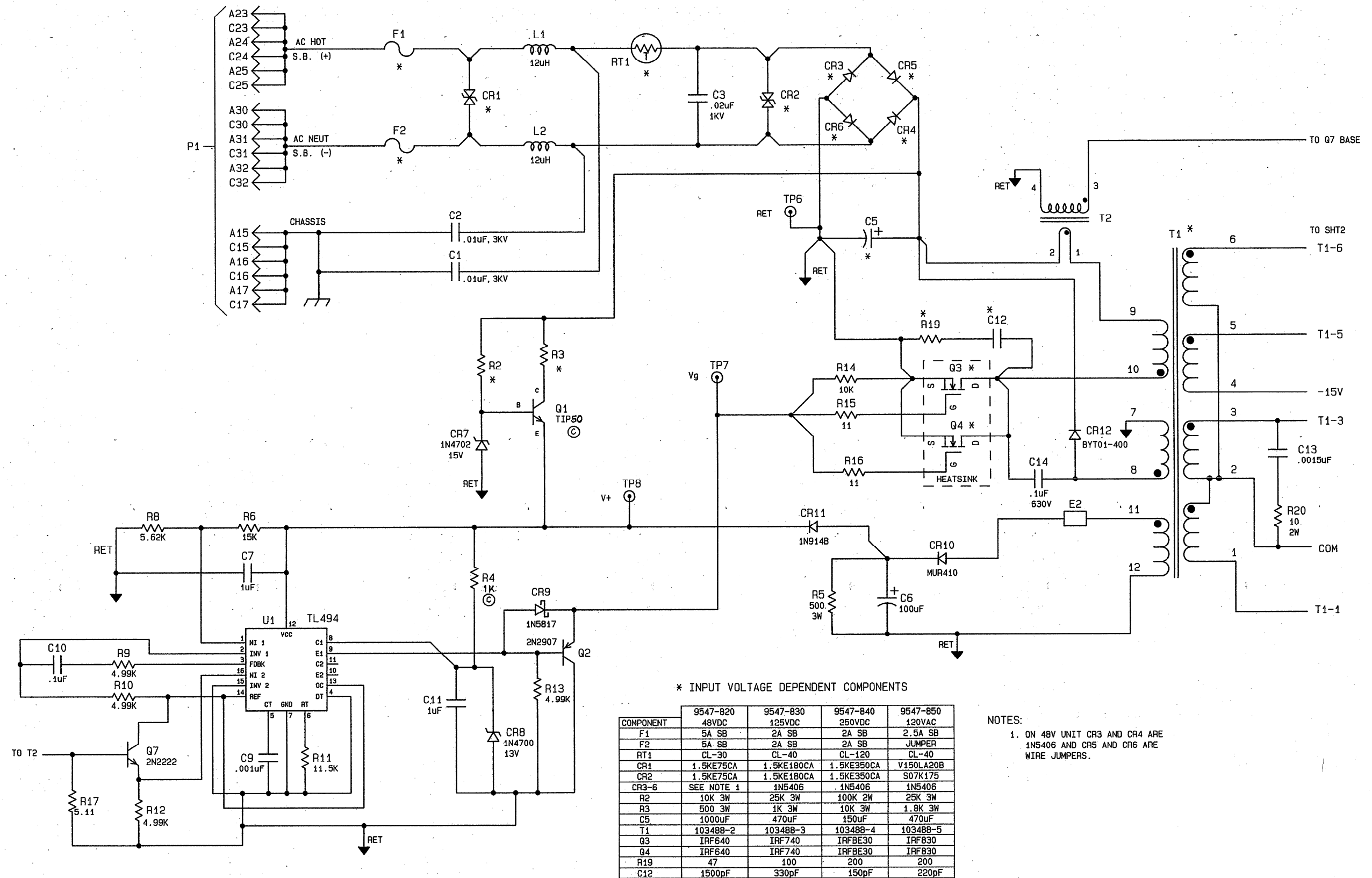
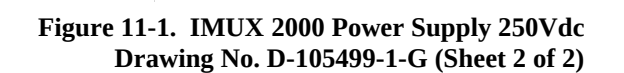
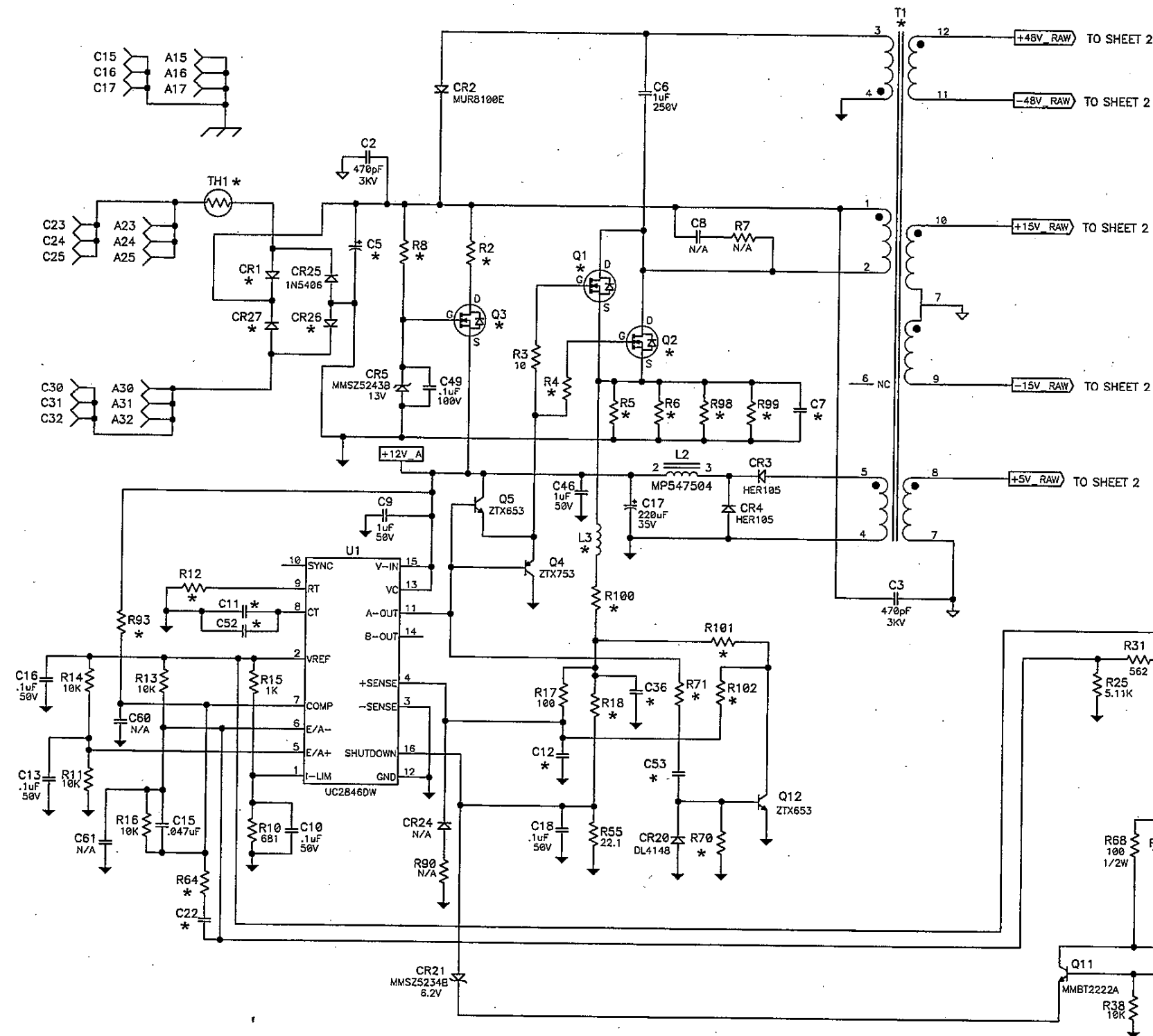
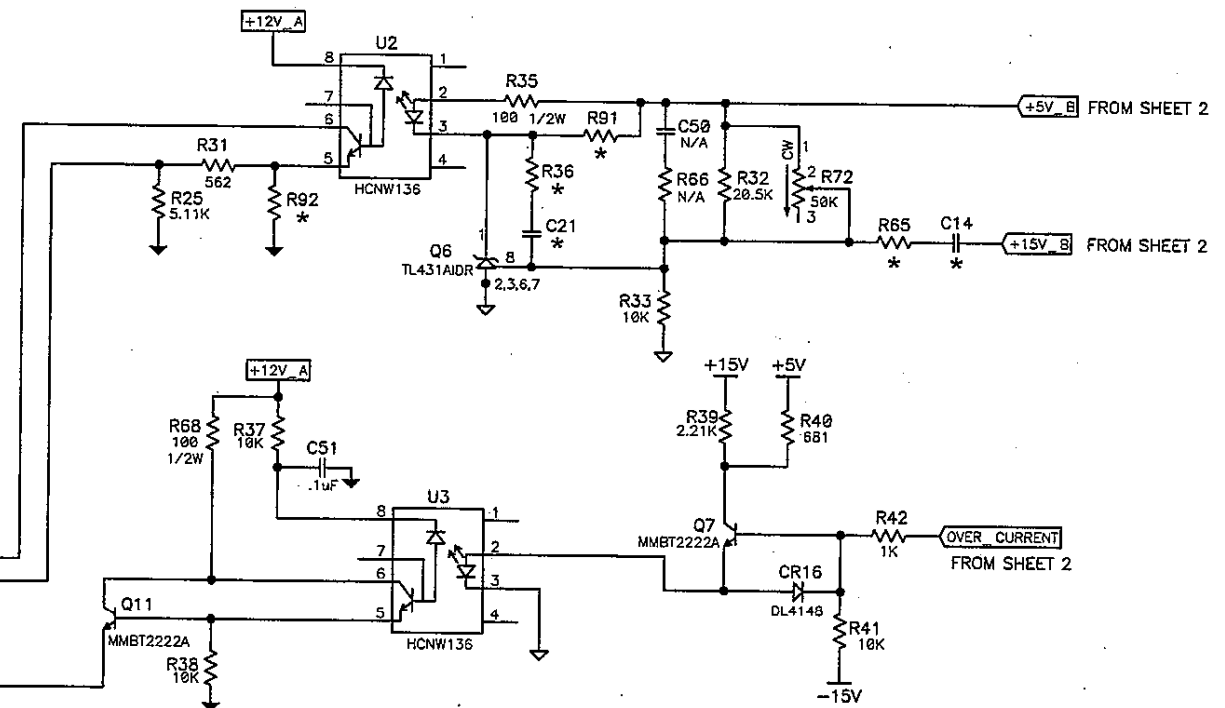


Figure 11-1. IMUX 2000 Power Supply 250Vdc
Drawing No. D-105499-1-G (Sheet 1 of 2)





CIRCUIT DESIGNATOR	48 - 125V 9547-965	24 VDC 9547-975	110 VAC 9547-985	CIRCUIT DESIGNATOR	48 - 125V 9547-965	24 VDC 9547-975	110 VAC 9547-985
C5	680 uF	15000 uF	1000 uF	R6	.2 3W	.04 2W	N/A
C7	1uF	NA	1 uF	R8	221K	100K	221K
C11	1000pF	.0047 uF	1000pF	R12	20K	4.22K	20K
C12	.0047 uF	.033 uF	.0047 uF	R18	150	82.5	150
C14	.0047 uF	.022 uF	.0047 uF	R36	332	2.21K	332
C21	.47 uF	.047 uF	.47 uF	R64	274	1K	274
C22	1 uF	.1 uF	.22 uF	R65	47.5K	10K	47.5K
C36	NA	.1 uF	NA	R70	215	10K	215
C52	1000 pF	NA	NA	R71	200	332	200
C53	330 pF	56 pF	330 pF	R91	1K	NA	1K
CR1,CR26	0 OHM	0 OHM	1N5406	R92	2K	NA	2K
CR27	NA	NA	1N5406	R93	10K	NA	10K
L3	2.7 uH	1 UH	2.7 uH	R97	10	10	7.5
Q1	IRFP360LC	IRFP150N	STW29NK50Z	R98-99	.2 3W	NA	NA
Q2	IRFP360LC	IRFP150N	NA	R100	0 OHM	4.7 OHM	100 OHM
Q3	IRF610	IRF610	IRF740	R101	NA	0 OHM	NA
R2	1K 1/2W	100 1/2W	1K 1/2W	R102	0 OHM	NA	0 OHM
R4	10	10	NA	T1	107621	107641	106922
R5	.2 3W	.04 2W	.2 3W	TH1	CL30	CL11	CL30



* - REFER TO TABLE

Figure 11-2. IMUX 2000 Power Supply, 24 Vdc, 48/125Vdc, and 120Vac – High Power
(Drawing No. B-107454-4-H Sheet 1 of 3)

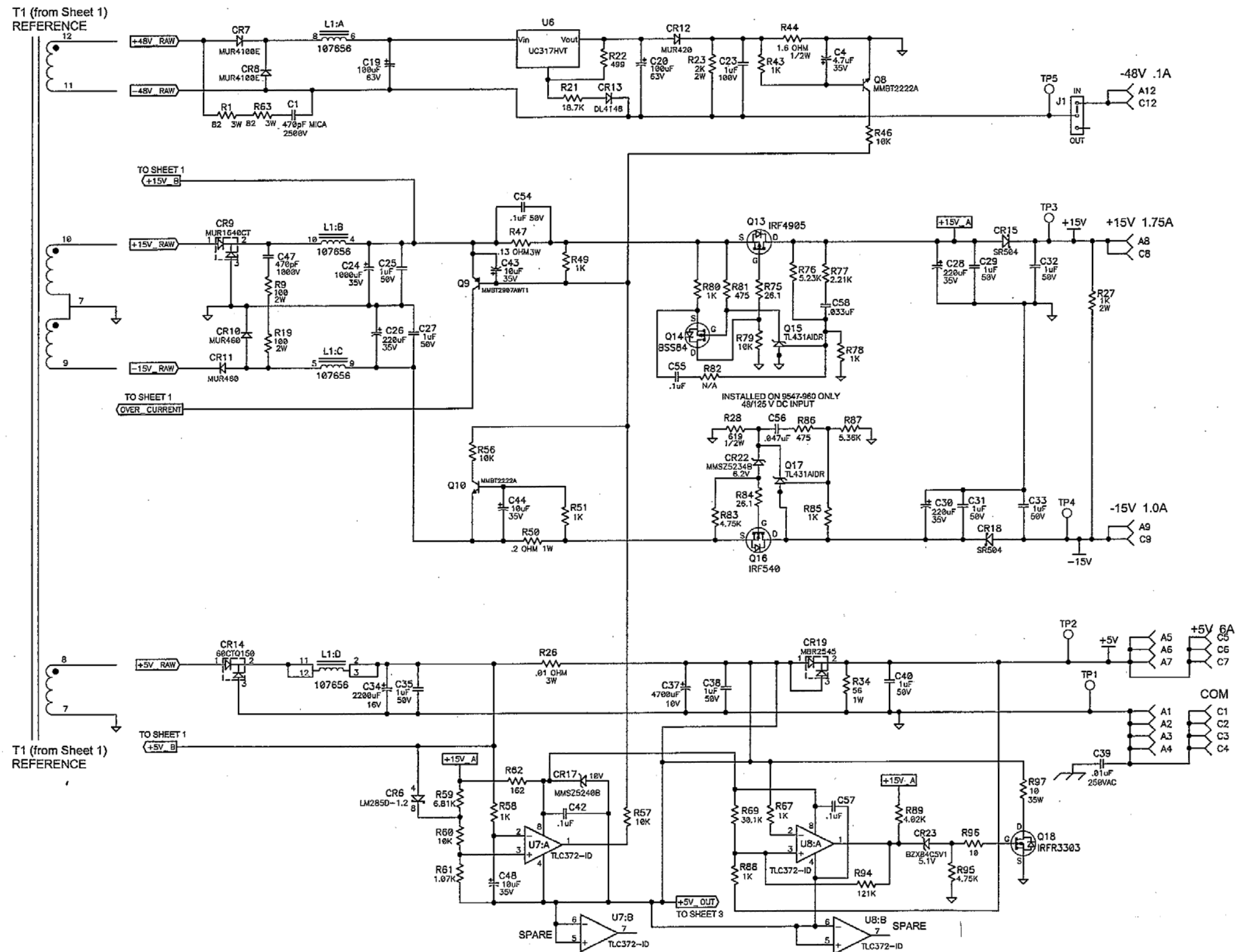


Figure 11-2. IMUX 2000 Power Supply, 24 Vdc, 48/125Vdc, and 120Vac – High Power
(Drawing No. B-107454-4-H Sheet 2 of 3)



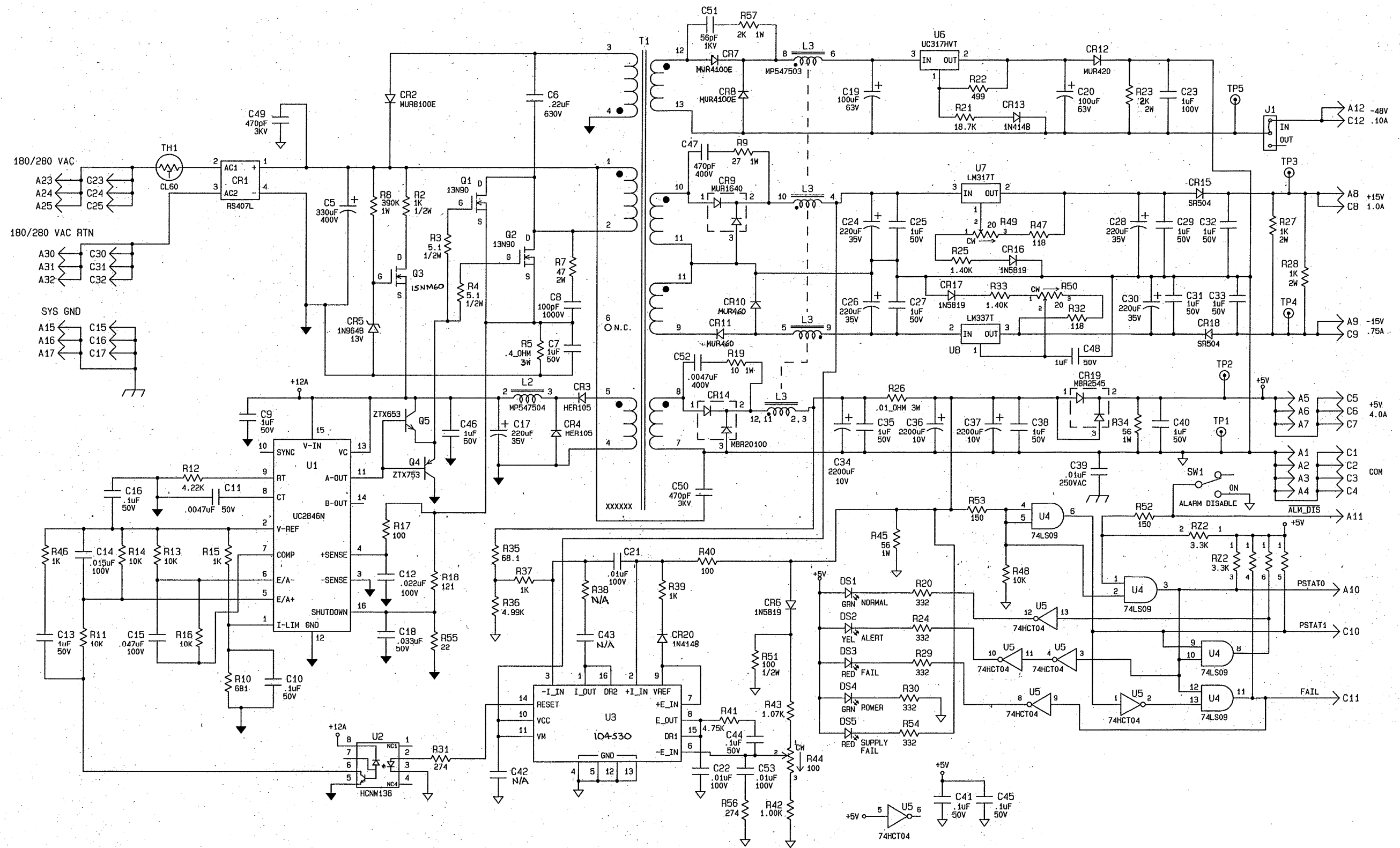


Figure 11-3. Schematic, IMUX 2000 Power Supply, 220 Vac
(Drawing No. D-106824-E)

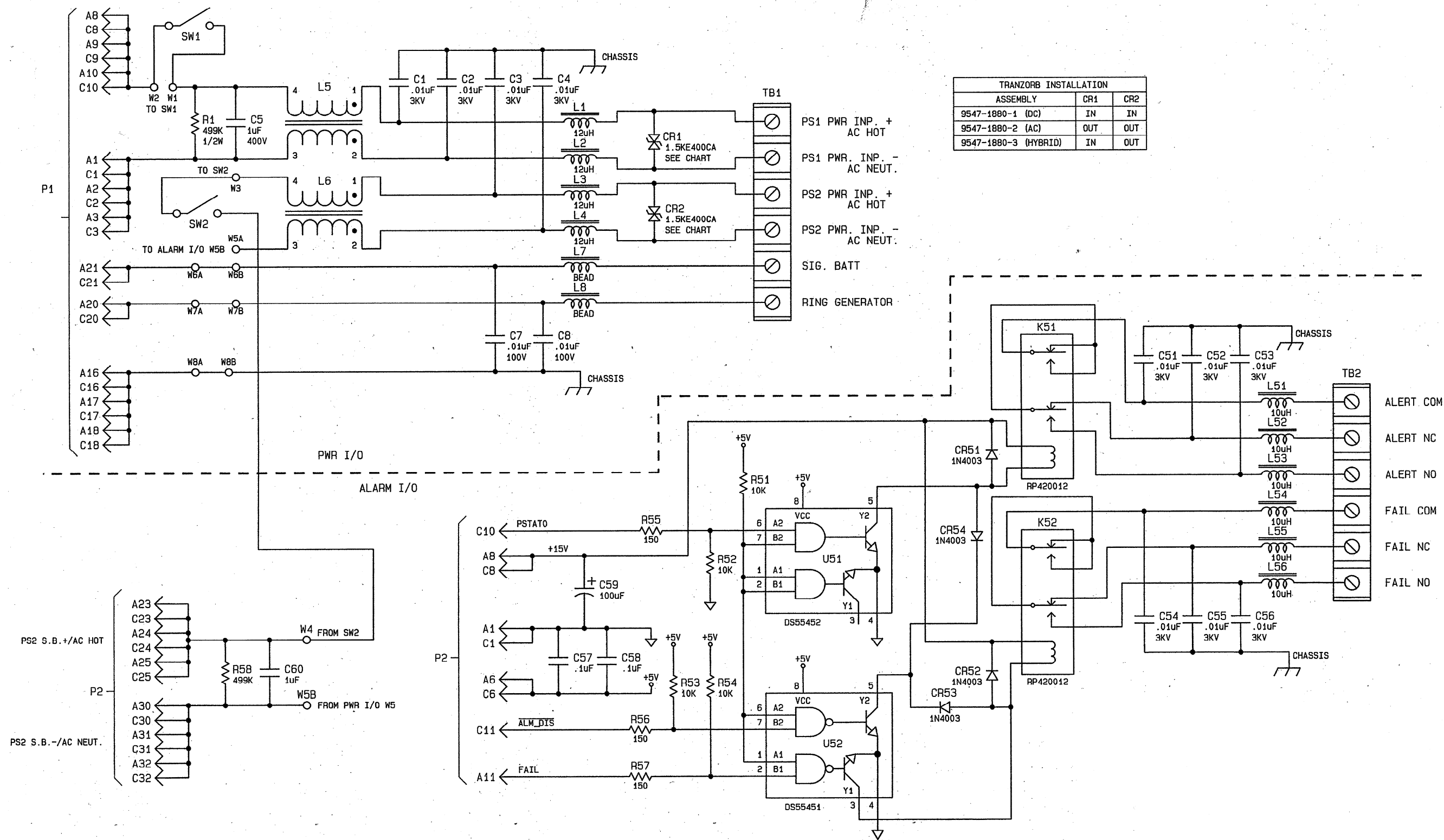


Figure 11-4. Schematic, IMUX 2000 Power Supply Alarm I/O
(Drawing No. D-105494-C)

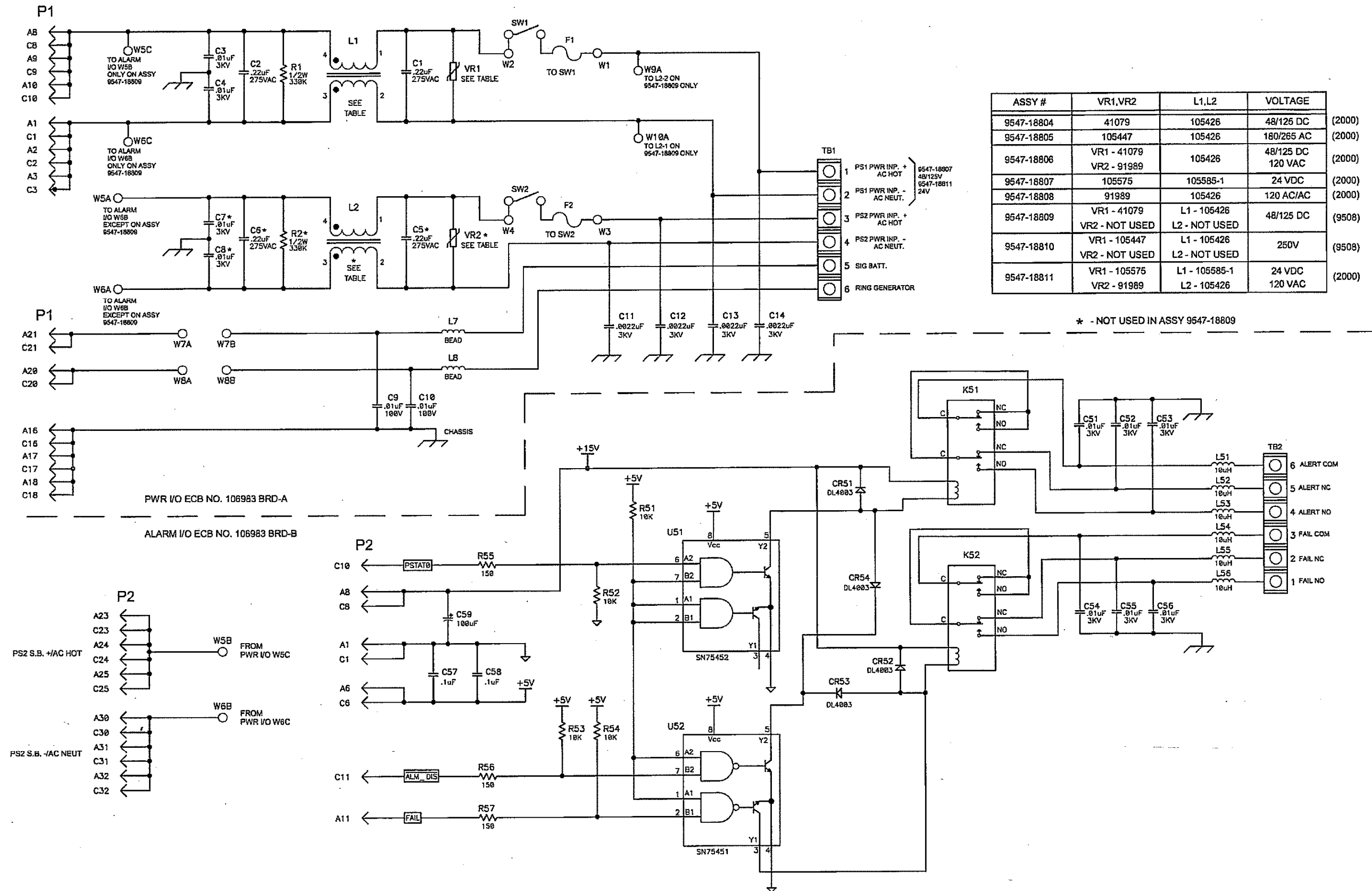


Figure 11-5. Schematic, IMUX 2000 Power Supply, Alarm I/O 24 Vdc
(Drawing No. D-106984-1-C)

SECTION 12. OPTICAL INTERFACE ADAPTERS

12.1 INTRODUCTION

This section provides technical information on the Optical Interface Adapters (OIAs) used to connect IMUX 2000 Intelligent T1 Multiplexers to fiber optic cables. Figure 12-1 shows the panel view of a typical OIA. Table 12-1 gives the characteristics of each Optical Interface Adapter.

WARNING!

YOUR IMUX 2000 TERMINAL MAY BE EQUIPPED WITH FIBER OPTIC INPUT/OUTPUT MODULES THAT HAVE FIBER OPTIC EMITTER HEADS. FIBER OPTIC EMITTER HEADS USE A LASER LIGHT SOURCE THAT PRODUCE INVISIBLE RADIATION. FIBER OPTIC COMMUNICATION SYSTEMS ARE INHERENTLY SAFE IN NORMAL OPERATION BECAUSE ALL RADIATION IS CONTAINED IN THE SYSTEM. IT IS POSSIBLE DURING MAINTENANCE TO EXPOSE THE RADIATION BY REMOVING OR BREAKING THE FIBER. STARING DIRECTLY INTO THE LIGHT BEAM MAY RESULT IN PERMANENT EYE DAMAGE AND/OR BLINDNESS. NEVER LOOK DIRECTLY INTO THE LIGHT BEAM AND BE CAREFUL NOT TO SHINE THE LIGHT AGAINST ANY REFLECTIVE SURFACE.

THE LASER SOURCE IS A CLASS I LASER PRODUCT WHICH COMPLIES WITH APPLICABLE FDA, OSHA AND ANSI STANDARDS.

If your IMUX 2000 is equipped with a Fiber Optic Module, fiber optic connectors must be connected to the fiber optic heads on the rear panel of the IMUX 2000 chassis. Type ST series bayonette fiber optic connectors (or their equivalent) are used with both singlemode and multimode fibers. The exact mating connector used will depend upon the head that is installed in the fiber optic module, and the specific optic cable being used.

When connecting fiber optic cables, make sure the connectors are properly aligned before tightening and then fully tighten them. This will help minimize losses in the connector.

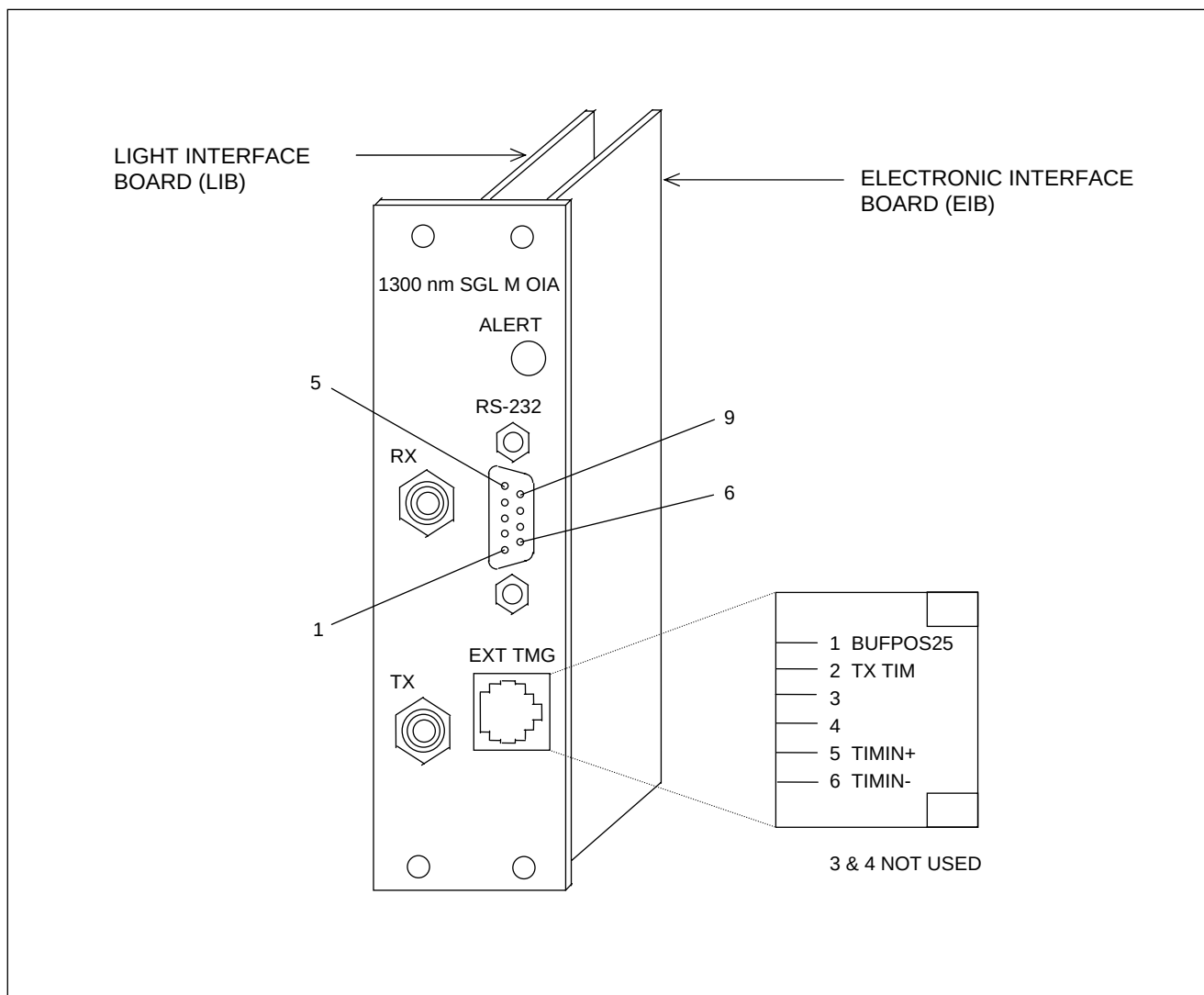


Figure 12-1. Typical Optical Interface Adapter (OIA), front view

Table 12-1. Characteristics of the IMAX 2000 Optical Interface Adapters

Assembly Number	Type	Wavelength/ Mode	Connector Type	Receiver Sensitivity (average)	TX Power (average)	System Gain	Typical Distance (3dB margin)
9547-1001 9547-1011	LED Emitter/ Detector	850 nm Multimode	ST	-52dBm	-18dBm	34dB	6 mi (9.6 km)
9547-3001 9547-3011	LED Emitter/ Detector	1300 nm Multimode	ST	-39dBm	-13dBm	26dB	10 mi (16 km)
9547-2001 9547-2011	LED Emitter/ Detector	1300 nm Singlemode	ST	-39dBm	-17dBm	22dB	17 mi (27 km)
9547-4001 9547-4011	Laser Emitter/ Detector	1300 nm Singlemode	ST	-39dBm	0dBm	39dB	36 mi (58 km)
9547-5001 9547-5011	Laser Emitter/ Detector	1500 nm Singlemode	ST	-39dBm	-3dBm	36dB	62 mi (99.7 km)

Each OIA contains an Electronic Interface Board and a Light Interface Board. Each of these boards is described below.

12.2 ELECTRONIC INTERFACE BOARD

The Electronic Interface Board (EIB), when connected to a Light Interface Board (LIB), forms an Optical Interface Adapter for the IMUX 2000 Intelligent T1 Multiplexer. It is an active Module Adapter that plugs into the rear of the multiplexer shelf. The EIB connects to the IMUX 2000's Common Module through 30-terminal edge connector JP1, which mates with a connector on the chassis motherboard. Electrical connections to the LIB are made through 16-terminal connector JP2. RS-232 connections are made through 9-pin D-subminiature (DB-9S) connector P1, and external timing inputs are applied to JP3, which is a modular telephone connector (RJ-12).

The EIB has all customer interface connections, RS-232 for remote control, and an external timing output. The LIB has the fiber optic connections for transmit and receive. A block diagram of the EIB appears in Figure 12-2.

12.2.1 EIB BLOCK DIAGRAM DISCUSSION

The balanced T1 signal from the Common Module (AMI or B8ZS) is applied to the EIB at edge connector terminals JP1-17 and JP1-18. Each side of the balanced signal is terminated in 51 ohms to provide a 100-ohm T1 termination across the Common Module's balanced output. A transistor array provides positive and negative TTL logic rails from the balanced bipolar signal, and feeds the rails to the logic array.

If AMI coding is being used, the positive and negative rails are OR'ed and re-timed by transmit daisy timing from the Common Module (received through edge connector terminal JP1-26). The re-timed NRZ TTL data is fed to a 7-bit scrambler. The scrambled TTL data is sent out of the logic array to a line driver that feeds it to the LIB through connector JP2-1. The TTL data is used to modulate the laser or LED light source on the LIB.

If B8ZS coding is being used, the positive and negative rails are applied to a B8ZS decoder. This decoder removes the B8ZS code before the data is applied to the 7-bit scrambler.

The transmit side has two alarms: "TXACT" and "TXALM." TXACT is the activity monitored at the TTL data output at the point where it is sent to the LIB. TXALM is an alarm generated by the LIB if the outgoing light level falls below a set limit. Both alarms are reported over the Serial Control Bus (SCB) in the status byte. If either alarm is active, the ALERT indicator on the EIB will light.

The receive side of the EIB accepts incoming data from the LIB. It recovers the timing, and then retimes and descrambles the data. The receive side also generates B8ZS or AMI, and drives a balanced T1 signal to the receive side of the IMUX 2000 Common Module.

TTL NRZ scrambled data from the LIB is fed to the EIB through connector JP2-16. The data is sent to the logic circuits and a timing recovery circuit. A monostable multivibrator in the timing recovery circuit generates half-width pulses for each transition of the data (both positive and negative). These pulses are sent to one side of a phase detector.

The timing recovery circuit contains a voltage-controlled oscillator (VCO) that runs at twice the T1 frequency, or 3.088 MHz. This is divided by two in the logic circuits and sent to the other side of the phase detector. The output of the phase detector locks the VCO onto the incoming data frequency.

The logic circuit uses the recovered timing to retime the NRZ data, and then passes it through a 7-bit descrambler. The descrambled data is sent to a B8ZS encoder if B8ZS mode has been selected; if AMI mode has been selected, the data is sent to an AMI encoder. Once encoded, the data is fed to a T1 line driver circuit, and on to the Common Module through edge connector terminals JP1-13 and JP1-14.

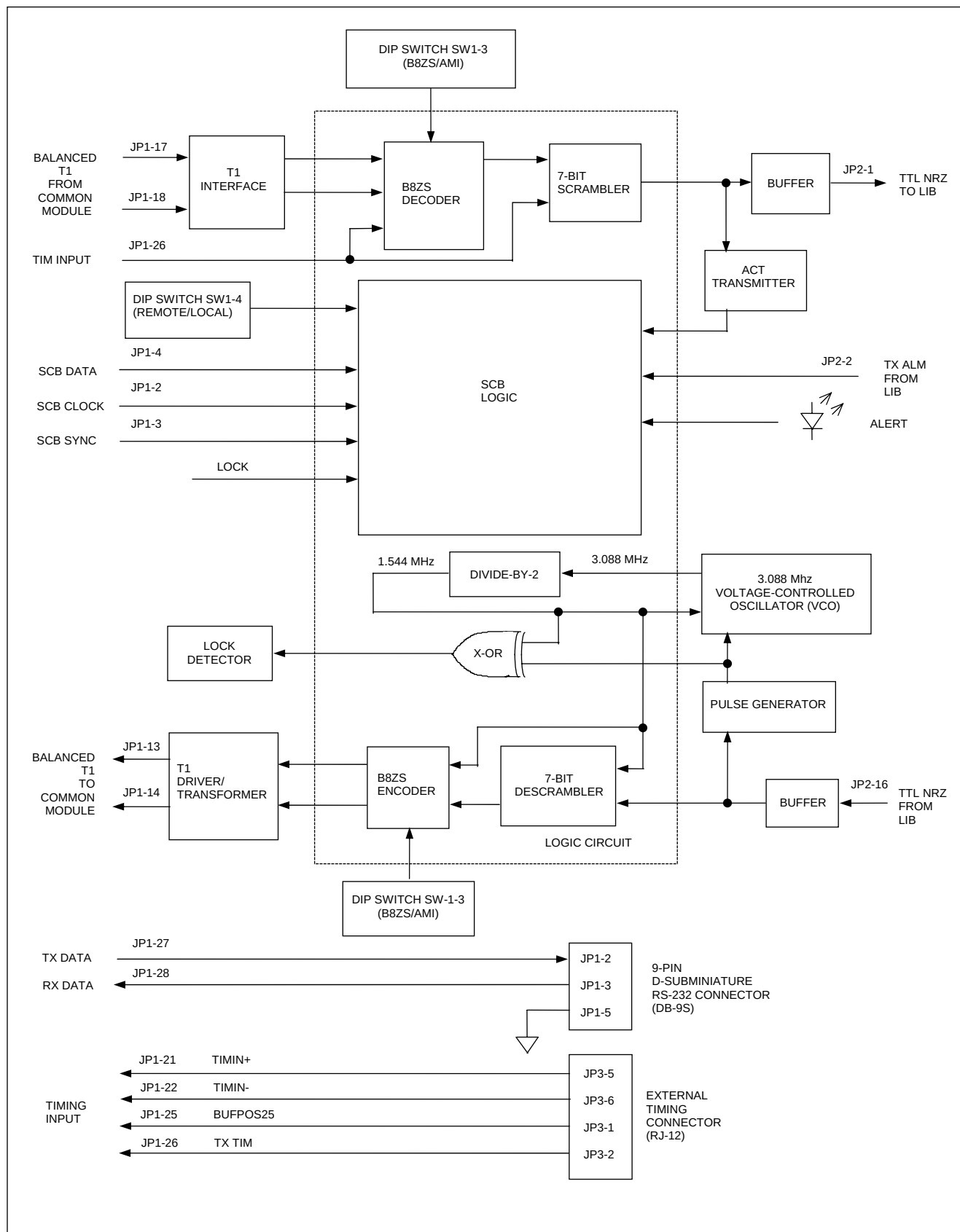


Figure 12-2. Block diagram, Electronic Interface Board (EIB) for IMUX 2000 Optical Interface Adapters (OIAs)

12.3 LIGHT INTERFACE BOARD (LIB)

The Light Interface Board (LIB) contains an emitter section and a detector section. The emitter section contains a fiber optic emitter (LED or laser), a driver, and failure detector circuits to detect misoperation due to component failures. The receive section consists of the fiber optic photodetector, a light level detector, a trans-impedance amplifier (with automatic gain control), several amplifier stages, and a threshold detector. A block diagram of the LIB appears in Figure 12-3.

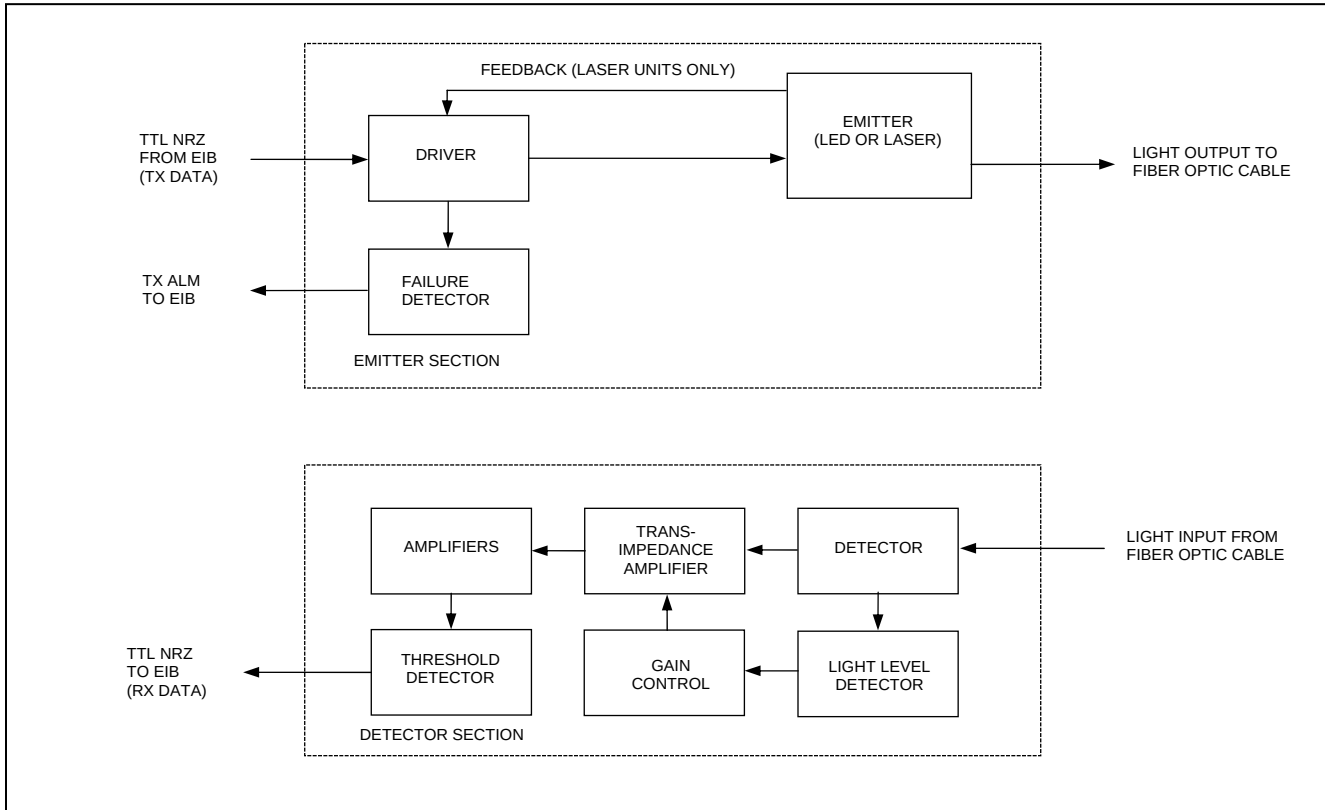


Figure 12-3. Block diagram, Light Interface Board (LIB) for IMUX 2000 Optical Interface Adapters (OIAs)

The emitter section accepts the TTL NRZ data produced by the EIB, and applies it to the input of the driver circuit. The driver circuit produces a modulated current that is fed to the fiber optic emitter. The emitter produces a light signal that is modulated by the NRZ data. This modulated light output is then fed to a fiber optic cable for transmission to a remote IMUX 2000 multiplexer.

In the detector section, a modulated light signal from an incoming fiber optic cable is applied to the fiber optic detector, where it is converted to an electrical signal. This signal is then fed to a trans-impedance amplifier. A portion of this signal is also fed to a light level detector. The output of this detector drives a gain control circuit connected to the transimpedance amplifier. When the incoming light level is high, the light level detector and gain control circuit reduce the trans-impedance amplifier's gain; when light levels are low, the gain is increased. This automatic optical gain adjustment avoids saturation of the receiver, and allows IMUX 2000 multiplexers with OIAs to be connected without using fiber optic attenuators.

The output of the trans-impedance amplifier is fed through several more amplifier stages before it is applied to a threshold detector. The threshold detector produces a TTL NRZ signal that is a replica of the signal applied to the LIB at the remote multiplexer.

During system operation, the LIB can generate the following alarms and pass them to the logic circuits on the EIB:

TXACT

XACT is the activity monitored at the TTL data output at the point where the data is sent to the LIB.

TXALM

TXALM is an alarm generated by the LIB if the outgoing light level falls below a set limit.

LOCK

LOCK is an indication that the VCO has locked onto the incoming data. When this alarm is active, the data output to the Common Module is set to all zeroes. This occurs in both the B8ZS and AMI modes.

If any of these alarms are active, the ALERT indicator on the EIB will light.

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SECTION 13. REFERENCE DATA

13.1 SF AND ESF FORMATS

See Figures 13-1 and 13-2.

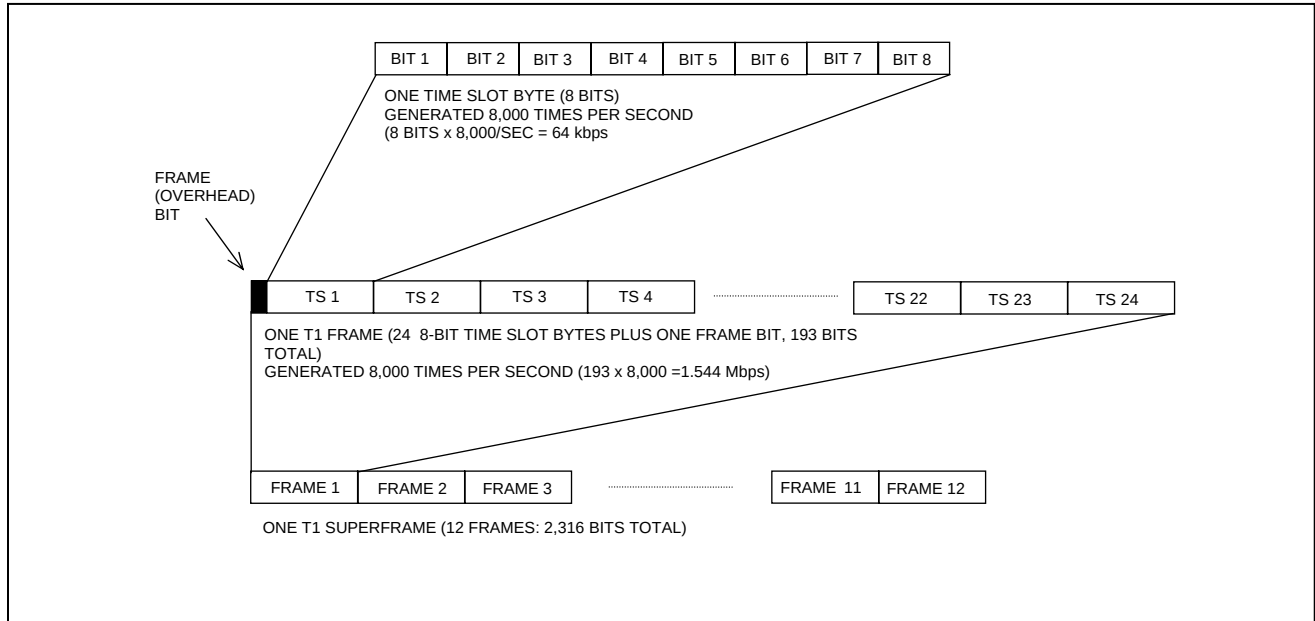


Figure 13-1. T1 Superframe (SF) format

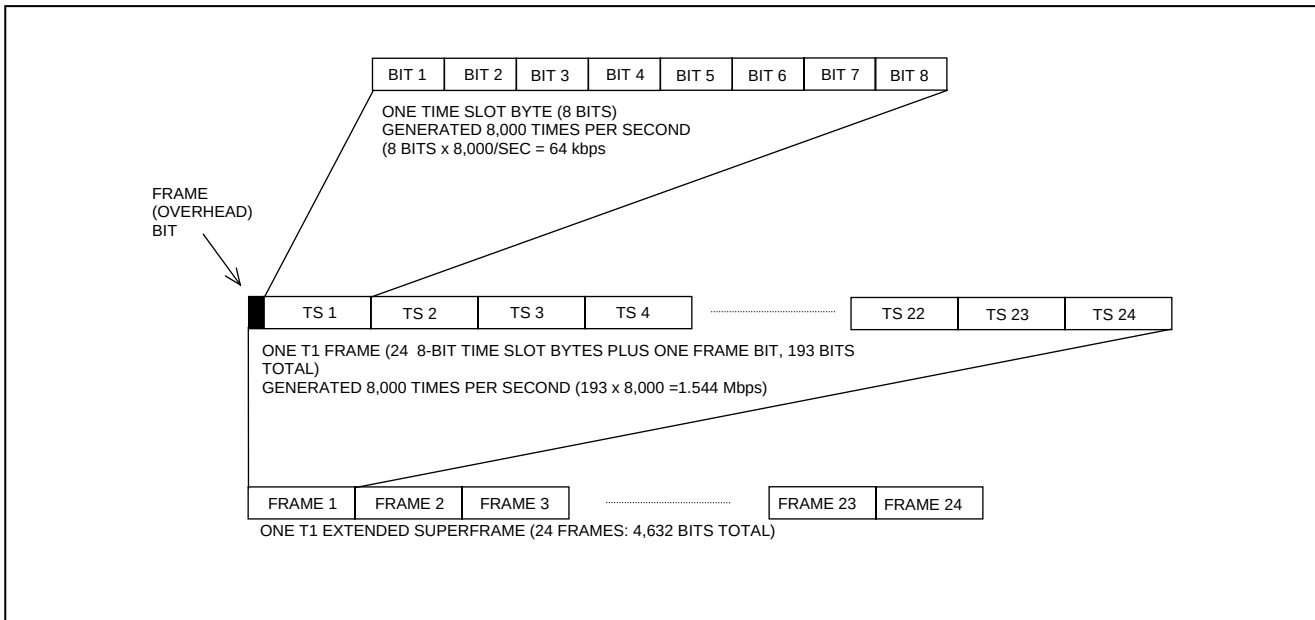


Figure 13-2. T1 Extended Superframe (ESF) format

13.2 GLOSSARY OF ACRONYMS

ADPCM	Adaptive Differential Pulse Code Modulation
AIS	Alarm Indication Signal
AMI	Alternate Mark Inversion
ANSI	American National Standards Institute
B8ZS	Bipolar with 8-Zero Substitution
BPV	Bipolar Violation
CCITT	International Telephone and Telegraph Consultative Committee
CODEC	Coder-Decoder
CPU	Central Processing Unit (microprocessor)
CRC-6	Cyclic Redundancy Code (6-bit)
CSU	Channel Service Unit
DACS	Digital Access and Cross-connect System
DCE	Data Communications Equipment
DI-A	Drop/Insert Direction A.
DI-B	Drop/Insert Direction B.
DRR	Digital Rate Reducer
DS0	Digital Signal Level 0 (64 Kbps)
DS1	Digital Signal Level 1 (same as "T1")
DSP	Digital Signal Processing
DSU/CSU	Data Service Unit/Channel Service Unit
DSX-1	Digital Signal Cross-connect (for T1/DS1 signals)
DTE	Data Terminal Equipment
EIB	Electronic Interface Board

ESF	Extended Superframe
FDL	Facility Data Link
ILS	Intelligent Line Switch
Kbps	Thousands of bits per second (bit rate)
kHz	Thousands of cycles per second (frequency)
LED	Light Emitting Diode
LIB	Light Interface Board
LLB	Line Loopback
MA	Module Adapter
Mbps	Millions of bits per second (bit rate)
MDAC	Multi-Channel Digital Audio Codec
MHz	Millions of cycles per second (frequency)
MTBF	Mean Time Between Failure
OIA	Optical Interface Adapter
PCM	Pulse Code Modulation
PLL	Phase-Locked Loop
RLB	Remote Loopback
SCB	Serial Control Bus
SCL	Simplified Command Language
SF	Superframe
SONET	Synchronous Optical Network
T1	Common name for DS1 (1.544 Mbps signals and circuits)
T1 CSU	T1 (1.544 Mbps) Channel Service Unit
TDM	Time Division Multiplexing

TTL

Transistor-transistor Logic

SECTION 14. INDEX

A

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SECTION 15. ASYNCHRONOUS DATA CHANNEL MODULES

This section contains Instruction Data Sheets for all asynchronous data channel modules available for use with the IMUX 2000 Intelligent Multiplexer, as of the date this manual was printed:

- o **RFL DA-91I Asynchronous Data Channel Module**
- o **RFL DA-121I Asynchronous Data Channel Module**
- o **RFL DA-291B Four-Port Asynchronous Data Channel Module**

Additional schematics, wiring diagrams, or other documents specific to your application may also be placed in this section.

For information on other asynchronous data channel modules that may be available for use with your IMUX 2000, contact the factory or an RFL Sales Representative.

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INSTRUCTION DATA

RFL DA-91I Two Port Asynchronous Data Polling Channel Module

DESCRIPTION

The RFL DA-91I is an Asynchronous Data Polling Channel Module designed for use in RFL IMUX 2000 multiplexers. It provides one or two full duplex channels between an unlimited number of locations using a single 64 kbps DS0 time slot. The DA-91I is ideal for interconnecting remotely located DTE equipment that can respond to data polling. It constantly monitors data from one or both directions of the T1 or E1 bus in either a drop and insert or terminal shelf application. Transmission is activated upon the reception of an RTS (Request to Send) from the DTE equipment. The transmission rate for single channel operation is up to 9.6 kbps (up to 19.2 kbps with 35% jitter). The transmission rate for dual channel operation is up to 4.8 kbps for each channel. This module is used in applications that require multiple DA-91I cards on the same time slot, and within the same multiplexer chassis. The DA-91I requires the use of an MA-402I Module Adapter, which provides two RS-232 interface ports. The DA-91I automatically detects if the system is T1 or E1 and configures itself appropriately.

The DA-91I is remote-controllable when installed in an RFL remote controllable shelf. The following module parameters can be configured remotely via the SCB or locally via DIP switches. A DIP switch setting will control whether the card is in remote or local mode.

o	TX/RX Time Slot	1-32
o	TX Bus Direction	TX-A(RX-B) / TX-B(RX-A)
o	Service enable/disable	ON/OFF
o	Local Loopback	ON/OFF
o	Remote Loopback	ON/OFF
o	Signaling (CAS)	ON/OFF
o	CTS1/CTS2 (clear to send CH1/CH2)	ON/OFF
o	7 bit (using extra bit to sample data)	ON/OFF
o	Mode	Single/Dual
o	Time Slot Sharing (see note on next page)	ON/OFF

NOTE

Time Slot Sharing is only supported by software version SW200091I04 or later. To determine the software version of the DA-91I in your system, remove the module from the multiplexer chassis and read the label on device U1. The second line on the label is the software version. The software label will be similar to the one shown below.

U1 5-17-01 SW200091I04 © '01 RFL

SPECIFICATIONS

As of the date this Instruction Data Sheet was published, the following specifications apply to the RFL DA-91I Asynchronous Data Polling Channel Module. Because all of RFL products undergo constant improvement and refinement, these specifications are subject to change without notice.

Live Insertion/Extraction: The DA-91I is capable of live insertion and extraction into the IMUX 2000 shelf without interruption to the DS1 or any other DS0.

Asynchronous Data Interface:

Full duplex, one or two channel operation, two independent RS-232 data ports.

Data Rates:

One Channel operation: 0 bps to 19.2 kbps
Two Channel operation: 0 bps to 4.8 kbps

Time Slots: Both channels occupy one selectable DS0 time slot.

Jitter: Jitter rates shown below are proportionally lower for lower input rates:

At 4.8 kbps output data jitter is 20%.
At 9.6 kbps output data jitter is 20%.
At 19.2 kbps output data jitter is 35%.

RS-232 Interface:

Supports: Tx Data, Rx Data, Receive Line Signal Detect, Request to Send, Clear to Send, Data Set Ready, Signal Ground.

Connector:

The DA-91I module requires the use of the MA-402I Module Adapter, which provides two DB-9 connectors for the RS-232 interface.

Power Dissipation: 1 Watt nominal

RFI/EMI: C.37.90.2

MTBF (Calculated): Greater than 500,000 hours per Bellcore TR-332.

Operating Temperature: -20°C to +55°C (-4°F to +131°F).

Humidity: 0 to 95 %, non-condensing.

INSTALLATION

Before the RFL DA-91I can be placed in service, it must be installed in a multiplexer shelf. Installation involves determining the module slot in the Main Shelf or Expansion Shelf where the module will be installed, inserting a Module Adapter into the rear of the shelf behind the module slot, connecting all signal and power wiring to the Module Adapter, checking the settings of all switches, and inserting the module into the front of the shelf.

NOTES

Power supply and time slot considerations may affect the installation of this module into an existing multiplexer shelf. Refer to the multiplexer manual for more information.

The following instructions are provided for installing an RFL DA-91I module into an existing system. If the module was included as part of a system, installation was done at the factory. Otherwise, proceed as follows:

1. Carefully inspect the module for any visible signs of shipping damage. If you suspect damage to the module, immediately call RFL Customer Service at the number listed at the bottom of this page.
2. Determine the module slot in the Main Shelf or Expansion Shelf where the module will be installed.
RFL DA-91I module occupies one module slot in the Main Shelf or Expansion Shelf.
3. Insert a Module Adapter into the rear of the shelf directly behind the module slot where the RFL DA-91I will be installed.
Each RFL DA-91I module requires an MA-402I Module Adapter as shown in Figure 1. This module adapter has two 9-pin D-subminiature (DC-9S) connectors on its rear panel. Each of these 9-pin connectors is wired in a standard RS-232 configuration as shown in Table 1. Each connector is labeled to show the corresponding channel on the RFL DA-91I.
4. Using Table 1 as a guide, connect all signal wiring to the MA-402I Module Adapter.
5. Refer to Figure 2 and Table 2 for the location of DIP switches on the DA-91I module.

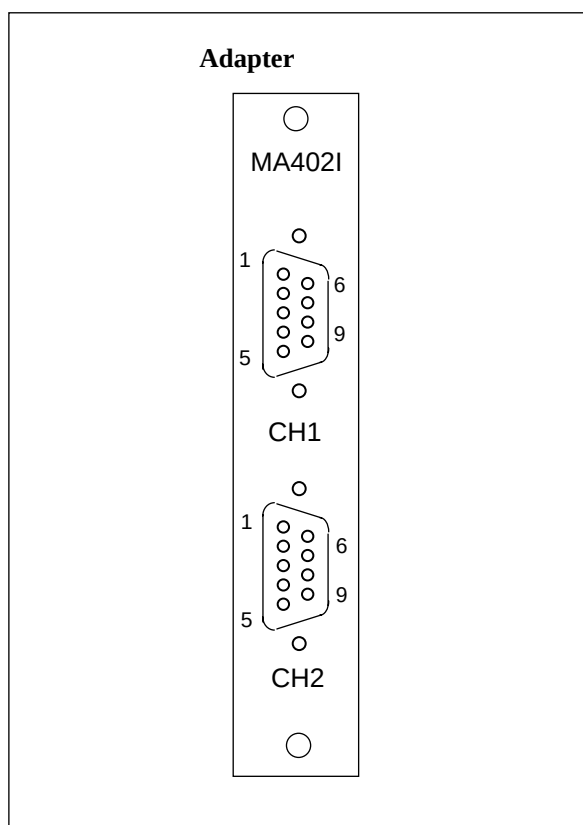


Table 1. Wiring assignments, MA-402I Module

Pin No.	Signal Name
1	Receive Line Signal Detect
2	Receive Data
3	Transmit Data
4	Not used
5	Signal Ground
6	Data Set Ready
7	Request To Send
8	Clear To Send
9	Not used

Figure 1. MA-402I Module Adapter

6. Set the module address using DIP switches SW1-1 through SW1-6 for the desired remote address (SCB address).

For remote access, each channel module in the IMUX 2000 must have a distinct module address. Valid addresses are the numbers “1” to “36”. In most installations the address will be set to the number of the slot the module is occupying. Table 2 shows the switch settings for the module address. (Consult your multiplexer manual for details on using the remote access and configuration features of the system).

7. Select an unused time slot for channel 1 using DIP switches SW2-1 through SW2-5. Each active voice channel uses one 64 Kbps digital time slot within the multiplexer’s aggregate rate. Set the time slot using direct binary coding as shown in Table 4. Refer to the multiplexer manual for guidelines on time slot selection.

Note that selecting an invalid time slot will disable the module. In T1 systems, only time slots 1 through 24 are allowed.

In E1 systems, time slots 1 through 31 are allowed, however, time slots 0 and 16 are reserved and cannot be used.

8. Set DIP switch SW2-6 to enable or disable CAS (channel associated signaling).

Place SW2-6 in the UP position to disable signaling

Place SW2-6 in the DOWN position to enable signaling

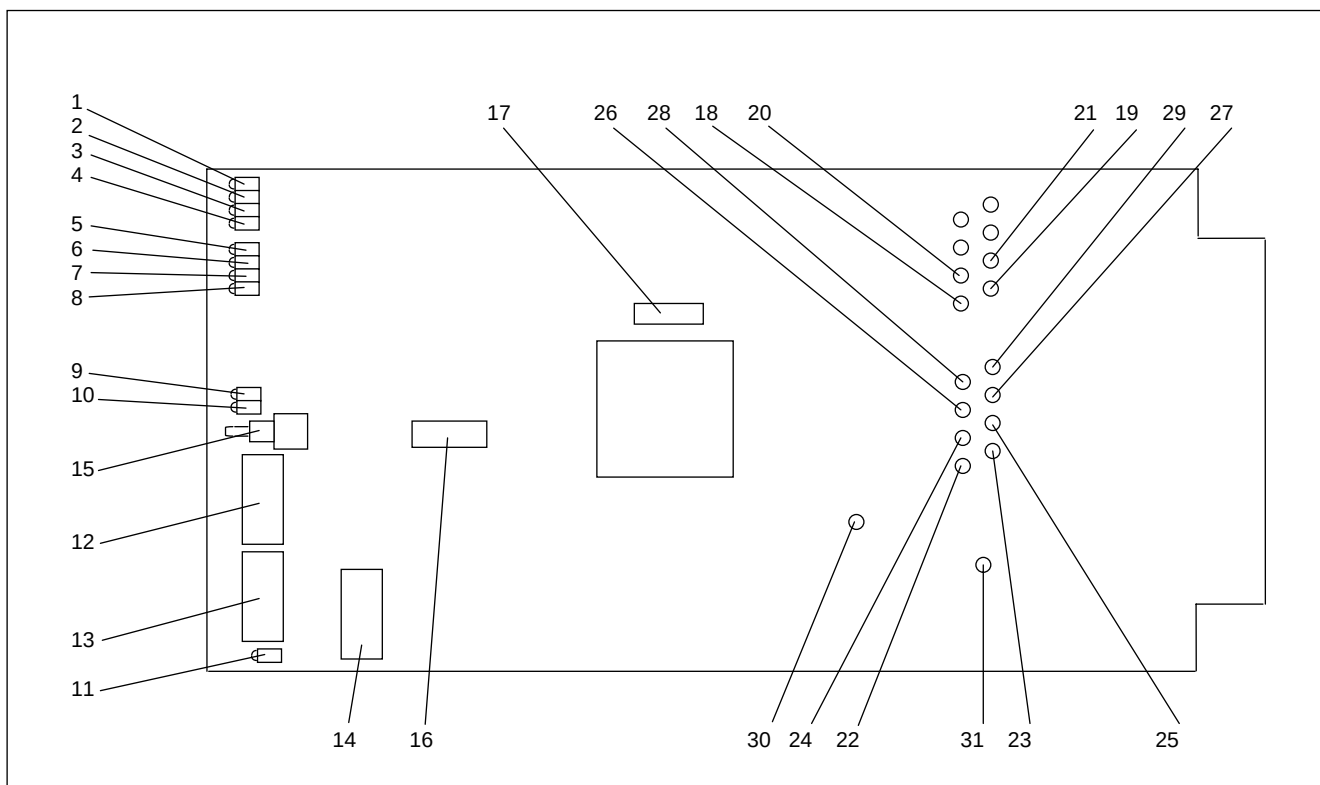


Figure 2. Controls and indicators, RFL DA-91I Asynchronous Data Polling Channel Module

9. Select Bus direction by using DIP switches SW2-7 and SW2-8.
Place SW2-7 in the DOWN position to transmit in the B direction and receive from the A direction. Place SW2-7 in the UP position to disable the B Bus.
Place SW2-8 in the DOWN position to transmit in the A direction and receive from the B direction. Place SW2-8 in the UP position to disable the A Bus.
10. Set DIP switch SW3-1 to select one channel or two channel operation..
Place SW3-1 to the ON position to select one channel operation
Place SW3-1 to the OFF position to select two channel operation
11. Set DIP switch SW3-2 to turn on CTS1.
Place SW3-2 to the ON position to turn on CTS1 at all times
Place SW3-2 to the OFF position to make CTS1 operate as a function of RTS1
12. Set DIP switch SW3-3 to turn on CTS2.
Place SW3-3 to the ON position to turn on CTS2 at all times
Place SW3-3 to the OFF position to make CTS2 operate as a function of RTS2
13. Set DIP switch SW3-4 to enable 7-bit sampling.
Place SW3-4 to the ON position to use 7 bits for sampling in single mode and 1 signaling bit. In dual mode it will enable 2 signaling bits.
Place SW3-4 to the OFF position to use 6 bits for sampling in single mode and 1 signaling bit. In dual mode it will enable 1 signaling bit.

>> text continues on page 8 <<

Table 2. Controls and indicators, RFL DA-91I Module

Item	Name/Description	Function
1	CH1 RTS LED (green), DS2	Lights when Channel 1 RTS (Request To Send) is active
2	CH1 TX LED (green), DS3	Lights when Channel 1 is transmitting
3	CH1 RX LED (green), DS4	Lights when Channel 1 is receiving
4	CH1 RLSD LED (green), DS5	Lights when Channel 1 RLSD (Receive Line Signal Detect) is active
5	CH2 RTS LED (green), DS10	Lights when Channel 2 RTS is active
6	CH2 TX LED (green), DS11	Lights when Channel 2 is transmitting
7	CH2 RX LED (green), DS12	Lights when Channel 2 is receiving
8	CH2 RLSD LED (green), DS13	Lights when Channel 2 RLSD is active
9	LOC LB LED (red), DS18	Lights when module is in Local Loopback mode
10	REM LB LED (red), DS19	Lights when module is in Remote Loopback mode
11	Service LED (green), DS1	Lights when service is ON
12	DIP Switch, SW1	SW1-1 to SW1-6 Selects SCB Address (See Table 3)
		SW1-7 Selects Local or Remote control UP = Local Control DOWN = Remote Control
		SW1-8 Selects module service ON or OFF UP = Service ON DOWN = Service OFF
13	DIP Switch, SW2	SW2-1 to SW2-5 Selects Time Slot (See Table 4)
		SW2-6 Selects CAS ON or OFF UP = CAS ON DOWN = CAS OFF
		SW2-7 Selects transmit on B receive on A
		SW2-8 Selects transmit on A receive on B
14	DIP Switch, SW3	SW3-1 Selects one channel or two channel operation ON = one channel operation OFF = two channel operation
		SW3-2 Enables CTS1 ON = CTS1 on at all times OFF = CTS1 a function of RTS1
		SW3-3 Enables CTS2 ON = CTS2 on at all times OFF = CTS2 a function of RTS2
		SW3-4 Enables 6 or 7 sampling bits ON = Enables 7 sampling bits (Used when DA-91I is interfaced with another DA-91I. OFF = Enables 6 sampling bits (Used when DA-91I is interfaced with a DA-91.
		SW3-5 Time slot sharing ON= Time Slot Sharing is enabled. OFF= Time Slot Sharing is disabled (Normal Operation). (See Paragraph 14 of Installation Section for more information)
15	Toggle Switch, SW4	Selects Local Loopback, Normal, or Remote Loopback
16	Jumper array, J1	For factory use only
17	Jumper J2	For factory test only using ACTEL Probe
18	Test point, TP1	Channel 1 TX local data
19	Test point, TP2	Channel 1 RTS bit
20	Test point, TP3	Channel 2 TX local data
21	Test point, TP4	Channel 2 RTS bit
22	Test point, TP9	Channel 1 CTS bit

Table 2. - continued, Controls and indicators, RFL DA-91I Module

Item	Name/Description	Function
23	Test point, TP10	Channel 1 RX local data
24	Test point, TP11	Channel 1 DSR
25	Test point, TP12	Channel 1 RLSD
26	Test point, TP13	Channel 2 RLSD
27	Test point, TP14	Channel 2 RX local data
28	Test point, TP15	Channel 2 DSR
29	Test point, TP16	Channel 2 CTS
30	Test point, TP17	+5 VDC
31	Test point, TP0	Ground

Table 3. SCB address settings, RFL DA-91I module

Module Address	SW1-1	SW1-2	SW1-3	SW1-4	SW1-5	SW1-6
1	DOWN	DOWN	DOWN	DOWN	DOWN	UP
2	DOWN	DOWN	DOWN	DOWN	UP	DOWN
3	DOWN	DOWN	DOWN	DOWN	UP	UP
4	DOWN	DOWN	DOWN	UP	DOWN	DOWN
5	DOWN	DOWN	DOWN	UP	DOWN	UP
6	DOWN	DOWN	DOWN	UP	UP	DOWN
7	DOWN	DOWN	DOWN	UP	UP	UP
8	DOWN	DOWN	UP	DOWN	DOWN	DOWN
9	DOWN	DOWN	UP	DOWN	DOWN	UP
10	DOWN	DOWN	UP	DOWN	UP	DOWN
11	DOWN	DOWN	UP	DOWN	UP	UP
12	DOWN	DOWN	UP	UP	DOWN	DOWN
13	DOWN	DOWN	UP	UP	DOWN	UP
14	DOWN	DOWN	UP	UP	UP	DOWN
15	DOWN	DOWN	UP	UP	UP	UP
16	DOWN	UP	DOWN	DOWN	DOWN	DOWN
17	DOWN	UP	DOWN	DOWN	DOWN	UP
18	DOWN	UP	DOWN	DOWN	UP	DOWN
19	DOWN	UP	DOWN	DOWN	UP	UP
20	DOWN	UP	DOWN	UP	DOWN	DOWN
21	DOWN	UP	DOWN	UP	DOWN	UP
22	DOWN	UP	DOWN	UP	UP	DOWN
23	DOWN	UP	DOWN	UP	UP	UP
24	DOWN	UP	UP	DOWN	DOWN	DOWN
25	DOWN	UP	UP	DOWN	DOWN	UP
26	DOWN	UP	UP	DOWN	UP	DOWN
27	DOWN	UP	UP	DOWN	UP	UP
28	DOWN	UP	UP	UP	DOWN	DOWN
29	DOWN	UP	UP	UP	DOWN	UP
30	DOWN	UP	UP	UP	UP	DOWN
31	DOWN	UP	UP	UP	UP	UP
32	UP	DOWN	DOWN	DOWN	DOWN	DOWN
33	UP	DOWN	DOWN	DOWN	DOWN	UP
34	UP	DOWN	DOWN	DOWN	UP	DOWN
35	UP	DOWN	DOWN	DOWN	UP	UP
36	UP	DOWN	DOWN	UP	DOWN	DOWN

NOTE: For SW1, UP = ON and DOWN = OFF.

Table 4. Time Slot Select for RFL DA-91I module

Switch Code (Decimal)	Switch Settings					T1	E1
	SW2-1	SW2-2	SW2-3	SW2-4	SW2-5		
0	DOWN	DOWN	DOWN	DOWN	DOWN	*	*
1	DOWN	DOWN	DOWN	DOWN	UP	1	1
2	DOWN	DOWN	DOWN	UP	DOWN	2	2
3	DOWN	DOWN	DOWN	UP	UP	3	3
4	DOWN	DOWN	UP	DOWN	DOWN	4	4
5	DOWN	DOWN	UP	DOWN	UP	5	5
6	DOWN	DOWN	UP	UP	DOWN	6	6
7	DOWN	DOWN	UP	UP	UP	7	7
8	DOWN	UP	DOWN	DOWN	DOWN	8	8
9	DOWN	UP	DOWN	DOWN	UP	9	9
10	DOWN	UP	DOWN	UP	DOWN	10	10
11	DOWN	UP	DOWN	UP	UP	11	11
12	DOWN	UP	UP	DOWN	DOWN	12	12
13	DOWN	UP	UP	DOWN	UP	13	13
14	DOWN	UP	UP	UP	DOWN	14	14
15	DOWN	UP	UP	UP	UP	15	15
16	UP	DOWN	DOWN	DOWN	DOWN	16	16****
17	UP	DOWN	DOWN	DOWN	UP	17	17
18	UP	DOWN	DOWN	UP	DOWN	18	18
19	UP	DOWN	DOWN	UP	UP	19	19
20	UP	DOWN	UP	DOWN	DOWN	20	20
21	UP	DOWN	UP	DOWN	UP	21	21
22	UP	DOWN	UP	UP	DOWN	22	22
23	UP	DOWN	UP	UP	UP	23	23
24	UP	UP	DOWN	DOWN	DOWN	24**	24
25	UP	UP	DOWN	DOWN	UP	*	25
26	UP	UP	DOWN	UP	DOWN	*	26
27	UP	UP	DOWN	UP	UP	*	27
28	UP	UP	UP	DOWN	DOWN	*	28
29	UP	UP	UP	DOWN	UP	*	29
30	UP	UP	UP	UP	DOWN	*	30**
31	UP	UP	UP	UP	UP	*	31***

Notes: * This setting is not allowed . Setting switches to this code will cause the module's service to be disabled.
 **A T1 or E1 network utilizing fast reframing cannot utilize this time slot for voice channel.
 *** An E1 network utilizing inter-node communications (NMX) cannot use timeslot 31 for voice channel.
 **** Not valid if signaling is enabled in E1. Time slot 16 is reserved for CAS.

14. Set DIP switch SW3-5 to enable or disable Time Slot Sharing.

Place SW3-5 to the ON position to enable Time Slot Sharing. The TX data outputs on the T1 bus are deactivated unless RTS1 or RTS2 or both are active. This setting allows multiple DA-91I cards to use the same time slot in the same multiplexer chassis. Only a single RTS signal on any of the cards may be active at one time.

Place SW3-5 to the OFF position to disable Time Slot Sharing. The TX data outputs on the T1 bus are always active, regardless of RTS1 or RTS2. "IDLE" data bits are inserted onto the TX data output corresponding to an inactive RTS signal.

15. If you plan to operate the RFL DA-91I module under local control, perform the following steps; otherwise, go to step 16 for remote control.
 - a. Set to local control by placing DIP switch SW1-7 in the UP position.
 - b. Turn service on by placing DIP switch SW1-8 in the UP position.
 - c. Slide the module into the selected module slot until it is firmly seated and the module front panel is flush with the top and bottom of the shelf.
 - d. Go to step 17.
16. If you plan to operate the RFL DA-91I module under remote control, perform the following steps:
 - a. Set to local control by placing DIP switch SW1-7 in the UP position.
 - b. Turn service off by placing DIP switch SW1-8 in the DOWN position.
 - c. Slide the module into the selected module slot until it is firmly seated and the module front panel is flush with the top and bottom of the shelf.
 - d. Wait 15 seconds for the RFL DA-91I module's parameter settings to be loaded into the shelf Common Module.
 - e. Pull the module out of the shelf and set to remote control by placing DIP switch SW1-7 in the DOWN position.

Do not move SW1-8.
 - f. Slide the module back into the shelf.
 - g. Verify the module configuration through remote control by issuing a "CONFIG?" query. See the Remote Control Interface section of this Instruction Data Sheet for an explanation of the "CONFIG?" response.
 - h. Turn service on through remote control by issuing a "SRVC=ON" command.

The RFL DA-91I's operating parameters can now be changed by remote control. See the Remote Control Interface section of this Instruction Data Sheet for more information.
 - i. Go to step 17.
17. On the Module Record Card located to the right of the shelf, record the channel bank type, time slot, and any other pertinent information.
18. The RFL DA-91I is now installed. If your multiplexer is set up for remote access and control, you can now change the operating parameters of the module by using simple commands. For more information on remote access and control, consult your multiplexer operation manual.

FUNCTIONAL DESCRIPTION

Figure 3 is a functional block diagram of the RFL DA-91I module. It is provided to familiarize the user with the RFL DA-91I's signal flow and interfacing. The figure shows signal flow in the transmit and receive modes of operation.

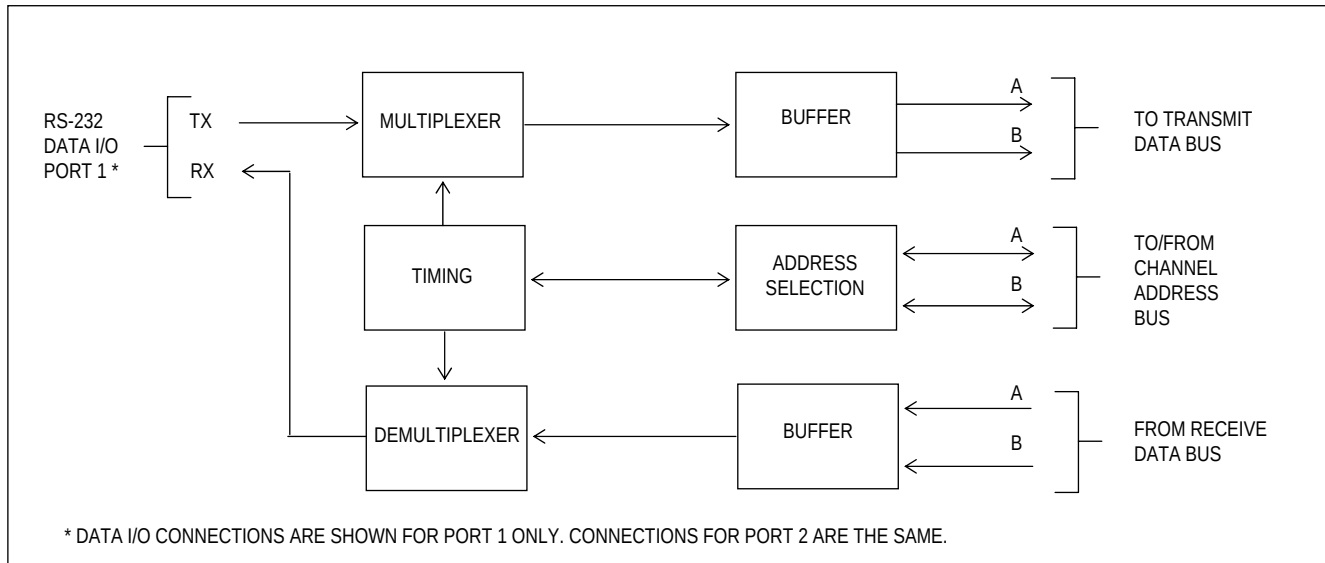


Figure 3. Functional block diagram, RFL DA-91I module.

The RFL DA-91I can provide one or two full duplex channels between an unlimited number of locations using a single 64 kbps DS0 time slot. It can be used in IMUX 2000 Terminal or Drop/Insert multiplexers. The data channels are interfaced to the RFL DA-91I through the MA-402I Module Adapter. A cable adapter plugs into the MA-402I to provide a 9-pin D-subminiature (DB-9S) connector for each channel. Each 9-pin connector is wired in a standard RS-232 configuration, as shown below, and is labeled to show the corresponding channel on the RFL DA-91I.

Receive Data (RxD)	Pin 2
Transmit Data (TxD)	Pin 3
Ground	Pin 7

Connections to and from the RFL DA-91I is accomplished through an edge connector on the module, the motherboard bus, and an RS-232 interface to the IMUX 2000 control and monitor modules. The received data contains the data extracted from the T1 line, and the transmit data contains the data to be inserted into the T1 line. Transmit and receive bus directions and time slot selections are independently selectable by DIP switches SW1 and SW2.

The RFL DA-91I supports Tx Data, Rx Data, Receive Line Signal Detect, Request to Send, Clear to Send, Data Set Ready and Signal Ground. Once the control signals have been established, the transmitted data is sampled at 8 kHz in 4.8 or 9.6 kbps per channel. This data is multiplexed and inserted into the T1 line. The received data from the T1 line is demultiplexed, separating the data through the interface. The asynchronous data is decoded, retimed, and sent through one or two RS-232 interfaces for distribution.

ALERTS/ALARMS

The RFL DA-91I module reports no module level ALERT or ALARM signals to the shelf Common Module.

REMOTE CONTROL INTERFACE

When installed in an IMUX 2000 remote controllable shelf, the RFL DA-91I module can be operated under local or remote control. When under remote control, certain configuration parameters can only be changed through the RS-232 remote port on the multiplexer. The remote interface for these modules involves two codes: a “P” (parameter) code, and an “S” (status) code. See the IMUX 2000 instruction manual for more information on the remote control interface.

The RFL DA-91I reports itself as a “Type 126” module when installed in a T1 or E1 system.

“P” CODES

“P” codes, when used in the parameter field on a “SET” command, allow the user to set certain parameters on the module by remote control, just like setting the switches on a module under local control. “P” codes also appear in the response to a “CONFIG?” query, showing the current parameter settings on the module.

There are three “P” codes for the RFL DA-91I when operated in a T1 or E1 system: P1, P2 and P3. Each of these P codes can be a decimal number from 0 to 255, which can also be represented as an eight-digit binary number (in parenthesis). The binary representation is more useful for setting and interpreting the “P” codes, since each binary digit (0 or 1) corresponds to the ON or OFF setting for a particular switch on the module. Table 4 describes the meanings of the “P” codes for the RFL DA-91I.

A typical RFL DA-91I response to a “CONFIG?” query of a T1 or E1 system looks like this:

*** OK**
CHANNEL CARD 3, TYPE 126
UNDER REMOTE CONTROL
SVCE = ON
P01 = 3 (B00000011)
P02 = 128 (B10000000)
P03 = 16(B00010000);

NOTE

When using binary numbers with a SET command, they must be preceded by the letter “B” as shown in the following example:

<MULTIPLEXER ADDRESS>:<CARD ADDRESS>:SET:P1 = B00000011;

Besides using the P code, it is also possible to turn module service on or off by sending one of the following in the parameter field with a SET command:

SRVC = ON
SRVC = OFF

Table 4. Remote configuration settings (“P” codes) for T1 or E1 systems

P Code	Digit(s) And Switch Equivalent	Value ⁽¹⁾	Description
P1	B 0 0 0 0 0 0 0 0 - - - ↑↑↑↑↑ TIME SLOT SELECT	00001 to 11000 T1 Settings	From left to right, these five bits represent the binary value of the desired time slot between 1 through 24 in a T1 network. See Table 8 for a complete list of these values.
		00001 to 11111 E1 Settings	From left to right, these five bits represent the binary value of the desired time slot between 1 through 31 in an E1 network. See Table 8 for a complete list of these values.
	B 0 0 0 0 0 0 0 0 - - ↑ - - - - CAS	0	Sets CAS = OFF
		1	Sets CAS = ON
	B 0 0 0 0 0 0 0 0 ↑ - - - - - BUS A	0	Disables Bus A
		1	Transmit on Bus A, Receive on Bus B
	B 0 0 0 0 0 0 0 0 - ↑ - - - - - BUS B	0	Disables Bus B
		1	Transmit on Bus B, Receive on Bus A
	B 0 0 0 0 0 0 0 0 ↑ - - - - - LOCAL LOOPBACK	0	Local Loopback OFF
		1	Local Loopback ON
P2	B 0 0 0 0 0 0 0 0 - ↑ - - - - - REMOTE LOOPBACK	0	Remote Loopback OFF
		1	Remote Loopback ON
	B 0 0 0 0 0 0 0 0 ↑ - - - - - MODE	0	Dual mode
		1	Single mode
P3	B 0 0 0 0 0 0 0 0 - ↑ - - - - - CTS1	0	Depends on RTS
		1	ON
	B 0 0 0 0 0 0 0 0 - - ↑ - - - - CTS2	0	Depends on RTS
		1	ON
	B 0 0 0 0 0 0 0 0 - - - ↑ - - - 7BIT	0	7 bit inactive (works with old DA-91)
		1	7 bit active
	B 0 0 0 0 0 0 0 0 - - - - ↑ - - TIME SLOT SHARING	0	Time Slot Sharing Disabled (Normal)
		1	Time Slot Sharing Enabled

1. These are the only legal values for setting the parameters. Setting any parameter to a value outside its specified range will produce an unpredictable result.

“S” CODES

“S” codes appear in response to a “STATUS?” query. There are two “S” codes for the RFL DA-91I when operated in a T1 or E1 system: S1 and S2. Like the “P” code, this number is displayed in both decimal and binary form.

A typical response to a “STATUS?” query looks like this:

*** OK**
CHANNEL CARD 3, TYPE 126
S01 = 3 (B00000011)
S02 = 15 (B00001111);

Table 5. Remote status messages (“S” codes) for a T1 or E1 system

S CODE	Position	Value	Description
S1	B 0 0 0 0 0 0 0 0	0	T1 system
	- - - - - ↑	1	E1 system
	B 0 0 0 0 0 0 0 0	0	Configuration OK
	- - - - - ↑ -	1	Bad Configuration
	B 0 0 0 0 0 0 0 0	0	Remote Loopback OFF
	- - - - - ↑ - -	1	Remote Loopback ON
	B 0 0 0 0 0 0 0 0	0	Local Loopback OFF
	- - - - ↑ - - -	1	Local Loopback ON
	B 0 0 0 0 0 0 0 0	0	Service OFF
	- - - ↑ - - - -	1	Service ON
S2	B 0 0 0 0 0 0 0 0	0	No Tx Activity
	- - - - ↑ ↑ ↑ ↑	1	Tx activity on selected channel (See Table 6)
	B 0 0 0 0 0 0 0 0	0	No Rx Activity
	↑ ↑ ↑ ↑ - - - -	1	Rx activity on selected channel (See Table 6)

Table 6. Tx/Rx Activity

TX_ACT1 → TXD1	RX_ACT1 → RXD1
TX_ACT2 → TXD2	RX_ACT2 → RXD2
TX_ACT3 → RTS1	RX_ACT3 → RLSD1
TX_ACT4 → RTS2	RX_ACT4 → RLSD2

TESTING

After the RFL DA-91I module has been configured and installed, it should be tested for proper operation before it is put into service. At present, the only test necessary to verify RFL DA-91I performance is the loop test. This test is performed when the channel module is installed to verify operational performance in either a terminal or drop/insert configuration.

TEST EQUIPMENT REQUIRED

1. Asynchronous Bit Error Rate Test Set with RS-232 interface with Request to Send (RTS) control signal capability.
2. IMUX 2000 Multiplexer.
3. Patch cord terminated in bantam jacks (2 required).

LOOP TEST PROCEDURE FOR RFL DA-91I MODULES INSTALLED IN TERMINAL MULTIPLEXERS

The following procedure is used to test RFL DA-91I modules installed in IMUX 2000 terminal multiplexers.

1. Open the door on the front of the IMUX 2000 multiplexer.
2. Connect a patch cord between the EQUIP-T1-OUT and EQUIP-T1-IN jacks on the front of the IMUX 2000 chassis. The jacks are located on the Common Module.
3. With power applied to the IMUX 2000, check the indicators on the front of the power supply module.
The POWER indicator should be lit.
4. Check the CH1 Transmit and CH1 Receive activity LEDs on the front panel of the DA-91I module. See Figure 2 and Table 1 for locations.
Both activity LEDs should NOT be lit.
5. Connect the BIT Error Test Set to the CH1 RS-232 connector on the cable assembly connected to the Module Adapter for the RFL DA-91I module under test.
At this point, the equipment should be connected as shown in Figure 4.
6. At the test set, apply power and initialize the Request To Send (RTS) signal, and set its output to any data rate up to 4.8 kbps for dual or up to 9.6 kbps for single. Check the CH1 Transmit and CH1 Receive activity LEDs on the front of the RFL DS-91I.
Both activity LEDs should be ON or flashing.
Check the RLSD LEDs. They should be ON according to the mode of operation to indicate the reception of the signaling bits.
7. Check the error count on the receive side of the test set.
The error count should be zero.
8. In dual mode repeat the tests for the second channel.
The results should be the same.

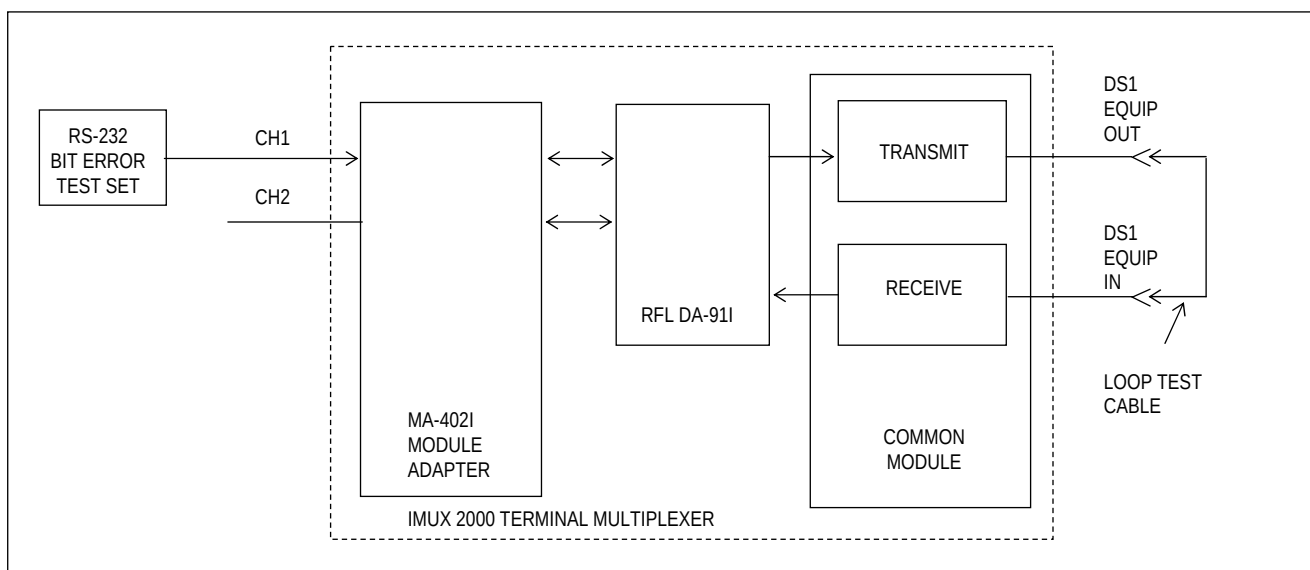


Figure 4. Simplified block diagram, loop test for RFL DA-91I modules installed in terminal multiplexers.

9. Disconnect the patch cord from the DS1 EQUIP OUT and DS1 EQUIP IN jacks on the front of the IMUX 2000, and close the front door.

If the above test procedure can be successfully completed, the RFL DA-91I module is functioning properly. If not, use standard troubleshooting procedures to isolate the problem to the module itself, to another module in the IMUX 2000, or to the T1 or E1 channel. If the problem lies in the RFL DA-91I module, replace it with a spare.

LOOP TEST PROCEDURE FOR RFL DA-91I MODULES INSTALLED IN DROP/INSERT MULTIPLEXERS

The following procedure is used to test RFL DA-91I modules installed in IMUX 2000 drop/insert multiplexers. To test DA-91I modules installed in IMUX 2000 terminal multiplexers, use the procedure on page 15 of this instruction data sheet. Before performing this procedure, make sure the system is on-line and out-of-service.

1. Open the door on the front of the IMUX 2000 multiplexer. Pull the DA-91I module out of the shelf, and check the setting of DIP switch SW2-8.
For this part of the test, SW2-8 must be in the DOWN position to transmit on the A bus and receive on the B bus.
2. Connect a patch cord between the DS1-A EQUIP OUT and DS1-B EQUIP IN jacks on the front of the IMUX 2000 chassis. The jacks are located on the Common Module.
3. With power applied to the IMUX 2000, check the indicator(s) on the front of the power supply module(s).
The POWER indicator(s) should be lit.

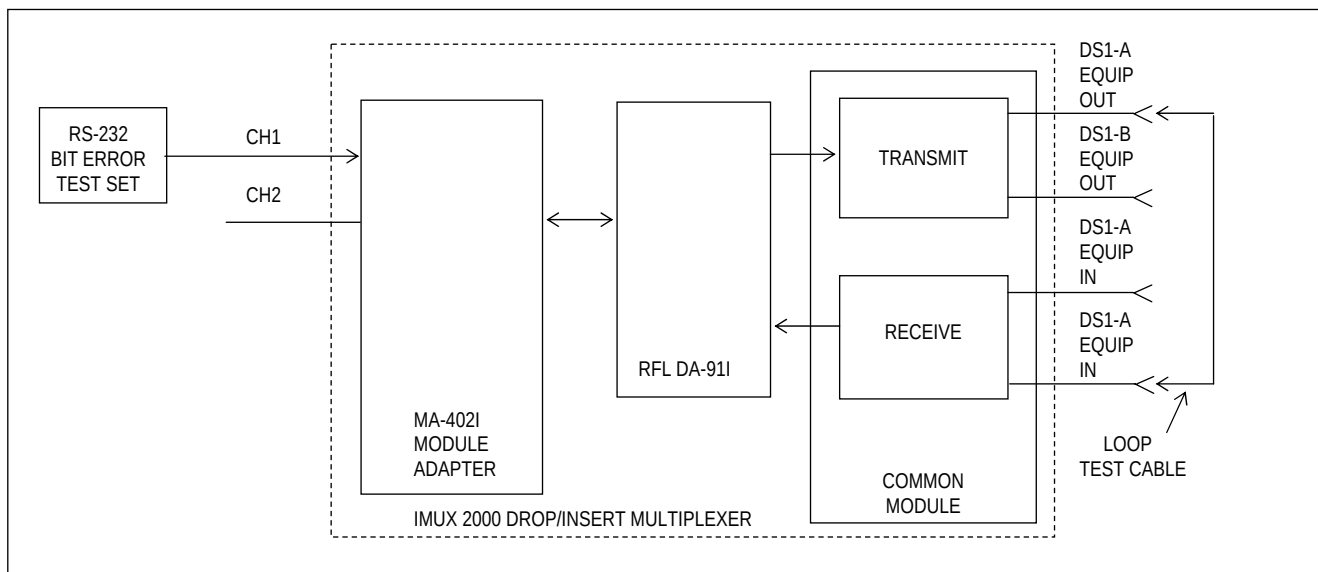


Figure 5. Simplified block diagram, first part of loop test for RFL DA-91I modules installed in drop/insert multiplexers.

4. Check the CH1 Transmit and CH1 Receive activity LEDs on the front panel of the DA-91I module. See Figure 2 and Table 1 for locations.
Both activity LEDs should NOT be lit.
5. Connect the BIT Error Test Set to the CH1 RS-232 connector on the cable assembly connected to the Module Adapter for the RFL DA-91I module under test.
At this point, the equipment should be connected as shown in Figure 5.
6. At the test set, apply power and initialize the Request To Send (RTS) signal, and set its output to 4.8 kbps for dual mode and to 9.6 kbps for single mode. Check the CH1 Transmit and CH1 Receive activity LEDs on the front of the RFL DS-91I.
Both activity LEDs should be ON, and the RLSD LEDs should correspond to the proper mode of operation to indicate the reception of the signaling bits.
7. Check the error count on the receive side of the test set.
The error count should be zero.
8. Repeat steps 3 through 7 with the test set connected to the other RS-232 connector in the cable assembly if it is in dual mode.
The results should be the same.
9. Disconnect the patch cord between the DS1-A EQUIP OUT and DS1-B EQUIP IN jacks on the front of the IMUX 2000 chassis.
10. Pull the DA-91I module out of the shelf, and place DIP switch SW2-7 to the DOWN position.
For this part of the test, SW2-7 must be in the DOWN position to transmit in the B direction and receive from the A direction.
11. Connect a patch cord between the DS1-B EQUIP OUT and DS1-A EQUIP IN jacks on the front of the IMUX 2000 chassis. The jacks are located on the Common Module.

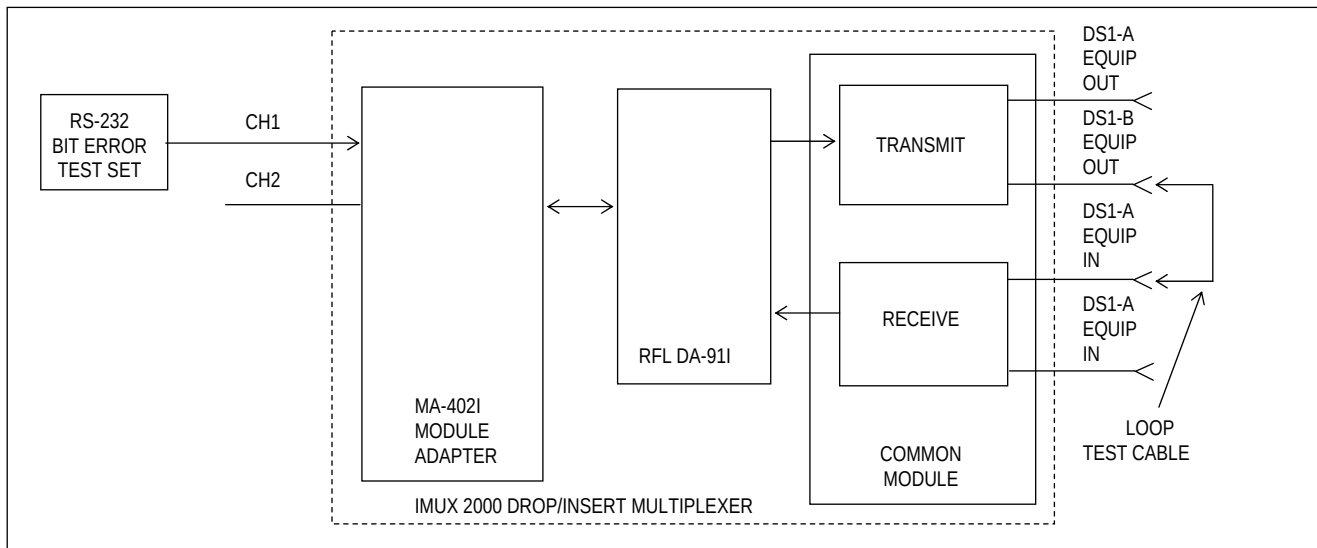


Figure 6. Simplified block diagram, second part of loop test for RFL DA-91I modules installed in drop/insert multiplexers.

12. With power applied to the IMUX 2000, check the indicator(s) on the front of the power supply module(s).
The POWER indicator(s) should be lit.
13. Check the CH1 Transmit and CH1 Receive activity LEDs on the front panel of the DA-91I module. See Figure 2 and Table 1 for locations.
Both activity LEDs should NOT be lit.
14. Connect the BIT Error Test Set to the CH1 RS-232 connector on the cable assembly connected to the Module Adapter for the RFL DA-91I module under test.
At this point, the equipment should be connected as shown in Figure 6.
15. At the test set, apply power and initialize the Request To Send (RTS) signal, and set its output to 4.8 kbps for dual or 9.6 kbps for single. Check the CH1 Transmit and CH1 Receive activity LEDs on the front of the RFL DS-91I.
Both activity LEDs should be ON or flashing. The RLSD LEDs should be ON according to the mode of operation to indicate the reception of the signaling bits.
16. Check the error count on the receive side of the test set.
The error count should be zero.
17. Repeat steps 3 through 7 with the test set connected to the other RS-232 connector if it is in dual mode.
The results should be the same.
18. Disconnect the patch cord between the DS1-B EQUIP OUT and DS1-A EQUIP IN jacks on the front of the IMUX 2000 chassis.

If the above test procedure can be successfully completed, the RFL DA-91I module is functioning properly. If not, use standard troubleshooting procedures to isolate the problem to the module itself, to another module in the IMUX 2000, or to the T1 or E1 channel. If the problem lies in the RFL DA-91I module, replace it with a spare.

TROUBLESHOOTING

If there is an apparent malfunction, first check that the configuration is appropriate for the transmission system in use, and that transmit and receive configurations are identical.

Problems may occur at the common equipment or facility level that may affect the operation of this module. Refer to the “Maintenance” section in your multiplexer manual for system analysis procedures.

NOTES

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RFL Electronics Inc.

INSTRUCTION DATA

RFL DA-121I Seven Port Asynchronous Data Channel Module

DESCRIPTION

The RFL DA-121I is an Asynchronous Data Channel Module designed for use in RFL IMUX 2000 multiplexers. It converts asynchronous data to a format appropriate for multiplexing and transmission over T1 or E1 lines. Data received is demultiplexed and restored as asynchronous data.

The RFL DA-121I can use up to seven RS-232 interface connectors for system operation. A channel or combination provides transmit and receive capabilities over T1, E1, or other digital communication systems at rates up to 1.2 Kbps. The module operates up to a maximum of 2.4 Kbps, depending on the maximum jitter the equipment can tolerate. Up to seven 1.2 Kbps data channels can be supported by one RFL DA-121I module. All seven channels together occupy one 64 kbps DS0 time slot. The DA-121I automatically detects if the system is T1 or E1 and configures itself appropriately.

The DA-121I is remote-controllable when installed in an RFL remote controllable shelf. The following module parameters can be configured remotely via SCB or locally via DIP switches. A DIP switch setting will control whether the card is in remote or local mode.

- o Selectable time slot assignment
- o Channel associated signaling (CAS) enable/disable
- o Selectable transmit/receive direction
- o Module service enable/disable
- o Remote or local loopback select

SPECIFICATIONS

As of the date this Instruction Data Sheet was published, the following specifications apply to the RFL DA-121I Asynchronous Data Channel Module. Because all of RFL products undergo constant improvement and refinement, these specifications are subject to change without notice.

Live Insertion/Extraction: The DA-121I is capable of live insertion and extraction into the IMUX 2000 shelf without interruption to the DS1 or any other DS0.

Asynchronous Data Interface:

One or seven channel operation, seven independent RS-232 data ports.

Data Rate:

0 to 1.2 kbps per channel. May operate up to a maximum of 2.4 Kbps, depending upon the maximum jitter the equipment can tolerate. Sample rate per input is 8 kHz.

Time Slots:

All seven channels occupy one selectable DS0 time slot.

Jitter: At maximum input rate, worst case output data jitter is 15% (proportionally lower for lower input rates).

RS-232 Interface:

Supports: TX data, RX data, Ground.

Input Voltage Range:

-30 volts to + 30 volts

Output Voltage Swing:

± 5 volts to ± 10 volts

Connector:

The DA-121I module requires the use of the MA-405I Module Adapter, which provides seven ports for RS-232 interface using one DB-25 connector.

Power Dissipation:

0.5 Watts nominal

RFI/EMI:

C.37.90.2

MTBF (Calculated):

Greater than 500,000 hours per Bellcore TR-332.

Operating Temperature: -20°C to +55°C (-4°F to +131°F).

Humidity: 0 to 90 %, non-condensing.

INSTALLATION

Before the RFL DA-121I can be placed in service, it must be installed in a multiplexer shelf. Installation involves determining the module slot in the Main Shelf or Expansion Shelf where the module will be installed, inserting a Module Adapter into the rear of the shelf behind the module slot, connecting all signal and power wiring to the Module Adapter, checking the settings of all switches, and inserting the module into the front of the shelf.

NOTES

Power supply and time slot considerations may affect the installation of this module into an existing multiplexer shelf. Refer to the multiplexer manual for more information.

The following instructions are provided for installing an RFL DA-121I module into an existing system. If the module was included as part of a system, installation was done at the factory. Otherwise, proceed as follows:

1. Carefully inspect the module for any visible signs of shipping damage. If you suspect damage to the module, immediately call RFL Customer Service at the number listed at the bottom of this page.
2. Determine the module slot in the Main Shelf or Expansion Shelf where the module will be installed.
RFL DA-121I module occupies one module slot in the Main Shelf or Expansion Shelf.

3. Insert a Module Adapter into the rear of the shelf directly behind the module slot where the RFL DA-121I will be installed.
Each RFL DA-121I module requires an MA-405I Module Adapter as shown in Figure 1. This module adapter has a 37-pin D-subminiature (DC-37S) connector on its rear panel. This module includes an Adapter Cable that plugs into this connector and provides seven 9-pin D-subminiature (DB-9S) connectors. Each of these 9-pin connectors is wired in a standard RS-232 configuration:

Transmit Data (TxD)	Pin 2
Receive Data (RxD)	Pin 3
Ground	Pin 7

Each 9-pin connector is labeled to show the corresponding channel on the RFL DA-121I.

As an option, the Adapter Cable is available with different connector types or cable lengths.

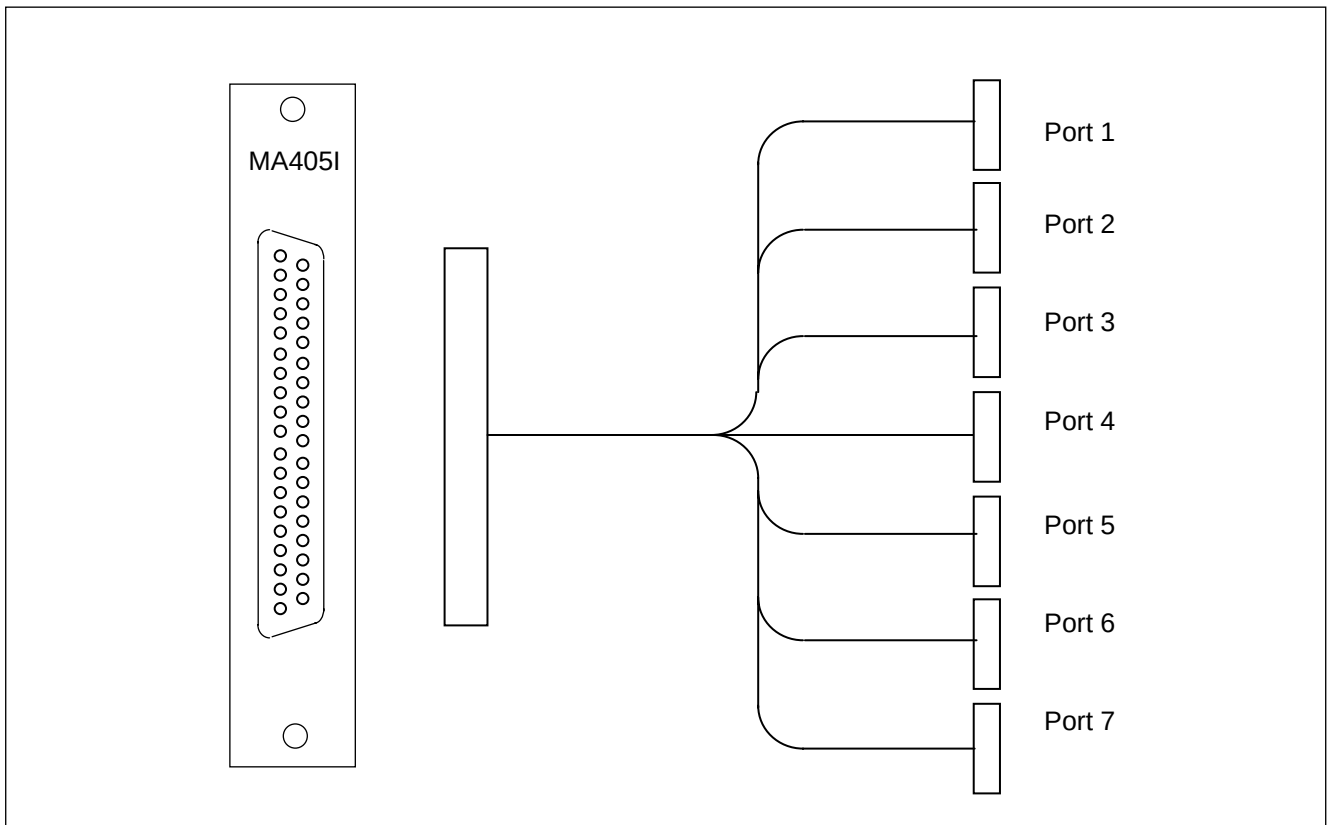


Figure 1. MA-405I Module Adapter and Adapter Cable

4. Refer to Figure 2 and Table 1 for the location of DIP switches on the DA-121I module.
5. Set the module address using DIP switches SW1-1 through SW1-6 for the desired remote address (SCB address).

For remote access, each channel module in the IMUX 2000 must have a distinct module address. Valid addresses are the numbers “1” to “36”. In most installations the address will be set to the number of the slot the module is occupying. Table 2 shows the switch settings for the module address. (Consult your multiplexermanual for details on using the remote access and configuration features of the system.)

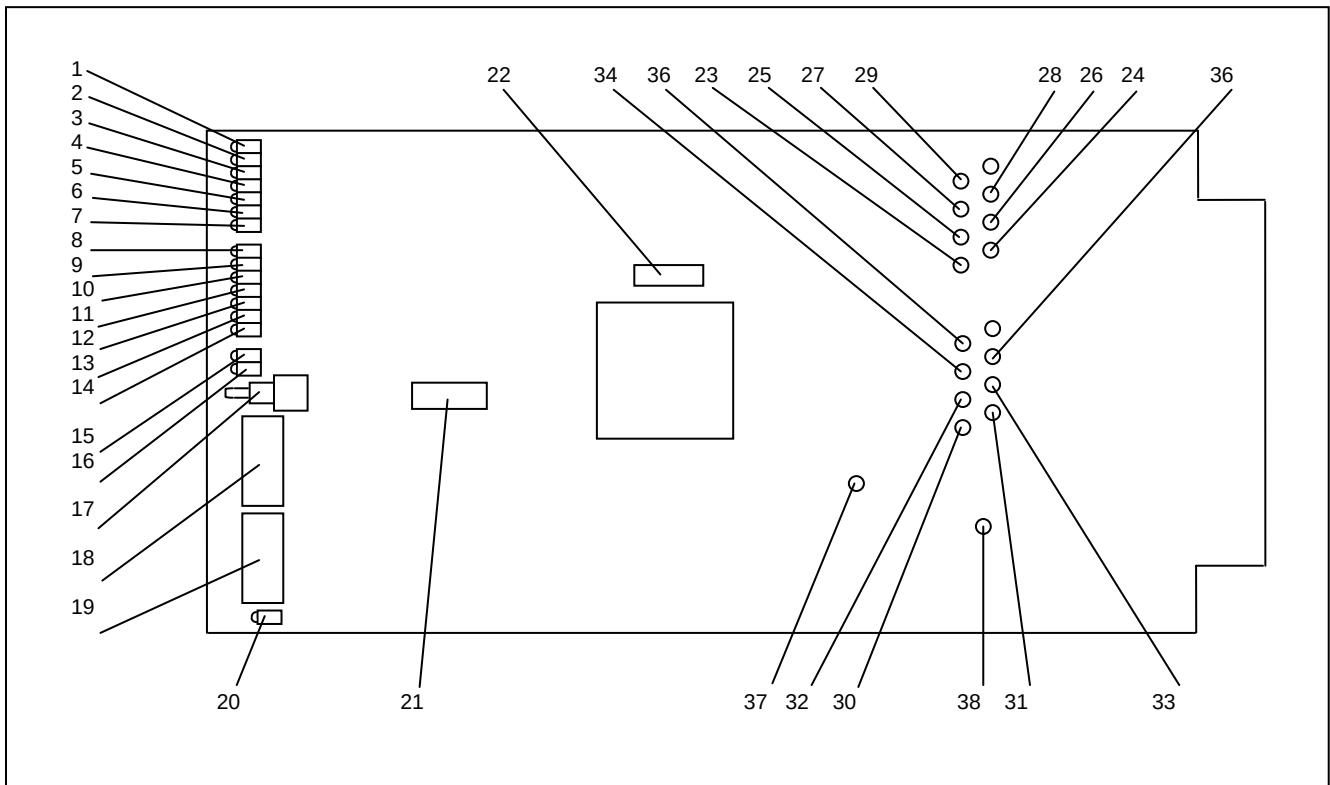


Figure 2. Controls and indicators, RFL DA-121I Asynchronous Data Channel Module

6. Select an unused time slot for channel 1 using DIP switches SW2-1 through SW2-5. Each active voice channel uses one 64 Kbps digital time slot within the multiplexer's aggregate rate. Set the time slot using direct binary coding as shown in Table 3. Refer to the multiplexer manual for guidelines on time slot selection.

Note that selecting an invalid time slot will disable the module. In T1 systems, only time slots 1 through 24 are allowed.

In E1 systems, time slots 1 through 31 are allowed, however, time slots 0 and 16 are reserved and cannot be used.

7. Select transmit direction by using DIP switch SW2-8.
Place SW2-8 in the UP position to transmit in the B direction and receive from the A direction. Place SW2-8 in the DOWN position to transmit in the A direction and receive from the B direction. Unless otherwise specified at time of order, SW2-8 is set in the DOWN position at the factory to transmit in the A direction, and receive from the B direction.

>> text continues on page 9 <<

Table 1. Controls and indicators, RFL DA-121I Module

Item	Name/Description	Function
1	TX LED 1 (green), DS2	Lights when Channel 1 is transmitting
2	TX LED 2 (green), DS3	Lights when Channel 2 is transmitting
3	TX LED 3 (green), DS4	Lights when Channel 3 is transmitting
4	TX LED 4 (green), DS5	Lights when Channel 4 is transmitting
5	TX LED 5 (green), DS6	Lights when Channel 5 is transmitting
6	TX LED 6 (green), DS7	Lights when Channel 6 is transmitting
7	TX LED 7 (green), DS8	Lights when Channel 7 is transmitting
8	RX LED 1 (green), DS10	Lights when Channel 1 is receiving
9	RX LED 2 (green), DS11	Lights when Channel 2 is receiving
10	RX LED 3 (green), DS12	Lights when Channel 3 is receiving
11	RX LED 4 (green), DS13	Lights when Channel 4 is receiving
12	RX LED 5 (green), DS14	Lights when Channel 5 is receiving
13	RX LED 6 (green), DS15	Lights when Channel 6 is receiving
14	RX LED 7 (green), DS16	Lights when Channel 7 is receiving
15	LOC Loopback LED (red), DS18	Lights when module is in Local Loopback mode
16	REM Loopback LED (red), DS19	Lights when module is in Remote Loopback mode
17	Toggle Switch, SW4 (3-position)	UP position Selects Local Loopback
		MIDDLE position Selects Normal Mode
		DOWN position Selects Remote Loopback
18	DIP Switch, SW1	SW1-1 to SW1-6 Selects SCB Address (See Table 2)
		SW1-7 Selects Local or Remote control UP = Local Control DOWN = Remote Control
		SW1-8 Selects module service ON or OFF UP = Service ON DOWN = Service OFF
19	DIP Switch, SW2	SW2-1 to SW2-5 Selects Time Slot (See Table 3)
		SW2-6 Selects CAS ON or OFF UP = CAS OFF DOWN = CAS ON
		SW2-7 Not Used
		SW2-8 Selects Bus A or Bus B
20	Service LED (green), DS1	Lights when service is ON
21	Jumper array, J1	For factory use only
22	Jumper J2	For factory test only using ACTEL Probe
23	Test point, TP1	Channel 1 TX local data
24	Test point, TP2	Channel 2 TX local data
25	Test point, TP3	Channel 3 TX local data
26	Test point, TP4	Channel 4 TX local data
27	Test point, TP5	Channel 5 TX local data
28	Test point, TP6	Channel 6 TX local data
29	Test point, TP7	Channel 7 TX local data
30	Test point, TP9	Channel 1 RX local data
31	Test point, TP10	Channel 2 RX local data
32	Test point, TP11	Channel 3 RX local data
33	Test point, TP12	Channel 4 RX local data
34	Test point, TP13	Channel 5 RX local data
35	Test point, TP14	Channel 6 RX local data
36	Test point, TP15	Channel 7 RX local data
37	Test point, TP17	+5 VDC
38	Test point, TP0	Ground

Table 2. SCB address settings, RFL DA-121I module

Module Address	SW1-1	SW1-2	SW1-3	SW1-4	SW1-5	SW1-6
1	DOWN	DOWN	DOWN	DOWN	DOWN	UP
2	DOWN	DOWN	DOWN	DOWN	UP	DOWN
3	DOWN	DOWN	DOWN	DOWN	UP	UP
4	DOWN	DOWN	DOWN	UP	DOWN	DOWN
5	DOWN	DOWN	DOWN	UP	DOWN	UP
6	DOWN	DOWN	DOWN	UP	UP	DOWN
7	DOWN	DOWN	DOWN	UP	UP	UP
8	DOWN	DOWN	UP	DOWN	DOWN	DOWN
9	DOWN	DOWN	UP	DOWN	DOWN	UP
10	DOWN	DOWN	UP	DOWN	UP	DOWN
11	DOWN	DOWN	UP	DOWN	UP	UP
12	DOWN	DOWN	UP	UP	DOWN	DOWN
13	DOWN	DOWN	UP	UP	DOWN	UP
14	DOWN	DOWN	UP	UP	UP	DOWN
15	DOWN	DOWN	UP	UP	UP	UP
16	DOWN	UP	DOWN	DOWN	DOWN	DOWN
17	DOWN	UP	DOWN	DOWN	DOWN	UP
18	DOWN	UP	DOWN	DOWN	UP	DOWN
19	DOWN	UP	DOWN	DOWN	UP	UP
20	DOWN	UP	DOWN	UP	DOWN	DOWN
21	DOWN	UP	DOWN	UP	DOWN	UP
22	DOWN	UP	DOWN	UP	UP	DOWN
23	DOWN	UP	DOWN	UP	UP	UP
24	DOWN	UP	UP	DOWN	DOWN	DOWN
25	DOWN	UP	UP	DOWN	DOWN	UP
26	DOWN	UP	UP	DOWN	UP	DOWN
27	DOWN	UP	UP	DOWN	UP	UP
28	DOWN	UP	UP	UP	DOWN	DOWN
29	DOWN	UP	UP	UP	DOWN	UP
30	DOWN	UP	UP	UP	UP	DOWN
31	DOWN	UP	UP	UP	UP	UP
32	UP	DOWN	DOWN	DOWN	DOWN	DOWN
33	UP	DOWN	DOWN	DOWN	DOWN	UP
34	UP	DOWN	DOWN	DOWN	UP	DOWN
35	UP	DOWN	DOWN	DOWN	UP	UP
36	UP	DOWN	DOWN	UP	DOWN	DOWN

Table 3. Time Slot Select for RFL DA-121I module

Switch Code (Decimal)	Switch Settings					T1	E1
	SW2-1	SW2-2	SW2-3	SW2-4	SW2-5		
0	DOWN	DOWN	DOWN	DOWN	DOWN	*	*
1	DOWN	DOWN	DOWN	DOWN	UP	1	1
2	DOWN	DOWN	DOWN	UP	DOWN	2	2
3	DOWN	DOWN	DOWN	UP	UP	3	3
4	DOWN	DOWN	UP	DOWN	DOWN	4	4
5	DOWN	DOWN	UP	DOWN	UP	5	5
6	DOWN	DOWN	UP	UP	DOWN	6	6
7	DOWN	DOWN	UP	UP	UP	7	7
8	DOWN	UP	DOWN	DOWN	DOWN	8	8
9	DOWN	UP	DOWN	DOWN	UP	9	9
10	DOWN	UP	DOWN	UP	DOWN	10	10
11	DOWN	UP	DOWN	UP	UP	11	11
12	DOWN	UP	UP	DOWN	DOWN	12	12
13	DOWN	UP	UP	DOWN	UP	13	13
14	DOWN	UP	UP	UP	DOWN	14	14
15	DOWN	UP	UP	UP	UP	15	15
16	UP	DOWN	DOWN	DOWN	DOWN	16	16****
17	UP	DOWN	DOWN	DOWN	UP	17	17
18	UP	DOWN	DOWN	UP	DOWN	18	18
19	UP	DOWN	DOWN	UP	UP	19	19
20	UP	DOWN	UP	DOWN	DOWN	20	20
21	UP	DOWN	UP	DOWN	UP	21	21
22	UP	DOWN	UP	UP	DOWN	22	22
23	UP	DOWN	UP	UP	UP	23	23
24	UP	UP	DOWN	DOWN	DOWN	24**	24
25	UP	UP	DOWN	DOWN	UP	*	25
26	UP	UP	DOWN	UP	DOWN	*	26
27	UP	UP	DOWN	UP	UP	*	27
28	UP	UP	UP	DOWN	DOWN	*	28
29	UP	UP	UP	DOWN	UP	*	29
30	UP	UP	UP	UP	DOWN	*	30**
31	UP	UP	UP	UP	UP	*	31***

Notes: * This setting is not allowed . Setting switches to this code will cause the module's service to be disabled.
 **A T1 or E1 network utilizing fast reframing cannot utilize this time slot for voice channel.
 *** An E1 network utilizing inter-node communications (NMX) cannot use timeslot 31 for voice channel.
 **** Not valid if signaling is enabled in E1. Time slot 16 is reserved for CAS.

8. Set DIP switch SW2-6 to enable or disable signaling.
Place SW2-6 in the DOWN position to enable signaling
Place SW2-6 in the UP position to disable signaling
9. If you plan to operate the RFL DA-121I module under local control, perform the following steps; otherwise, go to step 10 for remote control.
 - a. Set to local control by placing DIP switch SW1-7 in the UP position.
 - b. Turn service on by placing DIP switch SW1-8 in the UP position.
 - c. Slide the module into the selected module slot until it is firmly seated and the module front panel is flush with the top and bottom of the shelf.
 - d. Go to step 11.
10. If you plan to operate the RFL DA-121I module under remote control, perform the following steps:
 - a. Set to local control by placing DIP switch SW1-7 in the UP position.
 - b. Turn service off by placing DIP switch SW1-8 in the DOWN position.
 - c. Slide the module into the selected module slot until it is firmly seated and the module front panel is flush with the top and bottom of the shelf.
 - d. Wait 15 seconds for the RFL DA-121I module's parameter settings to be loaded into the shelf Common Module.
 - e. Pull the module out of the shelf and set to remote control by placing DIP switch SW1-7 in the DOWN position.
Do not move SW1-8.
 - f. Slide the module back into the shelf.
 - g. Verify the module configuration through remote control by issuing a "CONFIG?" query. See the Remote Control Interface section of this Instruction Data Sheet for an explanation of the "CONFIG?" response.
 - h. Turn service on through remote control by issuing a "SRVC=ON" command.
The RFL DA-121I's operating parameters can now be changed by remote control. See the Remote Control Interface section of this Instruction Data Sheet for more information.
 - i. Go to step 11.
11. On the Module Record Card located to the right of the shelf, record the channel bank type, time slot, and any other pertinent information.
12. The RFL DA-121I is now installed. If your multiplexer is set up for remote access and control, you can now change the operating parameters of the module by using simple commands. For more information on remote access and control, consult your multiplexer operation manual.

FUNCTIONAL DESCRIPTION

Figure 3 is a functional block diagram of the RFL DA-121I module. It is provided to familiarize the user with the RFL DA-121's signal flow and interfacing. The figure shows signal flow in the transmit and receive modes of operation.

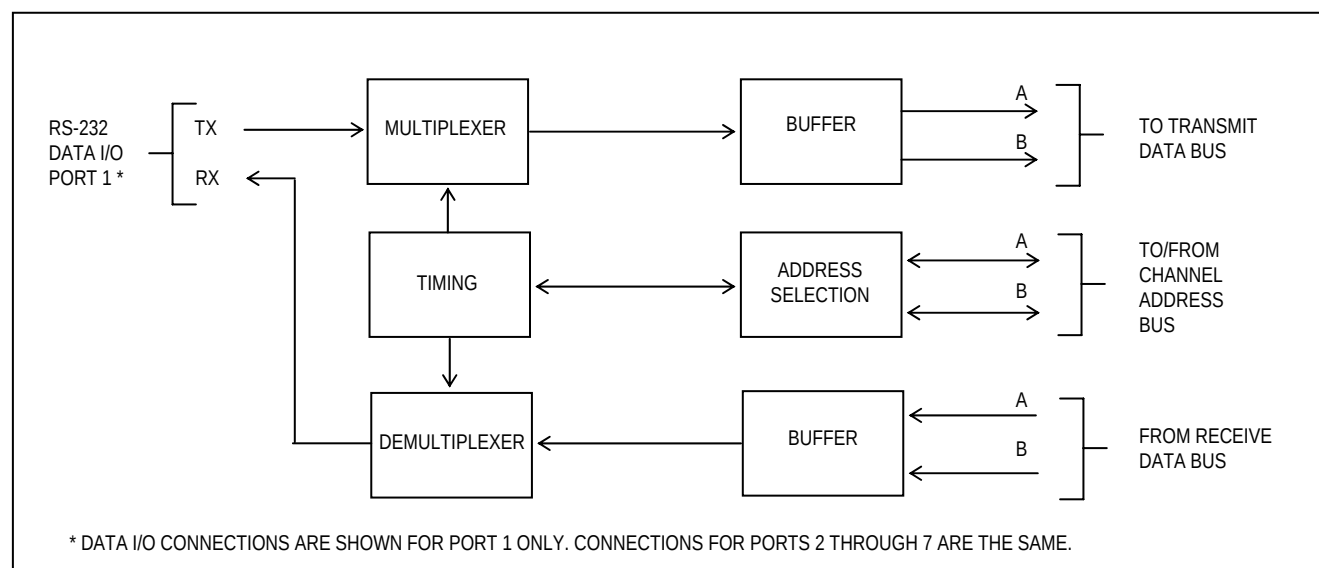


Figure 3. Functional block diagram, RFL DA-121I module.

The RFL DA-121I can provide up to seven 1.2 kbps data channels incorporating transmitter/receiver pairs in one T1 time slot. It can be used in IMUX 2000 Terminal or Drop/Insert multiplexers. The seven 1.2 kbps data channels are interfaced to the RFL DA-121I through the MA-405I Module Adapter. A cable adapter plugs into the MA-405I to provide seven 9-pin D-subminiature (DB-9S) connectors. Each 9-pin connector is wired in a standard RS-232 configuration, as shown below, and is labeled to show the corresponding channel on the RFL DA-121I.

Transmit Data (TxD)	Pin 2
Receive Data (RxD)	Pin 3
Ground	Pin 7

Connections to and from the RFL DA-121I is accomplished through an edge connector on the module, the motherboard bus, and an RS-232 interface to the IMUX 2000 control and monitor modules. The received data contains the data extracted from the T1 line, and the transmit data contains the data to be inserted into the T1 line. Transmit and receive bus directions and time slot selections are independently selectable by DIP switches SW1 and SW2.

The RFL DA-121I does not provide control signals, and may be needed to be looped at the RS-232 connector for some configurations. Once the control signals have been established, the transmitted data is sampled at 8 kHz in 1.2 kbps per channel operation. This data is multiplexed and inserted into the T1 line. The received data from the T1 line is demultiplexed, separating the data through the interface. The asynchronous data is decoded, retimed, and sent through one or more RS-232 interfaces for distribution.

ALERTS/ALARMS

The RFL DA-121I module reports no module level ALERT or ALARM signals to the shelf Common Module.

REMOTE CONTROL INTERFACE

When installed in an IMUX 2000 remote controllable shelf, the RFL DA-121I module can be operated under local or remote control. When under remote control, certain configuration parameters can only be changed through the RS-232 remote port on the multiplexer. The remote interface for these modules involves two codes: a “P” (parameter) code, and an “S” (status) code. See the IMUX 2000 instruction manual for more information on the remote control interface.

The RFL DA-121I reports itself as a “Type 127” module when installed in a T1 or E1 system.

“P” CODES

“P” codes, when used in the parameter field on a “SET” command, allow the user to set certain parameters on the module by remote control, just like setting the switches on a module under local control. “P” codes also appear in the response to a “CONFIG?” query, showing the current parameter settings on the module.

There are two “P” codes for the RFL DA-121I when operated in a T1 or E1 system: P1 and P2. Each of these P codes can be a decimal number from 0 to 255, which can also be represented as an eight-digit binary number (in parenthesis). The binary representation is more useful for setting and interpreting the “P” codes, since each binary digit (0 or 1) corresponds to the ON or OFF setting for a particular switch on the module. Table 4 describes the meanings of the “P” codes for the RFL DA-121I.

A typical RFL DA-121I response to a “CONFIG?” query of a T1 or E1 system looks like this:

*** OK**
CHANNEL CARD 3, TYPE 127
UNDER REMOTE CONTROL
SVCE = ON
P01 = 3 (B00000011)
P02 = 1 (B00000001);

NOTE

When using binary numbers with a SET command, they must be preceded by the letter “B” as shown in the following example:

<MULTIPLEXER ADDRESS>:<CARD ADDRESS>:SET:P1 = B00000011;

Besides using the P code, it is also possible to turn module service on or off by sending one of the following in the parameter field with a SET command:

SRVC = ON
SRVC = OFF

Table 4. Remote configuration settings (“P” codes) for T1 or E1 systems

P Code	Digit(s) And Switch Equivalent	Value ⁽¹⁾	Description
P1	B 0 0 0 0 0 0 0 0 - - - ↑↑↑↑↑↑ TIME SLOT SELECT	00001 to 11000 T1 Settings ⁽²⁾	From left to right, these five bits represent the binary value of the desired time slot between 1 through 24 in a T1 network. See Table 8 for a complete list of these values.
		00001 to 11111 E1 Settings ⁽²⁾	From left to right, these five bits represent the binary value of the desired time slot between 1 through 31 in an E1 network. See Table 8 for a complete list of these values.
	B 0 0 0 0 0 0 0 0 - - ↑ - - - - - CAS	0	Sets CAS = OFF
		1	Sets CAS = ON
	B 0 0 0 0 0 0 0 0 ↑ - - - - - - - TERM	0	This setting may be used only in a drop/insert multiplexer. If the module is installed in a terminal multiplexer, this digit should always be set to “1”. If the module is installed in a drop/insert multiplexer, set this digit to a “1” to transmit in the A direction and receive from the B direction. Set this digit to “0” to transmit in the B direction and receive from the A direction. (For guidelines on setting channel module direction, refer to the IMUX 2000 instruction manual).
		1	This setting is required when the module is installed in a terminal multiplexer.
	B 0 0 0 0 0 0 0 0 - ↑ - - - - - -	...	Not used.
P2	B 0 0 0 0 0 0 0 0 ↑ - - - - - - - LOCAL LOOPBACK	0	Sets local loopback OFF
		1	Sets local loopback ON
	B 0 0 0 0 0 0 0 0 - ↑ - - - - - - REMOTE LOOPBACK	0	Sets remote loopback OFF
		1	Sets remote loopback ON

1. These are the only legal values for setting the parameters. Setting any parameter to a value outside its specified range will produce an unpredictable result.
2. The RFL DA-121I automatically detects whether it is used in a T1 or E1 system.

“S” CODES

“S” codes appear in response to a “STATUS?” query. There are three “S” codes for the RFL DA-121I when operated in a T1 or E1 system: S1, S2 or S3. Like the “P” code, this number is displayed in both decimal and binary form.

A typical response to a “STATUS?” query looks like this:

*** OK**
CHANNEL CARD 3, TYPE 127
S01 = 3 (B00000011);

Table 5. Remote status messages (“S” codes) for a T1 or E1 system

S CODE	Position	Value	Description
S1	B 0 0 0 0 0 0 0 0 - - - - - ↑ T1/E1	1	T1 is detected
		0	E1 is detected
	B 0 0 0 0 0 0 0 0 - - - - - ↑ - CONFIGURATION	1	SCB configuration errors detected
		0	SCB configuration errors not detected
	B 0 0 0 0 0 0 0 0 - - - - - ↑ - - REMOTE LOOPBACK	1	Remote loopback ON
		0	Remote loopback OFF
	B 0 0 0 0 0 0 0 0 - - - - - ↑ - - - LOCAL LOOPBACK	1	Local loopback ON
		0	Local loopback OFF
	B 0 0 0 0 0 0 0 0 - - - ↑ - - - - SERVICE	1	Service ON
		0	Service OFF

Table 5. continued - Remote status messages (“S” codes) for a T1 or E1 system

S CODE	Position	Value	Description
S2	B 0 0 0 0 0 0 0 0 - - - - - ↑ TX CHANNEL 1	1	Tx Channel 1 active
		0	Tx Channel 1 inactive
	B 0 0 0 0 0 0 0 0 - - - - - ↑ - TX CHANNEL 2	1	Tx Channel 2 active
		0	Tx Channel 2 inactive
	B 0 0 0 0 0 0 0 0 - - - - - ↑ - - TX CHANNEL 3	1	Tx Channel 3 active
		0	Tx Channel 3 inactive
	B 0 0 0 0 0 0 0 0 - - - - - ↑ - - - TX CHANNEL 4	1	Tx Channel 4 active
		0	Tx Channel 4 inactive
	B 0 0 0 0 0 0 0 0 - - - ↑ - - - - TX CHANNEL 5	1	Tx Channel 5 active
		0	Tx Channel 5 inactive
	B 0 0 0 0 0 0 0 0 - - ↑ - - - - - TX CHANNEL 6	1	Tx Channel 6 active
		0	Tx Channel 6 inactive
	B 0 0 0 0 0 0 0 0 - ↑ - - - - - - TX CHANNEL 7	1	Tx Channel 7 active
		0	Tx Channel 7 inactive
	B 0 0 0 0 0 0 0 0 ↑ - - - - - - - TX CHANNEL 8	...	Not used

Table 5. continued - Remote status messages (“S” codes) for a T1 or E1 system

S CODE	Position	Value	Description
S3	B 0 0 0 0 0 0 0 0 - - - - - ↑ RX CHANNEL 1	1	Rx Channel 1 active
		0	Rx Channel 1 inactive
	B 0 0 0 0 0 0 0 0 - - - - - ↑ - RX CHANNEL 2	1	Rx Channel 2 active
		0	Rx Channel 2 inactive
	B 0 0 0 0 0 0 0 0 - - - - - ↑ - - RX CHANNEL 3	1	Rx Channel 3 active
		0	Rx Channel 3 inactive
	B 0 0 0 0 0 0 0 0 - - - - - ↑ - - - RX CHANNEL 4	1	Rx Channel 4 active
		0	Rx Channel 4 inactive
	B 0 0 0 0 0 0 0 0 - - - ↑ - - - - RX CHANNEL 5	1	Rx Channel 5 active
		0	Rx Channel 5 inactive
	B 0 0 0 0 0 0 0 0 - - ↑ - - - - - RX CHANNEL 6	1	Rx Channel 6 active
		0	Rx Channel 6 inactive
	B 0 0 0 0 0 0 0 0 - ↑ - - - - - - RX CHANNEL 7	1	Rx Channel 7 active
		0	Rx Channel 7 inactive
	B 0 0 0 0 0 0 0 0 ↑ - - - - - - - RX CHANNEL 8	...	Not used

TESTING

After the RFL DA-121I module has been configured and installed, it should be tested for proper operation before it is put into service. At present, the only test necessary to verify RFL DA-121I performance is the loop test. This test is performed when the channel module is installed to verify operational performance in either a terminal or drop/insert configuration.

TEST EQUIPMENT REQUIRED

1. Asynchronous Bit Error Rate Test Set with RS-232 interface with Request to Send (RTS) control signal capability.
2. IMUX 2000 Multiplexer.
3. Patch cord terminated in bantam jacks (2 required).

LOOP TEST PROCEDURE FOR RFL DA-121I MODULES INSTALLED IN TERMINAL MULTIPLEXERS

The following procedure is used to test RFL DA-121I modules installed in IMUX 2000 terminal multiplexers.

1. Open the door on the front of the IMUX 2000 multiplexer.
2. Connect a patch cord between the EQUIP-T1-OUT and EQUIP-T1-IN jacks on the front of the IMUX 2000 chassis. The jacks are located on the Common Module.
3. With power applied to the IMUX 2000, check the indicators on the front of the power supply module.
The POWER indicator should be lit.
4. Check the CH1 Transmit and CH1 Receive activity LEDs on the front panel of the DA-121I module. See Figure 2 and Table 1 for locations.
Both activity LEDs should NOT be lit.
5. Connect the BIT Error Test Set to the CH1 RS-232 connector on the cable assembly connected to the Module Adapter for the RFL DA-121I module under test.
At this point, the equipment should be connected as shown in Figure 4.
6. At the test set, apply power and initialize the Request To Send (RTS) signal, and set its output to any data rate up to 1.2 kbps. Check the CH1 Transmit and CH1 Receive activity LEDs on the front of the RFL DS-121I.
Both activity LEDs should be ON or flashing.
7. Check the error count on the receive side of the test set.
The error count should be zero.
8. Repeat steps 3 through 7 with the test set connected to the other RS-232 connectors in the cable assembly.
The results should be the same.

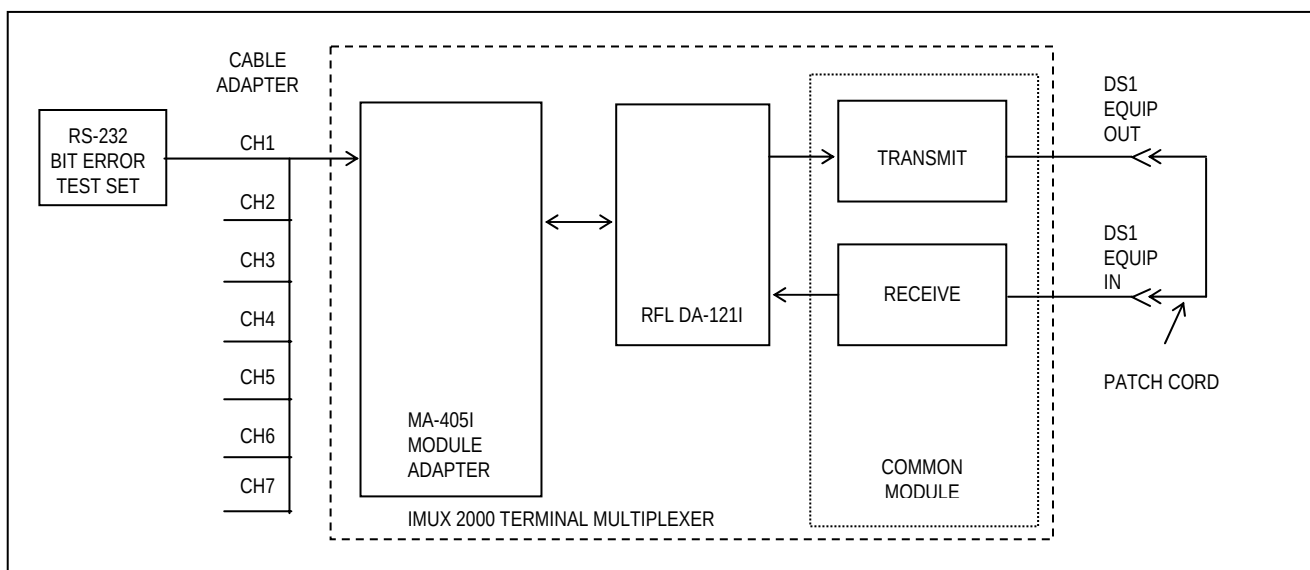


Figure 4. Simplified block diagram, loop test for RFL DA-121I modules installed in terminal multiplexers.

9. Disconnect the patch cord from the DS1 EQUIP OUT and DS1 EQUIP IN jacks on the front of the IMUX 2000, and close the front door.

If the above test procedure can be successfully completed, the RFL DA-121I module is functioning properly. If not, use standard troubleshooting procedures to isolate the problem to the module itself, another module in the IMUX 2000, or the T1 channel. If the problem lies in the RFL DA-121I module, replace it with a spare.

LOOP TEST PROCEDURE FOR RFL DA-121I MODULES INSTALLED IN DROP/INSERT MULTIPLEXERS

The following procedure is used to test RFL DA-121I modules installed in IMUX 2000 drop/insert multiplexers. To test DA-121I modules installed in IMUX 2000 terminal multiplexers, use the procedure on page 15 of this instruction data sheet. Before performing this procedure, make sure the system is on-line and out-of-service.

1. Open the door on the front of the IMUX 2000 multiplexer. Pull the DA-121I module out of the shelf, and check the setting of DIP switch SW2-8.
For this part of the test, SW2-8 must be in the ON position to transmit on the A bus and receive on the B bus.
2. Connect a patch cord between the DS1-A EQUIP OUT and DS1-B EQUIP IN jacks on the front of the IMUX 2000 chassis. The jacks are located on the Common Module.
3. With power applied to the IMUX 2000, check the indicator(s) on the front of the power supply module(s).
The POWER indicator(s) should be lit.

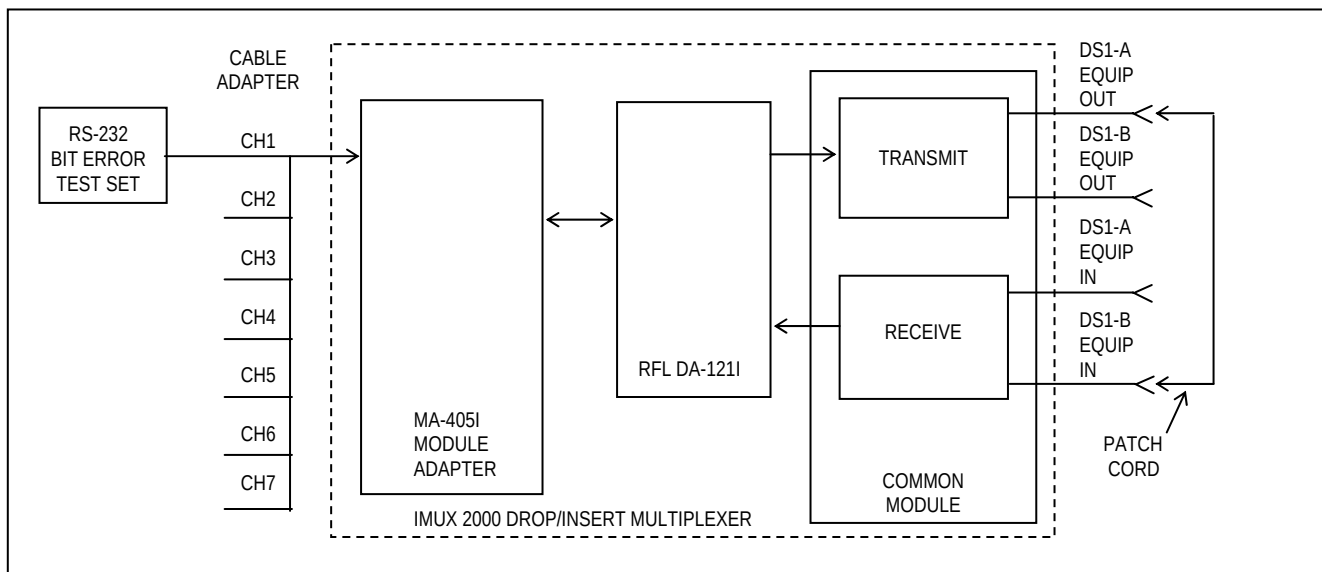


Figure 5. Simplified block diagram, loop test for RFL DA-121I modules installed in drop/insert multiplexers.

4. Check the CH1 Transmit and CH1 Receive activity LEDs on the front panel of the DA-121I module. See Figure 2 and Table 1 for locations.
Both activity LEDs should NOT be lit.
5. Connect the BIT Error Test Set to the CH1 RS-232 connector on the cable assembly connected to the Module Adapter for the RFL DA-121I module under test.
At this point, the equipment should be connected as shown in Figure 5.
6. At the test set, apply power and initialize the Request To Send (RTS) signal, and set its output to any data rate up to 1.2 kbps. Check the CH1 Transmit and CH1 Receive activity LEDs on the front of the RFL DS-121I.
Both activity LEDs should be ON.
7. Check the error count on the receive side of the test set.
The error count should be zero.
8. Repeat steps 3 through 7 with the test set connected to the other RS-232 connectors in the cable assembly.
The results should be the same.
9. Disconnect the patch cord between the DS1-A EQUIP OUT and DS1-B EQUIP IN jacks on the front of the IMUX 2000 chassis.
10. Pull the DA-121I module out of the shelf, and reset the setting of DIP switch SW2-8.
For this part of the test, SW2-8 must be in the OFF position to transmit on the B bus and receive on the A bus.
11. Connect a patch cord between the DS1-B EQUIP OUT and DS1-A EQUIP IN jacks on the front of the IMUX 2000 chassis. The jacks are located on the Common Module.

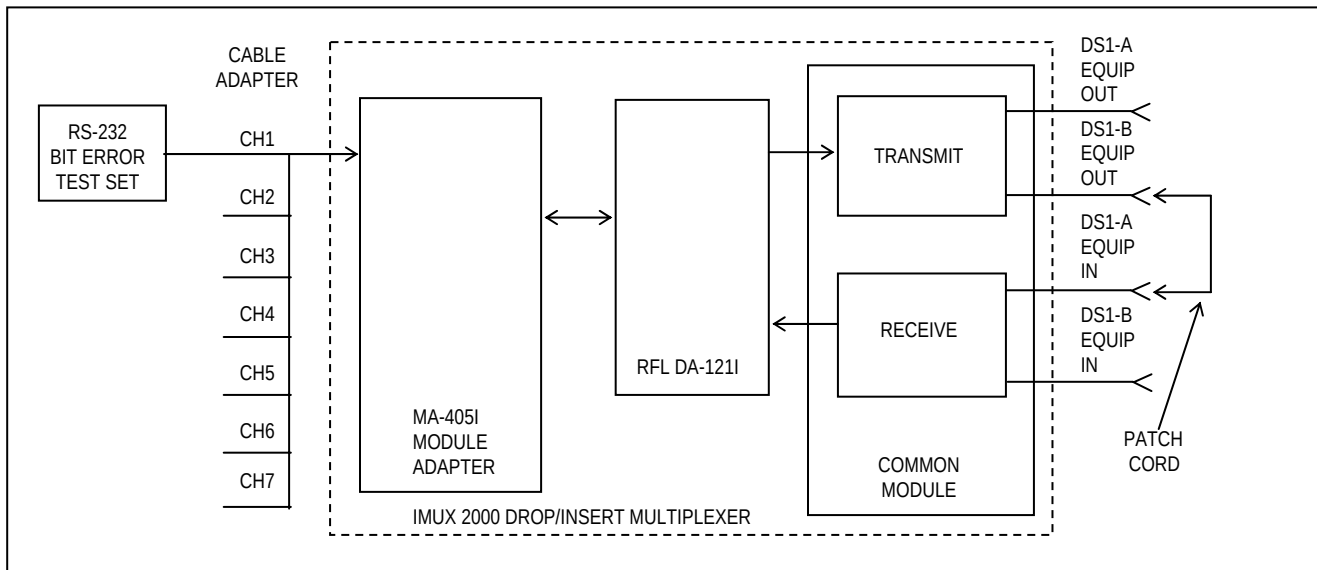


Figure 6. Simplified block diagram, second part of loop test for RFL DA-121I modules installed in drop/insert multiplexers.

12. With power applied to the IMUX 2000, check the indicator(s) on the front of the power supply module(s).
The POWER indicator(s) should be lit.
13. Check the CH1 Transmit and CH1 Receive activity LEDs on the front panel of the DA-121I module. See Figure 2 and Table 1 for locations.
Both activity LEDs should NOT be lit.
14. Connect the BIT Error Test Set to the CH1 RS-232 connector on the cable assembly connected to the Module Adapter for the RFL DA-121I module under test.
At this point, the equipment should be connected as shown in Figure 6.
15. At the test set, apply power and initialize the Request To Send (RTS) signal, and set its output to any data rate up to 1.2 kbps. Check the CH1 Transmit and CH1 Receive activity LEDs on the front of the RFL DS-121I.
Both activity LEDs should be ON.
16. Check the error count on the receive side of the test set.
The error count should be zero.
17. Repeat steps 3 through 7 with the test set connected to the other RS-232 connectors in the cable assembly.
The results should be the same.
18. Disconnect the patch cord between the DS1-B EQUIP OUT and DS1-A EQUIP IN jacks on the front of the IMUX 2000 chassis.

If the above test procedure can be successfully completed, the RFL DA-121I module is functioning properly. If not, use standard troubleshooting procedures to isolate the problem to the module itself, another module in the IMUX 2000, or the T1 channel. If the problem lies in the RFL DA-121I module, replace it with a spare.

TROUBLESHOOTING

If there is an apparent malfunction, first check that the configuration is appropriate for the transmission system in use, and that transmit and receive configurations are identical.

Problems may occur at the common equipment or facility level that may affect the operation of this module. Refer to the “Maintenance” section in your multiplexer manual for system analysis procedures.

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RFL Electronics Inc.

INSTRUCTION DATA

RFL DA-291B Four-Port Asynchronous Data Channel Module (RFL Part No. 108010)

DESCRIPTION

This Instruction Data Sheet describes the setup and installation procedures for the DA-291B Asynchronous Data Module. The DA-291B is a four-port data module, designed for use in Terminal and Drop/Insert Multiplexers. The module provides transmission of one to four asynchronous data channels over T1, E1 or other digital communications systems, with either an RS-232C or an RS-422 data interface. The maximum data rate is 38.4 kbps for one, two or four channel operation. The module uses one to four time slots depending on the number of channels used and the data rates of the channels being transmitted.

Each channel can be configured to use a different timeslot and direction. Timeslots on a common direction can be shared based on the data rate.

User-adjustable switches and remote configuration commands allow the configuration of the following parameters:

- SCB address
- Module enable
- Remote/Local configuration
- For each channel there are the following settings:
 - Enable/Disable
 - Data rate kbps (0.6, 1.2, 2.4, 4.8, 9.6, 19.2, 38.4)
 - Character format (9, 10, 11 bits including start/stop /parity)
 - Time slot selection
 - Data bus direction
 - Timeslot start bit (0-7 to allow compatibility with third party V.110 devices)
 - Data loopback (none, local, remote)

SPECIFICATIONS

As of the date this Instruction Data Sheet was published, the following specifications apply to all RFL DA-291B modules. Because all RFL products undergo constant refinement and improvement, these specifications are subject to change without notice.

Data Rates	0.6, 1.2, 2.4, 4.8, 9.6, 19.2 and 38.4 kbps each channel
Coding	V.14 and V.110
Jitter	Less than 5%
Input bit rate tolerance	-2.5 to +1%
Character formats	9, 10, 11 bits total including start, stop and parity
Interface	Asynchronous data interface, one-way or full duplex, one to four channel operation, four independent data ports
Time Slots	Depending on data rates, any one time slot or up to four contiguous time slots. 4.8 kb/s and below occupies 1/8 of one timeslot 9.6 kb/s occupies 1/4 of one timeslot 19.2 kb/s occupies 1/2 of one timeslot 38.4 kb/s occupies a full timeslot
RS-232 Interface (MA-404A)	Supports TX Data, RX Data, Clear to Send (CTS), Carrier Detect (CD) Notes: CTS is always held in the active state RJ-11 Connector
RS-232 Interface (MA-420A, MA-440A)	Supports TX Data, RX Data, Clear to Send (CTS), Carrier Detect (CD) Notes: CTS is always held in the active state CD (RLSD) is active when T1/E1 receiver is in frame
Four-Wire RS-485/422 Interface (MA-425)	Supports Send Data A, Send Data B, Receive Data A, Receive Data B
Indicators	LED indicators for Service On, Data In (Tx activity), and Data Out (Rx activity) for each port
Connector	DB-9 or RJ-11 on the Module Adapters
Operating Temperature	-20°C to +65°C
Humidity	0% - 90% Non-condensing
Power Consumption	Less than 1W
Dimensions	Length: 9.8 in (24.8 cm) Width: 0.6 in (1.5 cm) Height: 4.5 in (11.4 cm)
Weight	Net: 4.8 oz (0.13 kg) Shipping: 1 lb (0.45 kg)

INSTALLATION

Before the DA-291B module can be placed in service, it must be installed in a multiplexer shelf. Installation involves determining the module slot in the Main Shelf or Expansion Shelf where the module will be installed, inserting an I/O adapter module into the rear of the shelf behind the module slot, connecting all signal wiring to the I/O adapter module, checking the settings of all switches and jumpers, and inserting the module into the front of the shelf.

NOTE

Power supply and time slot considerations may affect the installation of RFL DA-291B modules into an existing multiplexer shelf. Refer to the portions of your multiplexer operation manual covering “Channel Module Configuration Guidelines” and “Adding More Channel Modules To Existing Systems” for more information.

The following instructions are provided for installing RFL DA-291B modules into existing systems. If the module was included as part of a system, installation was done at the factory, otherwise, proceed as follows:

1. Carefully inspect the RFL DA-291B and its I/O adapter module for shipping damage.
If you suspect damage to the module or its Module Adapter, immediately contact RFL’s Customer Service Department at the number shown at the bottom of this page.
2. Determine which module slot in the Main Shelf or Expansion Shelf the RFL DA-291B will be installed in.
The RFL DA-291B module occupies one or two module slots in the Main Shelf or Expansion Shelf depending on the Module Adapter selected. Refer to the “as supplied” drawings furnished with the equipment for more information.
3. Determine which I/O Adapter Module will be used to make connections to the RFL DA-291B module.
Each RFL DA-291B module installed in an IMUX 2000 multiplexer requires an I/O Adapter Module. The I/O Adapter Module provides the appropriate connections for the desired interface.

There are four Module Adapters for the RFL DA-291B:

<u>Module Adapter</u>	<u>Part Number</u>	<u>Interface Type</u>	<u>Socket</u>	<u>Figure</u>
MA-420A	9547-169221	2-Port RS-232	9 pin D-subminiature (DB-9)	1a
MA-440A	9547-169241	4-Port RS-232	9 pin D-subminiature (DB-9)	1b
MA-425	9547-16925	2-Port RS-422	9 pin D-subminiature (DB-9)	1c
MA-404A	9547-16381	5-Port RS-232*	5 RJ-11 Jacks*	1d

*** Available Channels 1 thru 4 only.**

Make sure the I/O Module Adapter you are installing is the correct one for the desired application.

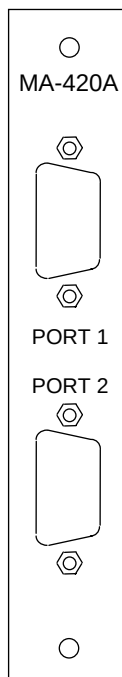


Figure 1a.

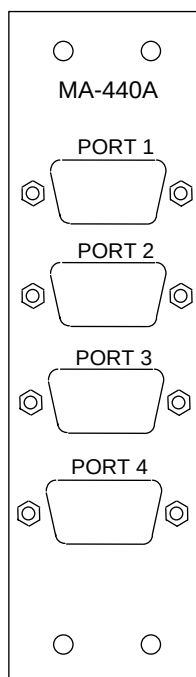


Figure 1b.

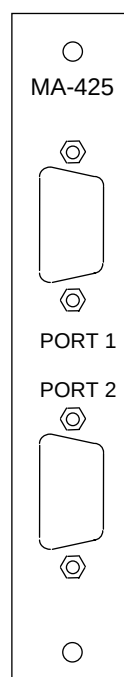


Figure 1c.

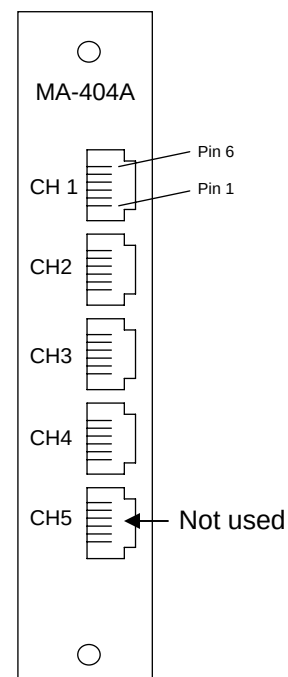


Figure 1d.

Figure 1. DA-291B Module Adapters

Table 1A. Wiring Assignments for MA-420A and MA-440A Module Adapters

Pin No.	Signal Name
1	Receive Line Signal Detect
2	Receive Data
3	Transmit Data
4	Not used
5	Signal Ground
6	Not used
7	Not used
8	Clear To Send
9	Not used

Table 1B. Wiring Assignments for MA-425 Module Adapter

Pin No.	Signal Name
1	TXA
2	TXB
3	RXA
4	RXB
5	Signal Ground
6	Not used
7	Not used
8	Not used
9	Not used

Table 1C. Wiring Assignments for MA-404A Module Adapter

RJ-11 Pin No.	Signal Name
1	CTS (always on)
2	Transmit Data
3	Not used
4	Receive Data
5	Ground
6	Carrier Detect

4. Insert the Adapter Module into the rear of the shelf directly behind the module slot where the DA-291B will be installed. Secure the module with the screws provided.
5. Connect the Adapter Module to the user equipment using the connector pin assignments detailed in Tables 1A or 1B as applicable.
6. Refer to Figure 2 and Table 2 for the location of switches on the DA-291B.
7. On the DA-291B check the setting of DIP switch SW1-8.
SW1-8 sets the module to operate in 2 or 4-port operation set the switch to OFF (default) for 2-port operation and ON for 4-port operation.
8. On the DA-291B check the setting of DIP switches SW10-1 thru SW10-4.
SW10-1 thru SW10-4 will enable channels 1 thru 4. Set to ON (DOWN) to enable the required channel.
9. On the DA-291B check the setting of DIP switches SW11-1 thru SW11-8.
These dip switches will set the required channel to either local or remote when loopback testing is employed, the default is OFF (UP). If loopback is required refer to Table 5 on page 10 to set each channel.
10. On the DA-291B dip switches SW1-1 thru SW1-6 will set the SCB address.
Refer to table 6 on page 11.
11. On the DA-291B check that dip switch SW1-7 is set to the OFF position.
This switch is for factory use only.
12. On the DA-291B Dip Switches SW2 thru SW9 will set various parameters for up to four channels of operation. Following are steps for setting Dip Switch SW2 (CH1), repeat these steps for Dip Switch SW3 thru SW5 for channel 2 thru 4 as required.
Dip switch SW2-3 (TERM) will set the required channel to operate in either the DI-A or DI-B ports. Set the switch to ON for the DI-A port to transmit on A and receive on B in a drop/insert multiplexer or terminal multiplexer. Set the switch to OFF for the DI-B port to transmit on B and receive on B in a drop/insert multiplexer.

Dip switches SW2-4 thru SW2-8 are used for timeslot settings; refer to table 7 on page 12.

Following are steps for setting dip switch SW6 (CH1), repeat these steps for Dip Switch SW7 thru SW9 for channel 2 thru 4 as required.

Dip switches SW6-1 thru SW6-3 are used to set baud rate; refer to table 8 on page 13.

Dip switches SW6-4 thru SW6-6 are used to set the timeslot start bit; refer to table 9 on page 13.

Dip switches SW6-7 and SW6-8 are used to set the number of bits per character; refer to table 10 on page 13.

13. After completing the above procedures, set the module for local control or remote control operation using the following steps.
 - A. For **local** control operation:
 1. Set to local control: REMOTE switch (SW10-7) UP (OFF).
 2. Turn service on: SERVICE switch (SW10-8) UP (OFF).
 3. Insert the module into the selected slot in the multiplexer. The module must be inserted so that the white ejector tab is at the *bottom* in a full size (5¼" high) shelf.
 - B. For **remote** control operation:
 1. Set to local control: REMOTE switch (SW10-7) DOWN (ON).
 2. Turn service off: SERVICE switch (SW10-8) DOWN (ON).
 3. Insert the module into the selected slot in the multiplexer. The module must be inserted so that the white ejector tab is at the *bottom* in a full size (5¼" high) shelf.
 4. Wait 15 seconds; this loads the parameter settings for the card into the shelf common module.
 5. Remove the module and set to remote control: REMOTE switch (SW10-7) DOWN (ON). Do not turn service on.
 6. Reinstall the module.
 7. Verify the configuration via remote control by issuing a CONFIG? query. See Section on *Remote Control Interface* for an explanation of the CONFIG? response.
 8. Set service on via remote control (SCL SET command, with "SRVC = ON" in the parameter field). You can now change the operating parameters for the module using SCL commands. For details on using the Simple Command Language (SCL) for remote access and control, consult your multiplexer operation manual.

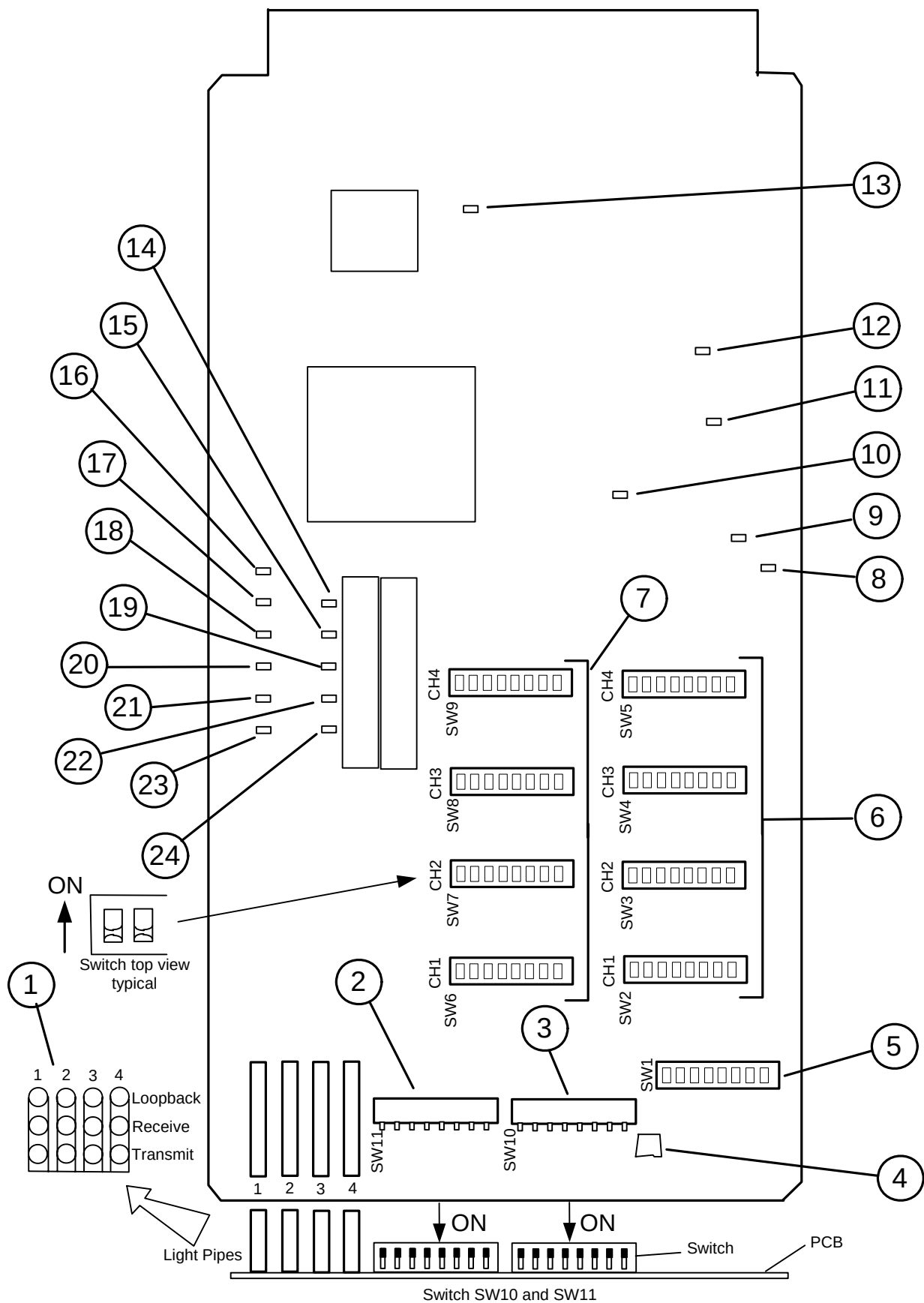


Figure 2. Controls and Indicators, RFL DA-291B Four Port Asynchronous Data Module

Table 2. Controls and indicators, DA-291B

Item	Name/Description	Function
1	LED indicator	Indicates the status of channel 1 thru 4. As shown in Figure 2. No channel LED lit – The channel is disabled. TX and RX are both RED – Framer is not synchronized for that channel. TX and RX are both GREEN – Framer is synchronized but no data transfer. TX and /or RX ORANGE – Data transfer occurring. No data transfer LED remains GREEN. All 3 LEDS blinking RED – If occurring for 1 channel indicates a setting problem for that channel. If occurring for more than I channel could indicate an overlap of setting. Loopback indication: ORANGE – Loopback active for that channel. No illumination – Loopback is not active for that channel.
2	Piano Switch SW11	Sets loopback to either Remote or Local mode for the required channel. Default is OFF – UP (See Table 5).
3	Piano Switch SW10	SW10-1 thru SW10-4 Enables channel 1 thru 4, set to DOWN to enable the required channel.
		SW10-5 thru SW10-6 not used.
		SW10-7 Selects Local or Remote mode UP: Local (Settings obtained from DIP switches) DOWN: Remote (Settings obtained from SCB)
		SW10-8 Sets service ON or OFF UP: Service ON (board enabled) DOWN: Service OFF (board disabled)
4	LED indicator (green)	Indicates Module Service. LED lit – the module is enabled and functional. LED not lit – the module is not enabled or is enabled but not functional.
5	DIP Switch SW1	SW1-1 thru SW1-6 Sets the SCB address (See Table 6).
		SW1-7 For factory test use only, would normally be set to OFF.
		SW1-8 Set to 2 or 4 port operation. OFF: Two port (default) ON: Four port
6	DIP Switch SW2 thru SW5 channel switches	SW2-1 thru SW2-2, SW3-1 thru SW3-2, SW4-1 thru SW4-2 and SW5-1 thru SW5-2 not used.
		SW2-3 TERM: ON: Sets the module to operate via the DI-A port in a drop/insert multiplexer, or operates in a terminal multiplexer. (TX on A, RX on B) OFF: Sets the module to operate via the DI-B port in a drop/insert multiplexer. (TX on B, RX on A) Continue to set SW3 thru SW5 as required.

7	DIP Switch SW6 thru SW9 channel switches	SW6-1 thru SW6-3 for Channel 1 SW7-1 thru SW7-3 for Channel 2 SW8-1 thru SW8-3 for Channel 3 SW9-1 thru SW9-3 for Channel 4 Used to set the baud rate (See Table 8 and Note 1).
		SW6-4 thru SW6-6 for Channel 1 SW7-4 thru SW7-6 for Channel 2 SW8-4 thru SW8-6 for Channel 3 SW9-4 thru SW9-6 for Channel 4 Used to set the channel start bit (See Table 9 and Note 2).
		SW6-7 thru SW6-8 for Channel 1 SW7-7 thru SW7-8 for Channel 2 SW8-7 thru SW8-8 for Channel 3 SW9-7 thru SW9-8 for Channel 4 Used to set the number of bits per character (See Table 10 and Note 3).
8	Test point TP3	Ground
9	Test point TP4	+3.3V
10	Test point TP5	+2.5V
11	Test point TP1	+5V
12	Test point TP2	Ground
13	Test point TP12	Ground
14	Test point TP16	Channel 4 Receive Data
15	Test point TP15	Channel 3 Receive Data
16	Test point TP6	Ground
17	Test point TP11	Channel 4 Transmit Data
18	Test point TP10	Channel 3 Transmit Data
19	Test point TP14	Channel 2 Receive Data
20	Test point TP9	Channel 2 Transmit Data
21	Test point TP8	Channel 1 Transmit Data
22	Test point TP13	Channel 1 Receive Data
23	Test point TP7	250Hz Clock
24	Test point TP17	Ground

Note 1. (Baud Rate)

Used to select the Asynchronous baud rate of the channel. Available options are 38400, 19200, 9600, 4800, 2400, 1200, and 600 baud.

Note 2. (Channel Start Bit)

Sets the least significant timeslot bit on which the channel data is placed. 0-7 may be chosen. Channel data is transmitted MSB (most significant bit) first, which is bit 7. The amount of bits used is determined automatically from the baud rate (see table below). Time slot sharing is only allowed between the two channels of a single Async module, not between two modules. For example with 19200 baud and 4 as the channel timeslot start bit, bits 4 through 7 are used for this channel.

Users of Nokia brand multiplexers should note that Nokia documentation considers the most significant bit as bit 1 and the least significant bit as bit 8. So in the above example using bits 4 through 7, Nokia configuration should be bits 1 through 4 or a bitmask of 11110000.

Table 3. Timeslot Baud Rate

Baud Rate (bps)	Bits per timeslot
38400	8
19200	4
9600	2
4800	1
2400	1
1200	1
600	1

Note 3. (Number of Bits per Character)

Sets the number of bits per character, including start, data, parity, and stop bits. 9, 10, and 11 are the available options. Possible character formats are listed below:
See Table 10 for Switch settings.

Table 4. Character Formats

Data Bits	Parity (none = 0 bits, all others = 1 bit)	Start bits	Stop Bits	Bits per character (DA-291B Setting)
6	None	1	2	9
6	Even	1	1	9
6	Odd	1	1	9
6	Space	1	1	9
6	Even	1	2	10
6	Odd	1	2	10
6	Space	1	2	10
7	None	1	1	9
7	Even	1	1	10
7	Odd	1	1	10
7	Space	1	1	10
7	None	1	2	10
7	Even	1	2	11
7	Odd	1	2	11
7	Space	1	2	11
8	None	1	1	10
8	Even	1	1	11
8	Odd	1	1	11
8	Space	1	1	11
8	None	1	2	11
9	None	1	1	11

Input bit rate tolerance: -2.5% to +1%
Output bit rate tolerance: Start, data, parity bits
Nominal: $\pm 0.01\%$

Stop bit
Normal stop bit (Nominal): $\pm 0.01\%$
Reduced length stop bit: (Nominal -12.5%) $\pm 0.01\%$

Table 5. Setting Remote or Local Loopback

SW11 Switch Positions			Function
Channel 1	SW11-1	Up	Loopback Disabled
	SW11-2	Up	
	SW11-1	Down	Remote Loopback
	SW11-2	Up	
	SW11-1	Up	Local Loopback
	SW11-2	Down	

The remaining Channels (2-4) are set in the same manner for SW11-3 through SW11-8

Table 6. SCB Address Settings DA-291B

Module Address	SW1-1	SW1-2	SW1-3	SW1-4	SW1-5	SW1-6
1	OFF	OFF	OFF	OFF	OFF	ON
2	OFF	OFF	OFF	OFF	ON	OFF
3	OFF	OFF	OFF	OFF	ON	ON
4	OFF	OFF	OFF	ON	OFF	OFF
5	OFF	OFF	OFF	ON	OFF	ON
6	OFF	OFF	OFF	ON	ON	OFF
7	OFF	OFF	OFF	ON	ON	ON
8	OFF	OFF	ON	OFF	OFF	OFF
9	OFF	OFF	ON	OFF	OFF	ON
10	OFF	OFF	ON	OFF	ON	OFF
11	OFF	OFF	ON	OFF	ON	ON
12	OFF	OFF	ON	ON	OFF	OFF
13	OFF	OFF	ON	ON	OFF	ON
14	OFF	OFF	ON	ON	ON	OFF
15	OFF	OFF	ON	ON	ON	ON
16	OFF	ON	OFF	OFF	OFF	OFF
17	OFF	ON	OFF	OFF	OFF	ON
18	OFF	ON	OFF	OFF	ON	OFF
19	OFF	ON	OFF	OFF	ON	ON
20	OFF	ON	OFF	ON	OFF	OFF
21	OFF	ON	OFF	ON	OFF	ON
22	OFF	ON	OFF	ON	ON	OFF
23	OFF	ON	OFF	ON	ON	ON
24	OFF	ON	ON	OFF	OFF	OFF
25	OFF	ON	ON	OFF	OFF	ON
26	OFF	ON	ON	OFF	ON	OFF
27	OFF	ON	ON	OFF	ON	ON
28	OFF	ON	ON	ON	OFF	OFF
29	OFF	ON	ON	ON	OFF	ON
30	OFF	ON	ON	ON	ON	OFF
31	OFF	ON	ON	ON	ON	ON
32	ON	OFF	OFF	OFF	OFF	OFF
33	ON	OFF	OFF	OFF	OFF	ON
34	ON	OFF	OFF	OFF	ON	OFF
35	ON	OFF	OFF	OFF	ON	ON
36	ON	OFF	OFF	ON	OFF	OFF

Table 7. Timeslot Settings

T1 Timeslot	E1 Timeslot	SW2-4 (16)	SW2-5 (8)	SW2-6 (4)	SW2-7 (2)	SW2-8 (1)	Max # of T1 Timeslots	Max # of E1 Timeslots
N/A	N/A	OFF	OFF	OFF	OFF	OFF	N/A	N/A
1	1	OFF	OFF	OFF	OFF	ON	24	31(30)**
2	2	OFF	OFF	OFF	ON	OFF	23	30(29) **
3	3	OFF	OFF	OFF	ON	ON	22	29 (28)**
4	4	OFF	OFF	ON	OFF	OFF	21	28 (27)**
5	5	OFF	OFF	ON	OFF	ON	20	27(26)**
6	6	OFF	OFF	ON	ON	OFF	19	26 (25)**
7	7	OFF	OFF	ON	ON	ON	18	25 (24)**
8	8	OFF	ON	OFF	OFF	OFF	17	24 (23)**
9	9	OFF	ON	OFF	OFF	ON	16	23 (22)**
10	10	OFF	ON	OFF	ON	OFF	15	22 (21)**
11	11	OFF	ON	OFF	ON	ON	14	21 (20)**
12	12	OFF	ON	ON	OFF	OFF	13	20 (19)**
13	13	OFF	ON	ON	OFF	ON	12	19 (18)**
14	14	OFF	ON	ON	ON	OFF	11	18 (17)**
15	15	OFF	ON	ON	ON	ON	10	17 (16)**
16	16 *	ON	OFF	OFF	OFF	OFF	9	16 (N/A)*
17	17	ON	OFF	OFF	OFF	ON	8	15
18	18	ON	OFF	OFF	ON	OFF	7	14
19	19	ON	OFF	OFF	ON	ON	6	13
20	20	ON	OFF	ON	OFF	OFF	5	12
21	21	ON	OFF	ON	OFF	ON	4	11
22	22	ON	OFF	ON	ON	OFF	3	10
23	23	ON	OFF	ON	ON	ON	2	9
24	24	ON	ON	OFF	OFF	OFF	1	8
N/A	25	ON	ON	OFF	OFF	ON	N/A	7
N/A	26	ON	ON	OFF	ON	OFF	N/A	6
N/A	27	ON	ON	OFF	ON	ON	N/A	5
N/A	28	ON	ON	ON	OFF	OFF	N/A	4
N/A	29	ON	ON	ON	OFF	ON	N/A	3
N/A	30	ON	ON	ON	ON	OFF	N/A	2
N/A	31	ON	ON	ON	ON	ON	N/A	1

* Do not use timeslot 16 in an E1 system which uses CAS (channel associated signaling).

** The maximum timeslots available is reduced by “1” for an E1 system using CAS when the starting timeslot is between timeslot 1 and 15.

Table 8. Data Port Configuration (baud rate)

SWITCH SETTINGS Set the appropriate channel (1-4)				Maximum Data Rate	Number Of Time Slots
CH1	SW6-1	SW6-2	SW6-3		
CH2	SW7-1	SW7-2	SW7-3		
CH3	SW8-1	SW8-2	SW8-3		
CH4	SW9-1	SW9-2	SW9-3		
	ON	ON	OFF	38.4 kbps	1
	ON	OFF	ON	19.2 kbps	1/2
	ON	OFF	OFF	9.6kbps	1/4
	OFF	ON	ON	4.8 kbps	1/8
	OFF	ON	OFF	2.4 kbps	1/8
	OFF	OFF	ON	1.2 kbps	1/8
	OFF	OFF	OFF	0.6 kbps	1/8

Table 9. Time Slot Start Bit

CHANNEL START BIT SETTINGS Configure the appropriate channel (1-4)				Channel Start Bit
CH1	SW6-4	SW6-5	SW6-6	
CH2	SW7-4	SW7-5	SW7-6	
CH3	SW8-4	SW8-5	SW8-6	
CH4	SW9-4	SW9-5	SW9-6	
	OFF	OFF	OFF	0
	OFF	OFF	ON	1
	OFF	ON	OFF	2
	OFF	ON	ON	3
	ON	OFF	OFF	4
	ON	OFF	ON	5
	ON	ON	OFF	6
	ON	ON	ON	7

Table 10. Bits per Character

BITS PER CHARACTER Configure the appropriate channel (1-4)			Bits per character
CH1	SW6-7	SW6-8	
CH2	SW7-7	SW7-8	
CH3	SW8-7	SW8-8	
CH4	SW9-7	SW9-8	
	OFF	OFF	9
	OFF	ON	10
	ON	OFF	11

FUNCTIONAL DESCRIPTION

MODULE OVERVIEW

The RFL DA-291B Four-Port Asynchronous Data Module is a channel card for use in the RFL IMUX 2000 line of products. Each of the four ports has independent channel settings. The module supports V.110 and V.14 protocol specifications and will therefore communicate with similar type modules by other manufacturers (i.e. NOKIA™). The DA-291B transmits and receives data from/to the T1/E1 bus and generates and receives data via an I/O module adapter. Two or four port adapters that support RS-232 or RS-422 interfaces are available. There are several data rates supported between 600 and 38400 baud, using an entire timeslot or a portion of a timeslot. The DA-291B module can be set-up and interrogated remotely via the SCB of the IMUX 2000. The RFL NMS (Network Management Software) provides a user friendly Windows™ interface for settings of the DA-291B module. Optionally, DIP switches enable the user to set-up the module locally. Front panel LED's will indicate the status of each port to the user.

SIGNAL BUFFERING CPLD

The Signal Buffering CPLD consists of a Xilinx XC9572XL used to buffer the signals that pass between the Actel and the RFL IMUX 2000 Motherboard. These signals include the T1/E1 bus signals and the pass-thru signals to/from the I/O. It is important to note that the Xilinx is +3V/+5V signal compatible, and therefore provides the necessary level translation between the motherboard signals and the Actel which only supports 3.3V signals.

I/O ADAPTER MODULES

The signals to/from the user equipment pass through the I/O Adapter Module. The I/O module performs the required level shifting between the DA-291B and the user equipment, thus allowing the same channel card to be used with any one of several types of communication interface I/O adapter modules. There are three I/O types currently available:

2-port RS-232, 4-port RS-232 and 2-port RS-422.

COMMS FPGA

The Comms FPGA consists of an Actel ProASIC APA-450 which is the heart of the DA-291B module. It has several main functions which include Transmit interface, receive interface, SCB interface, Baud generator, and local /remote loop-backs.

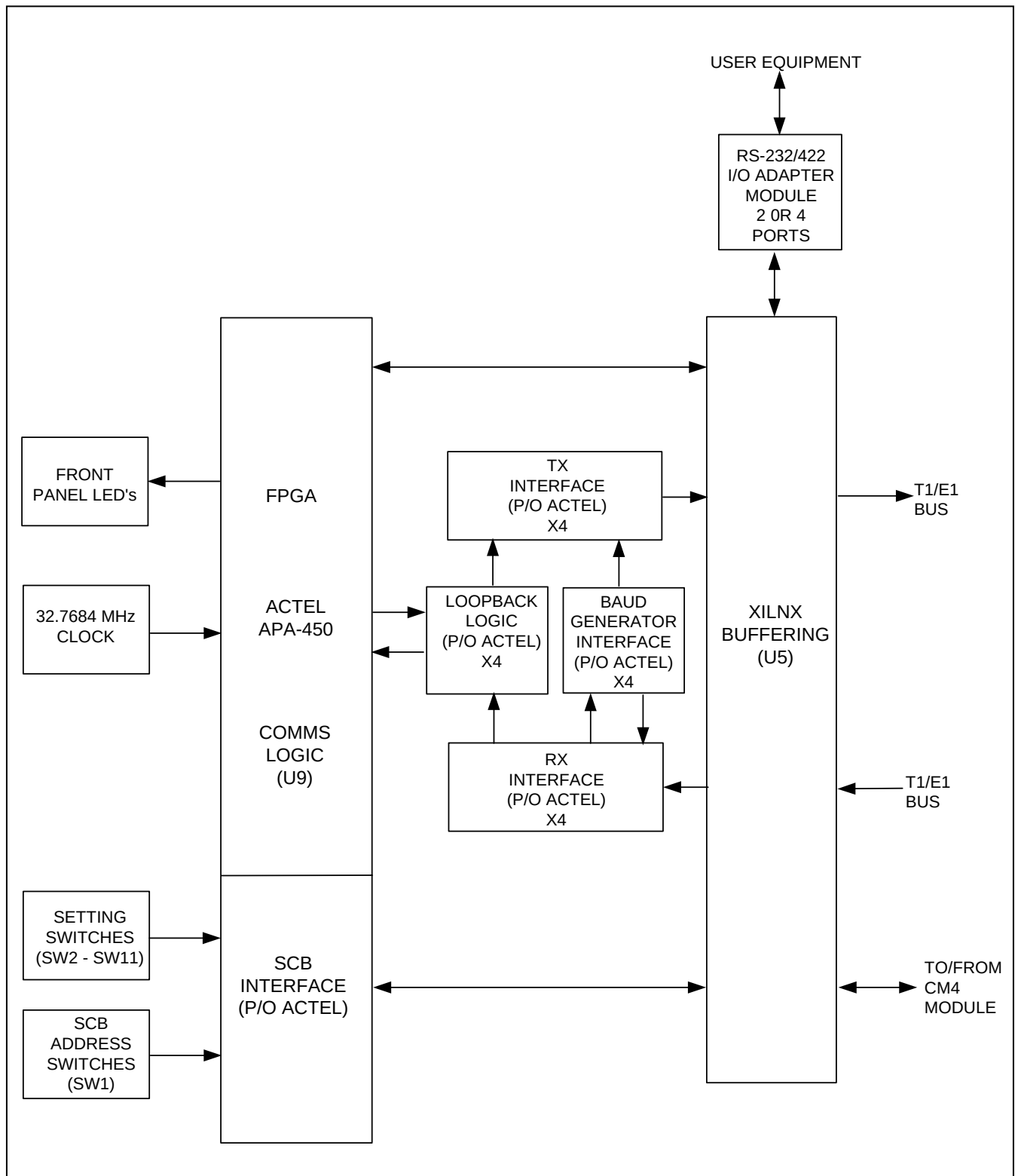


Figure 3. DA-291B Data Module, Block Diagram

TRANSMIT INTERFACE

There are four independent transmitters, one for each channel. The serial data from the user equipment is routed to the transmit circuit where it is over-sampled by the baud clock. The length of a character can be 9, 10 or 11 bits, including start, stop, parity and the data bits. An asynchronous-to-synchronous converter that complies with the CCITT Recommendation V.14 is used to synchronize the (asynchronous) serial stream to the (synchronous) T1/E1 network. This synchronized data is then formatted to the CCITT Recommendation V.110 frame structure and then transmitted into the T1/E1 data stream on the set timeslot (and bit position). Note that the control signal inputs are not supported and the data flow is always assumed to be constant.

RECEIVE INTERFACE

There are four independent receivers, one for each channel. The incoming serial data stream is received from the T1/E1 bus by the receive interface and routed to the CCITT Recommendation V.110 framer. The data is extracted when framers at each end of the network are synchronized. The data is then converted from synchronous-to-asynchronous format by means of CCITT Recommendation V.14 conversion. A baud clock locked to the T1/E1 receiver is used to generate the asynchronous data output to the user equipment. Flow control is handled by the transmitter-end providing status to the receiver-end. The receiver-end will reduce the stop-bit length per specification to prevent a buffer over flow condition.

SCB INTERFACE

The SCB interface circuit communicates with the CM4 module via the SCB (Serial Control Bus). A DIP switch is provided to allow the user to set the SCB address of the module which is read by the SCB FPGA. Each module installed in the chassis will have a unique SCB address. The DA-291B has a type ID of 245 encoded into the SCB FPGA device. The CM-4 module periodically interrogates the DA-291B to read its status information. The configuration is also read by the CM-4 if the DA-291B is set for “local” mode of operation, but is written by the CM-4 if the DA-291B is set for “remote” mode of operation. A DIP switch is set by the user for either “local” or “remote.”

BAUD GENERATOR

There are two baud (clock) generator circuits, one for each of the T1/E1 buses. The frequency of these clocks is either 18.528MHz for T1 systems or 24.576MHz for E1 systems. The receive bus setting for a channel determines which of the two clocks is being used as the baud clock source. Each of the four channels includes an independent circuit that generates a “BAUD_ENABLE” from the baud clock that is exactly 16X the set baud rate. Both the transmitter and the receiver interfaces use the “BAUD_ENABLE” (along with the baud clock) to sample and generate the serial data respectively.

LOCAL/REMOTE LOOPBACKS

The loopback logic resides inside the Actel APA-450 FPGA.

The local loopback causes the data received from the local user equipment to be transmitted back to the local user equipment un-molested. This is comparable to “wire” loopback since the data is not buffered in any way. This loopback does NOT test the V.14 or V.110 circuits.

The remote loopback places the serial output receiver data (from the remote user equipment) into the local transmitter path, and is ultimately transmitted back over the T1/E1 to the remote user equipment. This loopback tests the transmit V.14 or V.110 circuits at BOTH the local and remote locations.

ALERTS/ALARMS

The DA-291B sends no Alert or Alarm signals to the shelf common card.

DROP AND INSERT OPERATION

A drop and insert multiplexer operates at a central point on a three (or more) node system. In the example shown in Figure 4, Node 2 has a drop and insert multiplexer whose DI-A port is connected to the transmission line to Node 1, and whose DI-B port is connected to the transmission line to Node 3. Individual payload channels may connect Nodes 1 and 2, 1 and 3, or 2 and 3.

NOTE

In the drop and insert multiplexer at Node 2, a DA-291B module can set each individual channel to transmit and receive either via the DI-A port (toward Node 1) or via the DI-B port (toward Node 3), but not both.

When a DA-291B is installed in a terminal multiplexer (Node 1 or Node 3), each TERM switch must be set UP. However, when it is installed in a drop and insert multiplexer (Node 2), set the TERM switches UP to transmit and receive via the DI/A port (toward Node 1) and DOWN to transmit and receive via the DI/B port (toward Node 3).

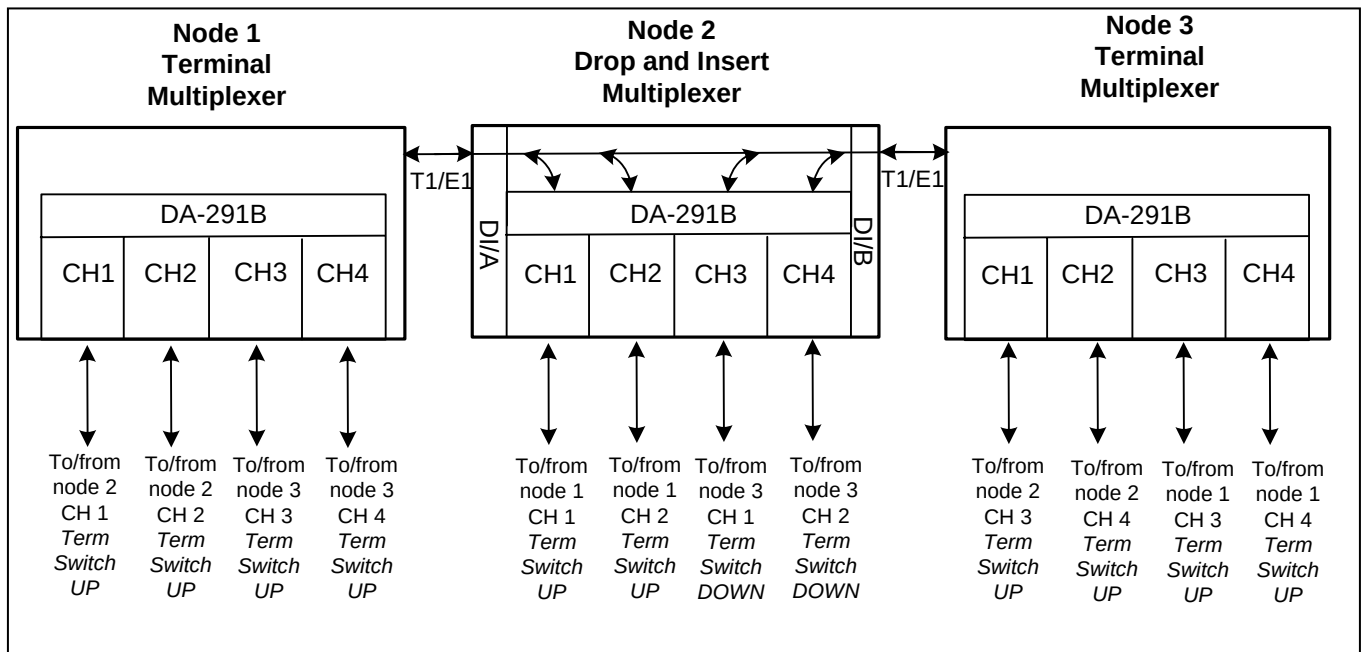


Figure 4. Example of a Three-Node System Using Drop and Insert

REMOTE CONTROL INTERFACE

When the DA-291B module is installed in an IMUX 2000 multiplexer it can be used under local or remote control. When under remote control, certain configuration parameters can be changed only via the RS-232 remote port on the multiplexer. See the IMUX 2000 manual for information on using the remote control interface.

Before the module can receive remote commands, it must first be assigned a card address. The card address is used to route remote commands and queries to a specific module in the multiplexer. In a full size shelf, it is generally set to the physical slot number the card occupies. It may be set to any number from 1 to 36 which is not in use by another card in the same multiplexer. The card address is determined by the SCB ADDRESS switch bank (SW1) settings, as shown below in Table 11.

The remote control interface for the DA-291B involves two sets of codes: "P" (parameter) codes, and "S" (status) codes, as described in the following two sections. The DA-291B reports itself as a "TYPE 245" module.

Table 11. Card Address Settings

Card Address	Switch Settings:* SW1, Positions 1 2 3 4 5 6	Card Address	Switch Settings:* SW1, Positions 1 2 3 4 5 6
1	0 0 0 0 0 1	19	0 1 0 0 1 1
2	0 0 0 0 1 0	20	0 1 0 1 0 0
3	0 0 0 0 1 1	21	0 1 0 1 0 1
4	0 0 0 1 0 0	22	0 1 0 1 1 0
5	0 0 0 1 0 1	23	0 1 0 1 1 1
6	0 0 0 1 1 0	24	0 1 1 0 0 0
7	0 0 0 1 1 1	25	0 1 1 0 0 1
8	0 0 1 0 0 0	26	0 1 1 0 1 0
9	0 0 1 0 0 1	27	0 1 1 0 1 1
10	0 0 1 0 1 0	28	0 1 1 1 0 0
11	0 0 1 0 1 1	29	0 1 1 1 0 1
12	0 0 1 1 0 0	30	0 1 1 1 1 0
13	0 0 1 1 0 1	31	0 1 1 1 1 1
14	0 0 1 1 1 0	32	1 0 0 0 0 0
15	0 0 1 1 1 1	33	1 0 0 0 0 1
16	0 1 0 0 0 0	34	1 0 0 0 1 0
17	0 1 0 0 0 1	35	1 0 0 0 1 1
18	0 1 0 0 1 0	36	1 0 0 1 0 0

* 0 = OFF, 1 = ON

“P” CODES

“P” codes, when used in the parameter field of an SCL “SET” command, allow the user to set parameters on the DA-291B by remote control, just like setting the DIP switches on a module under local control. The ten “P” codes for the DA-291B are “P1” thru “P10”. Each is displayed as a decimal number from 0 to 255, also represented as an eight-digit binary number (in parentheses). The binary representation is more useful for setting and interpreting the “P” codes, since each binary digit (0 or 1) corresponds to the on or off setting for a particular switch on the module. Table 12 describes the meanings of the “P” codes. “P” codes also appear in the response to a CONFIG? query, showing the current parameter settings on the card. A typical DA-291B response to a CONFIG? query looks like this:

```
*OK  
CHANNEL CARD 1, TYPE 245  
UNDER REMOTE CONTROL  
SRVC = ON  
P01 = 33 (B00100001)  
P02 = 34 (B00100010)  
P03 = 35 (B00100011)  
P04 = 36 (B00100100)  
P05 = 161(B10100001)  
P06 = 161(B10100001)  
P07 = 161(B10100001)  
P08 = 161(B10100001)  
P09 = 240(B11110000)  
P10 = 0(B00000000);
```

IMPORTANT: When using binary numbers in the parameter field of a SET command, they must be preceded by the letter "B", as follows:

```
<MULTIPLEXER ADDRESS>:<CARD ADDRESS>:SET:P02 = B00000011;
```

In addition to the P codes, it is also possible to turn service on or off for the card by sending SRVC = ON or SRVC = OFF in the ISCL parameter field with a SET command.

Table 12. Remote Configuration Settings (P Codes)

P Codes	Bits Used	Switch Equivalent	Value ⁽¹⁾	Description
P0	B00000000 -----↑	SRVC OFF	1	Module in Service
			0	Module Out of Service
P1/2/3/4	B00000000 --↑-----	TERM	1	Sets DI-A port to transmit (TX on A, RX on B) per channel
			0	Sets DI-B port to transmit (TX on B, RX on A) Per channel
	B00000000 ---↑↑↑↑↑	TIME SLOT	See Table 13	Timeslot selection T1/E1 per channel
P5/6/7/8	B00000000 ↑↑↑-----	BAUD	See Table 14	Baud rate selection per channel
	B00000000 ---↑↑↑--	TS START BIT	See Table 14	Timeslot start bit selection per channel
	B00000000 -----↑↑	CHAR	See Table 14	Sets the number of bits per character, set for each channel.
P9	B00000000 ↑-----	ENABLE CH1	1	Channel 1 enabled
			0	Channel 1 disabled
	B00000000 -↑-----	ENABLE CH2	1	Channel 2 enabled
			0	Channel 2 disabled
	B00000000 --↑-----	ENABLE CH3	1	Channel 3 enabled
			0	Channel 3 disabled
	B00000000 ---↑-----	ENABLE CH4	1	Channel 4 enabled
			0	Channel 4 disabled

- These are the only legal values for setting the parameters. Setting any parameter to a value outside its specified range will produce an unpredictable result.

Table 12. Remote Configuration Settings (P Codes) continued.....

P Codes	Bits Used	Switch Equivalent	Value ⁽¹⁾	Description
P10	B00000000 ↑↑-----	CH1 LOOPBACK	Bit7 Bit6 0 0	Loopback disabled for channel 1
		CH1 LLB	Bit7 Bit6 0 1	Local Loopback enabled for channel 1
		CH1 RLB	Bit7 Bit6 1 0	Remote Loopback enabled for channel 1
	B00000000 --↑↑----	CH2 LOOPBACK	Bit5 Bit4 0 0	Loopback disabled for channel 2
		CH2 LLB	Bit5 Bit4 0 1	Local Loopback enabled for channel 2
		CH2 RLB	Bit5 Bit4 1 0	Remote Loopback enabled for channel 2
	B00000000 ----↑↑--	CH3 LOOPBACK	Bit3 Bit2 0 0	Loopback disabled for channel 3
		CH3 LLB	Bit3 Bit2 0 1	Local Loopback enabled for channel 3
		CH3 RLB	Bit3 Bit2 1 0	Remote Loopback enabled for channel 3
	B00000000 -----↑↑	CH4 LOOPBACK	Bit1 Bit0 0 0	Loopback disabled for channel 4
		CH4 LLB	Bit1 Bit0 0 1	Local Loopback enabled for channel 4
		CH4 RLB	Bit1 Bit0 1 0	Remote Loopback enabled for channel 4

Table 13 lists the first time slot used for data. The number of time slots used depends on the selected rate and mode (see Table 14).

Table 13. Time Slot Selection Via Remote Access

Active Time Slot (s)	P1 Settings for Time Slot Select
1	Bxxx00001
2	Bxxx00010
3	Bxxx00011
4	Bxxx00100
5	Bxxx00101
6	Bxxx00110
7	Bxxx00111
8	Bxxx01000
9	Bxxx01001
10	Bxxx01010
11	Bxxx01011
12	Bxxx01100
13	Bxxx01101
14	Bxxx01110
15	Bxxx01111
16 ⁽¹⁾	Bxxx10000
17	Bxxx10001
18	Bxxx10010
19	Bxxx10011
20	Bxxx10100
21	Bxxx10101
22	Bxxx10110
23	Bxxx10111
24	Bxxx11000
25	Bxxx11001
26	Bxxx11010
27	Bxxx11011
28	Bxxx11100
29	Bxxx11101
30	Bxxx11110
31	Bxxx11111

1. Do not activate time slot 16 in an E1 multiplexer with CAS signaling turned on.

Table 14. Data Port Configuration Via Remote Access

P5 thru P8 Settings for Data Rate for Channel 1- 4	Maximum Data Rate	Time Slot Capacity
B000xxxxx	600 bps	1/8 of one time slot
B001xxxxx	1.2 kbps	1/8 of one time slot
B010xxxxx	2.4 kbps	1/8 of one time slot
B011xxxxx	4.8 kbps	1/8 of one time slot
B100xxxxx	9.6 kbps	1/4 of one time slot
B101xxxxx	19.2 kbps	1/2 of one time slot
B110xxxxx	38.4 kbps	Full time slot
P5 thru P8 Settings for Time Slot Start Bit for Channel 1- 4	Time Slot Start Bit	
Bxxx000xx	0	
Bxxx001xx	1	
Bxxx010xx	2	
Bxxx011xx	3	
Bxxx100xx	4	
Bxxx101xx	5	
Bxxx110xx	6	
Bxxx111xx	7	
P5 thru P8 Settings for Number of Bits per Character for Channel 1- 4	Number of Bits per Character	
Bxxxxxxx00	9	
Bxxxxxxx01	10	
Bxxxxxxx10	11	

“S” CODES

There is only one “S” code for the DA-291B module. It appears in response to a STATUS? query, and indicates the presence or absence of transmit and receive activity, as shown in Table 15. Like the “P” codes, the “S” codes are displayed in both decimal and binary form. A typical response to a STATUS? query looks like this:

***OK**

CHANNEL CARD 1, TYPE 245

S01 = 11 (B00001011)

S02 = 3 (B00000011)

S03 = 3 (B00000011)

S04 = 3 (B00000011)

S05 = 3 (B00000011)

S06 = 0 (B00000000)

S07 = 15 (B00001111)

S08 = 0 (B00000000)

S09 = 1 (B00000001)

S010 = 1 (B00000001);

Table 15. Remote Status Queries (S Codes)

S Code	Bits Used	Value	Description
S01	B00000000 ----↑----	0	2-port I/O installed.
		1	4-port I/O installed.
	B00000000 -----↑--	0	T1 Multiplexer installed.
		1	E1 Multiplexer installed.
	B00000000 -----↑-	0	Module configuration is invalid
		1	Module configuration is valid
	B00000000 -----↑	0	Module service OFF
		1	Module service ON

S Code	Bits Used	Value	Description
S02(CH1) S03(CH2) S04(CH3) S05(CH4)	B00000000 ↑-----	0	Channel has valid timeslot setting.
		1	Channel has invalid timeslot setting.
	B00000000 -↑-----	0	Channel timeslot bit allocation is OK
		1	Channel timeslot bit allocation overflow
	B00000000 --↑-----	0	Channel TX in data – not active
		1	Channel TX in data – active
	B00000000 ---↑-----	0	Channel RX out data – not active
		1	Channel RX out data – active
	B00000000 ----↑----	0	Channel remote loopback – not active
		1	Channel remote loopback – active
	B00000000 -----↑--	0	Channel local loopback – not active
		1	Channel local loopback – active
	B00000000 -----↑-	0	V.110 frame not OK
		1	V.110 frame OK
	B00000000 -----↑	0	Channel service OFF
		1	Channel service ON
S06	B00000000 --↑-----	0	Ch. 1 and Ch. 2 no bit overlap
		1	Ch. 1 and Ch. 2 bit overlap

S Code	Bits Used	Value	Description
S06 Cont.....	B00000000 ----↑----	0	Ch. 1 and Ch. 3 no bit overlap
		1	Ch. 1 and Ch. 3 bit overlap
	B00000000 -----↑----	0	Ch. 1 and Ch. 4 no bit overlap
		1	Ch. 1 and Ch. 4 bit overlap
	B00000000 -----↑--	0	Ch. 2 and Ch. 3 no bit overlap
		1	Ch. 2 and Ch. 3 bit overlap
	B00000000 -----↑-	0	Ch. 2 and Ch. 4 no bit overlap
		1	Ch. 2 and Ch. 4 bit overlap
S07	B00000000 ----↑----	0	Bus B, Baud clock PLL not OK
		1	Bus B, Baud clock PLL OK
	B00000000 -----↑--	0	Bus A, Baud clock PLL not OK
		1	Bus A, Baud clock PLL OK
	B00000000 -----↑-	0	Bus B not OK
		1	Bus B OK
	B00000000 -----↑	0	Bus A not OK
		1	Bus A OK
S08	B00000000 -----	Undefined (Reserved for future use)	

S Code	Bits Used	Value	Description
S09	B00000000 ---↑↑↑↑↑	Bit 0 = lowest rev.	Circuit board revision number. N=1 to 31
S010	B00000000 ↑↑↑↑↑↑↑↑	Bit 0 = lowest rev.	Actel revision number N = 1 to 255

TESTING

When the DA-291B Data Module has been configured and installed, test it for proper operation before putting it into service. There are two ways you can do the testing:

1. Local testing using the multiplexer equipment loopback, with the system out of service.
2. End-to-end testing using far end module data loopback, with the system in service but the channel being tested out of service.

Use the following procedure to test the modules:

1. For local testing, activate the multiplexer equipment loopback following the instructions in your multiplexer operation manual.

For end-to-end testing, set the loopback (LOOP) switch on the far end DA-291B module to the ON position, and set the multiplexer at one end of the circuit to use loop timing.

2. Connect a data error analyzer (Telecommunication Techniques Corp. Fireberd 2000 or equivalent) to the jack for channel one on the back of the module adapter, using a DB-9 cable.
3. Check for synchronization on the output signal.
4. Send single errors on the transmit side and check for single errors on the receive side.
5. Run for 30 seconds and confirm that the signal remains error-free.
6. Repeat test on each channel set up for use in the current configuration.
7. If you used end-to-end testing, return the LOOP switch at far end module to the OFF position. The system is now operational.

Testing with the fiber module adapters is identical. The fiber connection can be looped back from transmit to receive as well. If the problem appears to be in the fiber head the following check list should be used.

Is the transmit LED on or flashing? If not the DA-291B is not attempting to transmit any data. The problem is probably in the DA-291B or elsewhere in the network.

Is the receive LED on or flashing? If not no data is being received over the fiber. The problem is probably in the fiber or repeater equipment.

Are the fibers properly attached? The transmit connector on the module adapter should go to receive connector on the repeater and vice versa.

If there is an apparent malfunction during end to end testing, first check that the configuration at the two ends is identical.

Most problems occur at the common equipment or facility level. Refer to the *Troubleshooting* section in your multiplexer operation manual for system analysis procedures.

Notes

Notes

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SECTION 16. SYNCHRONOUS DATA CHANNEL MODULES

This section contains Instruction Data Sheets for all synchronous data channel modules available for use with the IMUX 2000 Intelligent Multiplexer, as of the date this manual was printed:

- o **RFL DS-562I Synchronous Data Module
(RS-449, CCITT V.35, G.703, X.21 or Short Haul Optical Fiber Interface)**
- o **RFL DS-562NC Multi-Baud Synchronous Data Module**
- o **RFL DS-961D Five Port Multi-Rate Port Synchronous Data Module**
- o **RFL OCUDP (Office Channel Unit Data Port) Module**

Additional schematics, wiring diagrams, or other documents specific to your application may also be placed in this section.

For information on other synchronous data channel modules that may be available for use with your IMUX 2000, contact the factory or an RFL Sales Representative.

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RFL Electronics Inc.

INSTRUCTION DATA

RFL DS-562I Synchronous Data Module (RS-449, CCITT V.35, G.703, X.21 or Short Haul Optical Fiber Interface) For RFL IMUX 2000 Intelligent T1/E1 Multiplexers

DESCRIPTION

The RFL DS-562I Synchronous Data Module provides RFL IMUX 2000 T1/E1 Multiplexers with synchronous full-duplex data communications at either 56 Kbps or 64 Kbps. The RFL DS-562I operates in terminal or drop and insert systems over T1/E1 carrier lines and uses RS-449/422, CCITT V.35, G.703, X.21/V.11, or short haul optical fiber interfaces. The RFL DS-562I communicates with older RFL DS-562B modules and occupies only one shelf location.

This module communicates using a single bi-directional time slot. When communicating at 56 Kbps the communication protocol includes provisions for programmable addressing to prevent DS0 misconnections. One of 63 addresses is selectable locally using DIP switches or remotely using software. LEDs indicate when the addressing feature is enabled, and when the DS-562I has established valid communications with the appropriate DS-562I. As an option the received data may be squelched during loss of valid address. This option can be selected locally using DIP switches or remotely using software.

When using an RS-449 interface, the RFL DS-562I allows the selection of local loopback or remote loopback functions. Local equipment loopback takes the data coming in on the 56/64 Kbps I/O port and sends it back out on the same I/O port. Local payload loopback (also called "remote loopback") echoes the T1/E1 data back to the source. The loopbacks may be enabled remotely via software or locally by either a front accessible toggle switch, or when using the RS-449 interface, via pins on the rear panel connector. The local loopback commands will override any remote (software) loopback commands. The board contains two LEDs to indicate when either type is enabled.

The RFL DS-562I may be operated as a DCE or DTE. In DTE mode the connected equipment supplies the transmit clock. The externally supplied clock must be synchronous with the T1/E1 carrier. The card supports data, clock, RTS, and CTS signals at the user connector. The CTS is normally a copy of the RTS signal, but as an option can be delayed by approximately 8 microseconds.

NOTE

Channel addressing cannot be used on G.703 interfaces since G.703 only operates at 64 Kbps.

SPECIFICATIONS

As of the date this Instruction Data Sheet was published, the following specifications apply to all RFL DS-562I Synchronous Data Modules, except as noted. Because all RFL products undergo constant refinement and improvement, these specifications are subject to change without notice.

Input Voltage Differential:

RS-449 (EIA-422) Interface: 0.2 to 6 volts
CCITT V.35 Interface: 0.2 to 6 volts
G.703 Interface: 0.35 to 1 volt
X.21 (Rec. V.11) Interface: 0.3 to 6.0 volts

Input Impedance:

RS-449 (EIA-422) Interface: 90 ohms to 150 ohms nominal
CCITT V.35 Interface: 100 ohms nominal
G.703 Interface: 120 ohms nominal
X.21 (Rec. V.11) Interface: 575 ohms nominal

Output Voltage Differential:

RS-449 (EIA-422) Interface: 2.0 to 4.0 volts
CCITT V.35 Interface: 0.44 to 0.66 volts
G.703 Interface: 0.95 to 1.05 volts
X.21 (Rec. V.11) Interface: 2.0 to 4.0 volts

Output Impedance:

RS-449 (EIA-422) Interface: Less than 100 ohms nominal
CCITT V.35 Interface: 100 ohms nominal
G.703 Interface: 300 ohms nominal
X.21 (Rec. V.11) Interface: Less than 100 ohms nominal

Distortion Tolerance:

Send Timing Jitter: $\pm 1\%$
Receive Timing Jitter: $\pm 2\%$
Send Data: $\pm 25\%$ of sampling interval.
Receive Data: $\pm 25\%$ of sampling interval.

Handshaking Delay:

Switched: 8 microseconds (approx.)
Unswitched: Zero delay.

Local Loopback (switched): Equivalent to CCITT V.54 Loop 3.

Remote Loopback (switched): Equivalent to CCITT V.54 Loop 2.

External Cabling:

Maximum Length:

RS-449, V.35, X.21: 60m

G.703: 250m

Optical: up to 1 km

Cable type:

Shielded twisted

AWG 24 (minimum)

Multimode optical fiber

Connector:

RS-449 Interface: 37-pin male D-subminiature (DC-37P).

CCITT V.35 Interface: 37-pin male D-subminiature (DC-37P).

CCITT G.703 Interface: 25-pin male D-subminiature (DC-25P).

CCITT X.21 Interface: 15-pin male D-subminiature (DC-15P).

Optical fiber interface: Type ST

Power Consumption: 2 watts maximum

Operating temperature: -20C to + 55 C (-4F to +131F)

Humidity: 0 to 95 percent, non-condensing

Dimensions:

Length: 9.8 in (24.8 cm)

Width: 0.6 in (1.5 cm)

Height: 4.5 in (11.4 cm)

Weight:

Net: 10 oz (0.28 kg)

Shipping: 1 lb (0.45 kg)

INSTALLATION

Before the DS-562I module can be placed in service, it must be installed in a multiplexer shelf. Installation involves determining the module slot in the Main Shelf or Expansion Shelf where the module will be installed, inserting an I/O adapter module into the rear of the shelf behind the module slot, connecting all signal wiring to the I/O adapter module, checking the settings of all switches and jumpers, and inserting the module into the front of the shelf.

NOTE

Power supply and time slot considerations may affect the installation of RFL DS-562I modules into an existing multiplexer shelf. Refer to the portions of your multiplexer operation manual covering “Channel Module Configuration Guidelines” and “Adding More Channel Modules To Existing Systems” for more information.

The following instructions are provided for installing RFL DS-562I modules into existing systems. If the module was included as part of a system, installation was done at the factory, otherwise, proceed as follows:

1. Carefully inspect the RFL DS-562I and its I/O adapter module for shipping damage.
If you suspect damage to the module or its Module Adapter, immediately contact RFL’s Customer Service Department at the number shown at the bottom of this page.
2. Determine which module slot in the Main Shelf or Expansion Shelf the RFL DS-562I will be installed in.
The RFL DS-562I module occupies one module slot in the Main Shelf or Expansion Shelf. Refer to the “as supplied” drawings furnished with the equipment for more information.
3. Determine which I/O Adapter Module will be used to make connections to the RFL DS-562I module.
Each RFL DS-562I module installed in an IMUX 2000 multiplexer requires an I/O Adapter Module. The I/O Adapter Module provides the appropriate connections for the desired interface.

There are eight Module Adapters for the RFL DS-562I:

<u>Module Adapter</u>	<u>Part Number</u>	<u>Interface Type</u>	<u>Socket</u>	<u>Figure</u>
MA-406IA	9547-16331	RS-449	37 pin D-subminiature (DC-37S)	1
MA-406IB	9547-16632	RS-530	25 pin D-subminiature (DC-25S)	2
MA-407I	9547-1750	G.703 contradirectional	25 pin D-subminiature (DC-25S)	3
MA-408I	9547-1755	G.703 codirectional	25 pin D-subminiature (DC-25S)	4
MA-409IA	9547-17271	V.35	37 pin D-subminiature (DC-37S)	5
MA-410I	9547-1760	X.21	15 pin D-subminiature (DC-15S)	6
MA-600	9547-600	Optical fiber	Type ST	8
MA-620	107245	Optical fiber	Type ST	10

Make sure the I/O Module Adapter you are installing is the correct one for the desired application.

4. Once the Adapter Module has been selected, set it for the following desired configuration as applicable:

MA-406IA

Select DCE or DTE mode by installing J2 jumpers

MA-406IB

Select DCE or DTE mode by installing J2 jumpers

MA-407I

No configuration is required for this module.

MA-408I

No configuration is required for this module.

MA-409IA

Select DCE or DTE:

DCE: Set jumpers J1 to J9 to DCE

DTE: Set jumpers J1 to J9 to DTE

MA-410I

DCE: S1-1 to S1-4 (toward "DCE")

DTE: S1-1 to S1-4 (toward "DTE")

MA-600

No configuration is required for this module.

MA-620

Select Normal or Inverted Data:

Normal Data: SW1-1 (DOWN)

Inverted Data: SW1-1 (UP)

5. Insert the Adapter Module into the rear of the shelf directly behind the module slot where the DS-562I will be installed. Secure the module with the two screws provided.
6. Connect the Adapter Module to the user equipment using the connector pin assignments detailed in Tables 1, 2, 3, 4, 5, or 6 as applicable.
7. Refer to Figure 7 for the location of switches on the DS-562I
8. On the DS-562I check the setting of toggle switch SW6.
SW6 controls the loopback, up to enable equipment loopback, down to enable payload loopback, or center for no loopback. Set SW6 to the center position.
9. On the DS-562I check the setting of DIP switch SW7-1 through SW7-6.
SW7-1 through SW7-6 controls the modules SCB address. Set the switches to achieve the desired SCB address setting as shown in Table 7.
10. On the DS-562I check the setting of DIP switch SW7-7.
SW7-7 turns the DS-562I's service on or off. Down turns the service off (board disabled) up turns the service on (board enabled). Set the switch down.
11. On the DS-562I check the setting of DIP switch SW7-8.
SW7-8 sets the DS-562I for local or remote control. Down places the DS-562I in remote mode (settings obtained from the SCB), up sets the module for local mode (settings obtained from the DIP switches). Set the switch up.

12. On the DS-562I check the setting of DIP switch SW1-1 through SW1-5.
SW1-1 through SW1-5 controls the modules transmit and receive timeslot. Set the switches to achieve the desired timeslot setting as shown in Table 8.
13. On the DS-562I check the setting of DIP switch SW2-1 through SW2-6.
SW2-1 through SW2-6 controls the modules transmit address. Set the switches to achieve the desired transmit address setting as shown in Table 9.
14. On the DS-562I check the setting of DIP switch SW3-1 through SW3-6.
SW3-1 through SW3-6 controls the modules receive address. Set the switches to achieve the desired receive address setting as shown in Table 9.
15. On the DS-562I check the setting of DIP switch SW4-1.
SW4-1 turns the octet timing on or off. Right turns the service off, left turns the octet timing on. Set the switch to the desired position.
16. On the DS-562I check the setting of DIP switch SW4-2.
SW4-2 selects normal or inverted receive clock. Right sets normal polarity, left sets inverted polarity. If the DS-562I does not reliably receive data from the 64/56 Kbps connector, the receive clock may have to be inverted. For the initial setup, set the switch to the right.
17. On the DS-562I check the setting of DIP switch SW4-3.
SW4-3 selects normal or inverted transmit clock. Right sets normal polarity, left sets inverted polarity. If the user equipment does reliably receive data from the DS-562I's 64/56 Kbps connector, the transmit clock may have to be inverted. For the initial setup, set the switch to the right.
18. On the DS-562I check the setting of DIP switch SW4-4.
SW4-4 turns the squelch on or off. Right turns the squelch off, left turns the squelch on (the DS-562I stops sending data out the 64/56 Kbps connector upon loss of valid receive address). Set the switch to the desired setting.
19. On the DS-562I check the setting of DIP switch SW4-7.
SW4-7 sets the data rate. Right selects 64 Kbps, left selects 56 Kbps. Set the switch to the desired setting.
20. On the DS-562I check the setting of DIP switch SW4-8.
SW4-8 selects the DS-562I transmit bus direction. Right selects transmit on B, receive on A (for drop and insert B), left selects transmit of A, receive on B (drop and insert A or terminal end). Set the switch to the desired setting.
21. On the DS-562I check the setting of DIP switch SW5-1.
SW5-1 selects T1/E1. Right selects T1 carrier, left selects E1 carrier. Set the switch for the format being used.

22. On the DS-562I check the setting of DIP switch SW5-2.
SW5-2 turns the handshaking delay on or off. Right sets no delay, left sets an 8 microsecond delay.
23. On the DS-562I check the setting of DIP switch SW5-3.
SW5-3 selects normal or inverted data. Right sets normal data, left sets inverted data, this setting inverts incoming and outgoing data from the interface.
24. Install the DS-562I into the IMUX 2000 chassis and allow a few seconds for the board to complete its power-up process.
25. Turn the DS-562I's service to ON (SW7-7). Allow a minimum of 16 seconds to ensure the common module has read all configuration data from the module.
26. Verify performance of the module using loopback testing.
27. When the configuration and performance of the DS-562I has been verified, set the module to remote mode (SW7-8).

Table 1. Connector J1 pin assignments for the MA-406IA Module Adapter

Pin No.	Signal Name
4	SD(A) - Send Data
22	SD(B) - Send Data
5	ST(A) - Send Timing
23	ST(B) - Send Timing
6	RD(A) - Receive Data
24	RD(B) - Receive Data
7	RS(A) - Request To Send (RTS)
25	RS(B) - Request To Send (RTS)
8	RT(A) - Receive Timing
26	RT(B) - Receive Timing
9	CS(A) - Clear To Send
27	CS(B) - Clear To Send
10	Local Loopback
14	Remote Loopback
19	Signal Ground

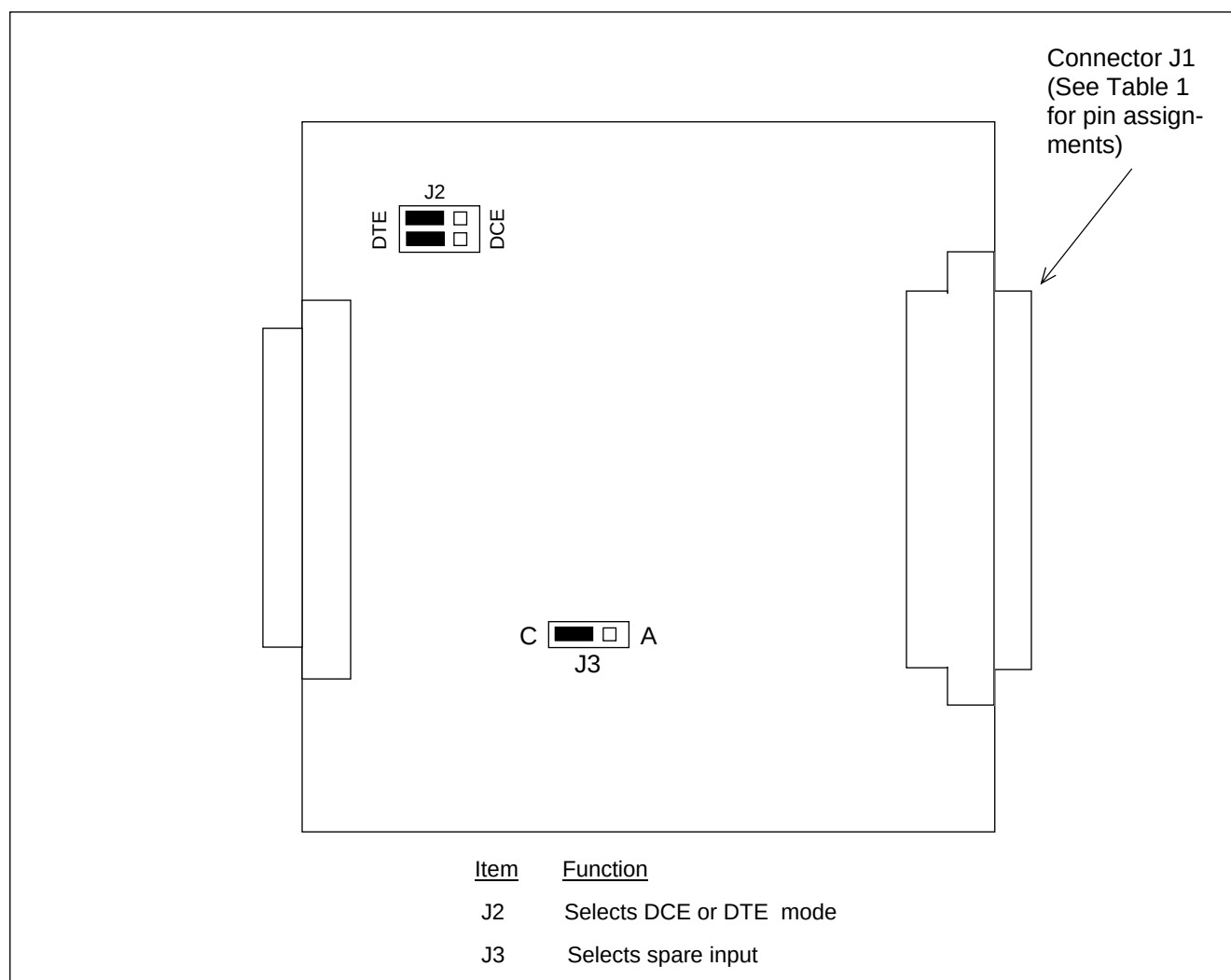


Figure 1. Controls and indicators, MA-406IA Module Adapter

Table 2. Connector J1 pin assignments for the MA-406IB Module Adapter

Pin No.	Signal Name
2	SD(A) - Send Data
14	SD(B) - Send Data
15	ST(A) - Send Timing
12	ST(B) - Send Timing
3	RD(A) - Receive Data
16	RD(B) - Receive Data
4	RS(A) - Request To Send (RTS)
19	RS(B) - Request To Send (RTS)
17	RT(A) - Receive Timing
9	RT(B) - Receive Timing
5	CS(A) - Clear To Send
13	CS(B) - Clear To Send
18	Local Loopback
21	Remote Loopback
7, 23	Signal Ground

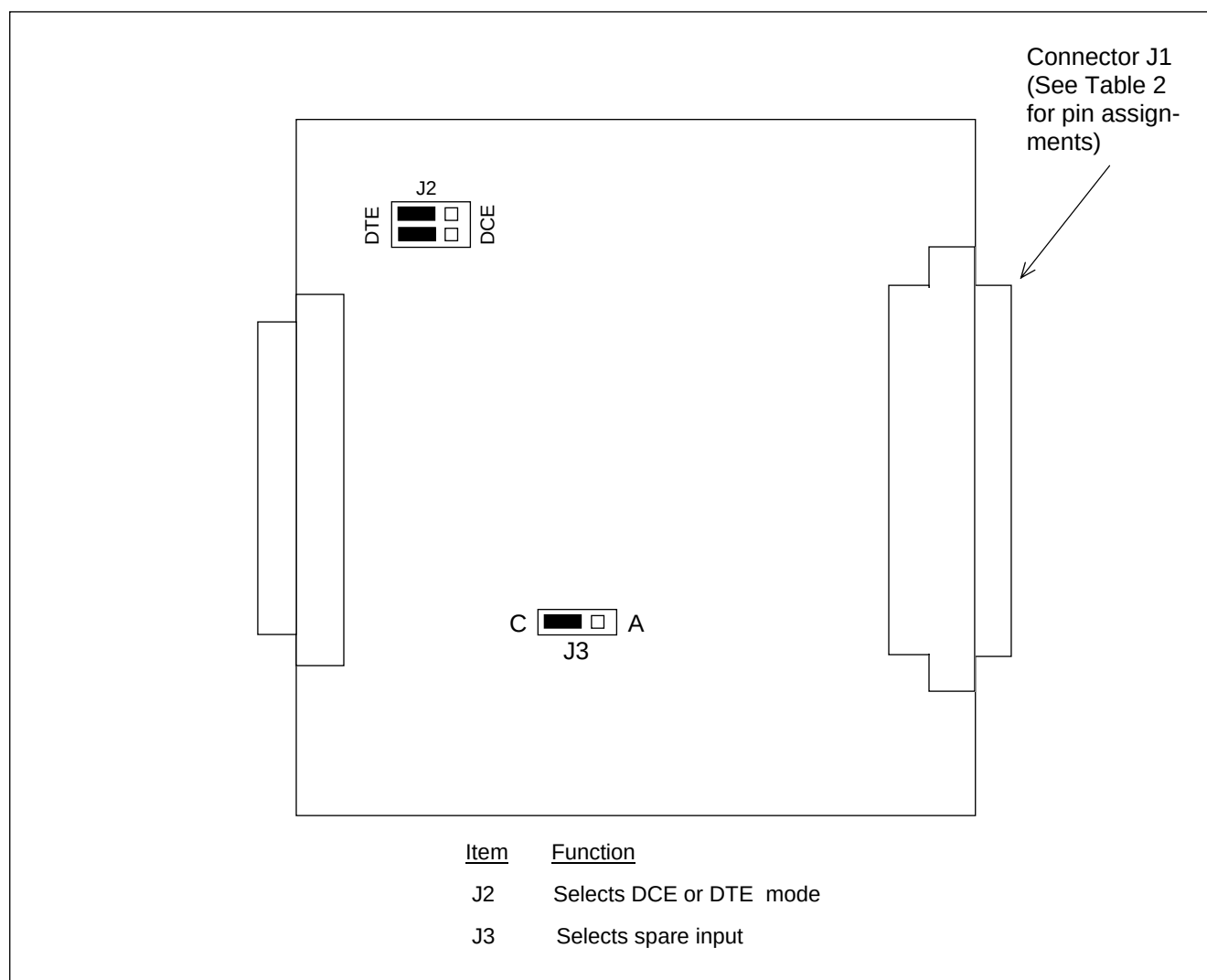


Figure 2. Controls and indicators, MA-406IB Module Adapter

Table 3. Connector J1 pin assignments for the MA-407I Module Adapter

Pin No.	Signal Name
1	GND - Chassis
2	TD(A) - Transmit Data
9	TD(B) - Transmit Data
3	RD(A) - Receive Data
16	RD(B) - Receive Data
12	RT(A) - Receive Timing
13	RT(B) - Receive Timing
15	TT(A) - Transmit Timing
14	TT(B) - Transmit Timing

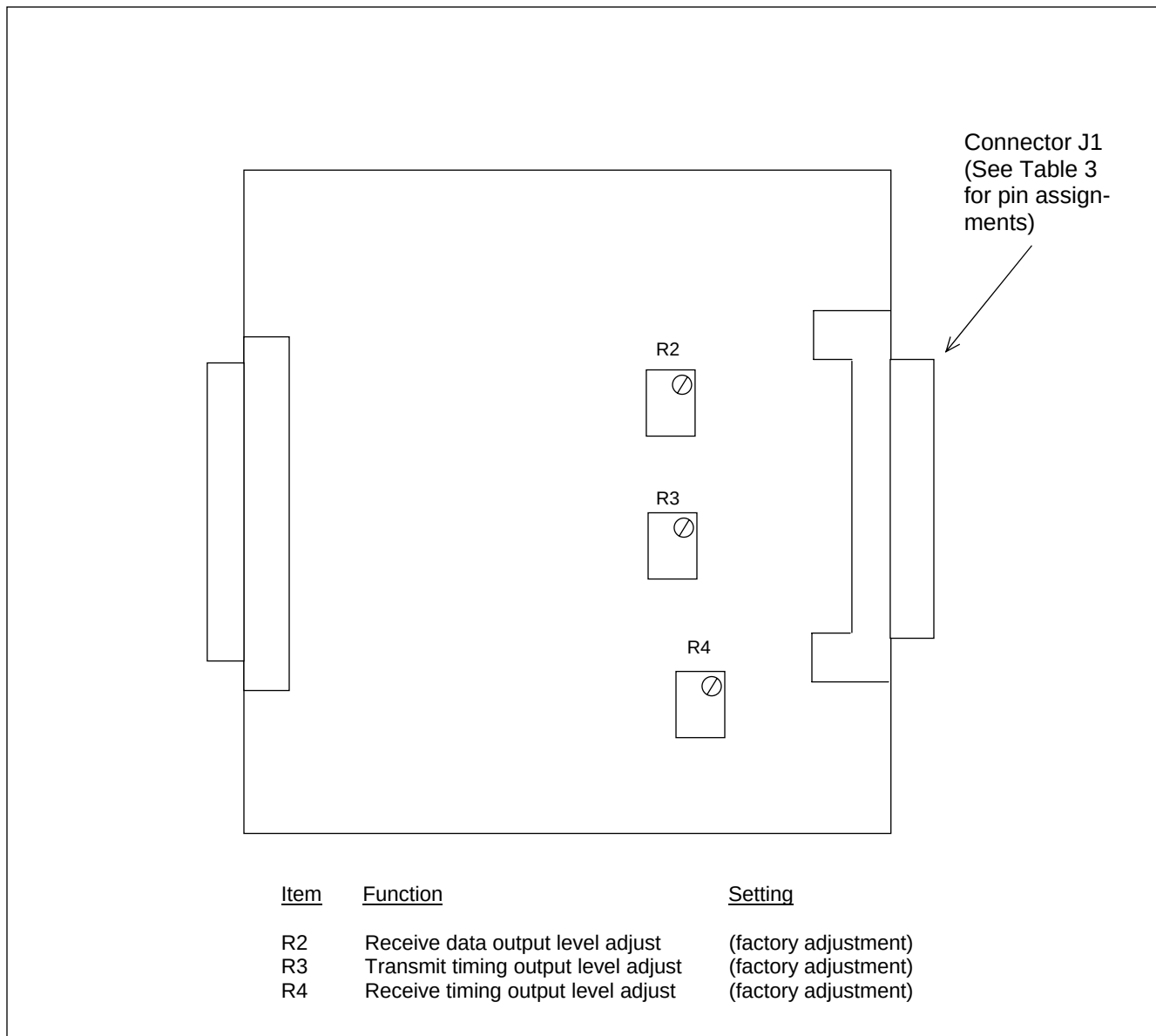


Figure 3. Controls and indicators, MA-407I Module Adapter

Table 4. Connector J1 pin assignments for the MA-408I Module Adapter

Pin No.	Signal Name
1	GND - Chassis
2	TD(A) - Transmit Data (input)
9	TD(B) - Transmit Data (input)
3	RD(A) - Receive Data (output)
16	RD(B) - Receive Data (output)

Note: The clock is embedded within the Transmit and Receive data signal.
The customer interface recovers the clock provided by the MA-408I

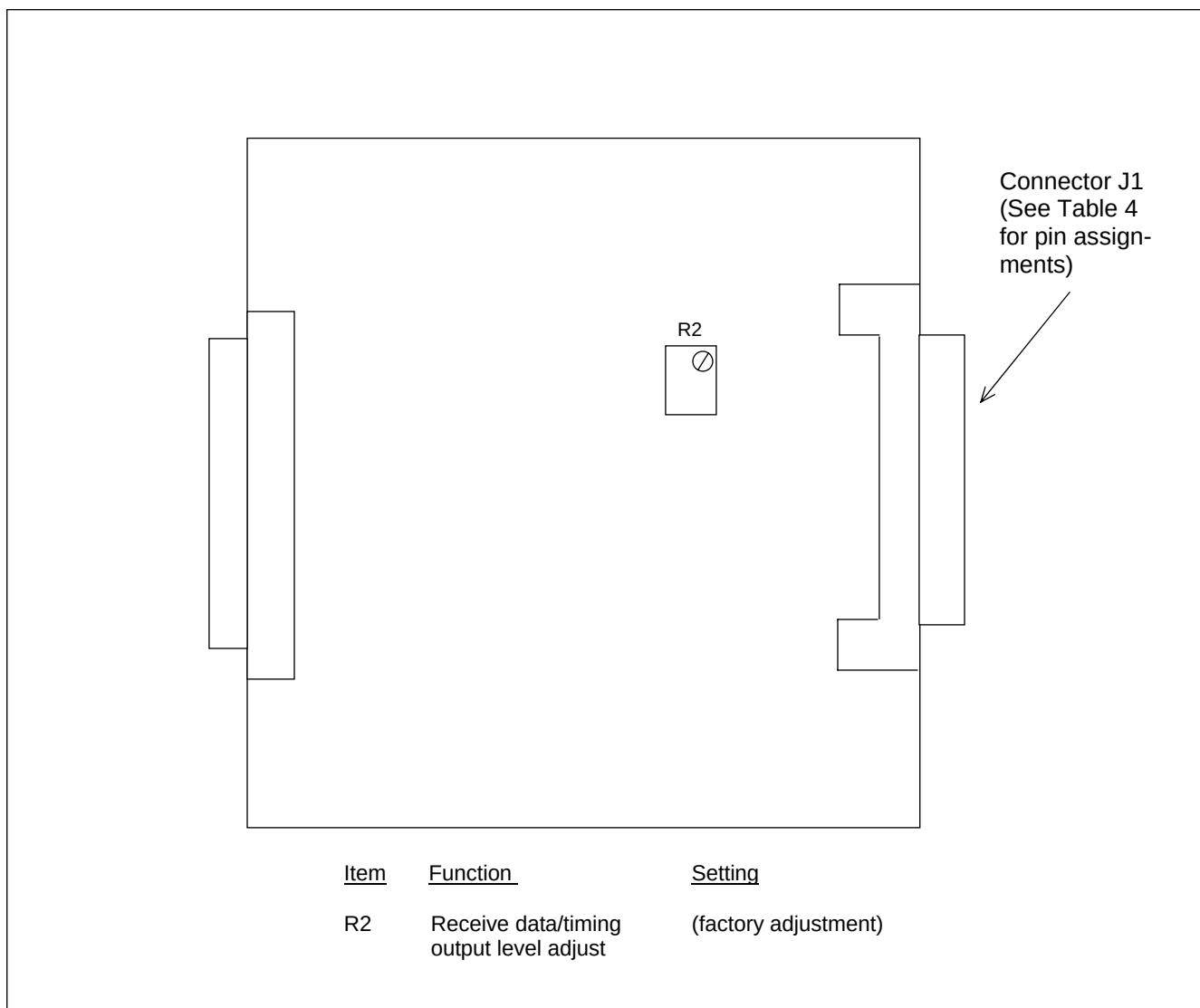


Figure 4. Controls and indicators, MA-408I Module Adapter

Table 5. Connector J1 pin assignments for the MA-409IA Module Adapter

V.35 Pin No.	Signal Name	DC-37S Pin No.
S	SD (B) - Send Data	22
P	SD (A) - Send Data	4
AA	SCT (B) - Serial Clock Transmit	23
Y	SCT (A) - Serial Clock Transmit	5
X	SCR (B) - Serial Clock Receive	26
V	SCR (A) - Serial Clock Receive	8
T	RD (B) - Receive Data	24
R	RD (A) - Receive Data	6
D	CB - Clear To Send (CTS)	9
C	CA - Request To Send (RTS)	7
B	AB - Signal Ground	19

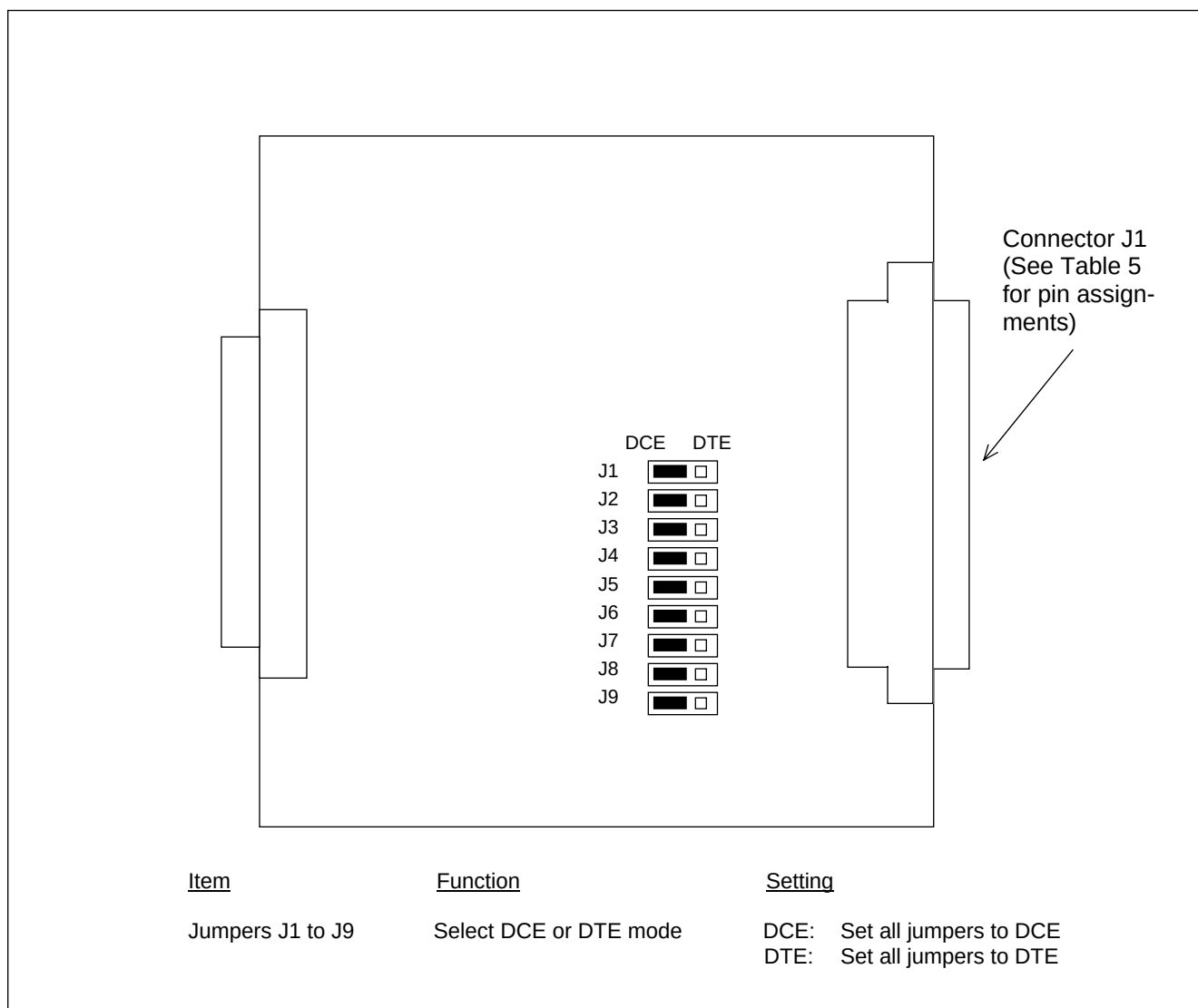


Figure 5. Controls and indicators, MA-409IA Module Adapter

Table 6. Connector J1 pin assignments for the MA-410I Module adapter

Pin No.	Signal Name
1	Chassis
2	TX Data A
3	Control A
4	Rx Data A
5	Indicate A
6	Signal Timing A
8	Signal Ground
9	Tx Data B
10	Control B
11	Rx Data B
12	Indicate B
13	Signal Timing B

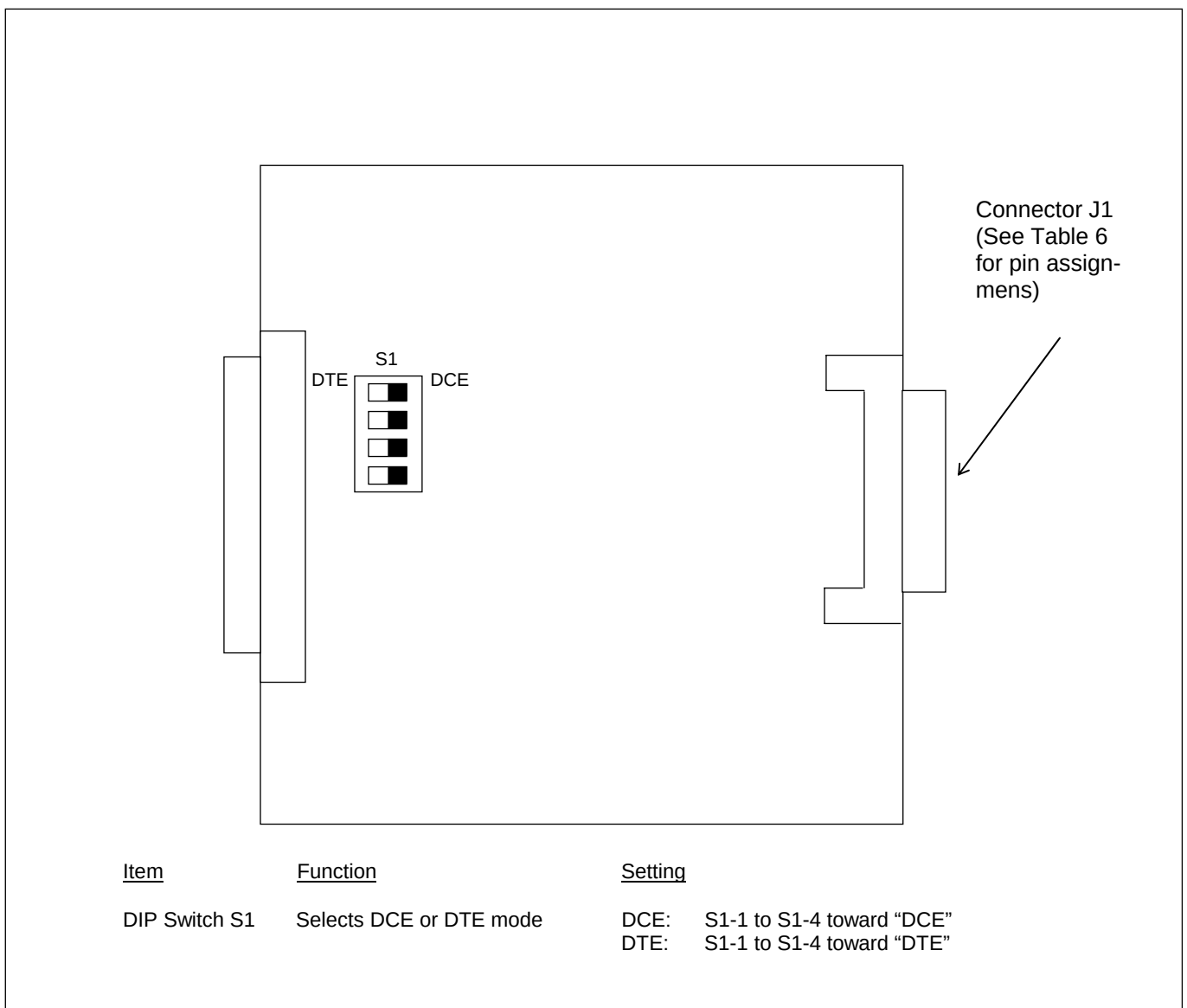


Figure 6. Controls and Indicators, MA-410I Module adapter

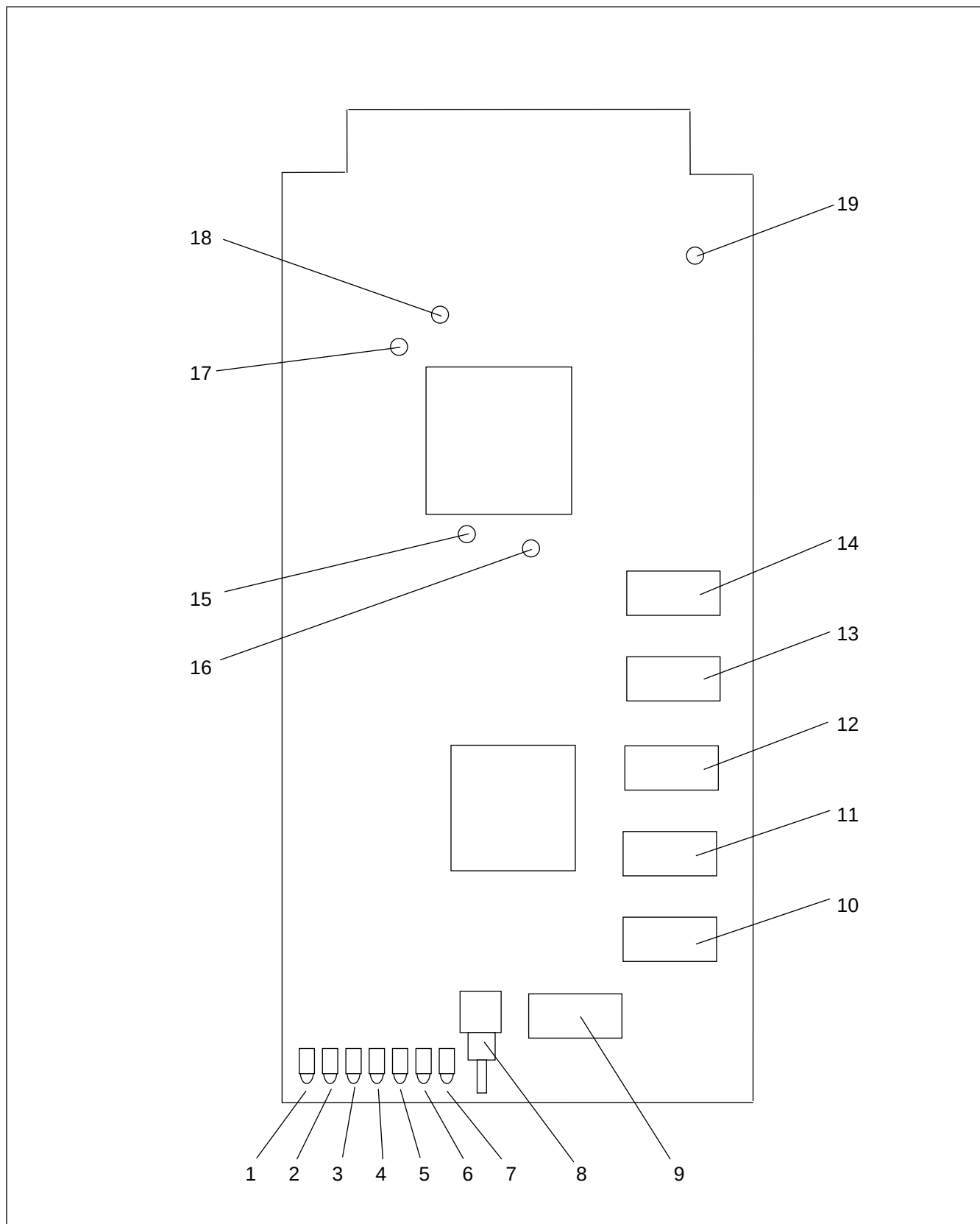


Figure 7. Controls and indicators, RFL DS-562I synchronous data module

Table 7. Controls and indicators, DS-562I

Item	Name/Description	Function
1	LED indicator (green)	ADR EN: Lights when the transmit address is enabled (not set to 0). Used in 56K mode only.
2	LED indicator (green)	ADR VLD: Lights when the receive address is enabled (not set to 0) and matches the address embedded in the T1/E1 signal. Used in 56K mode only.
3	LED indicator (red)	EQ LB: Lights when the equipment loopback is enabled.
4	LED indicator (red)	PL LB: Lights when the payload loopback is enabled.
5	LED indicator (green)	RX: Lights when the DS-562I is receiving data from the remote equipment
6	LED indicator (green)	TX: Lights when the DS-562I is transmitting data to the remote equipment
7	LED indicator (green)	SVC: Lights when the DS-562I's service is enabled.
8	Switch SW6	This is a three position toggle switch: UP: Sets the board to equipment loopback. Center: Normal operation (no loopback, but can be overridden remotely). Down: Sets the board to payload loopback. NOTE: If this unit is used for protective relaying applications, disable the protection equipment before using loopbacks.
9	DIP Switch SW7	SW7-1 to SW7-6 Sets the SCB address, see Table 7.
		SW7-7 Sets the DS-562I service ON or OFF: ON(up): Service ON (board enabled). OFF(down): Service OFF (board disabled).
		SW7-8 Sets the DS-562I for local or remote mode: ON(up): Local (settings obtained from DIP switches). OFF(down): Remote (settings obtained from SCB).
10	DIP Switch SW1	SW1-1 to SW1-5 Sets the T1/E1 timeslot, see Table 8.
11	DIP Switch SW2	SW2-1 to SW2-6 In 56 Kbps mode, sets the transmit address, see Table 9.
12	DIP Switch SW3	SW3-1 to SW3-6 In 56 Kbps mode, sets the receive address, see Table 9.
13	DIP Switch SW4	SW4-1 Enables/disables octet timing: ON(right): Octet timing OFF. OFF(left): Octet timing ON.
		SW4-2 Sets the receive clock polarity: ON(right): Normal polarity. OFF(left): Inverted polarity.
		SW4-3 Sets the transmit clock polarity: ON(right): Normal polarity. OFF(left): Inverted polarity.
		SW4-4 Sets receiver squelch: ON(right): Squelch OFF. OFF(left): Squelch ON (DS-562I stops output to user equipment upon loss of valid address).
		SW4-7 Sets the data rate: ON(right): 64 Kbps. OFF(left): 56 Kbps.
		SW4-8 Sets the T1/E1 transmit bus direction: ON(right): Transmit on "B" (receive on "A"). OFF(left): Transmit on "A" (receive on "B").
14	DIP Switch SW5	SW5-1 Selects the carrier type: ON(right): T1 carrier. OFF(left): E1 carrier.
		SW5-2 Controls the handshaking delay: ON(right): No delay. OFF(left): 8 microseconds delay (approx.)
		SW5-3 Selects Normal Data or Inverted Data: ON(right): Normal Data. OFF(left): Inverted Data.
15	Test point TP1	Transmit data
16	Test point TP2	Receive data
17	Test point TP3	Transmit clock
18	Test point TP4	Receive clock
19	Test point TP5	Ground

Table 8. SCB Address Settings, RFL DS-562I

Module Address	SW7-1 (A5)	SW7-2 (A4)	SW7-3 (A3)	SW7-4 (A2)	SW7-5 (A1)	SW7-6 (A0)
1	DOWN	DOWN	DOWN	DOWN	DOWN	UP
2	DOWN	DOWN	DOWN	DOWN	UP	DOWN
3	DOWN	DOWN	DOWN	DOWN	UP	UP
4	DOWN	DOWN	DOWN	UP	DOWN	DOWN
5	DOWN	DOWN	DOWN	UP	DOWN	UP
6	DOWN	DOWN	DOWN	UP	UP	DOWN
7	DOWN	DOWN	DOWN	UP	UP	UP
8	DOWN	DOWN	UP	DOWN	DOWN	DOWN
9	DOWN	DOWN	UP	DOWN	DOWN	UP
10	DOWN	DOWN	UP	DOWN	UP	DOWN
11	DOWN	DOWN	UP	DOWN	UP	UP
12	DOWN	DOWN	UP	UP	DOWN	DOWN
13	DOWN	DOWN	UP	UP	DOWN	UP
14	DOWN	DOWN	UP	UP	UP	DOWN
15	DOWN	DOWN	UP	UP	UP	UP
16	DOWN	UP	DOWN	DOWN	DOWN	DOWN
17	DOWN	UP	DOWN	DOWN	DOWN	UP
18	DOWN	UP	DOWN	DOWN	UP	DOWN
19	DOWN	UP	DOWN	DOWN	UP	UP
20	DOWN	UP	DOWN	UP	DOWN	DOWN
21	DOWN	UP	DOWN	UP	DOWN	UP
22	DOWN	UP	DOWN	UP	UP	DOWN
23	DOWN	UP	DOWN	UP	UP	UP
24	DOWN	UP	UP	DOWN	DOWN	DOWN
25	DOWN	UP	UP	DOWN	DOWN	UP
26	DOWN	UP	UP	DOWN	UP	DOWN
27	DOWN	UP	UP	DOWN	UP	UP
28	DOWN	UP	UP	UP	DOWN	DOWN
29	DOWN	UP	UP	UP	DOWN	UP
30	DOWN	UP	UP	UP	UP	DOWN
31	DOWN	UP	UP	UP	UP	UP
32	UP	DOWN	DOWN	DOWN	DOWN	DOWN
33	UP	DOWN	DOWN	DOWN	DOWN	UP
34	UP	DOWN	DOWN	DOWN	UP	DOWN
35	UP	DOWN	DOWN	DOWN	UP	UP
36	UP	DOWN	DOWN	UP	DOWN	DOWN

Table 9. Timeslot settings, RFL DS-562I

T1 Timeslot	SW1-1 (A4)	SW1-2 (A3)	SW1-3 (A2)	SW1-4 (A1)	SW1-5 (A0)	E1 Timeslot
1	RIGHT	RIGHT	RIGHT	RIGHT	RIGHT	N/A
2	RIGHT	RIGHT	RIGHT	RIGHT	LEFT	1
3	RIGHT	RIGHT	RIGHT	LEFT	RIGHT	2
4	RIGHT	RIGHT	RIGHT	LEFT	LEFT	3
5	RIGHT	RIGHT	LEFT	RIGHT	RIGHT	4
6	RIGHT	RIGHT	LEFT	RIGHT	LEFT	5
7	RIGHT	RIGHT	LEFT	LEFT	RIGHT	6
8	RIGHT	RIGHT	LEFT	LEFT	LEFT	7
9	RIGHT	LEFT	RIGHT	RIGHT	RIGHT	8
10	RIGHT	LEFT	RIGHT	RIGHT	LEFT	9
11	RIGHT	LEFT	RIGHT	LEFT	RIGHT	10
12	RIGHT	LEFT	RIGHT	LEFT	LEFT	11
13	RIGHT	LEFT	LEFT	RIGHT	RIGHT	12
14	RIGHT	LEFT	LEFT	RIGHT	LEFT	13
15	RIGHT	LEFT	LEFT	LEFT	RIGHT	14
16	RIGHT	LEFT	LEFT	LEFT	LEFT	15
17	LEFT	RIGHT	RIGHT	RIGHT	RIGHT	16 *
18	LEFT	RIGHT	RIGHT	RIGHT	LEFT	17
19	LEFT	RIGHT	RIGHT	LEFT	RIGHT	18
20	LEFT	RIGHT	RIGHT	LEFT	LEFT	19
21	LEFT	RIGHT	LEFT	RIGHT	RIGHT	20
22	LEFT	RIGHT	LEFT	RIGHT	LEFT	21
23	LEFT	RIGHT	LEFT	LEFT	RIGHT	22
24	LEFT	RIGHT	LEFT	LEFT	LEFT	23
N/A	LEFT	LEFT	RIGHT	RIGHT	RIGHT	24
N/A	LEFT	LEFT	RIGHT	RIGHT	LEFT	25
N/A	LEFT	LEFT	RIGHT	LEFT	RIGHT	26
N/A	LEFT	LEFT	RIGHT	LEFT	LEFT	27
N/A	LEFT	LEFT	LEFT	RIGHT	RIGHT	28
N/A	LEFT	LEFT	LEFT	RIGHT	LEFT	29
N/A	LEFT	LEFT	LEFT	LEFT	RIGHT	30
N/A	LEFT	LEFT	LEFT	LEFT	LEFT	31

* Do not use timeslot 16 in an E1 system which uses CAS (channel associated signalling).

Table 10. Transmit & Receive Address Settings, RFL DS-562I
(Used only in 56 Kbps mode)

Trans/Rcv Address	SW2/3-1 (A5)	SW2/3-2 (A4)	SW2/3-3 (A3)	SW2/3-4 (A2)	SW2/3-5 (A1)	SW2/3-6 (A0)
0 (disabled)	RIGHT	RIGHT	RIGHT	RIGHT	RIGHT	RIGHT
1	RIGHT	RIGHT	RIGHT	RIGHT	RIGHT	LEFT
2	RIGHT	RIGHT	RIGHT	RIGHT	LEFT	RIGHT
3	RIGHT	RIGHT	RIGHT	RIGHT	LEFT	LEFT
4	RIGHT	RIGHT	RIGHT	LEFT	RIGHT	RIGHT
5	RIGHT	RIGHT	RIGHT	LEFT	RIGHT	LEFT
6	RIGHT	RIGHT	RIGHT	LEFT	LEFT	RIGHT
7	RIGHT	RIGHT	RIGHT	LEFT	LEFT	LEFT
8	RIGHT	RIGHT	LEFT	RIGHT	RIGHT	RIGHT
9	RIGHT	RIGHT	LEFT	RIGHT	RIGHT	LEFT
10	RIGHT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
11	RIGHT	RIGHT	LEFT	RIGHT	LEFT	LEFT
12	RIGHT	RIGHT	LEFT	LEFT	RIGHT	RIGHT
13	RIGHT	RIGHT	LEFT	LEFT	RIGHT	LEFT
14	RIGHT	RIGHT	LEFT	LEFT	LEFT	RIGHT
15	RIGHT	RIGHT	LEFT	LEFT	LEFT	LEFT
16	RIGHT	LEFT	RIGHT	RIGHT	RIGHT	RIGHT
17	RIGHT	LEFT	RIGHT	RIGHT	RIGHT	LEFT
18	RIGHT	LEFT	RIGHT	RIGHT	LEFT	RIGHT
19	RIGHT	LEFT	RIGHT	RIGHT	LEFT	LEFT
20	RIGHT	LEFT	RIGHT	LEFT	RIGHT	RIGHT
21	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT
22	RIGHT	LEFT	RIGHT	LEFT	LEFT	RIGHT
23	RIGHT	LEFT	RIGHT	LEFT	LEFT	LEFT
24	RIGHT	LEFT	LEFT	RIGHT	RIGHT	RIGHT
25	RIGHT	LEFT	LEFT	RIGHT	RIGHT	LEFT
26	RIGHT	LEFT	LEFT	RIGHT	LEFT	RIGHT
27	RIGHT	LEFT	LEFT	RIGHT	LEFT	LEFT
28	RIGHT	LEFT	LEFT	LEFT	RIGHT	RIGHT
29	RIGHT	LEFT	LEFT	LEFT	RIGHT	LEFT
30	RIGHT	LEFT	LEFT	LEFT	LEFT	RIGHT
31	RIGHT	LEFT	LEFT	LEFT	LEFT	LEFT
32	LEFT	RIGHT	RIGHT	RIGHT	RIGHT	RIGHT
33	LEFT	RIGHT	RIGHT	RIGHT	RIGHT	LEFT
34	LEFT	RIGHT	RIGHT	RIGHT	LEFT	LEFT
35	LEFT	RIGHT	RIGHT	RIGHT	LEFT	LEFT
36	LEFT	RIGHT	RIGHT	LEFT	RIGHT	RIGHT
37	LEFT	RIGHT	RIGHT	LEFT	RIGHT	LEFT
38	LEFT	RIGHT	RIGHT	LEFT	LEFT	RIGHT
39	LEFT	RIGHT	RIGHT	LEFT	LEFT	LEFT
40	LEFT	RIGHT	LEFT	RIGHT	RIGHT	RIGHT
41	LEFT	RIGHT	LEFT	RIGHT	RIGHT	LEFT
42	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
43	LEFT	RIGHT	LEFT	RIGHT	LEFT	LEFT
44	LEFT	RIGHT	LEFT	LEFT	RIGHT	RIGHT
45	LEFT	RIGHT	LEFT	LEFT	RIGHT	LEFT

Table 10. (continued) Transmit & Receive Address Settings, RFL DS-562I
(Used only in 56 Kbps mode)

Trans/Rcv Address	SW2/3-1 (A5)	SW2/3-2 (A4)	SW2/3-3 (A3)	SW2/3-4 (A2)	SW2/3-5 (A1)	SW2/3-6 (A0)
46	LEFT	RIGHT	LEFT	LEFT	LEFT	RIGHT
47	LEFT	RIGHT	LEFT	LEFT	LEFT	LEFT
48	LEFT	LEFT	RIGHT	RIGHT	RIGHT	RIGHT
49	LEFT	LEFT	RIGHT	RIGHT	RIGHT	LEFT
50	LEFT	LEFT	RIGHT	RIGHT	LEFT	RIGHT
51	LEFT	LEFT	RIGHT	RIGHT	LEFT	LEFT
52	LEFT	LEFT	RIGHT	LEFT	RIGHT	RIGHT
53	LEFT	LEFT	RIGHT	LEFT	RIGHT	LEFT
54	LEFT	LEFT	RIGHT	LEFT	LEFT	RIGHT
55	LEFT	LEFT	RIGHT	LEFT	LEFT	LEFT
56	LEFT	LEFT	LEFT	RIGHT	RIGHT	RIGHT
57	LEFT	LEFT	LEFT	RIGHT	RIGHT	LEFT
58	LEFT	LEFT	LEFT	RIGHT	LEFT	RIGHT
59	LEFT	LEFT	LEFT	RIGHT	LEFT	LEFT
60	LEFT	LEFT	LEFT	LEFT	RIGHT	RIGHT
61	LEFT	LEFT	LEFT	LEFT	RIGHT	LEFT
62	LEFT	LEFT	LEFT	LEFT	LEFT	RIGHT
63	LEFT	LEFT	LEFT	LEFT	LEFT	LEFT

SHORT HAUL FIBER INTERFACE (MA-600)

The MA-600 is a Short Haul Fiber Interface Module that can be used with the RFL DS562I Synchronous Data Module. The Short Haul Fiber Interface Module is a single width module, and consists of an input section (detector) and an output section (emitter). The module is mounted at the rear of an RFL IMUX 2000 chassis, directly opposite the DS562I module. The input power requirement is +5 Volts at 175 mA maximum from the chassis supply. The input drive signals are TTL logic-level, generated by the DS562I.

Table 11. Short Haul Fiber Interface Module, Characteristics

Assembly Number	Type	Wavelength/ Mode	Connector Type	Receiver Sensitivity	Tx Level	Typical Distance
9547-600	LED Emitter/ Detector	850 nm/ multimode	ST	-11.5dBm to -26dBm	-14dBm to -21dBm Average into 50um fiber -11dBm to -18dBm Average into 62.5um fiber	Up to 1km (0.6 mi.)

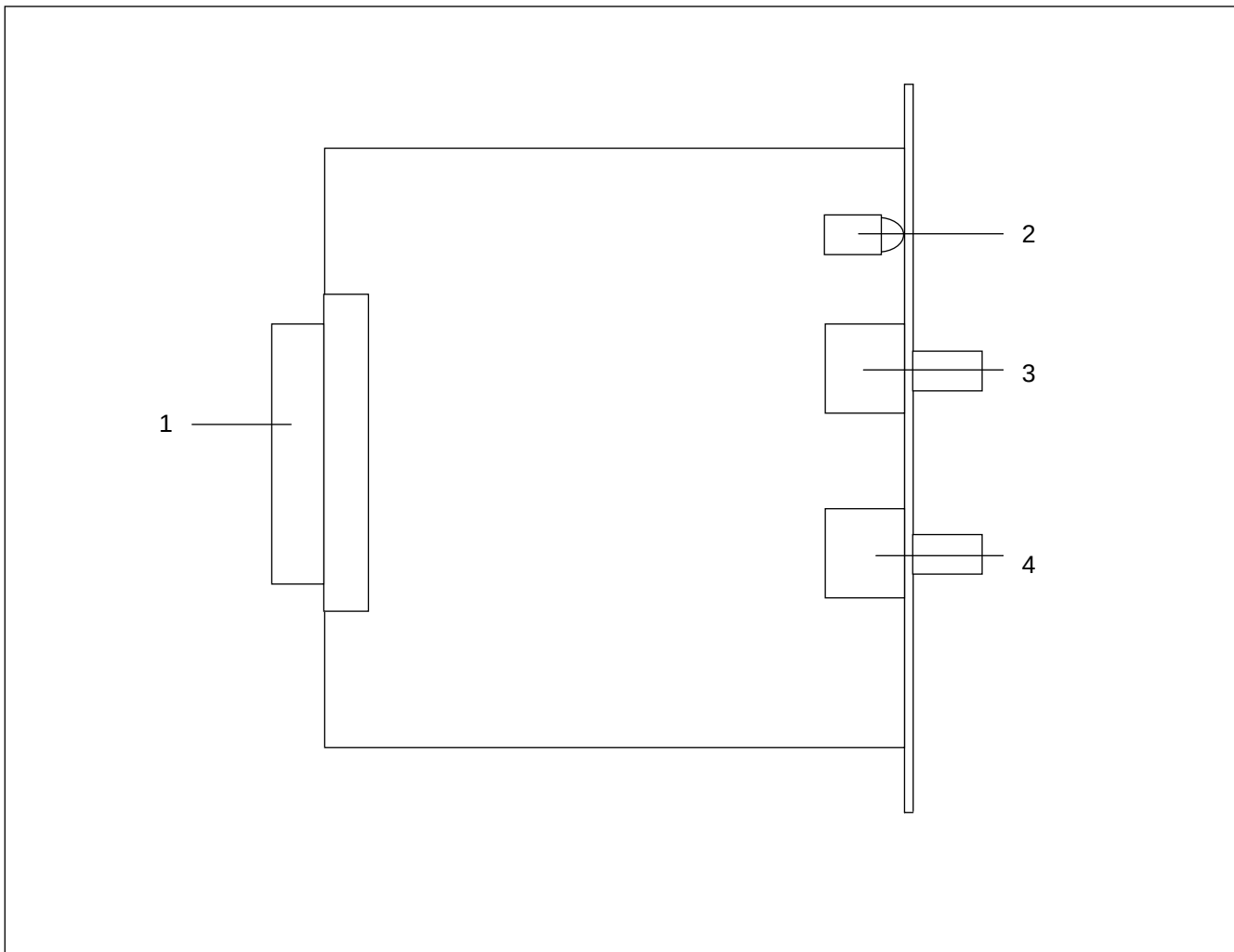


Figure 8. Controls and indicators, MA-600 Module Adapter

Table 12. Short Haul Fiber Interface Module, Controls and indicators

Item	Name/Description	Function
1	JP1 Connector	Motherboard connector (connects to the IMUX 2000 motherboard directly behind the DS562I module)
2	DS2 Fiber Data LED	Lights green when data (transitions) is present at the fiber optic receiver
3	U7 Fiber Optic Detector	Connects to fiber optic cable from remote end
4	DS1 Fiber Optic Emitter	Connects to fiber optic cable to remote end

The IMUX Short Haul Fiber module takes three signals from the DS562I and multiplexes them over a single fiber. The signals include transmit and receive timing and transmit data. The receive data coming from the other fiber is converted to TTL levels for use by the DS562I. An activity LED indicates that data is present on the incoming fiber. There are no jumpers or settings to be made on the unit.

The outgoing clocks and transmit data are asynchronously sampled at a 2.5 MHz rate generated by an oscillator. The three resulting bits are put into a serial 8-bit word by a multiplexer. The remaining 5 bits create a fixed pattern which is used by the receiving interface to determine frame alignment. This pattern is shown below. The serial signal is clocked out at 2.5 MHz and drives the fiber transmitter DS1.

The receive signal is clocked by the receive timing signal. This data is not modulated and therefore is passed to the DS562I in TTL format exactly as received. The receive data is also used to retrigger a multivibrator. If no transitions occur within a specified time, the rear panel LED DS2 is extinguished.

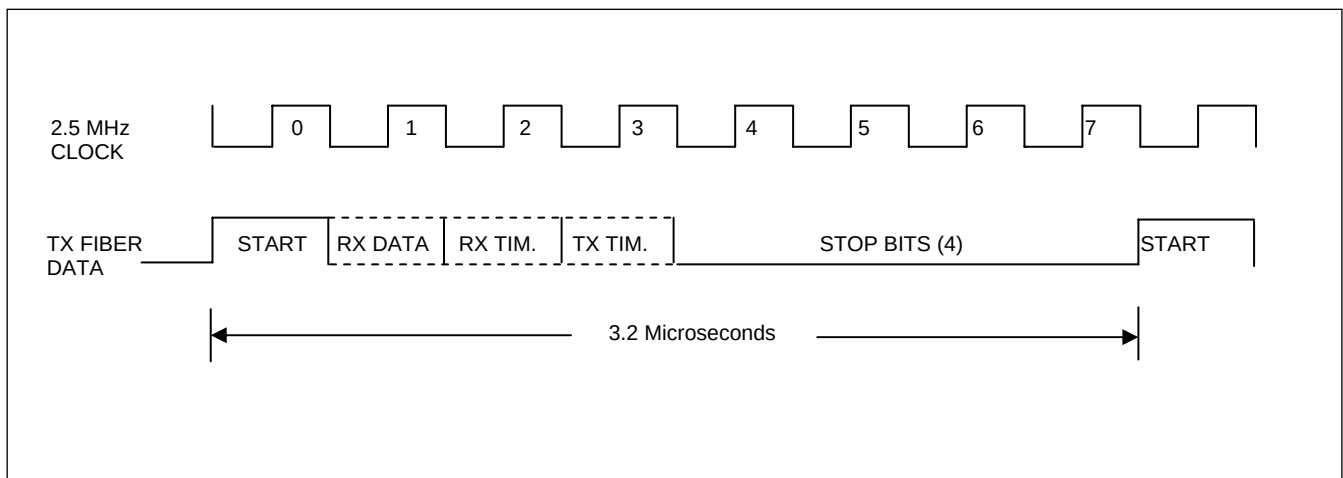


Figure 9. Short Haul Fiber Timing Diagram

SHORT HAUL FIBER INTERFACE (MA-620)

The MA-620 is a Short Haul Fiber Interface Module, which supports the new IEEE standard C37.94 for N times 64 kilobit per second Optical Fiber Interfaces between Teleprotection and Multiplexer Equipment. When used with the DS562I, the MA-620 complies with the standard for N = 1. The module is mounted at the rear of an RFL IMUX 2000 chassis, directly opposite the DS562I module. The input power requirement is +5 Volts at 200 mA maximum from the chassis supply. The input drive signals are TTL logic-level, generated by the DS562I.

Table 13. Short Haul Fiber Interface Module, Characteristics

Module	Assembly Number	Type	Wavelength/ Mode	Connector Type	Receiver Sensitivity	Tx Level	Typical Distance
MA-620	107245	LED Emitter/ Detector	830 (+/- 40 nm) multimode	ST	-11dBm to -32dBm	-14dBm to -21dBm Average into 50um fiber -11dBm to -18dBm Average into 62.5um fiber	Up to 2km (1.2 mi.)
MA-621	107245-1	LED Emitter/ Detector	1300nm singlemode	ST	-14dBm to -35dBm	-17dBm to -34dBm	Up to 2km (1.2 mi.)

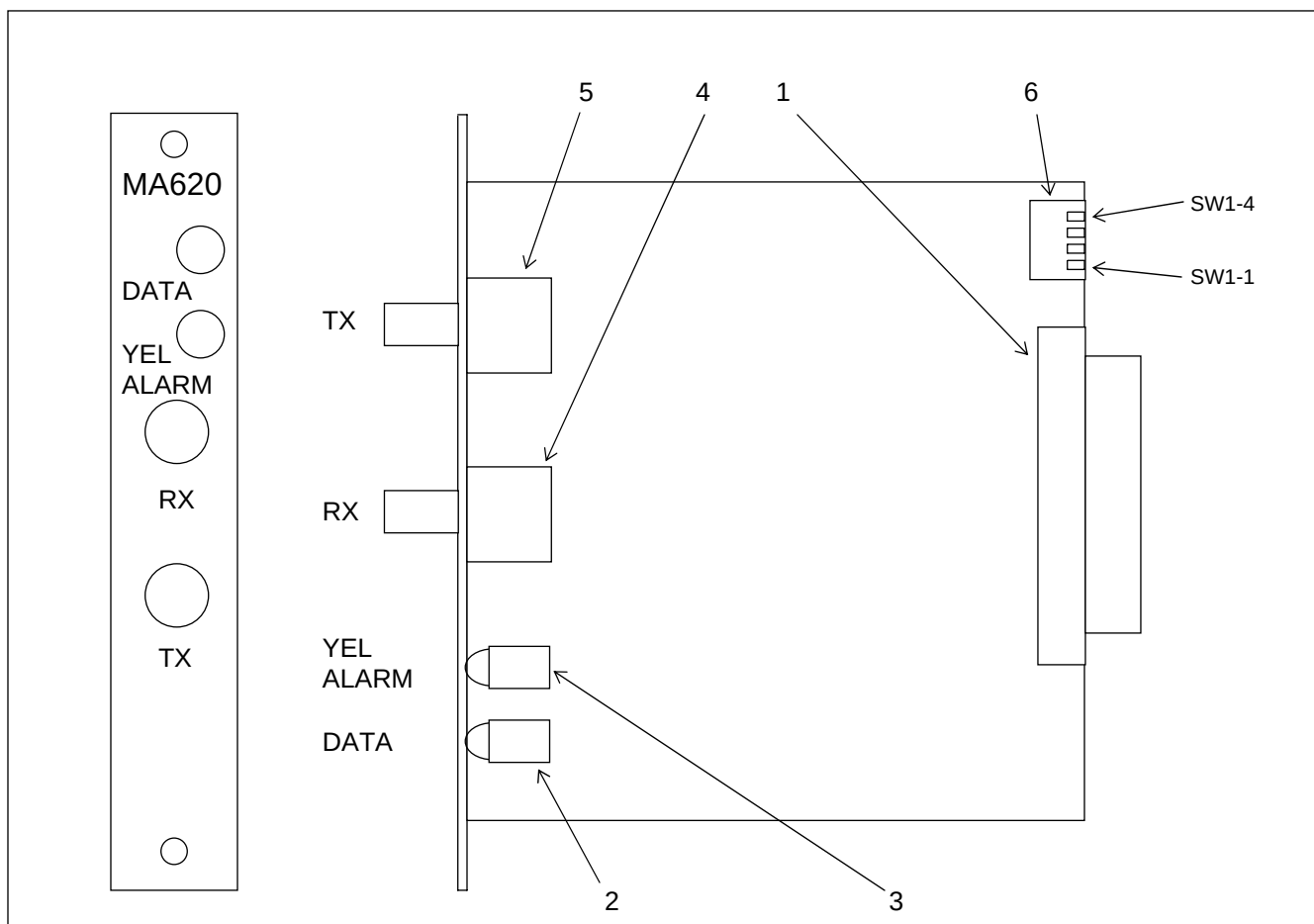


Figure 10. Controls and indicators, MA-620 Module Adapter

Table 14. Short Haul Fiber Interface Module, Controls and indicators

Item	Name/Description	Function
1	Connector	Motherboard connector (connects to the IMUX 2000 motherboard directly behind the DS562I module).
2	DATA LED (green)	Valid data when illuminated. Indicates that the Fiber Data is valid with no bit errors. Extinguished or pulsing indicates bit errors and or loss of signal.
3	YEL ALARM LED (yellow)	YELLOW alarm when illuminated. Indicates that the remote fiber receiver has failed and the remote transmitter is sending yellow code detected by the local fiber receive channel.
4	RX Fiber Optic Detector	Connects to fiber optic cable from remote end.
5	TX Fiber Optic Emitter	Connects to fiber optic cable to remote end.
6	DIP switch SW1	SW1-1 Selects Normal Data or Inverted Data DOWN (ON) = Normal Data (non-inverted) UP (OFF) = Inverted Data SW1-2 to SW1-4 Not used

The MA-620 is a single width module, which consists of an input section (detector) and an output section (emitter). The MA-620 provides an interface between synchronous electrical signals and multimode optical fiber. The present design operates with TTL logic-level RS449 equivalent signals generated by the DS562I at a data rate of 64kb/s. Clock and data signals are present on the dual row connector at TTL levels and uses a clock generated by the IMUX instead of recovering one from the interface. There are a few pins on the same connector which indicate to the IMUX what type of interface is installed. The module has a green LED to indicate when valid fiber data is present and a yellow LED to indicate when a YELLOW alarm is being received. On hot insertion, the MA-620 can take up to 10 or 15 seconds to initialize. The fiber can be looped back onto the IMUX for diagnostic purposes.

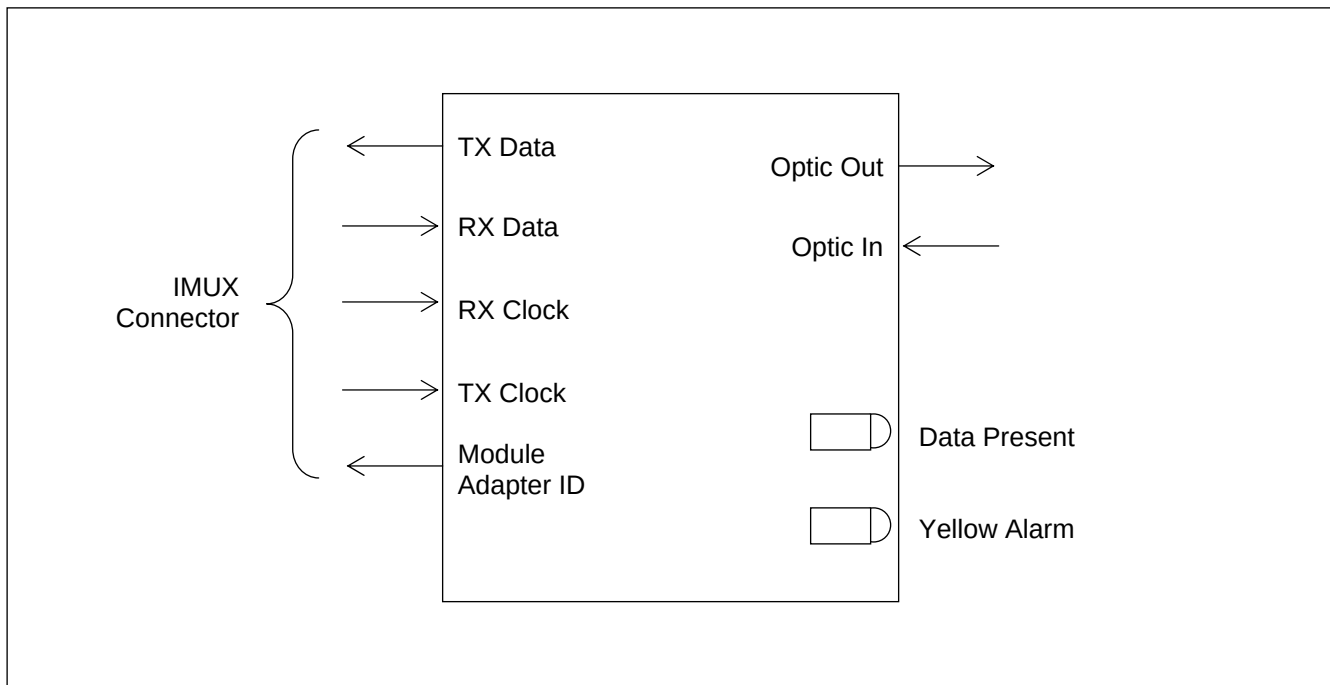


Figure 11. MA-620 Short Haul Fiber Interface Module, block diagram

INTERFACING THE IMUX 2000 WITH AN RFL 9745 USING C37.94 FIBER OPTIC MODULES

An IMUX 2000 can be connected to an RFL 9745 equipped with a Short Haul Fiber module (107310) as shown in Figure 12. There are no jumpers or settings on the 107310 or the MA620, however SW4-2 and SW4-3 on the DS562I must be set to the ON position.

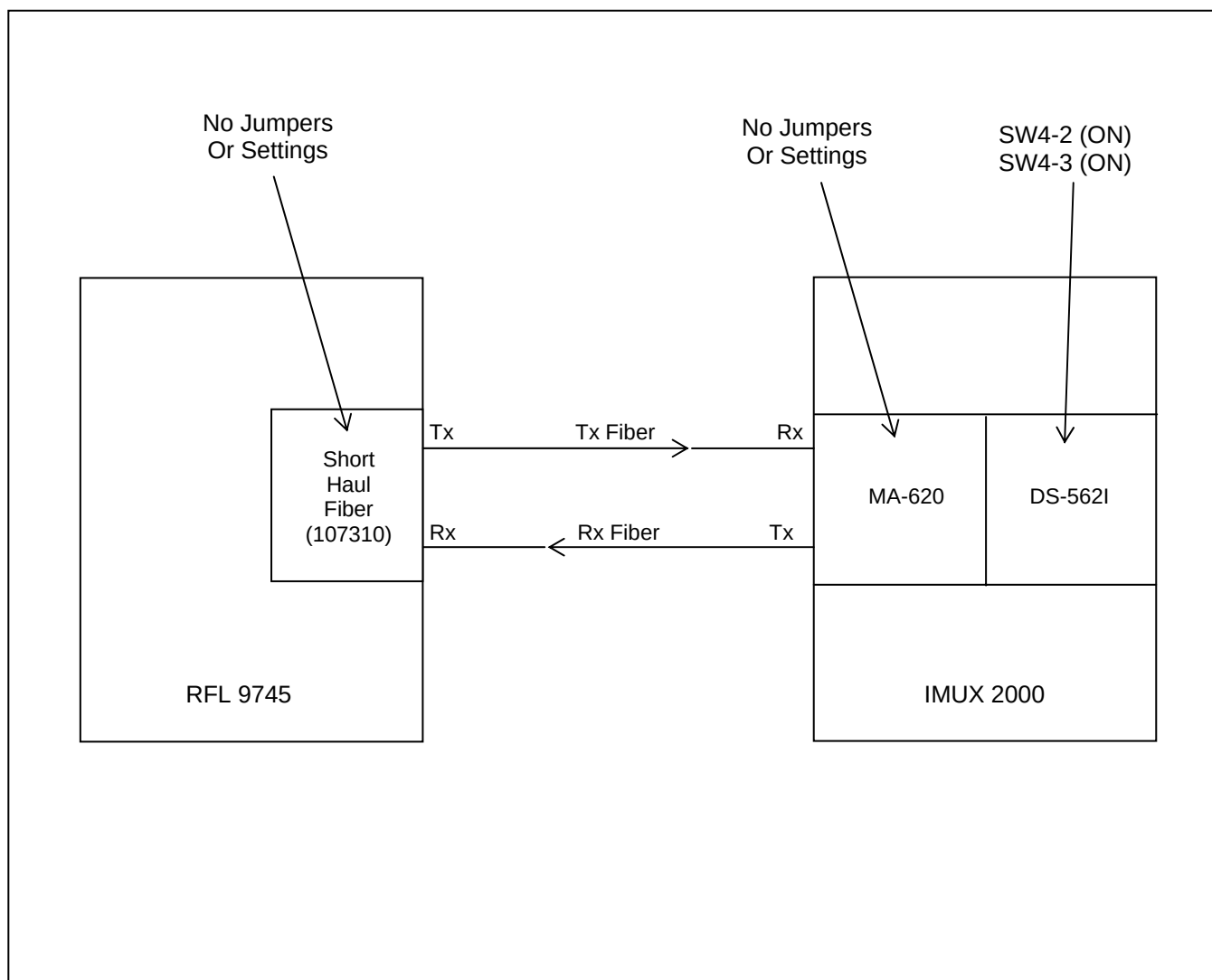


Figure 12. Interfacing the IMUX 2000 with an RFL 9745 using C37.94 Fiber Optic Modules

IMUX 2000 MULTIPLEXER INTERFACING USING RS-449

This section describes timing configuration settings when interfacing the IMUX 2000 Multiplexer with other RFL products using RS-449 communications. The IMUX 2000 can be interfaced with the RFL 9300, RFL 9700, RFL 9700A, RFL 9720 and RFL 9745. It is highly recommended that clock and data transitions are confirmed with a scope to insure proper system operation.

IMUX 2000 MULTIPLEXER AND RFL 9300 (RS-449)

Interfacing an IMUX 2000 with an RFL 9300 can be accomplished as follows:

A. The programmable jumpers on the 9300 Direct Digital I/O module shall be positioned as follows:

J2 (Send Timing): "A" Position

J3 (Receive Timing): "A" Position

B. The configuration of the IMUX 2000 RS-449 Channel Card shall be as follows:

1. DS-562I with MA-406IA I/O

MA-406IA I/O: J2 jumpers in DCE mode

J3 in any position

DS-562I, Switch SW4-2 (Receive Clock Polarity): Normal - ON (Right)

DS-562I, Switch SW4-3 (Transmit Clock Polarity): Normal - ON (Right)

2. DS-562I with MA-600 short haul fiber I/O

MA-600 I/O: No jumpers to set

DS-562I, Switch SW4-2 (Receive Clock Polarity): Normal - ON (Right)

DS-562I, Switch SW4-3 (Transmit Clock Polarity): Normal - ON (Right)

3. DS-562B with MA-406 I/O

MA-406 I/O: No jumpers to set

DS-562B, J1 (Send Timing Clock): Normal - Left (Middle and Front Posts)

DS-562B, J5 (Timing Mode): Internal - UP (Upper and Middle Posts)

C. Confirm Clock and Data Transitions to Insure Proper System Operation as follows:

1. RFL 9300 CCM: The positive edge of the RxClock (TP5) must be in the center of the RxData bit (TP4).

2. IMUX 2000: DS-562I - The positive edge of the TxClock (TP3) must be in the center of the TxData bit (TP1).

DS-562B - The positive edge of the TxClock (U30-Pin 3) must be in the center of the TxData bit (U30-Pin 2).

IMUX 2000 MULTIPLEXER AND RFL 9700 “ORIGINAL” (RS-449)

Interfacing an IMUX 2000 with an RFL 9700 can be accomplished as follows:

A. Configuration of RFL 9700:

97 DIG RX: ECB# 101563: No Clock Polarity Jumper

ECB# 101563-1: J2 - “B” Position

97 DIG TX: No Clock Polarity Jumper

B. The configuration of the IMUX 2000 RS-449 Channel Card shall be as follows:

1. DS-562I with MA-406IA I/O

MA-406IA I/O: J2 jumpers in DCE mode

J3 in any position

DS-562I, Switch SW4-2 (Receive Clock Polarity): ECB #101563: Inverted - OFF (Left)

ECB #101563-1: Normal - ON (Right)

DS-562I, Switch SW4-3 (Transmit Clock Polarity): Normal - ON (Right)

2. DS-562B with MA-406 I/O

MA-406 I/O: No jumpers to set

DS-562B, J1 (Send Timing Clock): Normal - Left (Middle and Front Posts)

DS-562B, J5 (Timing Mode): Internal - UP (Upper and Middle Posts)

NOTE: If the RFL 9700 uses 97 DIG RX having ECB# 101563 (No J2), the signal lines at Tx Timing “Plus” (Pin 8 of DB-37 Connector) and Rx Timing “Minus” (Pin 26 of DB-37 Connector) must be switched by modifying cable in order to obtain proper RxClock Polarity. Confirm clock and data transitions before modifying the cable.

C. Confirm Clock and Data Transitions to Insure Proper System Operation as follows:

1. RFL 97 DIG RX: The positive edge of the RxClock (TP2) must be in the center of the RxData bit (TP1).

2. IMUX 2000: DS-562I - The positive edge of the TxClock (TP3) must be in the center of the TxData bit (TP1).

DS-562B - The positive edge of the TxClock (U30-Pin 3) must be in the center of the TxData bit (U30-Pin 2).

IMUX 2000 MULTIPLEXER AND RFL 9700A (RS-449)

Interfacing an IMUX 2000 with an RFL 9700A can be accomplished as follows:

A. Configuration of RFL 9700A:

97A DIG RX: J2: "B" Position

97A DIG TX: J2: "B" Position

B. The configuration of the IMUX 2000 RS-449 Channel Card shall be as follows:

1. DS-562I with MA-406IA I/O

MA-406IA I/O: J2 jumpers in DCE mode

J3 in any position

DS-562I, Switch SW4-2 (Receive Clock Polarity): Normal - ON (Right)

DS-562I, Switch SW4-3 (Transmit Clock Polarity): Normal - ON (Right)

2. DS-562B with MA-406 I/O

MA-406 I/O: No jumpers to set

DS-562B, J1 (Send Timing Clock): Normal - Left (Middle and Front Posts)

DS-562B, J5 (Timing Mode): Internal - UP (Upper and Middle Posts)

C. Confirm Clock and Data Transitions to Insure Proper System Operation as follows:

1. RFL 97A DIG RX: The positive edge of the RxClock (TP2) must be in the center of the RxData bit (TP1).

2. IMUX 2000: DS-562I - The positive edge of the TxClock (TP3) must be in the center of the TxData bit (TP1).

DS-562B - The positive edge of the TxClock (U30-Pin 3) must be in the center of the TxData bit (U30-Pin 2).

IMUX 2000 MULTIPLEXER AND RFL 9720 (RS-449)

Interfacing an IMUX 2000 with an RFL 9720 can be accomplished as follows:

- A. The programmable jumpers on the piggyback board of the RFL 9720 module shall be positioned as follows:

J6 (Send Timing): "B" Position

J7 (Receive Timing): "B" Position

- B. The configuration of the IMUX 2000 RS-449 Channel Card shall be as follows:

1. DS-562I with MA-406IA I/O

MA-406IA I/O: J2 jumpers in DCE mode

J3 in any position

DS-562I, Switch SW4-2 (Receive Clock Polarity): Normal - ON (Right)

DS-562I, Switch SW4-3 (Transmit Clock Polarity): Normal - ON (Right)

2. DS-562B with MA-406 I/O

MA-406 I/O: No jumpers to set

DS-562B, J1 (Send Timing Clock): Normal - Left (Middle and Front Posts)

DS-562B, J5 (Timing Mode): Internal - UP (Upper and Middle Posts)

- C. Confirm Clock and Data Transitions to Insure Proper System Operation as follows:

1. RFL 9720 CCM: The positive edge of the RxClock (TP17) must be in the center of the RxData bit (TP16).

2. IMUX 2000: DS-562I - The positive edge of the TxClock (TP3) must be in the center of the TxData bit (TP1).

DS-562B - The positive edge of the TxClock (U30-Pin 3) must be in the center of the TxData bit (U30-Pin 2).

IMUX 2000 MULTIPLEXER AND RFL 9745 (RS-449)

Interfacing an IMUX 2000 with an RFL 9745 can be accomplished as follows:

A. The programmable jumpers on the 9745 RS-449 I/O shall be positioned as follows:

J1 (Send Timing): “Invert” Position

J2 (Receive Timing): “Invert” Position

B. The configuration of the IMUX 2000 RS-449 Channel Card shall be as follows:

1. DS-562I with MA-406IA I/O

MA-406IA I/O: J2 jumpers in DCE mode

J3 in any position

DS-562I, Switch SW4-2 (Receive Clock Polarity): Normal - ON (Right)

DS-562I, Switch SW4-3 (Transmit Clock Polarity): Normal - ON (Right)

2. DS-562I with MA-600 short haul fiber I/O

MA-600 I/O: No jumpers to set

DS-562I, Switch SW4-2 (Receive Clock Polarity): Normal - ON (Right)

DS-562I, Switch SW4-3 (Transmit Clock Polarity): Normal - ON (Right)

3. DS-562B with MA-406 I/O

MA-406 I/O: No jumpers to set

DS-562B, J1 (Send Timing Clock): Normal - Left (Middle and Front Posts)

DS-562B, J5 (Timing Mode): Internal - UP (Upper and Middle Posts)

C. Confirm Clock and Data Transitions to Insure Proper System Operation as follows:

1. RFL 9745 RS-449 I/O: The positive edge of the RxClock (TP4 or RT) must be in the center of the RxData bit (TP2 or RD).

2. IMUX 2000: DS-562I - The positive edge of the TxClock (TP3) must be in the center of the TxData bit (TP1).

DS-562B - The positive edge of the TxClock (U30-Pin 3) must be in the center of the TxData bit (U30-Pin 2).

USING THE DS-562I AND DS-562B END-TO-END

The DS-562B must be setup for Mode 2 operation. This is accomplished by setting SW3-8 in the ON (UP) position.

RS-449 LOOPBACK “PLUGS”

ONLY the data lines are “looped”. The Timing lines must not be looped back because the DS-562I (or DS-562B) provide both transmit and receive clocks.

“Looped Signals”: Send Data + (Pin 4) > Receive Data + (Pin 6)

Send Data - (Pin 22) > Receive Data - (Pin 24)

In addition, there is no guarantee that the TxData will be valid on the positive edge of the TxClock. Data errors may occur if data is sampled near the edge instead of the center of the data bit. It is therefore recommended that a “split” cable be used for testing purposes such that one end “sends data” and the other end “receives data”. Confirm both directions by switching the cable ends.

FUNCTIONAL DESCRIPTION

The following is a basic description of how the RFL DS-562I module operates. A simplified block diagram of the module is shown in Figure 13.

MODULE OVERVIEW

The DS-562I synchronous data module is a channel card for use in the IMUX 2000 system. It transmits and receives data from/to the T1/E1 bus and generates and receives data via an I/O adapter module. The module can be set up and interrogated remotely via the SCB of the IMUX 2000. DIP switches enable the user to set up the module locally. Seven front panel LEDs indicate to the user the status of the module.

The module provides the following five major functions: T1/E1 transmit interface, T1/E1 receive interface, loopback, SCB interfacing, and control logic. The Actel 1280XL and its associated circuitry handles all T1/E1 communication and I/O. The Actel 1020B connects the Actel 1280XL with the SCB of the IMUX 2000. Miscellaneous other circuits are present to handle the remaining functions. A bank of dip switches is provided to select the module parameters, a toggle switch is provided to select the loopback function, and LEDs provide the user with module status.

COMMS FPGA CIRCUIT

The Comms FPGA circuit consists of an Actel 1280XL which is the heart of the DS-562I module. It has several main functions which include T1/E1 receive and transmit control, SCB interfacing, LED control, reading switch settings, equipment and payload loopback, addressing and CRC, and I/O decoding for G.703. The Actel contains two phase locked loops for generating the 56 or 64 Kbps clocks synchronous to the T1/E1 input signals.

SCB FPGA CIRCUIT

The SCB FPGA circuit consists of an Actel 1020B which is used to communicate with the CM3B/C module via the SCB. A DIP switch is provided to allow the user to set the SCB address of the module which is read by the SCB FPGA. The DS-562I module has a type ID of 119 encoded into the SCB FPGA device.

I/O ADAPTER MODULES

The signals to and from the user equipment pass through the I/O module. The I/O module performs the required level shifting between the DS-562I and the user equipment, thus allowing the same channel card to be used with any one of four different types of communication interface I/O adapter modules.

T1/E1 TRANSMIT CIRCUIT

The 56 or 64 Kbps serial data from the user equipment is routed to the transmit circuit which synchronizes the signals and then feeds them to the T1/E1 data bus. If addressing is being used in the 56 Kbps mode, the transmit address is inserted into the data stream along with security coding information.

T1/E1 RECEIVE CIRCUIT

The incoming serial data stream is received from the T1/E1 bus by the receive interface and routed to the user equipment. If addressing is being used in the 56 Kbps mode, coded address and security information is extracted and verified, and then compared to the selected received address.

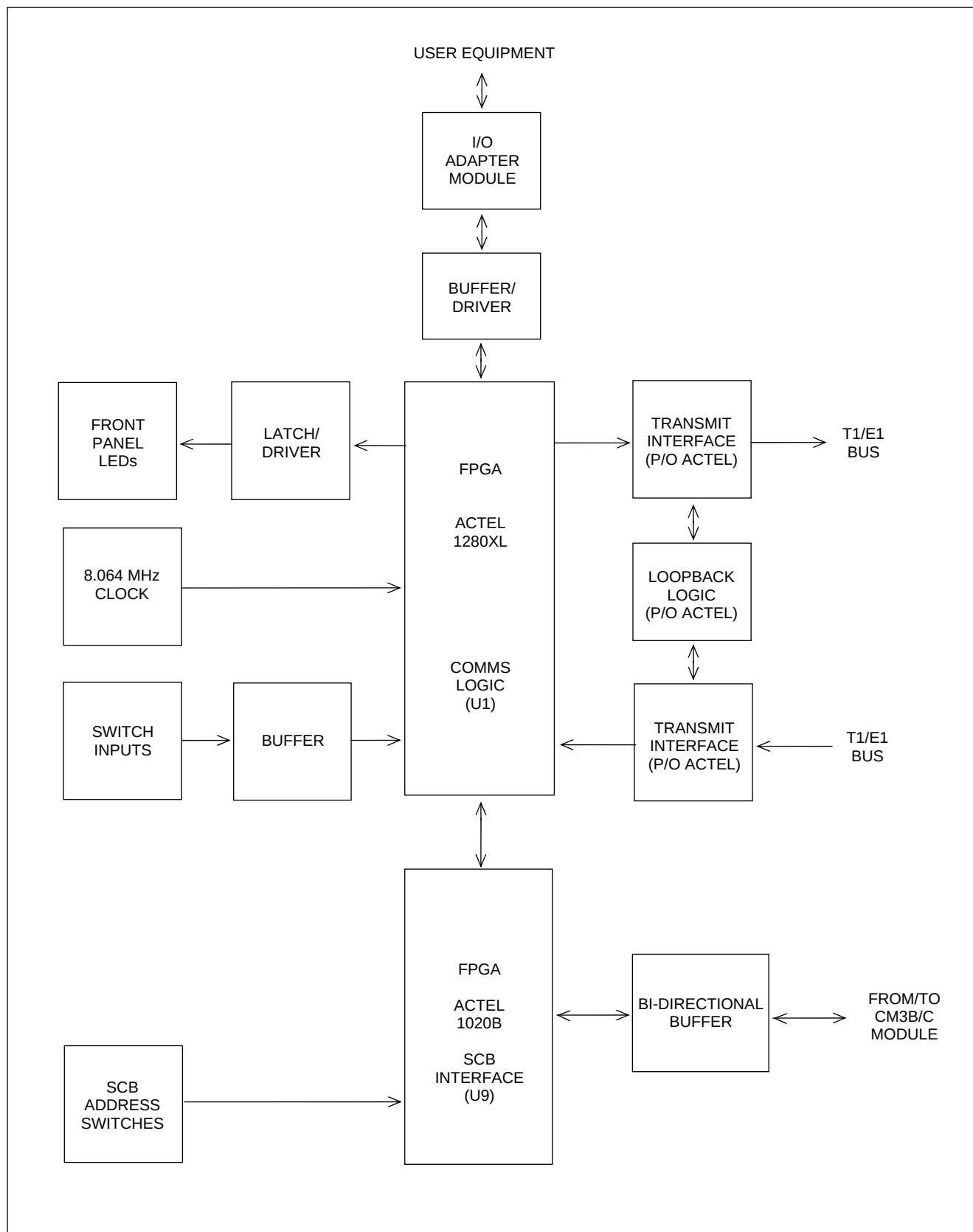


Figure 13. RFL DS-562I Block diagram.

LOOPBACK LOGIC

The T1/E1 transmit and receive interface circuits are interconnected by loopback logic inside the Actel 1280XL. The equipment loopback causes the data received from the user equipment to be read into a buffer and then retransmitted back to the user equipment. The payload loopback places the T1/E1 received data into a buffer and then retransmits it via the T1/E1 transmit circuit. Synchronizing circuits in the loopback logic compensates for varying phase relationships between the T1/E1 transmit and receive bus signals. A three position switch on the module front panel enables the user to select equipment loopback, payload loopback or no loopback.

NOTE

If this unit is used for protective relaying applications, disable the protection equipment at both ends before using equipment loopback or payload loopback modes.

ALERTS AND ALARMS

If payload loopback and equipment loopback are enabled, the DS-562I will issue a module level alert signal to the shelf common module.

If addressing is enabled and there is a loss of addressing, the DS-562I will issue a module level alert signal to the shelf common module.

REMOTE CONTROL INTERFACE

When the RFL DS-562I is installed in an IMUX 2000 multiplexer, it can be operated under local or remote control. When under remote control, most of the module setup parameters can only be changed through the RS-232 remote port on the shelf Common Module. See the IMUX 2000 manual for information on using the remote control interface.

The remote control interface for the RFL DS-562I involves two sets of codes: “P” (parameter) codes, and “S” (status) codes. The RFL DS-562I reports itself as a “Type 119” module.

“P” CODES

“P” codes, when used in the parameter field on an SCL “SET” command, allow the user to set certain parameters on the RFL DS-562I by remote control, just like setting DIP switches on a module under local control. “P” codes also appear in the response to a “CONFIG?” query, providing a list of the RFL DS-562I current parameter settings. A typical RFL DS-562I response to a “CONFIG?” query looks like this:

```
*OK
CHANNEL CARD 3, TYPE 119
UNDER REMOTE CONTROL
SRVC = ON
P01 = 13 (B00001101)
P02 = 0 (B00000000)
P03 = 0 (B00000000)
P04 = 190 (B10111110)
P05 = 0 (B00000000)
```

There are five “P” codes for the RFL DS-562I; “P1” through “P5”. Each “P” code is displayed as a decimal number from 0 to 255, followed by its eight-digit binary equivalent in parenthesis. Table 14 lists the meaning of all “P” codes for the RFL DS-562I module.

Table 15. Remote Configuration Settings (“P” codes)

P Code	Bits Used	Value	Description
SRVC	...	ON	Turns service on (module enabled).
		OFF	Turns service off (module disabled).
P01	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑↑	T1: 1 to 24 E1: 1 to 31	Selects the receive and transmit timeslot. Used in 56K mode only. *
P02	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑↑	0 to 63	Sets the transmit address (See Table 8). Used in 56K mode only. *
P03	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑↑	0 to 63	Sets the receive address (See Table 8)
P04	B 0 0 0 0 0 0 0 0 ↑	0	Octet timing OFF
		1	Octet timing ON
	B 0 0 0 0 0 0 0 0 ↑	0	Normal receive clock polarity
		1	Inverted receive clock polarity
	B 0 0 0 0 0 0 0 0 ↑	0	Normal transmit clock polarity
		1	Inverted transmit clock polarity
	B 0 0 0 0 0 0 0 0 ↑	0	Squelch OFF
		1	Squelch output to user equipment upon loss of valid address
	B 0 0 0 0 0 0 0 0 ↑	0	No remotely commanded equipment loopback (may be overridden at board)
		1	Remotely commanded equipment loopback
	B 0 0 0 0 0 0 0 0 ↑	0	No remotely commanded payload loopback (may be overridden at board)
		1	Remotely commanded payload loopback
	B 0 0 0 0 0 0 0 0 ↑	0	64 Kbps data rate
		1	56 Kbps data rate
	B 0 0 0 0 0 0 0 0 ↑	0	Transmit on bus B
		1	Transmit on bus A
P05	B 0 0 0 0 0 0 0 0 ↑	0	T1 carrier
		1	E1 carrier
	B 0 0 0 0 0 0 0 0 ↑	0	No handshaking delay
		1	8 microsecond handshaking delay (approx.)
	B 0 0 0 0 0 0 0 0 ↑	0	Normal
		1	Inverted data

* It is recommended that the TX and RX addresses are both set to a value other than 0 if the addressing function is being used.

“S” CODES

“S” codes appear in response to a “STATUS?” query. There are four “S” codes for the RFL DS-562I. Like the “P” codes, each “S” code is a number displayed in both decimal and binary form.

A typical response to a “STATUS?” query looks like this:

***OK**

CHANNEL CARD 3, TYPE 119

S01 = 0 (B00000000)

S02 = 57 (B00111001)

S03 = 0 (B00000000) (not currently used)

S04 = 0 (B00000000) (not currently used)

These codes provide information on the status of several conditions on the RFL DS-562I module. Table 16 lists the meaning of all “S” codes for the RFL DS-562I module.

Table 16. Remote status messages (“S” codes)

Code	Bits Used	Value	Description
S01	B 00000000 ↑↑↑	0	MA-406IA (RS-449), DCE mode / or MA-620 installed
		1	MA-406IA installed (RS-449) or MA-410I (X.21), DTE mode.
		2	MA-409IA installed (V.35), DCE mode.
		3	MA-409IA installed (V.35), DTE mode.
		4	MA-407I installed (G.703 contradirectional).
		5	MA-408I installed (G.703 codirectional).
		6	MA-410I installed (X.21), DCE mode.
		7	MA-600 installed (short haul fiber)
S02	B 00000000 ↑	0	Service off (module disabled).
		1	Service on (module enabled).
	B 00000000 ↑	0	RX address is disabled, or RX address is enabled and the DS-562I is not receiving a properly addressed signal. Used in 56K mode only.
		1	RX address is enabled, and the DS-562I is receiving a properly addressed signal. Used in 56K mode only.
	B 00000000 ↑	0	The transmit address is disabled. Used in 56K mode only.
		1	The transmit address is enabled. Used in 56K mode only.
	B 00000000 ↑	0	The equipment loopback is disabled.
		1	The equipment loopback is enabled.
	B 00000000 ↑	0	The payload loopback is disabled.
		1	The payload loopback is enabled.
	B 00000000 ↑	0	The DS-562I is not receiving data from the remote equipment.
		1	The DS-562I is receiving data from the remote equipment.
	B 00000000 ↑	0	The DS-562I is not transmitting data from the remote equipment.
		1	The DS-562I is transmitting data from the remote equipment.
S03	Not currently used		
S04	Not currently used		

LOOPBACK TESTING

A local loopback test is performed when the module is first installed, or any time the integrity of the module needs to be checked. The loopback test can be performed on modules in terminal systems or drop/insert systems. The loopback test is a tool for locating problems, but is no substitute for troubleshooting expertise.

Before starting a loopback test, make sure the following conditions have been met:

1. The DS-562I module and I/O adapter must be installed in an RFL IMUX 2000 chassis.
2. Power must be applied to the system.
3. The module must be out of service.
4. If the module is set for 56 Kbps, the transmit and receive addresses must be set to the same value, or set to zero.

A telecommunications test set that can accept RS-449/422, X.21/V.11, CCITT V.35, or CCITT G.703 signals (depending on the adapter module used), will be required for the loopback test (Telecommunications Techniques Corporation Fireberd 2000 or equivalent).

VERIFICATION TEST

1. Press the Group toggle switch on the CM-3 left or right until the function display reads LPBK. Then push the SET toggle switch left until the function display reads EqLB. At this time push the SET toggle switch twice to the right.

NOTE

Equipment Loopback on the CM-3 will loopback all DS0 channels within that shelf

The green LED above the SET toggle switch should blink after the first push and should be steady after the second push.

The yellow loopback LED on the CM-3 and the yellow LED on the power supply should be lit, indicating that the system is in local loopback.

2. Connect a test set to the cable assembly in accordance with the manufacturers procedures. Then perform a bit error rate test.

For test criteria, use a 63 or 511 test pattern. Alternately, use a 109 or lower bit pattern.

3. Observe that zero errors are indicated on the receive side of the test set.

**If an error count occurs, check all option selections and repeat steps 1 through 3.
If the error count persists, check the following:**

- a. **Make sure the test set is correctly set up.**
- b. **Make sure the test set cable is correctly connected.**
- c. **Make sure the module under test is correctly installed.**
- d. **Make sure the cable assembly is firmly and correctly connected.**

If the error source is localized to the module or the cable assembly, return the defective component to RFL for repair. If an error count persists after these steps have been taken, check for an outside error source.

TROUBLESHOOTING

Use the following procedure to determine whether a problem is being caused by the RFL DS-562I or by some other part of the system.

1. If more than one module is on the same time slot, remove those modules that are known to be good.
2. Perform a local loopback test, as described in steps 1 through 4 of the Loopback Testing procedure.
3. If the loopback test indicates that the module is functioning properly, then check that the terminal equipment is functioning properly. If so, then the test is complete. If not, then check for an outside error source.
4. If the error count persists, then swap modules. Replace the module with another that is known to be functioning properly. If the replacement module is OK, then use the Repair/Return procedure in the General Information Section of the manual to return the defective module to RFL for repair.
5. If proper function is not obtained, perform individual multiplex tests as described in the multiplexer manual. If an error count still persists after these steps have been taken, then check for an outside error source.

NOTES

NOTES

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RFL Electronics Inc.

INSTRUCTION DATA

RFL DS-562NC Multi-Baud Synchronous Data Module For RFL IMUX 2000 Intelligent T1/E1 Multiplexers (RFL Part No. 107695)

DESCRIPTION

The RFL DS-562NC Synchronous Data Module provides RFL IMUX 2000 T1/E1 Multiplexers with synchronous full-duplex data communications at either 56 Kbps or any multiple of 64 Kbps, with a maximum limit that is dependent upon the multiplexer type or interface adapter type. The DS-562NC can operate up to 1.536 Mbps in T1 Multiplexers, and up to 1.984 Mbps in E1 Multiplexers; unless CAS Mode is used, in which case the maximum rate is 1.920 Mbps. The RFL DS-562NC operates in terminal or drop and insert systems over T1/E1 carrier lines. The RFL DS-562NC is compatible with the older RFL DS-562I at data rates of 56 Kbps and 64 Kbps.

Features include the following:

- o User-selectable data rate, 56 Kbps or Nx64 Kbps.
- o Full duplex operation.
- o Choice of the following interface types:
 - o RS-449/EIA-422, DCE or DTE
 - o RS-530/EIA-422, DCE or DTE
 - o X.21/V.11, DCE or DTE
 - o CCITT V.35, DCE or DTE
 - o G.703, Co-directional or Contra-directional
 - o C37.94 Short-Haul Fiber
 - o RFL Short Haul Fiber
 - o Ethernet LAN
- o Octet timing support for G.703.
- o Contiguous time slot assignment.
- o Time Slot can be skipped for CAS multi-frame applications (E1).
- o Selectable transmit/receive direction.
- o Remote control configuration and status reporting using RFL NMS software.
- o Equipment and payload loopbacks.
- o RTS/CTS Handshaking support for V.35 and RS-449 & RS-530 interfaces
- o TX/RX interface clock and data polarity settings.

SPECIFICATIONS

As of the date this Instruction Data Sheet was published, the following specifications apply to all RFL DS-562NC Synchronous Data Modules, except as noted. Because all RFL products undergo constant refinement and improvement, these specifications are subject to change without notice.

Input Voltage Differential:

- RS-449 (EIA-422) Interface: 0.2 to 6 volts
- RS-530 (EIA-422) Interface: 0.2 to 6 volts
- CCITT V.35 Interface: 0.2 to 6 volts
- G.703 Interface: 0.35 to 1 volt
- X.21 (Rec. V.11) Interface: 0.3 to 6.0 volts

Input Impedance:

- RS-449 (EIA-422) Interface: 90 ohms to 150 ohms nominal
- RS-530 (EIA-422) Interface: 90 ohms to 150 ohms nominal
- CCITT V.35 Interface: 100 ohms nominal
- G.703 Interface: 120 ohms nominal
- X.21 (Rec. V.11) Interface: 575 ohms nominal

Output Voltage Differential:

- RS-449 (EIA-422) Interface: 2.0 to 4.0 volts
- RS-530 (EIA-422) Interface: 2.0 to 4.0 volts
- CCITT V.35 Interface: 0.44 to 0.66 volts
- G.703 Interface: 0.95 to 1.05 volts
- X.21 (Rec. V.11) Interface: 2.0 to 4.0 volts

Output Impedance:

- RS-449 (EIA-422) Interface: Less than 100 ohms nominal
- RS-530 (EIA-422) Interface: Less than 100 ohms nominal
- CCITT V.35 Interface: 100 ohms nominal
- G.703 Interface: 300 ohms nominal
- X.21 (Rec. V.11) Interface: Less than 100 ohms nominal

Handshaking Delay:

- Switched: 8 microseconds (approx.)
- Unswitched: Zero delay.

Local Loopback (switched): Equivalent to CCITT V.54 Loop 3.

Remote Loopback (switched): Equivalent to CCITT V.54 Loop 2.

External Cabling:

Maximum Length:

RS-449, RS-530, V.35, X.21: 60m, may be less at higher data rates.

G.703: 250m

Optical: From 1km to 4km depending on adapter used.

Cable type:

Shielded twisted

AWG 24 (minimum)

Single or Multimode optical fiber depending on module used.

Connector:

RS-449 Interface: 37-pin male D-subminiature (DB-37P).

RS-530 Interface: 25-pin male D-subminiature (DB-25P).

CCITT V.35 Interface: 37-pin male D-subminiature (DB-37P).

CCITT G.703 Interface: 25-pin male D-subminiature (DB-25P).

CCITT X.21 Interface: 15-pin male D-subminiature (DB-15P).

Optical fiber interface: Type ST

Ethernet LAN: RJ-45

Power Consumption: Less than 1W

Operating temperature: -20C to + 55 C (-4F to +131F)

Humidity: 0 to 95 percent, non-condensing

Dimensions:

Length: 9.8 in (24.8 cm)

Width: 0.6 in (1.5 cm)

Height: 4.5 in (11.4 cm)

Weight:

Net: 4.8 oz (0.13 kg)

Shipping: 1 lb (0.45 kg)

DS-562NC INSTALLATION INSTRUCTIONS

Before the DS-562NC module can be placed in service, it must be installed in a multiplexer shelf. Installation involves determining the module slot in the Main Shelf or Expansion Shelf where the module will be installed, inserting an I/O adapter module into the rear of the shelf behind the module slot, connecting all signal wiring to the I/O adapter module, checking the settings of all switches and jumpers, and inserting the module into the front of the shelf.

NOTE

Power supply and time slot considerations may affect the installation of RFL DS-562NC modules into an existing multiplexer shelf. Refer to the portions of your multiplexer operation manual covering “Channel Module Configuration Guidelines” and “Adding More Channel Modules To Existing Systems” for more information.

The following instructions are provided for installing RFL DS-562NC modules into existing systems. If the module was included as part of a system, installation was done at the factory, otherwise, proceed as follows:

1. Carefully inspect the RFL DS-562NC and its I/O adapter module for shipping damage.
If you suspect damage to the module or its Module Adapter, immediately contact RFL’s Customer Service Department at the number shown at the bottom of this page.
2. Determine which module slot in the Main Shelf or Expansion Shelf the RFL DS-562NC will be installed in.
The RFL DS-562NC module occupies one module slot in the Main Shelf or Expansion Shelf. Refer to the “as supplied” drawings furnished with the equipment for more information.
3. Determine which I/O Adapter Module will be used to make connections to the RFL DS-562NC module.
Each RFL DS-562NC module installed in an IMUX 2000 multiplexer requires an I/O Adapter Module. The I/O Adapter Module provides the appropriate connections for the desired interface.

There are eleven Module Adapters for the RFL DS-562NC:

<u>Module Adapter</u>	<u>Part Number</u>	<u>Interface Type</u>	<u>Socket</u>	<u>Figure</u>
MA-406IA	9547-16331	RS-449	37 pin D-subminiature (DB-37S)	1
MA-406IB	9547-16632	RS-530	25 pin D-subminiature (DB-25S)	2
MA-407I	9547-1750	G.703 contra-directional	25 pin D-subminiature (DB-25S)	3
MA-408I	9547-1755	G.703 co-directional	25 pin D-subminiature (DB-25S)	4
MA-409IA	9547-17271	V.35	37 pin D-subminiature (DB-37S)	5
MA-410I	9547-1760	X.21	15 pin D-subminiature (DB-15S)	6
MA-600	9547-600	Optical fiber	Type ST	8
MA-620	107245(multimode)	C37.94-ANSI SHF	Type ST	10
MA-621	107245-1(singlemode)	C37.94-ANSI SHF	Type ST	10
MA-427	9547-22361	IEEE 802.3 LAN	RJ-45	12
MA-428	9547-22362	IEEE 802.3 LAN	RJ-45	14

Make sure the I/O Module Adapter you are installing is correct for the desired application.

4. Once the Adapter Module has been selected, set it for the following desired configuration as applicable:

MA-406IA

Select DCE or DTE mode by installing J2 jumpers

MA-406IB

Select DCE or DTE mode by installing J2 jumpers

MA-407I

No configuration is required for this module.

MA-408I

No configuration is required for this module.

MA-409IA

Select DCE or DTE:

DCE: Set jumpers J1 to J9 to DCE

DTE: Set jumpers J1 to J9 to DTE

MA-410I

DCE: S1-1 to S1-4 (toward “DCE”)

DTE: S1-1 to S1-4 (toward “DTE”)

MA-600

No configuration is required for this module.

MA-620/621

Select Normal or Inverted Data:

Normal Data: SW1-1 (DOWN) ON

Inverted Data: SW1-1 (UP) OFF

MA-427

Refer to Table 16 for details on the DIP switch (SW2) settings for this I/O type.

MA-428

Refer to Table 23 for details on the DIP switch (SW2) settings for this I/O type.

5. Insert the Adapter Module into the rear of the shelf directly behind the module slot where the DS-562NC will be installed. Secure the module with the two screws provided.
6. Connect the Adapter Module to the user equipment using the connector pin assignments detailed in Tables 1, 2, 3, 4, 5, or 6 as applicable.
7. Refer to Figure 7 for the location of switches on the DS-562NC. Perform the following series of switch settings with the DS-562NC removed from the motherboard.

8. On the DS-562NC check the setting of toggle switch SW12.
SW12 controls the loopbacks, up to enable equipment loopback, down to enable payload loopback, or center for no loopback. Set SW12 to the center position.
9. On the DS-562NC check the setting of DIP switch SW1-1 through SW1-6.
SW1-1 through SW1-6 control the modules SCB address. Set the switches to achieve the desired SCB address setting as shown in Table 8.
10. On the DS-562NC check the setting of DIP switch SW2-1 through SW2-5.
SW2-1 through SW2-5 control the modules transmit and receive timeslot starting position. Set the switches to achieve the desired timeslot setting as shown in Table 9. Table 9 also indicates the maximum number of timeslots available for each starting timeslot for T1 and E1 systems.
11. On the DS-562NC check the setting of DIP switch SW2-6.
SW2-6 selects the DS-562NC transmit bus direction. OFF (UP) selects transmit on B, receive on A (for drop and insert B), ON (DOWN) selects transmit of A, receive on B (drop and insert A or terminal end). Set the switch to the desired setting.
12. On the DS-562NC check the setting of DIP switch SW2-7.
SW2-7 selects CAS. Place in the ON (DOWN) position ONLY if the DS-562NC is to be used in an E1 system with CAS (Channel Associated Signaling) *ENABLED* on the CM-4 module, otherwise it must be placed in the OFF (UP) position. For T1, this switch must be placed in the OFF (UP) position.
13. On the DS-562NC check the setting of DIP switch SW3-1 through SW3-5.
SW3-1 through SW3-5 controls the modules N-BAUD setting, which sets the data-rate, and effectively the number of timeslots that the module will use; up to 24 for T1, and up to 31 for E1 (30 maximum if CAS is used). Set the switches to achieve the desired data-rate as shown in Table 10. The maximum setting is also subject to limitations imposed by the starting timeslot setting previously made with SW2-1 through SW2-5. This setting must be set to “1” for G.703 (MA-407I and MA-408I), and RFL Short Haul Fiber (MA-600). Up to a maximum of “12” time slots can be set for the C37.94 Short-haul Fiber (MA-620/621).
14. On the DS-562NC check the setting of DIP switch SW3-6.
SW3-6 sets the data rate. OFF (UP) selects 64 Kbps, ON (DOWN) selects 56 Kbps. Set the switch to the desired setting; note, this setting must be set to 64 Kbps for G.703 (MA-407I and MA-408I), RFL Short Haul Fiber (MA-600), and C37.94 Short-haul Fiber (MA-620/621).
15. On the DS-562NC check the setting of DIP switch SW3-7.
SW3-7 sets the DS-562NC for local or remote control. ON (DOWN) places the DS-562NC in remote mode (settings obtained from the SCB), OFF (UP) sets the module for local mode (settings obtained from the DIP switches). Initially, set the switch to the OFF (UP) position for local control.

16. On the DS-562NC check the setting of DIP switch SW3-8.
SW3-8 turns the DS-562NC's service on or off. ON (DOWN) turns the service off (board disabled), OFF (UP) turns the service on (board enabled). Initially, set the switch to the ON (DOWN) position for service disabled.
17. On the DS-562NC check the setting of DIP switch SW4-3 through SW4-8.
SW4-3 through SW4-8 controls the modules transmit address. Set the switches to achieve the desired transmit address setting as shown in Table 11. This feature is ONLY available for data-rate of 56 Kbps for RS-449 (MA-406IA), RS-530 (MA-406IB), X.21 (MA-410I), or V.35 (MA-409IA).
18. On the DS-562NC check the setting of DIP switch SW5-3 through SW5-8.
SW5-3 through SW5-8 controls the modules receive address. Set the switches to achieve the desired receive address setting as shown in Table 11. This feature is ONLY available for data-rate of 56 Kbps for RS-449 (MA-406IA), RS-530 (MA-406IB), X.21 (MA-410I), or V.35 (MA-409IA).
19. On the DS-562NC check the setting of DIP switch SW5-2.
SW5-2 turns the squelch on or off. OFF (DOWN) turns the squelch off, ON (UP) turns the squelch on (the DS-562NC stops sending data out the 64/56 Kbps connector upon loss of valid receive address). Set the switch to the desired setting. This feature is ONLY available for data-rate of 56 Kbps for RS-449 (MA-406I A), RS-530 (MA-406IB), X.21 (MA-410I), or V.35 (MA-409IA).
20. On the DS-562NC check the setting of DIP switch SW6-3.
SW6-3 turns the octet timing on or off. Place in the OFF (DOWN) position to turn the service off. Place in the ON (UP) position to turn-on the octet timing feature. Set the switch to the desired position. This feature is ONLY available with G.703 (MA-407I and MA-408I).
21. On the DS-562NC check the setting of DIP switch SW6-4.
SW6-4 turns the handshaking delay on or off. OFF (DOWN) sets no delay, ON (UP) sets an 8 microsecond delay. This feature is ONLY available for RS-449 (MA-406IA), RS-530 (MA-406IB) and V.35 (MA-409IA).
22. On the DS-562NC check the setting of DIP switch SW6-5.
SW6-5 selects normal or inverted receive clock relative to the data out of the DS-562NC interface. OFF (DOWN) sets normal polarity, ON (UP) sets inverted polarity. If the customer equipment (or the local MA-427/428 I/O) interfacing with the DS-562NC does not reliably receive data, the receive clock may have to be inverted. For the initial setup, set the switch to the OFF position. This feature is ONLY applicable to RS-449 (MA-406IA), RS-530 (MA-406IB), X.21 (MA-410I), or V.35 (MA-409IA), or LAN (MA-427/428). Note that the DS-562NC interfaces directly with the MA-427/428 using RS-449 signals.

23. On the DS-562NC check the setting of DIP switch SW6-6.
SW6-6 selects normal or inverted receive data out of the DS-562NC interface. OFF (DOWN) sets normal polarity, ON (UP) sets inverted polarity. If the customer equipment interfacing with the DS-562NC interface does not receive any data correctly, the receive data out may have to be inverted. For the initial setup, set the switch to the OFF position.
24. On the DS-562NC check the setting of DIP switch SW6-7.
SW6-7 selects normal or inverted transmit clock relative to the data into the DS-562NC. OFF (DOWN) sets normal polarity, ON (UP) sets inverted polarity. If the DS-562NC module does not reliably receive data from the customer equipment (or from the local MA-427 I/O), the transmit clock may have to be inverted. For the initial setup, set the switch to the OFF position. This feature is ONLY applicable to RS-449 (MA-406IA), RS-530 (MA-406IB), X.21 (MA-410I), or V.35 (MA-409IA), or LAN (MA-427/428). Note that the DS-562NC interfaces directly with the MA-427/428 using RS-449 signals.
25. On the DS-562NC check the setting of DIP switch SW6-8.
SW6-8 selects normal or inverted transmit data into DS-562NC interface. OFF (DOWN) sets normal polarity, ON (UP) sets inverted polarity. If the DS-562NC module does not reliably receive data from the customer equipment, the transmit clock may have to be inverted. For the initial setup, set the switch to the OFF position.
26. Install the DS-562NC into the IMUX 2000 chassis and allow a few seconds for the board to complete its power-up process.
27. Turn the DS-562NC's service to ON by placing SW3-8 in the OFF (UP) position. Allow a minimum of 16 seconds to ensure the common module has read all configuration data from the module.
28. Verify performance of the module using appropriate test equipment and/or loop-back testing, as required. Interface clocks versus data may also need to be verified, but this depends upon the type of interface used with the DS-562NC. Perceived delays between DS-562NC and customer equipment due to very high data rate selection, interface delays, and cable delays due to high-capacitance, may require adjustment of clocks even though the cable pin-out is 100% correct.
29. When the configuration and performance of the DS-562NC has been verified, set the module to remote mode (if required) by placing SW3-7 in the ON (DOWN) position.

Table 1. Connector J1 pin assignments for the MA-406IA Module Adapter

Pin No.	Signal Name
4	SD(A) - Send Data
22	SD(B) - Send Data
5	ST(A) - Send Timing
23	ST(B) - Send Timing
6	RD(A) - Receive Data
24	RD(B) - Receive Data
7	RS(A) - Request To Send (RTS)
25	RS(B) - Request To Send (RTS)
8	RT(A) - Receive Timing
26	RT(B) - Receive Timing
9	CS(A) - Clear To Send
27	CS(B) - Clear To Send
10	Local Loopback
14	Remote Loopback
19	Signal Ground

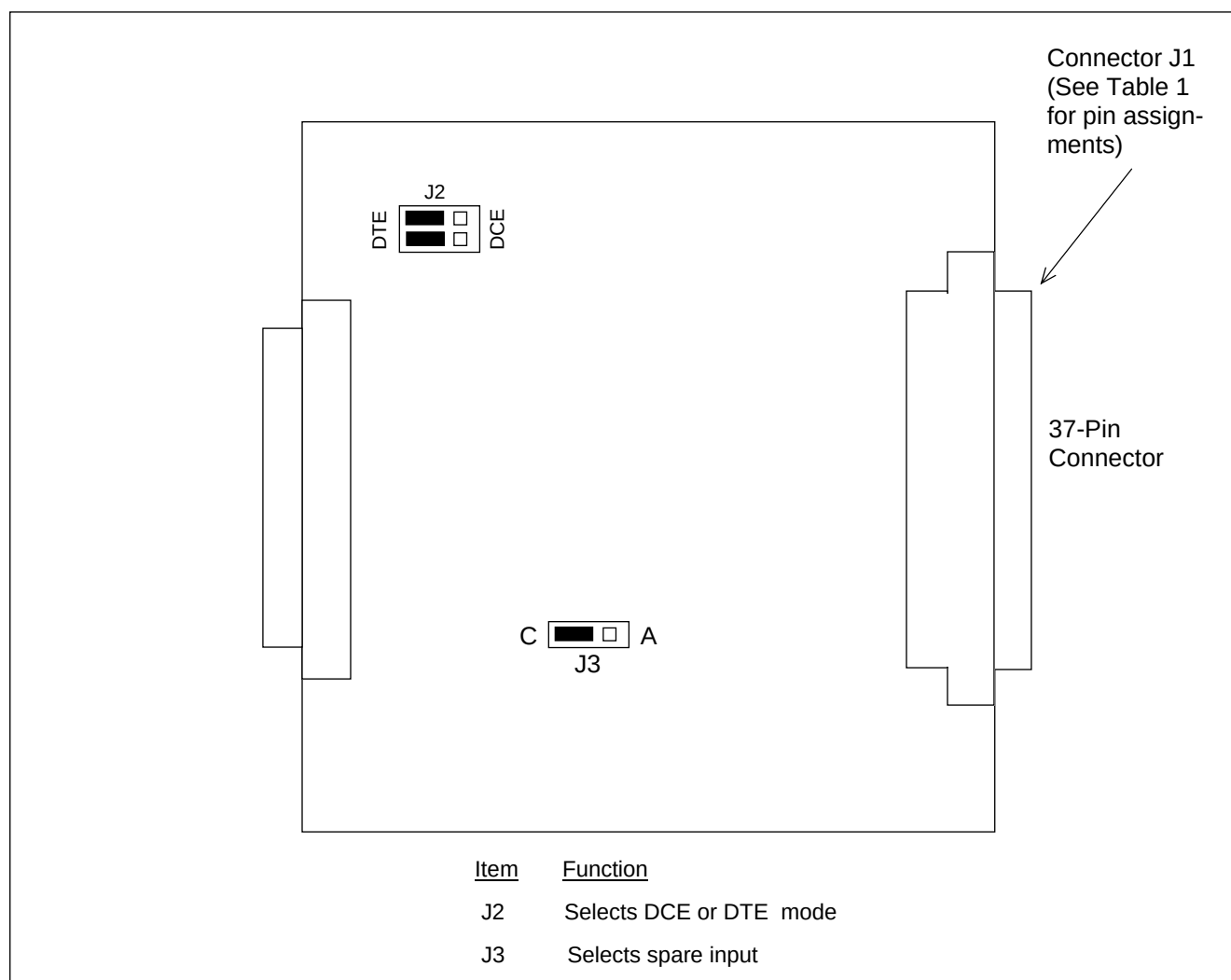


Figure 1. Controls and indicators, MA-406IA Module Adapter

Table 2. Connector J1 pin assignments for the MA-406IB Module Adapter

Pin No.	Signal Name
2	SD(A) - Send Data
14	SD(B) - Send Data
15	ST(A) - Send Timing
12	ST(B) - Send Timing
3	RD(A) - Receive Data
16	RD(B) - Receive Data
4	RS(A) - Request To Send (RTS)
19	RS(B) - Request To Send (RTS)
17	RT(A) - Receive Timing
9	RT(B) - Receive Timing
5	CS(A) - Clear To Send
13	CS(B) - Clear To Send
18	Local Loopback
21	Remote Loopback
7, 23	Signal Ground

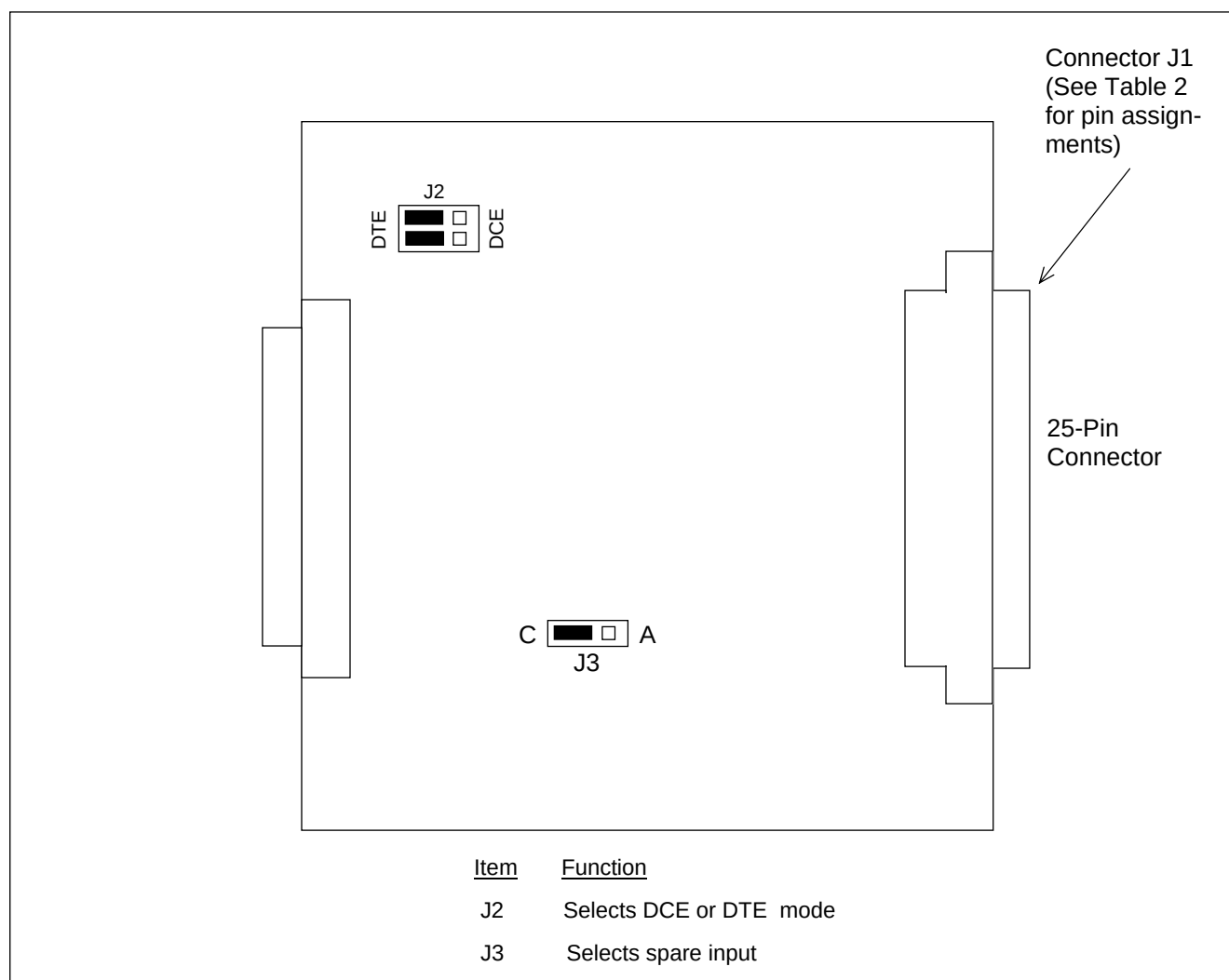


Figure 2. Controls and indicators, MA-406IB Module Adapter

Table 3. Connector J1 pin assignments for the MA-407I Module Adapter

Pin No.	Signal Name
1	GND - Chassis
2	TD(A) - Transmit Data
9	TD(B) - Transmit Data
3	RD(A) - Receive Data
16	RD(B) - Receive Data
12	RT(A) - Receive Timing
13	RT(B) - Receive Timing
15	TT(A) - Transmit Timing
14	TT(B) - Transmit Timing

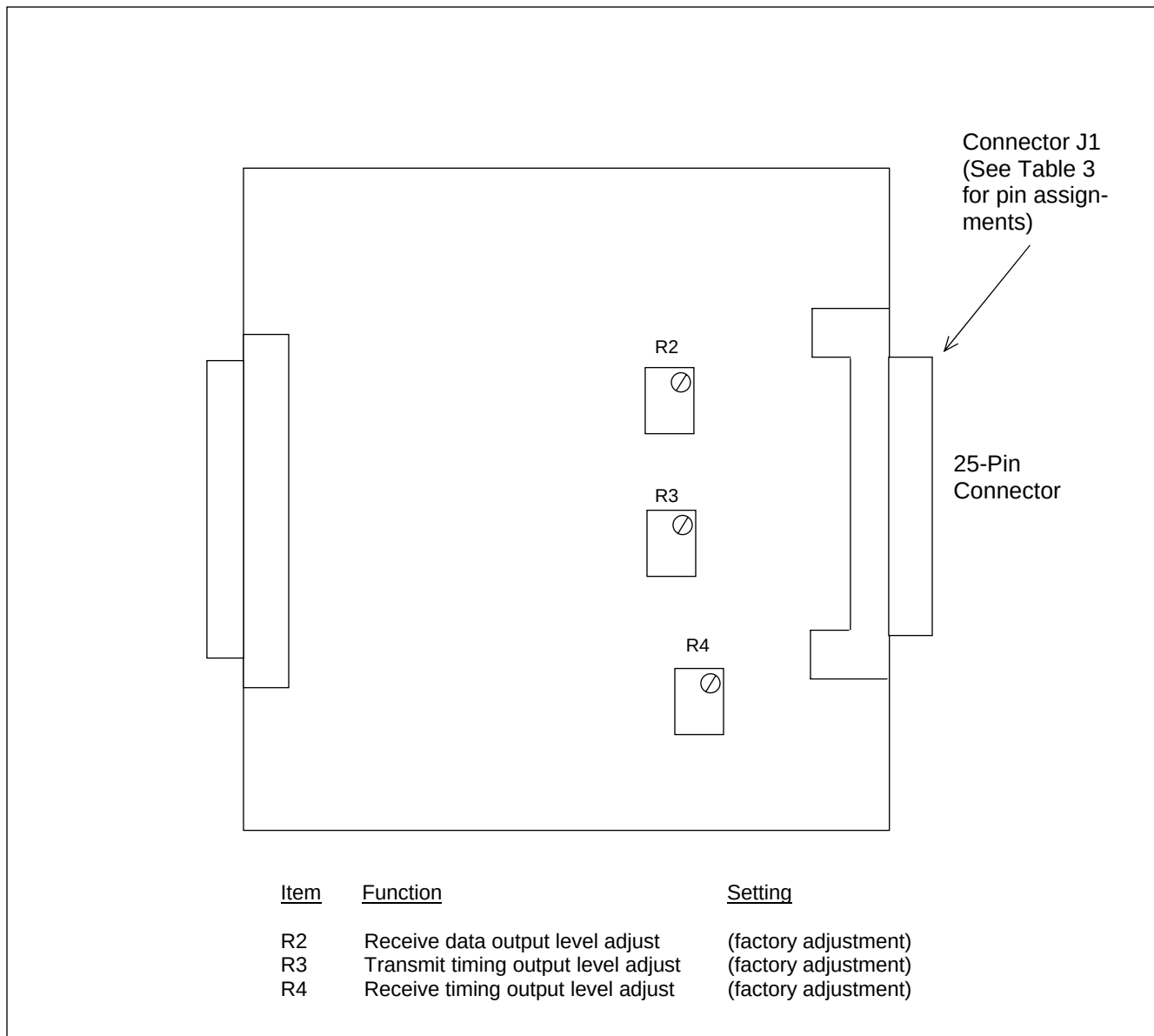


Figure 3. Controls and indicators, MA-407I Module Adapter

Table 4. Connector J1 pin assignments for the MA-408I Module Adapter

Pin No.	Signal Name
1	GND - Chassis
2	TD(A) - Transmit Data (input)
9	TD(B) - Transmit Data (input)
3	RD(A) - Receive Data (output)
16	RD(B) - Receive Data (output)

Note: The clock is embedded within the Transmit and Receive data signal.
The customer interface recovers the clock provided by the MA-408I

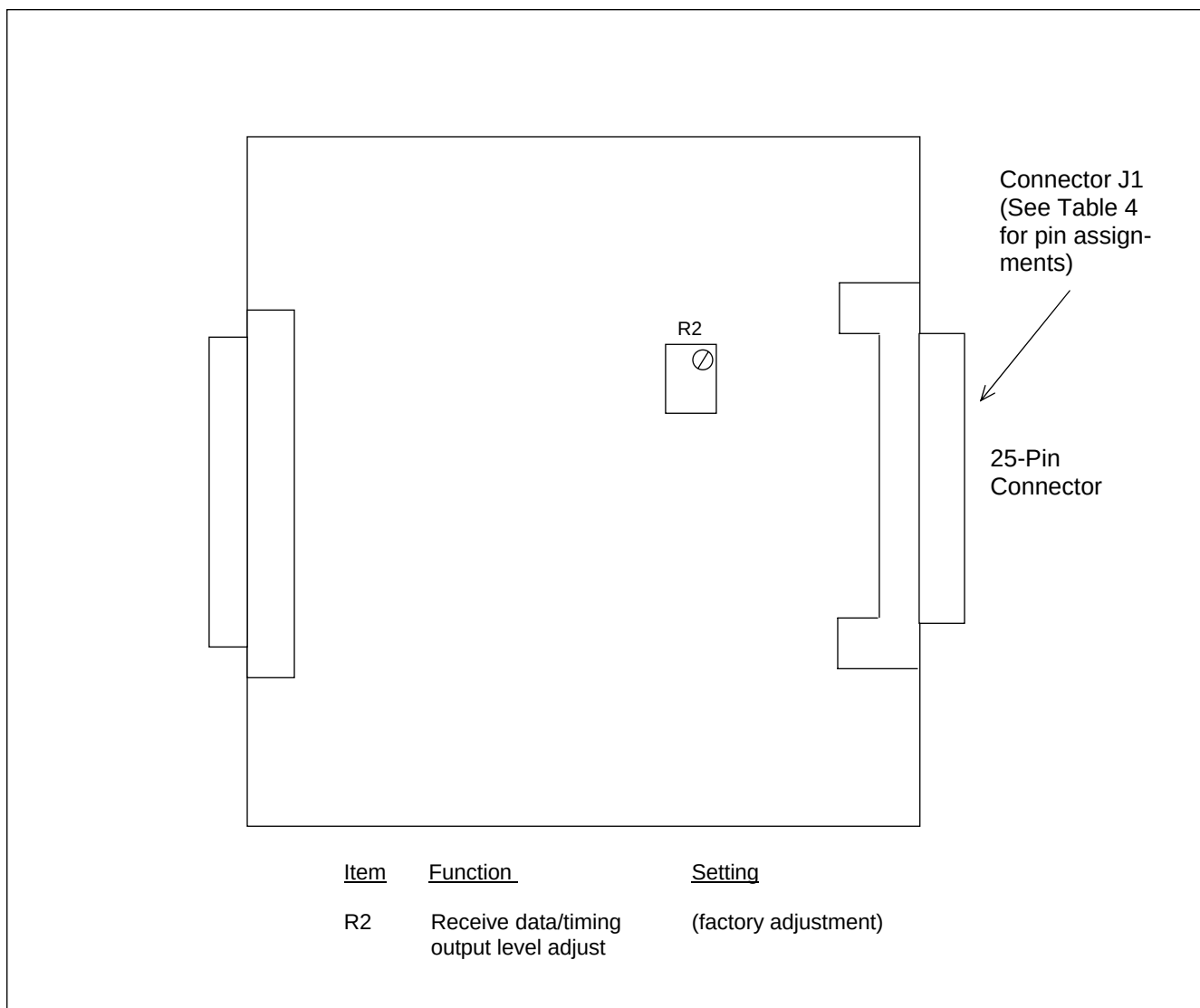


Figure 4. Controls and indicators, MA-408I Module Adapter

Table 5. Connector J1 pin assignments for the MA-409IA Module Adapter

V.35 Pin No.	Signal Name	DC-37S Pin No.
S	SD (B) - Send Data	22
P	SD (A) - Send Data	4
AA	SCT (B) - Serial Clock Transmit	23
Y	SCT (A) - Serial Clock Transmit	5
X	SCR (B) - Serial Clock Receive	26
V	SCR (A) - Serial Clock Receive	8
T	RD (B) - Receive Data	24
R	RD (A) - Receive Data	6
D	CB - Clear To Send (CTS)	9
C	CA - Request To Send (RTS)	7
B	AB - Signal Ground	19

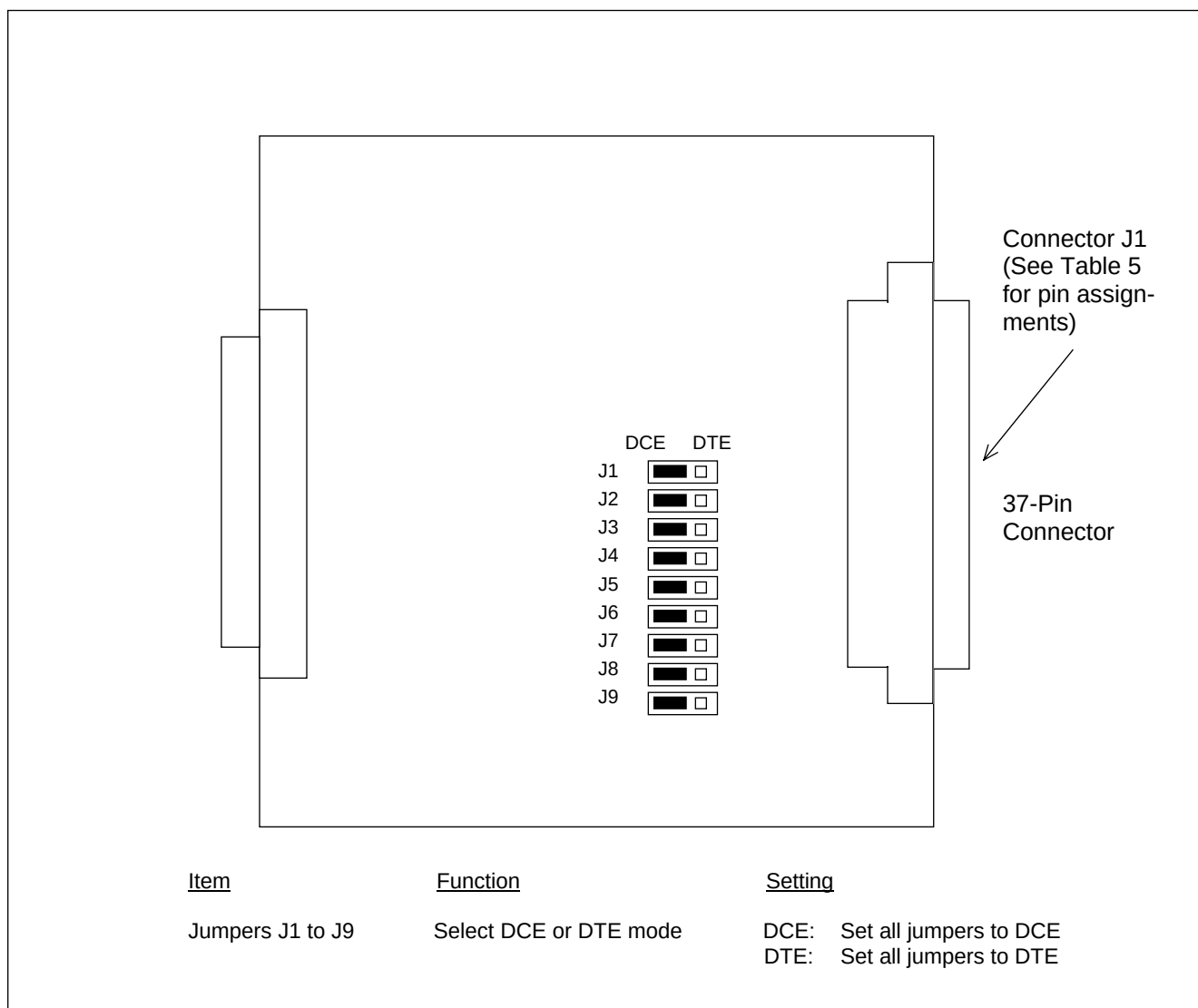


Figure 5. Controls and indicators, MA-409IA Module Adapter

Table 6. Connector J1 pin assignments for the MA-410I Module adapter

Pin No.	Signal Name
1	Chassis
2	TX Data A
3	Control A
4	Rx Data A
5	Indicate A
6	Signal Timing A
8	Signal Ground
9	Tx Data B
10	Control B
11	Rx Data B
12	Indicate B
13	Signal Timing B

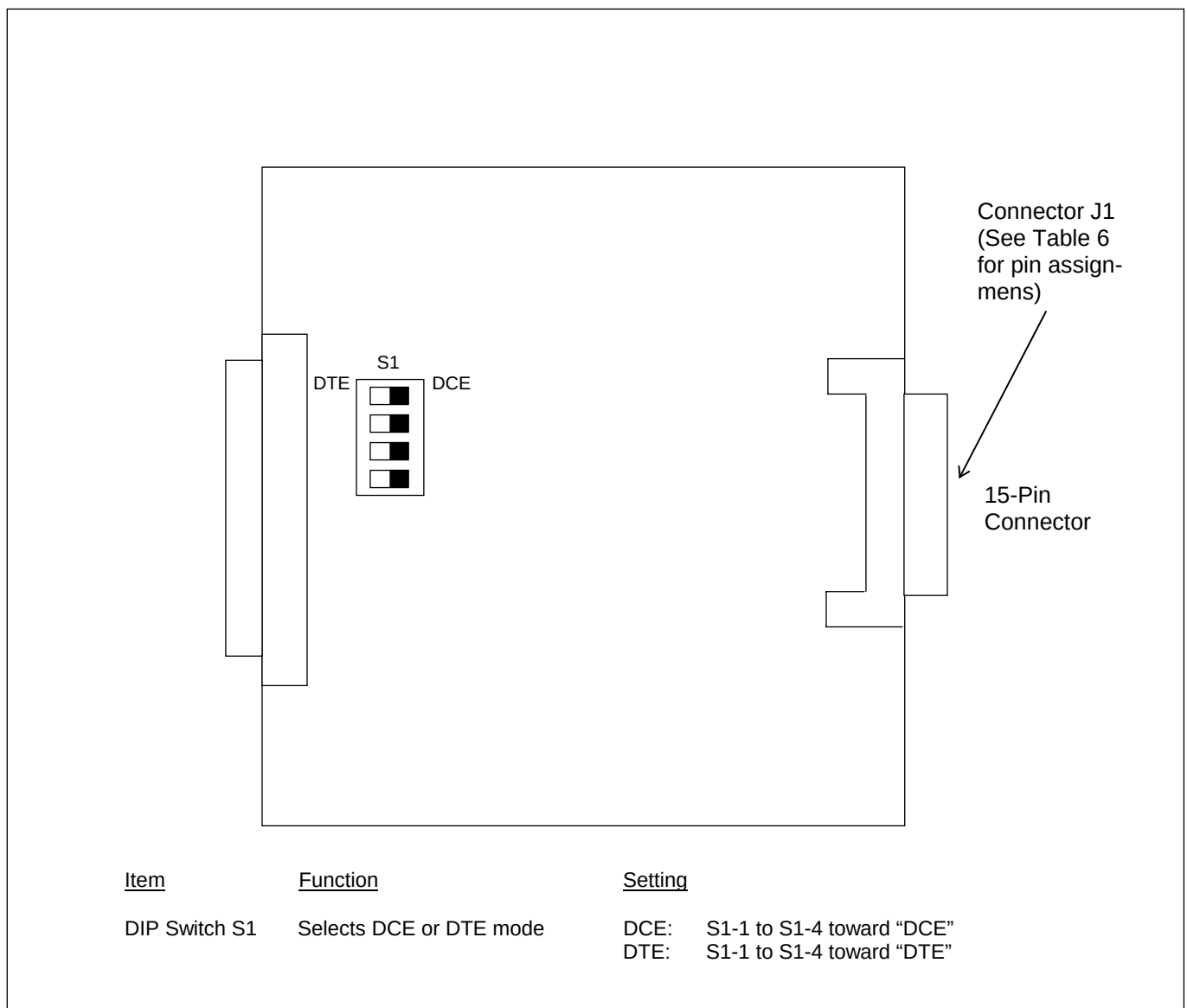


Figure 6. Controls and Indicators, MA-410I Module adapter

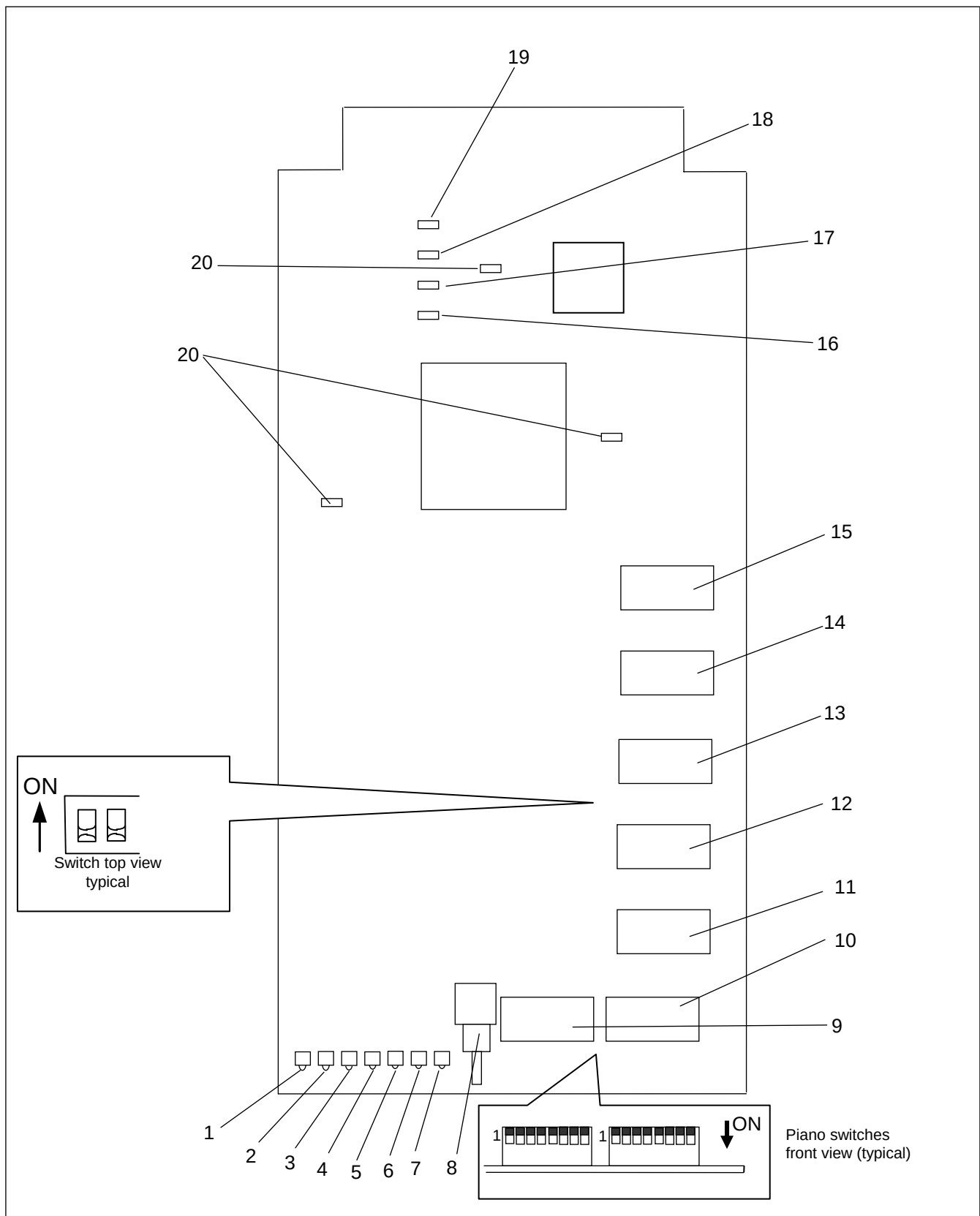


Figure 7. Controls and indicators, RFL DS-562NC multi-baud synchronous data module

Table 7. Controls and indicators, DS-562NC

Item	Name/Description	Function
1	LED indicator (green)	ADR EN: Lights when the transmit address is enabled (not set to 0). Used in 56K mode only.
2	LED indicator (green)	ADR VLD: Lights when the receive address is enabled (not set to 0) and matches the address embedded in the T1/E1 signal. Used in 56K mode only.
3	LED indicator (red)	EQ LB: Lights when the equipment loopback is enabled.
4	LED indicator (red)	PL LB: Lights when the payload loopback is enabled.
5	LED indicator (green)	RX: Lights when the DS-562NC is receiving data from the remote equipment
6	LED indicator (green)	TX: Lights when the DS-562NC is transmitting data to the remote equipment
7	LED indicator (green)	SVC: Lights when the DS-562NC's service is enabled.
8	Switch SW12	This is a three position toggle switch: UP: Sets the board to equipment loopback. CENTER: Normal operation (no loopback, but can be overridden remotely). DOWN: Sets the board to payload loopback. NOTE: If this unit is used for protective relaying applications, disable the protection equipment before using loopbacks.
9	Piano Switch SW2	SW2-1 to SW2-5 Sets T1/E1 timeslot, see Table 9.
		SW2-6 (TERM) Sets the T1/E1 transmit bus direction. ON (Down) – Transmit on 'A' (receive on 'B') drop/insert multiplexer or operates in a terminal multiplexer. OFF (Up) – Transmit on 'B' (receive on 'A') drop/insert multiplexer.
		SW2-7 (CAS) Selects the carrier type (default is T1) ON (Down) – selects E1 (sets CAS ON for E1 only) OFF (Up) – E1 is disabled (for T1 or E1 non-CAS)
10	Piano Switch SW3	SW3-1 to SW3-5 Selects the number of Timeslots used (N-Baud),
		SW3-6 Selects either 56 or 64Kbps mode. ON (Down) – 56Kbps mode (support of N=1 only) OFF (Up) – 64Kbps mode (support of N=1 to 24/31)
		SW3-7 Sets the DS-562NC for local or remote mode: ON (Down) – Remote (settings obtained from SCB). OFF (Up) – Local.
		SW3-8 Sets the DS-562NC service to ON or OFF: ON (Down) – Service OFF (board disabled). OFF (Up) – Service ON (board enabled). Note that any DS-562NC module intended to be used as a spare within a system must have the service switch set to "Disabled".
11	DIP Switch SW1	SW1-1 to SW1-6 Sets the SCB Address, see Table 8.
12	DIP Switch SW4	SW4-3 to SW4-8 Sets the transmit address – 56Kbps only, see table 11:
13	DIP Switch SW5	SW5-2 Sets receiver Squelch – 56K only: ON – Enabled OFF – Disabled
		SW5-3 to SW5-8 Sets the receive address – 56Kbps only, see table 11:

Table 7. Controls and indicators, DS-562NC (continued)

14	DIP Switch SW6	SW6-3	Enables/Disables octet timing – G.703 only: ON – Enabled OFF – Disabled		
		SW6-4	Controls the handshaking delay – RS-449, RS-530 and V.35 only: ON – 8 microseconds delay (approx). OFF – No Delay		
		SW6-5	Sets the receive clock polarity: ON – Inverted polarity OFF – Normal polarity		
		SW6-6	Sets the receive data polarity: ON – Inverted polarity OFF – Normal polarity		
		SW6-7	Sets the transmit clock polarity: ON – Inverted polarity OFF – Normal polarity		
		SW6-8	Sets the transmit data polarity: ON – Inverted polarity OFF – Normal polarity		
15	DIP Switch SW7	SW7-7 to SW7-8	Sets the interface: RS449/RS530/X.21/V.35/G.703/RFL Short Haul Fiber. (standard mode) Short Haul Fiber (C.37.94 MA-620/621) Ethernet (MA-427/428)	SW7-7 Not Used OFF OFF ON	SW7-8 Not Used OFF ON OFF
16	TP13	RX Data			
17	TP14	RX Clock			
18	TP15	TX Data			
19	TP16	TX Clock			
20	TP6, 12 and 17	Ground			

Table 8. SCB Address Settings, RFL DS-562NC

Module Address	SW1-1 (32)	SW1-2 (16)	SW1-3 (8)	SW1-4 (4)	SW1-5 (2)	SW1-6 (1)
1	OFF	OFF	OFF	OFF	OFF	ON
2	OFF	OFF	OFF	OFF	ON	OFF
3	OFF	OFF	OFF	OFF	ON	ON
4	OFF	OFF	OFF	ON	OFF	OFF
5	OFF	OFF	OFF	ON	OFF	ON
6	OFF	OFF	OFF	ON	ON	OFF
7	OFF	OFF	OFF	ON	ON	ON
8	OFF	OFF	ON	OFF	OFF	OFF
9	OFF	OFF	ON	OFF	OFF	ON
10	OFF	OFF	ON	OFF	ON	OFF
11	OFF	OFF	ON	OFF	ON	ON
12	OFF	OFF	ON	ON	OFF	OFF
13	OFF	OFF	ON	ON	OFF	ON
14	OFF	OFF	ON	ON	ON	OFF
15	OFF	OFF	ON	ON	ON	ON
16	OFF	ON	OFF	OFF	OFF	OFF
17	OFF	ON	OFF	OFF	OFF	ON
18	OFF	ON	OFF	OFF	ON	OFF
19	OFF	ON	OFF	OFF	ON	ON
20	OFF	ON	OFF	ON	OFF	OFF
21	OFF	ON	OFF	ON	OFF	ON
22	OFF	ON	OFF	ON	ON	OFF
23	OFF	ON	OFF	ON	ON	ON
24	OFF	ON	ON	OFF	OFF	OFF
25	OFF	ON	ON	OFF	OFF	ON
26	OFF	ON	ON	OFF	ON	OFF
27	OFF	ON	ON	OFF	ON	ON
28	OFF	ON	ON	ON	OFF	OFF
29	OFF	ON	ON	ON	OFF	ON
30	OFF	ON	ON	ON	ON	OFF
31	OFF	ON	ON	ON	ON	ON
32	ON	OFF	OFF	OFF	OFF	OFF
33	ON	OFF	OFF	OFF	OFF	ON
34	ON	OFF	OFF	OFF	ON	OFF
35	ON	OFF	OFF	OFF	ON	ON
36	ON	OFF	OFF	ON	OFF	OFF

Table 9. Timeslot settings, RFL DS-562NC

T1 Timeslot	E1 Timeslot	SW2-1 (16)	SW2-2 (8)	SW2-3 (4)	SW2-4 (2)	SW2-5 (1)	Max # of T1 Timeslots	Max # of E1 Timeslots
N/A	N/A	DOWN	DOWN	DOWN	DOWN	DOWN	N/A	N/A
1	1	DOWN	DOWN	DOWN	DOWN	UP	24	31(30)**
2	2	DOWN	DOWN	DOWN	UP	DOWN	23	30(29)**
3	3	DOWN	DOWN	DOWN	UP	UP	22	29 (28)**
4	4	DOWN	DOWN	UP	DOWN	DOWN	21	28 (27)**
5	5	DOWN	DOWN	UP	DOWN	UP	20	27(26)**
6	6	DOWN	DOWN	UP	UP	DOWN	19	26 (25)**
7	7	DOWN	DOWN	UP	UP	UP	18	25 (24)**
8	8	DOWN	UP	DOWN	DOWN	DOWN	17	24 (23)**
9	9	DOWN	UP	DOWN	DOWN	UP	16	23 (22)**
10	10	DOWN	UP	DOWN	UP	DOWN	15	22 (21)**
11	11	DOWN	UP	DOWN	UP	UP	14	21 (20)**
12	12	DOWN	UP	UP	DOWN	DOWN	13	20 (19)**
13	13	DOWN	UP	UP	DOWN	UP	12	19 (18)**
14	14	DOWN	UP	UP	UP	DOWN	11	18 (17)**
15	15	DOWN	UP	UP	UP	UP	10	17 (16)**
16	16 *	UP	DOWN	DOWN	DOWN	DOWN	9	16 (N/A)*
17	17	UP	DOWN	DOWN	DOWN	UP	8	15
18	18	UP	DOWN	DOWN	UP	DOWN	7	14
19	19	UP	DOWN	DOWN	UP	UP	6	13
20	20	UP	DOWN	UP	DOWN	DOWN	5	12
21	21	UP	DOWN	UP	DOWN	UP	4	11
22	22	UP	DOWN	UP	UP	DOWN	3	10
23	23	UP	DOWN	UP	UP	UP	2	9
24	24	UP	UP	DOWN	DOWN	DOWN	1	8
N/A	25	UP	UP	DOWN	DOWN	UP	N/A	7
N/A	26	UP	UP	DOWN	UP	DOWN	N/A	6
N/A	27	UP	UP	DOWN	UP	UP	N/A	5
N/A	28	UP	UP	UP	DOWN	DOWN	N/A	4
N/A	29	UP	UP	UP	DOWN	UP	N/A	3
N/A	30	UP	UP	UP	UP	DOWN	N/A	2
N/A	31	UP	UP	UP	UP	UP	N/A	1

* Do not use timeslot 16 in an E1 system which uses CAS (channel associated signaling).

** The maximum timeslots available is reduced by “1” for an E1 system using CAS when the starting timeslot is between timeslot 1 and 15.

Table 10. Setting the number of Timeslots (N-Baud), RFL DS-562NC

Number of Timeslots for T1	Number of Timeslots for E1	SW3-1 (16)	SW3-2 (8)	SW3-3 (4)	SW3-4 (2)	SW3-5 (1)
N/A	N/A	DOWN	DOWN	DOWN	DOWN	DOWN
1	1	DOWN	DOWN	DOWN	DOWN	UP
2	2	DOWN	DOWN	DOWN	UP	DOWN
3	3	DOWN	DOWN	DOWN	UP	UP
4	4	DOWN	DOWN	UP	DOWN	DOWN
5	5	DOWN	DOWN	UP	DOWN	UP
6	6	DOWN	DOWN	UP	UP	DOWN
7	7	DOWN	DOWN	UP	UP	UP
8	8	DOWN	UP	DOWN	DOWN	DOWN
9	9	DOWN	UP	DOWN	DOWN	UP
10	10	DOWN	UP	DOWN	UP	DOWN
11	11	DOWN	UP	DOWN	UP	UP
12	12	DOWN	UP	UP	DOWN	DOWN
13	13	DOWN	UP	UP	DOWN	UP
14	14	DOWN	UP	UP	UP	DOWN
15	15	DOWN	UP	UP	UP	UP
16	16	UP	DOWN	DOWN	DOWN	DOWN
17	17	UP	DOWN	DOWN	DOWN	UP
18	18	UP	DOWN	DOWN	UP	DOWN
19	19	UP	DOWN	DOWN	UP	UP
20	20	UP	DOWN	UP	DOWN	DOWN
21	21	UP	DOWN	UP	DOWN	UP
22	22	UP	DOWN	UP	UP	DOWN
23	23	UP	DOWN	UP	UP	UP
24	24	UP	UP	DOWN	DOWN	DOWN
N/A	25	UP	UP	DOWN	DOWN	UP
N/A	26	UP	UP	DOWN	UP	DOWN
N/A	27	UP	UP	DOWN	UP	UP
N/A	28	UP	UP	UP	DOWN	DOWN
N/A	29	UP	UP	UP	DOWN	UP
N/A	30	UP	UP	UP	UP	DOWN
N/A	31*	UP	UP	UP	UP	UP

* The maximum timeslots available is reduced by “1” for an E1 system using CAS.

Table 11. Transmit & Receive Address Settings, RFL DS-562NC
(Used only in 56 Kbps mode)

Trans/Rcv Address	SW4/5-3 (32)	SW4/5-4 (16)	SW4/5-5 (8)	SW4/5-6 (4)	SW4/5-7 (2)	SW4/5-8 (1)
0 (disabled)	OFF	OFF	OFF	OFF	OFF	OFF
1	OFF	OFF	OFF	OFF	OFF	ON
2	OFF	OFF	OFF	OFF	ON	OFF
3	OFF	OFF	OFF	OFF	ON	ON
4	OFF	OFF	OFF	ON	OFF	OFF
5	OFF	OFF	OFF	ON	OFF	ON
6	OFF	OFF	OFF	ON	ON	OFF
7	OFF	OFF	OFF	ON	ON	ON
8	OFF	OFF	ON	OFF	OFF	OFF
9	OFF	OFF	ON	OFF	OFF	ON
10	OFF	OFF	ON	OFF	ON	OFF
11	OFF	OFF	ON	OFF	ON	ON
12	OFF	OFF	ON	ON	OFF	OFF
13	OFF	OFF	ON	ON	OFF	ON
14	OFF	OFF	ON	ON	ON	OFF
15	OFF	OFF	ON	ON	ON	ON
16	OFF	ON	OFF	OFF	OFF	OFF
17	OFF	ON	OFF	OFF	OFF	ON
18	OFF	ON	OFF	OFF	ON	OFF
19	OFF	ON	OFF	OFF	ON	ON
20	OFF	ON	OFF	ON	OFF	OFF
21	OFF	ON	OFF	ON	OFF	ON
22	OFF	ON	OFF	ON	ON	OFF
23	OFF	ON	OFF	ON	ON	ON
24	OFF	ON	ON	OFF	OFF	OFF
25	OFF	ON	ON	OFF	OFF	ON
26	OFF	ON	ON	OFF	ON	OFF
27	OFF	ON	ON	OFF	ON	ON
28	OFF	ON	ON	ON	OFF	OFF
29	OFF	ON	ON	ON	OFF	ON
30	OFF	ON	ON	ON	ON	OFF
31	OFF	ON	ON	ON	ON	ON
32	ON	OFF	OFF	OFF	OFF	OFF
33	ON	OFF	OFF	OFF	OFF	ON
34	ON	OFF	OFF	OFF	ON	OFF
35	ON	OFF	OFF	OFF	ON	ON
36	ON	OFF	OFF	ON	OFF	OFF
37	ON	OFF	OFF	ON	OFF	ON
38	ON	OFF	OFF	ON	ON	OFF
39	ON	OFF	OFF	ON	ON	ON
40	ON	OFF	ON	OFF	OFF	OFF
41	ON	OFF	ON	OFF	OFF	ON
42	ON	OFF	ON	OFF	ON	OFF
43	ON	OFF	ON	OFF	ON	ON
44	ON	OFF	ON	ON	OFF	OFF
45	ON	OFF	ON	ON	OFF	ON

Cont.....

Table 11. (continued) Transmit & Receive Address Settings, RFL DS-562NC
(Used only in 56 Kbps mode)

Trans/Rcv Address	SW4/5-3 (32)	SW4/5-4 (16)	SW4/5-5 (8)	SW4/5-6 (4)	SW4/5-7 (2)	SW4/5-8 (1)
46	ON	OFF	ON	ON	ON	OFF
47	ON	OFF	ON	ON	ON	ON
48	ON	ON	OFF	OFF	OFF	OFF
49	ON	ON	OFF	OFF	OFF	ON
50	ON	ON	OFF	OFF	ON	OFF
51	ON	ON	OFF	OFF	ON	ON
52	ON	ON	OFF	ON	OFF	OFF
53	ON	ON	OFF	ON	OFF	ON
54	ON	ON	OFF	ON	ON	OFF
55	ON	ON	OFF	ON	ON	ON
56	ON	ON	ON	OFF	OFF	OFF
57	ON	ON	ON	OFF	OFF	ON
58	ON	ON	ON	OFF	ON	OFF
59	ON	ON	ON	OFF	ON	ON
60	ON	ON	ON	ON	OFF	OFF
61	ON	ON	ON	ON	OFF	ON
62	ON	ON	ON	ON	ON	OFF
63	ON	ON	ON	ON	ON	ON

SHORT HAUL FIBER INTERFACE (MA-600)

The MA-600 is a Short Haul Fiber Interface Module that can be used with the RFL DS562NC Synchronous Data Module. The Short Haul Fiber Interface Module is a single width module, and consists of an input section (detector) and an output section (emitter). The module is mounted at the rear of an RFL IMUX 2000 chassis, directly opposite the DS-562NC module. The input power requirement is +5 Volts at 175 mA maximum from the chassis supply. The input drive signals are TTL logic-level, generated by the DS-562NC. The Short Haul Fiber Interface (MA-600) can only occupy one time slot at a data rate of 64kbps.

Table 12. Short Haul Fiber Interface Module, Characteristics

Assembly Number	Type	Wavelength/ Mode	Connector Type	Receiver Sensitivity (average)	Tx Power (average)	Typical Distance
9547-600	LED Emitter/ Detector	850 nm/ multimode	ST	-26dBm	-14dBm to -21dBm into 50µm fiber -11dBm to -18dBm into 62.5µm fiber.	Up to 1km (0.6 mi.)

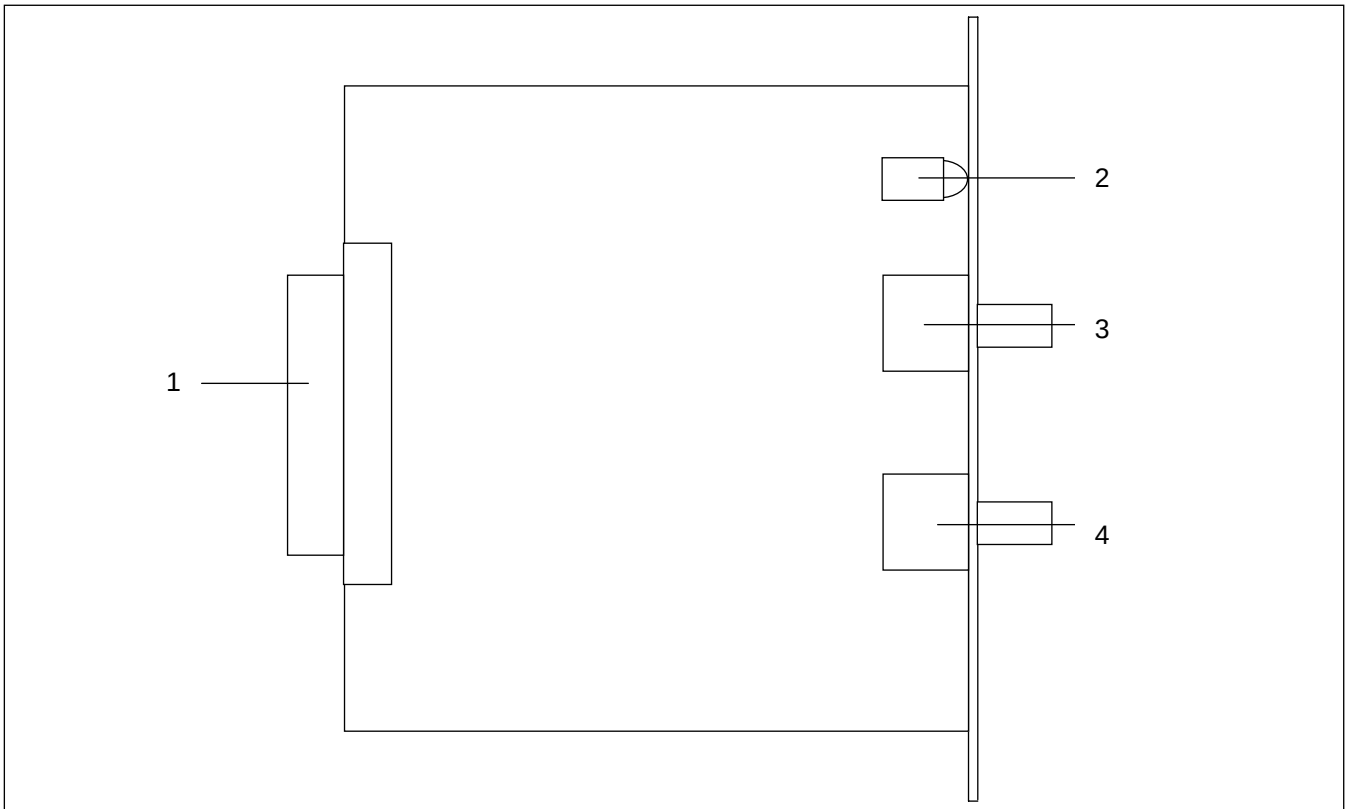


Figure 8. Controls and indicators, MA-600 Module Adapter

Table 13. Short Haul Fiber Interface Module, Controls and indicators

Item	Name/Description	Function
1	JP1 Connector	Motherboard connector (connects to the IMUX 2000 motherboard directly behind the DS-562NC module)
2	DS2 Fiber Data LED	Lights green when data (transitions) is present at the fiber optic receiver
3	U7 Fiber Optic Detector	Connects to fiber optic cable from remote end
4	DS1 Fiber Optic Emitter	Connects to fiber optic cable to remote end

The IMUX Short Haul Fiber module takes three signals from the DS-562NC and multiplexes them over a single fiber. The signals include transmit and receive timing and transmit data. The receive data coming from the other fiber is converted to TTL levels for use by the DS-562NC. An activity LED indicates that data is present on the incoming fiber. There are no jumpers or settings to be made on the unit.

The outgoing clocks and transmit data are asynchronously sampled at a 2.5 MHz rate generated by an oscillator. The three resulting bits are put into a serial 8-bit word by a multiplexer. The remaining 5 bits create a fixed pattern which is used by the receiving interface to determine frame alignment. This pattern is shown below. The serial signal is clocked out at 2.5 MHz and drives the fiber transmitter DS1.

The receive signal is clocked by the receive timing signal. This data is not modulated and therefore is passed to the DS-562NC in TTL format exactly as received. The receive data is also used to retrigger a multivibrator. If no transitions occur within a specified time, the rear panel LED DS2 is extinguished.

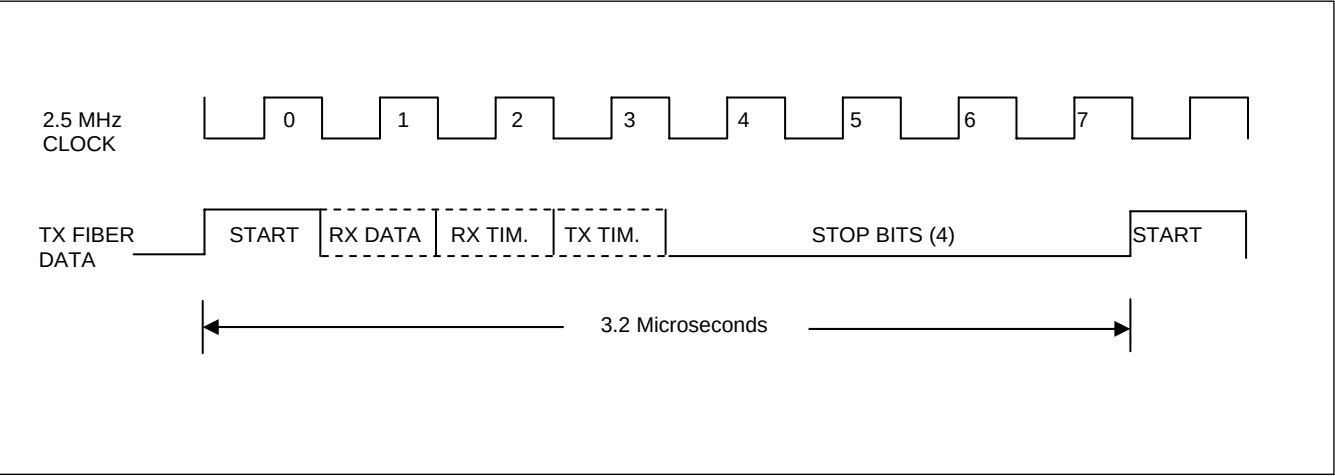


Figure 9. Short Haul Fiber Timing Diagram

SHORT HAUL FIBER INTERFACE (MA-620 and MA-621)

The MA-620/621 is a Short Haul Fiber Interface Module, which supports IEEE standard C37.94 for N times 64 kilobit per second Optical Fiber Interfaces between Teleprotection and Multiplexer Equipment. When used with the DS562NC, the MA-620/621 complies with the standard for N = 1 through 12. The module is mounted at the rear of an RFL IMUX 2000 chassis, directly opposite the DS562NC module. The input power requirement is +5 Volts at 200 mA maximum from the chassis supply. The input drive signals are TTL logic-level, generated by the DS-562NC.

Table 14. Short Haul Fiber Interface Module, Characteristics at 25° C

Module	Assembly Number	Type	Wavelength/ Mode	Connector Type	Receiver Sensitivity (average)	Tx power (average)	Typical Distance
MA-620	107245	LED Emitter/ Detector	830 (+/- 40 nm) multimode	ST	-11dBm to -32dBm	-11dBm to -23dBm average into 50µm fiber -11dBm to -19dBm average into 62.5µm fiber	Up to 2km (1.2 mi.)
MA-621	107245-1	LED Emitter/ Detector	1300nm singlemode	ST	-35dBm	-20dBm to -22dBm average into 9µm fiber	Up to 10km (6.2 mi.)

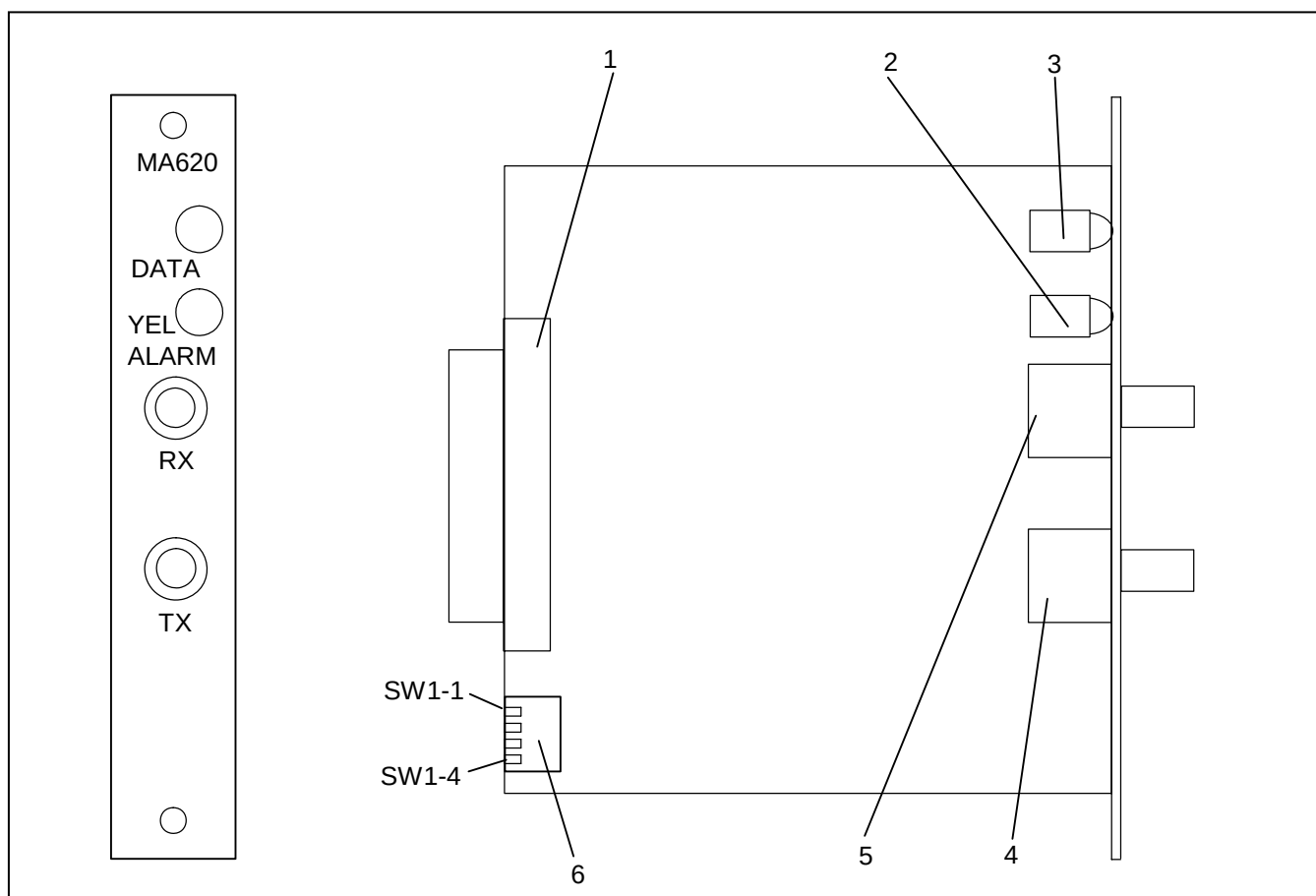


Figure 10. Controls and indicators, MA-620/621 Module Adapter

Table 15. Short Haul Fiber Interface Module, Controls and indicators

Item	Name/Description	Function
1	Connector	Motherboard connector (connects to the IMUX 2000 motherboard directly behind the DS-562NC module).
2	YEL ALARM LED (yellow)	Yellow alarm when illuminated. Indicates that the remote fiber receiver has failed and the remote transmitter is sending yellow code detected by the local fiber receive channel.
3	DATA LED (green)	Valid data when illuminated. Indicates that the Fiber Data is valid with no bit errors. Not illuminated or pulsing indicates bit errors and/or loss of signal.
4	TX Fiber Optic Emitter	Connects to fiber optic cable to remote end.
5	RX Fiber Optic Detector	Connects to fiber optic cable from remote end.
6	DIP switch SW1	SW1-1 Selects Normal Data or Inverted Data DOWN (ON) = Normal Data (non-inverted) UP (OFF) = Inverted Data SW1-2 to SW1-4 Not used

The MA-620/621 is a single width module, which consists of an input section (detector) and an output section (emitter). The MA-620/621 provides an interface between synchronous electrical signals and multimode optical fiber. The present design using the DS-562NC module can operate at data rates between 64kb/s and 768kb/s. Clock and data signals are present on the dual row connector at TTL levels and uses a clock generated by the IMUX instead of recovering one from the interface. There are pins on the same connector which indicate to the IMUX what type of interface is installed. The module has a green LED to indicate when valid fiber data is present and a yellow LED to indicate when a YELLOW alarm is being received. On hot insertion, the MA-620/621 can take up to 15 seconds to initialize. The fiber can be looped back onto the IMUX for diagnostic purposes.

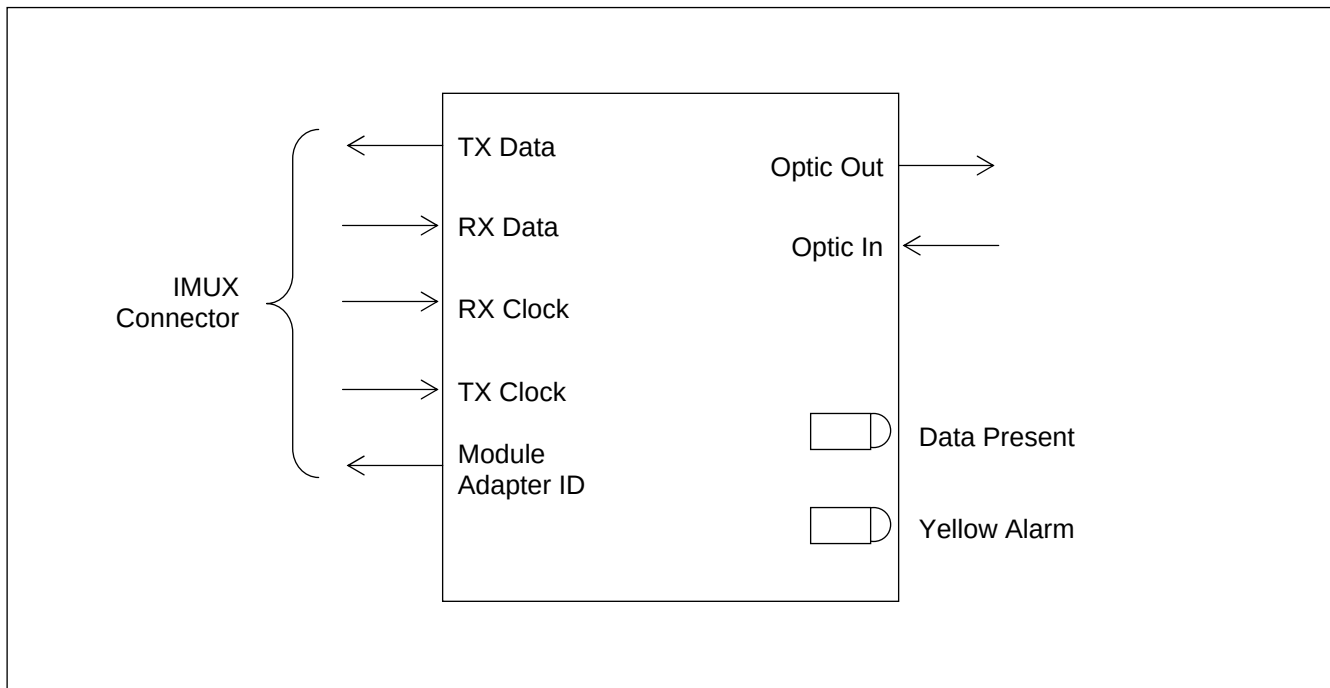


Figure 11. MA-620/621 Short Haul Fiber Interface Module, block diagram

MA-427 LAN BRIDGE MODULE ADAPTER

The MA-427 LAN Bridge module adapter provides a high performance, remote, self-learning Ethernet bridge. It is used for bridging applications or as a LAN extender or segmenter over bit stream type infrastructures for data channel modules such as the RFL DS-562NC.

FEATURES

1. High performance Ethernet bridge/extender
2. Fully compatible with IEEE 802.3
3. 10baseT LAN interface with unshielded twisted pair (UTP) RJ-45
4. Support for full and half duplex Ethernet applications
5. Transparent simplex, half duplex, or full duplex support on the WAN interface
6. WAN link rate of up to 10 Mbps sync or up to 115.2 kbps async
7. Switch-selectable filtering with 15,000 frames per second filtering and forwarding rate
8. 256 frame buffer
9. 10,000 MAC address table
10. Automatic learning and aging of MAC addresses
11. Switch-selectable enhanced compression

INSTALLATION AND OPERATION

The installation of the MA-427 is comprised of three parts: verification of switch settings, connecting the MA-427 LAN Bridge to your LAN, and verification of LAN-to-LAN operation.

Verification of Switch Settings

Verify that the MA-427 LAN Bridge's switches are set to the defaults described in Table 16 on the following page. Refer to Figure 12 to locate the switches on the board.

Table 16. MA-427 LAN Bridge SW2 Settings

Switch Number	Switch	Default Settings	Switch Options
1	MODE 0	Up*	Down = Not applicable Up = Indicates 10Mb half duplex when it is the only mode set to the UP position. When combined with MODE 4 in the UP position, indicates 10Mb full duplex.
2	MODE 1	Down*	Future application.
3	MODE 2	Down*	
4	MODE 3	Down*	
5	MODE 4	Up	Down = Setting for 10Mb half duplex. Up = Combined with mode 0 in the UP position creates setting for 10Mb full duplex.
6	WMODE (WAN)	Down**	Down = Synchronous. Up = Asynchronous.
7	FILTER***	Up	Down = Filter and forward (bridge) ON. Up = Filter and forward (bridge) OFF.
8	COMPR*** (Compression)	Down	Down = Compression OFF. Up = Compression ON

Notes:

* Unless it is necessary to change from full to half duplex, do not change the MODE 0-4 settings from their default.

** To ensure proper operation with the DS-562NC, do not change the WMODE setting from the default.

*** The compression and filter settings must be the same as their corresponding switch on the far side of the network.

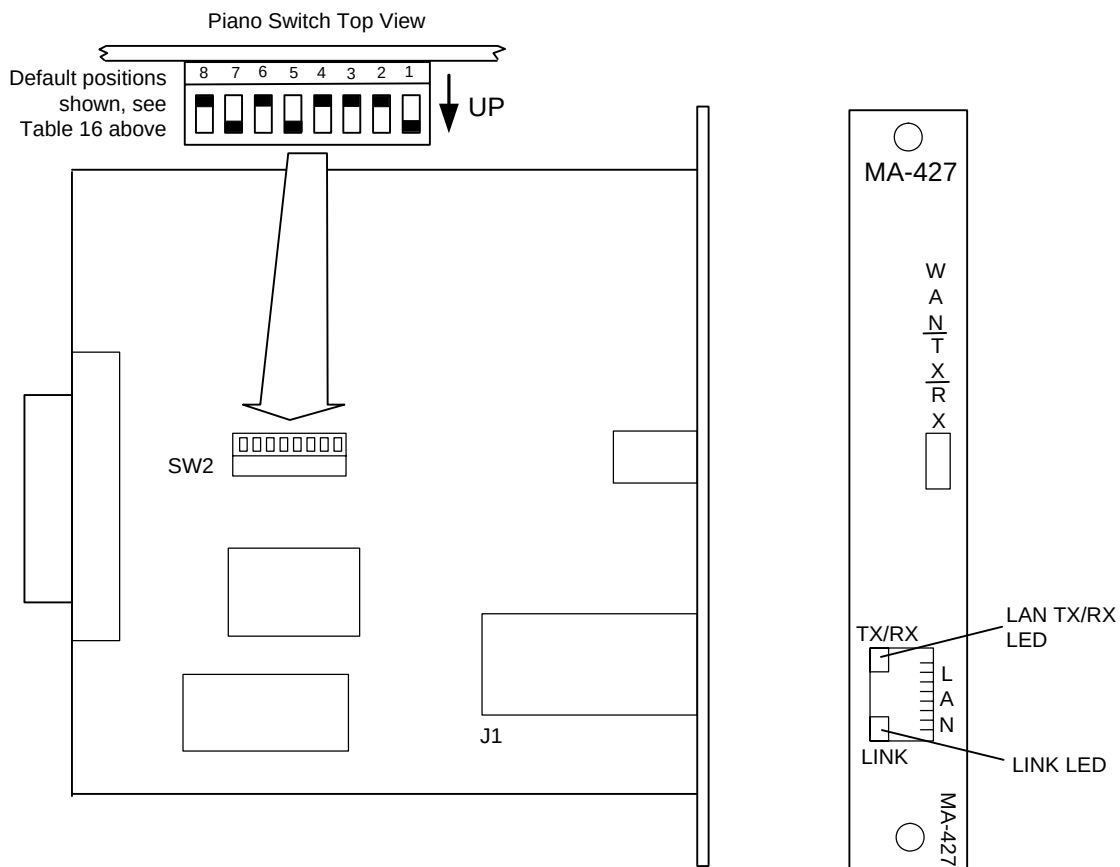


Figure 12. MA-427 LAN Bridge Module Adapter

Filtering

Over time the MA-427 LAN Bridge will automatically learn and store a table with up to 10,000 MAC addresses of devices on the WAN. When the filter is on, the MA-427 LAN Bridge will use the MAC address table to only allow frames destined for another LAN over the WAN. When the filter is off, all frames are sent over the WAN. RFL recommends that this setting be left in the default (UP) position for optimum operation of the DS-562NC.

Compression

Compression increases data throughput. Valid Ethernet frames have a minimum length of 64 bytes. Shorter frames are padded. With compression enabled (by asserting the COMPR signal), these padding bytes are stripped off before transmission over the WAN, and re-padded while being received at the other end. RFL recommends that this setting be left in the default (DOWN) position for optimum operation of the DS-562NC.

Connecting the MA-427 LAN Bridge to Your LAN

You should connect the MA-427 LAN Bridge to a hub or Ethernet switch using a straight-through cable such as a Black Box 10 ft. straight-through cable (P/N EVSA85-0010).

If you connect the MA-427 directly to a PC or a network interface card (NIC), the RJ-45 cable must implement a UTP crossover function, such as Black Box 10 ft. crossover cable (P/N EVCRA85-0010).

Table 17 provides information for straight-through and crossover cable pin connections. Figure 13 shows the locations of pins 1 and 8 on the RJ-45 connector and on the MA-427.

Table 17. Straight-Through and Crossover RJ-45 UTP Cable Pin Connections

Straight-Through RJ-45 UTP Cable Pin Connections				Crossover RJ-45 UTP Cable Pin Connections			
MA-427		HUB or Ethernet switch		MA-427		PC or NIC	
Pin	Function	Pin	Function	Pin	Function	Pin	Function
1	TX+	1	TX+	1	TX+	1	RX+
2	TX-	2	TX-	2	TX-	2	RX-
3	RX+	3	RX+	3	RX+	3	TX+
4	Not Used	4	Not Used	4	Not Used	4	Not Used
5	Not Used	5	Not Used	5	Not Used	5	Not Used
6	RX-	6	RX-	6	RX-	6	TX-
7	Not Used	7	Not Used	7	Not Used	7	Not Used
8	Not Used	8	Not Used	8	Not Used	8	Not Used



Figure 13. Pins 1 and 8 on RJ-45 connector and on MA-427 LAN Bridge

Verifying LAN-to-LAN Operation

Once you have completed the installation, verify that the MA-427 LAN Bridge is operating properly by checking LAN-to-LAN operation with your network administrator. You can also verify the operation of the MA-427 by checking its LEDs. Table 18 describes the LEDs and their state under normal operating conditions when connected to a functioning LAN.

Table 18. MA-427 LAN Bridge LEDs

LED	Color	State	Function	Normal State
WAN TX/RX	Yellow	On	Indicates transmission of data to or receiving data from the WAN	This LED will flash on and off when connected to a functioning WAN
		Off	Indicates no transmission of data to or receiving data from the WAN	
LAN TX/RX	Yellow	On	Indicates transmission of data to or receiving data from the LAN	This LED will flash on and off when connected to a functioning LAN
		Off	Indicates no transmission of data to or receiving data from the LAN	
LINK	Green	On	Indicates connection to LAN	This LED should always be on when connected to a functioning LAN
		Off	Indicates no connection to LAN	

Troubleshooting

Use the table below to troubleshoot any problems you encounter during installation or operation of the MA-427 LAN Bridge.

Table 19. Troubleshooting Problems and Solutions for the MA-427 LAN Bridge

Problem	Probable Cause	Solution
LINK LED is not on	No LAN connection	Remove and reconnect the RJ-45 cable connected to the MA-427 port.
	Wrong cable for device connection	Check that the proper cable is being used. Use UTP RJ-45 for hub or Ethernet switch. Use UTP RJ-45 with crossover for PC or NIC. See Table 17.
	Problem with LAN	See your network administrator
	T1/E1 link is not working	Contact your T1/E1 service provider
No LAN-to-LAN communication (data is not being sent or received)	No LAN connection	Verify that the LINK LED is on. If it is not, see "LINK LED is not on" above
	Incompatible switch settings	Verify that the COMPR switch settings are the same at both ends of the network. Verify that the FILTER switch settings are the same on both ends of the network. Verify that the WMODE and MODE 0-4 switches are set to their defaults. See Table 16.
	Problem with LAN	See your network administrator
	Synchronous data link is not working	Check the operation of the DS-562NC using the DS-562NC troubleshooting procedure on page 50.
WAN TX/RX LED and LAN TX/RX LED are always on	MODE 0 switch is in the DOWN position	Set the MODE 0 switch to the UP position. See Figure 12 for the switch location.

MA-428 ENHANCED LAN BRIDGE MODULE ADAPTER

The MA-428 Enhanced LAN Bridge module adapter provides a high performance, remote, self-learning Ethernet bridge. It is used for bridging applications or as a LAN extender or segmenter over bit stream type infrastructures for data channel modules such as the RFL DS-562NC. The MA-428 replaces the MA-427 and provides features not found in the MA-427 module adapter. **Therefore the MA-427 and MA-428 are not compatible. Both ends of the channel must be either MA-427 or MA-428, they cannot be mixed.**

FEATURES

1. High performance Ethernet bridge/extender
2. Fully compatible with IEEE 802.3
3. Auto-negotiation or user defined fixed operation at 10 Mbps and 100 Mbps in either full or half duplex mode
4. Switch-selectable filtering with 15,000 frames per second filtering and forwarding rate
5. 256 frame buffer
6. 10,000 MAC address table
7. Automatic learning and aging of MAC addresses
8. Switch-selectable enhanced compression
9. VLAN capabilities
10. Asymmetric bandwidth
11. Prioritization based on VLAN and QoS

INSTALLATION AND OPERATION

The installation of the MA-428 is comprised of three parts: verification of switch settings, connecting the MA-428 LAN Bridge to your LAN, and verification of LAN-to-LAN operation.

Verification of Switch Settings

Verify that the MA-428 LAN Bridge’s switches are set to the defaults described in Table 23 on page 34. Refer to Figure 14 to locate the switches on the board. Following is an overview of the module adapter’s controls and indicators:

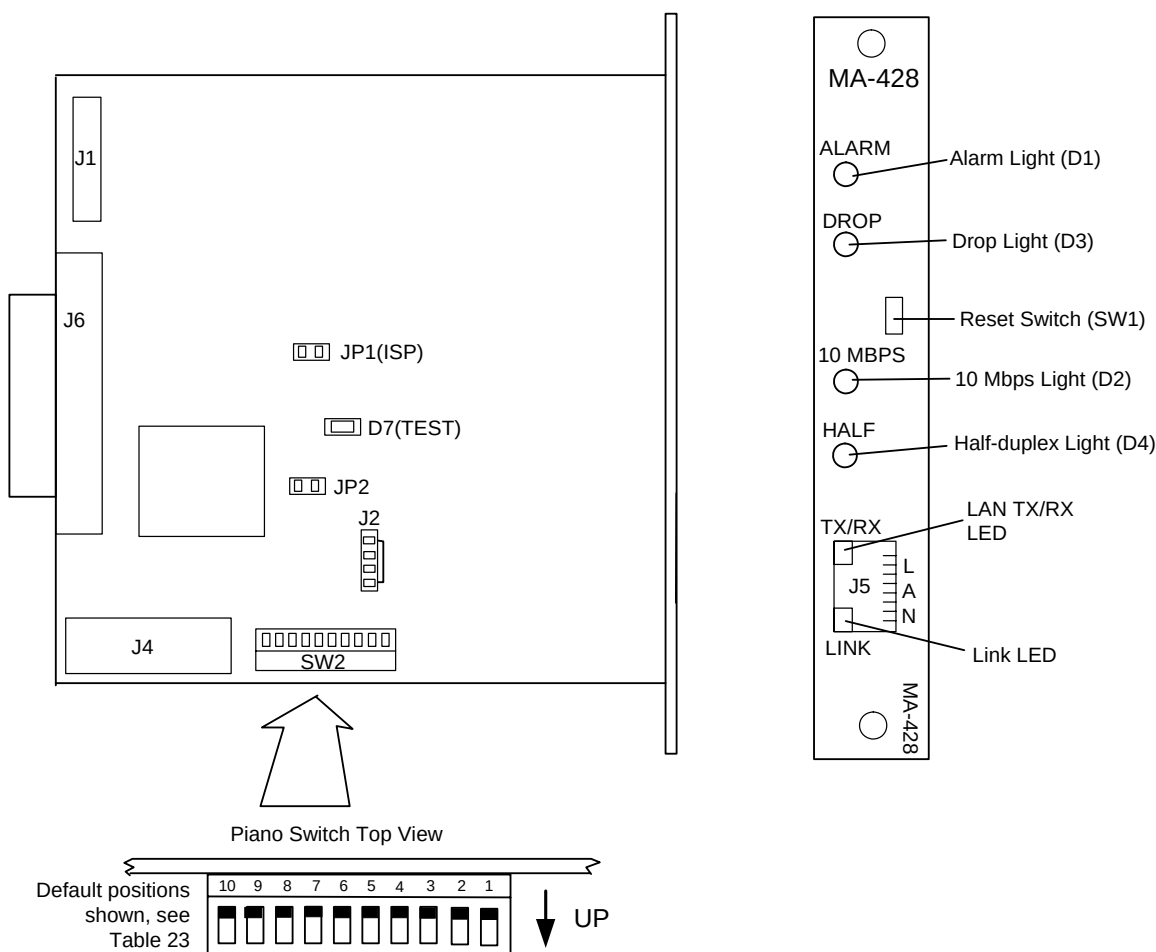


Figure 14. MA-428 Enhanced LAN Bridge Module Adapter

Table 21. MA-428 Controls and indicators

Switch/Jumper	Function	Description
SW1	Reset switch	Allows for a manual reset in running condition
SW2	DIP switch bank	Provides for various user-selectable inputs (See table 23)
J5	RJ-45 female	For LAN side connection
J6	Back plane connector	For backplane connection
J1 and J2	Jumpers	Always leave open
D1	Alarm Indicator	Front panel LED Indicator
D2	10/100 Mbps Indicator	Front panel LED Indicator
D3	Drop indicator	Front panel LED Indicator
D4	Half/full duplex mode	Front panel LED Indicator

Table 22. MA-428 Indicator Light Description

Light Indication	Color	On/Off	State	Function
LINK	Green	Blinks	No valid link	There may be a link between the module adapter and the device, but it is not valid.
		On	Valid link	There is a valid link between the module adapter and the device.
		Off	No link	There is no link between the module adapter and the device.
TX/RX	Yellow	Blinks	Frame passing	Ethernet frames are passing.
HALF	Green	On	Half-duplex	The module adapter is in half duplex mode.
		Off	Full-duplex	The module adapter is in full duplex mode.
10MBPS	Green	On	10Mbps	The module adapter is operating at 10Mbps speed.
		Off	100Mbps	The module adapter is operating at 100Mbps speed.
DROP	Yellow	Blinks	Data lost	Data is being lost.
		Off	No data lost	No data is being lost.
ALARM ¹	Red	Blinks	Alarm 1	There is an alarm condition
		On	Alarm 2	
		Off	Module OK	There is no alarm condition.
TEST ²	Red	Blinks	Module OK	The module adapter is functioning properly
		On	Module not OK	The module adapter is experiencing a problem
		Off		
POWER ²	Red	On	Module on	The module adapter is powered up.
		Off	Module off	There is no power to the module adapter.

1. The MA-428 module adapter's ALARM indicator represents various alarm conditions, see Table 28.
2. These indicator lights are located on top of the board.

Table 23. MA-428 Enhanced LAN Bridge SW2 Settings

Switch 2 Position	Name	Default Settings	Switch Options
1	FILTER	Down	Down = Filter (bridge) off Up = Filter (bridge) on
2	APST ¹	Down	Down = Compression off Up = Compression on
3	AUTO	Down ²	Down = Auto-negotiation mode on Up = Forced mode on
4	10/100	Down ²	Down = 100 Mbps speed Up = 10 Mbps speed (See table 22)
5	HALF/FULL	Down ²	Down = Full-duplex mode Up = Half-duplex mode
6	DBS	Down	Down = Pass broadcast frames Up = Filter broadcast frames
7-10	-	Down	Switches 7 through 10 are reserved for future use.

1. APST – Automatic Pad Stripping.

2. Applicable only in forced mode (See Table 24).

Filtering

Over time the MA-428 Enhanced LAN Bridge will automatically learn and store a table with up to 10,000 MAC addresses of devices on the WAN. When the filter is on, the MA-428 Enhanced LAN Bridge will use the MAC address table to only allow frames destined for another LAN over the WAN. When the filter is off, all frames are sent over the WAN. RFL recommends that this setting be left in the default (DOWN) position for optimum operation of the DS-562NC.

Compression

Compression increases data throughput. Valid Ethernet frames have a minimum length of 64 bytes. Shorter frames are padded. With compression enabled (by asserting the APST signal), these padding bytes are stripped off before transmission over the WAN, and re-padded while being received at the other end. RFL recommends that this setting be left in the default (DOWN) position for optimum operation of the DS-562NC.

Auto-negotiation and Forced mode

Auto-negotiation can be selected for the port so that the fastest bandwidth is always selected. The following table gives all the combinations of auto-negotiation and forced mode.

Table 24. MA-428 Combinations of Auto-Negotiation and Forced Modes

Auto SW2/3	10/100 SW2/4	Half/Full SW2/5	Function
Down	N/A	N/A	Auto-negotiation 100 FD
Up	Down	Down	100 Mbps speed and full-duplex mode
Up	Down	Up	100 Mbps speed and half-duplex mode
Up	Up	Down	10 Mbps speed and full duplex mode
Up	Up	Up	10 Mbps speed and half duplex mode

Connecting the MA-428 Enhanced LAN Bridge to Your LAN

Table 25 provides information for straight-through and crossover cable pin connections. Figure 15 shows the locations of pins 1 and 8 on the RJ-45 connector and on the MA-428. Table 26 shows the cables supported by the MA-428.

Table 25. Straight-Through and Crossover RJ-45 UTP Cable Pin Connections

Straight-Through RJ-45 UTP Cable Pin Connections				Crossover RJ-45 UTP Cable Pin Connections			
MA-428		HUB or Ethernet switch		MA-428		PC or NIC	
Pin	Function	Pin	Function	Pin	Function	Pin	Function
1	TX+	1	TX+	1	TX+	1	RX+
2	TX-	2	TX-	2	TX-	2	RX-
3	RX+	3	RX+	3	RX+	3	TX+
4	Not Used	4	Not Used	4	Not Used	4	Not Used
5	Not Used	5	Not Used	5	Not Used	5	Not Used
6	RX-	6	RX-	6	RX-	6	TX-
7	Not Used	7	Not Used	7	Not Used	7	Not Used
8	Not Used	8	Not Used	8	Not Used	8	Not Used

Table 26. Cables supported by the MA-428 Module Adapter

Mode	MA-428 to PC	
	Cross	Straight
Auto-negotiation	Yes	Yes
Forced mode	Yes	No



Figure 15. Pins 1 and 8 on RJ-45 connector and on MA-428 LAN Bridge

Verifying LAN-to-LAN Operation

Once you have completed the installation, verify that the MA-428 LAN Bridge is operating properly by checking LAN-to-LAN operation with your network administrator. You can also verify the operation of the MA-428 by checking its LEDs. Table 27 describes their state under normal operating conditions when connected to a functioning LAN.

Table 27. MA-428 LAN bridge functioning LEDs

Light Indication	Condition	Function
LINK	Solid Green	The link is functioning correctly.
TX/RX	Blinks Yellow	Ethernet frames are passing correctly.
DROP	Light Off	No data is being lost.
ALARM	Light Off	There are no alarm conditions.

Table 28. MA-428 Alarm conditions

Alarm	State	Possible Cause
1	Blinking Red Note: When first powering up this light may blink 2-3 times, this is normal	• DS562NC module not connected • Clock not received from the DS562NC • Improper code in Complex Programmable Logic Device (CPLD)
2	Solid Red	• Hardware assembly problem • CPLD is not programmed • Mapper and physical ID are somehow at “0”

Troubleshooting

Use the table below to troubleshoot any problems you encounter during installation or operation of the MA-428 LAN Bridge.

Table 29. Troubleshooting Problems and Solutions for the MA-428 LAN Bridge

Problem	Possible Solution
Auto-negotiation mode is not working	Check that both the module adapter and device are set to auto-negotiation mode.
	Check that the module adapter and the device are connected with a straight or cross cable.
Forced mode is not working	Check that the module adapter and the device are connected with a cross cable. Forced mode does not work with a straight cable connection.
	Check that the module adapter and the device are set to Forced mode.
	Disable and enable the LAN port on the device.
	Restart the device.
	Try connecting to another device.
	Re-configure the computer and the module adapter and then re-start the module adapter.
Link light is blinking continuously	Check that the cable is connected correctly.
	Check that the module adapter and the device are in the correct modes, <i>see the following table</i> .
	Restart the device and the module adapter.
	Try connecting the module adapter to a different device.
Data loss due to unmatched mode	Check that both the module adapter and the computer are in the same mode (auto-negotiation or forced.) Valid link is the preferred mode combination. <i>See the following table</i> .
Some Ethernet frames do not pass	Check that the APST switch is off. When it is on, Ethernet frames with length field zero do not pass.
Some application layer protocols do not work	Check that the DBS (disable broadcast frame) switch is off. When it is on, application layer protocols such as remote desktop connection and IP messenger do not work.
The TEST light does not blink	Either the Multi-point control unit (MCU) on the is not programmed or the board is faulty. (The rapidity of blinking varies with the mode of operation.)

Note: Pad bytes are stripped if the length field in the frame is less than the minimum frame size.

The following table gives all the possible auto-negotiation/forced mode combinations. Valid link is the preferred mode combination. Modes such as unstable link, no link and false link are not preferred, even though there appears to be a link.

Table 30. Auto-Negotiation/Forced Mode Combinations

		Device Modes				
		Auto-neg	Forced 100 FD	Forced 100 HD	Forced 10 FD	Forced 10 HD
MA-428 Modes	Auto-neg	Valid Link	Unstable Link	Valid Link	Unstable Link	Valid Link
	Forced 100 FD	Unstable Link	Valid Link	False Link	No Link	No Link
	Forced 100 HD	Valid Link	False Link	Valid Link	No Link	No Link
	Forced 100 HD	Unstable Link	No Link	No Link	Valid Link	False Link
	Forced 100 HD	Valid Link	No Link	No Link	False Link	Valid Link

The Link light varies to indicate the current link state.

- **Valid Link** – The light is green and steadily on. The MA-428 module adapter is ready to operate. There should be no data loss.
- **No Link** – The link light is not on and there should not be any data transfer.
- **Unstable Link** – A few of the Ethernet network interface cards (NICs) in the computer may not be able to identify the duplex mode at the other end, because of this limitation, auto-negotiation does not always work and the module adapter defaults to half-duplex.
- **False Link** – Even though the link is established, data loss occurs.

INTERFACING THE IMUX 2000 WITH AN RFL 9745 USING C37.94 FIBER OPTIC MODULES

An IMUX 2000 can be connected to an RFL 9745 equipped with a Short Haul Fiber module (107310) as shown in Figure 14. There are no jumpers or settings on the 107310 or the MA620, however SW6-5 and SW6-7 on the DS562NC must be set to the OFF position.

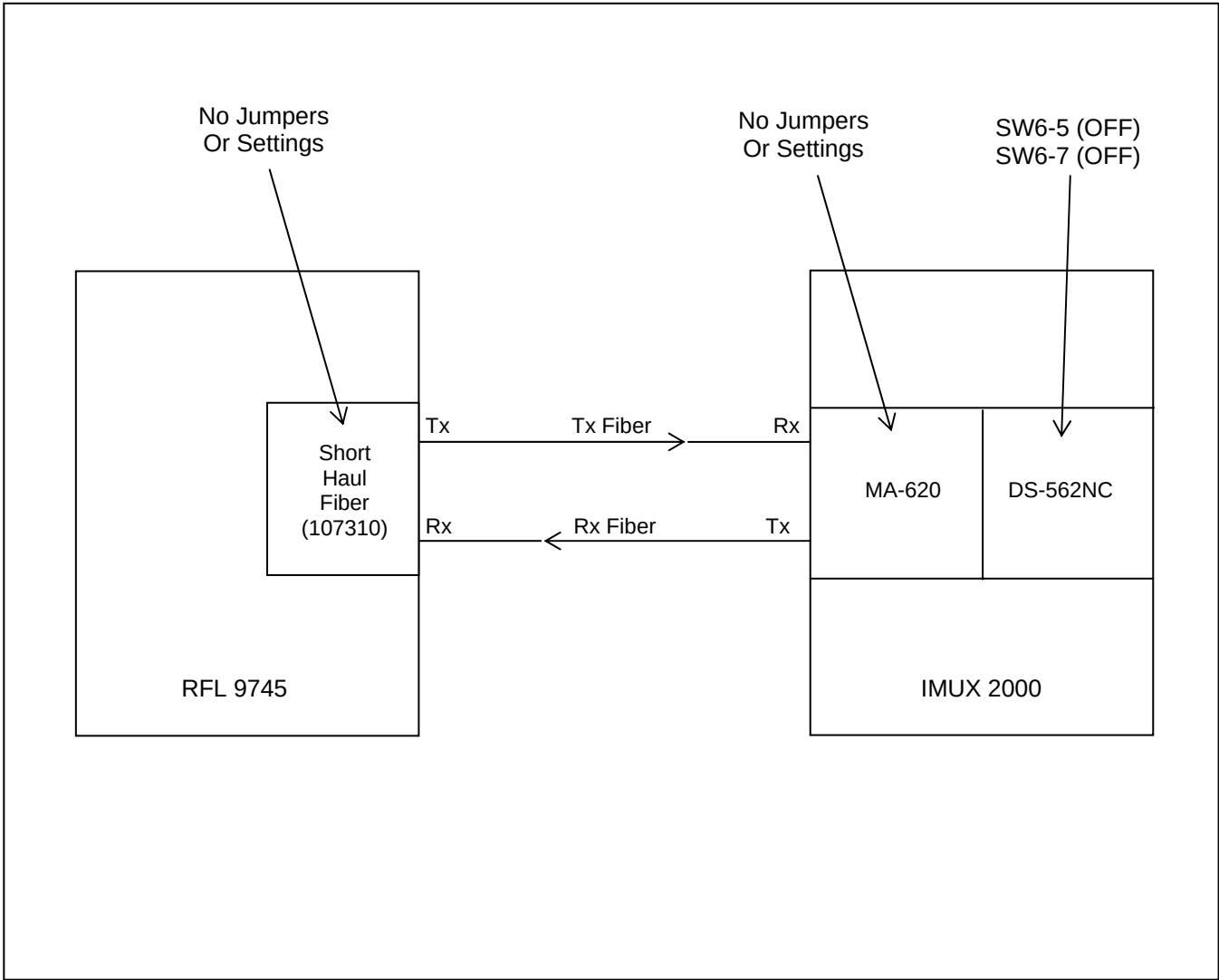


Figure 16. Interfacing the IMUX 2000 with an RFL 9745 using C37.94 Fiber Optic Modules

IMUX 2000 DS-562NC RS-449 INTERFACING WITH OTHER RFL PRODUCTS

This section describes timing configuration settings when interfacing the IMUX 2000 DS-562NC with other RFL products using RS-449 communications. The IMUX 2000 DS-562NC can be interfaced with the RFL 9300, RFL 9700, RFL 9700A, RFL 9720 and RFL 9745. It is highly recommended that clock and data transitions are confirmed with a scope to insure proper system operation.

IMUX 2000 DS-562NC AND RFL 9300 (RS-449, RS-530)

Interfacing an IMUX 2000 DS-562NC with an RFL 9300 can be accomplished as follows:

A. The programmable jumpers on the 9300 Direct Digital I/O module shall be positioned as follows:

J2 (Send Timing): "A" Position

J3 (Receive Timing): "A" Position

B. The configuration of the IMUX 2000 RS-449 Channel Card shall be as follows:

1. DS-562NC with MA-406IA I/O

MA-406IA I/O: J2 jumpers in DCE mode

J3 in any position

DS-562NC, Switch SW6-5 (Receive Clock Polarity): Normal - OFF (DOWN)

DS-562NC, Switch SW6-7 (Transmit Clock Polarity): Normal - OFF (DOWN)

2. DS-562NC with MA-600 short haul fiber I/O

MA-600 I/O: No jumpers to set

DS-562NC, Switch SW6-5 (Receive Clock Polarity): Normal - OFF (DOWN)

DS-562NC, Switch SW6-7 (Transmit Clock Polarity): Normal - OFF (DOWN)

C. Confirm Clock and Data Transitions to Insure Proper System Operation as follows:

1. RFL 9300 CCM: The positive edge of the RxClock (TP5) must be in the center of the RxData bit (TP4).

2. IMUX 2000: DS-562NC - The positive edge of the TxClock (TP16) must be in the center of the TxData bit (TP15).

IMUX 2000 DS-562NC AND RFL 9700 “ORIGINAL” (RS-449, RS-530)

Interfacing an IMUX 2000 DS-562NC with an RFL 9700 can be accomplished as follows:

A. Configuration of RFL 9700:

97 DIG RX: ECB# 101563: No Clock Polarity Jumper

ECB# 101563-1: J2 - “B” Position

97 DIG TX: No Clock Polarity Jumper

B. The configuration of the IMUX 2000 DS-562NC Channel Card shall be as follows:

1. DS-562NC with MA-406IA I/O

MA-406IA I/O: J2 jumpers in DCE mode
J3 in any position

DS-562NC, Switch SW6-5 (Receive Clock Polarity):
For ECB #101563: Inverted - ON (UP)
For ECB #101563-1: Normal - OFF (DOWN)

DS-562NC, Switch SW6-7 (Transmit Clock Polarity): Normal – OFF-(DOWN)

NOTE: If the RFL 9700 uses 97 DIG RX having ECB# 101563 (No J2), the signal lines at Tx Timing “Plus” (Pin 8 of DB-37 Connector) and Rx Timing “Minus” (Pin 26 of DB-37 Connector) must be switched by modifying cable in order to obtain proper RxClock Polarity. Confirm clock and data transitions before modifying the cable.

C. Confirm Clock and Data Transitions to Insure Proper System Operation as follows:

1. RFL 97 DIG RX: The positive edge of the RxClock (TP2) must be in the center of the RxData bit (TP1).
2. IMUX 2000: DS-562NC - The positive edge of the TxClock (TP16) must be in the center of the TxData bit (TP15).

IMUX 2000 DS-562NC AND RFL 9700A (RS-449, RS-530)

Interfacing an IMUX 2000 DS-562NC with an RFL 9700A can be accomplished as follows:

A. Configuration of RFL 9700A:

97A DIG RX: J2: "B" Position

97A DIG TX: J2: "B" Position

B. The configuration of the IMUX 2000 RS-449 Channel Card shall be as follows:

1. DS-562NC with MA-406IA I/O

MA-406IA I/O: J2 jumpers in DCE mode

J3 in any position

DS-562NC, Switch SW6-5 (Receive Clock Polarity): Normal - OFF (DOWN)

DS-562NC, Switch SW6-7 (Transmit Clock Polarity): Normal - OFF (DOWN)

C. Confirm Clock and Data Transitions to Insure Proper System Operation as follows:

1. RFL 97A DIG RX: The positive edge of the RxClock (TP2) must be in the center of the RxData bit (TP1).

2. IMUX 2000: DS-562NC - The positive edge of the TxClock (TP16) must be in the center of the TxData bit (TP15).

IMUX 2000 DS-562NC AND RFL 9720 (RS-449, RS-530)

Interfacing an IMUX 2000 DS-562NC with an RFL 9720 can be accomplished as follows:

- A. The programmable jumpers on the piggyback board of the RFL 9720 module shall be positioned as follows:

J6 (Send Timing): "B" Position

J7 (Receive Timing): "B" Position

- B. The configuration of the IMUX 2000 RS-449 Channel Card shall be as follows:

1. DS-562NC with MA-406IA I/O

MA-406IA I/O: J2 jumpers in DCE mode

J3 in any position

DS-562NC, Switch SW6-5 (Receive Clock Polarity): Normal - OFF (DOWN)

DS-562NC, Switch SW6-7 (Transmit Clock Polarity): Normal - OFF (DOWN)

- C. Confirm Clock and Data Transitions to Insure Proper System Operation as follows:

1. RFL 9720 CCM: The positive edge of the RxClock (TP17) must be in the center of the RxData bit (TP16).

2. IMUX 2000: DS-562NC - The positive edge of the TxClock (TP16) must be in the center of the TxData bit (TP15).

IMUX 2000 DS-562NC AND RFL 9745 (RS-449, RS-530)

Interfacing an IMUX 2000 DS-562NC with an RFL 9745 can be accomplished as follows:

A. The programmable jumpers on the 9745 RS-449 I/O shall be positioned as follows:

J1 (Send Timing): “Invert” Position

J2 (Receive Timing): “Invert” Position

B. The configuration of the IMUX 2000 RS-449 Channel Card shall be as follows:

1. DS-562NC with MA-406IA I/O

MA-406IA I/O: J2 jumpers in DCE mode

J3 in any position

DS-562NC, Switch SW6-5 (Receive Clock Polarity): Normal - OFF (DOWN)

DS-562NC, Switch SW6-7 (Transmit Clock Polarity): Normal - OFF (DOWN)

2. DS-562NC with MA-600 short haul fiber I/O

MA-600 I/O: No jumpers to set

DS-562NC, Switch SW6-5 (Receive Clock Polarity): Normal - OFF (DOWN)

DS-562NC, Switch SW6-7 (Transmit Clock Polarity): Normal - OFF (DOWN)

C. Confirm Clock and Data Transitions to Insure Proper System Operation as follows:

1. RFL 9745 RS-449 I/O: The positive edge of the RxClock (TP4 or RT) must be in the center of the RxData bit (TP2 or RD).

2. IMUX 2000: DS-562NC - The positive edge of the TxClock (TP16) must be in the center of the TxData bit (TP15).

USING THE DS-562NC AND DS-562I END-TO-END

The DS-562NC is fully compatible with the DS-562I at either 64 Kbps or 56 Kbps. The addressing feature is also compatible.

RS-449, RS-530 HARDWARE LOOPBACK “PLUGS”

ONLY the data lines are “looped”. The Timing lines must not be looped back because the DS-562NC provides both transmit and receive clocks in the DCE mode.

“Looped Signals”: **RS-449**
Send Data + (Pin 4) > Receive Data + (Pin 6)
Send Data - (Pin 22) > Receive Data - (Pin 24)

RS-530
Send Data + (Pin 2) > Receive Data + (Pin 3)
Send Data - (Pin 14) > Receive Data - (Pin 16)

In addition, there is no guarantee that the TxData will be valid on the positive edge of the TxClock. Data errors may occur if data is sampled near the edge instead of the center of the data bit. It is therefore recommended that a “split” cable be used for testing purposes such that one end “sends data” and the other end “receives data”. Confirm both directions by switching the cable ends.

FUNCTIONAL DESCRIPTION

The following is a basic description of the RFL DS-562NC features. A simplified block diagram of the module is shown in Figure 15.

MODULE DESCRIPTION OVERVIEW

The RFL DS-562NC Synchronous Data Module provides RFL IMUX 2000 T1/E1 Multiplexers with synchronous full-duplex data communications at either 56 Kbps or any multiple of 64 Kbps, with a maximum limit that is dependent upon the multiplexer type or interface I/O type. The DS-562NC can operate up to 1.536 Mbps in T1 Multiplexers, and up to 1.984 Mbps in E1 Multiplexers; unless CAS Mode is used, in which case the maximum rate is 1.920 Mbps. The RFL DS-562NC operates in terminal or drop and insert systems over T1/E1 carrier lines and uses RS-449/530/422, CCITT V.35, G.703, X.21/V.11, C37.94 short haul optical fiber, RFL short haul fiber, and Ethernet LAN interfaces. The RFL DS-562NC can communicate with older RFL DS-562I modules at 56kbps and 64kbps data rates and occupies only one shelf location. The module can be set up and interrogated remotely via the SCB of the IMUX 2000. DIP switches enable the user to set up the module locally. Seven front panel LEDs indicate to the user the status of the module.

This module communicates using one or more bi-directional time slots. When communicating at 56 Kbps the communication protocol includes provisions for programmable addressing to prevent DS0 misconnections. One of 63 addresses is selectable locally using DIP switches or remotely using software. LEDs indicate when the addressing feature is enabled, and when the DS-562NC has established valid communications with the appropriate DS-562NC. As an option the received data may be squelched during loss of valid address. This option can be selected locally using DIP switches or remotely using software.

NOTE

Channel addressing cannot be used on G.703 and RFL Short Haul Fiber (MA-600) interfaces since these modules only operates at 64 Kbps.

The RFL DS-562NC allows the selection of local loopback or remote loopback functions. Local equipment loopback (EQLB) takes the data coming in on the 56/N x 64 Kbps I/O port and sends it back out on the same I/O port. Local payload loopback (PLLB) also referred to as “remote loopback”, echoes the T1/E1 data back to the source. The loopbacks may be enabled remotely via software or locally by either a front accessible toggle switch, or when using the RS-449 or RS-530 interface, via pins on the rear panel connector. The local loopback commands will override any remote (software) loopback commands. The board contains two LEDs to indicate when either type is enabled.

The RFL DS-562NC may be operated as a DCE or DTE. In DCE mode, the DS-562NC provides the interface timing to the external customer equipment; all of the interface modules support this mode. In DTE mode, the external customer equipment provides the interface timing to the DS-562NC; this externally supplied interface timing must be synchronous with the T1/E1 carrier. The card supports data, clock, RTS, and CTS signals at the user connector. The CTS is normally a copy of the RTS signal, but as an option can be delayed by approximately 8 microseconds. Note that only the RS-449, RS-530 and V.35 interfaces currently support the RTS/CTS handshake function.

THEORY OF OPERATION

The following is the basic circuit description of the RFL DS-562NC. A simplified block diagram of the module is shown in Figure 15.

INTRODUCTION

The DS-562NC module provides the following six major functions: T1/E1 transmit interface, T1/E1 receive interface, loopback, SCB interfacing, PLL interfacing, and I/O Adapter interfacing. The Actel ProASIC APA-150 and its associated circuitry handle all T1/E1 communication engines, Interface communication engines, and SCB of the IMUX 2000.

The Xilinx XC9572XL provides buffering between the Actel and the IMUX motherboard signals.

The EXAR XRT8001 IC devices are PLL with frequency synthesizers to provide interface clocks synchronous to the T1/E1 bus clocks. Other miscellaneous circuits are present to handle the remaining functions. A bank of dip switches is provided to select the module parameters, a toggle switch is provided to select the loopback function, and LEDs provide the user with module status.

SIGNAL BUFFERING CPLD

The Signal Buffering CPLD consists of a Xilinx XC9572XL which is used to buffer the signals that pass between the Actel and the IMUX motherboard. These signals include the T1/E1 bus signals and the pass-thru signals to/from the I/O. It is important to note that the Xilinx is +3V/+5V signal compatible, and therefore provides the necessary level-translation between the motherboard signals and the Actel which only supports 3.3V signals.

PLL INTEGRATED CIRCUITS

Each PLL IC consists of an EXAR XRT8001 PLL. Each PLL has frequency synthesizers to provide the necessary 56 Kbps or Nx64 Kbps interface clock that is synchronous to the respective T1/E1 bus clocks. Each PLL is responsible for one of the two T1/E1 buses, A or B; The FIN input of each PLL is provided with an 8KHZ signal that is synchronous to each of the T1/E1 buses. The Actel FPGA programs each PLL for the required clock output frequency.

I/O ADAPTER MODULES

The signals to and from the user equipment pass through the I/O module. The I/O module performs the required level shifting between the DS-562NC and the user equipment, thus allowing the same channel card to be used with any one of several types of communication interface I/O adapter modules. The supported interface types include RS-449, RS-530, X.21, V.35, G.703 (Co-Dir & Contra-Dir), RFL Short Haul Fiber, C37.94 (Short-haul Fiber), and Ethernet (LAN).

COMMS FPGA

The Comms FPGA consists of an Actel ProASIC APA-150 which is the heart of the DS-562NC module. It has several main functions which include T1/E1 receive and transmit control, SCB interfacing, PLL interfacing, I/O Interfacing, LED control, reading switch settings, equipment and payload loopback, addressing and CRC, and I/O type decoding. The Actel also is responsible for programming two external phase locked loops devices.

T1/E1 TRANSMIT CIRCUIT

The 56 or Nx64 Kbps serial data from the user equipment is routed to the transmit circuit which synchronizes the signals and then feeds them to the T1/E1 data bus. The transmit timeslot utilization is established by using the starting timeslot, data-rate, and multiplexer type (T1 or E1) information. As multiple timeslots can be used, a FIFO is used to insure that there is enough data to send onto the T1/E1 bus following circuit initialization; otherwise data-run out would occur.

The FIFO also synchronizes the data transfer between the interface clock and T1/E1 clock.

If addressing is being used in the 56 Kbps mode, the transmit address is inserted into the data stream along with security coding information.

T1/E1 RECEIVE CIRCUIT

The incoming serial data stream is received from the T1/E1 bus by the receive interface and routed to the user equipment. The receive timeslot utilization is established by using the starting timeslot, data-rate, and multiplexer type (T1 or E1) information. A FIFO is used to synchronize the data transfer between the T1/E1 clock and interface clock.

If addressing is being used in the 56 Kbps mode, coded address and security information is extracted and verified, and then compared to the selected received address. The receive data can be optionally squelched if the 56 Kbps mode when addressing is used but an invalid address is detected.

I/O ADAPTER INTERFACE CIRCUITS

The I/O Adapter Interface circuit is responsible for decoding the Interface I/O Type installed in the rear slot that corresponds with the DS-562NC module located in the front slot of the chassis. The state of three ID signals that pass thru the motherboard and the expanded I/O type settings programmed via dip switches or remote SCB settings are all monitored. The appropriate interface engines are then used based upon the I/O Type installed. The required data and clocks are also routed as required. The DS-562NC provides clocks to the customer equipment when a DCE-type I/O Adapter is installed, and receives clocks when a DTE-type I/O Adapter is installed.

When the RS-449 and the RS-530 I/O adapters are set for DCE, they provide 56 Kbps or Nx64 Kbps TX/RX clocks that independent of each other, and are relative to the T1 transmit and T1 receive buses respectively.

The V.35 (DCE) provides 56 Kbps or Nx64 Kbps TX/RX clocks that are in phase with one another and are based solely upon the T1/E1 receive bus. The X.21 (DCE) provides a single clock based solely upon the T1/E1 receive bus. The incoming data for the V.35 and X.21 (DCE) interfaces must be synchronized to the T1/E1 transmit bus because ONLY the RX clock is used by the interface.

The DTE-type I/O adapters, regardless of RS-449, RS-530, X.21, or V.35, assume that the clocks are not in phase, but does however require that the clocks provided by the customer DCE equipment be synchronous to the multiplexer T1/E1 clocks.

The G.703 Co-Directional I/O adapter is a 64 Kbps DCE interface that generates data with embedded timing information to the customer equipment based upon the T1 receive clock. The receiver recovers the clock and data, and then synchronizes the data with the T1 transmitter circuits. Octet timing generation and detection circuits are used if the Octet timing feature is enabled.

The G.703 Contra-Directional I/O adapter is a 64 Kbps DCE interface that provides TX/RX clocks that independent of each other, and are relative to the T1 transmit and T1 receive buses respectively. Octet timing generation circuits are used if the Octet timing feature is enabled.

The C37.94 Short-haul Fiber I/O adapter's interface operates in the same fashion as the RS-449 and the RS-530 DCE I/O adapter, the data-rate is provided by signals that originate from the Actel, and ultimately pass thru the motherboard to the I/O adapter.

The RFL Short-haul Fiber I/O adapter's interface operates in the same fashion as the RS-449 and the RS-530 DCE I/O adapter, and operates only at 64 Kbps.

The Ethernet (LAN) adapter's interface operates in the same fashion as the RS-449 and the RS-530 DCE I/O adapter. The I/O adapter auto-detects the data-rate, and provides any data buffering required.

SCB INTERFACE CIRCUIT

The SCB Interface circuit communicates with the CM4 module via the SCB (Serial Control Bus). A DIP switch is provided to allow the user to set the SCB address of the module which is read by the SCB FPGA. Each module installed in the chassis will have a unique SCB address. The DS-562NC module has a type ID of 116 encoded into the SCB FPGA device. The CM-4 module periodically interrogates the DS-562NC to read its status information. The configuration is also read by the CM-4 if the DS-562NC is set for "local" mode of operation, but is written by the CM-4 if set for "remote" mode of operation. A DIP switch is set by the user to set the DS-562NC for either "local" or "remote" operation.

PLL INTERFACE CIRCUIT

The PLL Interface circuit provides the settings for the EXAR XRT8001 PLL devices. The communication between the Actel and PLL is performed serially. The settings are written to the PLL devices, and then they are read back to verify the settings were correctly written. The state machine continually monitors any requested change to the PLL parameters. The Actel also provides the FIN input of each PLL with an 8KHZ signal that is synchronous to each of the T1/E1 buses. The Actel then receives a synthesized clock from each PLL, and routes them to the T1/E1 circuits and interface I/O circuits, as required.

LOOPBACK CIRCUIT

The T1/E1 transmit and receive interface circuits are interconnected by loopback logic inside the Actel APA-150. The equipment loopback causes the data received from the user equipment to be read into a buffer and then retransmitted back to the user equipment. The payload loopback places the T1/E1 received data into a buffer and then retransmits it via the T1/E1 transmit circuit. Synchronizing circuits in the loopback logic compensates for varying phase relationships between the T1/E1 transmit and receive bus signals. A three position toggle switch on the module front panel enables the user to select equipment loopback, payload loopback or no loopback.

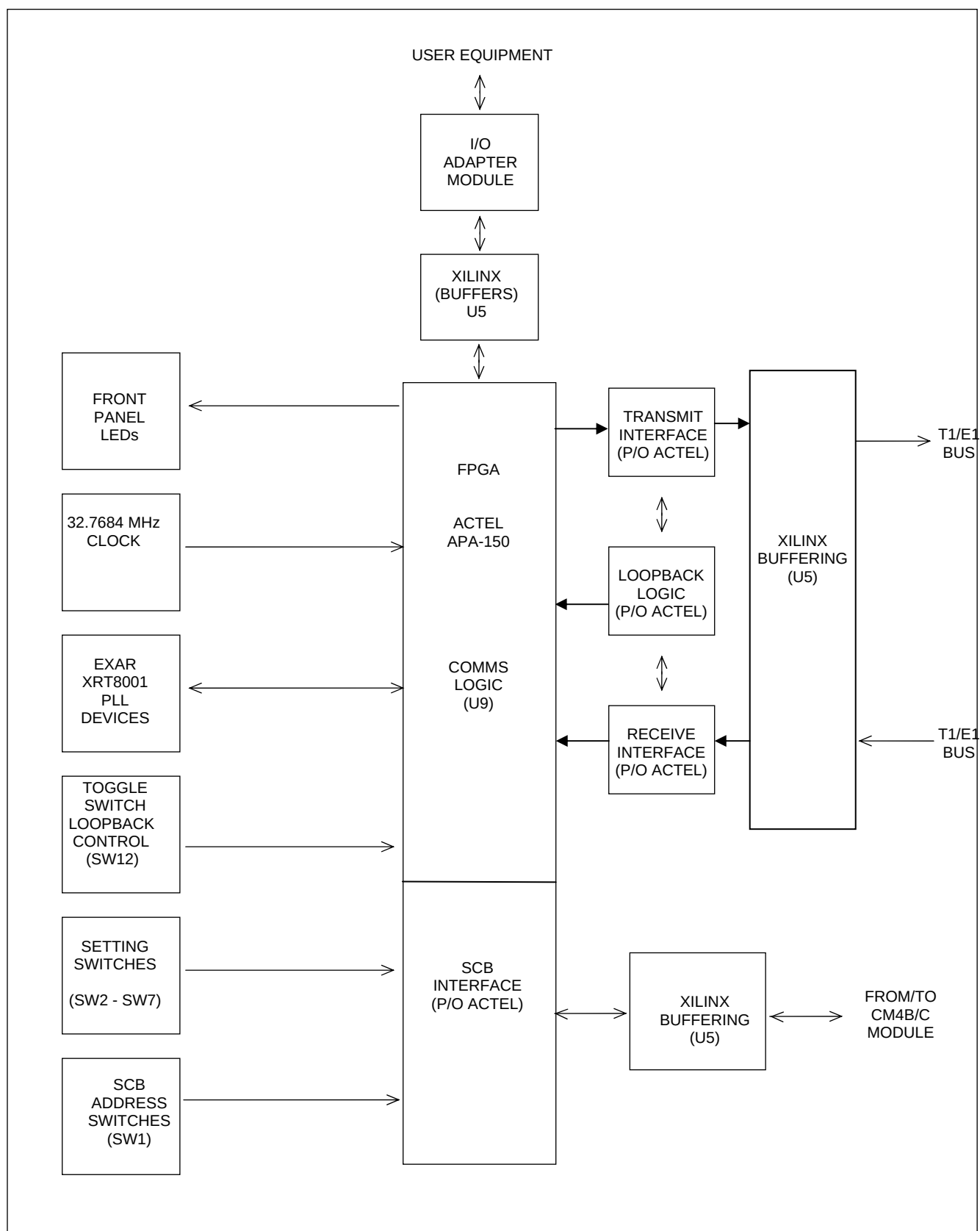


Figure 157 RFL DS-562NC Block diagram.

NOTE

If this unit is used for protective relaying applications, disable the protection equipment at both ends before using equipment loopback or payload loopback modes.

ALERTS AND ALARMS

If payload loopback and equipment loopback are enabled, the DS-562NC will issue a module level alert signal to the shelf common module.

If addressing is enabled and there is a loss of addressing, the DS-562NC will issue a module level alert signal to the shelf common module.

REMOTE CONTROL INTERFACE

When the RFL DS-562NC is installed in an IMUX 2000 multiplexer, it can be operated under local or remote control. When under remote control, most of the module setup parameters can only be changed through the RS-232 remote port on the shelf Common Module. See the IMUX 2000 manual for information on using the remote control interface.

The remote control interface for the RFL DS-562NC involves two sets of codes: “P” (parameter) codes, and “S” (status) codes. The RFL DS-562I reports itself as a “Type 116” module.

“P” CODES

“P” codes, when used in the parameter field on an SCL “SET” command, allow the user to set certain parameters on the RFL DS-562NC by remote control, just like setting DIP switches on a module under local control. “P” codes also appear in the response to a “CONFIG?” query, providing a list of the RFL DS-562NC current parameter settings. A typical RFL DS-562NC response to a “CONFIG?” query looks like this:

```
*OK
CHANNEL CARD 3, TYPE 116
UNDER REMOTE CONTROL
SRVC = ON
P01 = 129 (B1000001)
P02 = 8 (B00001000)
P03 = 0 (B00000000)
P04 = 0 (B00000000)
P05 = 0 (B00000000)
P06 = 0 (B00000000)
P07 = 0 (B00000000)
P08 = 0 (B00000000)
P09 = 0 (B00000000)
P10 = 0 (B00000000);
```

There are ten “P” codes for the RFL DS-562NC; “P1” through “P10”. Each “P” code is displayed as a decimal number from 0 to 255, followed by its eight-digit binary equivalent in parenthesis. Table 20 lists the meaning of all “P” codes for the RFL DS-562NC module.

Table 31. Remote Configuration Settings (“P” codes)

P Code	Bits Used	Value	Description
SRVC	B 0 0 0 0 0 0 0 0 ↑	0	Turns service off (module disabled)
		1	Turns service on (module enabled)
P01	B 0 0 0 0 0 0 0 0 ↑	0	Transmit on bus B
		1	Transmit on bus A
	B 0 0 0 0 0 0 0 0 ↑	0	CAS (channel associated signaling) disabled for E1
		1	CAS enabled for E1
	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑	T1: 1 to 24 E1: 1 to 31	Timeslot selection (binary)*
P02	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑	T1: 1 to 24 E1: 1 to 31	Number of timeslots used (N-baud)**
	B 0 0 0 0 0 0 0 0 ↑	0	Selects 64Kbps mode (N = 1 to 24/31)
		1	Selects 56Kbps mode (N=1 only)
	B 0 0 0 0 0 0 0 0 ↑	0	No remotely commanded payload loopback (may be overridden at board by SW12)
		1	Remotely commanded payload loopback
P03	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑↑↑	0 to 63	Sets the transmit address (56Kbps only, 0=disabled) . See table 11.
P04	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑↑↑	0 to 63	Sets the receive address (56Kbps only, 0=disabled) . See table 11.
	B 0 0 0 0 0 0 0 0 ↑	0	Squelch OFF
		1	Squelch output to user equipment upon loss of valid address (56Kbps only)
P05	B 0 0 0 0 0 0 0 0 ↑	0	Octet timing OFF (G.703 only)
		1	Octet timing ON (G.703 only)
	B 0 0 0 0 0 0 0 0 ↑	0	No handshaking delay
		1	8 microseconds handshaking delay (approx.)
	B 0 0 0 0 0 0 0 0 ↑	0	Normal receive clock polarity
		1	Inverted receive clock polarity
	B 0 0 0 0 0 0 0 0 ↑	0	Normal receive data polarity
		1	Inverted receive data polarity
	B 0 0 0 0 0 0 0 0 ↑	0	Normal transmit clock polarity
		1	Inverted transmit clock polarity

Table 31. Remote Configuration Settings (“P” codes) Continued.....

P Code	Bits Used	Value	Description
P05	B 0 0 0 0 0 0 0 0 ↑	0	Normal transmit data polarity
		1	Inverted transmit data polarity
P06	B 0 0 0 0 0 0 0 0 ↑↑	Bit1 Bit0 0 0	Selects RS-449/X.21/V.35 (standard mode)
	B 0 0 0 0 0 0 0 0 ↑↑	Bit1 Bit0 0 1	Selects MA-620 – Short-Haul Fiber (C.37.94)
	B 0 0 0 0 0 0 0 0 ↑↑	Bit1 Bit0 1 0	Selects MA-427/428 – Ethernet
P07	Currently used for test-point control		TP7
P08	Currently used for test-point control		TP8
P09	Currently used for test-point control		TP9
P010	Currently used for test-point control		TP10

* It is recommended that the TX and RX addresses are both set to a value other than 0 if the addressing function is being used.

** Subject to limits due to the starting timeslot number and CAS (for E1).

“S” CODES

“S” codes appear in response to a “STATUS?” query. There are ten “S” codes for the RFL DS-562NC. Like the “P” codes, each “S” code is a number displayed in both decimal and binary form.

A typical response to a “STATUS?” query looks like this:

```
*OK
CHANNEL CARD 3, TYPE 116
S01 = 0 (B00000000)
S02 = 199 (B11000111)
S03 = 0 (B00000000)
S04 = 65 (B01000001)
S05 = 127 (B01111111)
S06 = 0 (B00000000)
S07 = 0 (B00000000)
S08 = 0 (B00000000)
S09 = 0 (B00000001)
S10 = 0 (B00000001);
```

These codes provide information on the status of several conditions on the RFL DS-562NC module. Table 21 lists the meaning of all “S” codes for the RFL DS-562NC module.

Table 32. Remote status messages (“S” codes)

S Code	Bits Used	Value	Description
S01 (I/O Type ID)	Binary value	0	MA-406IA (RS-449 DCE) installed
		1	MA-406IA, MA-410 (RS-449/X.21 DTE) installed
		2	MA-409IA (V.35 DCE) installed
		3	MA-409IA (V.35 DTE) installed
		4	MA-407I (G.703 contra directional) installed
		5	MA-408I (G.703 co directional) installed
		6	MA-410 (X.21 DCE) installed
		7	MA-600 RFL Short Haul Fiber installed
		8	MA-620 (C37.94 Short Haul Fiber) installed
		9	MA-427/428 (Ethernet Module) installed
		255	Invalid I/O Type or setting

Table 32. Remote status messages (“S” codes) Continued.....

S Code	Bits Used	Value	Description
S02 (Module Status)	B 0 0 0 0 0 0 0 0	0	T1/E1 Transmit Data not Active
	↑	1	T1/E1 Transmit Data Active
	B 0 0 0 0 0 0 0 0	0	T1/E1 Receive Data not Active
	↑	1	T1/E1 Receive Data Active
	B 0 0 0 0 0 0 0 0	0	T1/E1 Transmit Addressing Not Enabled (56K Only)
	↑	1	T1/E1 Transmit Addressing Enabled (56K Only)
	B 0 0 0 0 0 0 0 0	Bit4 0	T1/E1 Receive Addressing Not Enabled (56K Only)
	B 0 0 0 0 0 0 0 0 ↑ ↑	Bit4 Bit3 1 0	T1/E1 Receive Addressing Fail (56K Only)
	B 0 0 0 0 0 0 0 0 ↑ ↑	Bit4 Bit3 1 1	T1/E1 Receive Addressing OK (56K Only)
	B 0 0 0 0 0 0 0 0 ↑	0 1	T1 MUX E1 MUX
	B 0 0 0 0 0 0 0 0 ↑	0 1	Configuration Invalid Configuration Valid
	B 0 0 0 0 0 0 0 0 ↑	0 1	Module Service OFF (Qualified) ¹ Module Service ON (Qualified) ²
S03 (Interface Status)	B 0 0 0 0 0 0 0 0 ↑	0 1	The payload loopback is disabled The payload loopback is enabled
	B 0 0 0 0 0 0 0 0 ↑	0 1	The equipment loopback is disabled The equipment loopback is enabled
	B 0 0 0 0 0 0 0 0 ↑	Bit3 0	Octet Timing disabled or not used
	B 0 0 0 0 0 0 0 0 ↑ ↑	Bit3 Bit2 1 0	Octet Timing not detected (G.703 only)
	B 0 0 0 0 0 0 0 0 ↑ ↑	Bit3 Bit2 1 1	Octet Timing detected (G.703 only)
	B 0 0 0 0 0 0 0 0 ↑ ↑		Not used
	B 0 0 0 0 0 0 0 0 ↑ ↑		

¹ Either the Service is OFF or has configuration errors.

² The service is ON and has no configuration errors.

Table 32. Remote status messages (“S” codes) Continued.....

S Code	Bits Used	Value	Description
S04 (Baud Rate Status)	B 0 0 0 0 0 0 0 0	1 0 0 0 0 1	56Kbps
	↑↑↑↑↑↑↑	0 0 0 0 0 1	64Kbps (N = 1)
		0 x x x x x	Valid N x 64 Baud Rate Settings where N = (1 to 31)
		0 1 1 1 1 1	1984Kbps (N = 31)
	B 0 0 0 0 0 0 0 0	0	Baud Rate Setting Invalid
	↑	1	Baud Rate Setting valid
S05 (PLL/Bus/Clock Status)	B 0 0 0 0 0 0 0 0	0	Transmit clock OK or not available for Head
	↑	1	Transmit clock slip occurred
	B 0 0 0 0 0 0 0 0	0	Receive clock OK or not available for Head
	↑	1	Receive clock slip occurred
	B 0 0 0 0 0 0 0 0	0	Phase Locked Loop for Bus ‘B’ not OK
	↑	1	Phase Locked Loop for Bus ‘B’ OK
	B 0 0 0 0 0 0 0 0	0	Phase Locked Loop for Bus ‘A’ not OK
	↑	1	Phase Locked Loop for Bus ‘A’ OK
	B 0 0 0 0 0 0 0 0	0	Bus ‘A’ and ‘B’ are not locked
	↑	1	Bus ‘A’ and ‘B’ locked
	B 0 0 0 0 0 0 0 0	0	Bus ‘B’ not OK
	↑	1	Bus ‘B’ OK
	B 0 0 0 0 0 0 0 0	0	Bus ‘A’ not OK
	↑	1	Bus ‘A’ OK
S06	B 0 0 0 0 0 0 0 0 -----		Not defined (Reserved for future use)
S07	B 0 0 0 0 0 0 0 0 -----		Not defined (Reserved for future use)
S08	B 0 0 0 0 0 0 0 0 -----		Not defined (Reserved for future use)
S09	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑↑		ECB Revision Number (N = 1 to 31)
S010	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑↑↑↑		Actel Revision Number

LOOPBACK TESTING

A local loopback test is performed when the module is first installed, or any time the integrity of the module needs to be checked. The loopback test can be performed on modules in terminal systems or drop/insert systems. The loopback test is a tool for locating problems, but is no substitute for troubleshooting expertise.

Before starting a loopback test, make sure the following conditions have been met:

1. The DS-562NC module and I/O adapter must be installed in an RFL IMUX 2000 chassis.
2. Power must be applied to the system.
3. The module must be out of service.
4. If the module is set for 56 Kbps, the transmit and receive addresses must be set to the same value, or set to zero.

A telecommunications test set that can accept RS-449/RS-530/422, X.21/V.11, CCITT V.35, or CCITT G.703 signals (depending on the adapter module used), will be required for the loopback test (Telecommunications Techniques Corporation Firebird 2000 or equivalent).

VERIFICATION TEST

1. Press the Group toggle switch on the CM-4 left or right until the function display reads LPBK. Then push the SET toggle switch left until the function display reads EqLB. At this time push the SET toggle switch twice to the right.

NOTE

Equipment Loopback on the CM-4 will loopback all DS0 channels within that shelf

The green LED above the SET toggle switch should blink after the first push and should be steady after the second push.

The yellow loopback LED on the CM-4 and the yellow LED on the power supply should be lit, indicating that the system is in local loopback.

2. Connect a test set to the cable assembly in accordance with the manufacturers procedures. Then perform a bit error rate test.

For test criteria, use a 63 or 511 test pattern. Alternately, use a 109 or lower bit pattern.

3. Observe that zero errors are indicated on the receive side of the test set.

If an error count occurs, check all option selections and repeat steps 1 through 3. If the error count persists, check the following:

- a. **Make sure the test set is correctly set up.**
- b. **Make sure the test set cable is correctly connected.**
- c. **Make sure the module under test is correctly installed.**
- d. **Make sure the cable assembly is firmly and correctly connected.**

If the error source is localized to the module or the cable assembly, return the defective component to RFL for repair. If an error count persists after these steps have been taken, check for an outside error source.

TROUBLESHOOTING

Use the following procedure to determine whether a problem is being caused by the RFL DS-562NC or by some other part of the system.

1. If more than one module is on the same time slot, remove those modules that are known to be good.
2. Perform a local loopback test, as described in steps 1 through 4 of the Loopback Testing procedure.
3. If the loopback test indicates that the module is functioning properly, then check that the terminal equipment is functioning properly. If so, then the test is complete. If not, then check for an outside error source.
4. If errors appear to be occurring from the direction of the customer equipment to the DS-562NC, verify that the data transitions are not occurring near the positive edge of the clock when observing TXD (TP15) versus TXC (TP16) on the DS-562NC. If this is the case, place TXICP (SW6-7) in the ON (UP) position, and check to see if the errors still persist. If they do continue to occur, return TXICP (SW6-7) to the OFF (DOWN) position.

If errors appear to be occurring from the direction of the DS-562NC to the customer equipment, verify on the customer's external equipment that the data transitions are not occurring near the positive edge of the clock when observing the data into the equipment relative to the sampling clock. If this is the case, or if it cannot be verified, place RXICP (SW6-5) in the ON (UP) position, and check to see if the errors still persist. If they do continue to occur, return RXICP (SW6-5) to the OFF (DOWN) position.

5. If the error count persists, then swap modules. Replace the module with another that is known to be functioning properly. If the replacement module is OK, then use the Repair/Return

procedure in the General Information Section of the manual to return the defective module to RFL for repair.

6. If proper function is not obtained, perform individual multiplex tests as described in the multiplexer manual. If an error count still persists after these steps have been taken, then check for an outside error source.

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RFL Electronics Inc.

INSTRUCTION DATA

RFL DS-961D Five-Port Multi-Rate Synchronous Data Module

DESCRIPTION

The DS-961D is a five-port multi-rate synchronous data channel module, designed for use in IMUX 2000 T1 Multiplexers. The module uses an RS-232C interface to enable transmission of up to five 9.6 kbps or two 19.2 kbps data signals over T1 and other digital communications facilities, using only one 64 kbps time slot.

The DS-961D has three switch banks, one setup jumper, and four LEDs, one each for channels transmitting, channels receiving data, no framing bit, and transmit fault.

The DS-961D is remote-controllable when installed in an RFL remote controllable shelf. The following module parameters can be configured remotely via SCB or locally via DIP switches.

User-adjustable switches and jumpers allow configuration of the following parameters:

- o Data rate selection from 1200 bps to 19.2 kbps
- o Optional three-channel operation (two at 19.2 kbps, one at 9.6 kbps)
- o Selection of transmit timing or terminal timing
- o Selectable transmit/receive direction for drop and insert operation
- o Optional timing inversion
- o Switchable loopback of all channels at the receive side
- o Time slot selection

SPECIFICATIONS

As of the date this Instruction Data Sheet was published, the following specifications apply to the RFL DS-961D module. Because all of RFL products undergo constant improvement and refinement, these specifications are subject to change without notice.

Multiple Synchronous

Data Channels:	Full duplex, five independent RS-232 data ports
Clock/Data Rates:	Five channel operation: A selectable common rate of 1200 bps, 2400 bps, 4800 bps, or 9600 bps Two channel operation: A common rate of 19.2 kbps Three channel operation: Two channels at 19.2 kbps, one at 9600 bps
Timing:	Selectable, internal or external
Buffer:	Three-bit when using external timing source (terminal timing)
Time Slot:	Five channels occupy a single selectable 64 kbps time slot
RS-232 Interface:	Supports TXD, RXD, RX TIMING, TX TIMING, TERMINAL TIMING, GROUND
Remote Interface:	Compatible with SCL remote command language, allows module configuration and status access
Connector:	The DS-961D requires the use of an MA-404A Module Adapter, which provides five RJ-11 jacks for the RS-232 interfaces
Temperature:	0° - 50°C Operating
Humidity:	0% - 90% Non-condensing
Power Consumption:	1.2 watts nominal

INSTALLATION

Before the RFL DS-961D module can be placed in service, it must be installed in a multiplexer shelf. Installation involves determining the module slot in the Main Shelf or Expansion Shelf where the module will be installed, inserting a Module Adapter into the rear of the shelf behind the module slot, connecting all signal and power wiring to the Module Adapter, checking the settings of all switches, and inserting the module into the front of the shelf.

NOTES

Power supply and time slot considerations may affect the installation of this module into an existing multiplexer shelf. Refer to the multiplexer manual for more information.

The following instructions are provided for installing an RFL DS-961D module into an existing system. If the module was included as part of a system, installation was done at the factory. Otherwise, proceed as follows:

1. Carefully inspect the module for any visible signs of shipping damage. If you suspect damage to the module, immediately call RFL Customer Service at the number listed at the bottom of this page.
2. Determine the module slot in the Main Shelf or Expansion Shelf where the module will be installed.
The RFL DS-961D module occupies one module slot in the Main Shelf or Expansion Shelf.
3. Each module in the IMUX 2000 multiplexer requires a Module Adapter. The module adapter provides the appropriate connector for the desired interface.
The DS-961D Data Module uses an MA-404A Module Adapter. The MA-404A accepts up to five RS-232C lines via RJ-11 modular input connectors. Figure 1 shows the input jack arrangement. If you are setting up the module for two channels at 19.2 kbps each, use only the first two jacks. For three channel operation, use the first two jacks for 19.2 kbps and the fifth jack for 9.6 kbps. The modes of operation are illustrated in Figure 2.
Jumpers on the MA-404A are used to select normal or three channel mode of operation. For NORMAL mode (two or five channel), set jumpers J1, J2 and J3 to the NORMAL position. For THREE CHANNEL mode, set jumpers J1, J2 and J3 to the THREE-CHANNEL position. Figure 3 illustrates these jumper settings.
4. Insert the MA-404A Module Adapter into the rear of the slot which will hold the RFL DS-961D module, and make all connections to the module adapter.
Connect the RJ-11 input lines, and insert the MA-404A into the rear of the slot that will hold the DS-961D module.

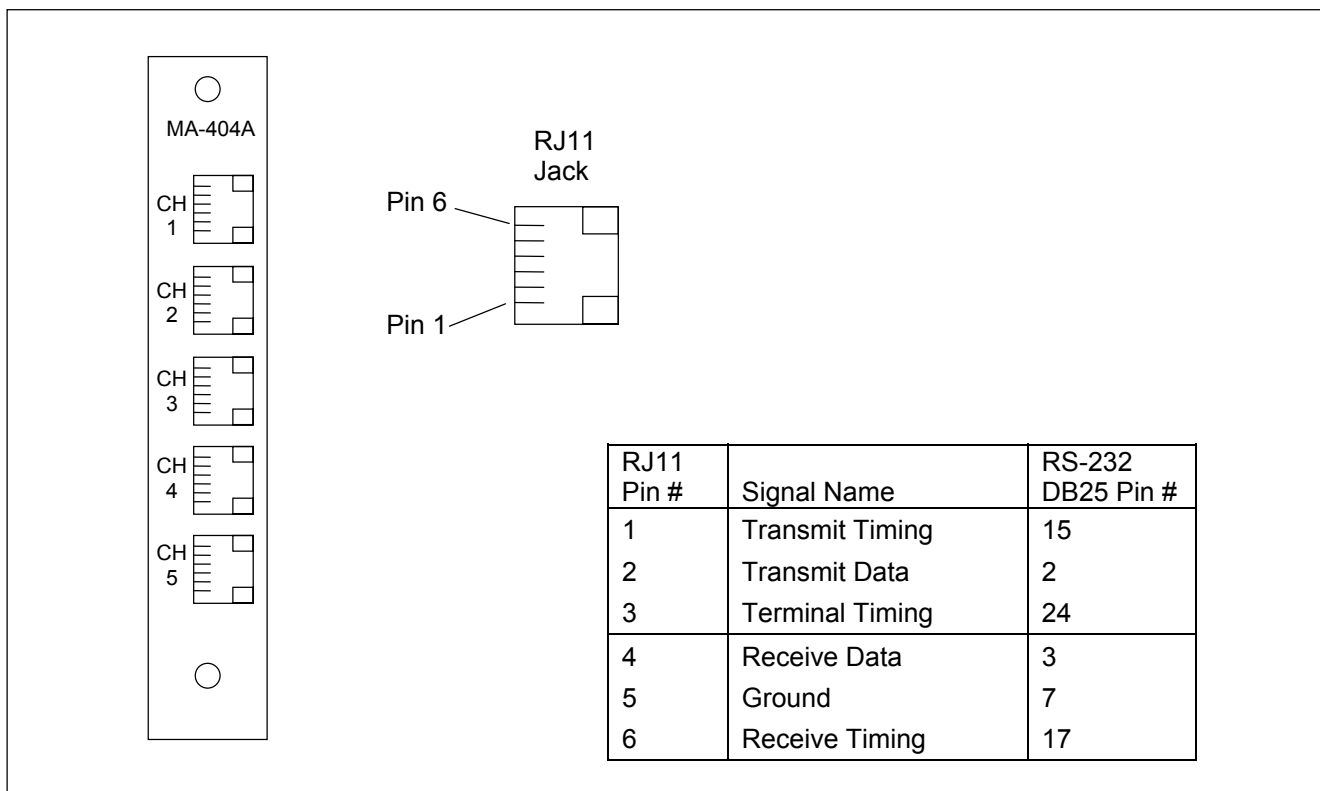


Figure 1. MA-404A Module Adapter Input Configuration.

5. Refer to Figure 4 and Table 2 for the location and function of DIP switches on the DS-961D.

6. Set the module address using DIP switches SW1-1 through SW1-6 for the desired remote address (SCB address).

For remote access, each channel module in the IMUX 2000 must have a distinct module address. Valid addresses are the numbers "1" to "36". In most installations the address will be set to the number of the slot the module is occupying. Table 3 shows the switch settings for the module address. (Consult your multiplexer manual for details on using the remote access and configuration features of the system.)

7. Set the channel configuration jumpers. To use this module in five channel mode at any data rate, or in two channel mode at 19.2 kbps, set jumper J1 to the NORMAL position as shown in Table 1 and Figure 4. Set the jumpers on the module adapter to the NORMAL position as shown in Figure 3.

To use the module in three channel mode (two channels at 19.2 kbps, and one channel at 9.6 kbps), make the following settings:

- Set jumper J1 to the THREE CHANNEL position.
- Set SW3-4 to the UP position (buffers out of circuit, uses DS-961D module timing).
- Set the jumpers on the module adapter to the THREE CHANNEL position as shown in Table 1 and Figure 3.

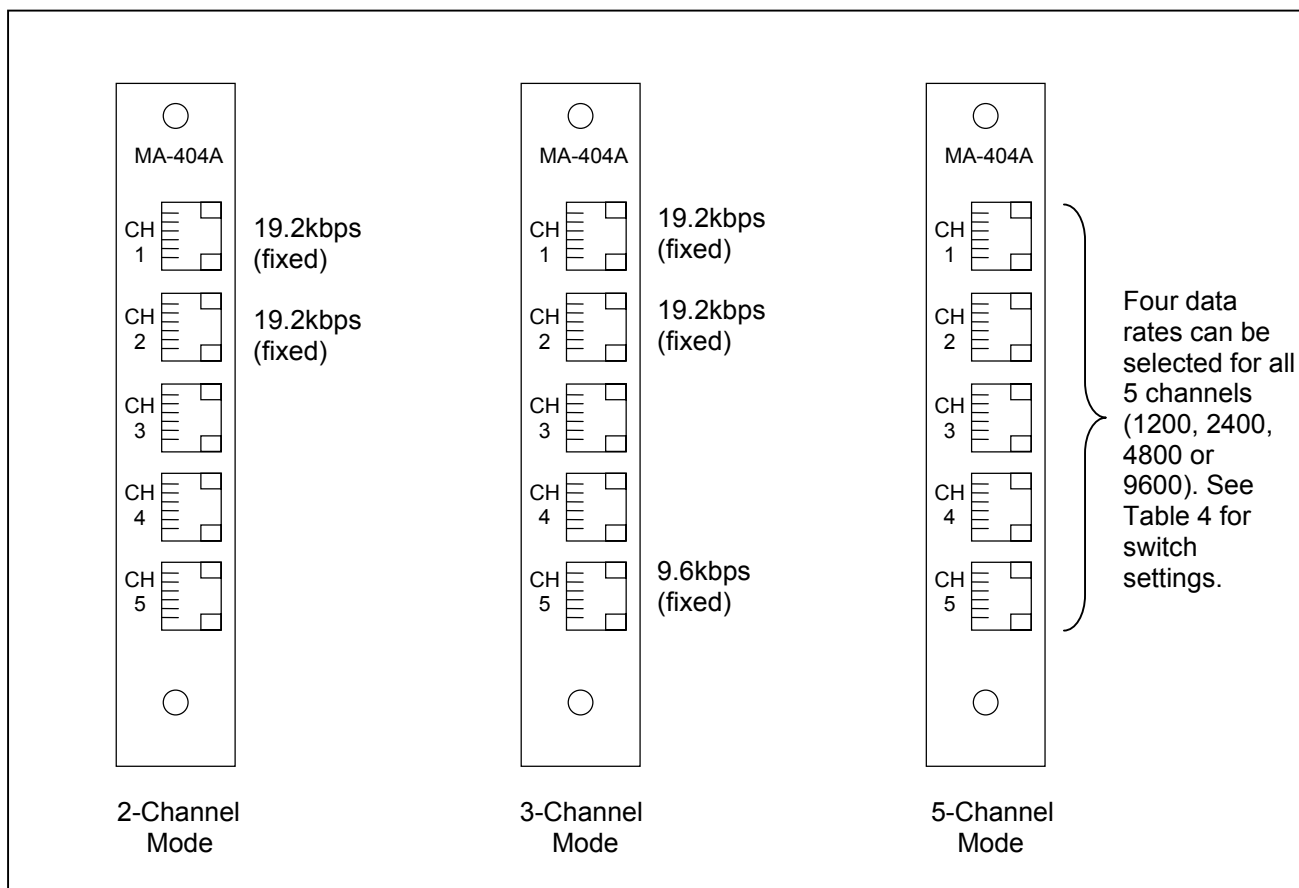


Figure 2. DS-961D/MA-404A modes of operation

Table 1. DS-961D/MA-404A Switch and Jumper Settings for various modes of operation

Mode Of Operation	Data Rate	DS-961D		MA-404A
		Switch Setting	Jumper Setting	Jumper Settings
2-Channel	CH1 and CH2 fixed at 19.2kbps	SW3-3 set to UP	J1 set to NORMAL	J1, J2 and J3 set to NORMAL
3-Channel	CH1 and CH2 fixed at 19.2kbps, and CH5 fixed at 9.6kbps	SW3-3 set to UP	J1 set to 3-CHANNEL	J1, J2 and J3 set to 3-CHANNEL
5-Channel	CH1 to CH5 all set to the same data rate as follows: 1200, 2400, 4800 or 9600. See Table 4 for switch settings	SW3-3 set to DOWN	J1 set to NORMAL	J1, J2 and J3 set to NORMAL

8. Select the time slot using DIP switches SW2-1 to SW2-5.
9. Set for use in a terminal or drop/insert multiplexer by using DIP switch SW2-6.
10. Select the data rate by using DIP switches SW3-1 and SW3-2. (See Table 5)
11. Select the buffer-in timing by using DIP switch SW3-4. If using three channel mode, this should be set to the UP position.
12. If using internal DS-961D module timing, set each channel to normal or inverted clock by using DIP switches SW3-5 to SW3-9.
13. Set the loop switch, SW3-10, to the UP position,.
14. If you plan to operate the RFL DS-961D module under local control, perform the following steps; otherwise, go to step 15 for remote control.
 - a. Set to local control by placing DIP switch SW1-7 in the OFF position.
 - b. Turn service on by placing DIP switch SW1-8 in the OFF position.
 - c. Slide the module into the selected module slot until it is firmly seated and the module front panel is flush with the top and bottom of the shelf.
 - d. Go to step 16.
15. If you plan to operate the RFL DS-961D module under remote control, perform the following steps:
 - a. Set to local control by placing DIP switch SW1-7 in the OFF position.
 - b. Turn service off by placing DIP switch SW1-8 in the ON position.
 - c. Slide the module into the selected module slot until it is firmly seated and the module front panel is flush with the top and bottom of the shelf.
 - d. Wait 15 seconds for the RFL DS-961D module's parameter settings to be loaded into the shelf Common Module.
 - e. Pull the module out of the shelf and place DIP switch SW1-7 in the ON position.
 - f. Slide the module back into the shelf.
 - g. Verify the module configuration through remote control by issuing a "CONFIG?" query. See the Remote Control Interface section of this Instruction Data Sheet for an explanation of the "CONFIG?" response.
 - h. Turn service on through remote control by issuing a "SRVC=ON" command.
The RFL DS-961D's operating parameters can now be changed by remote control. See the Remote Control Interface section of this Instruction Data Sheet for more information.
 - i. Go to step 16.

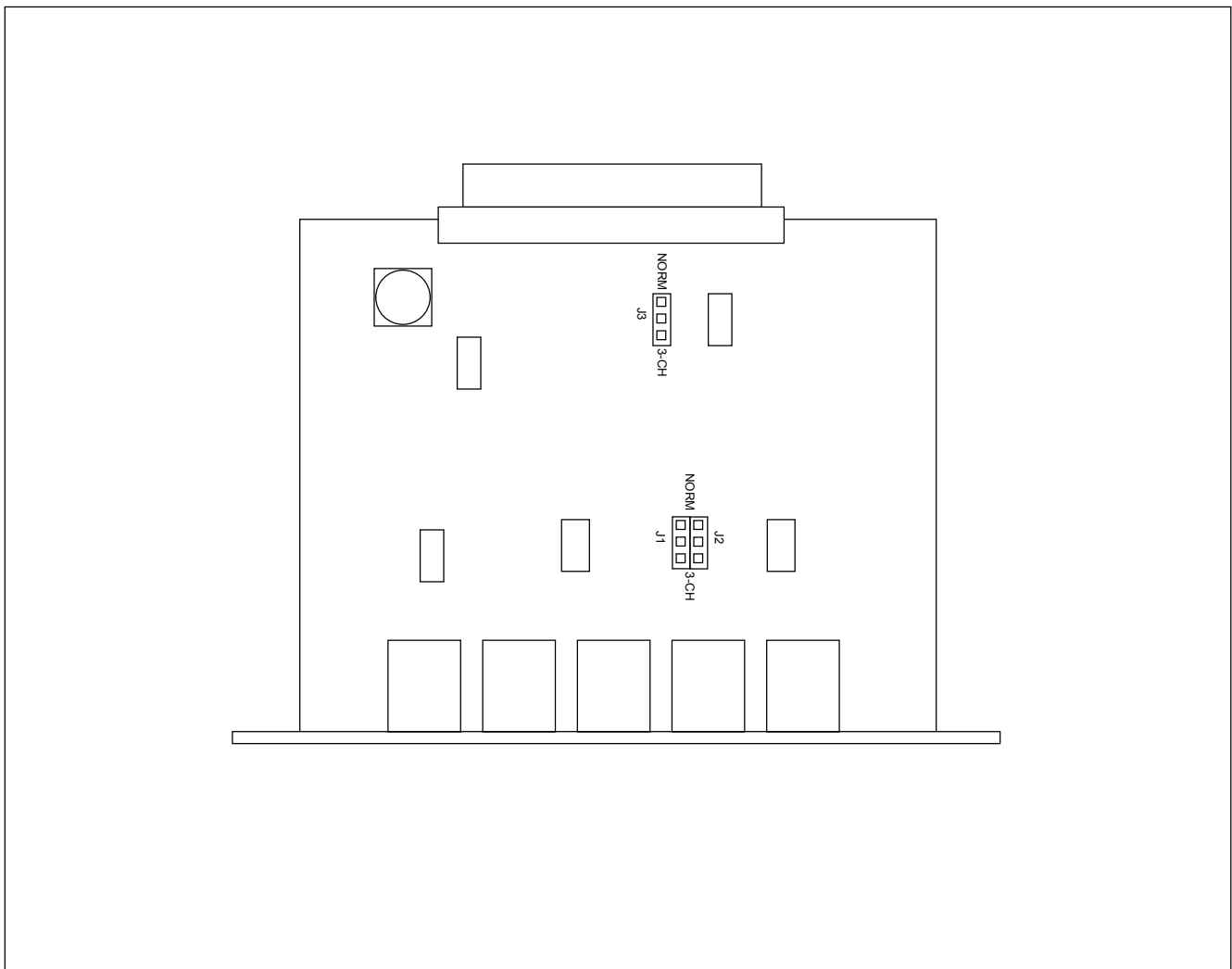


Figure 3. MA-404A Module Adapter jumper settings

16. On the Module Record Card located to the right of the shelf, record the channel bank type, time slot, and any other pertinent information.

The RFL DS-961D is now installed. If your multiplexer is set up for remote access and control, you can now change the operating parameters of the module by using simple commands. For more information on remote access and control, consult your multiplexer operation manual.

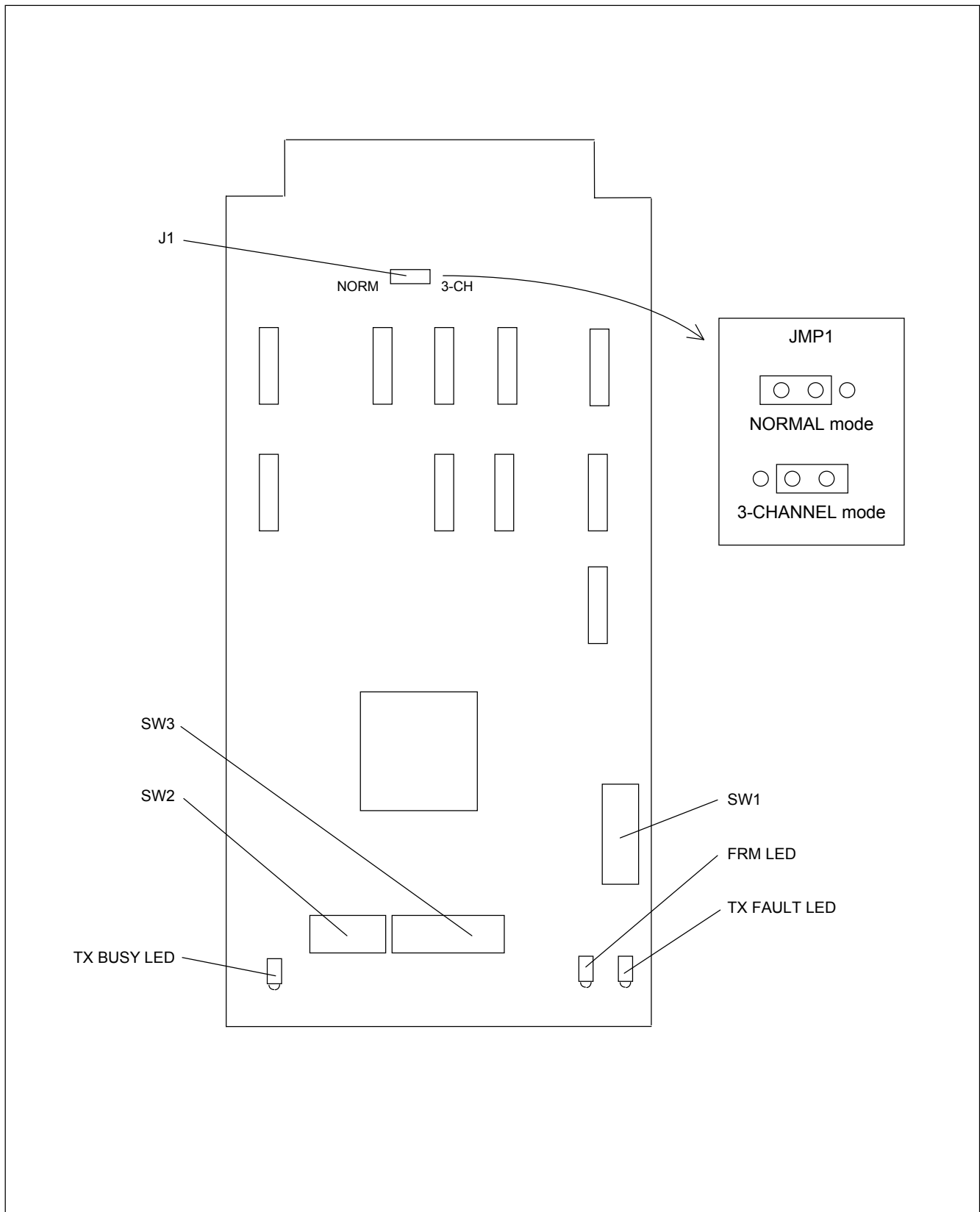


Figure 4. Controls and indicators, RFL DS-961D Synchronous Data Module

Table 2. Controls and indicators, RFL DS-961D Module

Control/ Indicator	Label	Setting	Description
Jumper	J1	NORMAL 3-CHANNEL	Sets module to 2-channel mode or 5-channel mode. Sets module to 3-channel mode.
LED DS1 (green)	TX BUSY	...	Indicates if one or more channels is transmitting.
LED DS3 (red)	FRM	...	Indicates if the receiver side of the module cannot find the proper framing bit in the receive time slot selected. A card level ALERT signal is sent to the Common Module
LED DS4 (red)	TX FAULT	...	Indicates if a fault is detected in the transmit circuitry of the logic array. A card level ALARM signal is sent to the Common Module.
SW1-1 to SW1-6	...	...	Sets card address for remote access in accordance with Table 3. (See Note 1 below).
SW1-7	...	ON OFF	Sets module to remote control (See Note 1 below). Sets module to local control.
SW1-8	...	ON OFF	Module service is disabled. Module service is enabled.
SW2-1 to SW2-5	TIME SLOT SELECT	...	Select time slot in accordance with Table 4.
SW2-6	TX A BUS	UP DOWN	Operate via DI-B port in a drop/insert multiplexer (see page 14). Operate in a terminal multiplexer, or via DI-A port in a drop/insert multiplexer.
SW3-1 & SW3-2	RATE 1 RATE 2	...	Select data rate in 5-Channel mode in accordance with Table 5.
SW3-3	SEL 9.6	UP DOWN	Selects 2 or 3-Channel mode (Ports 1 & 2 = 19.2) Selects 5-Channel mode
SW3-4	BUF IN	UP DOWN	Takes buffers out of circuit and sets module to use its internal timing (See Note 2 below). Places buffers in circuit and sets module to use DTE device timing.
SW3-5 to SW3-9	INV A,B,C,D,E	UP DOWN	Standard timing for selected channel. Inverts timing for selected channel (See Note 3 below)
SW3-10	LOOP	UP DOWN	Turns loopback off (normal operation) . Turns loopback on (See Note 4 below).

1. When this module is installed in a non-remote controllable multiplexer SW1-1 to SW1-7 must be OFF.
2. The input buffers must be used when the DTE device timing is in use, so this switch sets both of these conditions.
3. These switches are active only when internal timing is selected (SW3-4).
4. When the loop switch is DOWN, all five receive channels are looped back into the transmitter (used for far end loopback during end to end testing).

Table 3. SCB address settings, RFL DS-961D module

SCB ADDRESS	SW1-1	SW1-2	SW1-3	SW1-4	SW1-5	SW1-6
1	OFF	ON	ON	ON	ON	ON
2	ON	OFF	ON	ON	ON	ON
3	OFF	OFF	ON	ON	ON	ON
4	ON	ON	OFF	ON	ON	ON
5	OFF	ON	OFF	ON	ON	ON
6	ON	OFF	OFF	ON	ON	ON
7	OFF	OFF	OFF	ON	ON	ON
8	ON	ON	ON	OFF	ON	ON
9	OFF	ON	ON	OFF	ON	ON
10	ON	OFF	ON	OFF	ON	ON
11	OFF	OFF	ON	OFF	ON	ON
12	ON	ON	OFF	OFF	ON	ON
13	OFF	ON	OFF	OFF	ON	ON
14	ON	OFF	OFF	OFF	ON	ON
15	OFF	OFF	OFF	OFF	ON	ON
16	ON	ON	ON	ON	OFF	ON
17	OFF	ON	ON	ON	OFF	ON
18	ON	OFF	ON	ON	OFF	ON
19	OFF	OFF	ON	ON	OFF	ON
20	ON	ON	OFF	ON	OFF	ON
21	OFF	ON	OFF	ON	OFF	ON
22	ON	OFF	OFF	ON	OFF	ON
23	OFF	OFF	OFF	ON	OFF	ON
24	ON	ON	ON	OFF	OFF	ON
25	OFF	ON	ON	OFF	OFF	ON
26	ON	OFF	ON	OFF	OFF	ON
27	OFF	OFF	ON	OFF	OFF	ON
28	ON	ON	OFF	OFF	OFF	ON
29	OFF	ON	OFF	OFF	OFF	ON
30	ON	OFF	OFF	OFF	OFF	ON
31	OFF	OFF	OFF	OFF	OFF	ON
32	ON	ON	OFF	ON	ON	OFF
33	OFF	ON	OFF	ON	ON	OFF
34	ON	OFF	OFF	ON	ON	OFF
35	OFF	OFF	OFF	ON	ON	OFF
36	ON	ON	OFF	ON	ON	OFF

NOTE: For SW1, ON = UP and OFF = DOWN.

Table 4. Time Slot Selection for RFL DS-961D module.

Time Slot	SW2-1	SW2-2	SW2-3	SW2-4	SW2-5
1	UP	UP	UP	UP	UP
2	UP	UP	UP	UP	DOWN
3	UP	UP	UP	DOWN	UP
4	UP	UP	UP	DOWN	DOWN
5	UP	UP	DOWN	UP	UP
6	UP	UP	DOWN	UP	DOWN
7	UP	UP	DOWN	DOWN	UP
8	UP	UP	DOWN	DOWN	DOWN
9	UP	DOWN	UP	UP	UP
10	UP	DOWN	UP	UP	DOWN
11	UP	DOWN	UP	DOWN	UP
12	UP	DOWN	UP	DOWN	DOWN
13	UP	DOWN	DOWN	UP	UP
14	UP	DOWN	DOWN	UP	DOWN
15	UP	DOWN	DOWN	DOWN	UP
16	UP	DOWN	DOWN	DOWN	DOWN
17	DOWN	UP	UP	UP	UP
18	DOWN	UP	UP	UP	DOWN
19	DOWN	UP	UP	DOWN	UP
20	DOWN	UP	UP	DOWN	DOWN
21	DOWN	UP	DOWN	UP	UP
22	DOWN	UP	DOWN	UP	DOWN
23	DOWN	UP	DOWN	DOWN	UP
24	DOWN	UP	DOWN	DOWN	DOWN

Table 5. Data Rate Selection for RFL DS-961D module in 5-Channel mode

Data Rate	SW3-1	SW3-2
1200 bits/second	UP	UP
2400 bits/second	UP	DOWN
4800 bits/second	DOWN	UP
9600 bits/second	DOWN	DOWN

FUNCTIONAL DESCRIPTION

The DS-961D Data Module has three basic configuration modes:

1. Five independent full duplex data channels with a common data rate of 1200 to 9600 bps.
2. Two independent full duplex data channels with a data rate of 19.2 kbps.
3. Two independent full duplex data channels with a data rate of 19.2 kbps, plus a third independent channel with a data rate of 9600 bps.

Figure 5 shows a block diagram of the DS-961D.

TRANSMIT SIDE

Each input signal enters via a connection to the module adapter at the rear of the shelf. Data and timing pass to the RS-232 line receivers on the DS-961D module. The module can be set to use transmit timing from either the Data Terminal Equipment (DTE) input signals, or the DS-961D internal module timing. The line receivers convert each channel to TTL output. If DTE timing is in use, each channel then goes to its own three-bit buffer.

The Logic Array multiplexes the five channels together, adds a framing bit, and feeds the resulting bit stream to the main multiplexer for transmission in the desired direction. User-selectable switches on the module determine which time slot is used.

RECEIVE SIDE

The high speed multiplexed data from the receive direction enters the receive side of the Logic Array. The Logic Array feeds the framing bit to a synchronization counter, which provides the proper timing and phase to read out the five data channels.

The Logic Array and synchronization counter separate the data back into five TTL data signals. Each channel then goes to an RS-232 line driver, which converts it back to RS-232 level. Finally, the RS-232 output signal goes to the module adapter, where it passes to the output connector.

ALERTS/ALARMS

The RFL DS-961D module reports the following module level ALERT or ALARM signals to the shelf Common Module. If the receive side cannot find a proper framing bit in the time slot selected, the DS-961D will light its “FRM” LED and send a card-level ALERT to shelf Common Module. If a fault is detected in the transmit circuitry, the module will light its “TX FAULT” LED and send a card-level ALARM to the shelf Common Module.

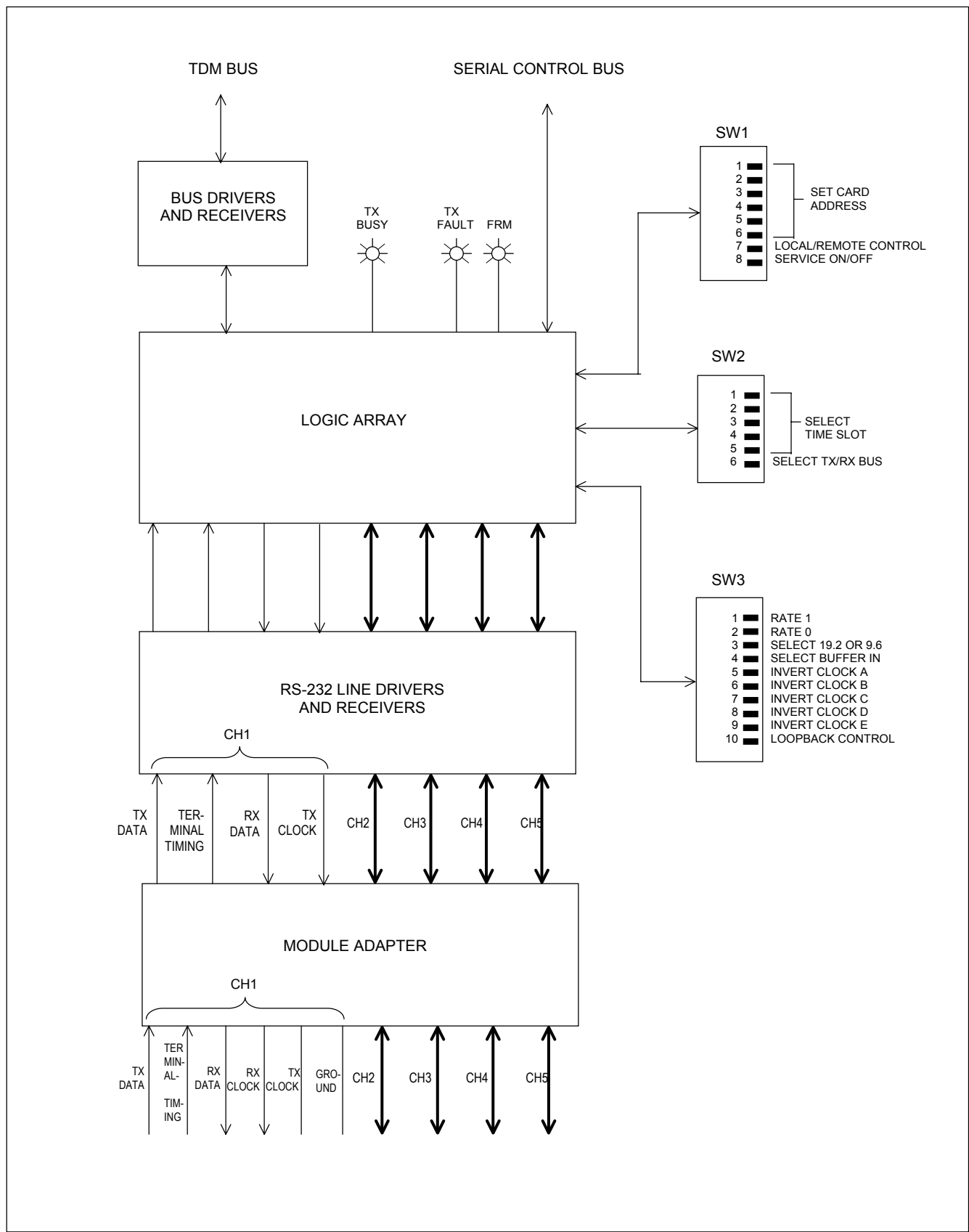


Figure 5. DS-961D Data Module, Block Diagram

DROP AND INSERT OPERATION

A drop and insert multiplexer operates at a central node on a three (or more) node system. In the example shown in Figure 6, node 2 has a drop and insert multiplexer whose DI/A port is connected to the transmission line to node 1, and whose DI/B port is connected to the transmission line to node 3. Individual payload channels may connect nodes 1 and 2, 1 and 3, or 2 and 3.

In the drop and insert multiplexer at node 2, a DS-961D module can be set to transmit and receive either via the DI/A port (toward node 1) or via the DI/B port (toward node 3), but not both.

When a DS-961D is installed in a terminal multiplexer (node 1 or node 3), its TX-A switch must be set **DOWN**. However, when it is installed in a drop and insert multiplexer (node 2) the TX-A switch setting must be **DOWN** to transmit and receive via the DI/A port (toward node 1) and **UP** to transmit and receive via the DI/B port (toward node 3).

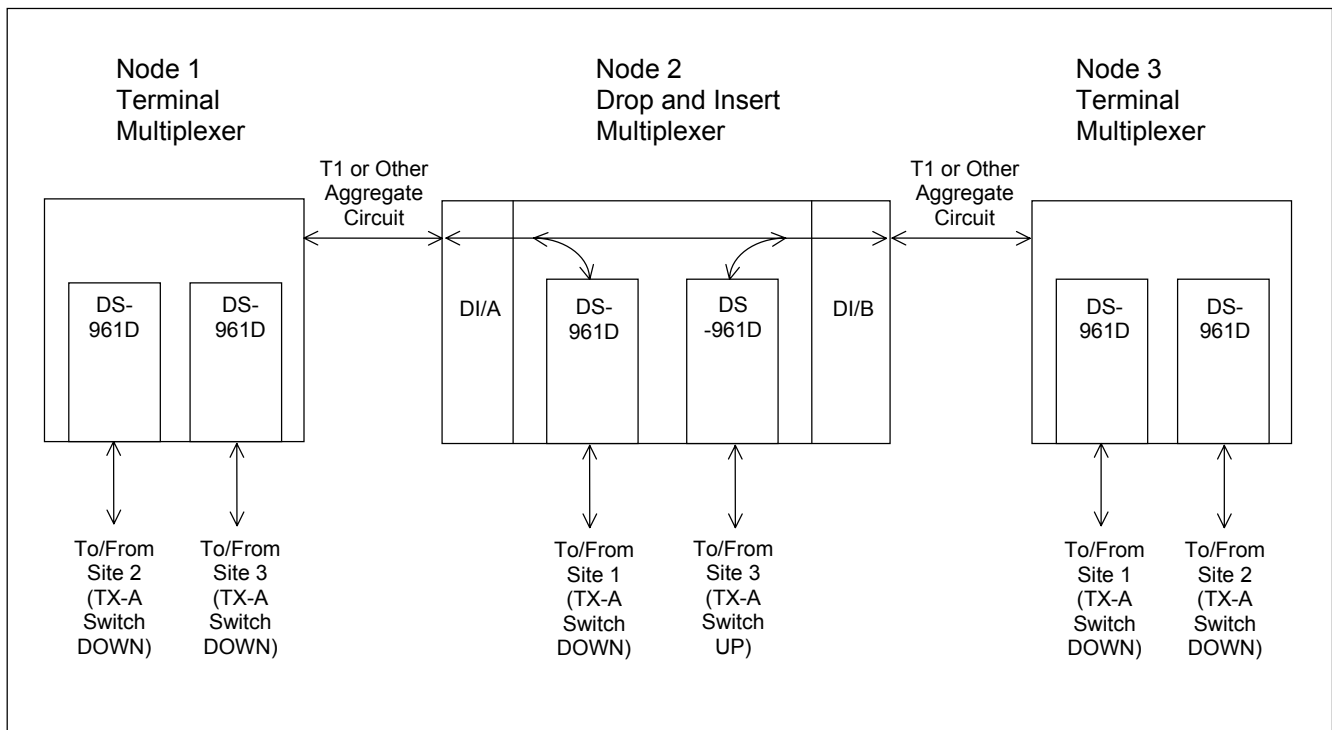


Figure 6. Example of a Three-Site System Using Drop and Insert

COMPATIBILITY WITH EARLIER DS-961D VERSIONS

The DS-961D is circuit-compatible with both the DS-961B and DS-961C modules; that is, a circuit can be established with a DS-961D at one end and either a DS-961B or DS-961C at the other end.

The DS-961D is essentially identical to the DS-961C with the addition of remote access and control, so there are no compatibility issues. However, the DS-961B does not support DTE timing, so a DS-961D being used at the other end of a circuit from a DS-961B must have SW3-4 set to the UP position.

REMOTE CONTROL INTERFACE

When the RFL DS-961D module is installed in an IMUX 2000 multiplexer, it can be operated under local or remote control. When under remote control, most of the module setup parameters can only be changed through the RS-232 remote port on the shelf Common Module. See the IMUX 2000 manual for information on using the remote control interface.

The remote control interface for the RFL DS-961D involves two sets of codes: “P” (parameter) codes, and “S” (status) codes. The RFL DS-961D reports itself as a “Type 68” module.

“P” CODES

“P” codes, when used in the parameter field of an SCL “SET” command, allow the user to set certain parameters on the RFL DS-961D by remote control, just like setting the DIP switches on a module under local control. “P” codes also appear in the response to a “CONFIG?” query, providing a list of the RFL DS-961D’s current parameter settings. A typical RFL DS-961D response to a “CONFIG?” query looks like this:

Response:

This line means:

*** OK**

A valid command was received

**CHANNEL CARD 3, TYPE 68
UNDER REMOTE CONTROL**

The card address is 3, it is a DS-961D

SRVC = ON

This module is under remote control

P01 = 4 (B00000100)

Service is turned on

P02 = 0 (B00000000)

Module is using time slot 4

P03 = 2 (B00000010)

Module is in terminal mode (TX-A, RX-B)

P04 = 1 (B00000001)

Data rate is 2400 bps

P05 = 0 (B00000000)

High-speed operation is turned off

P06 = 1 (B00000001)

Buffer out, using internal timing

P07 = 1 (B00000001)

Channel 1 clock is inverted

P08 = 0 (B00000000)

Channel 2 clock is inverted

P09 = 0 (B00000000)

Channel 3 clock is normal

P10 = 0 (B00000000)

Channel 4 clock is normal

P11 = 0 (B00000000);

Channel 5 clock is normal

Loopback is off (semicolon indicates end of message)

There are eleven “P” codes for the DS-961D, “P1” through “P11”. Each “P” code is displayed as a decimal number from 0 to 255, followed by an eight-digit binary equivalent in parentheses. The decimal display is generally more useful for both setting and interpreting most of the “P” codes. For example, P1 sets the time slot the module will use. To set the module to use time slot 9, issue a SET command in the format:

<multiplexer address>:<card address>:SET:P1 = 9;

The binary value may be used if desired.

NOTE

When using binary numbers in the parameter field of a SET command, they must be preceded by the letter "B", as shown in the following example. To set the module to use time slot 9 in binary, issue this command:

<multiplexer address>:<card address>:SET:P1 = B00001001;

In addition to the "P" codes, it is also possible to turn service on or off for the RFL DS-961D by sending one of the following commands in the parameter field of a "SET" command:

SRVC = ON

SRVC = OFF

Table 6 lists the meaning of the "P" codes for this module.

"S" CODES

"S" codes appear in response to a STATUS? query. There are two S codes for the DS-961D. Like the "P" codes, each is displayed as both a decimal and an eight-digit binary number. A typical response to a STATUS? query looks like this:

OK

CHANNEL CARD 3, TYPE 68

>>>ALERT or ALARM message here, if there is one<<<

S00 = 0 (B00000000)

S01 = 0 (B00000000);

S0 indicates the frame status of the card: when S0 = 0, the card is in frame; when S0 = 1, it is out of frame and an ALERT message is displayed.

S1 indicates the transmit status of the card: when S1 = 0, there is no transmission alarm; when S1 = 1, there is a transmission alarm and an ALARM message is displayed.

Table 6. Remote Configuration Settings (P Codes)

Code	Legal Settings (Note 1)	Description
SRVC	ON	Turns service on (module enabled)
	OFF	Turns service off (module disabled)
P1	1 to 24	Selects the desired time slot.
P2	0, 1	Set transmit and receive directions: 0 = Set for operation in a terminal multiplexer or via the DI-A port of a drop/insert multiplexer. 1 = Set for operation via the DI-B port of a drop/insert multiplexer.
P3	0 to 3	Low-speed rate select (inoperative when P4 is set to "0"): 0 = 9600 bps, 1 = 2400 bps, 2 = 4800 bps, 3 = 1200 bps
P4	0, 1	High-speed rate select: 0 = Sets data rate to 19.2 kbps and deactivates P3 1 = Activates P3, low-speed rate select
P5	0, 1	Selects buffers and timing (Note 2): 0 = Buffers out of circuit, module uses internal timing 1 = Buffers in circuit, module uses DTE device timing
P6	0, 1	Channel 1 clock: 0 = normal, 1 = inverted (Note 3)
P7	0, 1	Channel 2 clock: 0 = normal, 1 = inverted (Note 3)
P8	0, 1	Channel 3 clock: 0 = normal, 1 = inverted (Note 3)
P9	0, 1	Channel 4 clock: 0 = normal, 1 = inverted (Note 3)
P10	0, 1	Channel 5 clock: 0 = normal, 1 = inverted (Note 3)
P11	0, 1	Set loopback: 0 = on, 1 = off (Note 4)

1. These are the only legal values for setting the parameters. Setting any parameter to a value outside its specified range will produce an unpredictable result.
2. The input buffers must be used when the DTE device timing is in use, so this code sets both of these conditions.
3. These codes are active only when internal timing is selected (P5 = 0).
4. When the loopback is on, all five receive channels are looped back into the transmitter (used for far end loopback during end to end testing).

TESTING

When the RFL DS-961D Data Module has been configured and installed, it should be tested for proper operation before it is put into service.

There are two ways you can do the testing:

1. Local testing using loopback, with the system out of service.
2. End-to-end testing using far end loopback, with the system in service but the channel being tested taken out of service.

Use the following procedure to test the modules:

1. For loopback testing, set up the multiplexer loopback following the instructions in the section on System Checkout Procedures in your multiplexer instruction manual.

For end to end testing, set the LOOP switch on the far end system to the ON position.

2. Connect a data error analyzer (Telecommunication Techniques Corp. Fireberd 2000 or equivalent) to the jack for channel one on the back of the module adapter, using an RJ-11 cable.
3. Check for synchronization on the output signal.
4. Send single errors on the transmit side and check for single errors on the receive side.
5. Run for 30 seconds and confirm that the signal remains error-free. Observe that the "TX FAULT" LED and the "FRM" LED are not lit.
6. Repeat test on each channel set up for use in the current configuration.
7. If you used end to end testing, return the LOOP switch at the far end to the OFF position. The system is now operational.

If there is an apparent malfunction during end to end testing, first check that the configuration at the two ends is identical.

Most problems occur at the common equipment or facility level. Refer to the Troubleshooting section in your multiplexer instruction manual for system analysis procedures.

NOTES

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RFL Electronics Inc.

INSTRUCTION DATA

RFL OCUDP (Office Channel Unit Data Port) Module

Frame Relay Users (DYMEC Dynaster 2000): See Application Note at the end of this document

DESCRIPTION

The RFL OCUDP is a single slot module designed for use in IMUX 2000 T1 multiplexers and provides the interface between a DS0 timeslot of the T-carrier data stream and the 4-wire metallic loop extending to a midspan DDS repeater or the customer premises. The OCUDP can interoperate over the carrier system with another OCUDP or a DS0DP at a central office. The card can transmit and receive data at a rate of 56 kbps.

The OCUDP module has eight LEDs, one each for receiving idle code, no sealing current, OCU loopback, CSU loopback, line loopback, and three presently unused. There is also a green LED to show when the card is in service.

The OCUDP is remote-controllable when installed in an RFL remote controllable shelf. The following module parameters can be configured remotely via SCB or locally via DIP switches.

o	Local/Remote	Use DIP switches or SCB
o	Transmit timeslot	Sets the transmit T1 channel slot
o	Receive timeslot	Sets the receive T1 channel slot
o	Baud rate	Sets the DDS data baud rate
o	Zero code suppression	Ensures pulse density for an AMI T1 data stream
o	AB signaling enable	Determines the state of the A and B signaling bits
o	Latched loopback	Enables loopback response capability for the OCUDP

SPECIFICATIONS

As of the date this Instruction Data Sheet was published, the following specifications apply to the RFL OCUDP module. Because all of RFL products undergo constant improvement and refinement, these specifications are subject to change without notice.

Operational:

ANSI T1.410	Metallic interface
AT&T TR62310	DS0 digital local channel interface
Bellcore TA-TSY-000077	Dataport channel unit functions
Baud rate	56 kbps user rate and 64 kbps clear-channel user rate.
OCUDP Channel Loopback 56 kbps ONLY	Responds to code from CO to reverse loop current thereby causing customer equipment to loopback signal to OCUDP. Latching loopbacks supported only.
OCU Loopback 56 kbps ONLY	Responds to code from CO to loop 4 wire circuit back to CO on output of OCUDP. Latching loopbacks supported only.
OCU Cable Loss	Up to 45 dB
Interface connector	RJ-48S

Environmental:

ANSI C37.90 – 1989	Service conditions
Operating Temperature	-20°C to +55°C
Storage Temperature	-40°C to +75°C
Humidity	95% at 40°C, non-condensing

SWC/Fast Transient:

ANSI C37.90 – 1989	Dielectric
ANSI C37.90.1 – 1989	SWC and fast transient

RFI Susceptibility:

ANSI C37.90.2 – 35 V/M

System Performance:

Power consumption	2 watts nominal
MTBF	>500,000 hours at 25°C

INSTALLATION

Before the RFL OCUDP module can be placed in service, it must be installed in a multiplexer shelf. Installation involves determining the module slot in the Main Shelf or Expansion Shelf where the module will be installed, inserting a Module Adapter into the rear of the shelf behind the module slot, connecting all signal and power wiring to the Module Adapter, checking the settings of all switches, and inserting the module into the front of the shelf.

NOTES

Power supply and time slot considerations may affect the installation of this module into an existing multiplexer shelf. Refer to the multiplexer manual for more information.

The following instructions are provided for installing an RFL OCUDP module into an existing system. If the module was included as part of a system, installation was done at the factory. Otherwise, proceed as follows:

1. Carefully inspect the module for any visible signs of shipping damage. If you suspect damage to the module, immediately call RFL Customer Service at the number listed at the bottom of this page.
2. Determine the module slot in the Main Shelf or Expansion Shelf where the module will be installed.
The RFL OCUDP module occupies one module slot in the Main Shelf or Expansion Shelf.
3. Determine which Module Adapter will be used to make connections to the RFL OCUDP module.
Each module in the IMUX 2000 multiplexer requires a Module Adapter. The module adapter provides the appropriate connector for the desired interface. The Module Adapter that is used with the RFL OCUDP is the MA-455. The MA-455 provides one RJ-48S jack for connection to the circuit as shown in [Figure 1](#).
4. Insert the MA-455 Module Adapter into the rear of the slot which will hold the RFL OCUDP module, and make all connections to the module adapter.
Connect the RJ-48S plug into the MA-455's jack. The only electrical interface connections that have to be made to the RFL OCUDP are RX RING, RX TIP, TX TIP and TX RING, which are made to terminals 1, 2, 7 and 8 on the RJ-48S connector, as shown in [Figure 1](#).
5. Refer to [Figure 2](#) and [Table 1](#) for the location and function of DIP switches on the OCUDP.

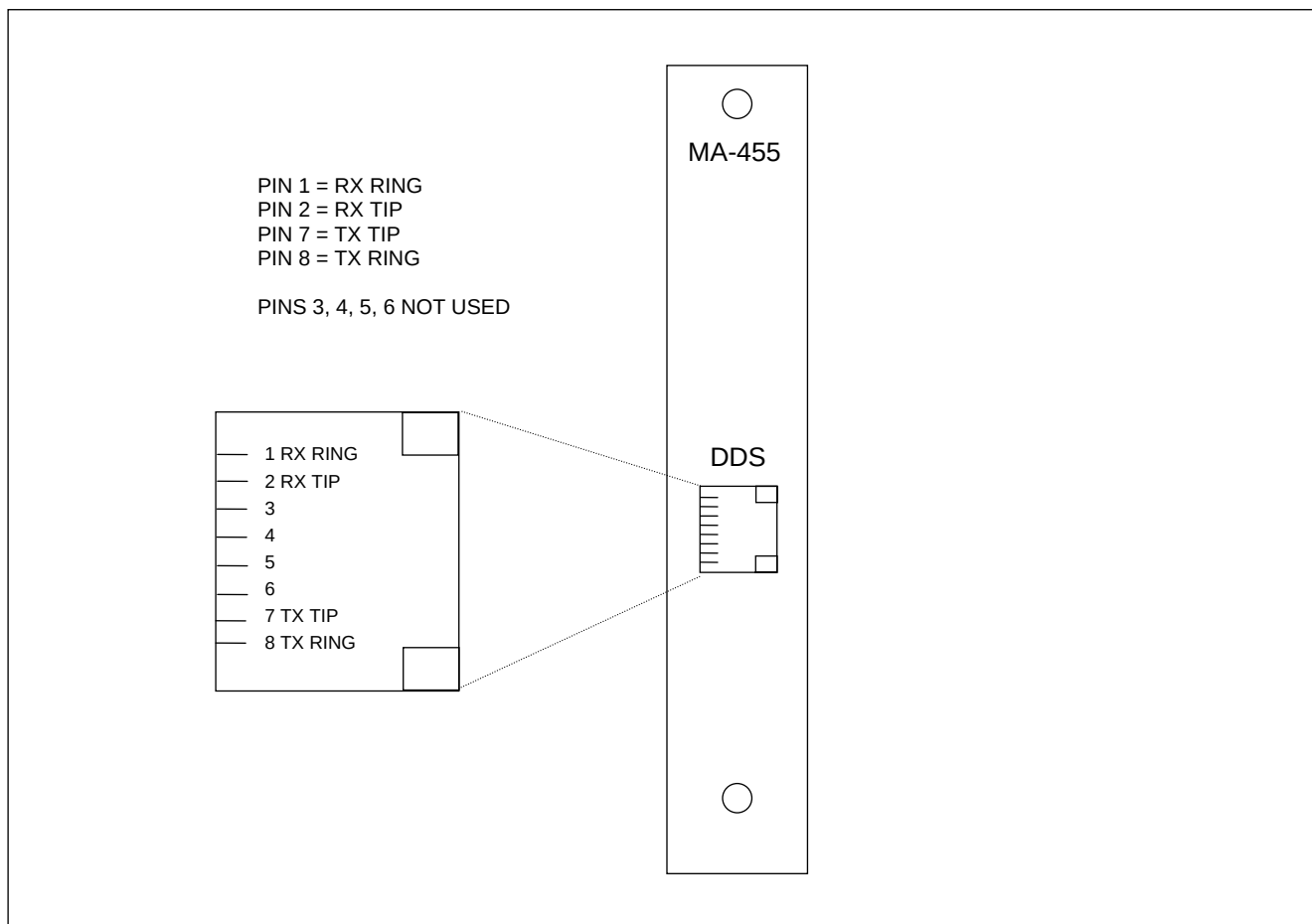


Figure 1. MA-455 Module Adapter.

6. Set the module address using DIP switches SW1-3 through SW1-8 for the desired remote address (SCB address).

For remote access, each channel module in the IMUX 2000 must have a distinct module address. Valid addresses for the OCUDP Module are the numbers “1” to “31.” In most installations the address will be set to the number of the slot the module is occupying. [Table 2](#) shows the switch settings for the module address. (Consult your multiplexer manual for details on using the remote access and configuration features of the system.)

NOTE

After changing DIP switch settings on the OCUDP card, the card must be hot inserted, or the local/remote DIP switch (SW1-2) must be toggled from local to remote and then back to local. If this is not done, the changed settings will not be recognized by the common module. After the card is either hot inserted, or SW1-2 is toggled, it will take approximately 10 seconds for the new settings to be recognized by the common module.

NOTE

The RFL OCUDP Module can be operated in local or remote control mode. In local-control mode its configuration is determined by on-board DIP-switches.

Under remote control, the switch positions are ignored and the module is remotely configured by the user, using terminal or Network Management Systems. Presetting local-control switches is not required for remote-control mode. If local-control switches are not preset, the channel module will not operate correctly until remotely configured.

The only configuration switches that **must** be set for remote-control mode are those for the SCB address (SW1-3 through SW1-8).

If you are planning to operate the RFL OCUDP Module under local control, continue to Step 7. on [page 10](#) to set the positions of the on-board DIP-switches.

Although remote control mode does not require it, RFL recommends setting local-control switches to the required configuration at this time. Doing this allows the Common Module to discover the desired settings and activate the channel module during initial commissioning, without the need for remote access by the user or Network Management System. This also enhances operation reliability by providing a configuration backup in case of NMS file loss or equipment failure.

If you do not intend to preset local-control switches for remote-control mode, go to Step 15 on [page 11](#).

The following pages show the location of the various configuration DIP switches and LED indicators on the OCUDP board with an explanation of their function.

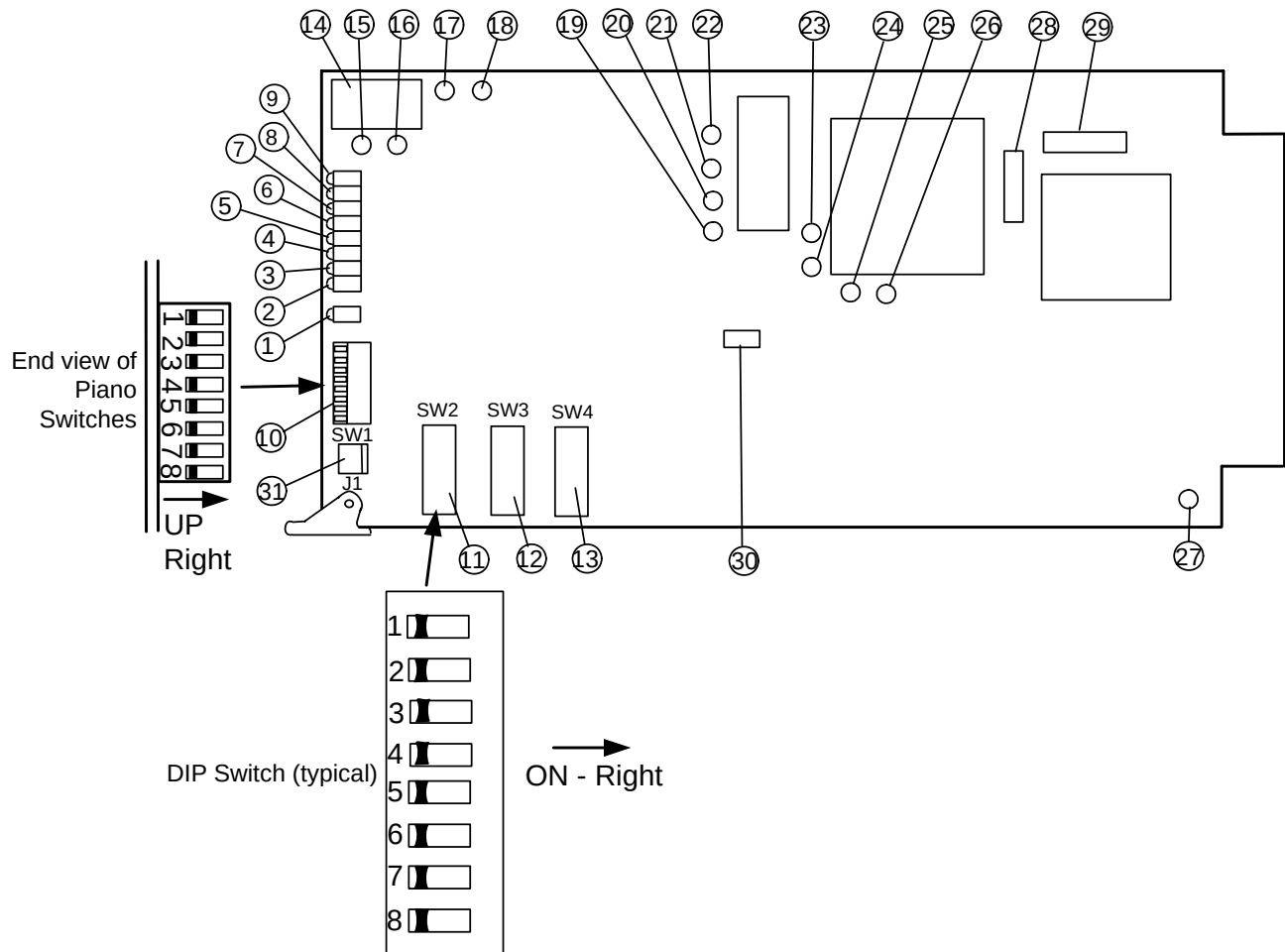


Figure 2. Controls and indicators, RFL OCUDP Selective Calling Unit

Table 1. Controls and indicators, RFL OCUDP Module

Item	Name/Description	Function
1	SVC LED, DS17	Lights green when card is in service
2	SPARE LED, DS8	Presently not used
3	SPARE LED, DS7	Presently not used
4	LN LB LED, DS6	Lights yellow when line loopback (local loopback) is active
5	CSU LB LED, DS5	Lights yellow when CSU (Channel Service Unit) loopback is active
6	OCU LB LED, DS4	Lights yellow when OCU (Office Channel Unit) loopback is active
7	ADIS LED, DS3	Presently not used
8	NOSX LED, DS2	Lights red when there is a sealing current
9	IDLE LED, DS1	Lights yellow when receiving idle code from customer loop
10	Piano Switch, SW1	SW1-1 Not used – Set to UP/RIGHT SW1-2 Local/Remote (Local=UP/RIGHT, Remote=DOWN/LEFT) SW1-3 to SW1-8 Sets SCB address (See Table 2)

Table 1 - continued. Controls and indicators, RFL OCUDP Module

Item	Name/Description	Function
11	DIP Switch, SW2	SW2-1 to SW2-5 Sets Transmit Channel timeslot (See Table 3) SW2-6 Module Service ON/OFF switch. SW2-6 in the ON/RIGHT position turns Service OFF. SW2-6 in the OFF/LEFT position turns Service ON. SW2-7 to SW2-8 Not used.
12	DIP Switch, SW3	SW3-1 to SW3-5 Sets Receive Channel timeslot (See Table 3) SW3-6 Sets the transmit bus direction. Set to OFF/LEFT to transmit in direction A and receive from direction B (default). Set to ON/RIGHT to transmit in direction B and receive from direction A. When the OCUDP Module is in a terminal-end multiplexer, the OCUDP Module must be configured to transmit in direction A. SW3-7 Not used. SW3-8 Alert on loss of Sealant Current. To enable set to OFF/LEFT. To disable set to ON/RIGHT (default)
13	DIP Switch, SW4	SW4-1 to SW4-4 Sets baud rate (See Table 4) SW4-5 Switched – 56k mode – not supported, must be set to ON/RIGHT for normal mode. SW4-6 ZCS (zero code suppression). Set to OFF/LEFT to enable, Set to ON/RIGHT to disable. SW4-7 AB signaling enable. Set to OFF/LEFT to enable, set to ON/RIGHT to disable. SW4-8 Latched loopback Functionality . Set to OFF/LEFT to enable, Set to ON/RIGHT to disable.
14	J5	Bantam Test Jacks (J5-A Input, J5-B Output)
15	Test Point TP13	TX- Negative side of transmitted bipolar signal
16	Test Point TP12	TX+ Positive side of transmitted bipolar signal
17	Test Point TP10	RX+ Positive side of received bipolar signal
18	Test Point TP11	RX- Negative side of received bipolar signal
19	Test Point TP6	TCLK Timing clock for transmitted logic signals
20	Test Point TP7	RPOS Logic signal from received bipolar positive pulse
21	Test Point TP8	RNEG Logic signal from received bipolar negative pulse
22	Test Point TP9	RCLK Timing clock for received logic signals
23	Test Point TP4	TPOS Logic input which generates positive pulse of bipolar output signal
24	Test Point TP5	TNEG Logic input which generates negative pulse of bipolar output signal
25	Test Point TP3	FRAME Frame pulse
26	Test Point TP2	ADDR OK Channel address pulse
27	Test Point TP1	Ground Signal ground
28	J3	ACTEL connector Used for factory testing
29	J4	ACTEL connector Used for factory testing
30	J2	Test/Run jumper Set to RUN position
31	J1	Serial port Used for factory testing

Table 2. SCB address settings, RFL OCUDP module

SCB ADDRESS	SW1-3	SW1-4	SW1-5	SW1-6	SW1-7	SW1-8
1	DOWN	DOWN	DOWN	DOWN	DOWN	UP
2	DOWN	DOWN	DOWN	DOWN	UP	DOWN
3	DOWN	DOWN	DOWN	DOWN	UP	UP
4	DOWN	DOWN	DOWN	UP	DOWN	DOWN
5	DOWN	DOWN	DOWN	UP	DOWN	UP
6	DOWN	DOWN	DOWN	UP	UP	DOWN
7	DOWN	DOWN	DOWN	UP	UP	UP
8	DOWN	DOWN	UP	DOWN	DOWN	DOWN
9	DOWN	DOWN	UP	DOWN	DOWN	UP
10	DOWN	DOWN	UP	DOWN	UP	DOWN
11	DOWN	DOWN	UP	DOWN	UP	UP
12	DOWN	DOWN	UP	UP	DOWN	DOWN
13	DOWN	DOWN	UP	UP	DOWN	UP
14	DOWN	DOWN	UP	UP	UP	DOWN
15	DOWN	DOWN	UP	UP	UP	UP
16	DOWN	UP	DOWN	DOWN	DOWN	DOWN
17	DOWN	UP	DOWN	DOWN	DOWN	UP
18	DOWN	UP	DOWN	DOWN	UP	DOWN
19	DOWN	UP	DOWN	DOWN	UP	UP
20	DOWN	UP	DOWN	UP	DOWN	DOWN
21	DOWN	UP	DOWN	UP	DOWN	UP
22	DOWN	UP	DOWN	UP	UP	DOWN
23	DOWN	UP	DOWN	UP	UP	UP
24	DOWN	UP	UP	DOWN	DOWN	DOWN
25	DOWN	UP	UP	DOWN	DOWN	UP
26	DOWN	UP	UP	DOWN	UP	DOWN
27	DOWN	UP	UP	DOWN	UP	UP
28	DOWN	UP	UP	UP	DOWN	DOWN
29	DOWN	UP	UP	UP	DOWN	UP
30	DOWN	UP	UP	UP	UP	DOWN
31	DOWN	UP	UP	UP	UP	UP

NOTE: For SW1, ON = UP/RIGHT and OFF = DOWN/LEFT.

Table 3. Tx/Rx Time Slot Select for RFL OCUDP module.

T1 Tx/Rx Time Slot	Switch Settings				
	SW2-5/SW3-5	SW2-4/SW3-4	SW2-3/SW3-3	SW2-2/SW3-2	SW2-1/SW3-1
1	OFF	OFF	OFF	OFF	OFF
2	OFF	OFF	OFF	OFF	ON
3	OFF	OFF	OFF	ON	OFF
4	OFF	OFF	OFF	ON	ON
5	OFF	OFF	ON	OFF	OFF
6	OFF	OFF	ON	OFF	ON
7	OFF	OFF	ON	ON	OFF
8	OFF	OFF	ON	ON	ON
9	OFF	ON	OFF	OFF	OFF
10	OFF	ON	OFF	OFF	ON
11	OFF	ON	OFF	ON	OFF
12	OFF	ON	OFF	ON	ON
13	OFF	ON	ON	OFF	OFF
14	OFF	ON	ON	OFF	ON
15	OFF	ON	ON	ON	OFF
16	OFF	ON	ON	ON	ON
17	ON	OFF	OFF	OFF	OFF
18	ON	OFF	OFF	OFF	ON
19	ON	OFF	OFF	ON	OFF
20	ON	OFF	OFF	ON	ON
21	ON	OFF	ON	OFF	OFF
22	ON	OFF	ON	OFF	ON
23	ON	OFF	ON	ON	OFF
24	ON	OFF	ON	ON	ON

See Note following Table 5. on equivalency between DIP-switch settings and remote control P-codes for time slot selection.

NOTE: For SW2 and SW3, ON = RIGHT and OFF = LEFT.

Table 4. User Baud Rate Selection for RFL OCUDP module.

Baud Rate	SW4-4	SW4-3	SW4-2	SW4-1
56 kbps	OFF	ON	ON	ON
64 kbps	OFF	OFF	OFF	OFF

NOTE: For SW4, ON = RIGHT and OFF = LEFT.

7. Select an unused transmit channel time slot using DIP switches SW2-1 through SW2-5 using direct binary coding as shown in Table 3. Select an unused receive channel time slot using DIP switches SW3-1 through SW3-5 using direct binary coding as shown in [Table 3](#). Refer to the multiplexer manual for guidelines on time slot selection.

Note that selecting an invalid time slot will disable the module. In T1 systems, only time slots 1 through 24 are allowed. Time slot 24 is not available for a T1 system using fast reframing.

8. Select transmit bus direction by using DIP switch SW3-6.
Place SW3-6 in the OFF/LEFT position to transmit in the A direction and receive from the B direction (default). Place SW3-6 in the ON/RIGHT position to transmit in the B direction and receive from the A direction.

Note: When the OCUDP Module is in a terminal-end multiplexer, the OCUDP Module must be configured to transmit in direction A.

9. Select the baud rate by using DIP switches SW4-1 to SW4-4 in accordance with Table 4.
10. Set DIP switch SW4-5 to the ON/RIGHT position. OFF/LEFT is currently not supported.
11. Select ZCS (zero code suppression) enable or disable by using DIP switch SW4-6.
Set DIP switch SW4-6 to the OFF/LEFT position to enable ZCS.
Set DIP switch SW4-6 to the ON/RIGHT position to disable ZCS.
12. Select AB signaling enable or disable by using DIP switch SW4-7.
Set DIP switch SW4-7 to the OFF/LEFT position to enable AB signaling.
Set DIP switch SW4-7 to the ON/RIGHT position to disable AB signaling.
13. Select latched loopback functionality by using DIP switch SW4-8.
Set DIP switch SW4-8 to the OFF/LEFT position to enable latched loopback functionality.
Set DIP switch SW4-8 to the ON/RIGHT position to disable latched loopback functionality.

Note: Latched Loopback Functionality allows the OCUDP Module to act upon inline commands to force OCU/DSU loopbacks.

DIP Switch SW4-8 does not cause these loopbacks; it only permits the function.

14. If you plan to operate the RFL OCUDP module under **local control**, perform the following steps; otherwise, go to step 15 for remote control.
- Set to local control by placing DIP switch SW1-2 in the UP/RIGHT position.
 - Turn service on by placing DIP switch SW2-6 in the OFF/LEFT position.
 - Slide the module into the selected module slot until it is firmly seated and the module front panel is flush with the top and bottom of the shelf.
 - Go to step 16.

Notes:

- Switch SW1-1 has no user functionality.
- DIP Switch settings go into effect when the module is reset by either re-powering or toggling SW1-2 from remote to local.

15. If you are planning to operate the RFL OCUDP Module under remote control, perform the steps shown below.

If you **intend to store** the preset local-control Channel Module DIP-switch settings into the Common Module, in order to use as initial module configuration for remote-control mode further on, **continue with step a).**

If you **do not intend to store** the local-control DIP-switch settings into the Common Module **skip to step e).**

- Set to Local Control by placing DIP switch SW1-2 in the UP/RIGHT position.
- Turn Module Service off by placing DIP switch SW2-6 in the ON/RIGHT position.
- Slide the module into the selected module slot until it is firmly seated and the module front panel is flush with the top and bottom of the shelf.
- Wait 15 seconds for all of the channel module's DIP-switch settings to be read and stored into the shelf Common Module. This saves the preset configuration without activating the channel module (since service is off).
- Set the remote control mode on by placing DIP switch SW1-2 into the DOWN/LEFT position. The OCUDP Module does not have to be pulled out or reset for this change.
- At this point, the Common Module is downloading saved (if any) configurations into the channel module.
- Verify module configuration, either through remote control "CONFIG?" user query or through the Network Management System.

- h. Turn Module Service on, either through the remote control P4 parameter or through the Network Management System.

The RFL OCUDP's operating parameters can now be changed by remote control. See Remote Control Interface section of this Instruction Data Sheet for more information.

- i. Go to step 16.

- 16. On the Module Record Card located to the right of the shelf, record the channel bank type, time slot, and any other pertinent information.

The RFL OCUDP is now installed. If your multiplexer is set up for remote access and control, you can now change the operating parameters of the module by using simple commands. For more information on remote access and control, consult your multiplexer operation manual.

PHYSICAL DESCRIPTION

The OCUDP module consists of a Level One LXT400 Transceiver integrated circuit, a logic Actel chip, an SCB Actel chip, an 80C320 microprocessor with associated memory chips, DIP switches, LEDs, and some interface and isolation circuitry. A functional block diagram of the OCUDP module is shown in Figure 3.

The LXT400 performs the transmitter and receiver functions at the metallic bipolar interface, including transmit pulse shaping, receive signal detection and timing recovery, line equalization, digital back-end loopback, and monitoring of line status and equalizer performance. The chip conforms to the AT&T, ANSI and Bellcore specifications. The logic Actel chip handles the channel interface to the T1 backplane signals, the digital logic to process the data, and the interface and control circuits to communicate with the LXT400 and the microprocessor. The SCB Actel handles the interface between the microprocessor and the SCB bus. The microprocessor performs the function of monitoring the data and status information, communicating with the SCB bus, and controlling the functions of the board. The main data flow remains within the logic Actel chip.

The OCUDP card also provides both the source and the sink for DC sealing current that is circulated in the cable pairs to reduce splice resistance. In addition, polarity reversal of the sealing current is required to signal the terminating DSU/CSU to initiate channel loopback. Sealing current should be in the range of 4 to 20mA. Normal polarity is for the transmit pair to be negative with respect to the receive pair. The card initiates channel loopback upon receiving the channel loopback code from upstream by reversing sealing current. Both normal and latching loopback capability are provided. The unit also loops the transmit pair back into the receive pair, disconnecting it from the customer loop.

Bantam access jacks permit module testing using a portable test set.

ALERTS/ALARMS

The RFL OCUDP module reports no module level ALERT or ALARM signals to the shelf Common Module.

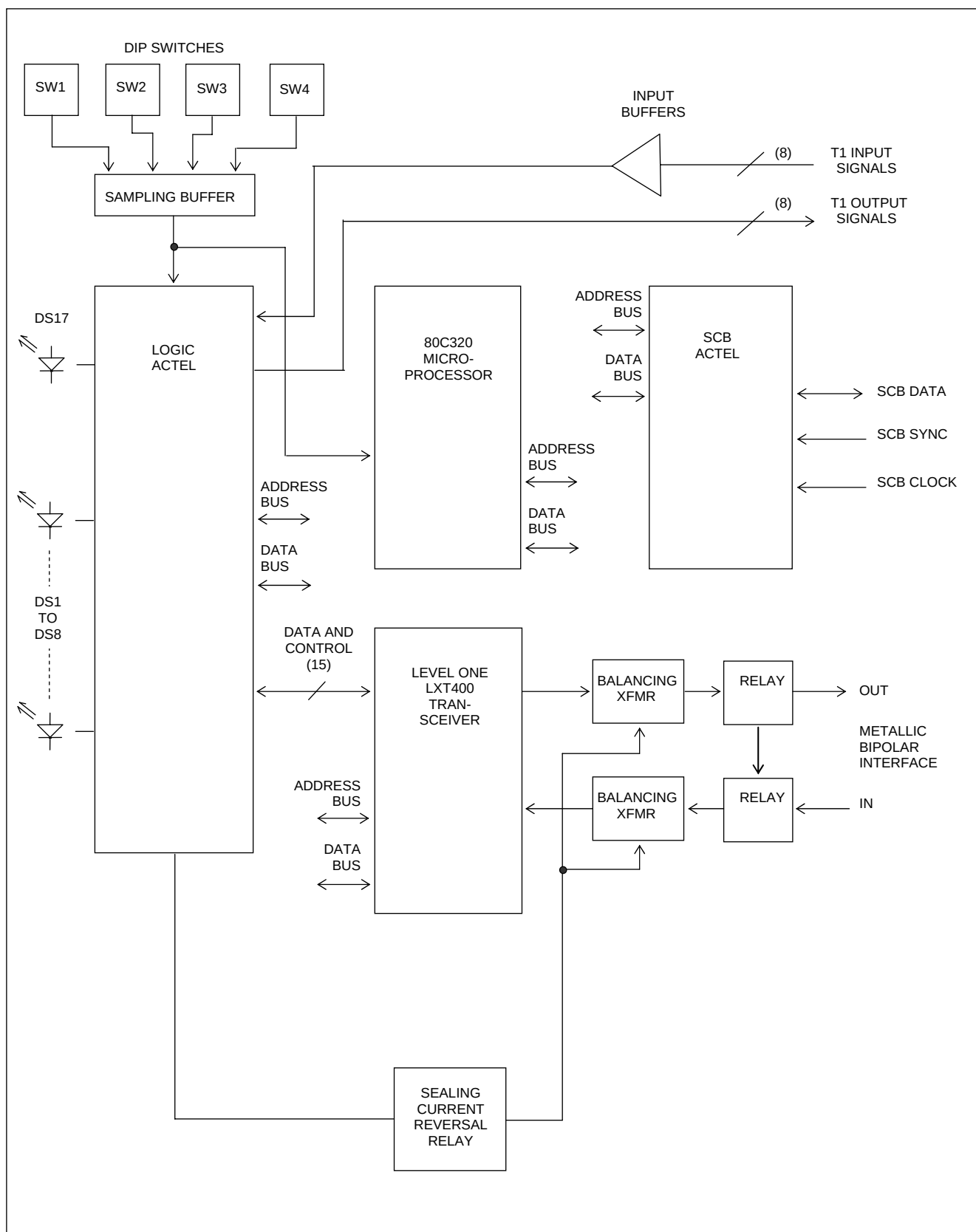


Figure 3. Functional block diagram, RFL OCUDP module.

REMOTE CONTROL INTERFACE

When installed in an IMUX 2000 remote controllable shelf, the RFL OCUDP module can be operated under local or remote control. When under remote control, certain configuration parameters can only be changed through the RS-232 remote port on the multiplexer. The remote interface for these modules involves two codes: a “P” (parameter) code, and an “S” (status) code. See the IMUX 2000 instruction manual for more information on the remote control interface.

The RFL OCUDP reports itself as a “Type 124” module when installed in a T1 system.

“P” CODES

“P” codes, when used in the parameter field on a “SET” command, allow the user to set certain parameters on the module by remote control, just like setting the switches on a module under local control. “P” codes also appear in the response to a “CONFIG?” query, showing the current parameter settings on the module.

There are six “P” codes for the RFL OCUDP when operated in T1 systems: P1 through P6. Each of these P codes can be a decimal number from 0 to 255, which can also be represented as an eight-digit binary number (in parenthesis). The binary representation is more useful for setting and interpreting the “P” codes, since each binary digit (0 or 1) corresponds to the ON or OFF setting for a particular switch on the module. Table 5 describes the meanings of the “P” codes for the RFL OCUDP module.

The RFL OCUDP Module may be queried about its current configuration as follows.

User command:

<MULTIPLEXER ADDRESS>:<CARD ADDRESS>:CONFIG?;

Typical OCUDP Module response (actual values depend on current configuration):

***OK
CHANNEL CARD 3, TYPE 124
UNDER REMOTE CONTROL
SRVC = ON
P01 = 1 (B00000001)
P02 = 104 (B01101000)
P03 = 118 (B01110110)
P04 = 246 (B11110110)
P05 = 0 (B00000000)
P06 = 0 (B00000000)
P07 = 1 (B00000001)**

NOTE

Unlike other RFL IMUX Modules, Module Service for the OCUDP Module is **not controlled** by parameter SRVC = ON/OFF. The value of parameter SRVC returned in response a configuration inquiry has no meaning for the OCUDP Module.

Module Service for the OCUDP Module is controlled by bit 5 of [7:0] of configuration parameter P4.

The RFL OCUDP Module may be configured as follows:

User command:

<MULTIPLEXER ADDRESS>:<CARD ADDRESS>:SET:<PARAMETER>=<VALUE>;

The value may be in decimal format or in binary (binary value preceded by B).

For example, Module Service for the OCUDP with Card Address 3, located in Multiplexer Shelf 2, may be set as follows:

2:C3:SET:P4=B00110110;

Note that the complete parameter must be set; in this particular example, parameter P4 configured Module Service to be ON and Receive Time Slot = 10.

The RFL OCUDP Module may be interrogated about its status, as follows.

User command:

<MULTIPLEXER ADDRESS>:<CARD ADDRESS>:STATUS?;;

Typical OCUDP Module response (actual values depend on current status):

***OK
FROM NET ADDRESS 2
CHANNEL CARD 3, TYPE 124
S01 = 67 (B01000011)
S02 = 47 ... (etc.)
...**

For convenience, status values are returned both in decimal and binary format.

Table 5. Remote configuration settings (“P” codes) for OCUDP module

P Code	Bit positions	Value ⁽¹⁾	Description
P1	B 0 0 0 0 0 0 0 0	...	Spare
P2	B 0 0 0 0 0 0 0 0 - - - - ↑↑↑↑ BAUD RATE	0000 to 1111	1000 = 56.0 kbps user rate 1111 = 64.0 kbps user rate Other values invalid
	B 0 0 0 0 0 0 0 0 - - - ↑ - - - - SW56	1	Not used
		0	Disable switch 56 operation (must be set to this value)
	B 0 0 0 0 0 0 0 0 - - ↑ - - - - ZERO CODE SUPPRESSION	1	Enable zero code suppression
		0	Disable zero code suppression
	B 0 0 0 0 0 0 0 0 - ↑ - - - - - AB SIGNALING	1	Enable AB signaling
		0	Disable AB signaling
	B 0 0 0 0 0 0 0 0 ↑ - - - - - -	...	Not used
P3	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑ RECEIVE TIME SLOT	00000 to 11111	Sets receive time slot in accordance with Table 3, with “OFF” equivalent to 1 and “ON” equivalent to 0.
	B 0 0 0 0 0 0 0 0 - - ↑ - - - - A/B DIRECTION	1	Transmit on A, receive on B
		0	Transmit on B, receive on A
	B 0 0 0 0 0 0 0 0 - ↑ - - - - - QUALITY MONITOR	...	Not used
	B 0 0 0 0 0 0 0 0 ↑ - - - - - - SEALING CURRENT ALERT	1	Loss of sealing current causes alert
		0	Loss of sealing current does not cause alert

1. These are the only legal values for setting the parameters. Setting any parameter to a value outside its specified range will produce an unpredictable result.

Table 5. - continued. Remote configuration settings (“P” codes) for OCUDP module

P Code	Bit positions	Value ⁽¹⁾	Description
P4	B 0 0 0 0 0 0 0 0 - - - ↑↑↑↑↑ TRANSMIT TIMESLOT	00000 to 11111	Sets transmit timeslot in accordance with Table 3 With “OFF” equivalent to 1 and “ON” equivalent to 0
	B 0 0 0 0 0 0 0 0 - - ↑ - - - - MODULE SERVICE ENABLE	1	Module service enabled
		0	Module service disabled
	B 0 0 0 0 0 0 0 0 ↑↑ - - - - -	...	Not Used
P5	B 0 0 0 0 0 0 0 0 - - - - - ↑ DIGITAL LOOPBACK	1	Loopback enabled
		0	Loopback disabled
	B 0 0 0 0 0 0 0 0 - - - - - ↑ - LATCHING LOOPBACK FUNCTIONALITY	1	Latching loopback functionality for DSU and channel, enable (this permits reception of inline control codes)
		0	Latching loopback functionality for DSU and channel, disable
	B 0 0 0 0 0 0 0 0 ↑ - - - - - RESET LATCHED STATUS	1	0 to 1 transition resets latching status, Contained in Status Bytes S4 through S7
		0	
	B 0 0 0 0 0 0 0 0 - ↑↑↑↑↑ - -	...	Not used
P6	B 0 0 0 0 0 0 0 0	...	Spare

Notes:

For time slot selection, the setting of switches shown in Table 3. are equivalent to Remote Control Settings as follows:

TX Slot: Local Control SW2 – Positions 5 through 1
 Remote Control P4 – Bits 4 through 0.

RX Slot: Local Control SW3 – Positions 5 through 1
 Remote Control P3 – Bits 4 through 0.

Example: Time slot 10:
 SW2/3 = X X X OFF OFF OFF OFF ON
 P4/3 = X X X 1 0 1 1 0

Note:

- OCUDP Module Service is controlled by P4, bit 5 of [7:0].
- Module Service is not controlled by parameter SRVC = ON/OFF, unlike some of the other RFL IMUX modules.
- Value of parameter SRVC shown in response to a configuration inquiry has no meaning for the OCUDP Module.

“S” CODES

“S” codes appear in response to a “STATUS?” query. There are seven “S” codes for the RFL OCUDP when operated in T1 systems. Like the “P” code, this number is displayed in both decimal and binary form. Table 6 describes the meanings of the “S” codes for the RFL OCUDP module.

A typical response to a “STATUS?” query looks like this:

*** OK**
CHANNEL CARD 3, TYPE 124
S01 = 3 (B00000011);

Table 6. Remote status messages (“S” codes) for OCUDP module

S CODE	Bit positions	Value	Description
S1	B 0 0 0 0 0 0 0 0 - - - - - ↑ MULTIPLEXER TROUBLE	1	Multiplexer backplane status normal
		0	Multiplexer backplane trouble condition
	B 0 0 0 0 0 0 0 0 - - - - - ↑ - SEALING CURRENT	1	Sealing current detected
		0	Sealing current NOT detected
	B 0 0 0 0 0 0 0 0 - - ↑ ↑ ↑ - -	...	Not used
	B 0 0 0 0 0 0 0 0 ↑ ↑ - - - - -	...	Hardware generation ID code 00 = Design capable of 56 kbps only 01 = Design capable of 56 and 64 kbps

Table 6. – continued, Remote status messages (“S” codes) for OCUDP module

S CODE	Position	Value	Description
S2	B 0 0 0 0 0 0 0 0 - - - - ↑ ↑ ↑ ↑ LOOP LENGTH		See Table 7
	B 0 0 0 0 0 0 0 0 - - - ↑ - - - - RECEIVER CONVERGING	1	Receiver converging process (condition exists during link synchronization)
		0	Synchronization complete or failed
	B 0 0 0 0 0 0 0 0 - - ↑ - - - - FULL OPERATION	1	Full operation of metallic line receiver
		0	metallic line receiver operation impaired
	B 0 0 0 0 0 0 0 0 - ↑ - - - - - LEVEL DETECTION	1	Level detection
		0	NO level detection
	B 0 0 0 0 0 0 0 0 ↑ - - - - - RECEIVE LOSS OF SIGNAL	1	Receive loss of signal
		0	NO receive loss of signal
S3	B 0 0 0 0 0 0 0 0 ↑ ↑ ↑ ↑ ↑ ↑ ↑ ↑ RX SIGNAL MAGNITUDE	00000000 to 11111111	See LEVEL ONE LXT400 data sheet

Table 6. – continued, Remote status messages (“S” codes) for OCUDP module

S CODE	Position	Value	Description
S4*	B 0 0 0 0 0 0 0 0 - - - - - ↑ TEST CODE	1	Code detected in data stream.
		0	Code not detected in data stream since last reset.
	B 0 0 0 0 0 0 0 0 - - - - - ↑ - UNASSIGNED MUX CHANNEL	1	Code detected in data stream.
		0	Code not detected in data stream since last reset.
	B 0 0 0 0 0 0 0 0 - - - - - ↑ - - MUX-OUT-OF-SYNC	1	Code detected in data stream.
		0	Code not detected in data stream since last reset.
	B 0 0 0 0 0 0 0 0 - - - - ↑ - - - ABNORMAL STATION	1	Code detected in data stream.
		0	Code not detected in data stream since last reset.
	B 0 0 0 0 0 0 0 0 - - - ↑ - - - - OCU LOOPBACK	1	Code detected in data stream.
		0	Code not detected in data stream since last reset.
	B 0 0 0 0 0 0 0 0 - - ↑ - - - - - DSU LOOPBACK	1	Code detected in data stream.
		0	Code not detected in data stream since last reset.
	B 0 0 0 0 0 0 0 0 - ↑ - - - - - - CHANNEL LOOPBACK	1	Code detected in data stream.
		0	Code not detected in data stream since last reset.
	B 0 0 0 0 0 0 0 0 ↑ - - - - - - - RECEIVING IDLE CODE	1	Code detected in data stream.
		0	Code not detected in data stream since last reset.

* S4 Remote Status Message from T1 side. **Not used in 64 kbps mode.**

Note:

Status bits in S4 latch events occurred since the last reset of the Latched Status. To refresh S4, toggle P5 – Bit 7 (Reset Latched Status) from 0 to 1.

Table 6. – continued, Remote status messages (“S” codes) for OCUDP module

S CODE	Position	Value	Description
S5*	B 0 0 0 0 0 0 0 0 - - - - - ↑ RELEASE CODE	1	Code detected in data stream.
		0	Code not detected in data stream since last reset.
	B 0 0 0 0 0 0 0 0 - - - - - ↑ - BLOCK CODE	1	Code detected in data stream.
		0	Code not detected in data stream since last reset.
	B 0 0 0 0 0 0 0 0 - - - - - ↑ - - TRANSIT IN PROGRESS	1	Code detected in data stream.
		0	Code not detected in data stream since last reset.
	B 0 0 0 0 0 0 0 0 - - - - ↑ - - - FAR-END VOICE	1	Code detected in data stream.
		0	Code not detected in data stream since last reset.
	B 0 0 0 0 0 0 0 0 - - - ↑ - - - - LOOPBACK ENABLE	1	Code detected in data stream.
		0	Code not detected in data stream since last reset.
	B 0 0 0 0 0 0 0 0 - - ↑ - - - - - MULTIPOINT UNIT ALERT	1	Code detected in data stream.
		0	Code not detected in data stream since last reset.
	B 0 0 0 0 0 0 0 0 - ↑ - - - - - - TEST ALERT	1	Code detected in data stream.
		0	Code not detected in data stream since last reset.

* S5 Remote Status Message from T1 side. **Not used in 64 kbps mode.**

Note:

Status bits in S5 latch events occurred since the last reset of the Latched Status. To refresh S5, toggle P5 – Bit 7 (Reset Latched Status) from 0 to 1.

Table 6. – continued, Remote status messages (“S” codes) for OCUDP module

S CODE	Position	Value	Description
S6**	B 0 0 0 0 0 0 0 0 - - - - - ↑ TRANSMITTING IDLE	1	Code detected in data stream.
		0	Code not detected in data stream since last reset.
	B 0 0 0 0 0 0 0 0 - - - - - ↑ - TRANSMITTING LOOPBACK	1	Code detected in data stream.
		0	Code not detected in data stream since last reset.
	B 0 0 0 0 0 0 0 0 - - - - - ↑ - - TRANSMITTING ABNORMAL STATION	1	Code detected in data stream.
		0	Code not detected in data stream since last reset.
S7	B 0 0 0 0 0 0 0 0	...	Spare

** S6 Remote Status Message from data port side. **Not used in 64 kbps mode.**

Note:

Status bits in S6 latch events occurred since the last reset of the Latched Status. To refresh S6, toggle P5 – Bit 7 (Reset Latched Status) from 0 to 1

Table 7. LS Loop Length Bits LL3-LL0

User Rate Kbps	Approximate line loss in dB/Loop length in km (24 AWG, no bridged taps) *								
	0111	1000	1001	1010	1011	1100	1101	1110	1111
56.0	50.5/8.5	44.4/7.5	38.4/6.4	32.3/5.3	26.0/4.2	19.7/3.2	13.6/2.1	7.3/1.1	0.0/0.0
64.0	50.7/8.0	45.0/7.0	38.8/6.0	32.5/5.0	26.3/4.0	20.0/3.0	14.0/2.0	7.4/1.0	0.0/0.0

* Based on received signal strength/filter selection, assuming far-end pulse transmission compliant with AT&T Pub 62310 or T1E1/90-051. See LEVEL ONE LXT400 data sheet, Revision 3.2 for more information.

LOOPBACK TESTING

A local loopback test should be performed when the module is first installed, or any time the integrity of the module needs to be checked. The loopback test can be performed on modules in terminal systems or drop/insert systems. The loopback test is a tool for locating problems, but is no substitute for troubleshooting expertise.

Before starting a loopback test, make sure the following three conditions have been met:

1. The OCUDP module and I/O adapter must be installed in an RFL IMUX 2000 chassis.
2. Power must be applied to the system.
3. The module must be out of service.

A telecommunications CSU/DSU test set that can accept DDS loop signals will be required for the loopback test (Black Box Corporation CSU/DSU MS or equivalent).

LOCAL LOOPBACK TEST PROCEDURE

1. Press the Group toggle switch on the CM-3 left or right until the function display reads LPBK. Then push the SET toggle switch left until the function display reads EqLB. At this time push the SET toggle switch twice to the right.

NOTE

Equipment Loopback on the CM-3 will loopback all DS0 channels within that shelf

The green LED above the SET toggle switch should blink after the first push and should be steady after the second push.

The yellow loopback LED on the CM-3 and the yellow LED on the power supply should be lit, indicating that the system is in local loopback.

2. Connect the test set to the cable assembly in accordance with the manufacturers procedures. Then perform a bit error rate test.

3. Observe that zero errors are indicated on the receive side of the test set.

**If an error count occurs, check all option selections and repeat steps 1 through 3.
If the error count persists, check the following:**

- a. **Make sure the test set is correctly set up.**
- b. **Make sure the test set cable is correctly connected.**
- c. **Make sure the module under test is correctly installed.**
- d. **Make sure the cable assembly is firmly and correctly connected.**

If the error source is localized to the module or the cable assembly, return the defective component to RFL for repair. If an error count persists after these steps have been taken, check for an outside error source.

TROUBLESHOOTING

If there is an apparent malfunction, first check that the configuration is appropriate for the transmission system in use, and that the transmit and receive configurations are identical.

Problems may occur at the common equipment or facility level that may affect the operation of this module. Refer to the “Maintenance” section in your multiplexer manual for system analysis procedures.

Use the following procedure to determine whether a problem is being caused by the OCUDP or by some other part of the system.

1. If more than one module is on the same time slot, remove those modules that are known to be good.
2. Perform a local loopback test, as described in steps 1 through 3 of the Local Loopback test procedure.
3. If the loopback test indicates that the module is functioning properly, then check that the terminal equipment is functioning properly. If so, then the test is complete. If not, then check for an outside error source.
4. If the error count persists, then swap modules. Replace the module with another that is known to be functioning properly. If the replacement module is OK, then use the Repair/Return procedure in the General Information Section of the manual to return the defective module to RFL for repair.
5. If proper function is not obtained, perform individual multiplex tests as described in the multiplexer manual. If an error count still persists after these steps have been taken, then check for an outside error source.



RFL Electronics, Inc.

IMUX Application Note AN2000-020

Reference Ass'y 106960-5

IMUX 2000

OCUDP for Frame Relay Applications

This Application Note is specific to customers that use the RFL IMUX 2000 OCUDP to carry 56 kb/s Frame Relay circuits such as the DYMEC Dynaster 2000

The data content in certain frame relay circuits can mimic the in-band control codes in a 56 kb/s OCUDP link and cause the OCUDP to erroneously go into loopback. This severs the link and requires the OCUDP to be power cycled to recover.

To prevent this, a special version of the OCUDP Module has been developed that does not react to in-band control codes. The part number is 106960-5.

- When the 106960-5 is set to 56 kb/s it will not accept in-band control codes originating from the customer's frame relay equipment or the T1 data stream.
- Operation at 64 kbps is unaffected.
- Configuration settings in the OCUDP are un-changed from the standard module.

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Notes

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SECTION 17. VOICE MODULES

This section contains Instruction Data Sheets for all voice modules available for use with the IMUX 2000 Intelligent Multiplexer, as of the date this manual was printed:

- o RFL VF-5A Dual-Channel Four-Wire E&M Voice Module**
- o RFL VF-5C Dual-Channel Four-Wire E&M Voice Module**
- o RFL VF-6I Single-Channel Four-Wire Orderwire Voice Frequency Module**
- o RFL VF-8A Selective Calling Unit**
- o RFL VF-10B/11B Foreign Exchange Voice Module (Office End/ Station End)**
- o RFL VF-15/16 Dual-Channel Foreign Exchange Voice Module (Office End/ Station End)**
- o RFL VF-15C Dual-Channel Foreign Exchange Voice Module (Office End)**
- o RFL VF-16B Dual-Channel Foreign Exchange Voice Module (Station End)**
- o RFL VF-25 Four-Port PCM, Four-Wire E&M Voice Module**

Additional schematics, wiring diagrams, or other documents specific to your application may also be placed in this section.

For information on other voice modules that may be available for use with your IMUX 2000, contact the factory or an RFL Sales Representative.

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RFL Electronics Inc.

INSTRUCTION DATA

RFL VF-5A Dual-Channel Four-Wire E&M Voice Module

DESCRIPTION

The RFL VF-5A is a dual-channel four-wire E&M voice-frequency module, designed for use in IMUX 2000 T1 multiplexers. It accepts two voice channels as input and digitizes them; each channel occupies one 64-Kbps time slot on T1 and other digital communications facilities. The RFL VF-5A can be used in both terminal and drop/insert IMUX 2000 multiplexers.

The RFL VF-5A provides high-quality voice characteristics, compatible with AT&T Publication 43801. It allows E&M signaling of Type I, II, and III, with front-panel busy indicators. It has calibrated extended-range input and output signal level adjustments to facilitate interfaces in most four-wire applications.

User-adjustable switches and jumpers allow configuration of several parameters:

- o Selectable Type I, II, or III signaling.
- o Signaling on or off selection.
- o Busy out settings.
- o Selectable transmit/receive direction.
- o Input/output attenuation.
- o Time slot selection.
- o Remote control configuration and status reporting.

SPECIFICATIONS

As of the date this Instruction Data sheet was published, the following specifications apply to the RFL VF-5A module. Because all RFL products undergo constant refinement and improvement, these specifications are subject to change without notice.

Configuration: Two independent voice-frequency channels.

Frequency Response: 300 to 3000 Hz, ± 0.15 dB.

Input Level: -19.0 dBm to +5.0 dBm (-16dBm nominal), adjustable in 0.1-dB steps.

Output Level: -14.0 dBm to +10.0 dBm (+7dBm nominal), adjustable in 0.1-dB steps.

Input Impedance: 600 Ω

Output Impedance: 600 Ω

Idle Channel Noise: Less Than 23 dBnc0.

Signal-To-Distortion (1004-Hz Input, 0 to -30 dBm): Greater Than 33 dB C Message.

Signaling: Selectable, E&M Type I, II, or II, or Transmission Only (TO) Mode

M Lead Input:

Input Impedance: Greater than 20K ohms to ground

Busy: -20 to -60 Volts

Idle: Open or Ground

E Lead Output:

Busy: Less than 50 ohms to ground

Idle: Open

Time Slots Required:

One-Channel Operation: One selectable time slot.

Two-Channel Operation: Two adjacent selectable time slots.

Remote Interface: Compatible with SCL remote command language; allows module configuration and status access.

Operating Temperature: -20°C to +55°C (-4°F to +131°F).

Relative Humidity: 0 to 90 percent, non-condensing.

Input Power: 1.0 watt nominal

INSTALLATION

Before the RFL VF-5A can be placed in service, it must be installed in a multiplexer shelf. Installation involves determining the module slot in the Main Shelf or Repeater Shelf where the module will be installed, inserting a Module Adapter into the rear of the shelf behind the module slot, connecting all signal and power wiring to the Module Adapter, checking the settings of all jumpers, and inserting the module into the front of the shelf.

NOTE

Power supply and time slot considerations may affect the installation of this module into an existing multiplexer shelf. Refer to the multiplexer manual for more information.

The following instructions are provided for installing RFL VF-5A modules into existing systems. If the module was included as part of a system, installation was done at the factory. Otherwise proceed as follows:

1. Carefully inspect the module for any visible signs of shipping damage. If you suspect damage to the module, immediately call RFL Customer Service at the number listed at the bottom of this page.
2. Determine the module slot in the Main Shelf or Repeater Shelf where the RFL VF-5A will be installed.

RFL VF-5A modules occupy one module slot in the Main Shelf or Repeater Shelf.

3. Determine which Module Adapter will be used to make connections to the RFL VF-5A module.

Each module in the IMUX 2000 multiplexer requires a Module Adapter. The module adapter provides the appropriate connector for the desired interface. There are six Module Adapters compatible with the RFL VF-5A:

MA-301 The MA-301 accepts a 50-pin Telco connector (Amphenol 57-30500 or equivalent, as shown in Figure 1.) One MA-301 Module Adapter can be used to connect up to three RFL VF-5A modules, for a total of up to six voice channels. If you will be using more than one module with an MA-301, they must be inserted into adjacent slots in the multiplexer. Ribbon cables are provided with the MA-301 to make connections to it from the second and third module locations. (See Figure 2.)

MA-301A The MA-301A is used to isolate the VF-5A from SWC type surges sometimes present on 4-wire voice lines. A terminal strip is provided for hard wire connections to the voice circuit for Channel 1 and Channel 2, as shown in Figure 3.

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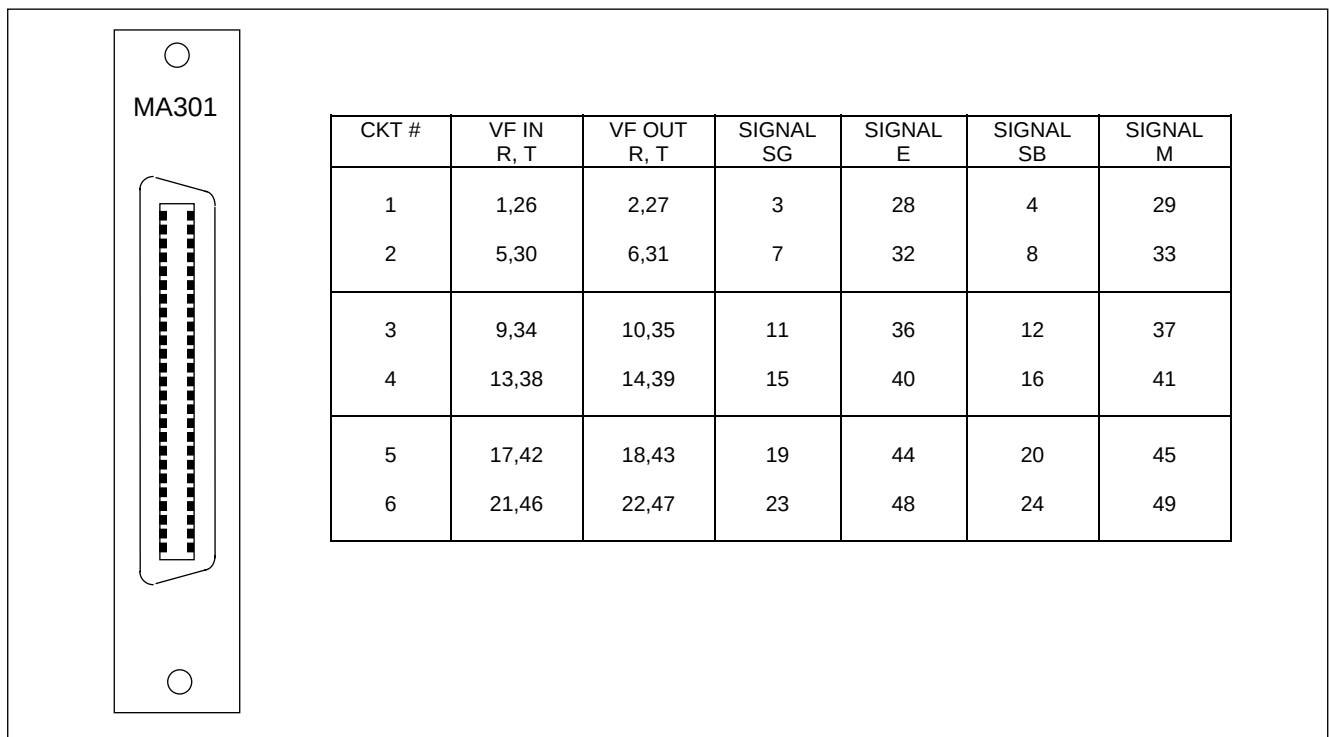


Figure 1. MA-301 Module Adapter

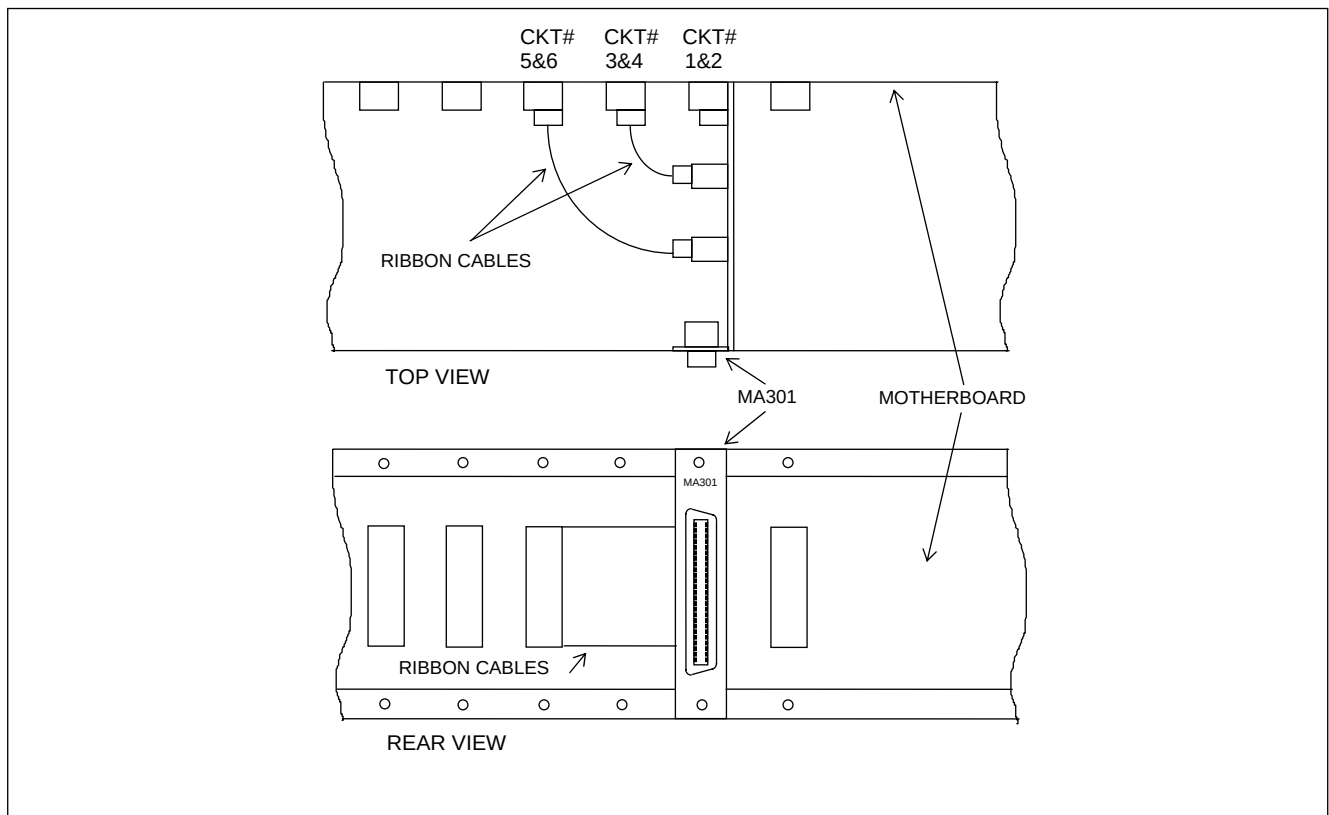


Figure 2. Connecting two RFL VF-5A modules to a single MA-301 Module Adapter.

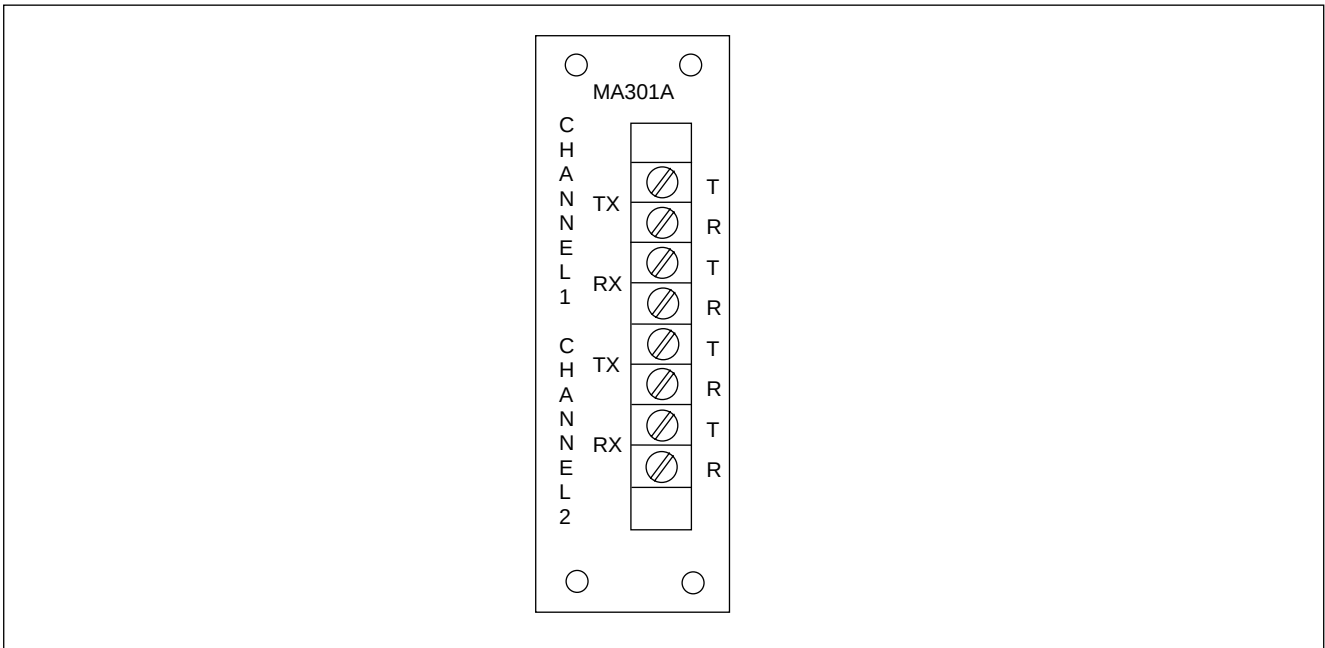


Figure 3. MA-301A Module Adapter

MA-301B The MA-301B provides pluggable terminal block connections for a single VF-5A module. Audio and signalling connections are available at the terminal block. No additional SWC or fast transient protection is provided on this I/O. Refer to Figure 4 for panel view and terminal connections.

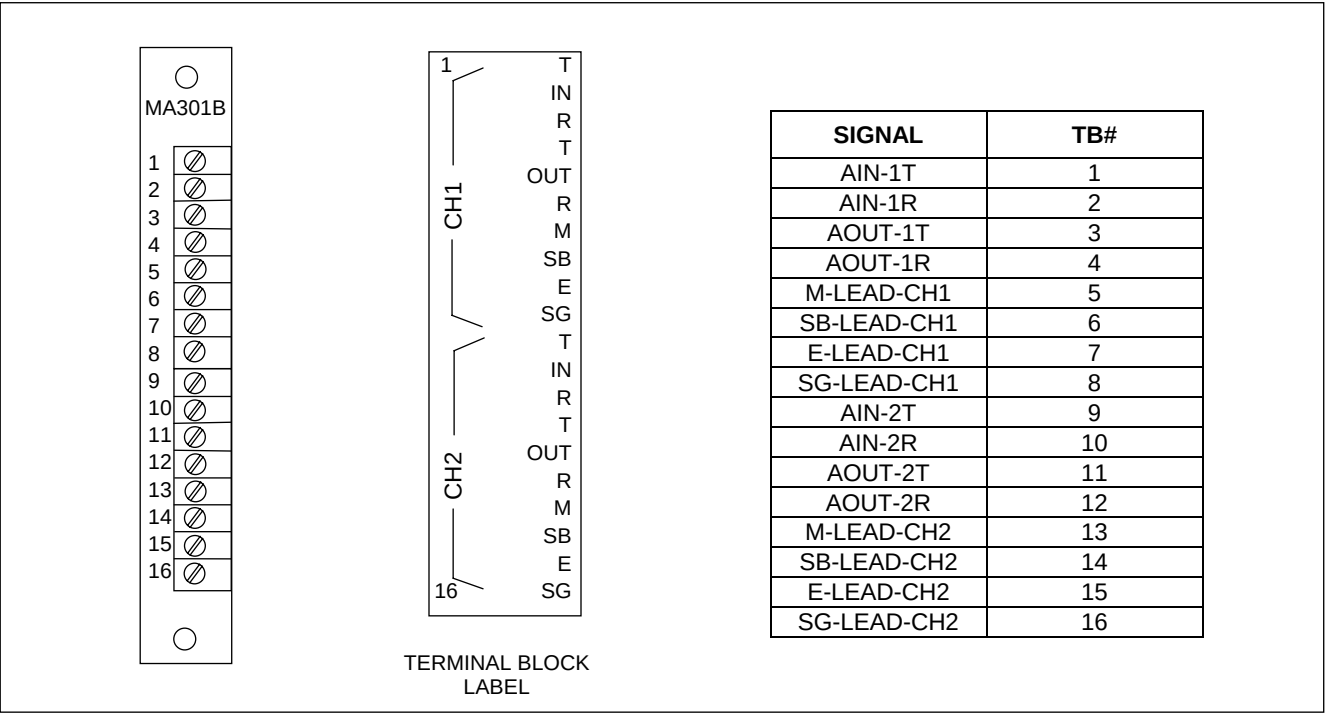


Figure 4. MA-301B Module Adapter

MA-301D

The MA-301D provides pluggable terminal block connections for a single VF-5A module. Tip and Ring test points are available for the inputs and outputs of channels 1 and 2. Audio and signaling connections are available at the terminal block. No additional SWC or fast transient protection is provided on this I/O. Refer to Figure 5 for panel view and terminal connections.

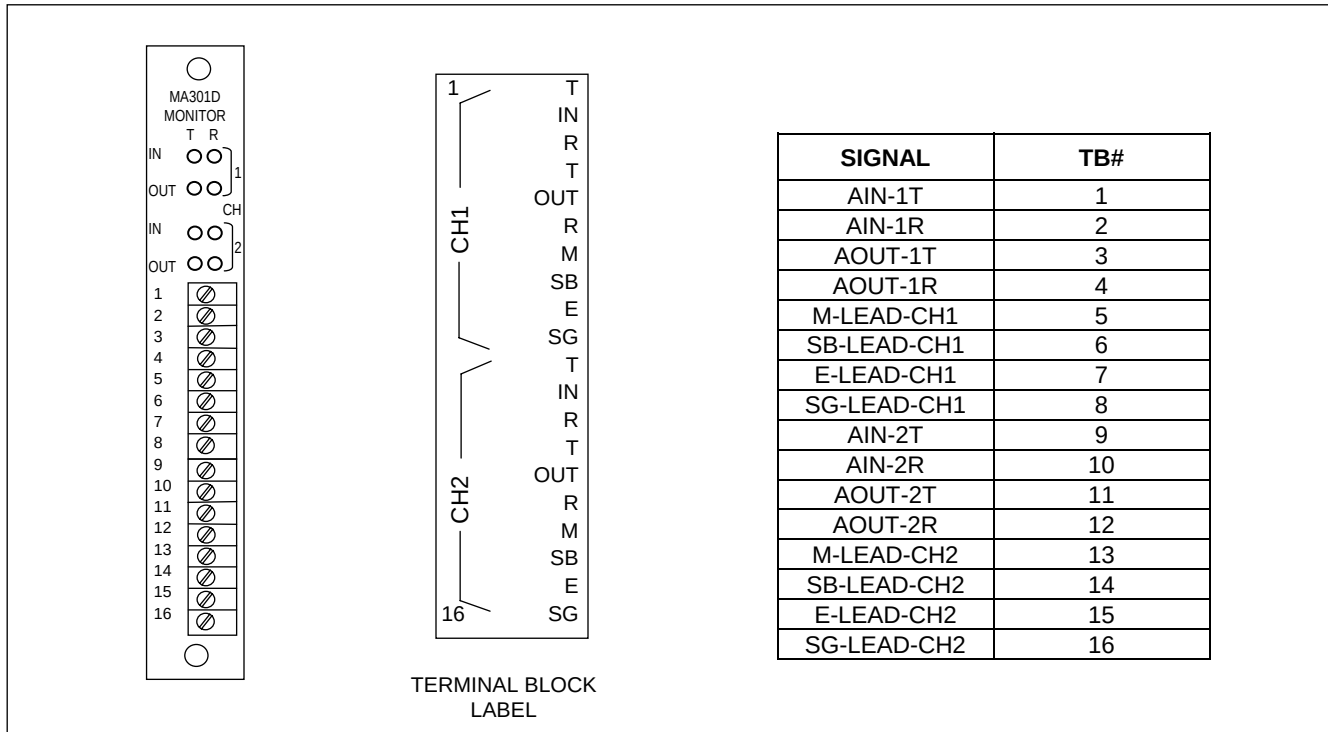


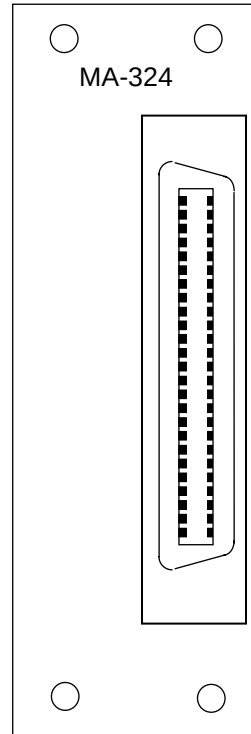
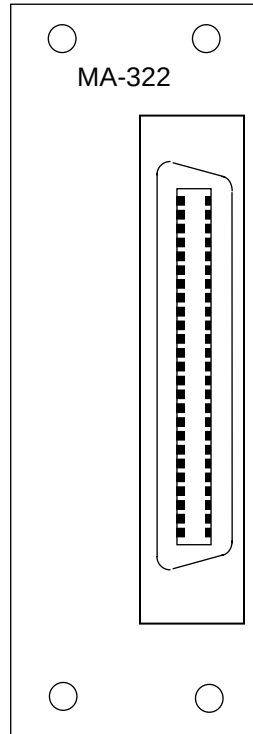
Figure 5. MA-301D Module Adapter

MA-322

The MA-322 accepts a 50-pin Telco connector (Amphenol 57-30500 or equivalent, as shown in Figure 6.) One MA-322 Module Adapter is used for each RFL VF-5A module, and occupies two rear slots in the IMUX 2000 chassis. The MA-322 is used to convert both of the 4-wire outputs (Channel 1 and 2) from 4-wire to 2-wire. The impedance is 600 Ohms, the frequency response is ± 2 dB from 200Hz to 3000Hz, and the transformer loss (hybrid loss) is $\cong 4.0$ dB.

MA-324

The MA-324 accepts a 50-pin Telco connector (Amphenol 57-30500 or equivalent, as shown in Figure 6.) One MA-324 Module Adapter is used for each RFL VF-5A module and occupies two rear slots in the IMUX 2000 chassis. The MA-324 is used to convert one of the 4-wire outputs (Channel 1) from 4-wire to 2-wire. The other 4-wire output (Channel 2) remains 4-wire. The impedance is 600 Ohms, the frequency response is ± 2 dB from 200Hz to 3000Hz, and the transformer loss (hybrid loss) is $\cong 4.0$ dB.



Pin No.	MA-322 Pin Functions	MA-324 Pin Functions
1	Channel 1 Ring	Channel 1 Ring
3	SG - Channel 1	SG - Channel 1
4	SB - Channel 1	SB - Channel 1
5	Channel 2 Ring	VF IN Channel 2 Ring
6	Not Used	VF OUT Channel 2 Ring
7	SG - Channel 2	SG - Channel 2
8	SB - Channel 2	SB - Channel 2
26	Channel 1 Tip	Channel 1 Tip
28	E1 - Channel 1	E1 - Channel 1
29	M1 - Channel 1	M1 - Channel 1
30	Channel 2 Tip	VF IN Channel 2 Tip
31	Not Used	VF OUT Channel 2 Tip
32	E1 - Channel 2	E1 - Channel 2
33	M1 - Channel 2	M1 - Channel 2

Note: All unlisted pins are not used.

Figure 6. MA-322/MA-324 Module Adapters

4. Insert the desired Module Adapter into the rear of the slot which will hold the RFL VF-5A module, and make all connections to the module Adapter.
If an MA-301, MA-322 or MA-324 Module Adapter is being used, plug the 50-pin Telco connector into its 50-pin connector.

If an MA-301A Module Adapter is being used, connect all signal wiring to the terminal strip at the rear of the MA-301A using Figure 3 as a guide.

If an MA-301B or MA-301D Module Adapter is being used, connect all signal wiring to the terminal strip at the rear of the module using Figures 4 and 5 as a guide.

5. Refer to Figure 7 for the location of switches and other controls and indicators on the VF-5A.
6. Set jumper E5 for either one-channel or two-channel operation.
When jumper E5 is in place, Channel 2 is disabled. The RFL VF-5A is set for one-channel operation. For two-channel operation, remove jumper E5; this enables Channel 2.
7. Set jumper E6 for the type of signaling required on Channel 1.
When jumper E6 is in place, Channel 1 will use Type I signaling. For Type II or Type III signaling, remove jumper E6.
8. Set jumper E7 for the type of signaling required on Channel 2.
When jumper E7 is in place, Channel 2 will use Type I signaling. For Type II or Type III signaling, remove jumper E7.
9. Set DIP switches SW1-1 through SW1-6 for the desired remote access address.
For remote access, each channel module in the IMUX 2000 must have a distinct module address. Valid addresses are the numbers "1" to "36." In most installations, the address will be set to the slot number of the shelf the module is occupying. Table 2 shows the switch settings for the module address.

10. Set DIP switch SW1-7 for either local or remote control.
If you plan to access the RFL VF-5A remotely, place SW1-7 in the ON position. If you will be using the RFL VF-5A under local control, place SW1-7 in the OFF position.
11. Set DIP switch SW1-8 to turn service on or off.
When SW1-8 is in the ON position, service is off. If the RFL VF-5A is under local control, the module is disabled. When SW1-8 is in the OFF position, service is on. If the RFL VF-5A is under local control, the module is enabled.
12. Set DIP switches SW2-1 through SW2-8 for the desired amount of Channel 2 receive attenuation.

Each section of SW2 controls a specific amount of attenuation:

SW2-1	0.1 db
SW2-2	0.2 dB
SW2-3	0.4 dB
SW2-4	0.8 dB
SW2-5	1.5 dB
SW2-6	3.0 dB
SW2-7	6.0 dB
SW2-8	12.0 dB

Switch settings are cumulative. For example, to set the attenuation to 19.0 dB, set the switches as follows:

<u>Section</u>	<u>Value</u>	<u>Setting</u>	<u>Set Value</u>
SW2-1	0.1 dB	OFF	0.0
SW2-2	0.2 dB	ON	0.2
SW2-3	0.4 dB	OFF	0.0
SW2-4	0.8 dB	ON	0.8
SW2-5	1.5 dB	OFF	0.0
SW2-6	3.0 dB	OFF	0.0
SW2-7	6.0 dB	ON	6.0
SW2-8	12.0 dB	ON	12.0
TOTAL			19.0

>> text continues on page 11<<

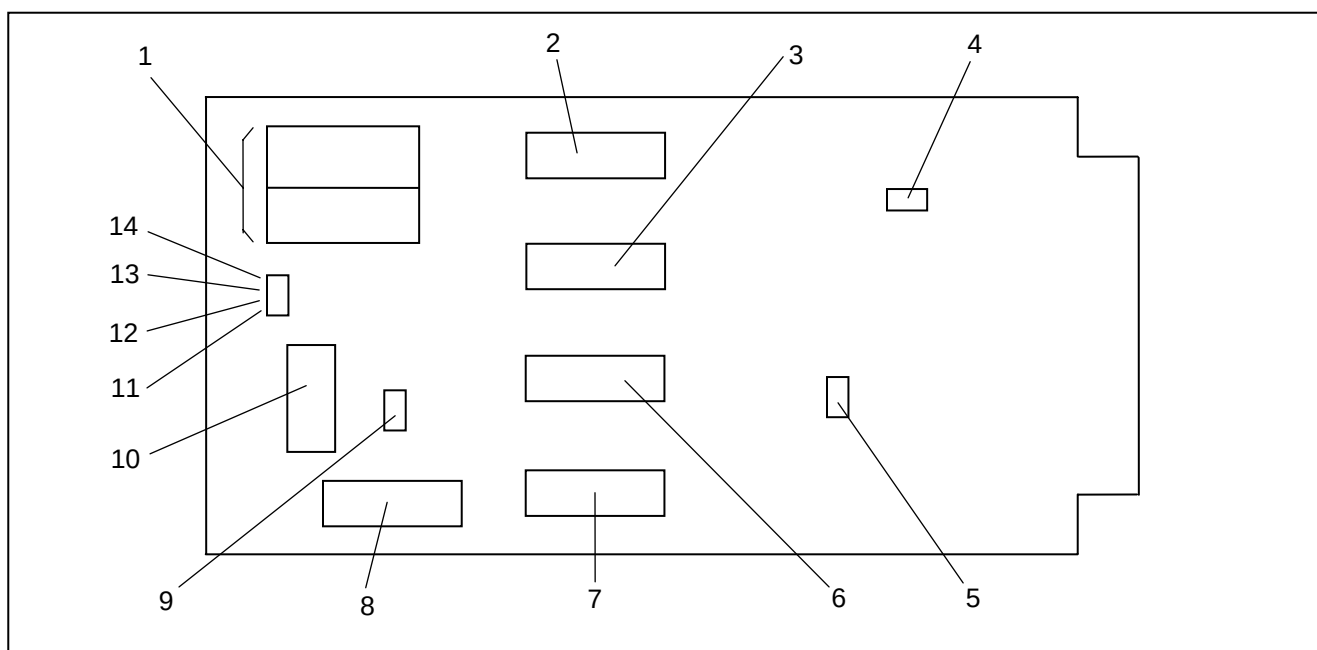


Figure 7. Controls and indicators, RFL VF-5A Dual-Channel Four Wire E&M Voice Module

Table 1. Controls and indicators, RFL VF-5A Dual-Channel Four Wire E&M Voice Module

Item	Name/Description	Function
1	Equipment jacks	Allow channel signals to be equipped: CH1 IN Equipment point for Channel 1 input signal CH1 OUT Equipment point for Channel 1 output signal CH2 IN Equipment point for Channel 2 input signal CH2 OUT Equipment point for Channel 2 output signal
2	DIP switch SW5	Sets Channel 1 transmit attenuator: SW5-1 0.1 dB SW5-2 0.2 dB SW5-3 0.4 dB SW5-4 0.8 dB SW5-5 1.5 dB SW5-6 3.0 dB SW5-7 6.0 dB SW5-8 12.0 dB Switch settings are cumulative. For example, to set the attenuation to 19.0 dB, turn on SW5-2, SW5-4, SW5-7, and SW5-8; to set attenuation to 7.6 dB, turn on SW5-1, SW5-5, and SW5-7. The values shown above allow any setting from zero (no attenuation) to 24 dB, in 0.1 dB increments. Set at the factory for 3 dB. (See Page 18 for more information)
3	DIP switch SW4	Sets Channel 1 receive attenuator. Settings are the same as SW5 above.
4	Jumper E6	Controls Channel 1 E&M signaling types: In Place (normal): Selects Type I signaling for Channel 1. Removed: ⁽¹⁾ Selects Type II or Type III signaling for Channel 1.

Table 1. Controls and indicators, RFL VF-5A Dual-Channel Four Wire E&M Voice Module - continued

Item	Name/Description	Function
5	Jumper E7	Controls Channel 2 E&M signaling types: In Place (normal): Selects Type I signaling for Channel 2. Removed: ⁽¹⁾ Selects Type II or Type III signaling for Channel 2.
6	DIP switch SW3	Sets Channel 2 transmit attenuator. Settings are the same as SW5 above
7	DIP switch SW2	Sets Channel 2 receive attenuator. Settings are the same as SW5 above
8	DIP switch SW1	SW1-1 to SW1-6 Select remote access address (See Table 2 on page 10)
		SW1-7 Enables local or remote control: ⁽²⁾ ON: Remote control is enabled. OFF: Local control is enabled
		SW1-8 Controls service: ON: Service is off. If module is under local control, module is disabled. OFF: Service is on. If module is under local control, module is enabled.
9	Jumper E5	Controls Channel 2 operation: In place: Channel 2 off for one-channel operation. Removed (normal): ⁽¹⁾ Channel 2 active for two-channel operation.
10	DIP switch SW6	SW6-1 to SW6-5 Selects time slots using codes shown in table 3.
		SW6-6 Transmit Bus Selection: ⁽³⁾ UP: Module will transmit on B, receive on A. DOWN: Module will receive on B, transmit on A.
		SW6-7 Controls E&M signaling (per AT&T Publication 43801): ⁽⁴⁾ UP: E&M signaling enabled. DOWN: E&M signaling disabled.
		SW6-8 Not used.
		SW6-9 Controls BUSY 1 output: UP: Normal operation. DOWN: BUSY OUT (OFF HOOK) on Channel 1.
		SW6-10 Controls BUSY 2 output: UP: Normal operation. DOWN: BUSY OUT (OFF HOOK) on Channel 2.
11	E2 indicator (green)	Lights when signaling is turned on and E2 lead is active.
12	M2 indicator (green)	Lights when M2 lead is active.
13	E1 indicator (green)	Lights when signaling is turned on and E1 lead is active
14	M1 indicator (green)	Lights when M1 lead is active.

1. When removing jumpers, attach them to one of the pins so that they are available for future use.
2. When the module is set for remote control (SW1-7 in ON position), SW1-8 is not used.
3. If the RFL VF-5A is being installed in a terminal multiplexer, this switch should always be OFF. If the RFL VF-5A is being installed in a drop/insert multiplexer, set this switch OFF to communicate via the DI-A common module; set it ON to communicate via the DI-B common module.
4. When signaling is turned on, the logic circuitry robs one bit from the transmission every sixth frame of the frame format to use for signaling. If signaling is OFF, it uses all bits for voice encoding. Signaling should be off when using a voice-grade data modem over a voice-frequency circuit.

Table 2. Remote access address selection, RFL VF-5A Dual-Channel Four Wire E&M Voice Module

Module Address	SW1-1	SW1-2	SW1-3	SW1-4	SW1-5	SW1-6
1	OFF	ON	ON	ON	ON	ON
2	ON	OFF	ON	ON	ON	ON
3	OFF	OFF	ON	ON	ON	ON
4	ON	ON	OFF	ON	ON	ON
5	OFF	ON	OFF	ON	ON	ON
6	ON	OFF	OFF	ON	ON	ON
7	OFF	OFF	OFF	ON	ON	ON
8	ON	ON	ON	OFF	ON	ON
9	OFF	ON	ON	OFF	ON	ON
10	ON	OFF	ON	OFF	ON	ON
11	OFF	OFF	ON	OFF	ON	ON
12	ON	ON	OFF	OFF	ON	ON
13	OFF	ON	OFF	OFF	ON	ON
14	ON	OFF	OFF	OFF	ON	ON
15	OFF	OFF	OFF	OFF	ON	ON
16	ON	ON	ON	ON	OFF	ON
17	OFF	ON	ON	ON	OFF	ON
18	ON	OFF	ON	ON	OFF	ON
19	OFF	OFF	ON	ON	OFF	ON
20	ON	ON	OFF	ON	OFF	ON
21	OFF	ON	OFF	ON	OFF	ON
22	ON	OFF	OFF	ON	OFF	ON
23	OFF	OFF	OFF	ON	OFF	ON
24	ON	ON	ON	OFF	OFF	ON
25	OFF	ON	ON	OFF	OFF	ON
26	ON	OFF	ON	OFF	OFF	ON
27	OFF	OFF	ON	OFF	OFF	ON
28	ON	ON	OFF	OFF	OFF	ON
29	OFF	ON	OFF	OFF	OFF	ON
30	ON	OFF	OFF	OFF	OFF	ON
31	OFF	OFF	OFF	OFF	OFF	ON
32	ON	ON	ON	ON	ON	OFF
33	OFF	ON	ON	ON	ON	OFF
34	ON	OFF	ON	ON	ON	OFF
35	OFF	OFF	ON	ON	ON	OFF
36	ON	ON	OFF	ON	ON	OFF

To set the attenuation to 7.6 dB, set the switches as follows:

<u>Section</u>	<u>Value</u>	<u>Setting</u>	<u>Set Value</u>
SW2-1	0.1 dB	ON	0.1
SW2-2	0.2 dB	OFF	0.0
SW2-3	0.4 dB	OFF	0.0
SW2-4	0.8 dB	OFF	0.0
SW2-5	1.5 dB	ON	1.5
SW2-6	3.0 dB	OFF	0.0
SW2-7	6.0 dB	ON	6.0
SW2-8	12.0 dB	OFF	0.0
TOTAL			7.6

See page 18 for more information about attenuator settings.

13. Set DIP switches SW3-1 through SW3-8 for the desired amount of Channel 2 transmit attenuation.
The settings for SW3 are the same as for SW2. (See step 12.)
14. Set DIP switches SW4-1 through SW4-8 for the desired amount of Channel 1 receive attenuation.
The settings for SW4 are the same as for SW2. (See step 12.)
15. Set DIP switches SW5-1 through SW5-8 for the desired amount of Channel 1 transmit attenuation.
The settings for SW5 are the same as for SW2. (See step 12.)
16. Select any unused time slot(s) using DIP switches SW6-1 through SW6-5.
SW6-1 through SW6-5 select the transmit time slot assignment, using the binary code shown in Table 3 on page 12 of this Instruction Data Sheet.
17. Set DIP switch SW6-6 to select the bus on which the RFL VF-5A is to transmit and receive.
Place SW6-6 in the ON position to transmit on A and receive on B. Place SW6-6 in the OFF position to transmit on B and receive on A.
18. Set DIP switch SW6-7 to enable or disable E&M signaling per AT&T Publication 43801.
Place SW6-7 in the ON position to enable E&M signaling. Place SW6-7 in the OFF position to disable E&M signaling.
19. DIP switch SW6-8 is not used. Leave it in the OFF position.
20. Set DIP switch SW6-9 to control the BUSY 1 output.
Place SW6-9 in the ON position for normal operation. To enable BUSY OUT (OFF-HOOK) on Channel 1, place SW6-9 in the OFF position.

Table 3. Time slot selection, RFL VF-5A Dual-Channel Four Wire E&M Voice Module

One-Channel Operation (Jumper E5 in place)	Two-Channel Operation (Jumper E5 removed)	SW6-1	SW6-2	SW6-3	SW6-4	SW6-5
1	1 and 2	UP	UP	UP	UP	UP
2	2 and 3	UP	UP	UP	UP	DOWN
3	3 and 4	UP	UP	UP	DOWN	UP
4	4 and 5	UP	UP	UP	DOWN	DOWN
5	5 and 6	UP	UP	DOWN	UP	UP
6	6 and 7	UP	UP	DOWN	UP	DOWN
7	7 and 8	UP	UP	DOWN	DOWN	UP
8	8 and 9	UP	UP	DOWN	DOWN	DOWN
9	9 and 10	UP	DOWN	UP	UP	UP
10	10 and 11	UP	DOWN	UP	UP	DOWN
11	11 and 12	UP	DOWN	UP	DOWN	UP
12	12 and 13	UP	DOWN	UP	DOWN	DOWN
13	13 and 14	UP	DOWN	DOWN	UP	UP
14	14 and 15	UP	DOWN	DOWN	UP	DOWN
15	15 and 16	UP	DOWN	DOWN	DOWN	UP
16	16 and 17	UP	DOWN	DOWN	DOWN	DOWN
17	17 and 18	DOWN	UP	UP	UP	UP
18	18 and 19	DOWN	UP	UP	UP	DOWN
19	19 and 20	DOWN	UP	UP	DOWN	UP
20	20 and 21	DOWN	UP	UP	DOWN	DOWN
21	21 and 22	DOWN	UP	DOWN	UP	UP
22	22 and 23	DOWN	UP	DOWN	UP	DOWN
23	23 and 24	DOWN	UP	DOWN	DOWN	UP
24	...	DOWN	UP	DOWN	DOWN	DOWN

NOTE: Each active time slot on an RFL VF-5A module occupies one 64-Kbps digital time slot within the multiplexer's aggregate rate. Consult the IMUX 2000 instruction manual for guidelines on time slot selection.

21. Set DIP switch SW6-10 to control the BUSY 1 output.
Place SW6-10 in the ON position for normal operation. To enable BUSY OUT (OFF-HOOK) on Channel 2, place SW6-10 in the OFF position.
22. Slide the RFL VF-5A module into the selected module slot until it is firmly seated and the module front panel is flush with the top and bottom of the shelf.
23. On the Module Record Card (located to the right of the shelf) record the channel bank type, time slot, and any other pertinent information.

The RFL VF-5A module is now installed.

FUNCTIONAL DESCRIPTION

The descriptions below refer to one channel; each of the two channels on this module operates identically. A simplified block diagram of the RFL VF-5A appears in Figure 8.

TRANSMIT SIDE

Voice inputs are fed to the RFL VF-5A through the Module Adapter at the rear of the shelf. The input signal goes to a balanced input transformer. The normal input level is -16.0 dBm, referenced to 600 ohms. An equipment input jack on the front of the module allows injection of a test tone. The transformer output goes to an amplifier stage, and then passes through the transmit attenuator.

Switches on the transmit attenuator allow attenuation settings from zero (no attenuation) to 24.0 dB, in 0.1 dB increments. The factory setting for this attenuator is 3.0 dB. At this setting, clipping begins at an input level of -13.0 dBm.

The attenuator output then passes through a test point (TP1 for Channel 1, TP2 for Channel 2) to the PCM CODEC, where it is converted to an eight-bit digital signal. Maximum level at the test point is 5 Vp-p; above this level clipping occurs. If the transmit attenuator is set to 3.0 dB, a -16.0 dBm input gives a +4.0 dBm reading at this test point.

The M lead detector responds to an IDLE or BUSY signal from the external device, and lights the corresponding LED indicators. A level of -48 volts at the M lead equals BUSY; open or ground equals IDLE. The M lead input impedance is greater than 20K ohms. Finally, the Logic Array multiplexes the output of the PCM together with the M lead detector signal, and places the resulting bitstream onto a user-selectable time slot on the backplane for transmission in the desired direction.

RECEIVE SIDE

The Logic Array gets the input signal from the appropriate time slot on the backplane and demultiplexes it. The E lead signal goes to the E lead driver, which activates the LED status indicators. When active in Type I format, ground equals BUSY; open equals IDLE. In Type II or III, the E lead and EB lead are both used. When signaling is active, the E lead and EB lead are tied together through the E lead relay.

The PCM CODEC converts this eight-bit digital signal back to an analog audio signal and passes it to the receive attenuator, which, like the transmit attenuator, has switches to allow settings from zero (no attenuation) to 24.0 dB in 0.1 dB increments. The factory setting is 3.0 dB of attenuation for a +7.0 dBm output.

The attenuator output passes to an amplifier stage, and finally through the output transformer to the output connectors on the module adapter. With a properly calibrated RFL VF-5A set for -16.0 dBm at the transmitter input, the output level will be +7.0 dBm referenced to 600 ohms. An equipment jack on the front of the module allows retrieval of the test tone.

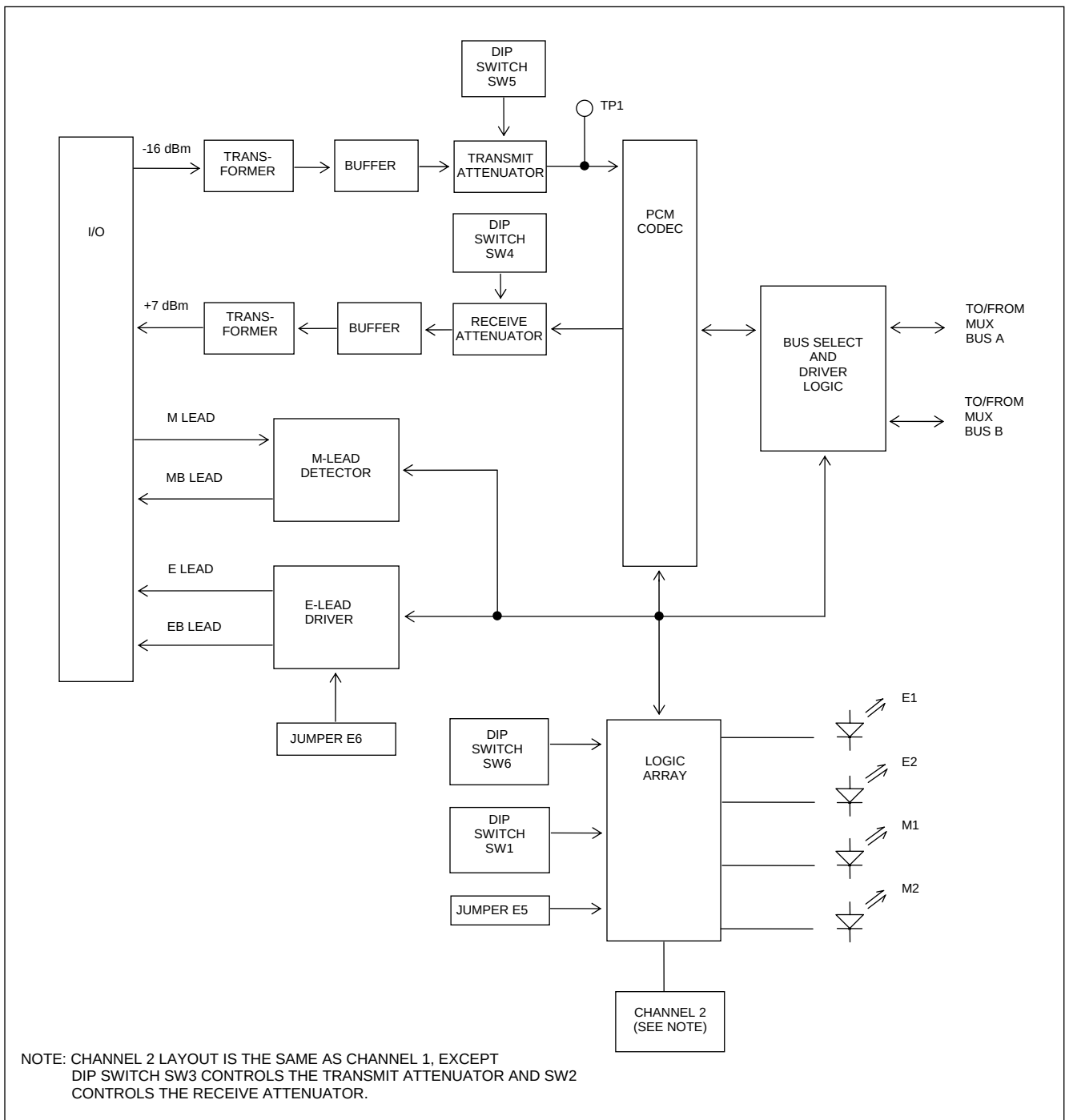


Figure 8. Simplified block diagram, RFL VF-5A Dual-Channel Four Wire E&M Voice Module

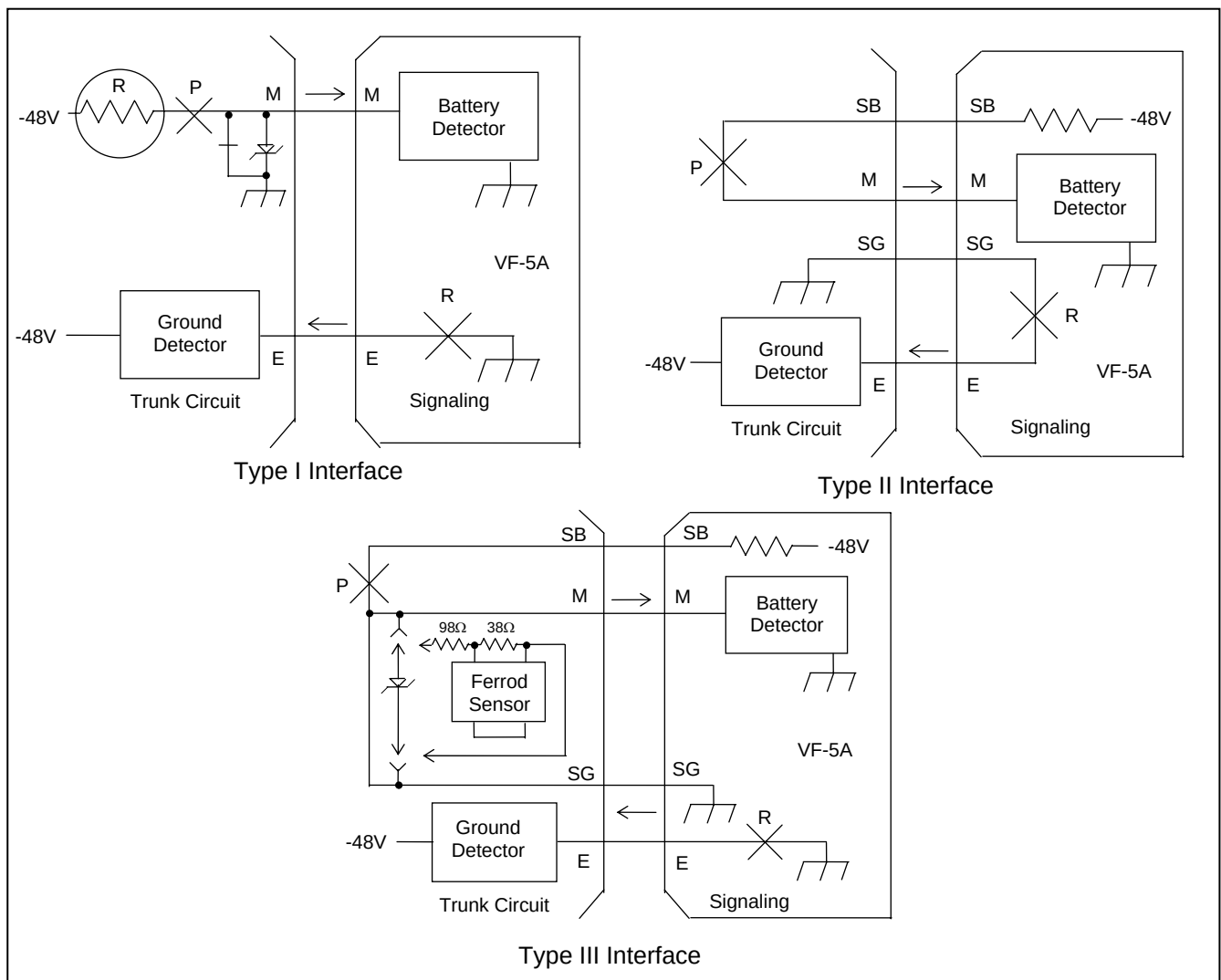


Figure 9. E&M signaling types

E&M SIGNALING

The E&M signaling jumper is set according to the type of E&M signaling being used. Refer to Table 1 and Figures 7 and 9 for more information.

Type I. Type I signaling is a two-wire scheme, normally encountered in electromechanical switching systems. The trunk circuit M lead provides the ground (on hook) and the battery -48V (off hook) toward the model VF-5A module. The signaling from the VF-5A to the trunk circuit is on the E lead with open circuit (on hook) and ground (off hook).

Type II. Type II signaling is a four-wire scheme, normally encountered in electronic switching systems. An on-hook (idle) condition is indicated by open circuits on both E and M leads and a closure for off-hook (busy).

Type III. Type III signaling is a partially looped four-wire scheme. It provides better protection against interference, and is used with electronic switching systems. An on-hook (idle) condition is indicated by an open circuit on the E lead and ground on the M lead. Signaling over the M lead is the same as Type I, except that battery and ground for M lead signaling are provided to the trunk circuit over the MB and EB leads. A distinction of the Type III interface is that three conductors are used for M lead signaling.

ALERTS AND ALARMS

The RFL VF-5A reports no module-level ALERT or ALARM signals to the shelf Common Module.

COMPATIBILITY WITH RFL VF-5 MODULES

RFL VF-5A modules are compatible with older RFL VF-5 modules; a circuit may consist of an RFL VF-5 at one end, and an RFL VF-5A at the other. However, there are a few differences between the two:

1. The RFL VF-5A is remote controllable; the RFL VF-5 is not.
2. On the RFL VF-5, DIP switch SW1 is unused except for SW1-8; this is the Channel 2 ON/OFF switch. On the RFL VF-5A, SW1 is used to set the module's remote access address (SW1-1 through SW1-6), set the module to local or remote control (SW1-7), and turn service on and off (SW1-8).
3. The RFL VF-5A has a jumper (E5) which acts as the Channel 2 ON/OFF switch. The RFL VF-5 has no E5 jumper

ATTENUATOR SETTINGS

The RFL VF-5A module has four attenuators: Channel 1 Transmit, Channel 1 Receive, Channel 2 Transmit, and Channel 2 Receive. Factory settings for these attenuators are 3.0 dB on the transmit side, and 3.0 dB on the receive side. This allows -16 dBm in, +7 dBm out with 3 dB of headroom.

Table 4 is an extended list of attenuator calibration settings. Set the attenuators based on the desired input and output levels listed in the table. These settings will permit a maximum signal level 3 dBm higher than the indicated level. For example, with -10 dBm input, the transmitter attenuator setting would be 9 dB and the maximum line input would be -7 dBm. Using these settings on the transmit side will place a signal of 1 digital mW into the transmission bitstream.

Table 4. Attenuator calibration settings, RFL VF-5A Dual-Channel Four Wire E&M Voice Module

Transmit Level In	Transmit Attenuator Setting	Receive Level Out	Receive Attenuator Setting
+5 dBm	24 dB	-14 dBm	24 dB
+4 dBm	23 dB	-13 dBm	23 dB
+3 dBm	22 dB	-12 dBm	22 dB
+2 dBm	21 dB	-11 dBm	21 dB
+1 dBm	20 dB	-10 dBm	20 dB
0 dBm	19 dB ⁽¹⁾	-9 dBm	19 dB
-1 dBm	18 dB	-8 dBm	18 dB
-2 dBm	17 dB	-7 dBm	17 dB
-3 dBm	16 dB	-6 dBm	16 dB
-4 dBm	15 dB	-5 dBm	15 dB
-5 dBm	14 dB	-4 dBm	14 dB
-6 dBm	13 dB	-3 dBm	13 dB
-7 dBm	12 dB	-2 dBm	12 dB
-8 dBm	11 dB	-1 dBm	11 dB
-9 dBm	10 dB	0 dBm	10 dB ⁽¹⁾
-10 dBm	9 dB	+1 dBm	9 dB
-11 dBm	8 dB	+2 dBm	8 dB
-12 dBm	7 dB	+3 dBm	7 dB
-13 dBm	6 dB	+4 dBm	6 dB
-14 dBm	5 dB	+5 dBm	5 dB
-15 dBm	4 dB	+6 dBm	4 dB
-16 dBm	3 dB ⁽²⁾	+7 dBm	3 dB ⁽²⁾
-17 dBm	2 dB	+8 dBm	2 dB
-18 dBm	1 dB	+9 dBm	1 dB
-19 dBm	0 dB	+10 dBm	0 dB

NOTES: (1) = Settings for 0 dBm in and 0 dBm out.

(2) = Settings for -16 dBm in and +7 dBm out.

REMOTE CONTROL INTERFACE

When installed in an IMUX 2000 shelf, the RFL VF-5A module can be operated under local or remote control. When under remote control, most of the module set-up parameters can only be changed through the RS-232 remote port on the shelf Common Modules. See your IMUX 2000 instruction manual for details on using the remote control interface.

"P" CODES AND "S" CODES

The RFL VF-5A reports itself as a "Type 64" module. Its remote control interface involves two sets of codes: "P"(parameter) codes, and "S" (status) codes.

"P" codes, when used in the parameter field on an "SCL SET" command, allow the user to set certain parameters on the module by remote control, just like setting the switches on a module under local control. "P" codes also appear in the response to a "CONFIG?" query, providing a list of the current settings on the module. A typical RFL VF-5A response to a "CONFIG?" query looks like this:

```
*OK
CHANNEL CARD 3, TYPE 64
UNDER REMOTE CONTROL
SRVC = ON
P01 = 10 (B00001010)
P02 = 0 (B00000000)
P03 = 1 (B00000001)
P04 = 1 (B00000001);
```

Each "P" code is displayed in both decimal and binary representation. Table 5 lists the meaning of the "P" codes for the RFL VF-5A

Table 5. Remote configuration settings ("P" codes)

Parameter	Possible Settings ⁽¹⁾	Description
SRVC	ON	Turn service on (enable module).
	OFF	Turn service off (disable module).
P01	1 to 24	Selects time slot(s).
P02 ⁽²⁾	0	Module will transmit in A direction, receive from B direction.
	1	Module will transmit in B direction, receive from A direction.
P03 ⁽³⁾	0	Enables E&M signaling per AT&T Publication 43801.
	1	Disables E&M signaling.
P04	0	Channel 2 off (one-channel operation).
	1	Channel 2 on (two-channel operation).

NOTES:

- These are the only legal values for setting the parameters. Setting any parameter to a value outside its specified range will produce an unpredictable result.
- If the multiplexer is a Terminal version, P02 should always be set to zero. If the multiplexer is a Drop/Insert version, set it to 0 to transmit in the A direction and receive from the B direction. Set it to 1 to transmit in the B direction and receive from the A direction. Refer to the IMUX 2000 instruction manual for guidelines on setting channel module direction.
- With E&M signaling enabled, the logic circuitry robs one bit from the transmission every sixth frame of the frame format to use for signaling. If signaling is disabled, all bits are used for voice encoding. Signaling should be disabled when using a voice-grade data modem over a voice-frequency circuit.

"S" codes appear in response to a "STATUS?" query in the following format:

***OK**
CHANNEL CARD 3, TYPE 64
S01 = 00 (B00000000);

The "S" code will be a number between 0 and 15, inclusive. The binary representation is more useful here than the decimal; the four least significant digits of the binary number represent the on/off status of the "E" and "M" leads, as shown in Table 6. The four most-significant digits are not used.

Table 6. Remote Status Messages (S codes)

Position	Value	Description
B 0 0 0 0 0 0 0 0 ↑ - - -	0	E2 lead is idle.
	1	Signaling is enabled and the E2 lead is active.
B 0 0 0 0 0 0 0 0 - ↑ - -	0	E1 lead is idle.
	1	Signaling is enabled and the E1 lead is active.
B 0 0 0 0 0 0 0 0 - - ↑ -	0	M2 lead is idle.
	1	M2 lead is active.
B 0 0 0 0 0 0 0 0 - - - ↑	0	M1 lead is idle.
	1	M1 lead is active.

TESTING

Once the RFL VF-5A Module has been configured and installed, it should be tested for proper operation before it is placed into service. There are two ways you can do the testing:

1. Local testing using T1 or aggregate loopback, with the system out of service.
2. End-to-end testing, with the system in service but the channel being tested taken out of service

Use the following procedure to test the RFL VF-5A:

1. If using T1 or aggregate loopback testing, set up the multiplexer loopback following the instructions in your multiplexer operation manual.
2. Test each channel separately. If using end-to-end testing, test each channel first from Site 1 to Site 2, then reverse the setup and test from Site 2 to Site 1.
3. Connect the output of an audio signal generator (Hewlett-Packard Model 4935A or equivalent) to the equipment input jack for the channel being tested. Insert a 1004 kHz test tone at -16 dBm referenced to 600 ohms.

NOTE

For the following steps, check the output on the same RFL VF-5A module if you are using loopback testing, or on the module at the receive end if you are using end to end testing.

4. Measure the channel output at the equipment output jack.
The output should be +7 dBm referenced to 600 ohms, ± 0.5 dB.
5. Measure the signal-to-noise (S/N) ratio with C Message weighing.
This should be greater than 33 dB S/N.
6. Activate the M lead and observe that the corresponding M indicator LED on the transmit module and the E indicator LED on the receive module both light up.
7. Measure idle channel noise.
This should be less than 23 dBrc0.
8. Remove the test equipment and disconnect the loopback if one was used.
The module is now available for operation.

If there is an apparent malfunction, first check that the configuration is appropriate for the transmission system in use. If using end-to-end testing, check that the transmit and receive configuration is identical.

Problems may occur at the common equipment or facility level which affect the operation of this module. Refer to your multiplexer operation manual for system analysis procedures.

NOTES

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RFL Electronics Inc.

INSTRUCTION DATA

RFL VF-5C Dual-Channel Four-Wire E&M Voice Module For RFL IMUX 2000 Intelligent T1 And E1 Multiplexers

DESCRIPTION

The RFL VF-5C is a dual-channel four-wire E&M voice-frequency module, designed for use in IMUX 2000 T1 and E1 multiplexers. It accepts two voice channels as input and digitizes them; each channel occupies one 64-Kbps time slot. The RFL VF-5C can be used in both terminal and drop/insert IMUX 2000 multiplexers.

The RFL VF-5C provides high-quality voice characteristics, compatible with AT&T Publication 43801. It allows E&M signaling of Type I, II, III and V, with front-panel busy indicators. It has extended-range input and output signal level settings to facilitate interfaces in most four-wire applications.

The VF-5C is remote-controllable when installed in an RFL IMUX 2000 remote-controllable shelf. User-adjustable switches and jumpers allow the configuration of the following parameters:

- o One-channel or two-channel operation.
- o Selectable Type I, II, III or V signaling.
- o Individual channel enable/disable.
- o Signaling on or off selection.
- o FXS/FXO signaling modes.
- o Busy out settings.
- o Independent selectable transmit/receive direction for each channel.
- o Extended range input/output level settings
- o Independent time slot assignment for each channel
- o Three loopback modes (Local, Remote, 2713 Hz detect).
- o Remote control configuration and status reporting.
- o Addressing enable/disable
- o Tx and Rx addresses for each channel
- o 1kHz test tone generation

SPECIFICATIONS

As of the date this Instruction Data Sheet was published, the following specifications apply to the RFL VF-5C module. Because all of RFL products undergo constant refinement and improvement, these specifications are subject to change without notice.

Configuration: Two independent voice channels per module.

Time Slots Required:

One-Channel Operation: Requires one user-selectable 64-Kbps time slot.

Two-Channel Operation: Requires any two user-selectable 64-Kbps time slots.

Remote Interface:

All settings can be changed in remote mode using NMS, except E&M signaling type. Access to status registers, including board and firmware revision levels, is also provided through NMS.

Signal Levels:

TLP transmit range: -23 dBm to +10 dBm nominal (+13 dBm peak)

TLP receive range: -31.5 dBm to +10 dBm nominal (+13 dBm peak)

Level control resolution: 0.5 dB

Absolute level accuracy: 0.5 dB

Input Impedance: 600 Ω nominal

Output Impedance: 600 Ω nominal

Frequency Response relative to 1004 Hz: 300 to 3000 Hz, ± 0.5 dB (bidirectional)

Idle Channel Noise: Less than 21 dBnc0

Signal-To-Distortion (1004 Hz Input, 0 to -30 dBm0): Greater than 36 dB

Peak-To-Average Ratio (PAR): Greater Than 94

Impulse Noise:

Maximum counts per 30-minute interval. (Input level -13dbm0(-29dbm) @ 1004 Hz.

Level Adjustment set to -16dBm in, +7dBm out.

Threshold Level (dBnc)

Counts/30 minutes

-61

0

Signaling Format (Digital interface):

T1 systems: RBS (Robbed-Bit Signaling) AT&T PUB 43801

E1 systems: CAS (Channel Associated Signaling)

Transmission Only

*Signaling is unavailable when using addressing feature.

E&M Signaling Types: Jumper selectable, E&M Type I, II, III and V

M Lead INPUT:

Input Impedance: Greater than 3.5K ohms to ground

Current limited to less than 6ma

Type I, II, III

Busy: -20 to -60 volts

Idle: 0 to -10 volts or open

Type V

Busy: 0 to -35 volts

Idle: Open

E Lead Output:

Busy: Less than 35 ohms to ground

Idle: -42 to -60 volts or open

Module Adapters:

MA-301, MA-301A, MA-301B, MA-301D, MA-322, MA-324 or MA-350.

Address Range: 1 to 127**Addressing Sync Time:**

9ms max (measured from channel card's receipt of valid data)

Addressing Loss of Sync Time:

7ms max (measured from channel card's receipt of invalid data)

2713 Hz Detect Thresholds:

Detect frequency range: 2691 to 2736 Hz

Non-detect frequency range: Less than 2680 Hz or greater than 2742 Hz

Nominal T1 minimum amplitude: -34dBm0

Nominal E1 minimum amplitude: -31dBm0

Turn on time: 2 seconds

Turn off time: 1 second

Auto turn-off time: 2 minutes

Power Consumption:

120 mA max from +5V supply

70 mA max from +15V supply

50 mA max from -15V supply

0 mA max from -48V supply*

*Note: The VF-5C itself draws no current from the -48Volt supply. However SB-Lead outputs are provided for each channel for external wiring of E&M signaling. There is a 1k-ohm ½ watt resistor in series with each output. No more than 20mA should be drawn from any SB-Lead output at any time.

Operating Temperature: -20°C to +55°C (-4°F to +131°F).

Relative Humidity: Zero to 90 percent, non-condensing.

INSTALLATION

Before the RFL VF-5C can be placed in service, it must be installed in a multiplexer shelf. Installation involves determining the module slot in the Main Shelf or Repeater Shelf where the module will be installed, inserting a Module Adapter into the rear of the shelf behind the module slot, connecting all signal wiring to the Module Adapter, checking the settings of all switches and jumpers, and inserting the module into the front of the shelf.

NOTE

Power supply and time slot considerations may affect the installation of this module into an existing multiplexer shelf. Refer to the multiplexer manual for more information.

The following instructions are provided for installing RFL VF-5C modules into existing systems. If the module was included as part of a system, installation was done at the factory. Otherwise, proceed as follows:

1. Carefully inspect the module for any visible signs of shipping damage. If you suspect damage to the module, immediately call RFL Customer Service at the number listed at the bottom of this page.
2. Determine the module slot in the Main Shelf or Repeater Shelf where the module will be installed.
The RFL VF-5C module occupies one module slot in the Main Shelf or Repeater Shelf.
3. Determine which Module Adapter will be used to make connections to the RFL VF-5C module.
Each module in the IMUX 2000 multiplexer requires a Module Adapter. The module adapter provides the appropriate connector for the desired interface. There are six Module Adapters compatible with the RFL VF-5C:

MA-301

The MA-301 accepts a 50-pin Telco connector (Amphenol 57-30500 or equivalent, as shown in Figure 1.) One MA-301 Module Adapter can be used to connect up to three RFL VF-5C modules, for a total of up to six voice channels. If you will be using more than one module with the MA-301, they must be inserted into adjacent slots in the multiplexer. Ribbon cables are provided with the MA-301 to make connections to it from the second and third module locations as shown in Figure 2.

MA-301A

The MA-301A is used to isolate the VF-5C from SWC type surges sometimes present on 4-wire voice lines. This module adapter occupies two rear slots in the IMUX 2000 chassis. A terminal strip is provided for hard wire connections to the voice circuit for Channel 1 and Channel 2, as shown in Figure 3. E&M signaling connections are not available when using the MA-301A.

<u>MA-301B</u>	The MA-301B provides pluggable terminal block connections for a single VF-5C module. Audio and signaling connections are available at the terminal block. No additional SWC or fast transient protection is provided on this I/O. Refer to Figure 4 for panel view and terminal connections.
<u>MA-301D</u>	The MA-301D provides pluggable terminal block connections for a single VF-5C module. Tip and Ring test points are available for the inputs and outputs of channels 1 and 2. Audio and signaling connections are available at the terminal block. No additional SWC or fast transient protection is provided on this I/O. Refer to Figure 5 for panel view and terminal connections.
<u>MA-322</u>	The MA-322 accepts a 50-pin Telco connector (Amphenol 57-30500 or equivalent, as shown in Figure 6.) One MA-322 Module Adapter is used for each RFL VF-5C module, and occupies two rear slots in the IMUX 2000 chassis. The MA-322 is used to convert both of the 4-wire outputs (Channel 1 and 2) from 4-wire to 2-wire. The impedance is 600 Ohms, the frequency response is ± 2 dB from 200Hz to 3000Hz, and the transformer loss (hybrid loss) is $\cong 4.0$ dB. Refer to Application Note No.14 in the IMUX 2000 Instruction Manual for additional information on using this I/O.
<u>MA-324</u>	The MA-324 accepts a 50-pin Telco connector (Amphenol 57-30500 or equivalent, as shown in Figure 6.) One MA-324 Module Adapter is used for each RFL VF-5C module and occupies two rear slots in the IMUX 2000 chassis. The MA-324 is used to convert one of the 4-wire outputs (Channel 1) from 4-wire to 2-wire. The other 4-wire output (Channel 2) remains 4-wire. The impedance is 600 Ohms, the frequency response is ± 2 dB from 200Hz to 3000Hz, and the transformer loss (hybrid loss) is $\cong 4.0$ dB. Refer to Application Note No.14 in the IMUX 2000 Instruction Manual for additional information on using this I/O.
<u>MA-350</u>	The MA-350 is a special adapter capable of accepting up to 12 VF-5C voice modules. The MA-350 occupies 12 rear slots in the IMUX 2000 chassis and can handle a maximum of 24 voice channels. Connections are made to four 50-pin Telco connectors (Amphenol 57-30500) on the rear of the adapter. See Figure 7 and 8.

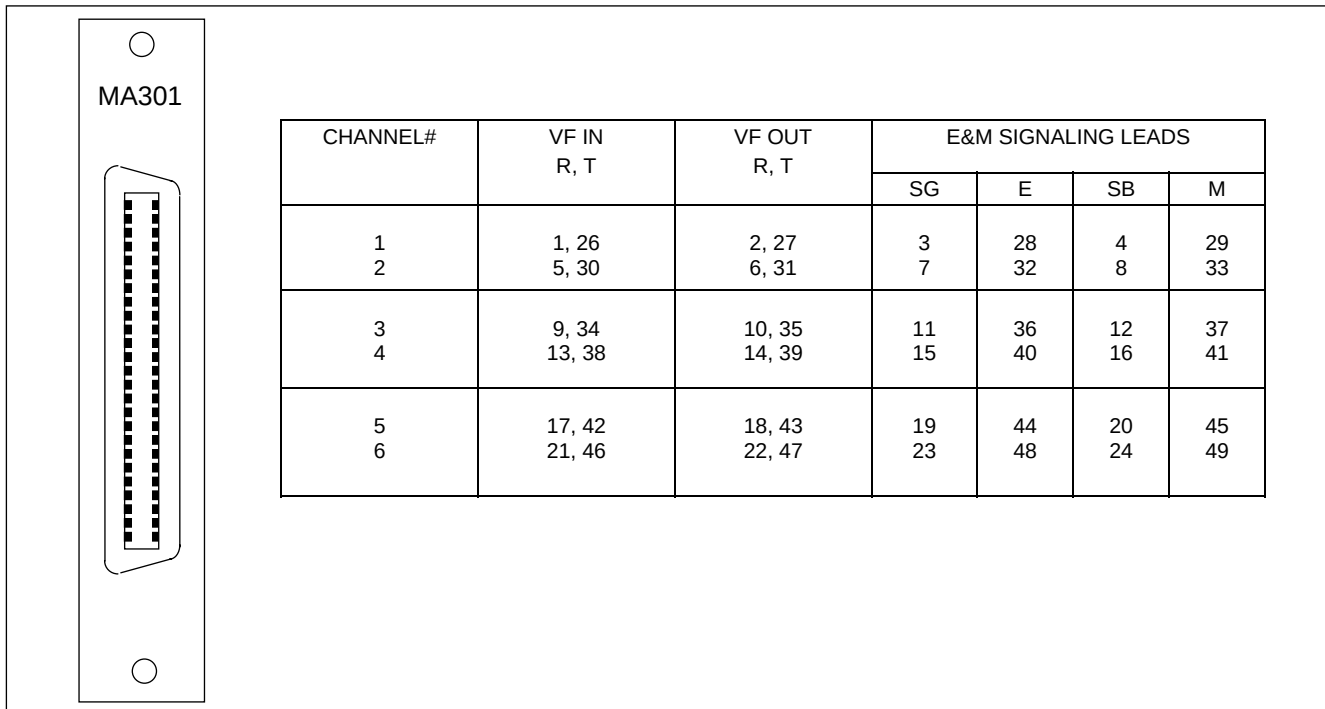


Figure 1. MA-301 Module Adapter

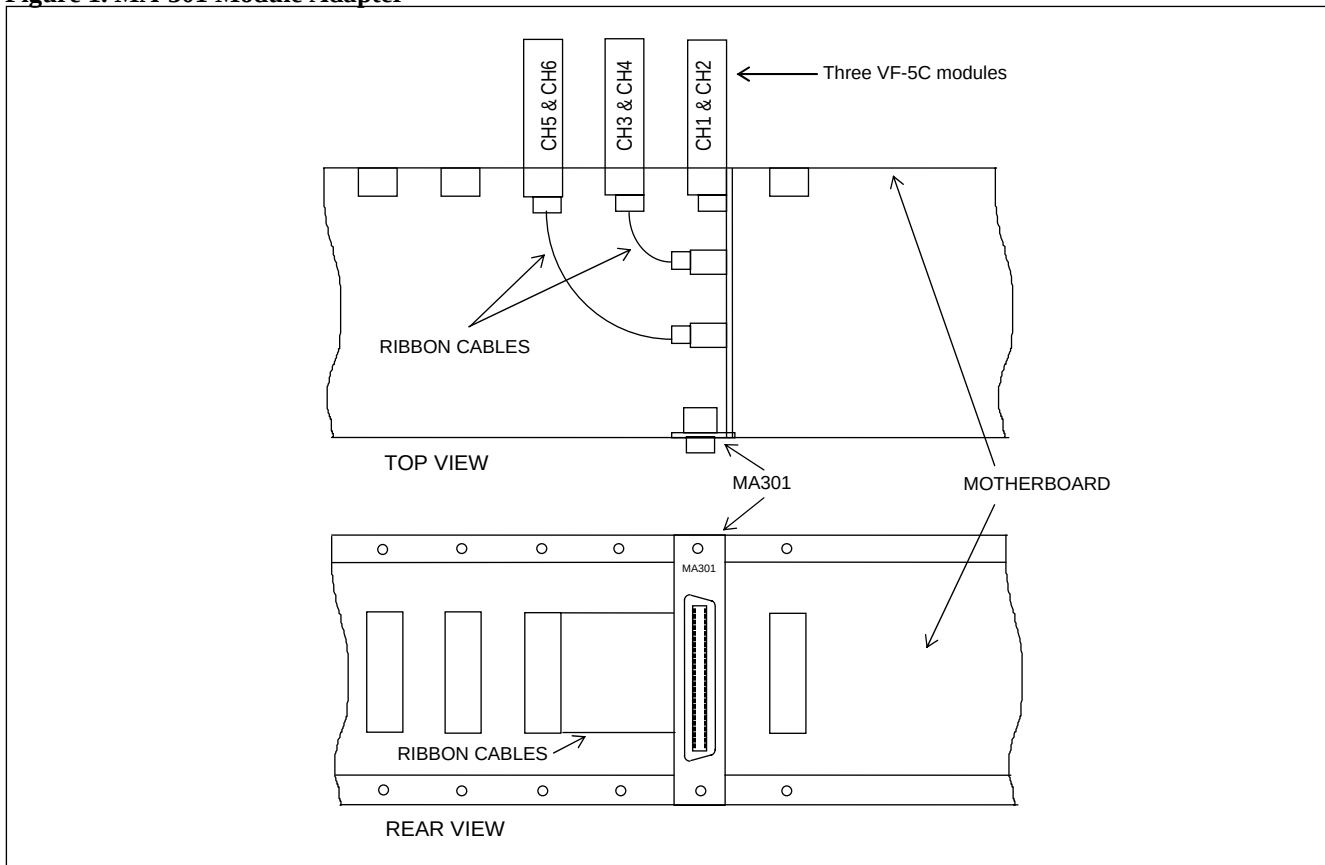


Figure 2. Connecting up to three RFL VF-5C modules to a single MA-301 Module Adapter.

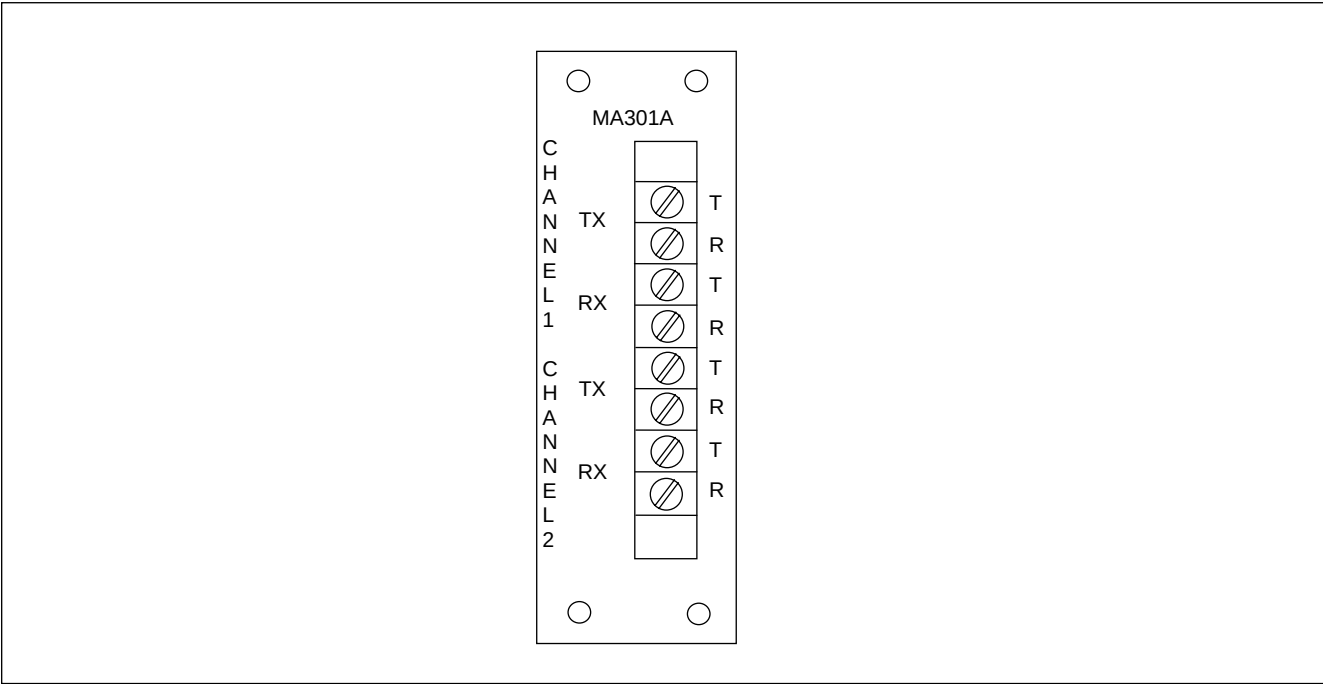


Figure 3. MA-301A, SWC rated 4-wire Module Adapter

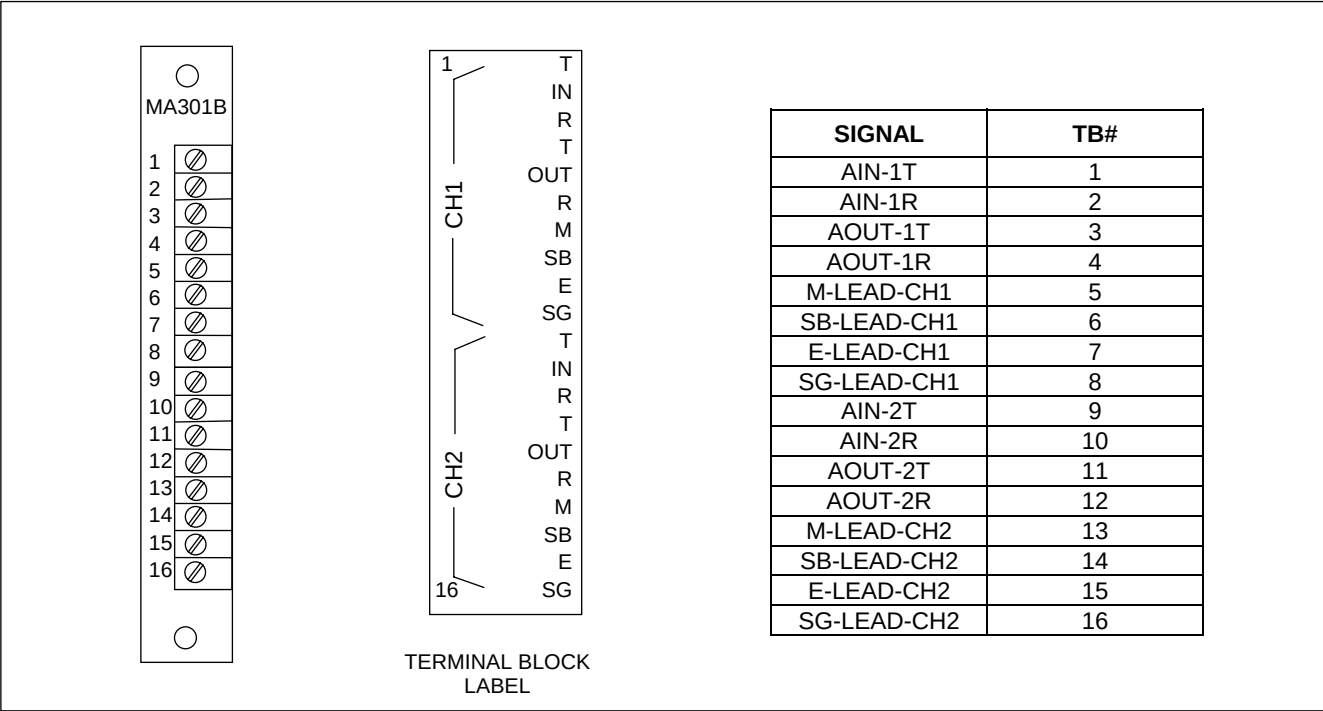
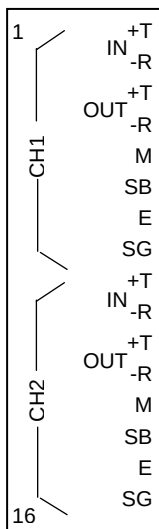
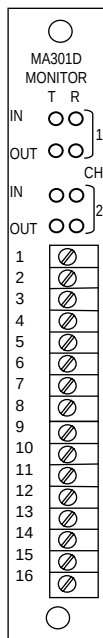


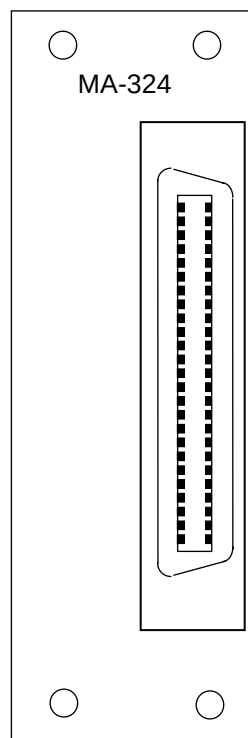
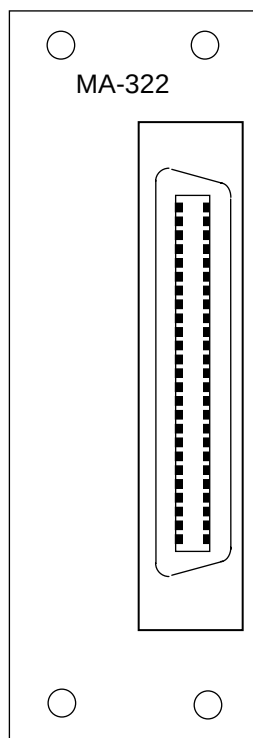
Figure 4. MA-301B Module Adapter



TERMINAL BLOCK
LABEL

SIGNAL	TB#
AIN-1T	1
AIN-1R	2
AOUT-1T	3
AOUT-1R	4
M-LEAD-CH1	5
SB-LEAD-CH1	6
E-LEAD-CH1	7
SG-LEAD-CH1	8
AIN-2T	9
AIN-2R	10
AOUT-2T	11
AOUT-2R	12
M-LEAD-CH2	13
SB-LEAD-CH2	14
E-LEAD-CH2	15
SG-LEAD-CH2	16

Figure 5. MA-301D Module Adapter



Pin No.	MA-322 Pin Functions	MA-324 Pin Functions
1	Channel 1 Ring	Channel 1 Ring
3	SG - Channel 1	SG - Channel 1
4	SB - Channel 1	SB - Channel 1
5	Channel 2 Ring	VF IN Channel 2 Ring
6	Not Used	VF OUT Channel 2 Ring
7	SG - Channel 2	SG - Channel 2
8	SB - Channel 2	SB - Channel 2
26	Channel 1 Tip	Channel 1 Tip
28	E - Channel 1	E - Channel 1
29	M - Channel 1	M - Channel 1
30	Channel 2 Tip	VF IN Channel 2 Tip
31	Not Used	VF OUT Channel 2 Tip
32	E - Channel 2	E - Channel 2
33	M - Channel 2	M - Channel 2

Note: All unlisted pins are not used. See Application Note No.14 in the IMUX 2000 Instruction Manual for additional information on using these I/Os.

Figure 6. MA-322/MA-324 Module Adapters

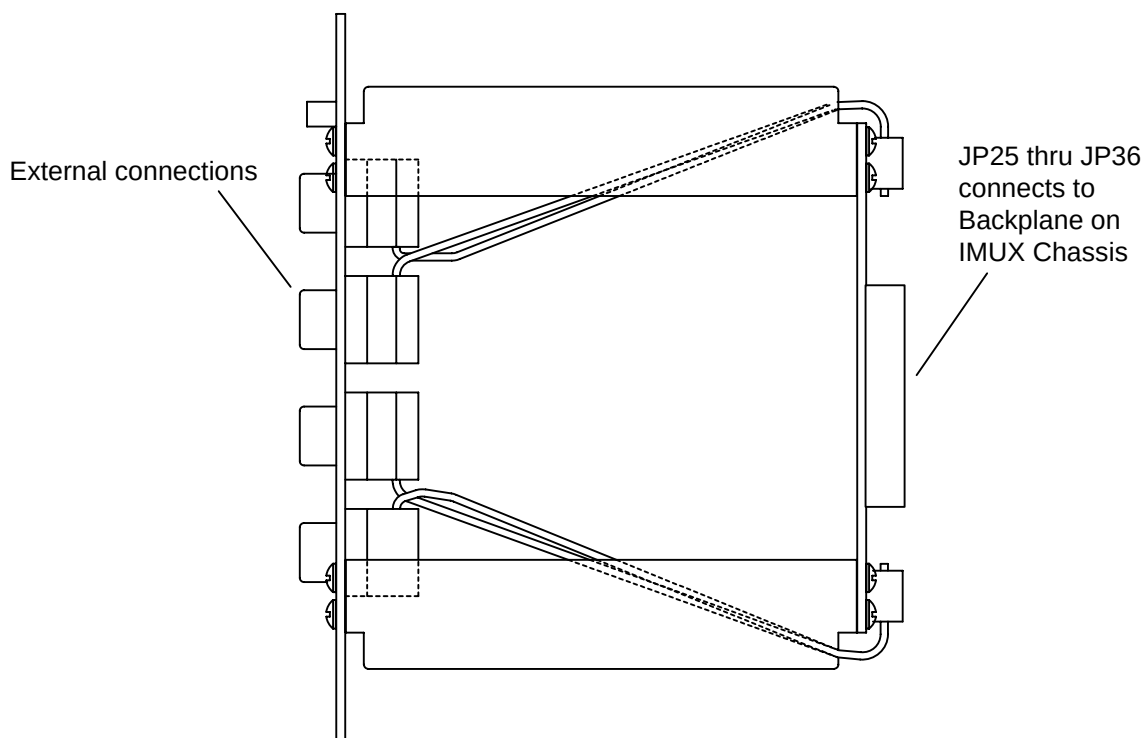


Figure 7. MA-350 Module Adapter, side view

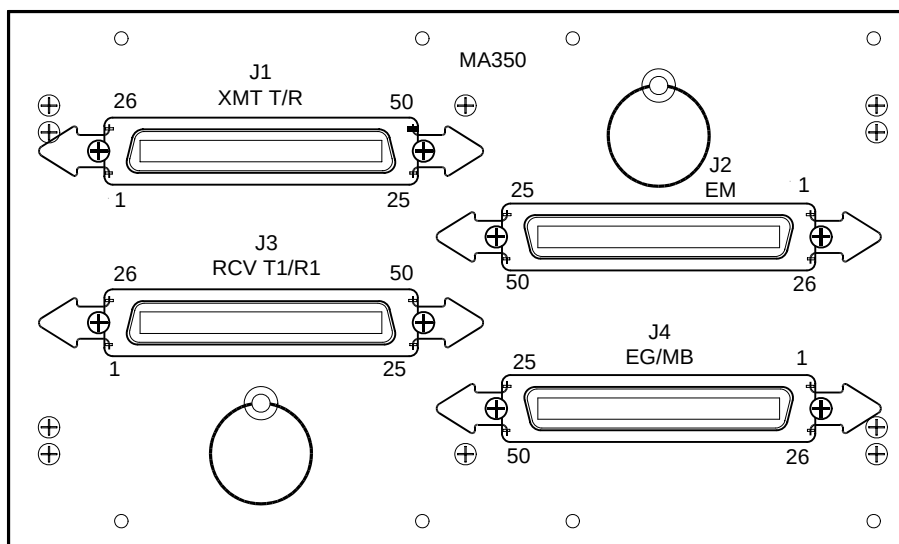


Figure 8. MA-350 Module Adapter, rear view

J1 (XMT T/R)	J2 (EM)	J3 (RCV T1/R1)	J4 (EG MB)
Pin 1 thru Pin 24	Pin 1 thru Pin 24	Pin 1 thru Pin 24	Pin 1 thru Pin 24
XMT-R-CH1 thru XMT-R-CH24	M-CH1 thru M-CH24	RCV-R1-CH1 thru RCV-R1-CH24	MB-CH1 thru MB-CH24
Pin 26 thru Pin 49	Pin 26 thru Pin 49	Pin 26 thru Pin 49	Pin 26 thru Pin 49
XMT-T-CH1 thru XMT-T-CH24	E-CH1 thru E-CH24	RCV-T1-CH1 thru RCV-T1-CH24	EG-CH1 thru EG-CH24

Note: Pin 25 and 50 not used.

4. Insert the desired Module Adapter into the rear of the slot which will hold the RFL VF-5C module and make all connections to the Module Adapter.
If an MA-301, MA-322 or MA-324 Module Adapter is being used, plug the 50-pin Telco connector into its 50-pin connector.

If an MA-301A Module Adapter is being used, connect all signal wiring to the terminal strip at the rear of the MA-301A using Figure 3 as a guide.

If an MA-301B or MA-301D Module Adapter is being used, connect all signal wiring to the terminal strip at the rear of the module using Figures 4 and 5 as a guide.

If an MA-350 Module Adapter is being used proceed as follows:
This is a large module adapter; care should be taken when inserting into the rear of the IMUX chassis. Carefully align the 30 pin connectors with their respective mating connectors on the Backplane and insert the adapter, do not use excessive force as this may damage the pins. Make connections to the 50-pin Telco connectors for 4-wire or signaling as required (See Figure 7 and 8). Note: Pull rings are provided for adapter removal.
5. Refer to Figure 10 and Table 1 for the location of switches, controls and indicators on the VF-5C.
6. Set DIP switches SW1-1 through SW1-6 for the desired remote access address.
For remote access, each channel module in the IMUX 2000 must have a distinct module address. Valid module addresses are the numbers 1 to 36. In most installations, the address will be set to the slot number of the shelf the module is occupying. Table 2 shows the switch settings for the module address.
7. Set the position of SW1-7 to enable or disable Channel 1.
When SW1-7 is in the OFF position, Channel 1 is enabled. When SW1-7 is in the ON position, Channel 1 is disabled.

Set the position of SW1-8 to enable or disable Channel 2.
When SW1-8 is in the OFF position, Channel 2 is enabled. When SW1-8 is in the ON position, Channel 2 is disabled.

The setting of these two switches will determine whether the module will be used for either one-channel or two-channel operation.
8. Set jumpers J7, J8 and J11 to select the type of E&M signaling required for Channel 1. Set jumpers J9, J10 and J12 to select the type of E&M signaling required for Channel 2.
There are four signaling types: Type I, Type II, Type III and Type V. Refer to Table 1 on page 19 for jumper assignments for each of these signaling types.
9. Select any unused time slot for Channel 1 using DIP switches SW2-1 to SW2-5.
SW2-1 through SW2-5 select the transmit timeslot assignment for Channel 1, in accordance with Table 3.

Select any unused time slot for Channel 2 using DIP switches SW3-1 to SW3-5.

SW3-1 through SW3-5 select the transmit timeslot assignment for Channel 2, in accordance with Table 3.

Select Channel 1 bus direction using DIP switch SW2-6.

Place SW2-6 in the DOWN position to transmit in the A direction and receive from the B direction. Place SW2-6 in the UP position to transmit in the B direction and receive from the A direction.

Select Channel 2 bus direction using DIP switch SW3-6.

Place SW3-6 in the DOWN position to transmit in the A direction and receive from the B direction. Place SW3-6 in the UP position to transmit in the B direction and receive from the A direction.

10. Select Channel 1 loopback mode by using DIP switches SW2-7, SW2-8, and SW1-9

There are four loopback modes: None, Local Loopback, Remote Loopback and 2713 Hz Loopback. As its name implies, None indicates that no loopbacks are selected. Local Loopback, when selected, is used to test TX and RX analog circuitry at the near end as shown in Figure 10a. Remote Loopback, when selected, is used to test TX and RX analog circuitry at the far end as shown in Figure 10b.

The 2713Hz Loopback mode, as shown in Figure 10c, is normally used if remote control of the VF-5C via NMS is not available. To use this mode you must first enable the “2713 Hz feature” and then select manual deactivation or automatic deactivation.

To use 2713 Hz loopback with manual deactivation do the following:

- 1. Enable the “2713 Hz feature” by setting SW2-7 and SW2-8 to ON, and SW1-9 to OFF.**
- 2. Activate remote loopback at the remote end VF-5C by injecting a 2713 Hz signal into the Input Equipment jack (from the master end towards the remote end) for at least two seconds using a “TIM” set or equivalent.**
- 3. The VF-5C at the remote end will stay in remote loopback mode until it is manually deactivated.**

If the 2713 Hz signal is still connected, remote loopback is deactivated, by removing the 2713 Hz signal and then momentarily reconnecting it for at least one second.

If the 2713 Hz signal is not connected, remote loopback is deactivated by momentarily connecting it for at least one second.

To use 2713 Hz loopback with automatic deactivation do the following:

- 1. Enable the “2713 Hz feature” by setting SW2-7 and SW2-8 to ON, and SW1-9 to ON.**
- 2. Activate the remote loopback at the remote end VF-5C by injecting a 2713 Hz signal into the Input Equipment jack (from the master end towards the remote end) for at least two seconds using a “TIM” set or equivalent.**
- 3. The VF-5C at the remote end will stay in remote loopback mode as long as the 2713 Hz signal is present at the master end. If the 2713 Hz signal is removed, the loopback at the**

remote end will automatically de-activate after two minutes. Any time during the two minute time out period you can manually deactivate the remote loopback by momentarily injecting the 2713 Hz signal for at least one second.

12. Select Channel 2 loopback mode by using DIP switches SW3-7, SW3-8 and SW1-10.
13. Set DIP switches SW4-1 through SW4-7 (Channel 1), and DIP switches SW8-1 through SW8-7 (Channel 2) to the nominal transmit level. The valid range is +10dBm to -23dBm. See Table 4 for reference.

For example if the nominal incoming audio (analog) TLP is -16dBm , then the Switches should be set for -16dBm. This will provide a nominal 0dBm0 on the DS0, which leaves approximately 3dB of headroom. In this case the peak transmit TLP would be -13dBm. The factory default is -16dBm transmit (analog in)

DIP switches SW4-1 to SW4-7 are labeled as follows:

SW4-1	+/-
SW4-2	16
SW4-3	8
SW4-4	4
SW4-5	2
SW4-6	1
SW4-7	0.5

The switch settings are cumulative. For example, to set the nominal transmit level to -16dBm, set the switches as follows:

<u>Section</u>	<u>Value</u>	<u>Setting</u>	<u>Set Value</u>
SW4-1	+/-	ON	-
SW4-2	16	ON	16
SW4-3	8	OFF	0
SW4-4	4	OFF	0
SW4-5	2	OFF	0
SW4-6	1	OFF	0
SW4-7	0.5	OFF	0

Nominal transmit level setting = -16dBm

14. Set DIP switches SW5-1 through SW5-7 (Channel 1), and DIP switches SW9-1 through SW9-7 (Channel 2) to the nominal receive level. The valid range is +10dBm to -31.5dBm. See Table 5 for reference.

For example if the nominal incoming PCM data is 0dBm0 and the desired output level is +7dBm then the switches should be set for +7dBm. This will provide a nominal +7dBm0 at the receive TLP, and leaves approximately 3dB of headroom. In this case the peak receive TLP would be +10dBm. The factory default is +7dBm receive (analog out).

DIP switches SW5-1 to SW5-7 are labeled as follows:

SW5-1	+/-
SW5-2	16
SW5-3	8
SW5-4	4
SW5-5	2
SW5-6	1
SW5-7	0.5

The switch settings are cumulative. For example, to set the nominal receive level to +7dBm, set the switches as follows:

<u>Section</u>	<u>Value</u>	<u>Setting</u>	<u>Set Value</u>
SW5-1	+/-	OFF	+
SW5-2	16	OFF	0
SW5-3	8	OFF	0
SW5-4	4	ON	4
SW5-5	2	ON	2
SW5-6	1	ON	1
SW5-7	0.5	OFF	0

Nominal receive level setting = +7dBm

15. Set the position of SW4-8 to enable or disable Channel 1 signaling.
Place SW4-8 to the ON position to enable Channel 1 signaling.
Place SW4-8 to the OFF position to disable Channel 1 signaling.
- Set the position of SW8-8 to enable or disable Channel 2 signaling.
Place SW8-8 to the ON position to enable Channel 2 signaling.
Place SW8-8 to the OFF position to disable Channel 2 signaling.
16. Set the position of SW7-8 and SW7-9 to enable or disable FXS/FXO modes for Channel 1 in accordance with Table 1 on page 18 as applicable.
- Set the position of SW11-8 and SW11-9 to enable or disable FXS/FXO modes for Channel 2 in accordance with Table 1 on page 18 as applicable.

17. Set the position of SW5-8 to activate or deactivate the Channel 1 Busy Function. This switch is used to force the off-hook condition to be either Busy or Not Busy.

Place SW5-8 to the ON position to activate the Channel 1 Busy Function (Busy).

Place SW5-8 to the OFF position to deactivate the Channel 1 Busy Function (Not Busy)

Set the position of SW9-8 to activate or deactivate the Channel 2 Busy Function. This switch is used to force the off-hook condition to be either Busy or Not Busy.

Place SW9-8 to the ON position to activate the Channel 2 Busy Function (Busy).

Place SW9-8 to the OFF position to deactivate the Channel 2 Busy Function (Not Busy)

18. Set the position of SW7-10 to activate or deactivate the Channel 1 1kHz Test Tone.

Place SW7-10 to the ON position to activate the Channel 1, 1kHz Test Tone.

Place SW7-10 to the OFF position to deactivate the Channel 1, 1kHz Test Tone

Set the position of SW11-10 to activate or deactivate the Channel 2 1kHz Test Tone.

Place SW11-10 to the ON position to activate the Channel 2, 1kHz Test Tone

Place SW11-10 to the OFF position to deactivate the Channel 2, 1kHz Test Tone

19. Set the position of SW6-8 to enable or disable Channel 1 addressing.

Place SW6-8 to the ON position to enable Channel 1 addressing.

Place SW6-8 to the OFF position to disable Channel 1 addressing.

Set the position of SW10-8 to enable or disable Channel 2 addressing.

Place SW10-8 to the ON position to enable Channel 2 addressing.

Place SW10-8 to the OFF position to disable Channel 2 addressing.

20. Set the position of SW6-1 to SW6-7 to select the Channel 1 TX Address. The switches are labeled as follows:

SW6-1	64
SW6-2	32
SW6-3	16
SW6-4	8
SW6-5	4
SW6-6	2
SW6-7	1

The switch settings are cumulative. For example, to set the Channel 1 TX Address = 117, set the switches as follows:

<u>Section</u>	<u>Value</u>	<u>Setting</u>	<u>Set Value</u>
SW6-1	64	ON	64
SW6-2	32	ON	32
SW6-3	16	ON	16
SW6-4	8	OFF	0
SW6-5	4	ON	4
SW6-6	2	OFF	0
SW6-7	1	ON	1

Channel 1 TX Address setting = 117

(Note: legal TX addresses are 1 to 127)

>> text continues on page 24 <<

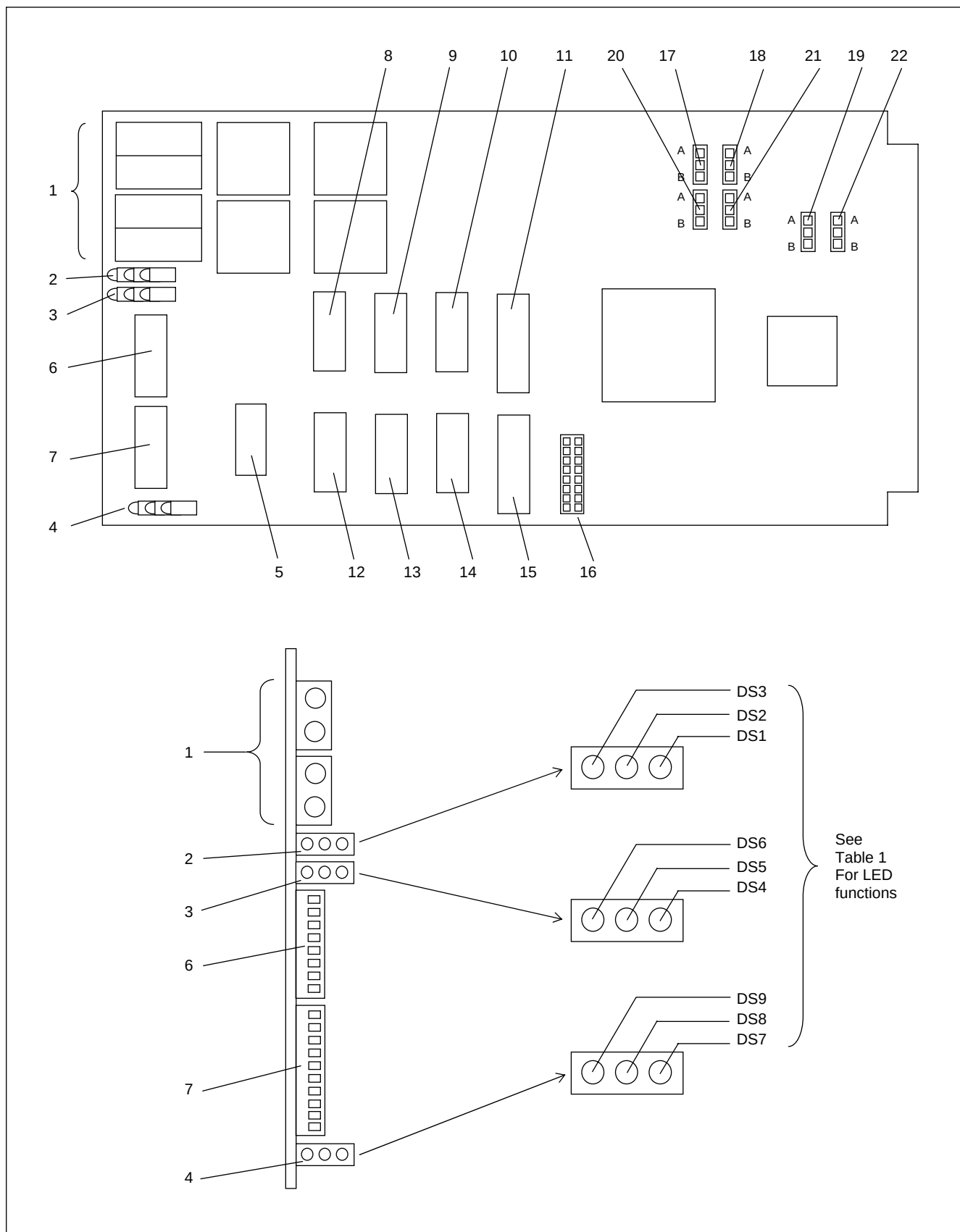


Figure 9. Controls and indicators, VF-5C module

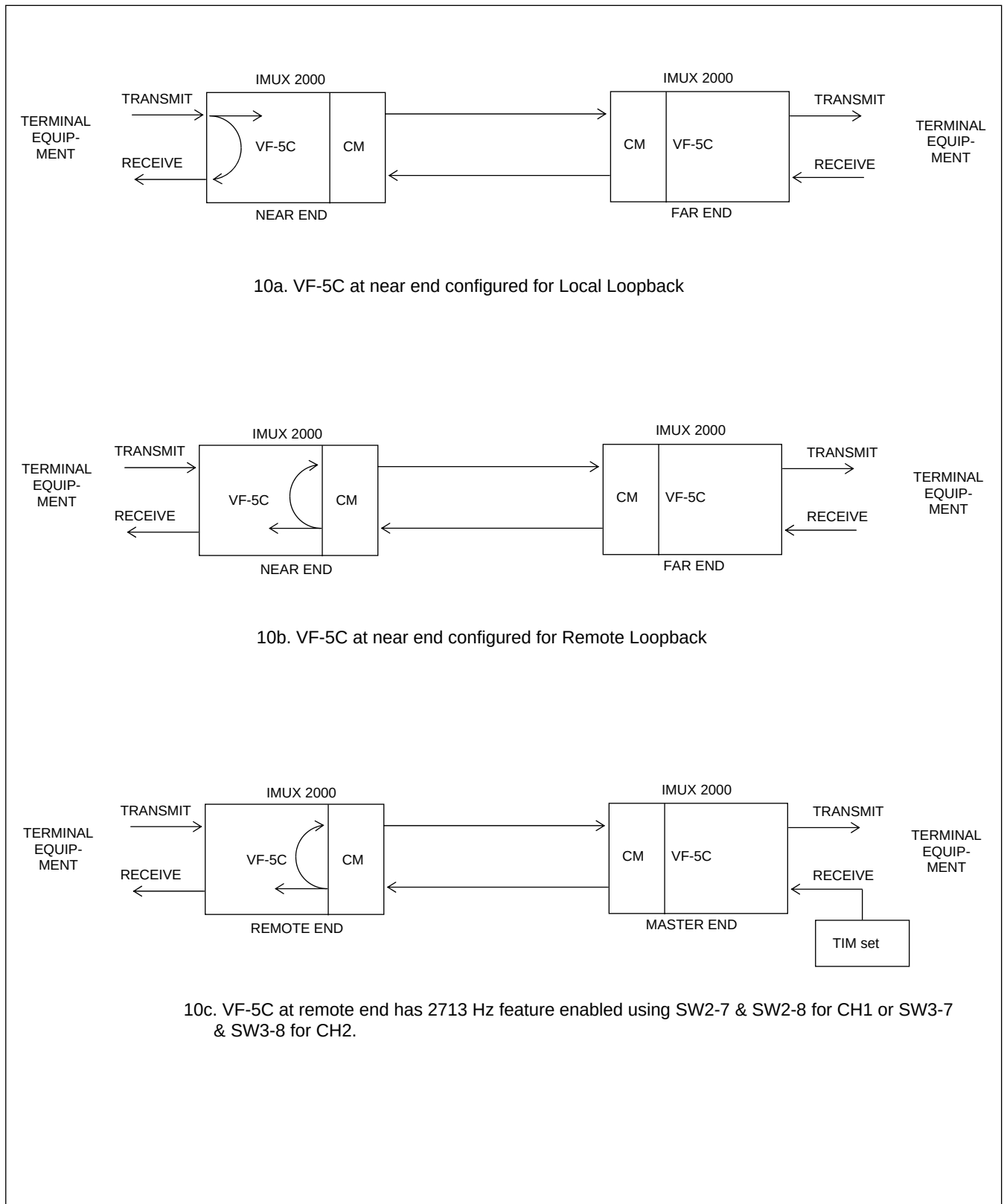


Figure 10. VF-5C loopback configurations

Table 1. Controls and indicators, RFL VF-5C module

Item	Name/Description	Function
1	Equipment jacks	Allow channel signals to be equipped: CH1 IN Equipment point for Channel 1 input signal. CH1 OUT Equipment point for Channel 1 output signal. CH2 IN Equipment point for Channel 2 input signal. CH2 OUT Equipment point for Channel 2 output signal.
2	DS1 LED	Channel 1 Addressing LED (has three states) Off: Addressing feature is turned OFF. Green: Addressing feature is turned ON and the module is receiving the correct address from the far end Red: Addressing feature is turned ON and the module is not receiving the correct address from the far end. This condition causes muting of CH1 OUT.
	DS2 LED	Channel 1 “E-Lead” LED (has two states) Off: Signaling is OFF or signaling is ON and “E-Lead” output is inactive. Green: Signaling is ON and “E-Lead” output is active.
	DS3 LED	Channel 1 “M-Lead” LED (has two states) Off: Signaling is OFF or signaling is ON and “M-Lead” input is inactive. Green: Signaling is ON and “M-Lead” input is active.
3	DS4 LED	Channel 2 Addressing LED (has three states) Off: Addressing feature is turned OFF. Green: Addressing feature is turned ON and the module is receiving the correct address from the far end Red: Addressing feature is turned ON and the module is not receiving the correct address from the far end. This condition causes muting of CH2 OUT.
	DS5 LED	Channel 2 “E-Lead” LED (has two states) Off: Signaling is OFF or signaling is ON and “E-Lead” output is inactive. Green: Signaling is ON and “E-Lead” output is active.
	DS6 LED	Channel 2 “M-Lead” LED (has two states) Off: Signaling is OFF or signaling is ON and “M-Lead” input is inactive. Green: Signaling is ON and “M-Lead” input is active.
4	DS7 LED	Channel 1 Loopback LED (has four states) Off: No loopbacks are active Red: Remote loopback is active Green: Local loopback is active Flashing Red: Remote loopback is active and was activated by 2713 Hz from Master end.
	DS8 LED	Channel 2 Loopback LED (has four states) Off: No loopbacks are active Red: Remote loopback is active Green: Local loopback is active Flashing Red: Remote loopback is active and was activated by 2713 Hz from Master end.
	DS9 LED	Service On/Off LED (has four states) Off: Service is OFF. Green: Service is ON and module configuration is valid. Red: Service is OFF due to CH1 and CH2 being set to same timeslot and bus direction. Amber: Service is ON but either CH1 or CH2 is set to an invalid timeslot.

Table 1. continued - Controls and indicators, VF-5C module

Item	Name/Description	Function
5	DIP Switch SW1	SW1-1 to SW1-6 Selects SCB address in accordance with Table 2.
		SW1-7: Enables or disables Channel 1 ON: Channel 1 disabled OFF: Channel 1 enabled
		SW1-8: Enables or disables Channel 2 ON: Channel 2 disabled OFF: Channel 2 enabled
		SW1-9: Selects automatic or manual deactivation of 2713 Hz loopback for Channel 1 ON: Selects automatic mode OFF: Selects manual mode
		SW1-10 Selects automatic or manual deactivation of 2713 Hz loopback for Channel 2 ON: Selects automatic mode OFF: Selects manual mode
6	DIP Switch SW2	SW2-1 to SW2-5 Selects Channel 1 timeslot in accordance with Table 3.
		SW2-6 Selects Channel 1 bus direction as follows: DOWN: Terminal or DI-A (Transmits in A direction, receives from B direction) UP: DI-B (Transmits in B direction, receives from A direction)
		SW2-7 & SW2-8 Selects Channel 1 Loopback Mode as follows:

Notes:

1. When SW2-7 and SW2-8 are both down, the 2713Hz loopback function is enabled. Then set SW1-9 and SW1-10 as required.
2. The value of these switches is additive, see the examples in steps 13 and 14 of Installation Instructions. The factory default setting is -16dBm in and +7dBm out. (See Tables 4 and 5 for Tx and Rx Level Settings)

Table 1. continued - Controls and indicators, VF-5C module

Item	Name/Description	Function
10	DIP Switch SW6 (CH1 TX ADDR)	SW6-1 to SW6-7 Selects Channel 1 Tx address
		SW6-8 Enables or disables Channel 1 addressing as follows: ON: Channel 1 addressing enabled OFF Channel 1 addressing disabled
11	DIP Switch SW7 (CH1 RX ADDR)	SW7-1 to SW7-7 Selects Channel 1 Rx address
		SW7-8 & SW7-9 Enables or disables FXS/FXO modes for Channel 1 as follows: <u>Mode</u> <u>SW7-8</u> <u>SW7-9</u> Normal mode OFF ON or OFF FXS mode ON ON FXO mode ON OFF
		SW7-10 Activates or deactivates 1kHz, 0dBm0 test tone (G.711 digital mW), in Tx path for Channel 1 as follows: ON: Test tone ON OFF Test tone OFF
12	DIP Switch SW8 (CH2 TX LVL)	SW8-1 Selects polarity (+ or -) of Channel 2 Tx level
		SW8-2 to SW8-7 Selects magnitude of Channel 2 Tx level

Table 2. Remote access address selection, VF-5C module

Module Address	SW1-1	SW1-2	SW1-3	SW1-4	SW1-5	SW1-6
1	OFF	OFF	OFF	OFF	OFF	ON
2	OFF	OFF	OFF	OFF	ON	OFF
3	OFF	OFF	OFF	OFF	ON	ON
4	OFF	OFF	OFF	ON	OFF	OFF
5	OFF	OFF	OFF	ON	OFF	ON
6	OFF	OFF	OFF	ON	ON	OFF
7	OFF	OFF	OFF	ON	ON	ON
8	OFF	OFF	ON	OFF	OFF	OFF
9	OFF	OFF	ON	OFF	OFF	ON
10	OFF	OFF	ON	OFF	ON	OFF
11	OFF	OFF	ON	OFF	ON	ON
12	OFF	OFF	ON	ON	OFF	OFF
13	OFF	OFF	ON	ON	OFF	ON
14	OFF	OFF	ON	ON	ON	OFF
15	OFF	ON	ON	ON	ON	ON
16	OFF	ON	OFF	OFF	OFF	OFF
17	OFF	ON	OFF	OFF	OFF	ON
18	OFF	ON	OFF	OFF	ON	OFF
19	OFF	ON	OFF	OFF	ON	ON
20	OFF	ON	OFF	ON	OFF	OFF
21	OFF	ON	OFF	ON	OFF	ON
22	OFF	ON	OFF	ON	ON	OFF
23	OFF	ON	OFF	ON	ON	ON
24	OFF	ON	ON	OFF	OFF	OFF
25	OFF	ON	ON	OFF	OFF	ON
26	OFF	ON	ON	OFF	ON	OFF
27	OFF	ON	ON	OFF	ON	ON
28	OFF	ON	ON	ON	OFF	OFF
29	OFF	ON	ON	ON	OFF	ON
30	OFF	ON	ON	ON	ON	OFF
31	OFF	ON	ON	ON	ON	ON
32	ON	OFF	OFF	OFF	OFF	OFF
33	ON	OFF	OFF	OFF	OFF	ON
34	ON	OFF	OFF	OFF	ON	OFF
35	ON	OFF	OFF	OFF	ON	ON
36	ON	OFF	OFF	ON	OFF	OFF

Table 3. Time slot selection by remote access

Switch Code (Decimal)	Physical Switch Settings SW2- or SW3-					T1	E1
	1	2	3	4	5	Time Slot	Time Slot
0	D	D	D	D	D	*	*
1	D	D	D	D	U	1	1
2	D	D	D	U	D	2	2
3	D	D	D	U	U	3	3
4	D	D	U	D	D	4	4
5	D	D	U	D	U	5	5
6	D	D	U	U	D	6	6
7	D	D	U	U	U	7	7
8	D	U	D	D	D	8	8
9	D	U	D	D	U	9	9
10	D	U	D	U	D	10	10
11	D	U	D	U	U	11	11
12	D	U	U	D	D	12	12
13	D	U	U	D	U	13	13
14	D	U	U	U	D	14	14
15	D	U	U	U	U	15	15
16	U	D	D	D	D	16	16****
17	U	D	D	D	U	17	17
18	U	D	D	U	D	18	18
19	U	D	D	U	U	19	19
20	U	D	U	D	D	20	20
21	U	D	U	D	U	21	21
22	U	D	U	U	D	22	22
23	U	D	U	U	U	23	23
24	U	U	D	D	D	24**	24
25	U	U	D	D	U	*	25
26	U	U	D	U	D	*	26
27	U	U	D	U	U	*	27
28	U	U	U	D	D	*	28
29	U	U	U	D	U	*	29
30	U	U	U	U	D	*	30
31	U	U	U	U	U	*	31***

D = down, U = up.

Notes: * This setting is not allowed . Setting switches to this code will cause the channel to be disabled.

**A T1 network utilizing fast reframing cannot utilize this time slot for voice channel.

*** An E1 network utilizing inter-node communications (NMX) cannot use timeslot 31 for voice channel.

**** An E1 network utilizing CAS cannot use Time Slot 16 for voice channel.

Table 4. TX Level Settings

	Nominal Level at Line		Tx Switch Setting*	Digital (T1)
	Vrms	dBm	dBm	dBm
(1)	2.449	+10	+10	0
	2.183	+9	+9	0
	1.946	+8	+8	0
	1.734	+7	+7	0
	1.546	+6	+6	0
	1.377	+5	+5	0
	1.228	+4	+4	0
	1.094	+3	+3	0
	0.975	+2	+2	0
	0.869	+1	+1	0
	0.775	+0	+0	0
(2)	0.690	-1	-1	0
	0.615	-2	-2	0
	0.548	-3	-3	0
	0.489	-4	-4	0
	0.436	-5	-5	0
	0.388	-6	-6	0
	0.346	-7	-7	0
	0.308	-8	-8	0
	0.275	-9	-9	0
	0.245	-10	-10	0
	0.218	-11	-11	0
	0.195	-12	-12	0
	0.173	-13	-13	0
	0.155	-14	-14	0
	0.138	-15	-15	0
	0.123	-16	-16	0
	0.109	-17	-17	0
	0.098	-18	-18	0
	0.087	-19	-19	0
	0.077	-20	-20	0
	0.069	-21	-21	0
	0.062	-22	-22	0
	0.055	-23	-23	0

*Use SW4-2 to SW4-7 for CH1 Tx setting
Use SW8-2 to SW8-7 for CH2 Tx setting

Table 5. RX Level Settings

	Digital (T1)	Rx Switch Setting*	Nominal Level at Line	
	dBm	dBm	dBm	Vrms
(2)	0	+10	+10	2.449
	0	+9	+9	2.183
	0	+8	+8	1.946
	0	+7	+7	1.734
	0	+6	+6	1.546
	0	+5	+5	1.377
	0	+4	+4	1.228
	0	+3	+3	1.094
	0	+2	+2	0.975
	0	+1	+1	0.869
(1)	0	+0	+0	0.775
	0	-1	-1	0.690
	0	-2	-2	0.615
	0	-3	-3	0.548
	0	-4	-4	0.489
	0	-5	-5	0.436
	0	-6	-6	0.388
	0	-7	-7	0.346
	0	-8	-8	0.308
	0	-9	-9	0.275
	0	-10	-10	0.245
	0	-11	-11	0.218
	0	-12	-12	0.195
	0	-13	-13	0.173
	0	-14	-14	0.155
	0	-15	-15	0.138
	0	-16	-16	0.123
	0	-17	-17	0.109
	0	-18	-18	0.098
	0	-19	-19	0.087
	0	-20	-20	0.077
	0	-21	-21	0.069
	0	-22	-22	0.062
	0	-23	-23	0.055
	0	-24	-24	0.049
	0	-25	-25	0.044
	0	-26	-26	0.039
	0	-27	-27	0.035
	0	-28	-28	0.031
	0	-29	-29	0.027
	0	-30	-30	0.024
	0	-31	-31	0.022
	0	-31.5	-31.5	0.021

*Use SW5-2 to SW5-7 for CH1 Rx setting
Use SW9-2 to SW9-7 for CH2 Rx setting

Notes:

1. Settings shown on these lines are for 0dBm in and 0dBm out.
2. Settings shown on these lines are for -16dBm in and +7dBm out (factory default)
3. Setting the switches for levels outside the range of these tables will cause signal degradation.

21. Set the position of SW7-1 to SW7-7 to select the Channel 1 RX Address. The settings for SW7 are the same as SW6.
22. Set the position of SW10-1 to SW10-7 to select the Channel 2 TX Address. The settings for SW10 are the same as SW6.
23. Set the position of SW11-1 to SW11-7 to select the Channel 2 RX Address. The settings for SW11 are the same as SW6.
24. If you plan to operate the RFL VF-5C module under **local** control, first perform steps 1 through 23, then perform the following steps; otherwise go to step 25.
 - a. Set to local control by placing DIP switch SW3-9 in the UP position.
 - b. Turn service on by placing DIP switch SW3-10 in the UP position.
 - c. Slide the module into the selected slot until it is firmly seated and the module front panel is flush with the top and bottom of the shelf.
 - d. Go to step 26.
25. If you plan to operate the RFL VF-5CB module under **remote** control, first perform steps 1 through 26, then perform the following steps:
 - a. Set to local control by placing DIP switch SW3-9 in the UP position.
 - b. Turn service off by placing DIP switch SW3-10 in the DOWN position.
 - c. Slide the module into the selected slot until it is firmly seated and the module front panel is flush with the top and bottom of the shelf.
 - d. Wait 15 seconds for the module's parameter settings to be loaded into the shelf Common Module.
 - e. Pull the module out of the shelf, and place DIP switch SW3-9 in the DOWN position.
Do not move SW3-10.
 - f. Slide the module back into the shelf.
 - g. Verify the module configuration through remote control by using NMS.
 - h. Turn service on through remote control by using NMS.
The operating parameters of the RFL VF-5C can now be changed by remote control. See page 31 of this Instruction Data Sheet for more information on remote control using NMS.
 - i. Go to step 26.
26. On the Module Record Card (located to the right of the shelf) record the channel bank type, time slot, and any other pertinent information.

The RFL VF-5C is now installed. If your multiplexer is set up for remote access and control, you can now change the operating parameters of the module by using NMS. For more information on remote access and control, consult your multiplexer operation manual.

FUNCTIONAL DESCRIPTION

For the following discussion, refer to the functional block diagram of the VF-5C shown in Figure 11, and typical applications shown in Figures 12, 13 and 14.

Overview

The VF-5C is a 4-wire voice frequency module for an IMUX E1 or T1 multiplexer. It is designed as a direct replacement for the VF-5A and VF-5AE. Typical applications are transmission only (Figure 12), push to talk (Figure 13), audio teleprotection tone transmission (Figure 14), etc. The VF-5C accepts (per channel) a voice frequency 600 ohm referenced input and uses μ -law (in T1) or A-law (in E1) PCM encoding to convert the analog voice into an 8-bit, 64 kbps digital signal. On the output side of the VF-5C, the digital DS0 data is decoded into the appropriate analog voice frequency output, referenced to 600 ohms. The VF-5C can be configured locally via switches or remotely via NMS software. All settings can be configured and/or monitored remotely except the signaling type selection which is done with jumpers.

Transmit section

An analog voice input signal is fed into the VF-5C through the module adapter being used. The audio signal then passes through a balanced input transformer. The transformer output feeds the gain section which includes a level control IC digitally controlled by the FPGA. The signals are then encoded by the codec, sent to the FPGA and finally transmitted to the far end through the backplane drivers and common module.

Receive section

The FPGA receives the appropriate PCM data through the backplane receivers and then passes it along to the codec. The codec then converts this PCM signal to an audio signal. The output of the codec feeds the level control stage, where the signal is adjusted to the appropriate signal level and through a transformer sent to the I/O.

Addressing

The VF-5C has addressing capabilities. The addressing feature uses the least significant bit (LSB) of the DS0 to transmit the TX address to the far end, where it is compared to the RX address of the far end. If the address matches, the channel operates normally. However, if the addresses don't match the RX channel mutes the output of the channel. This can be used to increase the security of an audio teleprotection channel.

The address is transmitted as part of a 16-bit message that includes the 7 address bits, 5 checksum bits, and 4 alignment bits. This structure ensures that no combination of mismatched addresses will be considered a match. Valid addresses range from 1 to 127. It is recommended that the TX and RX addresses on a channel be different. The use of the LSB decreases the signal to noise ratio from approximately 41dB to approximately 35dB.

>> text continues on page 28 <<

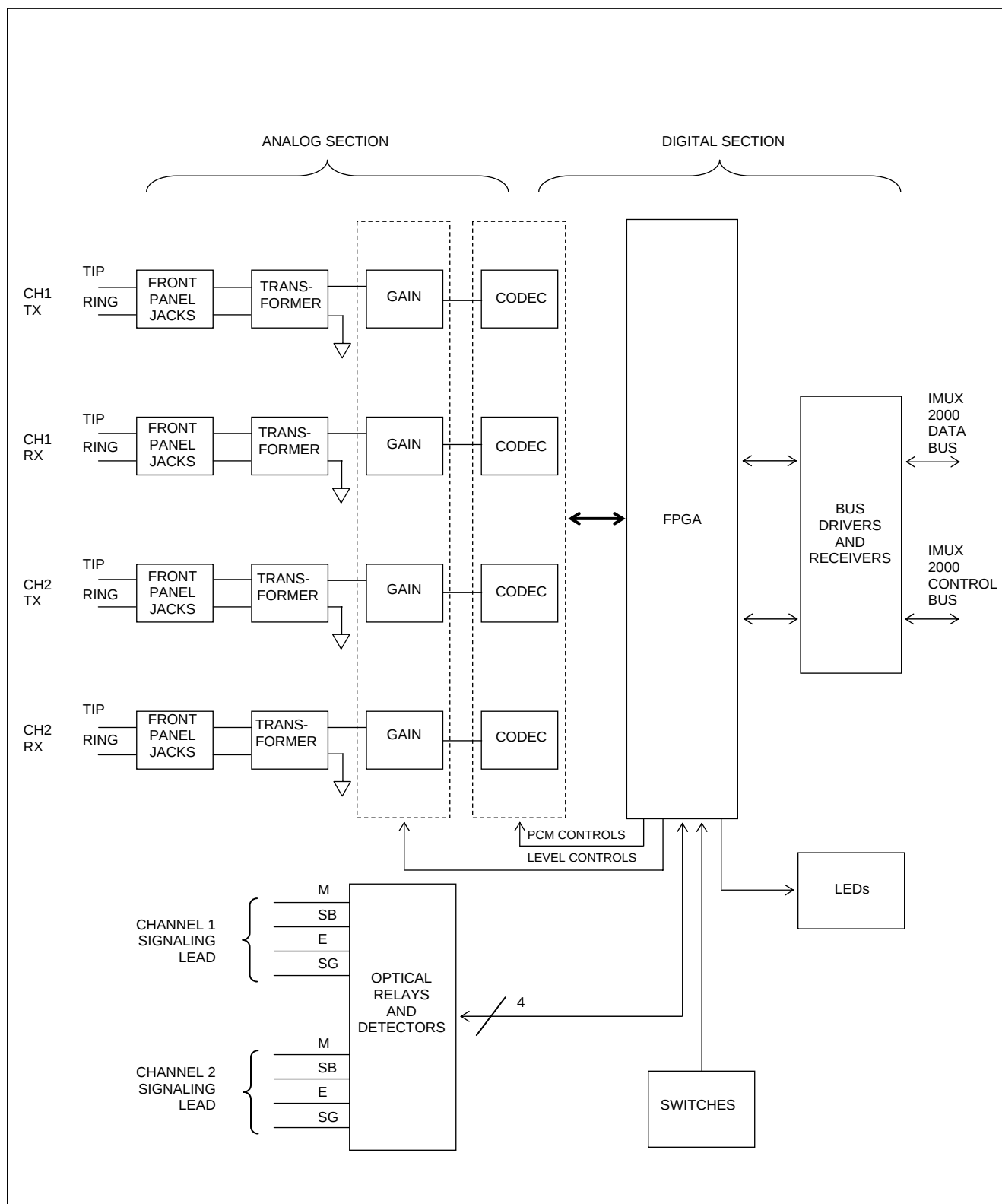


Figure 11. Functional block diagram, RFL VF-5C

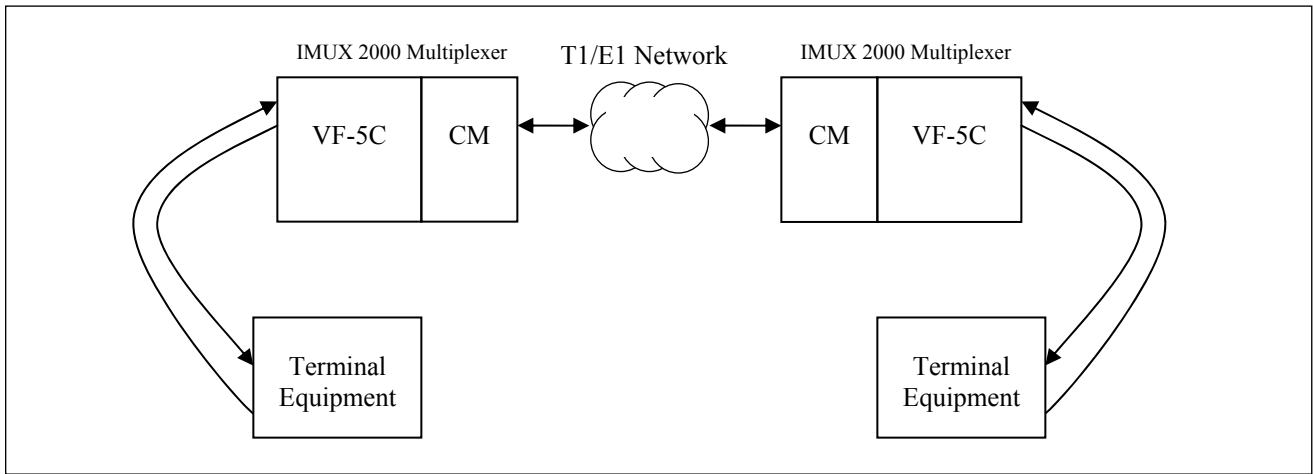


Figure 12. Typical transmission only "TO" application using VF-5C

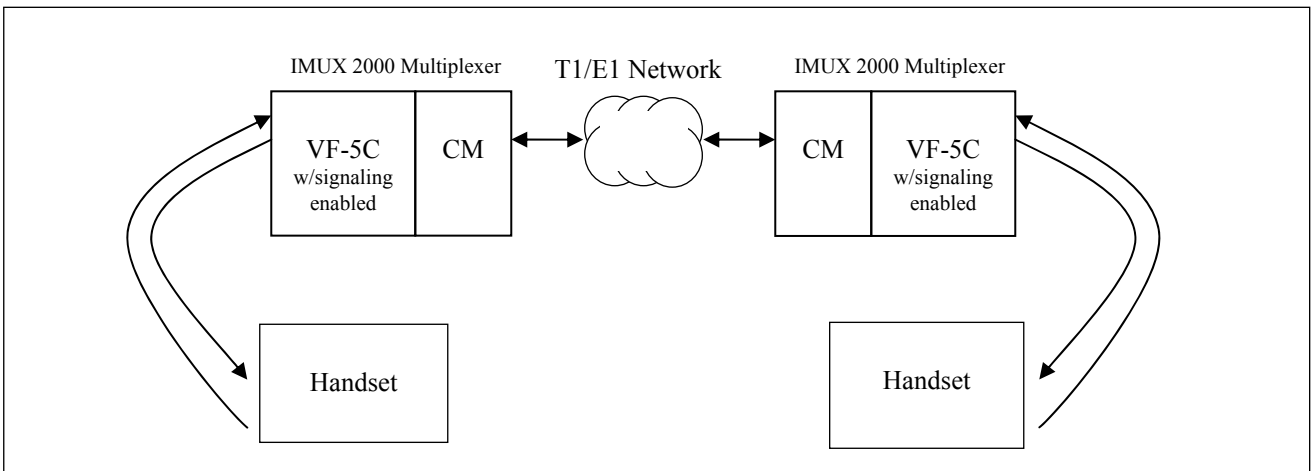


Figure 13. Typical "push to talk" application using VF-5C

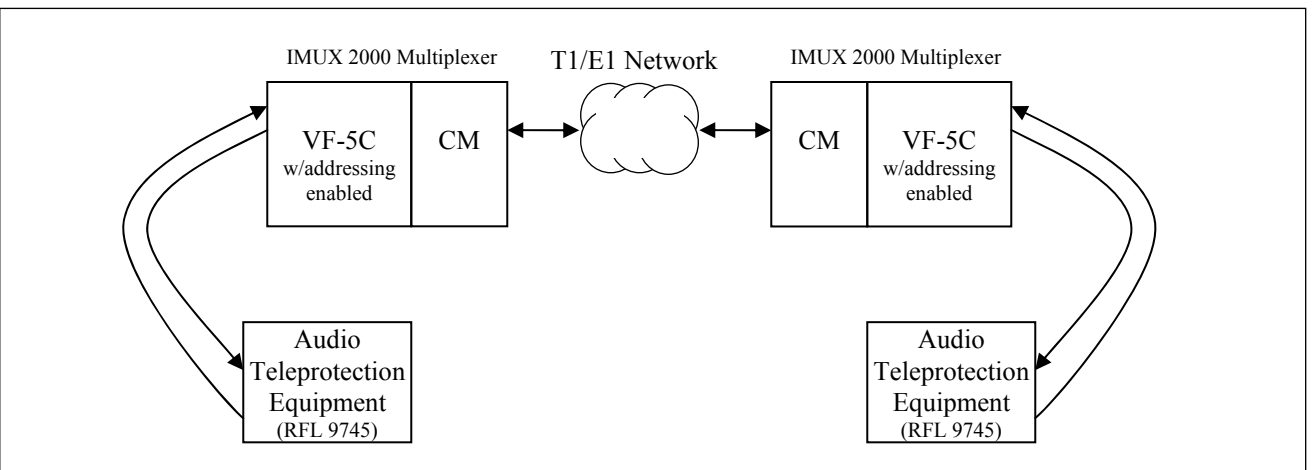


Figure 14. Typical audio teleprotection scheme using VF-5C

E&M Signaling

The VF-5C supports four types of E&M Signaling as shown in Figure 15: Type I, Type II, Type III and Type V. The E&M signaling jumpers are set according to the type of E&M signaling being used. Refer to the bottom of page 20 in Table 1 for information on how to set these jumpers.

Type I. Type I signaling is a two-wire scheme, normally encountered in electromechanical switching systems. The trunk circuit M lead provides the ground (on hook) and the battery –48V (off hook) toward the model VF-5C module. The signaling from the VF-5C to the trunk circuit is on the E lead with open circuit (on hook) and ground (off hook).

Type II. Type II signaling is a four-wire scheme, normally encountered in electronic switching systems. An on hook (idle) condition is indicated by open circuits on both E and M leads and a closure for off-hook (busy).

Type III. Type III signaling is a partially looped four-wire scheme. It provides better protection against interference, and is used with electronic switching systems. An on hook (idle) condition is indicated by an open circuit on the E lead and ground on the M lead. Signaling over the M lead is the same as type I, except that battery and ground for M lead signaling are provided to the trunk circuit over the MB and EB leads. A distinction of the Type III interface is that three conductors are used for M lead signaling.

Type V. Type V signaling is a two-wire scheme normally encountered outside North America. The trunk circuit M lead provides the ground (off-hook), and an open (on-hook) toward the VF-5C module. The signaling from the VF-5C to the trunk circuit is on the E lead with open circuit (on-hook) and ground (off-hook).

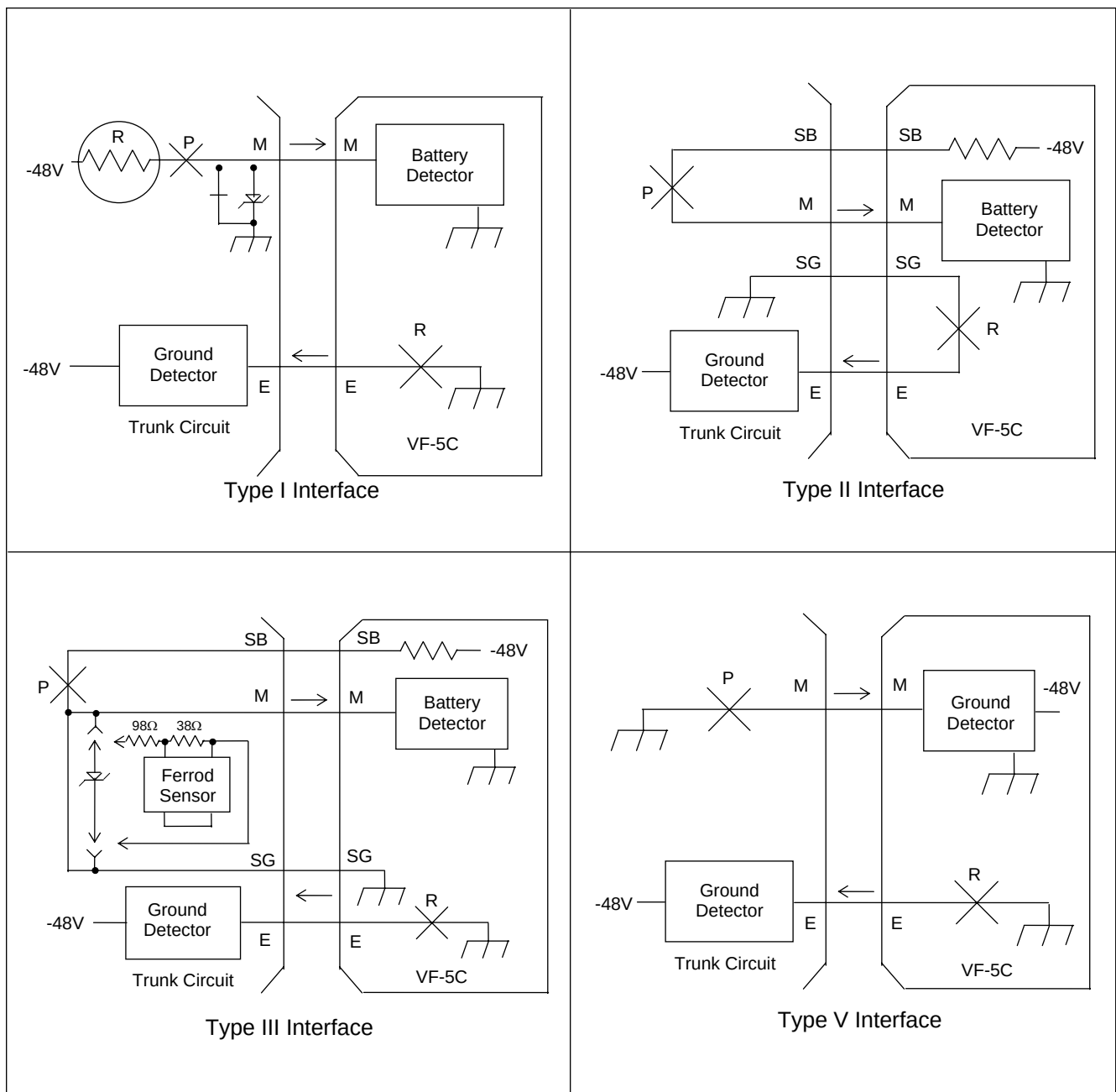


Figure 15. E&M signaling types

ALERTS AND ALARMS

The RFL VF-5C reports no module-level ALERT or ALARM signals to the shelf Common Module.

VF-5C COMPATIBILITY WITH PREVIOUS RFL VF-5 MODULES

The RFL VF-5C module is compatible with the VF-5, VF-5A and VF-5AE modules, however , many new features have been added to the VF-5C. The key differences and incompatibilities are as follows:

1. On the VF-5C, all settings other than signaling type are remotely programmable. Previous designs were much more limited.
2. The VF-5C supports type V signaling, which was previously unsupported.
3. An addressing feature has been added to the VF-5C. The addressing mode is not supported in older models.
4. Individual time slot and bus direction selection for each channel has been added. The previous designs require consecutive time slot selection, and the same bus direction.
5. The VF-5C has three loopback modes: local, remote, and 2713 Hz detect. These modes are not available with the previous designs, but they will function properly on a VF-5C when connected to one of these previous designs.
6. FXO/FXS modes are now switch selectable on every VF-5C. In the past this was only available with a custom modification.
7. A 1-kHz test tone can be injected into the transmit and receive paths to the VF-5C. This is a new feature and does not affect the functionality of the earlier designs.

REMOTE CONTROL USING NMS

PROGRAMMING THE VF-5C MODULE

There are two ways to program the VF-5C module, locally using DIP switches, or remotely using NMS (Network Management Software) version 10.3 or later. Refer to the IMUX 2000 or IMUX 2000E Instruction Manual for information on using NMS. To program the VF-5C module using NMS go to the VF-5C General Configurations Window and Status Window for Node 1, as shown in Figure 16. The General Configuration window is on the left and the General Status window is on the right. Note that the configuration window has five top-level pages selected by tabs at the top of the window as follows: General, Chan 1, Chan 1 continued, Chan 2 and Chan 2 continued. The following discussion covers the settings on the “General” page.

1. Module Enable

The Module Enable box can be checked or unchecked.

For the VF-5C module to be in service, check the Module Enable box (Service ON).

For the VF-5C module to be out of service, uncheck the Module Enable box (Service OFF).

After this setting is made, click on the “Chan 1” tab to get to the “Chan 1” window as shown in Figure 17.

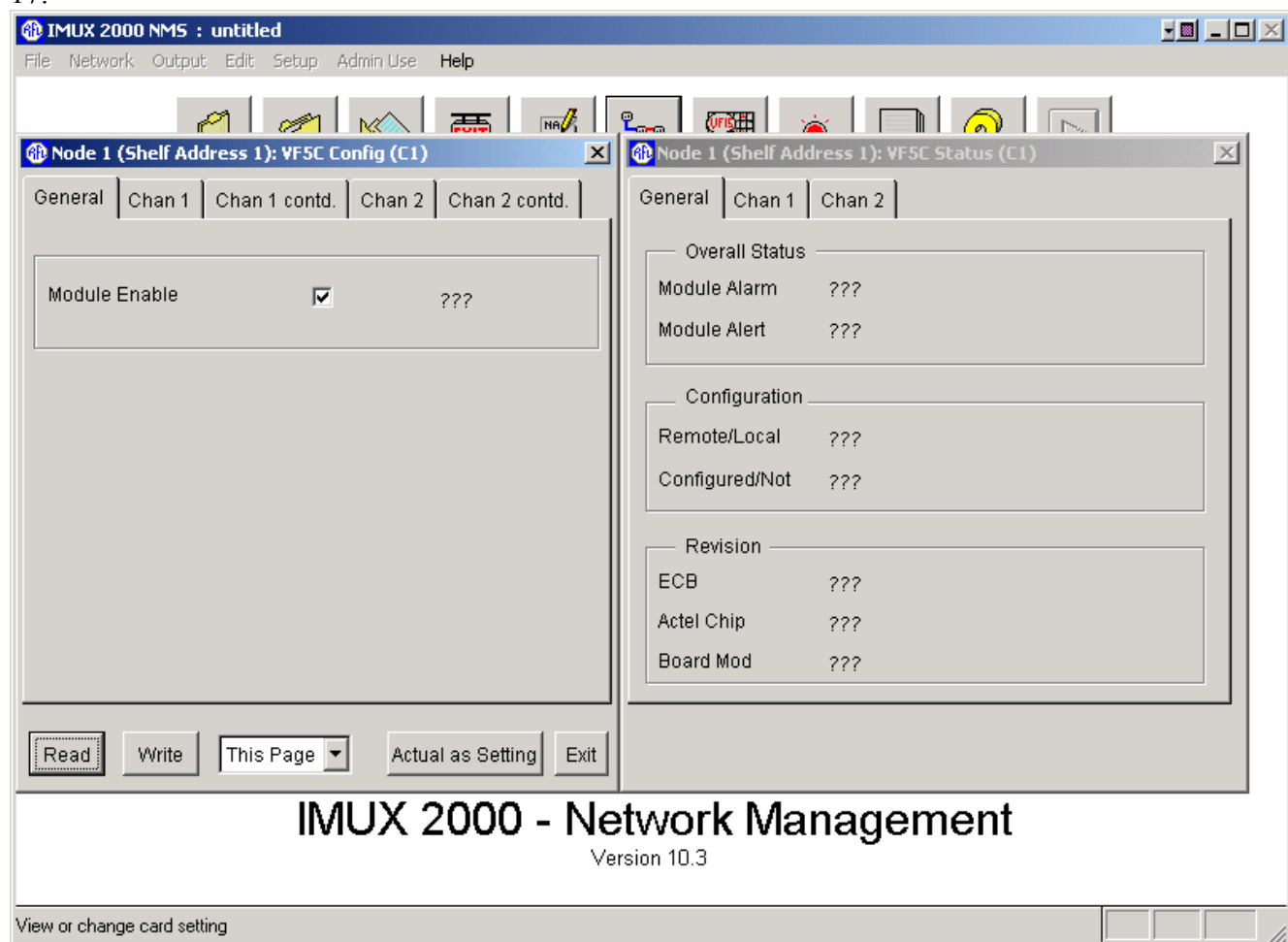


Figure 16. Typical VF-5C General Configurations and Status Window for Node 1

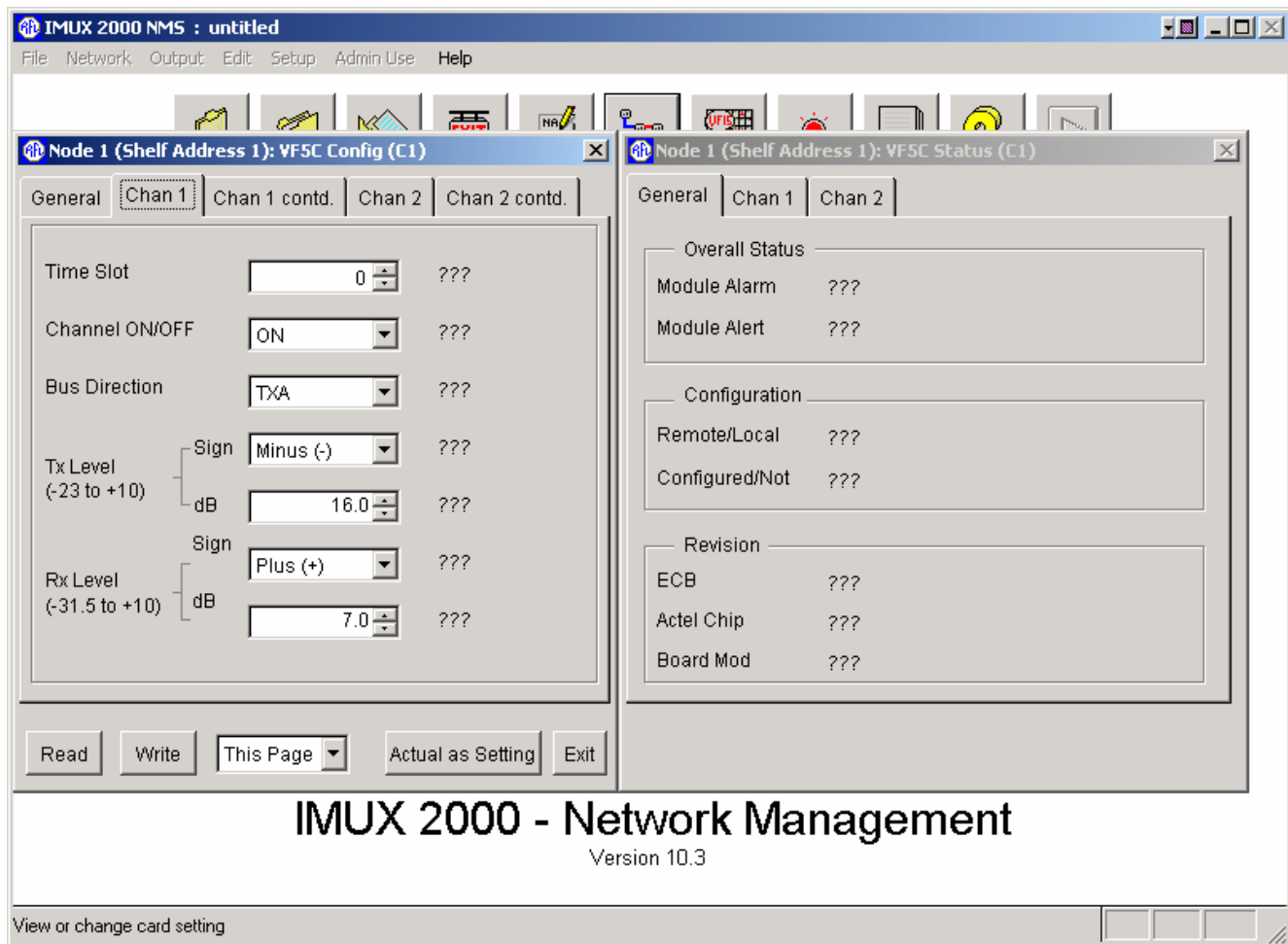


Figure 17. Typical VF-5C “Chan 1” Window for Node 1

The “Chan 1” window has five selections as follows: Time Slot, Channel On/Off, Bus Direction, Tx Level (-23 to +10) and Rx Level (-31.5 to +10). The following discussion covers the settings on the “Chan 1” page.

1. Time Slot

The Time Slot can be set from 1-24 for T1 networks and from 1-31 for E1 networks. Click on the spinner control (up and down arrows) to make the selection.

2. Channel On/Off

The Channel On/Off parameter can be set to ON or OFF.

When set to ON, Channel 1 is enabled (ON).

When set to OFF, Channel 1 is disabled (OFF).

3. Bus Direction

The Bus Direction can be set to TXA or TXB.

When set to TXA, Channel 1 transmits in the A direction and receives from the B direction.

When set to TXB, Channel 1 transmits in the B direction and receives from the A direction.

4. Tx Level (-23 to +10)

The Tx Level can be set from -23dBm to +10dBm in 0.5dBm steps, by clicking on the sign (+ or -) and then clicking on the dBm combo boxes (up and down arrows).

5. Rx Level (-31.5 to +10)

The Rx Level can be set from -31.5dBm to +10dBm in 0.5dBm steps, by clicking on the sign (+ or -) and then clicking on the dBm combo boxes (up and down arrows).

After all settings are made on the “Chan 1” page (Figure 17), click on the “Chan 1 continued” tab to go to the “Chan 1 continued” window as shown in Figure 18.

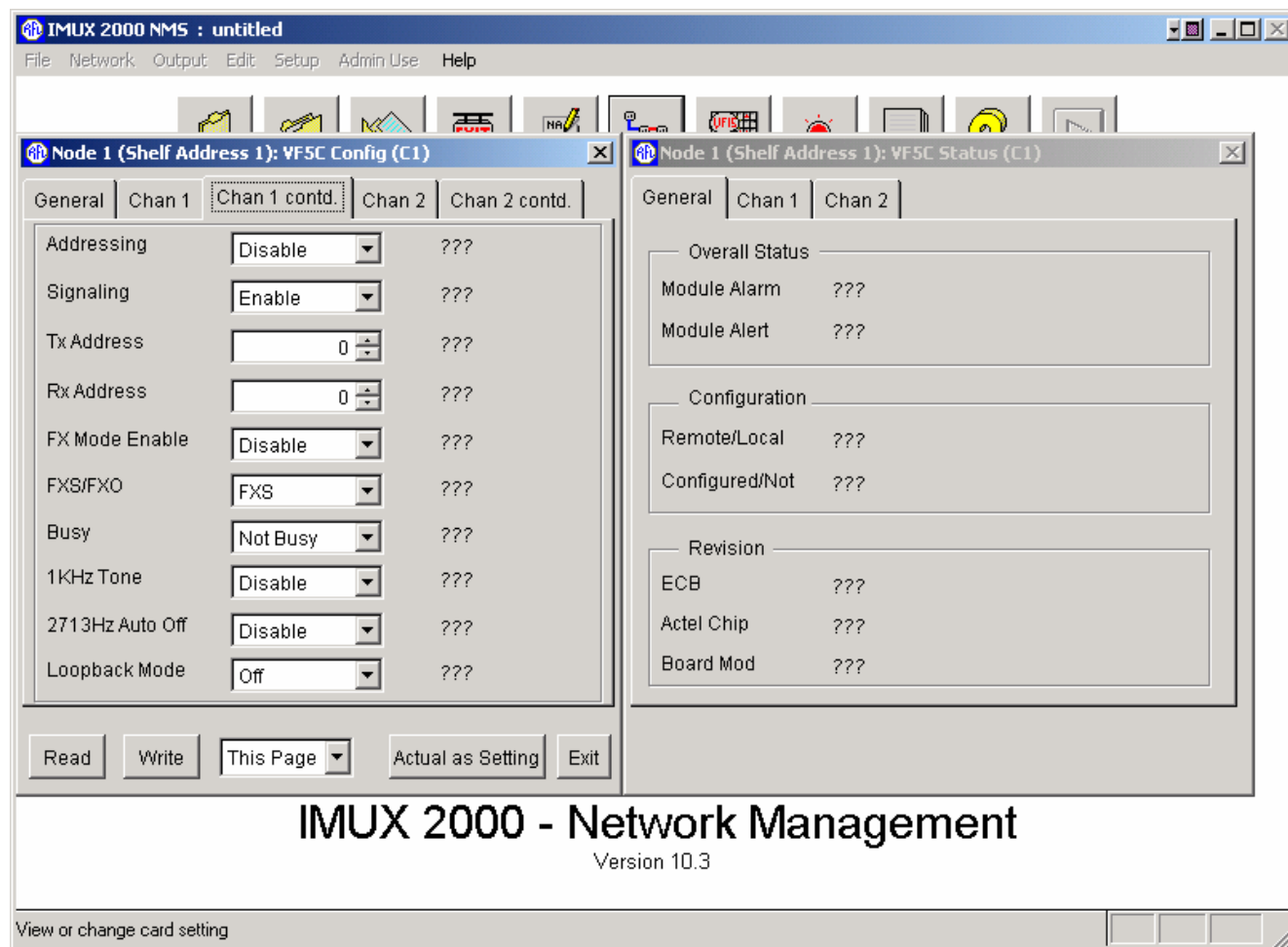


Figure 18. Typical VF-5C “Chan 1 continued” Window for Node 1

The “Chan 1 continued” window has ten selections as follows: Addressing, Signaling, Tx Address, Rx Address, FX Mode Enable, FXS/FXO, Busy, 1 kHz Tone, 2713 Hz Auto Off and Loopback Mode. The following discussion covers the settings on the “Chan 1 continued” page.

1. Addressing

The Addressing parameter can be enabled or disabled.

When set to enabled, Channel 1 Addressing is active (in use).

When set to disabled, Channel 1 Addressing is inactive (not in use).

2. Signaling

If the Addressing parameter is disabled, the Signaling parameter can be enabled or disabled. If Addressing is enabled, the Signaling parameter is automatically disabled.

When set to enabled, the Signaling parameter is active (in use).

When set to disabled, the Signaling parameter is inactive (not in use).

3. Tx Address

The Tx Address parameter can be set from 1 to 127 using the spinner control (up and down arrows).

4. Rx Address

The Rx Address parameter can be set from 1 to 127 using the spinner control (up and down arrows).

5. FX Mode Enable

The “FX Mode Enable” parameter can be set to enabled or disabled.

When set to enabled, the “FX Mode Enable” parameter is active (enabled).

When set to disabled, the “FX Mode Enable” parameter is inactive (disabled).

6. FXS/FXO

The “FXS/FXO” parameter allows the user to select either FXS mode or FXO mode using the combo box (up and down arrows).

7. Busy

The “Busy” parameter allows the user to activate or deactivate the Busy function using the combo box (up and down arrows). This is identical in function to the trunk circuit activating the M lead. Use this setting to force the off-hook condition as follows:

When set to Busy, the parameter is active (Busy).

When set to Not Busy the parameter is inactive (Not Busy).

8. 1 kHz Tone

The 1 kHz Tone parameter can be enabled or disabled

When set to enabled, the 1 kHz, 0dBm0 test tone in the Tx path is active (enabled).

When set to disabled, the 1 kHz, 0dBm0 test tone in the Tx path is inactive (disabled).

9. 2713 Hz Auto Off

The 2713 Hz Auto Off parameter selects either manual or automatic deactivation of the 2713 Hz loopback signal.

When set to enabled, the “2713 Hz Auto Off” parameter is active (manual deactivation of the 2713 Hz loopback signal).

When set to disabled, the “2713 Hz Auto Off” parameter is inactive (automatic deactivation of the 2713 Hz loopback signal).

10. Loopback Mode

In normal operation, all loopbacks are disabled. Loopback settings are used for troubleshooting purposes. There are four loopback settings as follows:

1. None (disable all loopbacks)
2. Local (enable local loopback)
3. Remote (enable remote loopback)
4. 2713 Hz (enable 2713Hz induced loopback)

After all settings are made in the “Chan 1 continued” window, set the parameters in the “Chan 2” window and “Chan 2 continued” window.

After all VF-5C parameter selections have been made they must be written to the VF-5C card in the network. This is done by using the “WRITE” operation as described in Section 7 of The IMUX 2000 Instruction Manual.

REMOTE CONTROL USING SCL COMMANDS

When installed in an IMUX 2000 remote controllable shelf, the RFL VF-5C module can be operated under local or remote control. When under remote control, certain configuration parameters can only be changed through the RS-232 remote port on the multiplexer. The remote interface for these modules involves two codes: a “P” (parameter) code, and an “S” (status) code. See the IMUX 2000 instruction manual for more information on the remote control interface.

The RFL VF-5C reports itself as a “Type 183” module.

“P” CODES

“P” codes, when used in the parameter field on a “SET” command, allow the user to set certain parameters on the module by remote control, just like setting the switches on a module under local control. “P” codes also appear in the response to a “CONFIG?” query, showing the current parameter settings on the module.

There are thirteen “P” codes for the RFL VF-5C, P1 through P13. Each of these P codes can be a decimal number from 0 to 255, which can also be represented as an eight-digit binary number (in parenthesis). The binary representation is more useful for setting and interpreting the “P” codes, since each binary digit (0 or 1) corresponds to the ON or OFF setting for a particular switch on the module. Table 6 describes the meanings of the “P” codes for the RFL VF-5C.

A typical RFL VF-5C response to a “CONFIG?” query looks like this:

```
* OK
CHANNEL CARD 3, TYPE 183
UNDER REMOTE CONTROL
SVCE = ON
P01 = 3 (B00000011)
P02 = 3 (B00000011)
P03 = 28 (B00011100)
P04 = 28 (B00011100)
P05 = 1 (B00000001)
P06 = 1 (B00000001)
P07 = 28 (B00011100)
P08 = 28 (B00011100)
P09 = 1 (B00000001)
P10 = 1 (B00000001)
P11 = 1 (B00000001)
P12 = 0 (B00000000)
P13 = 0 (B00000000);
```

NOTE

When using binary numbers with a SET command, they must be preceded by the letter “B” as shown in the following example:

<MULTIPLEXER ADDRESS>:<CARD ADDRESS>:SET:P1 = B00000011;

Besides using the P code, it is also possible to turn module service on or off by sending one of the following in the parameter field with a SET command:

SRVC = ON

SRVC = OFF

Table 6. Remote configuration settings (“P” codes)

P Code	Digit(s) And Switch Equivalent	Value ⁽¹⁾	Description
P1	B 0 0 0 0 0 0 0 0 0 ↑ ↑ - - - - - CH1 LOOPBACK MODE	00	OFF
		01	Remote
		10	Local
		11	2713 Hz mode
	B 0 0 0 0 0 0 0 0 0 - - ↑ - - - - CH1 TERMINAL	0	Ch1 = DI-B
		1	Ch1 = Terminal/DI-A
	B 0 0 0 0 0 0 0 0 0 - - - ↑ ↑ ↑ ↑ ↑ CH1 TIMESLOT	00001 to 11000 T1 Settings	From left to right, these five bits represent the binary value of the desired time slot between 1 through 24 in a T1 network. See Table 8 for a complete list of these values.
		00001 to 11111 E1 Settings	From left to right, these five bits represent the binary value of the desired time slot between 1 through 31 in an E1 network. See Table 8 for a complete list of these values.
P2	B 0 0 0 0 0 0 0 0 0 ↑ ↑ - - - - - CH2 LOOPBACK MODE	00	OFF
		01	Remote
		10	Local
		11	2713 Hz mode
	B 0 0 0 0 0 0 0 0 0 - - ↑ - - - - CH2 TERMINAL	0	Ch2 = DI-B
		1	Ch2 = Terminal/DI-A
	B 0 0 0 0 0 0 0 0 0 - - - ↑ ↑ ↑ ↑ ↑ CH2 TIMESLOT	00001 to 11000 T1 Settings	From left to right, these five bits represent the binary value of the desired time slot between 1 through 24 in a T1 network. See Table 8 for a complete list of these values.
		00001 to 11111 E1 Settings	From left to right, these five bits represent the binary value of the desired time slot between 1 through 31 in an E1 network. See Table 8 for a complete list of these values.

>> table continues on next page <<

1. These are the only legal values for setting the parameters. Setting any parameter to a value outside its specified range will produce an unpredictable result.

Table 6. continued - Remote configuration settings (“P” codes)

P Code	Digit(s) And Switch Equivalent	Value ⁽¹⁾	Description
P3	B 0 0 0 0 0 0 0 0 0 ↑ - - - - -	0	(+) Positive
	CH1 TRANSMIT LEVEL SIGN	1	(-) Negative
	B 0 0 0 0 0 0 0 0 0 - ↑ ↑ ↑ ↑ ↑ ↑ -	From 000000 to 101110	Range is from –23dB to +10dB Resolution is 0.5dB. For example +7dB = 001110, and set sign to (+). For example –16dB = 100000, and set sign to (-).
	B 0 0 0 0 0 0 0 0 0 - - - - - - - ↑	0	Ch1 Signaling Disabled
	CH1 SIGNALING ENABLE	1	Ch1 Signaling Enabled
P4	B 0 0 0 0 0 0 0 0 0 ↑ - - - - -	0	(+) Positive
	CH1 RECEIVE LEVEL SIGN	1	(-) Negative
	B 0 0 0 0 0 0 0 0 0 - ↑ ↑ ↑ ↑ ↑ ↑ -	From 000000 to 101100	Range is from –22dB to +10dB Resolution is 0.5dB. For example +7dB = 001110, and set sign to (+). For example –16dB = 100000, and set sign to (-).
	B 0 0 0 0 0 0 0 0 0 - - - - - - - ↑	0	Ch1 Not Busy
	CH1 BUSY	1	Ch1 Busy
P5	B 0 0 0 0 0 0 0 0 0 ↑ ↑ ↑ ↑ ↑ ↑ ↑ -	From 0000000 To 1111111	0 = 0000000 127 = 1111111 See description of addressing for more details.
	CH1 TRANSMIT ADDRESS		
	B 0 0 0 0 0 0 0 0 0 - - - - - - - ↑	0	Ch1 Addressing Disabled
	CH1 ADDRESSING ENABLE	1	Ch1 Addressing Enabled
P6	B 0 0 0 0 0 0 0 0 0 ↑ ↑ ↑ ↑ ↑ ↑ ↑ -	From 0000000 To 1111111	0 = 0000000 127 = 1111111 See description of addressing for more details.
	CH1 RECEIVE ADDRESS		
	B 0 0 0 0 0 0 0 0 0 - - - - - - - ↑	0	Ch1 FX Mode Disabled
	CH1 FX MODE ENABLE	1	Ch1 FX Mode Enabled

>> table continues on next page <<

Table 6. continued - Remote configuration settings (“P” codes)

P Code	Digit(s) And Switch Equivalent	Value ⁽¹⁾	Description
P7	B 0 0 0 0 0 0 0 0 0 ↑ - - - - -	0	(+) Positive
	CH2 TRANSMIT LEVEL SIGN	1	(-) Negative
	B 0 0 0 0 0 0 0 0 0 - ↑ ↑ ↑ ↑ ↑ ↑ -	From 000000 to 101110	Range is from –23dB to +10dB Resolution is 0.5dB. For example +7dB = 001110, and set sign to (+). For example –16dB = 100000, and set sign to (-).
	CH2 TRANSMIT LEVEL		
	B 0 0 0 0 0 0 0 0 0 - - - - - - - ↑	0	Ch2 Signaling Disabled
	CH2 SIGNALING ENABLE	1	Ch2 Signaling Enabled
P8	B 0 0 0 0 0 0 0 0 0 ↑ - - - - -	0	(+) Positive
	CH2 RECEIVE LEVEL SIGN	1	(-) Negative
	B 0 0 0 0 0 0 0 0 0 - ↑ ↑ ↑ ↑ ↑ ↑ -	From 000000 to 101100	Range is from –22dB to +10dB Resolution is 0.5dB. For example +7dB = 001110, and set sign to (+). For example –16dB = 100000, and set sign to (-).
	CH2 RECEIVE LEVEL		
	B 0 0 0 0 0 0 0 0 0 - - - - - - - ↑	0	Ch2 Not Busy
	CH2 BUSY	1	Ch2 Busy
P9	B 0 0 0 0 0 0 0 0 0 ↑ ↑ ↑ ↑ ↑ ↑ ↑ -	From 0000000 To 1111111	0 = 0000000 127 = 1111111 See description of addressing for more details.
	CH2 TRANSMIT ADDRESS		
	B 0 0 0 0 0 0 0 0 0 - - - - - - - ↑	0	Ch2 Addressing Disabled
	CH2 ADDRESSING ENABLE	1	Ch2 Addressing Enabled
P10	B 0 0 0 0 0 0 0 0 0 ↑ ↑ ↑ ↑ ↑ ↑ ↑ -	From 0000000 To 1111111	0 = 0000000 127 = 1111111 See description of addressing for more details.
	CH2 RECEIVE ADDRESS		
	B 0 0 0 0 0 0 0 0 0 - - - - - - - ↑	0	Ch2 FX Mode Disabled
	CH2 FX MODE ENABLE	1	Ch2 FX Mode Enabled

>> table continues on next page <<

Table 6. continued - Remote configuration settings (“P” codes)

P Code	Digit(s) And Switch Equivalent	Value ⁽¹⁾	Description
P11	B 0 0 0 0 0 0 0 0 0 ↑ - - - - - CH1 DISABLE	0	Ch1 Disabled
		1	Ch1 Enabled
	B 0 0 0 0 0 0 0 0 0 - ↑ - - - - - CH2 DISABLE	0	Ch2 Disabled
		1	Ch2 Enabled
	B 0 0 0 0 0 0 0 0 0 - - ↑ - - - - - CH1 (FXS or FXO)	0	Ch1 = FXO
		1	Ch1 = FXS
	B 0 0 0 0 0 0 0 0 0 - - - ↑ - - - - CH1 1kHz TONE ENABLE	0	Ch2 1kHz Tone Disabled
		1	Ch2 1kHz Tone Enabled
	B 0 0 0 0 0 0 0 0 0 - - - - ↑ - - - CH2 (FXS or FXO)	0	Ch2 = FXO
		1	Ch2 = FXS
	B 0 0 0 0 0 0 0 0 0 - - - - - ↑ - - CH1 1kHz TONE ENABLE	0	Ch2 1kHz Tone Disabled
		1	Ch2 1kHz Tone Enabled
	B 0 0 0 0 0 0 0 0 0 - - - - - - - ↑ - CH1 2713 AUTO TURN OFF ENABLE	0	Ch1 2713 Auto Turn Off Disabled
		1	Ch1 2713 Auto Turn Off Enabled
	B 0 0 0 0 0 0 0 0 0 - - - - - - - - ↑ CH2 2713 AUTO TURN OFF ENABLE	0	Ch2 2713 Auto Turn Off Disabled
		1	Ch2 2713 Auto Turn Off Enabled
P12	B 0 0 0 0 0 0 0 0 0	...	For future use. Do not write to this byte.
P13	B 0 0 0 0 0 0 0 0 0	...	For future use. Do not write to this byte.

“S” CODES

“S” codes appear in response to a “STATUS?” query. There are six “S” codes for the RFL VF-5C. Like the “P” code, this number is displayed in both decimal and binary form. The seven most significant digits of the binary number represent the conditions shown in Table 7. The least significant digit is not used.

A typical response to a “STATUS?” query looks like this:

*** OK**

CHANNEL CARD 3, TYPE 78 (or 69)

S01 = 2 (B00000010)

S02 = 2 (B00000010)

S03 = 8 (B00001000)

S04 = 1 (B00000001)

S05 = 0 (B00000000)

S06 = 1 (B00000001);

Table 7. Remote status messages (“S” codes)

S Code	Digit(s) And Switch Equivalent	Value ⁽¹⁾	Description
S1	B 0 0 0 0 0 0 0 0 0 ↑ - - - - -	0	Ch1 Config Valid
	CH1 CONFIG INVALID	1	Ch1 Config Invalid
	B 0 0 0 0 0 0 0 0 0 - ↑ - - - - -	0	Ch1 Disabled
	CH1 ENSABLED	1	Ch1 Enabled
	B 0 0 0 0 0 0 0 0 0 - - ↑ - - - - -	0	Ch1 E Lead Inactive
	CH1 E LEAD	1	Ch1 E Lead Active
	B 0 0 0 0 0 0 0 0 0 - - - ↑ - - - -	0	Ch1 M Lead Inactive
	CH1 M LEAD	1	Ch1 M Lead Active
	B 0 0 0 0 0 0 0 0 0 - - - - ↑ - - -	0	Ch1 2713 Loopback Inactive
	CH1 2713 LOOPBACK	1	Ch1 2713 Loopback Active
	B 0 0 0 0 0 0 0 0 0 - - - - - ↑ - -	0	Ch1 Address Mis-match
	CH1 ADDRESS MATCH	1	Ch1 Address Match
	B 0 0 0 0 0 0 0 0 0 - - - - - - - ↑ -	0	Ch1 Addressing Disabled
	CH1 ADDRESSING	1	Ch1 Addressing Enabled
	B 0 0 0 0 0 0 0 0 0 - - - - - - - ↑	...	Will always read zero.
	UNUSED BIT		

>> table continues on next page <<

Table 7. continued - Remote status messages ("S" codes)

S Code	Digit(s) And Switch Equivalent	Value ⁽¹⁾	Description
S2	B 0 0 0 0 0 0 0 0 0 ↑ - - - - - CH2 CONFIG INVALID	0	Ch2 Config Valid
		1	Ch2 Config Invalid
	B 0 0 0 0 0 0 0 0 0 - ↑ - - - - - CH2 ENSABLED	0	Ch2 Disabled
		1	Ch2 Enabled
	B 0 0 0 0 0 0 0 0 0 - - ↑ - - - - - CH2 E LEAD	0	Ch2 E Lead Inactive
		1	Ch2 E Lead Active
	B 0 0 0 0 0 0 0 0 0 - - - ↑ - - - - - CH2 M LEAD	0	Ch2 M Lead Inactive
		1	Ch2 M Lead Active
	B 0 0 0 0 0 0 0 0 0 - - - - ↑ - - - - CH2 2713 LOOPBACK	0	Ch2 2713 Loopback Inactive
		1	Ch2 2713 Loopback Active
	B 0 0 0 0 0 0 0 0 0 - - - - - ↑ - - - CH2 ADDRESS MATCH	0	Ch2 Address Mis-match
		1	Ch2 Address Match
	B 0 0 0 0 0 0 0 0 0 - - - - - - - ↑ - CH2 ADDRESSING	0	Ch2 Addressing Disabled
		1	Ch2 Addressing Enabled
	B 0 0 0 0 0 0 0 0 0 - - - - - - - - ↑ UNUSED BIT	...	Will always read zero.

>> table continues on next page <<

Table 7. continued - Remote status messages (“S” codes)

S Code	Digit(s) And Switch Equivalent	Value ⁽¹⁾	Description
S3	B 0 0 0 0 0 0 0 0 0 ↑ ↑ ↑ ↑ ↑ - - - ECB REVISION LEVEL	00001 = A 00010 = B 00011 = C etc.	The printed wiring board revision. (Not the complete assembly)
	B 0 0 0 0 0 0 0 0 0 - - - - - ↑ ↑ ↑ BOARD MODIFICATION LEVEL	000 to 111	Bit 0 = R110 Bit 1 = R111 Bit 3 = R112 If any resistor is installed, the corresponding bit will be zero. This is used to identify custom modifications to the assembly.
S4	B 0 0 0 0 0 0 0 0 0 ↑ ↑ ↑ ↑ ↑ ↑ ↑ ↑ ACTEL REVISION LEVEL	From 00000001 to 11111111	The ACTEL firmware revision level
S5	B 0 0 0 0 0 0 0 0 0 ↑ - - - - - - - SUB TYPE HIGH	0	For future use only.
S6	B 0 0 0 0 0 0 0 0 0 ↑ - - - - - - - SUB TYPE LOW	1	For future use only.

TESTING

Once the RFL VF-5C Module has been configured and installed, it should be tested for proper operation before it is placed in service. There are two ways you can do the testing:

1. Local testing using T1 or E1 loopback with the system out of service.
2. End-to-end testing, with the system inservice but the channel being tested taken out of service.

Use the following procedure to test the RFL VF-5C:

1. If using T1 or E1 loopback testing, set up the multiplexer loopback following the instructions in multiplexer operation manual.
2. Test each channel separately. If using end-to-end testing, test each channel first from Site 1 to Site 2, then reverse the setup and test from Site 2 to Site 1.
3. If addressing is enabled, the address on the receiving end must match the address at the transmitting end.
4. Connect the output of a TIM set or equivalent to the equipment input jack for the channel being tested. Insert a 1004 kHz test tone at the TX level selected for that channel referenced to 600 ohms.

NOTE

For the following steps, check the output on the same RFL VF-5C module if you are using loopback testing, or on the module at the receive end if you are using end-to-end testing.

5. Measure the channel output at the equipment output jack.
The output level should be the RX level selected for that channel referenced to 600 ohms, ± 0.5 dB.
6. If signaling is enabled, activate the M-Lead and observe that the corresponding M indicator LED on the transmit module and the E indicator LED on the receive module both light up.
7. Remove the test equipment and disconnect the loopback if one was used.
The module is now available for operation.

If there is an apparent malfunction, first check that the configuration is appropriate for the transmission system in use. If using end-to-end testing, check that the transmit and receive configuration is compatible.

Problems may occur at the common equipment or facility level which affect the operation of this module. Refer to your multiplexer operation manual for system analysis procedures.

Notes

Notes

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RFL Electronics Inc.

INSTRUCTION DATA

RFL VF-6I Single-Channel Four Wire Orderwire Voice Frequency Module

DESCRIPTION

The RFL VF-6I is a single-channel four wire voice-frequency module, designed for use in IMUX 2000 T1 and E1 multiplexers. It accepts one voice channel as input and uses u-law PCM encoding to convert the analog voice signal into a companded 8-bit, 64-Kbps digital signal. The RFL VF-6I can be used in both terminal and drop/insert multiplexers.

The RFL VF-6I provides high quality voice characteristics compatible with AT&T Publication 43801. It allows VF-6 compatible signaling control or E & M signaling of Type I, II, and III, with front panel busy indicators. It has calibrated extended-range input and output signal level adjustments to facilitate interfaces in most four-wire applications.

The VF-6I module is fully compatible with the RFL VF-6 module and is functionally compatible with the VF-5A module.

User-adjustable switches and jumpers allow the configuration of the following parameters:

- o Selectable signaling control (VF-6 compatible) or E&M Type I, II, and III signaling.
- o Signaling format - CAS in E1, RBS in T1, or no signaling.
- o Busy out setting.
- o Selectable Bus A, Bus B, or Both (D&I).
- o Input/output attenuation.
- o Time slot selection.
- o Remote control configuration and status reporting.
- o Selectable transmit control (continuous transmit, hook-switch, voice activate (VOX) or receive only).
- o Selectable Bridge mode or Multi-drop (orderwire) mode.

SPECIFICATIONS

As of the date this Instruction Data Sheet was published, the following specifications apply to the RFL VF-6I module. Because all RFL products undergo constant refinement and improvement, these specifications are subject to change without notice.

Configuration: One voice-frequency channel.

Frequency response: 300 to 3000 Hz (+/- 0.3 dB)

Input Level: -19.0 dBm to +5.0 dBm (-16 dBm nominal), adjustable in 0.1-dB steps.

Output Level: -14.0 dBm to +10.0 dBm (+7 dBm nominal), adjustable in 0.1-dB steps.

Input Impedance: 600 ohms.

Output Impedance: 600 ohms.

Idle Channel Noise: Less than 23 dBnc0.

Signal-To-Noise: Greater than 38 dB.

Signaling: Selectable signaling control, E & M Type I, II, or III or transmission only (TO) mode.

Signaling control input:

Busy: ground

Idle: open (pulled to Vcc through 4.7K Ω)

Hook-switch control input:

On-hook: open (pulled to Vcc through 4.7K Ω)

Off-hook: ground

M-Lead Input:

Input Impedance: Greater than 20K ohms to ground

Busy: -20 to -60 Volts

Idle: Open or Ground

E-Lead Output:

Busy: Less than 50 ohms to ground

Idle: Open

Time Slots Required:

One-Channel Operation: One selectable time slot.

Two-Channel Operation: Two adjacent selectable time slots.

Remote Interface: Compatible with SCL remote command language; allows module configuration and status access.

Operating Temperature: -20°C to +55°C (-4°F to +131°F).

Relative Humidity: 0 to 90 %, non-condensing.

Input Power: 1.0 watt nominal.

INSTALLATION

Before the RFL VF-6I can be placed in service, it must be installed in a multiplexer shelf. Installation involves determining the module slot in the Main Shelf or Repeater Shelf where the module will be installed, inserting a Module Adapter into the rear of the shelf behind the module slot, connecting all signal and power wiring to the Module Adapter, checking the settings of all jumpers, and inserting the module into the front of the shelf.

NOTE

Power supply and time slot considerations may affect the installation of this module into an existing multiplexer shelf. Refer to the multiplexer manual for more information.

The following instructions are provided for installing RFL VF-6I modules into existing systems. If the module was included as part of a system, installation was done at the factory. Otherwise, proceed as follows:

1. Carefully inspect the module for any visible signs of shipping damage. If you suspect damage to the module, immediately call RFL Customer Service at the number listed at the bottom of this page.

2. Determine the module slot in the Main Shelf or Repeater Shelf where the RFL VF-6I will be installed.

RFL VF-6I modules occupy one module slot in the Main Shelf or Repeater Shelf.

3. Determine which Module Adapter will be used to make connections to the RFL VF-6I module.

Each module in the IMUX 2000 multiplexer requires a Module Adapter. The module adapter provides the appropriate connector for the desired interface. There are four Module Adapters compatible with the RFL VF-6I:

MA-301

The MA-301 accepts a 50-pin Telco connector (Amphenol 57-30500 or equivalent, as shown in Figure 1.) One MA-301 Module Adapter can be used to connect up to three RFL VF-6I modules, for a total of up to three voice channels. If you will be using more than one module with an MA-301, they must be inserted into adjacent slots in the multiplexer. Ribbon cables are provided with the MA-301 to make connections to it from the second and third module locations. (See Figure 2.)

>> text continues on page 5 <<

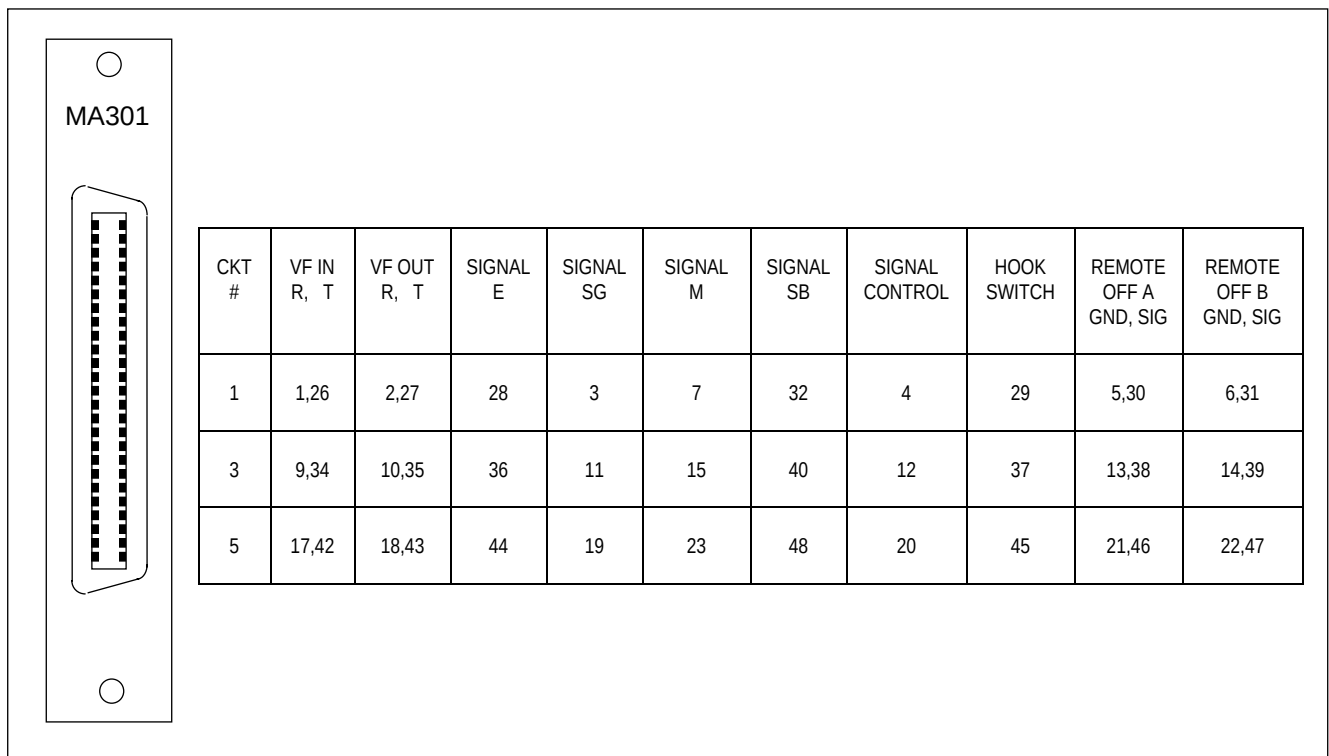


Figure 1. MA-301 Module Adapter

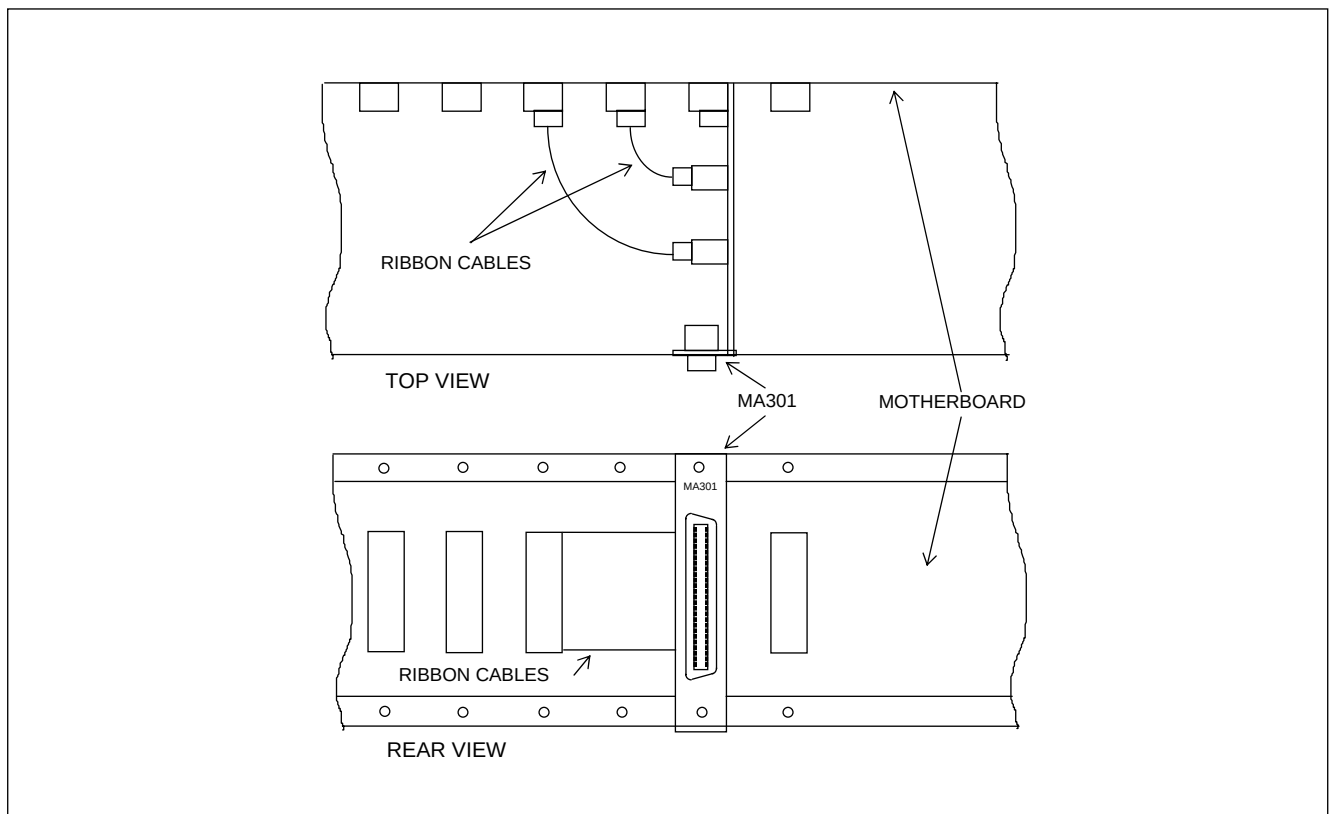


Figure 2. Connecting two RFL VF-6I modules to a single MA-301 Module Adapter.

MA-301A-1 The MA-301A-1 is used to isolate the VF-6I from SWC type surges sometimes present on 4-wire voice lines. A terminal strip is provided for hard wire connections to the voice circuit as shown in Figure 3. One MA-301A-1 must be used for each VF-6I module.

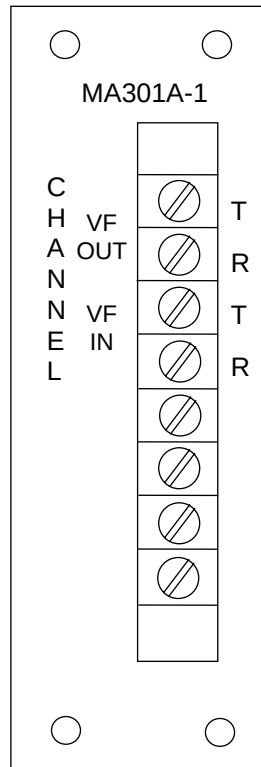


Figure 3. MA-301A-1, SWC rated 4-wire Module Adapter

MA-301B-2 The MA-301B-2 provides pluggable terminal block connections for a single VF-6I module. Audio and signalling connections are available at the terminal block. No additional SWC or fast transient protection is provided on this I/O. Refer to Figure 4 for panel view and terminal connections.

CKT #	VF IN R, T	VF OUT R, T	SIGNAL E	SIGNAL SG	SIGNAL M	SIGNAL SB
1	2, 1	4, 3	7	8	16	15

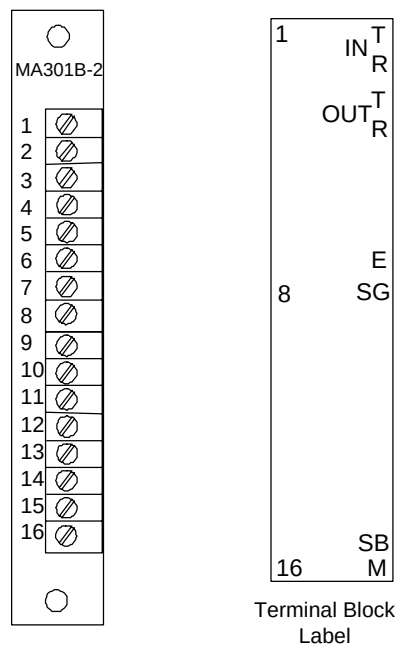


Figure 4. MA-301B-2 Module Adapter

MA-324

The MA-324 accepts a 50-pin Telco connector (Amphenol 57-30500 or equivalent, as shown in Figure 5.) One MA-324 Module Adapter is used for each RFL VF-6I module and occupies two rear slots in the IMUX 2000E chassis. The MA-324 is used to convert one of the 4-wire outputs (Channel 1) from 4-wire to 2-wire. The other 4-wire output is not used. The impedance is 600 Ohms, the frequency response is $\pm 2\text{dB}$ from 200Hz to 3000Hz, and the transformer loss (hybrid loss) is $\cong 4.0\text{dB}$.

Pin No.	MA-324 Pin Functions
1	Ring
3	SG
7	M
26	Tip
28	E
32	SB

Note: All unlisted pins are not used.

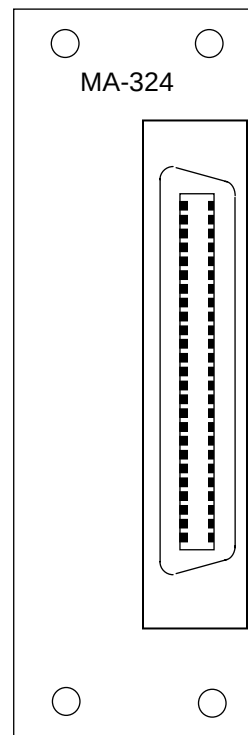


Figure 4. MA-324 Module Adapter

4. Insert the desired Module Adapter into the rear of the slot which will hold the RFL VF-6I module, and make all connections to the module Adapter.
If an MA-301 or MA-324 Module Adapter is being used, plug the 50-pin Telco connector into its 50-pin connector.

If an MA-301A-1 Module Adapter is being used, connect all signal wiring to the terminal strip at the rear of the MA-301A-1 using Figure 3 as a guide.

If an MA-301B-1 Module Adapter is being used, connect all signal wiring to the terminal strip at the rear of the MA-301B-1 using Figure 4 as a guide.
5. Refer to Figure 6 and Table 1 for the location of DIP switches on the VF-6I.
6. Set DIP switches SW1-1 through SW1-6 to the desired remote address (SCB address).
For remote access, each channel module in the IMUX 2000 must have a distinct module address. Valid addresses are the numbers “1” to “36”. In most installations, the address will be set to the slot number in the shelf the module is occupying. Table 2 shows the switch settings for the module address.
7. Set DIP switches SW2-1 through SW2-5 to select the desired time slot.
SW2-1 through SW2-5 select the time slot assignment, using the binary codes shown in Table 3 of this Instruction Data Sheet.
8. Set DIP switch SW2-6 to enable or disable bus A.
Place SW2-6 in the DOWN position to transmit on bus A and receive on bus B.
Place SW2-6 in the UP position to disable bus A.

9. Set DIP switch SW2-7 to enable or disable bus B.
Place SW2-7 in the DOWN position to transmit on bus B and receive on bus A.
Place SW2-7 in the UP position to disable bus B.
10. Set DIP switch SW2-8 to select T1 or E1 operation.
Place SW2-8 in the UP position for T1 operation.
Place SW2-8 in the DOWN position for E1 operation.
11. Set DIP switches SW3-1 & SW3-2 for transmit control modes.
Place SW3-1 DOWN and SW3-2 DOWN for Continuous mode
Place SW3-1 DOWN and SW3-2 UP for Hook Switch mode
Place SW3-1 UP and SW3-2 DOWN for Voice Activate (VOX) mode
Place SW3-1 UP and SW3-2 UP for Receive Only mode
12. Set DIP switch SW3-3 to enable or disable signaling.
Place SW3-3 in the UP position to enable signaling
Place SW3-3 in the DOWN position to disable signaling
13. Set DIP switch SW3-4 to control the BUSY output.
Place SW3-4 in the UP position for normal operation
Place SW3-4 in the DOWN position to enable BUSY OUT (OFF HOOK)
14. Set DIP switch SW3-5 to select BRIDGE mode or MULTI-DROP (Orderwire) mode.
Place SW3-5 in the UP position to select BRIDGE mode .
Place SW3-5 in the DOWN position to select MULTI-DROP mode.
15. DIP switch SW3-6 is not used. Leave it in the DOWN position.
16. DIP switches SW3-7 & SW3-8 are used to set the threshold for voice activate mode if card is configured for voice activate mode.
Place SW3-7 DOWN and SW3-8 DOWN to set minimum threshold
Place SW3-7 DOWN and SW3-8 UP to set higher than minimum threshold
Place SW3-7 UP and SW3-8 DOWN to set lower than maximum threshold
Place SW3-7 UP and SW3-8 UP to set maximum threshold
17. Set DIP switch SW3-9 for either local or remote control.
If you plan to access the RFL VF-6I remotely, place SW3-9 in the DOWN position.
If you will be using the RFL VF-6I under local control, place SW3-9 in the UP position.
18. Set DIP switch SW3-10 to turn service on or off.
When SW3-10 is in the DOWN position, service is OFF. If the RFL VF-6I is under local control, the module is disabled. When SW3-10 is in the UP position, service is ON. If the RFL VF-6I is under local control, the module is enabled.

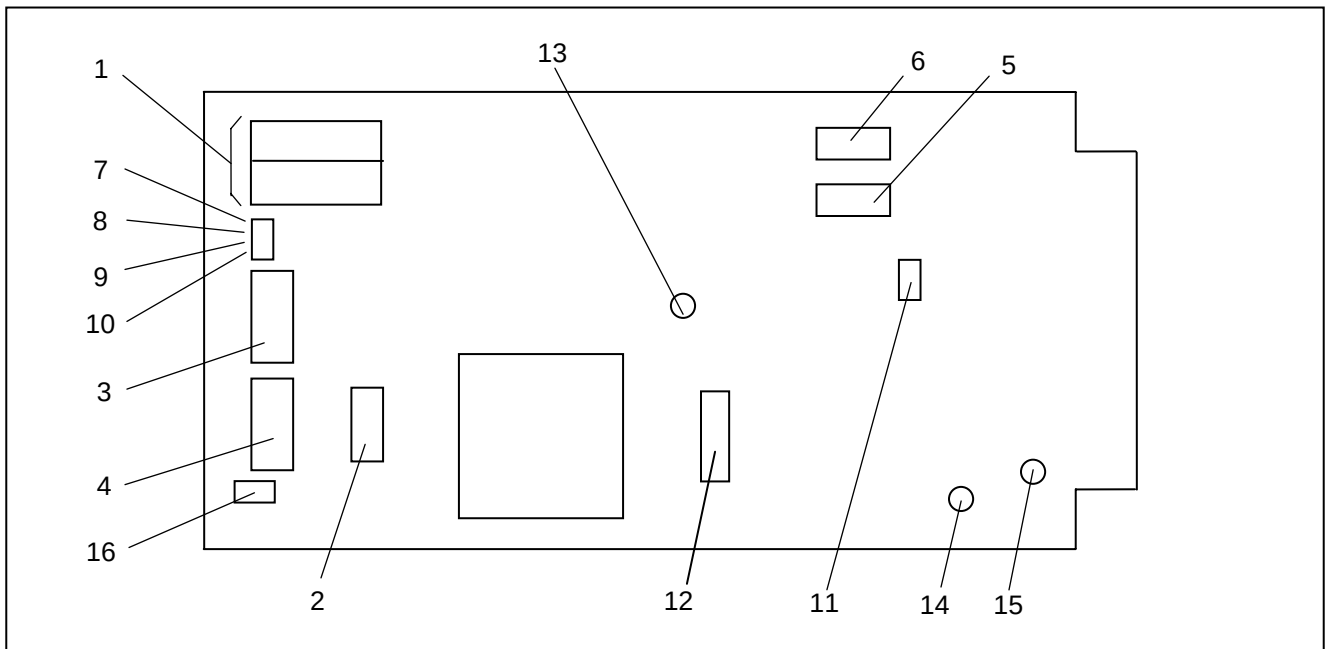


Figure 6. Controls and indicators, RFL VF-6I Four Wire Orderwire Voice Frequency Module

Table 1. Controls and indicators, RFL VF-6I Four Wire Orderwire Voice Frequency Module

Item	Name/Description	Function
1	Equipment jacks	Allow channel signals to be equipped: IN Equipment point for input signal OUT Equipment point for output signal
2	DIP switch SW1	SW1-1 to SW1-6 Selects the remote address (SCB address) using the codes shown in Table 2.
3	DIP switch SW2	SW2-1 to SW2-5 Selects time slots using codes shown in Table 3.
		SW2-6 ⁽³⁾ Bus A Selection: DOWN: Bus A enabled (TXA/RXB) UP: Bus A disabled
		SW2-7 ⁽³⁾ Bus B Selection: DOWN: Bus B enabled (TXB/RXA) UP: Bus B disabled
		SW2-8 Selects T1 or E1 UP: Selects T1 operation DOWN: Selects E1 operation.

Table 1. Controls and indicators, RFL VF-6I Four Wire Orderwire Voice Frequency Module - continued

Item	Name/Description	Function
4	DIP switch SW3	SW3-1 & SW3-2 Transmit control modes TC1 (SW3-1) TC0 (SW3-2) DOWN DOWN Continuous mode DOWN UP Hook Switch mode UP DOWN Voice activate (VOX) mode UP UP Receive only mode
		SW3-3 Signaling control ⁽⁴⁾ UP: Enables CAS for E1 or Enables RBS for T1 DOWN: Disables signaling
		SW3-4 Busy control UP: Normal DOWN: Busy out
		SW3-5 Bridge mode/Multi-drop mode UP (OFF): Bridge mode DOWN (ON): Multi-drop mode (orderwire mode)
		SW3-6 Spare
		SW3-7 & SW3-8 Sets threshold for voice activate mode. VOX1 (SW3-7) VOX0 (SW3-8) DOWN DOWN (minimum threshold) DOWN UP UP DOWN UP UP (maximum threshold)
		SW3-9 Remote/local control ⁽²⁾ UP: Local operation DOWN: Remote operation
		SW3-10 Service ON/OFF control UP: Service ON DOWN: Service OFF
5	DIP switch SW4	Sets receive attenuator: SW4-1 0.1 dB SW4-2 0.2 dB SW4-3 0.4 dB SW4-4 0.8 dB SW4-5 1.5 dB SW4-6 3.0 dB SW4-7 6.0 dB SW4-8 12.0 dB Switch settings are cumulative. For example, to set the attenuation to 19.0 dB, turn on SW4-2, SW4-4, SW4-7, and SW4-8; to set attenuation to 7.6 dB, turn on SW4-1, SW4-5, and SW4-7. The values shown above allow any setting from zero (no attenuation) to 24 dB, in 0.1 dB increments. Set at the factory for 3 dB. (See Table 4 for a list of attenuation calibration settings)
6	DIP switch SW5	Sets transmit attenuator. Settings are the same as SW4 above
7	M indicator (green)	Lights when M lead is active or signaling control input is active.
8	E indicator (green)	Lights when signaling is turned on and E lead is active
9	TX activity indicator (green)	Lights when data is transmitted to remote equipment
10	RX activity indicator (green)	Lights when data is received from remote equipment

Table 1. Controls and indicators, RFL VF-6I Four Wire Orderwire Voice Frequency Module - continued

Item	Name/Description	Function
11	Jumper J1 ⁽¹⁾	Controls signaling type: In Place (normal): Selects Type I signaling. Removed: Selects Type II or Type III signaling.
12	J3	For factory use only
13	Test point TP1	For factory use only
14	Test point TP2	For factory use only
15	Test point TP3	For factory use only
16	Service indicator (green)	Lights when module is in service.

1. When removing jumpers, attach them to one of the pins so that they are available for future use.
2. When the module is set for remote control (SW3-9 in DOWN position), SW3-10 is not used.
3. If the RFL VF-6I is being installed in a terminal multiplexer, set SW2-6 (DOWN) and SW2-7 (UP). If the RFL VF-6I is being installed in a drop/insert multiplexer, set SW2-6 (DOWN) to communicate via the DI-A common module and set SW2-7 (DOWN) to communicate via the DI-B common module.
4. If the card is set for E1 operation and signaling is enabled (CAS), the signaling bits are sent in time slot 16, per CCITT Recommendation G.704. The multiplexer must also be set to use CAS signaling.
5. If card is set for T1 operation and signaling is enabled (ROBBED BIT) the logic circuitry robs one bit from the PCM-encoded voice transmission every eighth frame and replaces it with a signaling bit.

Table 2. SCB address settings, RFL VF-6I Four Wire Orderwire Voice Frequency Module

Module Address	SW1-1	SW1-2	SW1-3	SW1-4	SW1-5	SW1-6
1	DOWN	DOWN	DOWN	DOWN	DOWN	UP
2	DOWN	DOWN	DOWN	DOWN	UP	DOWN
3	DOWN	DOWN	DOWN	DOWN	UP	UP
4	DOWN	DOWN	DOWN	UP	DOWN	DOWN
5	DOWN	DOWN	DOWN	UP	DOWN	UP
6	DOWN	DOWN	DOWN	UP	UP	DOWN
7	DOWN	DOWN	DOWN	UP	UP	UP
8	DOWN	DOWN	UP	DOWN	DOWN	DOWN
9	DOWN	DOWN	UP	DOWN	DOWN	UP
10	DOWN	DOWN	UP	DOWN	UP	DOWN
11	DOWN	DOWN	UP	DOWN	UP	UP
12	DOWN	DOWN	UP	UP	DOWN	DOWN
13	DOWN	DOWN	UP	UP	DOWN	UP
14	DOWN	DOWN	UP	UP	UP	DOWN
15	DOWN	DOWN	UP	UP	UP	UP
16	DOWN	UP	DOWN	DOWN	DOWN	DOWN
17	DOWN	UP	DOWN	DOWN	DOWN	UP
18	DOWN	UP	DOWN	DOWN	UP	DOWN
19	DOWN	UP	DOWN	DOWN	UP	UP
20	DOWN	UP	DOWN	UP	DOWN	DOWN
21	DOWN	UP	DOWN	UP	DOWN	UP
22	DOWN	UP	DOWN	UP	UP	DOWN
23	DOWN	UP	DOWN	UP	UP	UP
24	DOWN	UP	UP	DOWN	DOWN	DOWN
25	DOWN	UP	UP	DOWN	DOWN	UP
26	DOWN	UP	UP	DOWN	UP	DOWN
27	DOWN	UP	UP	DOWN	UP	UP
28	DOWN	UP	UP	UP	DOWN	DOWN
29	DOWN	UP	UP	UP	DOWN	UP
30	DOWN	UP	UP	UP	UP	DOWN
31	DOWN	UP	UP	UP	UP	UP
32	UP	DOWN	DOWN	DOWN	DOWN	DOWN
33	UP	DOWN	DOWN	DOWN	DOWN	UP
34	UP	DOWN	DOWN	DOWN	UP	DOWN
35	UP	DOWN	DOWN	DOWN	UP	UP
36	UP	DOWN	DOWN	UP	DOWN	DOWN

19. Set DIP switches SW4-1 through SW4-8 for the desired amount of receive attenuation.

Each section of SW4 controls a specific amount of attenuation:

SW4-1	0.1 dB
SW4-2	0.2 dB
SW4-3	0.4 dB
SW4-4	0.8 dB
SW4-5	1.5 dB
SW4-6	3.0 dB
SW4-7	6.0 dB
SW4-8	12.0 dB

The switch settings are cumulative. For example, to set the attenuation to 19.0 dB, set the switches as follows:

<u>Section</u>	<u>Value</u>	<u>Setting</u>	<u>Set Value</u>
SW4-1	0.1 dB	OFF	0.0
SW4-2	0.2 dB	ON	0.2
SW4-3	0.4 dB	OFF	0.0
SW4-4	0.8 dB	ON	0.8
SW4-5	1.5 dB	OFF	0.0
SW4-6	3.0 dB	OFF	0.0
SW4-7	6.0 dB	ON	6.0
SW4-8	12.0 dB	ON	12.0
TOTAL			19.0

To set the attenuation to 7.6 dB, set the switches as follows:

<u>Section</u>	<u>Value</u>	<u>Setting</u>	<u>Set Value</u>
SW4-1	0.1 dB	ON	0.1
SW4-2	0.2 dB	OFF	0.0
SW4-3	0.4 dB	OFF	0.0
SW4-4	0.8 dB	OFF	0.0
SW4-5	1.5 dB	ON	1.5
SW4-6	3.0 dB	OFF	0.0
SW4-7	6.0 dB	ON	6.0
SW4-8	12.0 dB	OFF	0.0
TOTAL			7.6

See Table 4 for more information about attenuator settings.

20. Set DIP switches SW4-1 through SW4-8 for the desired amount of receive attenuation.
21. Set DIP switches SW5-1 through SW5-8 for the desired amount of transmit attenuation.

22. Slide the RFL VF-6I module into the selected module slot until it is firmly seated.
23. On the Module Record Card (located to the right of the shelf) record the channel bank type, time slot, and any other other pertinent information.

The RFL VF-6I is now installed.

Table 3. Time slot selection, RFL VF-6I Four Wire Orderwire Voice Frequency Module

T1	E1	Switch Settings				
		SW2-1	SW2-2	SW2-3	SW2-4	SW2-5
1	0*	UP	UP	UP	UP	UP
2	1	UP	UP	UP	UP	DOWN
3	2	UP	UP	UP	DOWN	UP
4	3	UP	UP	UP	DOWN	DOWN
5	4	UP	UP	DOWN	UP	UP
6	5	UP	UP	DOWN	UP	DOWN
7	6	UP	UP	DOWN	DOWN	UP
8	7	UP	UP	DOWN	DOWN	DOWN
9	8	UP	DOWN	UP	UP	UP
10	9	UP	DOWN	UP	UP	DOWN
11	10	UP	DOWN	UP	DOWN	UP
12	11	UP	DOWN	UP	DOWN	DOWN
13	12	UP	DOWN	DOWN	UP	UP
14	13	UP	DOWN	DOWN	UP	DOWN
15	14	UP	DOWN	DOWN	DOWN	UP
16	15	UP	DOWN	DOWN	DOWN	DOWN
17	16**	DOWN	UP	UP	UP	UP
18	17	DOWN	UP	UP	UP	DOWN
19	18	DOWN	UP	UP	DOWN	UP
20	19	DOWN	UP	UP	DOWN	DOWN
21	20	DOWN	UP	DOWN	UP	UP
22	21	DOWN	UP	DOWN	UP	DOWN
23	22	DOWN	UP	DOWN	DOWN	UP
24	23	DOWN	UP	DOWN	DOWN	DOWN
	24	DOWN	DOWN	UP	UP	UP
	25	DOWN	DOWN	UP	UP	DOWN
	26	DOWN	DOWN	UP	DOWN	UP
	27	DOWN	DOWN	UP	DOWN	DOWN
	28	DOWN	DOWN	DOWN	UP	UP
	29	DOWN	DOWN	DOWN	UP	DOWN
	30	DOWN	DOWN	DOWN	DOWN	UP
	31	DOWN	DOWN	DOWN	DOWN	DOWN

NOTE: Each active Time Slot on an RFL VF-6I module occupies one 64-Kbps digital time slot within the multiplexer's aggregate rate. Consult the IMUX 2000E instruction manual for guidelines on time slot selection.

* Time Slot 0 is reserved for E1.

** Not valid if signaling is enabled in E1. Time Slot 16 is reserved for CAS.

RTU/MTU APPLICATION

This section describes how to configure the VF-6I for an RTU/MTU application. Signaling is not supported in Bridge Mode.

1. VF6I operating with an MTU.

- a. The VF-6I transmits and receives data from both bus directions. The VF6I only transmits local data and does not pass data thru from either direction.

BUS A	ENABLED	SW2-6 DOWN (ON)
BUS B	ENABLED	SW2-7 DOWN (ON)
BRIDGE MODE	BRIDGE MODE ENABLED	SW3-5 UP (OFF)

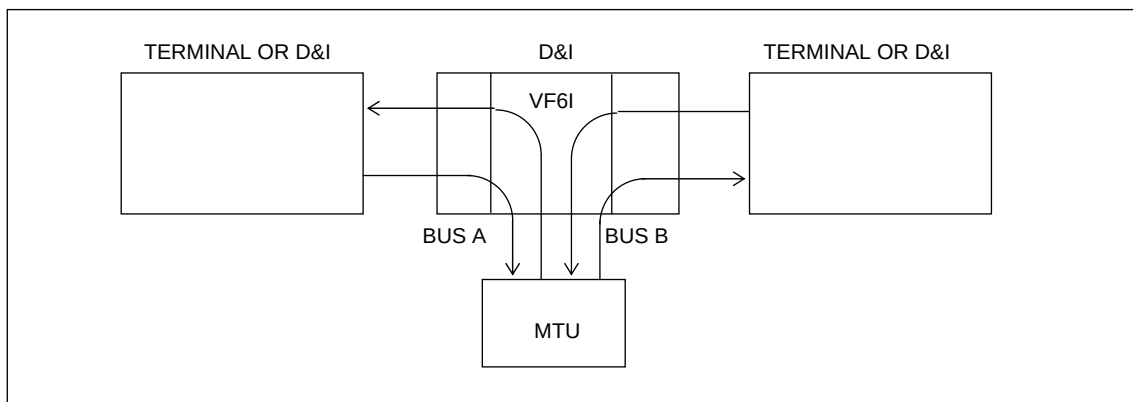


Figure 7. VF6I configured for MTU operation in both bus directions (Bus A and Bus B enabled)

- b. The VF-6I transmits only local data from the Terminal end (or D&I end) in one bus direction only.

BUS A or BUS B	ENABLED	SW2-6 or SW2-7 DOWN (ON)
MULTI-DROP MODE	MULTI-DROP MODE ENABLED	SW3-5 DOWN (ON)

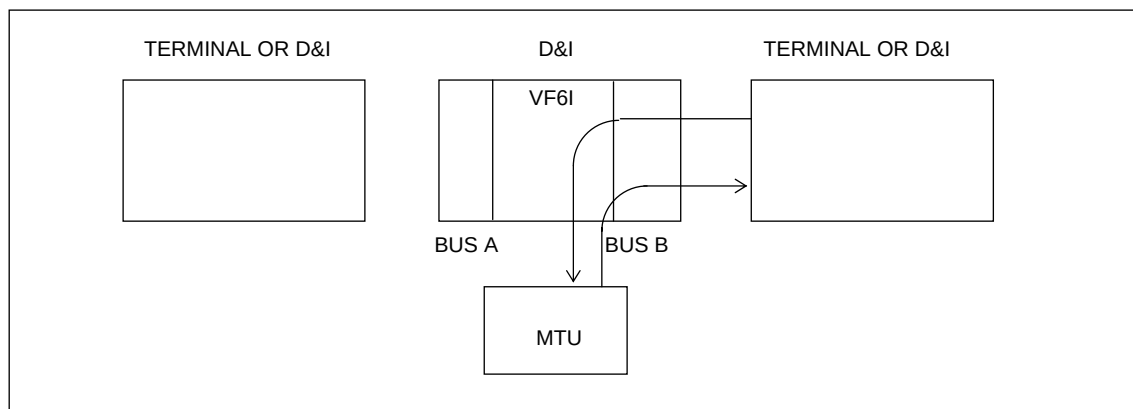


Figure 8. VF6I configured for MTU operation in one bus direction (Bus B enabled)

2. VF6I operating with an RTU.

- a. The VF-6I transmits local data in one bus direction, toward the Master (MTU), and passes received data in the same bus direction

BUS A OR BUS B	ENABLED	SW2-6 or SW2-7 DOWN (ON)
BRIDGE MODE	ENABLED	SW3-5 UP (OFF)

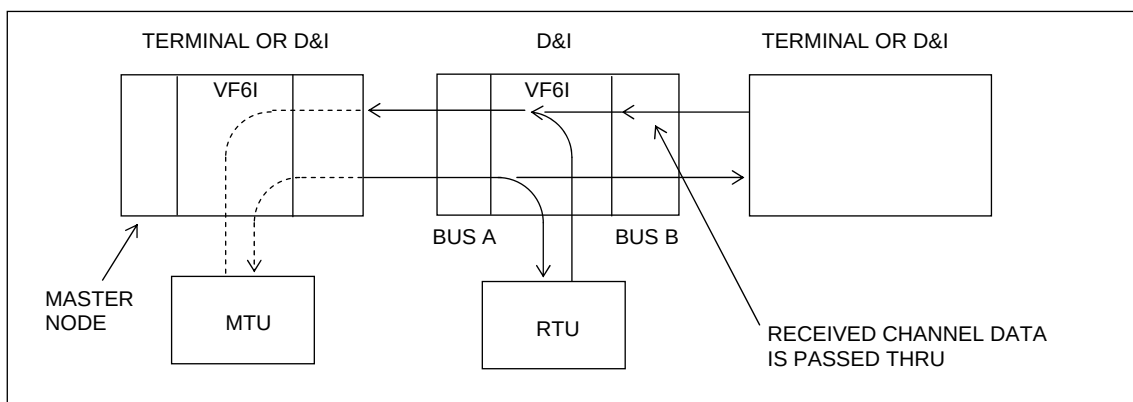


Figure 9. VF6I configured for RTU operation in one bus direction (Bus A enabled) in the middle of a chain of RTUs

- b. The VF-6I transmits local data from the Terminal end (or D&I end) toward the Master (MTU). The VF6I does not pass received data thru.

BUS A OR BUS B	ENABLED	SW2-6 or SW2-7 DOWN (ON)
MULTI-DROP MODE	MULTI-DROP MODE ENABLED	SW3-5 DOWN (ON)

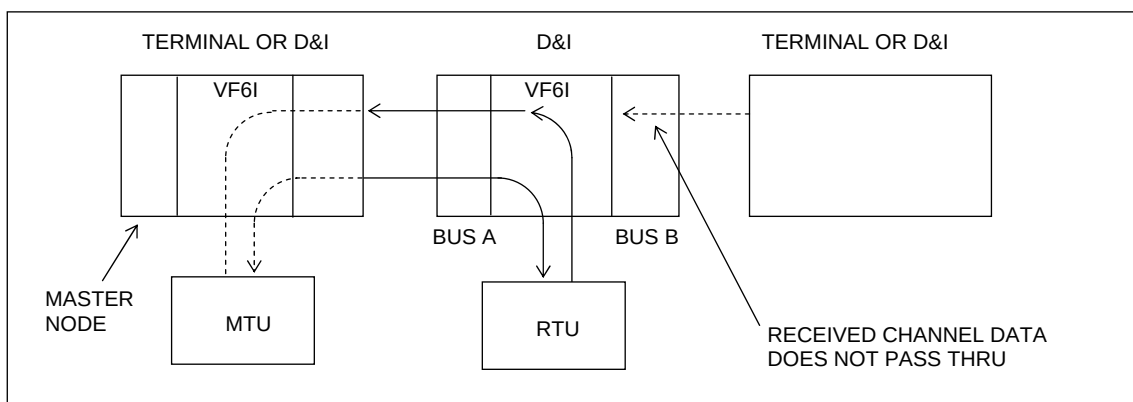


Figure 10. VF6I configured for RTU operation in one bus direction (Bus A enabled) at the end of a chain of RTUs

FUNCTIONAL DESCRIPTION

SYSTEM OVERVIEW

The VF-6I is a 4-wire Orderwire Voice Frequency Channel Module designed for RFL IMUX 2000 T1 and E1 multiplexers. It is designed as a direct replacement for the RFL VF-6 and can communicate with the RFL VF-5A. The VF-6I can interconnect multiple locations (nodes) for applications involving voice or multiple voice grade modems for alarm and control applications.

In a bridge configuration, each node hears the master node, and the addressed node responds back to the master. However, all nodes other than the master do not hear the response. In a multi-drop configuration, every node hears every other node, since there is no master.

One of four Transmit Modes can be selected: Continuous, Voice Activate (VOX), Hook-Switch, and Receive Only. In Continuous Mode the local audio signal is added to the transmit data stream regardless of signal level or any control input. In Voice Activate Mode (VOX) the local audio signal is added to the transmit data stream if the threshold set by the threshold level switches, VOX0 and VOX1, is exceeded. In Hook Switch Mode the local audio signal is only added to the transmit data stream when the hook-switch control input is externally grounded. In Receive Only Mode the local audio signal is never added to the transmit data stream regardless of the signal level or any control input. Data is only received.

The VF-6I accepts a single voice channel as input and uses μ -law PCM encoding to convert the analog voice into an 8-bit, 64-Kbps digital signal. The VF-6I can be configured via local switches (SW1 thru SW5) or remotely with the RFL SCL (Simple Command Language). However, the attenuator settings can only be set with the physical switches (SW4 & SW5).

Channel-Associated Signaling (CAS) is used in E1 applications, while Robbed-Bit Signaling (RBS) is used in T1 applications. Signaling can be disabled in T1 and E1.

Refer to the VF-6I Simplified Block Diagram shown in Figure 11.

BACKPLANE AND POWER CONNECTIONS

The VF-6I occupies a single physical slot in the multiplexer and conforms to the RFL IMUX 2000 backplane signal format. All T1 and E1 backplane signals in and out of the VF-6I are driven with 74HCT125 drivers except for the SCB clock, sync and data signals. All control signals passing through the backplane from the I/O module are pulled up to +5V through 4.7 K Ohm resistors.

The VF-6I requires +5V, +15V, -15V, -48V, and ground which are supplied by the IMUX 2000 backplane. The +5 volt input includes an inductor which lowers the inrush current to prevent interruption to the power during module insertion. TP2 is the +5V testpoint. TP3 is the ground testpoint. All pins which connect to the backplane except for voltages and grounds are cut back to prevent components from being driven by signals before the module is fully powered.

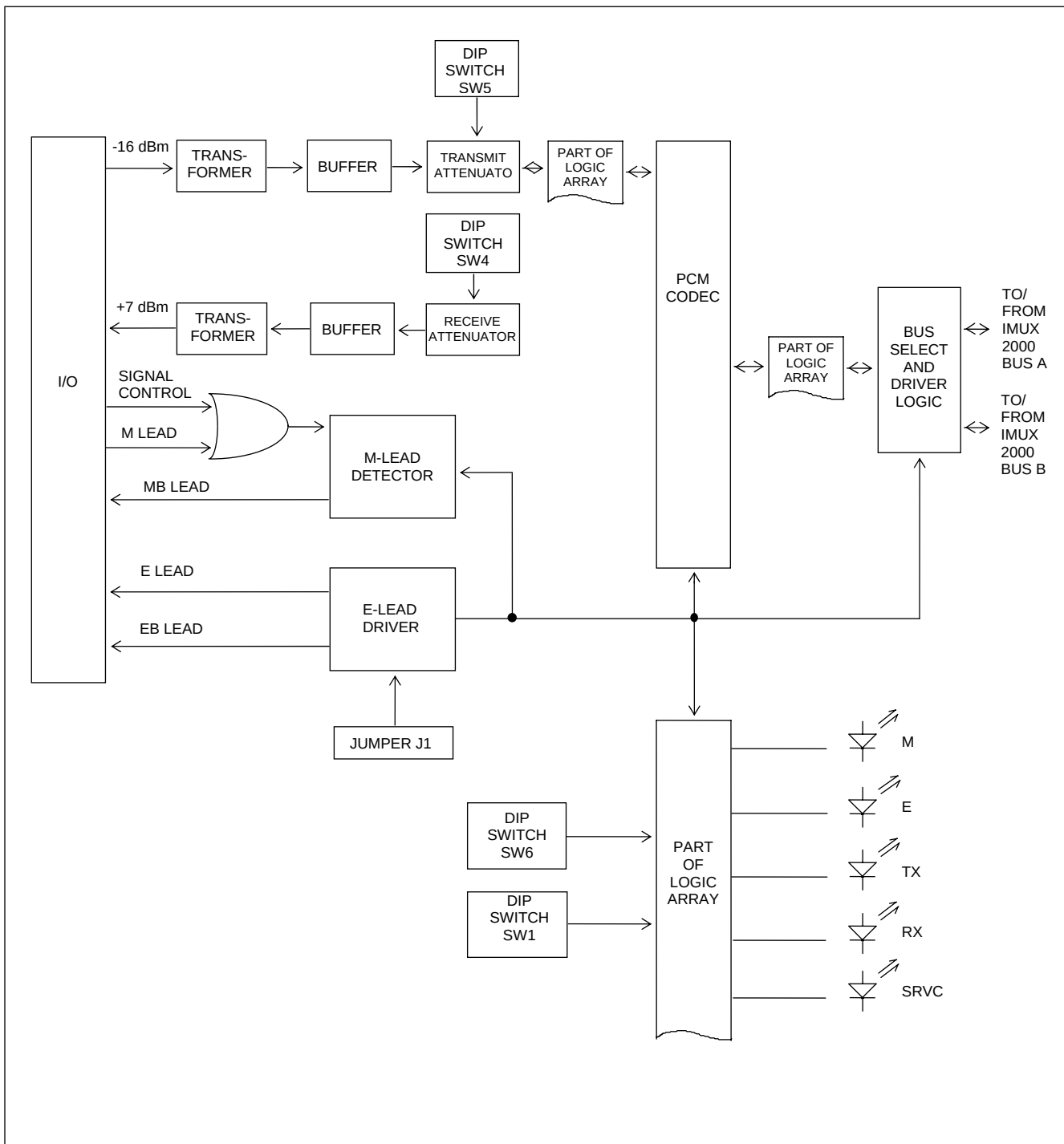


Figure 11. Simplified block diagram, RFL VF-6I Four Wire Orderwire Voice Frequency Module

TRANSMIT SECTION

An analog voice input signal is fed into the VF-6I module through the rear backplane connections which then goes to a balanced input transformer. The transformer output goes to an amplifier stage, and then passes through the transmit attenuator. The switches (SW5) allow attenuation settings from zero to 24.0 dB in 0.1 dB increments. The factory setting is +3 dB of attenuation for a -16 dBm input. The attenuator output then passes through a testpoint to the μ -law PCM CODEC where the analog voice is converted into an 8-bit, 64-Kbps digital signal. The maximum level at the testpoint is 5 Vp-p; above this clipping occurs. The digitized audio signal then goes to the Logic Array where it is processed before being transmitted to the proper timeslot. The equipment input jack in front of the card is used for injection of a test tone.

The RFL VF-6I offers a choice of one of two signaling inputs at the backplane: SIGCON (signal control) and M-LEAD.

SIGCON is compatible with the RFL VF-6. This input is pulled to +5V through a 4.7 K Ohm resistor. This signal goes directly into the Logic Array and is multiplexed into the transmitted data. When this input is grounded externally, the remote VF-6I is signaled and the local M Led is activated (BUSY). When this circuit is open, the signal is IDLE.

M-LEAD is compatible with RFL VF-5A. M-LEAD is used when E&M Signaling Types I, II, or III are desired. The M lead detector responds to an IDLE or BUSY signal from the external device. A level of -48 volts at the M-LEAD indicates BUSY. Open or grounded indicates IDLE. The output of M-LEAD goes into the Logic Array and is multiplexed in the TXDATA. The remote VF-6I is signaled and the local M Led is activated. The PTC Resettable Fuse protects the VF-6I Module if the MB-LEAD is accidentally shorted to ground.

RECEIVE SECTION

The VF-6I receives an 8-bit, 64-Kbps digital signal via the backplane from the appropriate timeslot. The input signals go to the Logic Array where it is processed and de-multiplexed. The 8-bit digital output of the Logic Array is then converted to an analog audio signal by the μ -law PCM CODEC and is passed to the receive attenuator. The switches (SW4) allow attenuation settings from zero to 24.0 dB in 0.1 dB increments. The factory setting is +3 dB of attenuation for a +7 dBm output. The attenuator output passes to an amplifier, and through the balanced output transformer to the rear backplane connections. The equipment output jack on the front of the board allows retrieval of a test tone.

The signaling portion of the received data from the Logic Array goes to the opto-coupler. Signaling is active (BUSY) when E-LEAD is low. Signaling is inactive (IDLE) when E-LEAD is high. When active in E&M Type I format, ground is BUSY and open is IDLE. In Type II or III, J1 is removed and EB-LEAD is used. The VF-6I must have J1 removed if to be used as a direct replacement of an RFL VF-6 module.

ALERTS AND ALARMS

The RFL VF-6I reports no module-level ALERT or ALARM signals to the shelf Common Module.

COMPATIBILITY WITH OTHER RFL MODULES

RFL VF-6I modules are fully compatible with older RFL VF-6 modules. A circuit may consist of an RFL VF-6 at one end and an RFL VF-6I at the other end. However there are few differences between the two:

1. The RFL VF-6I is remote controllable; the RFL VF-6 is not.
2. THE VF-6I can be used in terminal mode.

RFL VF-6I modules are functionally compatible with the RFL VF-5A voice module with the following differences:

1. The VF-6I uses one time slot.
2. I/O pin designations for the M-lead and MB-leads are different.
3. Bus-A and Bus-B can be simultaneously enabled for VF-6I.

ATTENUATOR SETTINGS

The RFL VF-6I module has two attenuators: Transmit and Receive. Factory settings for these attenuators are 3.0 dB on the transmit side and 3.0 dB on the receive side. This allows -16 dBm in, +7 dBm out with 3 dB of headroom.

Table 4 is an extended list of attenuator calibration settings. Set the attenuators based on the desired input and output levels listed in the table. These settings will permit a maximum signal level 3 dBm higher than the indicated level. For example, with -10 dBm input, the transmitter attenuator setting would be 9 dB and the maximum line input would be -7 dBm. Using these settings on the transmit side will place a signal of 1 digital mW into the transmission bit stream.

Table 4. Attenuator calibration settings, RFL VF-6I Four Wire Orderwire Voice Frequency Module

Transmit Level In	Transmit Attenuator Setting	Receive Level Out	Receive Attenuator Setting
+5 dBm	24 dB	-14 dBm	24 dB
+4 dBm	23 dB	-13 dBm	23 dB
+3 dBm	22 dB	-12 dBm	22 dB
+2 dBm	21 dB	-11 dBm	21 dB
+1 dBm	20 dB	-10 dBm	20 dB
0 dBm	19 dB ⁽¹⁾	-9 dBm	19 dB
-1 dBm	18 dB	-8 dBm	18 dB
-2 dBm	17 dB	-7 dBm	17 dB
-3 dBm	16 dB	-6 dBm	16 dB
-4 dBm	15 dB	-5 dBm	15 dB
-5 dBm	14 dB	-4 dBm	14 dB
-6 dBm	13 dB	-3 dBm	13 dB
-7 dBm	12 dB	-2 dBm	12 dB
-8 dBm	11 dB	-1 dBm	11 dB
-9 dBm	10 dB	0 dBm	10 dB ⁽¹⁾
-10 dBm	9 dB	+1 dBm	9 dB
-11 dBm	8 dB	+2 dBm	8 dB
-12 dBm	7 dB	+3 dBm	7 dB
-13 dBm	6 dB	+4 dBm	6 dB
-14 dBm	5 dB	+5 dBm	5 dB
-15 dBm	4 dB	+6 dBm	4 dB
-16 dBm	3 dB ⁽²⁾	+7 dBm	3 dB ⁽²⁾
-17 dBm	2 dB	+8 dBm	2 dB
-18 dBm	1 dB	+9 dBm	1 dB
-19 dBm	0 dB	+10 dBm	0 dB

NOTES: (1) = Settings for 0 dBm in and 0 dBm out.

(2) = Settings for -16 dBm in and +7 dBm out.

REMOTE CONTROL INTERFACE

When installed in an IMUX 2000 T1 or E1 shelf, the RFL VF-6I module can be operated under local or remote control. When under remote control, most of the module setup parameters can only be changed through the RS-232 remote port on the shelf Common Modules. See the IMUX 2000 manual for details on the remote control interface.

“P” CODES AND “S” CODES

The RFL VF-6I reports itself as a “Type 121” module. Its remote control interface involves two sets of codes: “P” (parameter) codes, and “S” (status) codes.

“P” codes, when used in the parameter field on an “SCL SET” command, allow the user to set certain parameters on the module by remote control, just like setting the switches on the module under local control. “P” codes also appear in the response to a “CONFIG?” query, providing a list of the current settings on the module. A typical RFL VF-6I response to a “CONFIG?” query looks like this:

```
* OK
CHANNEL CARD 3, TYPE 121
UNDER REMOTE CONTROL
SVCE = ON
P01 = 10 (B00001010)
P02 = 0 (B00000000);
```

Each “P” code is displayed in both decimal and binary representation, however, the binary representation is generally more useful, as each of the eight digits corresponds to a specific switch or jumper on the module. Table 5 lists the meaning of the “P” codes for the RFL VF-6I.

Table 5. Remote configuration settings (“P” codes)

P Code	Digit(s) and Switch Equivalent	Value	Description
P1	B00000000 ↑↑↑↑↑ TIME SLOT SELECT	00001 to 11111 for E1 00001 to 11000 for T1	From left to right, these five bits represent the binary value of the desired time slot. See Table 7 for a complete list of these values.
	B00000000 ↑ SYSTEM TYPE	0	Selects T1 system
		1	Selects E1 system
	B00000000 ↑ BUS B	0	Bus B disabled
		1	Bus B enabled
	B00000000 ↑ BUS A	0	Bus A disabled
		1	Bus A enabled
P2	B00000000 ↑↑ VOICE ACTIVATE SETTINGS (VOX)	00 to 11	Selects level of voice activate setting. 00 = minimum setting 11 = maximum setting
	B00000000 ↑ SIGNALING	0	Signaling enabled CAS for E1, RBS for T1
		1	Signaling disabled
	B00000000 ↑↑ TRANSMIT CONTROL MODES	00	Receive only
		01	Voice activate (VOX)
		10	Hook-switch
		11	Continuous
	B00000000 ↑ MODE	0	Bridge mode
		1	Multi-drop mode
	B00000000 ↑ ↑ SPARE	...	Not currently used

NOTE

When using binary numbers with a SET command, they must be preceded by the letter “B” as shown in the following example:

<MULTIPLEXER ADDRESS>:<CARD ADDRESS>:SET:P1 = B00000011;

In addition to the P code, it is also possible to turn service on or off for the card by sending SRVC = ON or SRVC = OFF in the parameter field of a SET command. The S code appears in response to a STATUS? query, in the format:

*** OK**

CHANNEL CARD 3, TYPE 121

S01 = 00 (B000000000);

This format is similar to that of the P code, but instead of representing switches, the five least significant digits of the binary number represent the remote status messages as shown in Table 6. The three most significant digits are not used.

Table 6. Remote Status Messages (S Codes)

S Code	Digit(s) and Switch Equivalent	Value	Description
S1	B000000000 ↑ SIGNALING/M-LEAD	0	M-Lead inactive
		1	Signaling on and M-Lead active
	B000000000 ↑ SIGNALING/E-LEAD	0	E-Lead inactive
		1	Signaling on and E-Lead active
	B000000000 ↑ TRANSMIT ACTIVITY	0	Not transmitting data to remote equipment
		1	Transmitting data to remote equipment
	B000000000 ↑ RECEIVE ACTIVITY	0	Not receiving data from the remote equipment
		1	Receiving data from remote equipment
	B000000000 ↑ CONFIGURATION	0	Invalid configuration - card disabled
		1	Valid configuration

Table 7. Time slot selection by remote access

Time Slot	P1-5*	P1-4*	P1-3*	P1-2*	P1-1*
1	0	0	0	0	1
2	0	0	0	1	0
3	0	0	0	1	1
4	0	0	1	0	0
5	0	0	1	0	1
6	0	0	1	1	0
7	0	0	1	1	1
8	0	1	0	0	0
9	0	1	0	0	1
10	0	1	0	1	0
11	0	1	0	1	1
12	0	1	1	0	0
13	0	1	1	0	1
14	0	1	1	1	0
15	0	1	1	1	1
16**	1	0	0	0	0
17	1	0	0	0	1
18	1	0	0	1	0
19	1	0	0	1	1
20	1	0	1	0	0
21	1	0	1	0	1
22	1	0	1	1	0
23	1	0	1	1	1
24	1	1	0	0	0
25	1	1	0	0	1
26	1	1	0	1	0
27	1	1	0	1	1
28	1	1	1	0	0
29	1	1	1	0	1
30	1	1	1	1	0
31	1	1	1	1	1

* These positions represent the five least significant digits of P1, as shown in Table 5.

** Not valid if signaling is enabled in E1. Time Slot 16 is reserved for CAS.

TESTING

Once the RFL VF-6I Module has been configured and installed, it should be tested for proper operation before it is placed in service. There are two ways you can do the testing:

1. Local testing using T1 or E1 loopback with the system out of service.
2. End-to-end testing, with the system inservice but the channel being tested taken out of service.

Use the following procedure to test the RFL VF-6I:

1. If using T1 or E1 loopback testing, set up the multiplexer loopback following the instructions in multiplexer operation manual.
2. Test each channel separately. If using end-to-end testing, test each channel first from Site 1 to Site 2, then reverse the setup and test from Site 2 to Site 1.
3. Connect the output of an audio signal generator (Hewlett-Packard model 4935A or equivalent) to the equipment input jack for the channel being tested. Insert a 1004 kHz test tone at -16 dBm referenced to 600 ohms.

NOTE

For the following steps, check the output on the same RFL VF-6I module if you are using loopback testing, or on the module at the receive end if you are using end-to-end testing.

4. Measure the channel output at the equipment output jack.
The output should be +7 dBm referenced to 600 ohms, ± 0.5 dB.
5. Measure the signal-to-noise (S/N) ratio with C Message weighing,
This should be greater than 38 dB S/N
6. Activate the M-Lead and observe that the corresponding M indicator LED on the transmit module and the E indicator LED on the receive module both light up.
7. Measure the idle channel noise.
This should be less than 23 dBrc0.
8. Remove the test equipment and disconnect the loopback if one was used.
The module is now available for operation.

If there is an apparent malfunction, first check that the configuration is appropriate for the transmission system in use. If using end-to-end testing, check that the transmit and receive configuration is identical.

Problems may occur at the common equipment or facility level which affect the operation of this module. Refer to your multiplexer operation manual for system analysis procedures.

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RFL Electronics Inc.

INSTRUCTION DATA

RFL VF-8A Selective Calling Unit

DESCRIPTION

The RFL VF-8A Selective Calling Unit is a two-wire selective calling “party line” module designed for use in IMUX 2000 terminal and drop/insert multiplexers. It accepts a single voice channel as input, and converts it into a 64kbps signal which can be transmitted over T1, E1 or other digital communications facilities. It does this using μ -law PCM encoding and decoding for both T1 and E1 systems. The VF-8A automatically detects if the system is T1 or E1 and configures itself appropriately.

The VF-8A is remote-controllable when installed in an RFL remote controllable shelf. The following module parameters can be configured remotely via SCB or locally via DIP switches. A DIP switch setting will control whether the card is in remote or local mode.

- o Selectable time slot assignment
- o Selectable TX bus direction(s)
- o 3-digit Station ID
- o Number of ring attempts
- o Extended range transmit and receive level settings
- o Service on/off
- o Selectable Busy Circuit modes

SPECIFICATIONS

As of the date this Instruction Data Sheet was published, the following specifications apply to the RFL VF-8A Selective Calling Unit. Because all RFL products undergo constant improvement and refinement, these specifications are subject to change without notice.

Configuration:	One voice channel per module
Timeslots:	Requires one user-selectable 64 kbps time slot
Frequency Response:	300 Hz to 3400 Hz: ± 1.5 dB
Signal Levels:	Input: -26 dBm to +9 dBm Output: -26 dBm to +9 dBm
Impedance:	600 ohms input/output
Idle Channel Noise:	Less than 23 dBnc0
Peak-To-Average Ratio (P/AR):	Greater than 94
Signaling Format:	T1 systems: RBS (Robbed-Bit Signaling) E1 systems: CAS (Channel-Associated Signaling)
Dialing Method:	DTMF for “station”, “group”, and “all” call
Audio Encoding/Decoding:	μ -law for both T1 and E1 systems
Call Progress Tones:	Dial Tone: Frequencies: 350 + 440 Hz, nominal Timing: Continuous tone Line Busy Tone: Frequencies: 480 + 620 Hz, nominal Timing: Cycles of 0.5 seconds ON and 0.5 seconds OFF Reorder Tone: Frequencies: 480 + 620 Hz, nominal Timing: Cycles of 0.25 seconds ON and 0.25 seconds OFF Audible Ring Tone: Frequencies: 440 + 480 Hz, nominal Timing: Cycles of 2 seconds ON and 4 seconds OFF

SPECIFICATIONS - continued

I/O Interface:	Through MA-306 module adapter			
Ringing Voltage:	Local (MA-306):	86 Vrms, 20 Hz		
	External:	50-90 Vrms, 20 to 30 Hz		
Station ID:	3-digit (000 to 899)			
Power Requirements:	VF-8A with MA-306:			
		<u>Idle</u>	<u>Off Hook</u>	<u>Ringing</u>
	+5V	68mA	70mA	90mA
	+15V	30mA	34mA	32mA
	-15V	25mA	26mA	25mA
	-48V	1mA	33mA	1mA
Operating Temperature:	-20°C to +55°C (-4°F to +131°F).			
Humidity:	0% to 90 %, non-condensing.			
RFI/EMI:	C.37.90.2			
MTBF:	Greater than 500,000 hours per Bellcore TR-332			

INSTALLATION

Before the RFL VF-8A can be placed in service, it must be installed in a multiplexer shelf. Installation involves determining the module slot in the Main Shelf or Expansion Shelf where the module will be installed, inserting a Module Adapter into the rear of the shelf behind the module slot, connecting all signal and power wiring to the Module Adapter, checking the settings of all switches, and inserting the module into the front of the shelf.

NOTES

Power supply and time slot considerations may affect the installation of this module into an existing multiplexer shelf. Refer to the multiplexer manual for more information.

The following instructions are provided for installing an RFL VF-8A module into an existing system. If the module was included as part of a system, installation was done at the factory. Otherwise, proceed as follows:

1. Carefully inspect the module for any visible signs of shipping damage. If you suspect damage to the module, immediately call RFL Customer Service at the number shown at the bottom of this page.

2. Determine the module slot in the Main Shelf or Expansion Shelf where the module will be installed.

RFL VF-8A module occupies one module slot in the Main Shelf or Expansion Shelf.

3. Determine which Module Adapter will be used to make connections to the RFL VF-8A module.

Each module in the IMUX 2000 multiplexer requires a Module Adapter. The module adapter provides the appropriate connector for the desired interface. The Module Adapter that is used with the RFL VF-8A is the MA-306.

MA-306 The MA-306 provides an RJ-11, FXS jack for the local phone connection, and an FXO jack for future use.

4. Insert the MA-306 Module Adapter into the rear of the slot which will hold the RFL VF-8A module, and make all connections to the module adapter.

Connect the RJ-11 plug for the local phone into the MA-306's FXS jack. The only electrical interface connections that have to be made to the RFL VF-8A are the RING and TIP connections, which are made to terminals 3 and 4 on the RJ-11 connector as shown in Figure 1.

5. Refer to Figure 2 and Table 1 for the location and function of DIP switches on the VF-8A.

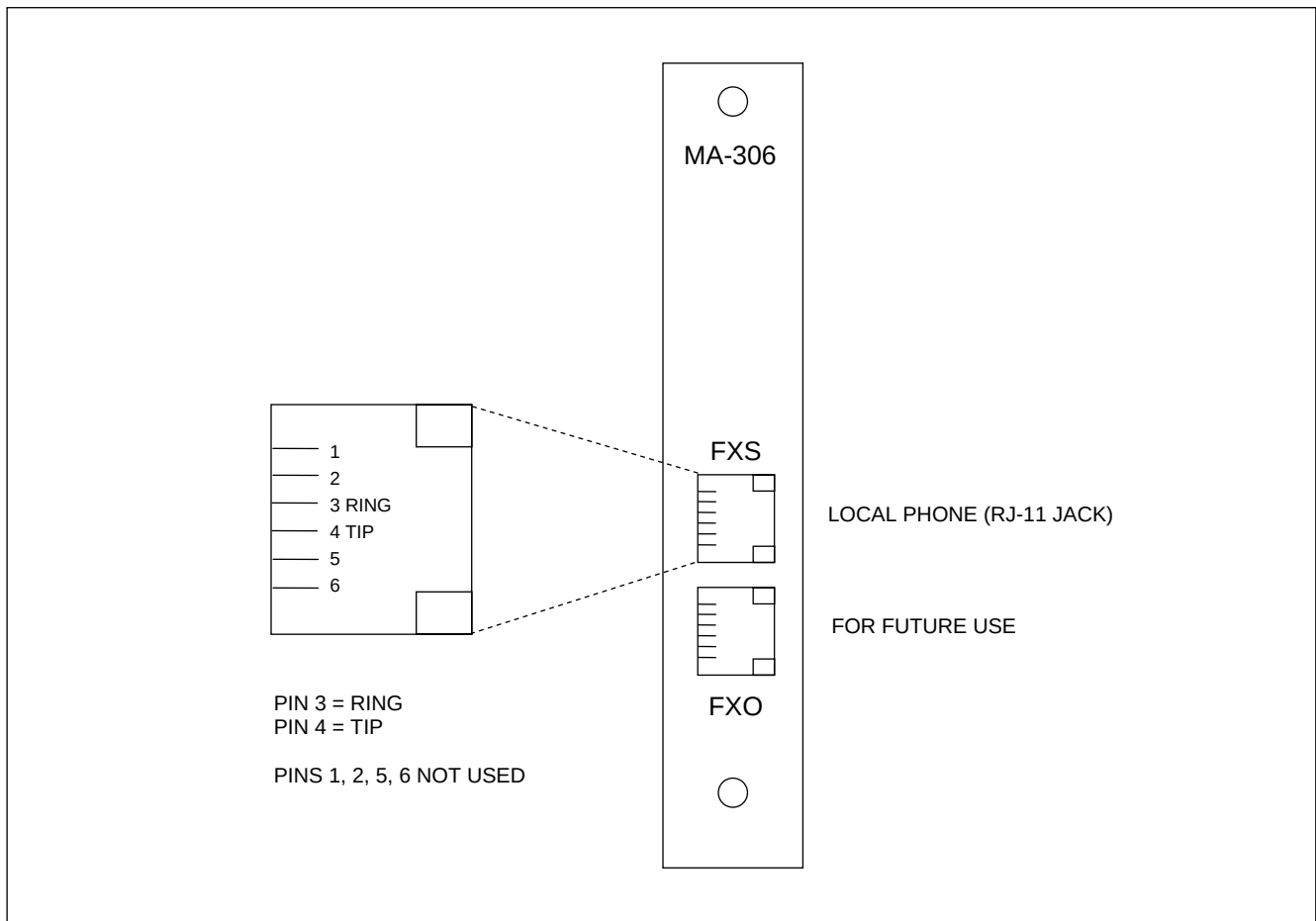


Figure 1. MA-306 Module Adapter.

6. Set the module SCB address using DIP switches SW1-1 through SW1-6.
For remote access, each channel module in the IMUX 2000 must have a distinct module address. Valid addresses are the numbers “1” to “36”. In most installations the address will be set to the number of the slot the module is occupying. Table 2 shows the switch settings for the module address. (Consult your multiplexer manual for details on using the remote access and configuration features of the system.)
7. Select an unused time slot using DIP switches SW2-1 to SW2-5. The voice channel uses one 64 kbps digital time slot within the multiplexer’s aggregate rate. Set the time slot using direct binary coding as shown in Table 3. Refer to the multiplexer manual for guidelines on time slot selection.

Note that selecting an invalid time slot will disable the module. In T1 systems, only time slots 1 through 24 are allowed. Time slot 24 is not available for a T1 system using fast reframing.

In E1 systems, time slots 1 through 31 are allowed, however, time slots 0 and 16 are reserved and cannot be used. Time slot 30 is not available for an E1 system using fast reframing. Time slot 31 is not available if inter-node communications (NMX) is used.

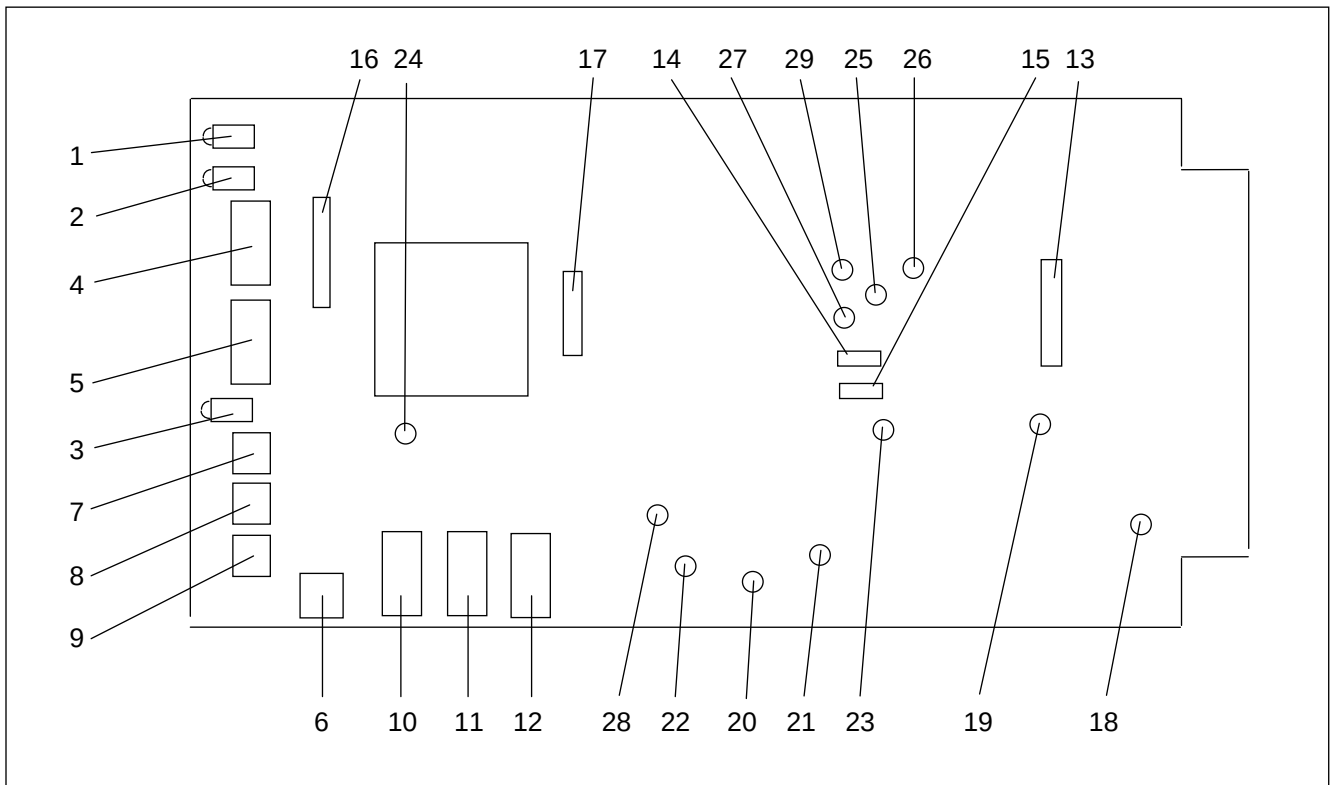


Figure 2. Controls and indicators, RFL VF-8A Selective Calling Unit

8. Set DIP switch SW2-6 to enable or disable Bus A.
Place SW2-6 in the DOWN position to transmit on Bus A and receive on Bus B.
Place SW2-6 in the UP position to disable Bus A.
9. Set DIP switch SW2-7 to enable or disable Bus B.
Place SW2-7 in the DOWN position to transmit on Bus B and receive on Bus A.
Place SW2-7 in the UP position to disable Bus B.
10. The 16-position rotary DIP switch SW3 is used to select the desired number of ring attempts.
Place SW3 to the desired setting in accordance with Table 4.

<< text continues on page 10 >>

Table 1. Controls and indicators, RFL VF-8A Selective Calling Unit

Item	Name/Description	Function
1	Ring LED (yellow), DS1	Lights when local phone is ringing
2	Busy LED (green), DS2	Lights when circuit is busy (in use)
3	Service LED (green), DS3	Lights when module service is ON
4	DIP switch SW1	SW1-1 to SW1-6 sets the SCB address in accordance with Table 2 SW1-7 selects local or remote mode as follows: UP: local mode (using switches) DOWN: remote mode (using SCB) SW1-8 turns module service ON or OFF as follows: UP: service ON DOWN: service OFF
5	DIP switch SW2	SW2-1 to SW2-5 selects the time slot in accordance with Table 3. SW2-6 enables or disables Bus A UP: disable Bus A DOWN: transmit on Bus A, receive on Bus B SW2-7 enables or disables Bus B UP: disable Bus B DOWN: transmit on Bus B, receive on Bus A SW2-8 (spare)
6	16 position rotary switch SW3	Selects the number of ring attempts (1 to 15, or unlimited) in accordance with Table 4.
7	10 position rotary switch SW4	Selects group # (100's position) of three number Station ID
8	10 position rotary switch SW5	Selects "tens position" of three number Station ID
9	10 position rotary switch SW6	Selects "units position" of three number Station ID
10	8 position DIP switch SW7	SW7-1 through SW7-5 (spare switches) SW7-6 selects Signaling delay as follows: UP: Signaling delay enabled DOWN: Signaling delay disabled SW7-7 and SW7-8 selects Busy Circuit Options in accordance with Table 5
11	8 position DIP switch SW8	SW8-1 (spare) SW8-2 to SW8-8 selects Tx attenuation in accordance with Table 6
12	8 position DIP switch SW9	SW9-1 (spare) SW9-2 to SW9-8 selects Rx attenuation in accordance with Table 6
13	J1	For future use
14	J2A	For factory use only (jumper is always installed)
15	J2B	For factory use only (jumper is always installed)
16	J3	For future use
17	J5	For engineering use only (J5 is not installed)
18	Test point TP1	Ground
19	Test point TP2	Digital +5VDC
20	Test point TP3	Analog +5VDC
21	Test point TP4	Analog +5VDC
22	Test point TP5	Analog +5VDC
23	Test point TP6	Analog -5VDC
24	Test point TP7	DTMF_CLKA (3.579545 MHz)
25	Test point TP8	TX audio before stereo volume control
26	Test point TP9	RX audio after stereo volume control
27	Test point TP10	TX audio after stereo volume control
28	Test point TP11	RX audio before stereo volume control
29	Test point TP12	Dial tone, busy tone, or ring back tone

Table 2. Module SCB address settings, RFL VF-8A module

Module Address	SW1-1	SW1-2	SW1-3	SW1-4	SW1-5	SW1-6
1	OFF	OFF	OFF	OFF	OFF	ON
2	OFF	OFF	OFF	OFF	ON	OFF
3	OFF	OFF	OFF	OFF	ON	ON
4	OFF	OFF	OFF	ON	OFF	OFF
5	OFF	OFF	OFF	ON	OFF	ON
6	OFF	OFF	OFF	ON	ON	OFF
7	OFF	OFF	OFF	ON	ON	ON
8	OFF	OFF	ON	OFF	OFF	OFF
9	OFF	OFF	ON	OFF	OFF	ON
10	OFF	OFF	ON	OFF	ON	OFF
11	OFF	OFF	ON	OFF	ON	ON
12	OFF	OFF	ON	ON	OFF	OFF
13	OFF	OFF	ON	ON	OFF	ON
14	OFF	OFF	ON	ON	ON	OFF
15	OFF	OFF	ON	ON	ON	ON
16	OFF	ON	OFF	OFF	OFF	OFF
17	OFF	ON	OFF	OFF	OFF	ON
18	OFF	ON	OFF	OFF	ON	OFF
19	OFF	ON	OFF	OFF	ON	ON
20	OFF	ON	OFF	ON	OFF	OFF
21	OFF	ON	OFF	ON	OFF	ON
22	OFF	ON	OFF	ON	ON	OFF
23	OFF	ON	OFF	ON	ON	ON
24	OFF	ON	ON	OFF	OFF	OFF
25	OFF	ON	ON	OFF	OFF	ON
26	OFF	ON	ON	OFF	ON	OFF
27	OFF	ON	ON	OFF	ON	ON
28	OFF	ON	ON	ON	OFF	OFF
29	OFF	ON	ON	ON	OFF	ON
30	OFF	ON	ON	ON	ON	OFF
31	OFF	ON	ON	ON	ON	ON
32	ON	OFF	OFF	OFF	OFF	OFF
33	ON	OFF	OFF	OFF	OFF	ON
34	ON	OFF	OFF	OFF	ON	OFF
35	ON	OFF	OFF	OFF	ON	ON
36	ON	OFF	OFF	ON	OFF	OFF

NOTE: For SW1, ON = UP and OFF = DOWN.

Table 3. Time Slot Select for RFL VF-8A module

Switch Code (Decimal)	Physical Switch Settings SW2-					T1	E1
	1	2	3	4	5	Time Slot	Time Slot
0	D	D	D	D	D	*	*
1	D	D	D	D	U	1	1
2	D	D	D	U	D	2	2
3	D	D	D	U	U	3	3
4	D	D	U	D	D	4	4
5	D	D	U	D	U	5	5
6	D	D	U	U	D	6	6
7	D	D	U	U	U	7	7
8	D	U	D	D	D	8	8
9	D	U	D	D	U	9	9
10	D	U	D	U	D	10	10
11	D	U	D	U	U	11	11
12	D	U	U	D	D	12	12
13	D	U	U	D	U	13	13
14	D	U	U	U	D	14	14
15	D	U	U	U	U	15	15
16	U	D	D	D	D	16	*
17	U	D	D	D	U	17	17
18	U	D	D	U	D	18	18
19	U	D	D	U	U	19	19
20	U	D	U	D	D	20	20
21	U	D	U	D	U	21	21
22	U	D	U	U	D	22	22
23	U	D	U	U	U	23	23
24	U	U	D	D	D	24**	24
25	U	U	D	D	U	*	25
26	U	U	D	U	D	*	26
27	U	U	D	U	U	*	27
28	U	U	U	D	D	*	28
29	U	U	U	D	U	*	29
30	U	U	U	U	D	*	30**
31	U	U	U	U	U	*	31***

D = down, U = up.

Notes: * This setting is not allowed . Setting switches to this code will cause the module's service to be disabled.

**A T1 or E1 network utilizing fast reframing cannot utilize this time slot for voice channel.

*** An E1 network utilizing inter-node communications (NMX) cannot use timeslot 31 for voice channel.

Table 4. Number of ring attempts selected by rotary switch SW3

SW3 Rotary Switch Position	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
Number Of Ring Attempts	unlim- ited	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

11. DIP switches SW4, SW5 and SW6 are used to select the 3-digit Station ID. Values from 000 to 899 are legal. Group number 9 is reserved.
Set SW4 to the desired group number (100's position) between 0 and 8.
Set SW5 to the desired (10's position) between 0 and 9.
Set SW6 to the desired (units position) between 0 and 9.

For example, to select a Station ID of 347, set SW4 to 3, SW5 to 4, and SW6 to 7. This Station ID belongs to group number 3.

12. Set DIP switch SW7-6 enable or disable signaling delay.
Place SW7-6 in the UP position to enable signaling delay.
Place SW7-6 in the DOWN position to disable signaling delay.
13. Set DIP switches SW7-7 and SW7-8 to select the desired Busy Circuit option in accordance with Table 5.
14. Select the Tx and Rx audio levels using DIP switches SW8-2 through SW8-8, and SW9-2 through SW9-8, in accordance with Table 6. These switches are used to alter the translation between analog signal levels and digital data.

The factory default level setting is 0 dBm IN and -6 dBm OUT (refer to Table 6). The input level setting was selected because high-level tones are generally produced by standard DTMF phones. The output level setting was selected so that a comfortable voice level is received at the local phone earpiece. It is recommended that these default settings be used.

The following information is useful if the level must be adjusted:

The switches are binary coded with a minimum step size of 0.5 dB. An offset of 32 dB is included to allow the signals to be attenuated or amplified. Table 6 shows the switch settings for both the Tx and Rx level adjustments. The table only includes full dB steps for clarity. Adjustments can be made in 0.5 dB increments by changing switch position 8 on the appropriate switch. A Tx or Rx level can be set 0.5 dB lower by placing switch SWX-8 to the UP position. For example, to set -25.5 dB, set SWX-2 through SWX-8 as follows: U, U, U, D, D, U, U. Note that the level used to determine the switch setting should allow for the maximum anticipated signal, or clipping may occur.

The RFL VF-8A is now installed. If your multiplexer is set up for remote access and control, you can now change the operating parameters of the module by using simple commands. For more information on remote access and control, consult your multiplexer instruction manual.

Table 5. Busy Circuit Modes for RFL VF-8A module

SW7-7	SW7-8	Mode	Function
DOWN	DOWN	Party-Line Mode	When SW7-7 and SW7-8 are set to DOWN, if a local phone is picked up when a conversation is in progress, the local phone will be connected to the conversation.
DOWN	UP	Break-In Mode	When SW7-7 is set to DOWN and SW7-8 is set to UP, if a local phone is picked up when a conversation is in progress, the local phone will get a busy tone. The local phone can break into the conversation by dialing any one of the following: 1. “ * ” (example: *) 2. “ group ID followed by the* ” (example: 3*) 3. “ the local three digit extension ” (example: 312)
UP	DOWN	Privacy Mode	When SW7-7 is set to UP and SW7-8 is set to DOWN, if a local phone is picked up when a conversation is in progress, the local phone will get a busy tone and cannot break into the conversation. Note: In this case, if the local phone is off-hook, another extension will not be able to call that extension.
UP	UP	Not Applicable	Not Used

15. If you plan to operate the RFL VF-8A module under local control, perform the following steps; otherwise, go to step 16 for remote control.
- Set to local control by placing DIP switch SW1-7 in the UP position.
 - Turn service on by placing DIP switch SW1-8 in the UP position.
 - Slide the module into the selected module slot until it is firmly seated and the module front panel is flush with the top and bottom of the shelf.
 - Go to step 17.

<< text continues on page 13 >>

Table 6. Tx and Rx level settings, RFL VF-8A module

Tx Input Level (dBm) ⁽¹⁾	Switch Code (Hex)	Switch Code (Decimal)	Physical Switch Settings (Tx) SW8- / (Rx) SW9-							Rx Output Level (dBm) ⁽¹⁾
			2	3	4	5	6	7	8 ⁽²⁾	
-26	74	116	U	U	U	D	U	D	D	-26
-25	72	114	U	U	U	D	D	U	D	-25
-24	70	112	U	U	U	D	D	D	D	-24
-23	6E	110	U	U	D	U	U	U	D	-23
-22	6C	108	U	U	D	U	U	D	D	-22
-21	6A	106	U	U	D	U	D	U	D	-21
-20	68	104	U	U	D	U	D	D	D	-20
-19	66	102	U	U	D	D	U	U	D	-19
-18	64	100	U	U	D	D	U	D	D	-18
-17	62	98	U	U	D	D	D	U	D	-17
-16	60	96	U	U	D	D	D	D	D	-16
-15	5E	94	U	D	U	U	U	U	D	-15
-14	5C	92	U	D	U	U	U	D	D	-14
-13	5A	90	U	D	U	U	D	U	D	-13
-12	58	88	U	D	U	U	D	D	D	-12
-11	56	86	U	D	U	D	U	U	D	-11
-10	54	84	U	D	U	D	U	D	D	-10
-9	52	82	U	D	U	D	D	U	D	-9
-8	50	80	U	D	U	D	D	D	D	-8
-7	4E	78	U	D	D	U	U	U	D	-7
-6	4C	76	U	D	D	U	U	D	D	-6 ⁽³⁾
-5	4A	74	U	D	D	U	D	U	D	-5
-4	48	72	U	D	D	U	D	D	D	-4
-3	46	70	U	D	D	D	U	U	D	-3
-2	44	68	U	D	D	D	U	D	D	-2
-1	42	66	U	D	D	D	D	U	D	-1
0 ⁽³⁾	40	64	U	D	D	D	D	D	D	0
+1	3E	62	D	U	U	U	U	U	D	1
+2	3C	60	D	U	U	U	U	D	D	2
+3	3A	58	D	U	U	U	D	U	D	3
+4	38	56	D	U	U	U	D	D	D	4
+5	36	54	D	U	U	D	U	U	D	5
+6	34	52	D	U	U	D	U	D	D	6
+7	32	50	D	U	U	D	D	U	D	7
+8	30	48	D	U	U	D	D	D	D	8
+9	2E	46	D	U	D	U	U	U	D	9

Notes for Table 6:

1. The maximum analog level for transmit and receive is +9dBm. Levels exceeding +9dBm are not recommended.
2. This switch position can be used to set 0.5 dB increments. See paragraph 14 for details.
3. Factory default level setting.

16. If you plan to operate the RFL VF-8A module under remote control, perform the following steps:
 - a. Set to local control by placing DIP switch SW1-7 in the UP position.
 - b. Turn service off by placing DIP switch SW1-8 in the DOWN position.
 - c. Slide the module into the selected module slot until it is firmly seated and the module front panel is flush with the top and bottom of the shelf.
 - d. Wait 15 seconds for the RFL VF-8A module's parameter settings to be loaded into the shelf Common Module.
 - e. Pull the module out of the shelf and place DIP switch SW1-7 in the DOWN position.
Do not move SW1-8.
 - f. Slide the module back into the shelf.
 - g. Verify the module configuration through remote control by issuing a "CONFIG?" query. See the Remote Control Interface section of this Instruction Data Sheet for an explanation of the "CONFIG?" response.
 - h. Turn service on through remote control by issuing a "SRVC=ON" command.
The RFL VF-8A's operating parameters can now be changed by remote control. See the Remote Control Interface section of this Instruction Data Sheet for more information.
 - i. Go to step 17.
17. On the Module Record Card located to the right of the shelf, record the channel bank type, time slot, and any other pertinent information.

FUNCTIONAL DESCRIPTION

SYSTEM OVERVIEW

The VF-8A is a two-wire Orderwire Voice Frequency Channel Module designed for RFL IMUX 2000 T1 and E1 multiplexers. The VF-8A provides a very reliable means of voice communication between multiple locations. Figure 3 is a simplified block diagram of the RFL VF-8A module.

The VF-8A accepts a single voice channel as input and uses u-law PCM (CODEC) encoding to convert the analog voice into an 8-bit, 64-Kbps digital signal. All of the VF-8A settings can be configured via local switches or remotely with use of the RFL SCL (Simple Command Language).

The VF-8A uses two signaling bits of the T1/E1 data stream. One is used to indicate a busy circuit, and the other is used to indicate ringing. Channel-Associated Signaling (CAS) is used in E1 applications, while Robbed-Bit Signaling (RBS) is used in T1 applications. A “signaling delay” is available for switching networks; i.e. containing RFL Mini-DACS module.

The VF-8A allows the use of Dual-Tone Multi-Frequency (DTMF) telephones to selectively place a call between any or all locations within the RFL orderwire network. The three levels of DTMF signaling include “Unique”, “Group”, and “All” call.

Call progress tones are provided to indicate phone ringing, circuit busy, circuit available, and phone out-of-service. These give the VF-8A the “feel” of a real phone instead of a party line.

Three busy circuit modes are available. The level of privacy that the local extension maintains depends on the setting of each remote extension.

A “timeout” feature is included to free up the network for other calls if a phone is inadvertently left in the off-hook condition for a period exceeding 50 seconds.

BACKPLANE AND POWER CONNECTIONS

The VF-8A occupies a single physical slot in the multiplexer and conforms to the RFL IMUX 2000 backplane signal format. All T1 and E1 backplane signals in and out of the VF-8A have drivers with hot-pluggable capability. Control signals passing through the backplane from the I/O to the VF-8A module are pulled up to +5V through 10 K Ohm resistors.

The VF-8A requires digital +5V, analog $\pm 15V$, -48V, and analog and digital ground. The IMUX 2000 Power Supply provides these. The -48V can be supplied by an optional external 48V talk battery. The +5 digital volt input includes an inductor which lowers the inrush current to prevent power interruption during module insertion, and also prevents high frequency noise to be injected into the VF-8A by other modules. The digital +5V supply is used to power the Actel FPGA and driver ICs. TP1 is the ground test point situated near the fingers of the module where digital and analog grounds are referenced to one another. The digital +5V and analog $\pm 15V$ from the backplane are routed to the Hot Swap Controller. This device, and surrounding circuitry control the ramp of the power to all of the ICs.

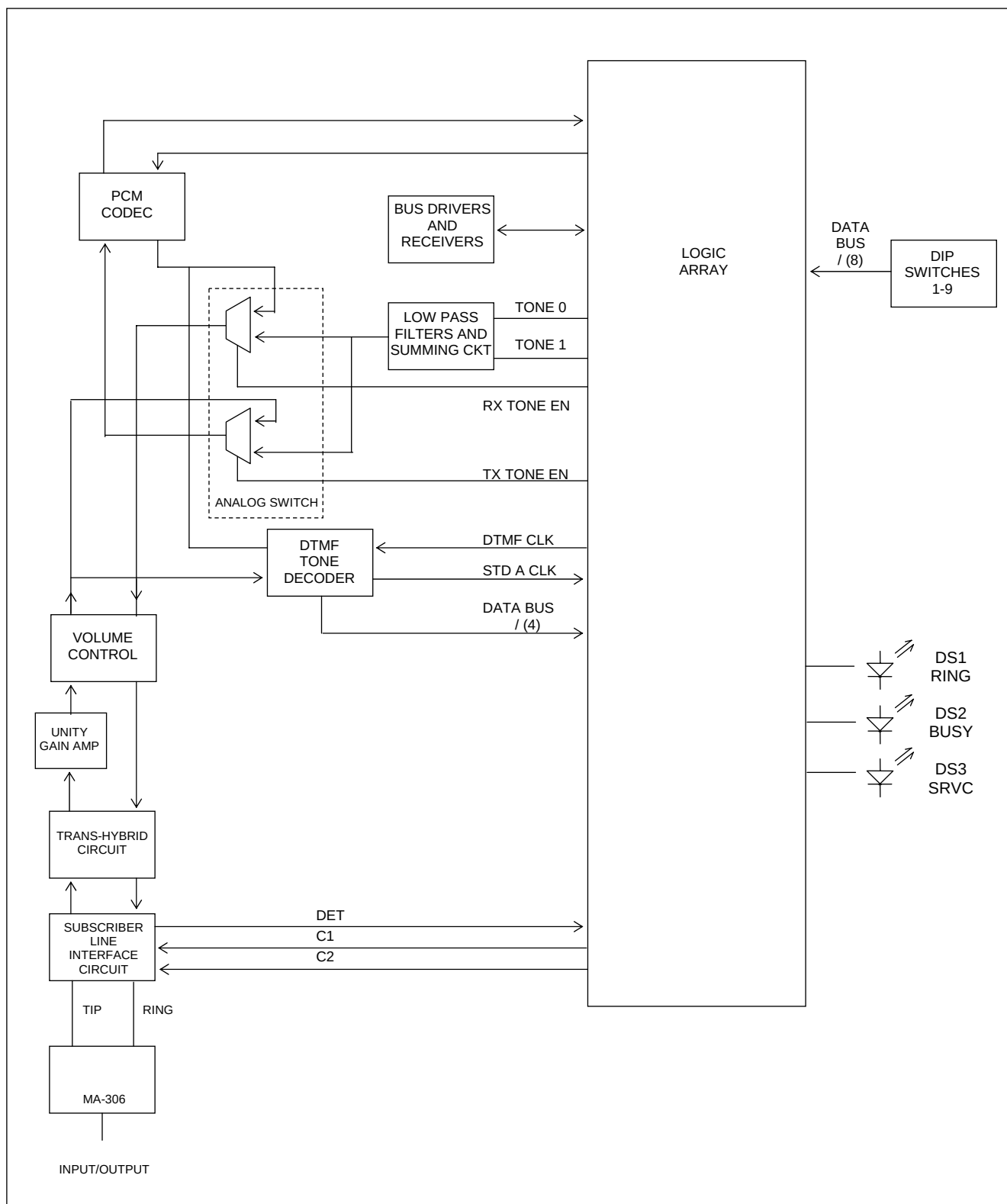


Figure 3. Functional block diagram, RFL VF-8A module.

Voltage regulators step-down the +15V and –15V analog supplies to produce multiple +5V and –5V analog supplies. The analog +5V and –5V supplies are used to power all analog ICs including the audio amplifier, stereo volume control, analog switch, DTMF decoder, and the CODEC. Decoupling capacitors are used as required. The analog +5V supplies can be monitored at test points TP3-5. The analog -5V supply can be monitored at test point TP6.

All pins which connect to the backplane, except for voltages and grounds, are cut back to prevent components from being driven by signals before the module is fully powered.

TRANSMIT SECTION

An analog voice input is fed from the MA-306 I/O into the VF-8A module through the rear backplane connections via TIP and RING inputs. The TIP and RING are protected by a diode bridge and a bi-directional telecommunication transorb. These voice input signals go through the Subscriber Line Interface Circuit (SLIC), trans-hybrid circuit, unity-gain amplifier, stereo volume control, and analog switch. The voice input then feeds two inputs, the PCM CODEC and the DTMF decoder.

The u-law PCM CODEC converts the analog voice into an 8-bit, 64-Kbps digital signal. The digitized audio signal then goes to the [Actel] Logic Array, where it is processed before being routed to the appropriate bus, and into the proper timeslot.

The DTMF decoder monitors all tones generated by the local telephone keypad. If a valid DTMF tone is detected which lasts for the required interval, the STD A clock signal will clock out the BCD equivalent of the tone detected into the Logic Array. It is necessary to monitor local tones in order for the supporting DTMF logic to differentiate between “Unique” station and “All” or “Group” call initiated locally. The “break-in” feature also requires that local tones be monitored.

In addition to the TIP and RING inputs, locally generated tones are transmitted. TONE 0 and TONE 1 are generated by the Logic Array at specific frequencies, and pass through low-pass filters before being summed by an operational amplifier. An active TX TONE EN signal from the Logic Array applied to the analog switch selects the tone to be transmitted and not the local voice input signal. The CODEC and Logic Array process the tone similar to the local voice input. Transmitted tones include ring back and re-order.

Local “connection/no-connection” and “ringing/not ringing” conditions are also transmitted. A signal from the SLIC determines whether (Loop-start) loop current is flowing between TIP and RING. In the on-hook or ringing condition, the loop is open (idle). In the off-hook condition, the loop is closed (busy) allowing approximately 20ma of current to flow. The “Ring” mode of the SLIC is programmed by inputs provided by the Logic Array. The Logic Array qualifies the signal to prevent false off-hook detection when the phone is ringing. When the SLIC and Logic Array determine that the phone is off-hook, the SLIC is programmed for “Active” mode. Local “ring” and “connection” states are routed to the appropriate bus and into the proper timeslot.

RECEIVE SECTION

The VF-8A receives an 8-bit, 64-Kbps digital signal from the appropriate bus and timeslot. The input signals go to the Logic Array where they are processed and de-multiplexed. The 8-bit digital output of the Logic Array is then converted to an analog audio signal by the u-law PCM CODEC and is passed to the analog switch, and the DTMF decoder. If the RX TONE EN signal applied to the analog switch is inactive, the audio signal passes through the stereo volume control, trans-hybrid circuit, SLIC, and rear backplane to the MA-306 I/O. For any voice or audio tone to pass through the SLIC, the local phone must be off-hook and the SLIC must be programmed for “Active” mode by inputs C1 and C2.

The DTMF decoder monitors all tones received from the CODEC generated by the remote telephone keypads. If a valid DTMF tone is detected which lasts for the required interval, the STD signal will clock out the BCD equivalent of the tone detected, into the Logic Array. It is necessary to monitor remote tones in order for the supporting local DTMF logic to determine whether the “Unique” station, “All”, and “Group” is a match. Once a DTMF match is determined by the logic, the SLIC is programmed for “Ring” mode by inputs C1 and C2. The amber RING LED will illuminate, corresponding to the ring cadence of 2 Sec ON and 4 Sec OFF.

In addition to audio tones and voice received from remote locations, locally generated tones are received. TONE 0 and TONE 1 digital signals are generated by the Logic Array at specific frequencies. These signals pass through low-pass filters before being summed by an operational amplifier. An active RX TONE EN signal from the Logic Array is applied to the analog switch which selects the tone to be received and not the remote voice input signal. The tone is passed through the stereo volume control, trans-hybrid circuit, SLIC, and rear backplane to the MA-306 I/O similar to the remote voice input. Received tones include ring back, dial, busy, and re-order.

Signaling information from remote VF-8As are also received. The remote “ring” and “connection” states are received from the appropriate bus(s) into the proper timeslot. If the local phone has dialed the remote phone(s), the received “ring” signal indicates the ring period. This is especially important as the locally generated ring back tone is used when a “group” or “all” call is initiated; the remote phones do not generate the ring tone. The first phone to be off-hook always makes “connection” by default. The green BUSY LED will illuminate at both local and remote locations. If that phone dials the remote phone(s), and a phone goes off-hook, it also has made “connection”. The local phone in the off-hook condition will “timeout” after 50 seconds if neither “ring” nor “connection” are received. A local re-order tone will be generated and the circuit will be freed up for other calls. If local and remote phones are all on-hook, the SLIC(s) are programmed for “open circuit” mode by inputs C1 and C2.

ALERTS/ALARMS

The RFL VF-8A module reports no module level ALERT or ALARM signals to the shelf Common Module.

NETWORK OPERATION

In a network, if only one phone is off-hook it is automatically “connected” to the circuit, receives a local dial tone, and is able to place a call. The dial tone will remain until any key is pressed. A dial tone will not be present if more than one phone is “connected” to the network.

Phones that go off-hook to *answer* a call will also become “connected” to the network. For a conference call, all current parties remain “connected”, and calls can be made to other stations. However, the period between calls must exceed five seconds. If more than one phone is “connected”, a local ring-back tone will not be heard if “Group” or “All” call is initiated. A ring back will be heard by all “connected” parties if a “Unique” call is placed, and will remain until the phone is answered or the number of ring attempts at the called phone is qualified.

If a phone goes off-hook to place a call, but does not receive a dial tone, the network is busy. A local busy-tone may or may not be present, depending on the “Busy Circuit” setting described below.

Each station in a network can belong to one of nine “Groups”. A “Group” can be called by dialing the “Group” number followed by the “*”. Only the phones at stations having the same “Group” number (0-8) will ring for a pre-programmed number of times. Ringing at each station will cease when the phone goes off-hook, or the number of ring attempts is qualified. Phones already in the off-hook condition will not ring. The phone that dialed the “Group” will receive a local ring back tone until any other phone in the network is “connected”.

A user can call “All” stations by dialing a “*”. This will cause all phones in the network to ring for a pre-programmed number of times. Ringing will cease when any phone goes off-hook, or the number of ring attempts is qualified. Phones already in the off-hook condition will not ring. The phone that dialed “All” stations will receive a local ring back tone until any other phone in the network is “connected”.

A user can call a “Unique” Station by dialing a 3-digit station ID within five seconds of one another. The phone at the “Unique” station will ring for a pre-programmed number of times. The ringing will cease if the receiving party goes off-hook, the calling party goes on-hook, or the number of ring attempts is qualified. The receiving phone will not ring if it was previously in the off-hook condition. The phone that dialed the “Unique” station, and any other connected phones will receive a ring back tone generated by the phone that was called. The tone will disappear once the “Unique” station goes off-hook, or the number of ring attempts has been qualified.

A 50-second timeout will release the circuit if a phone is inadvertently left off-hook. A local re-order tone will be heard to indicate a timeout. A phone selectively calling (Unique call) a phone that timed out, will also receive a re-order tone. A phone that has timed out must be placed on-hook to be back in service.

“Busy Circuit” Modes allow a level of privacy for calls already in progress as follows:

“Party-line” – The local handset picked up will be “connected” to any call in progress. The local extension does not required to be dialed to join or overhear a conversation.

“Break-in” – The local handset picked up receives a busy tone. If the nature of the call is not critical, simply hang-up, and try again later. However, if the nature of the call is critical, the local phone can break into any call in progress. This is accomplished by dialing the local “Unique” station ID, the local “Group” call, or “all” call. Note that the tones are only received locally, and not transmitted over the T1 data stream. This mode is recommended as the default setting; offering both local circuit accessibility for an emergency and a measure of privacy for remote phones.

“Private” – The local handset picked up receives a busy tone and cannot access the busy network. Break-in codes will not work; hang-up and try again later. As a rule, the local phone can only “connect” to the network when all other phones are on-hook, or if called by any “connected” phone while on-hook. Remaining off-hook when the circuit is busy may result in missed incoming calls.

REMOTE CONTROL INTERFACE

When installed in an IMUX 2000 remote controllable shelf, the RFL VF-8A module can be operated under local or remote control. When under remote control, certain configuration parameters can only be changed through the RS-232 remote port on the multiplexer. The remote interface for these modules involves two codes: a “P” (parameter) code, and an “S” (status) code. See the IMUX 2000 instruction manual for more information on the remote control interface.

The RFL VF-8A reports itself as a “Type 125” module when installed in a T1 or E1 system.

“P” CODES

“P” codes, when used in the parameter field on a “SET” command, allow the user to set certain parameters on the module by remote control, just like setting the switches on a module under local control. “P” codes also appear in the response to a “CONFIG?” query, showing the current parameter settings on the module.

There are six “P” codes for the RFL VF-8A: P1 through P6. Each of these P codes can be a decimal number from 0 to 255, which can also be represented as an eight-digit binary number (in parenthesis). The binary representation is more useful for setting and interpreting the “P” codes, since each binary digit (0 or 1) corresponds to the ON or OFF setting for a particular switch on the module. Table 7 describes the meanings of the “P” codes for the RFL VF-8A in normal mode. Table 6 describes the meanings of the “P” codes for the RFL VF-8A.

A typical RFL VF-8A response to a “CONFIG?” query of a T1 or E1 system in normal mode looks like this:

*** OK**
CHANNEL CARD 3, TYPE 125
UNDER REMOTE CONTROL
SRVC = ON
P01 = 3 (B00000011)

NOTE

When using binary numbers with a SET command, they must be preceded by the letter “B” as shown in the following example:

<MULTIPLEXER ADDRESS>:<CARD ADDRESS>:SET:P1 = B00000011;

Besides using the P code, it is also possible to turn module service on or off by sending one of the following in the parameter field with a SET command:

SRVC = ON
SRVC = OFF

Table 7. Remote configuration settings (“P” codes) for T1/E1

P Code	Digit(s) And Switch Equivalent	Value ⁽¹⁾	Description
P1	B 0 0 0 0 0 0 0 0 - - - ↑↑↑↑↑ TIME SLOT SELECT	00001 to 11000 T1 Settings	From left to right, these five bits represent the binary value of the desired time slot between 1 through 24 in a T1 network. See Table 3 for a complete list of these values.
		00001 to 11111 E1 Settings	From left to right, these five bits represent the binary value of the desired time slot between 1 through 31 in an E1 network. See Table 3 for a complete list of these values.
	B 0 0 0 0 0 0 0 0 - ↑ - - - - - BUS B ENABLE	0	Bus B disabled
		1	Bus B enabled
	B 0 0 0 0 0 0 0 0 - - ↑ - - - - BUS A ENABLE	0	Bus A disabled
		1	Bus A enabled
P2	B 0 0 0 0 0 0 0 0 ↑↑↑↑ - - - - NUMBER OF RINGS	0000 to 1111	These four bits represent the binary value of the number of rings from 0 to 15. See Table 4 for more information.
	B 0 0 0 0 0 0 0 0 - - - - ↑↑↑↑ GROUP NUMBER OF 3-DIGIT STATION ID	0000 to 1000	These four bits represent the binary value of the group number of the 3-digit Station ID from 0 to 8 (100’s position). Refer to P-Code P3 below for the tens position and units position
P3	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑↑↑↑ { } { } MSD LSD MSD = most significant digit, or value of tens position of 3-digit Station ID. LSD = least significant digit, or value of units position of 3-digit Station ID.	MSD = 0000 to 1001 LSD = 0000 to 1001	The four MSD bits represent the binary value of the tens position of the 3-position Station ID. The four LSD bits represent the binary value of the units position of the 3-position Station ID.

1. These are the only legal values for setting the parameters. Setting any parameter to a value outside its specified range will produce an unpredictable result.

Table 7 - continued. Remote configuration settings (“P” codes) for T1/E1

P Code	Digit(s) And Switch Equivalent	Value ⁽¹⁾	Description
P4	B 0 0 0 0 0 0 0 0 - - - - - ↑ - - SIGNALING DELAY	0	Signaling Delay disabled
		1	Signaling Delay enabled
	B 0 0 0 0 0 0 0 0 - - - - - ↑ ↑ BUSY CIRCUIT MODE	00	Selects Party Line Mode. If a local phone is picked up when a conversation is in progress, the local phone will be connected to the conversation.
		01	Selects Break-in Mode. If a local phone is picked up when a conversation is in progress, the local phone will get a busy tone. The local phone can break into the conversation by dialing any one of the following: 1. “ * ” (example: *) 2. “ group ID followed by the* ” (example: 3*) 3. “ the local three digit extension ” (example: 312)
		10	Selects Privacy Mode. If a local phone is picked up when a conversation is in progress, the local phone will get a busy tone and cannot break into the conversation. Note: In this case, if the local phone is off-hook, another extension will not be able to call that extension.
		11	Selects Privacy Mode. Same as 10 above.
P5	B 0 0 0 0 0 0 0 0 . ↑ ↑ ↑ ↑ ↑ ↑ ↑ TX LEVEL	0000000 to 1111111	Sets transmit level in 0.5dB increments/decrements From 0dB center at 1000000 (40H) Increment for lower input levels. Decrement for higher input levels.
P6	B 0 0 0 0 0 0 0 0 . ↑ ↑ ↑ ↑ ↑ ↑ ↑ RX LEVEL	0000000 to 1111111	Sets receive level in 0.5dB increments/decrements From 0dB center at 1000000 (40H) Increment for lower output levels. Decrement for higher output levels.

“S” CODES

“S” codes appear in response to a “STATUS?” query. There is one “S” code for the RFL VF-8A when operated in T1 or E1 systems. Like the “P” code, this number is displayed in both decimal and binary form. The six least significant digits of the binary number represent the conditions shown in Table 8. The two most significant digits are not used.

A typical response to a “STATUS?” query looks like this:

*** OK**
CHANNEL CARD 3, TYPE 125
S01 = 2 (B00000010);

Table 8. Remote status messages (“S” codes) for T1/E1

S CODE	Position	Value	Description
S1	B 0 0 0 1 1 0 1 0	0	Valid configuration
	- - ↑ - - - -	1	Invalid configuration
	B 0 0 0 0 0 0 0 0	0	Local ringing
	- - - - - ↑ -	1	Local not ringing
	B 0 0 0 0 0 0 0 0	1	Remote connected
	- - - - - ↑ - -	0	Remote not connected
	B 0 0 0 0 0 0 0 0	1	Local connected
	- - - - - - ↑	0	Local not connected
	B 0 0 0 0 0 0 0 0	0	Remote ringing
	- - - - ↑ - - -	1	Remote not ringing
	B 0 0 0 0 0 0 0 0	0	Timeout active (50 second timer exceeded)
	- - - ↑ - - - -	1	Timeout not active

TESTING

After the RFL VF-8A module has been configured and installed, it should be tested for proper operation before it is put into service. If a module is set up for two-channel operation, test each channel separately.

EQUIPMENT REQUIRED

1. Minimum of two (2) Telephone Sets, Type 2500 or equivalent; one for each VF-8A module.
2. External Ring Generator at each location. (optional)
3. External –48 Volt Battery at each location. (optional)

TEST PROCEDURE

1. Determine whether the –48V talk current battery is to be provided by the IMUX 2000 Power Supply or an external source for each location. Verify that the power supply is strapped accordingly at each location. If an external source is to be used, make the required connections to the IMUX Power Supply I/O at that location, as described in the Installation section of the multiplexer manual.
2. Determine whether the local ring generator (on the MA-306 I/O) or an external ring generator is to be used at each location. Verify that the MA-306 I/O is strapped accordingly at each location. If an external ring generator source is to be used, make the required connections to the IMUX Power Supply I/O at that location, as described in the Installation section of the multiplexer manual.
3. Connect the telephone to each MA-306 I/O of corresponding VF-8A module under test.
4. Check the setting of DIP switches SW2-1 through SW2-5 for each VF-8A module. Make sure that each VF-8A intended to be part of the same voice network are strapped for the same time slot.
5. Verify each VF-8A has a unique “Unique” 3-digit station ID. Visually inspect rotary switches SW4 through SW6.
6. Set each VF-8A module to local control by setting DIP switch SW1-7 in the UP position.
7. Set service ON for each VF-8A module by setting DIP switch SW1-8 in the UP position.
The SRVC LED (DS3) should be ON, on each module. All other LEDs should be OFF for each module, indicating all phones are on-hook and voice circuit is in the idle condition.

8. Verify the Signaling Delay setting of SW7-6. This is set by default to the UP position for approximately 500 ms of signaling delay. This is required for switching networks having an RFL Mini-DACS. This is to prevent erroneous phone rings from occurring during a switch.
9. Take the phone connected to the local VF-8A module off-hook and observe the presence of a local dial tone.
The green BUSY LED (DS2) at each VF-8A (local and remote modules) should be ON indicating the voice circuit is busy.
10. Keep phone connected to local VF-8A module off-hook for approximately 50 seconds, so that the timeout feature times out.
The green BUSY LED (DS2) at each VF-8A (local and remote modules) should be OFF indicating the voice circuit is not busy. A local re-order tone should be present at the local VF-8A's phone earpiece.
11. Dial the extension of the VF-8A that has timed out from any other remote extension. A remote re-order tone transmitted by the VF-8A that has timed out should be present at the remote VF-8A's phone earpiece.
12. Place the local phone on-hook while the remote phone remains off-hook. Take the local phone off-hook, and test the local phone's BUSY mode feature. Refer to Table5.
13. Place both phones on-hook. Using the local VF-8A extension, dial a * for an "All" [extension] call.
A local ringback tone should be heard in the local VF-8A earpiece until any remote phone is placed off-hook (or maximum number of rings has expired at all locations.)
14. Place both phones on-hook. Using the local VF-8A extension, dial the "Unique" ID of a remote VF-8A extension.
The phone connected to the remote RFL VF-8A should ring 2 seconds ON, and 4 seconds OFF. While it is ringing, the amber RING LED (DS1) on the front of the VF-8A should correspond to the cadence of the ringing phone. The BUSY LEDs (DS2) at all VF-8A extensions will be ON.

A remote ringback tone should be heard in the local VF-8A earpiece.
15. Jump to step 18 if configured for an "unlimited" number of rings or if this feature was tested on this remote card during a previous pass.
16. If a "maximum" number of rings is configured for the remote VF-8A, count the number of rings until it ceases to ring. Verify that the counted number is what is expected. Skip this step if configured for an unlimited number of rings.

17. Place the local phone on-hook. Using the local VF-8A extension, dial the same “unique” ID of the remote VF-8A extension in step 14.
18. Answer the ringing phone and verify that the ringing stops and the voice quality is acceptable.
The amber RING LED (DS1) on the front of the VF-8A will be OFF. The BUSY LEDs (DS2) at all VF-8A extensions will be ON.
19. If there is a problem with the audio signal at either end, the system may not be properly configured for the signal levels being applied. Low levels may be due to attenuation at either end of the circuit, i.e. long wire runs. Clipping (distortion of waveform) may be due to excessive gain at either end of the circuit. Refer to Step 14 on page 10 for additional information.
20. Repeat steps 14 thru 19 for each remote VF-8A.
21. Repeat steps 9 thru 20 until each VF-8A was tested as the local extension.
22. Change the settings on one or all of the modules, if necessary, to suit the desired circuit configuration. The circuit may now be placed in service.

TROUBLESHOOTING

If there is an apparent malfunction, first check that the configuration is appropriate for the transmission system in use, and that the transmit and receive configurations are identical.

Problems may occur at the common equipment or facility level that may affect the operation of this module. Refer to the “Maintenance” section in your multiplexer manual for system analysis procedures.

NOTES

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RFL Electronics Inc.

INSTRUCTION DATA

Foreign Exchange Voice Modules For RFL IMUX 2000 Intelligent T1 Multiplexers

**RFL VF-10B (Office End)
RFL VF-11B (Station End)**

DESCRIPTION

The RFL VF10B is a two-wire Foreign Exchange Office End (FXO) module, and the RFL VF-11B is a two-wire Foreign Exchange Station End (FXS) module. They are designed for use in RFL IMUX 2000 terminal and drop/insert multiplexers, and other RFL network interface products. Each accepts one voice channel as input, using PCM coding to convert the analog voice signal into a 64-Kbps digital signal. The digital signal is then transmitted over T1 and other digital communication facilities.

A circuit with an RFL VF-10B module at one end and an RFL VF-11B module at the other end can provide a Foreign Exchange (FX) line or an Off-Premise Extension (OPX) line. An automatic Ring Down (ARD) line can be set up by using RFL VF-11B modules at both ends of the circuit.

User-adjustable switches and jumpers allow the configuration of the following parameters:

- o Loop start.
- o Automatic Ring Down (ARD) usage (RFL VF-11B only).
- o Service enable/disable.
- o Remote control configuration and status reporting.
- o Selectable transmit/receive direction.
- o Extended range input/output attenuation.
- o Selectable time slot assignment.

SPECIFICATIONS

As of the date this Instruction Data Sheet was published, the following specifications apply to the RFL VF-10B Foreign Exchange Office End Voice Module and the RFL VF-11B Foreign Exchange Station End Voice Module. Because all of RFL products undergo constant refinement and improvement, these specifications are subject to change without notice.

Configuration: One voice channel per module.

Time Slots: Each module uses one user-selectable 64-Kbps time slot.

Signal Levels:

Input: -9.0 dBm to +9.0 dBm

Output: -9.0 dBm to +9.0 dBm

Frequency Response:

200 to 300 Hz: +0.0 dB to -3.0 dB

300 to 3000 Hz: +0.5 dB to -1.0 dB

3000 to 3300 Hz: +0.0 dB to -1.5 dB

Idle Channel Noise: Less than 23 dBrnc

Impulse Noise (threshold-level maximum counts per 30-minute interval):

41 dBrnc: 10.0 counts

51 dBrnc: 1.0 count

58 dBrnc: 0.1 counts

Signal-To-Distortion (1004 Hz to 1020 Hz):

0 to -30 dBm: Greater than 33 dB

-40 dBm: Greater than 27 dB

-45 dBm: Greater than 22 dB

Impedance: 600 Ω standard; for conversion to other impedance values, contact the factory.

Crosstalk Coupling:

400 Hz: 49 dB

700 - 1100 Hz: 59 dB

1100 - 3000 Hz: 58 dB

3700 Hz: 49 dB

Tracking:

+3 to -37 dBm0: 0.5 dB maximum

-37 to -50 dBm0: 1.0 dB maximum

“Tracking” is defined as the amount of deviation in gain for a 1004-Hz input.

Peak-To-Average Ratio (Par): Greater Than 94

Power Dissipation:

Off-Hook: 750 mW from shelf power supply, plus one watt from -48 VDC talk current supply.

On-Hook: 750 mW from shelf power supply.

Signaling:

RFL VF-10B:

Loop-Start Resistance:

Off-Hook: 1800 ohms or less.

On-Hook: 10K ohms or more.

Answering Resistance:

Off-Hook: 1800 ohms.

On-Hook: 10K ohms.

RFL VF-11B:

Loop-Start:

Off-Hook: 2000 ohms or less.

On-Hook: 10K ohms or more.

Ring Voltage: 50 to 120 Vrms, 20 to 30 Hz.

Automatic Ring Down (ARD): Requires RFL VF-11B FXS modules on each end of circuit. Ring 2 seconds on, 4 seconds off. Ringback tone 300 Hz.

Interface: MA-303, MA-303B, MA-304 or MA-304B module adapter.(See page 5 for more information)

Testing: Input level test point.

Operating Temperature: -20°C to +55°C (-4°F to +131°F).

Relative Humidity: Zero to 90 percent, non-condensing.

System Compatibility: RFL VF-10B and RFL VF-11B modules are compatible with all RFL IMUX 2000 Intelligent T1 Multiplexers. They can also be used in older non-programmable RFL 9001 multiplexers, but the remote access and control functions are not supported.

INSTALLATION

Before the RFL VF-10B or RFL VF-11B can be placed in service, they must be installed in a multiplexer shelf. Installation involves determining the module slot in the Main Shelf or Expansion Shelf where the module will be installed, inserting a Module Adapter into the rear of the shelf behind the module slot, connecting all signal and power wiring to the Module Adapter, checking the settings of all switches, and inserting the module into the front of the shelf.

NOTES

1. Power supply and time slot considerations may affect the installation of this module into an existing multiplexer shelf. Refer to the multiplexer manual for more information.
2. Before installing an RFL VF-11B module, make sure that the shelf is equipped with a ring generator and a source of -48-volt talk current. Refer to the multiplexer manual for more information on connecting ring generator and talk current.

The following instructions are provided for installing RFL VF-10B and RFL VF-11B modules into existing systems. If the module was included as part of a system, installation was done at the factory. Otherwise, proceed as follows:

1. Carefully inspect the module for any visible signs of shipping damage. If you suspect damage to the module, immediately call RFL Customer Service at the number listed at the bottom of this page.
2. Determine the module slot in the Main Shelf or Expansion Shelf where the module will be installed.
RFL VF-10B and RFL VF-11B modules occupy one module slot in the Main Shelf or Expansion Shelf.
3. Determine which module adapter will be used to make connections to the RFL VF-10B or VF-11B module.
Each module in the IMUX 2000 multiplexer requires a Module Adapter. The module adapter provides the appropriate connection for the desired interface.

There are four module adapters that are compatible with the RFL VF-10B and RFL VF-11B:

<u>Model Number</u>	<u>Voice Connections</u>	<u>Application</u>	<u>Figure</u>
MA-303	RJ-11 Jack	Used with all VF-10Bs and all VF-11Bs using external ring generators.	1
MA-303B	Removable terminal block	Used with all VF-10Bs and all VF-11Bs using external ring generators.	2
MA-304	RJ-11 Jack	Used with all VF-11Bs <u>not</u> using external ring generators	1
MA-304B	Removable terminal block	Used with all VF-11Bs <u>not</u> using external ring generators	2

The MA-303 Module Adapter is designed for use with all RFL VF-10B office-end modules, and all RFL VF-11B modules using external ring generators. Only the connectors for Channel 1 are used. Each MA-303 provides two RJ-11 jacks for connection to the voice circuits, and two bantam jacks for each channel. (See Figure 1.) These bantam jacks may be used for test access. Each LINE jack provides access to the line from the equipment side.

The MA-304 is similar to the MA-303, except it also contains a ring generator. It is used with all RFL VF-11B modules that are not connected to external ring generators.

The MA-303B is similar to the MA-303, except it has removable terminal blocks in place of the RJ-11 connectors for the voice connection.

The MA-304B is similar to the MA-304, except it has removable terminal blocks in place of the RJ-11 connectors for the voice connection.

Make sure the module adapter you are installing is correct for the desired application.

4. Insert the Module Adapter into the rear of the shelf directly behind the module slot where the module will be installed.

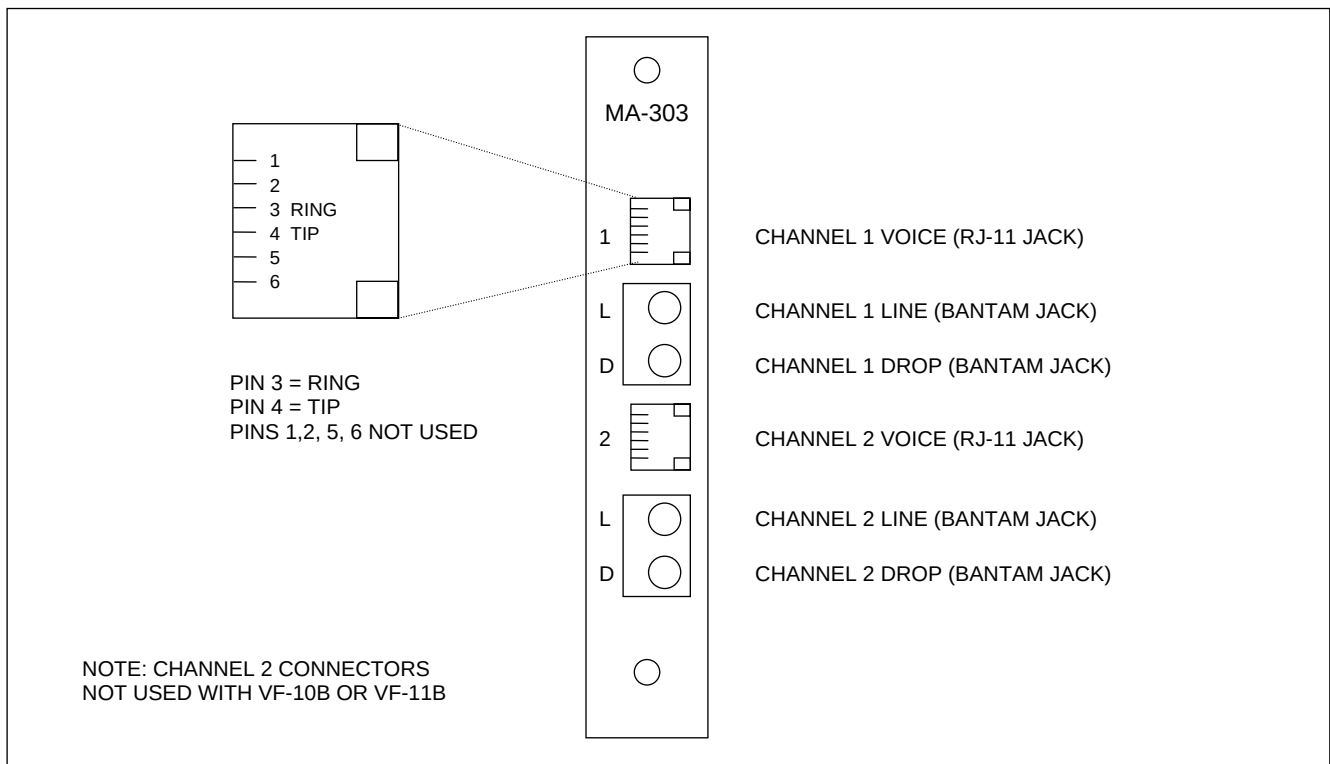


Figure 1. MA-303 Module Adapter, used with all RFL VF-10B office-end modules and all VF-11B station end modules using external ring generators. The MA-304 Module Adapter used with RFL VF-11B modules not using external ring generators is similar in appearance.

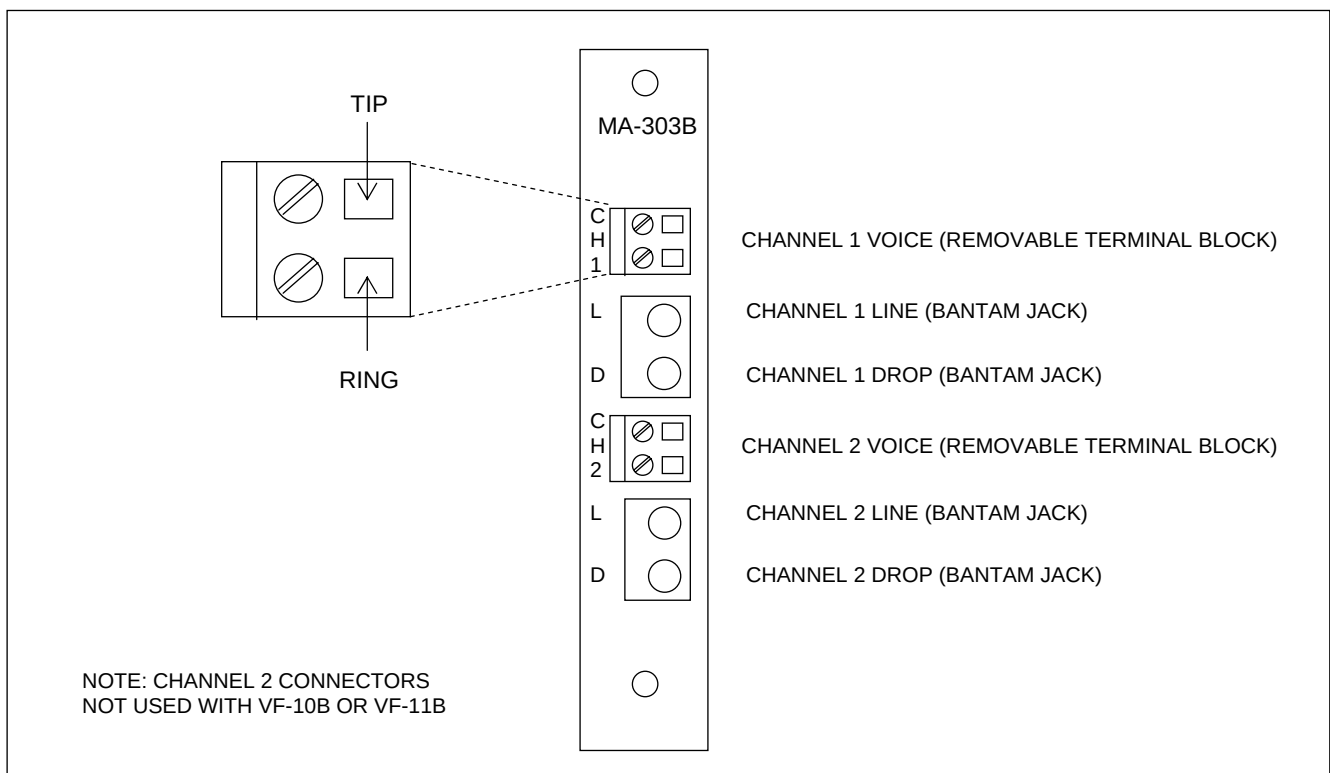


Figure 2. MA-303B Module Adapter, used with all RFL VF-10B office-end modules and all VF-11B station end modules using external ring generators. The MA-304B Module Adapter used with RFL VF-11B modules not using external ring generators is similar in appearance.

5. Plug in the RJ-11 connector or the removable terminal block, as applicable, into the Channel 1 jack on the module adapter.

The only electrical interface connections that have to be made to the RFL VF-10B and the RFL VF-11B are RING and TIP connections, which are made to terminals 3 and 4 on the RJ-11 connector, or to the screw terminals on the terminal block, (TIP is the top terminal, and RING is the bottom terminal) as shown in Figures 1 and 2 as applicable.

6. Set the module address using DIP switch SW7. (See Figures 2 and 3 for location).

For remote access, each channel module in the shelf must have a distinct module address. Valid addresses are the numbers 1 to 36, as shown in Table 1. In most installations the address will be set to the number of the slot the module is occupying. (Consult your multiplexer manual for details on using the remote access and configuration features of the system.)

WARNING

To prevent ring generator contention use either the MA-304 or MA-304B on board ring generator or an external ring generator, but not both at the same time. This applies only to voice frequency modules at the station end, to which the telephone is connected. The effected modules are the VF-11B, VF-16 and VF-18 voice frequency foreign exchange modules.

The VF-11B, VF-16 and VF-18 each has an E17 jumper pad near the connector end of the module as shown below. When this jumper pad has a wire jumper installed, it enables an external ring generator (external to the IMUX 2000 or the RFL 9001) and should never be installed when an MA-304 or MA-304B is used. Refer to paragraph 9.2.3 of the IMUX Installation Manual for information on external ring generator connections.

Improper application of the E17 jumper will cause erratic T1 transmissions.

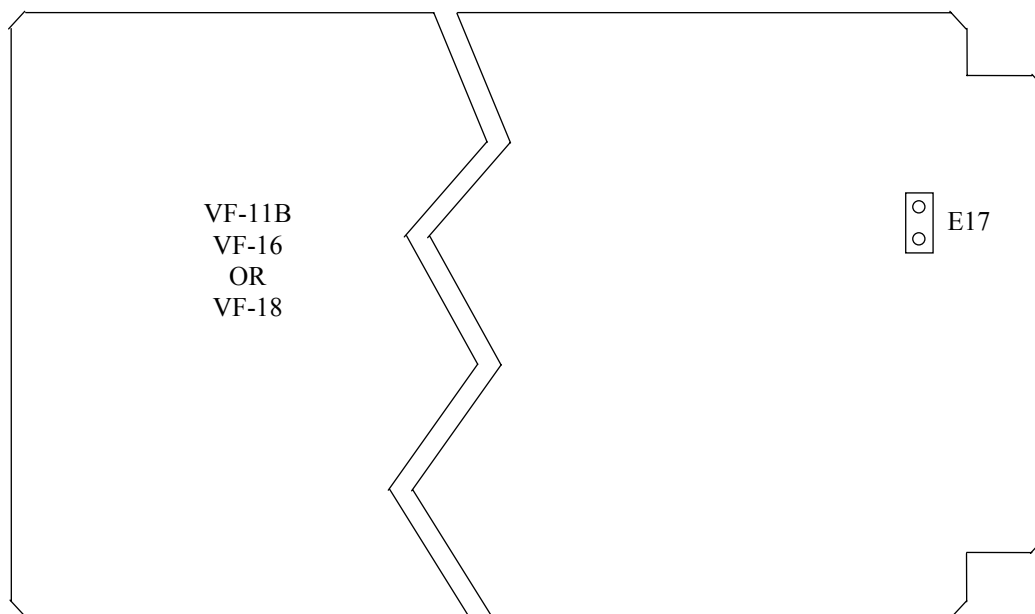


Table 1. Remote access address settings, RFL VF-10B and RFL VF-11B modules

Module Address	SW7-1	SW7-2	SW7-3	SW7-4	SW7-5	SW7-6
1	OFF	OFF	OFF	OFF	OFF	ON
2	OFF	OFF	OFF	OFF	ON	OFF
3	OFF	OFF	OFF	OFF	ON	ON
4	OFF	OFF	OFF	ON	OFF	OFF
5	OFF	OFF	OFF	ON	OFF	ON
6	OFF	OFF	OFF	ON	ON	OFF
7	OFF	OFF	OFF	ON	ON	ON
8	OFF	OFF	ON	OFF	OFF	OFF
9	OFF	OFF	ON	OFF	OFF	ON
10	OFF	OFF	ON	OFF	ON	OFF
11	OFF	OFF	ON	OFF	ON	ON
12	OFF	OFF	ON	ON	OFF	OFF
13	OFF	OFF	ON	ON	OFF	ON
14	OFF	OFF	ON	ON	ON	OFF
15	OFF	ON	ON	ON	ON	ON
16	OFF	ON	OFF	OFF	OFF	OFF
17	OFF	ON	OFF	OFF	OFF	ON
18	OFF	ON	OFF	OFF	ON	OFF
19	OFF	ON	OFF	OFF	ON	ON
20	OFF	ON	OFF	ON	OFF	OFF
21	OFF	ON	OFF	ON	OFF	ON
22	OFF	ON	OFF	ON	ON	OFF
23	OFF	ON	OFF	ON	ON	ON
24	OFF	ON	ON	OFF	OFF	OFF
25	OFF	ON	ON	OFF	OFF	ON
26	OFF	ON	ON	OFF	ON	OFF
27	OFF	ON	ON	OFF	ON	ON
28	OFF	ON	ON	ON	OFF	OFF
29	OFF	ON	ON	ON	OFF	ON
30	OFF	ON	ON	ON	ON	OFF
31	OFF	ON	ON	ON	ON	ON
32	ON	OFF	OFF	OFF	OFF	OFF
33	ON	OFF	OFF	OFF	OFF	ON
34	ON	OFF	OFF	OFF	ON	OFF
35	ON	OFF	OFF	OFF	ON	ON
36	ON	OFF	OFF	ON	OFF	OFF

7. Set transmit/receive attenuation switches SW1 and SW2, if settings other than factory standard are desired. (See Figures 3 and 4 for location.)

The transmit and receive attenuators can be set to any desired value up to 24 dB, in 0.1 dB increments. The values for these switch positions appear in Table 4 of this Instruction Data Sheet.

Switch settings are cumulative. For example, to set attenuation to 19.0 dB, turn on switch positions 2, 4, 7 and 8; to set attenuation to 7.6 dB, turn on switch positions 1, 5 and 7. Factory settings are as follows:

<u>RFL VF-10B:</u>	Transmit Side:	9.0 dB
	Receive Side:	9.0 dB

<u>RFL VF-11B:</u>	Transmit Side:	12.0 dB
	Receive Side:	10.0 dB

These settings provide 0 dBm in, 0 dBm out. See Tables 5 and 6 for attenuator calibration settings for various input and output levels.

8. Select any unused time slot using SW6-1 through SW6-5. (See Figures 3 and 4 for location.)
The digitized voice signal of the RFL VF-10B or RFL VF-11B module occupies one 64-Kbps digital time slot within the multiplexer's aggregate rate. Use the settings shown in Table 7 to select which time slot the module uses. Consult your multiplexer manual for guidelines on time slot selection.
9. Select loop start using SW6-6. (See Figures 3 and 4 for location.)
The factory setting is DOWN for loop start.
10. Select transmit direction using SW6-7. (See Figures 3 and 4 for location.)
The factory setting is DOWN to transmit in the A direction, and receive from the B direction.
11. If you are configuring an RFL VF-10B module, set SW6-8 to the UP position. If you are configuring an RFL VF-11B module, select normal or ARD operation using SW6-8. (See Figures 3 and 4 for switch locations.)
The factory setting is UP for normal operation.

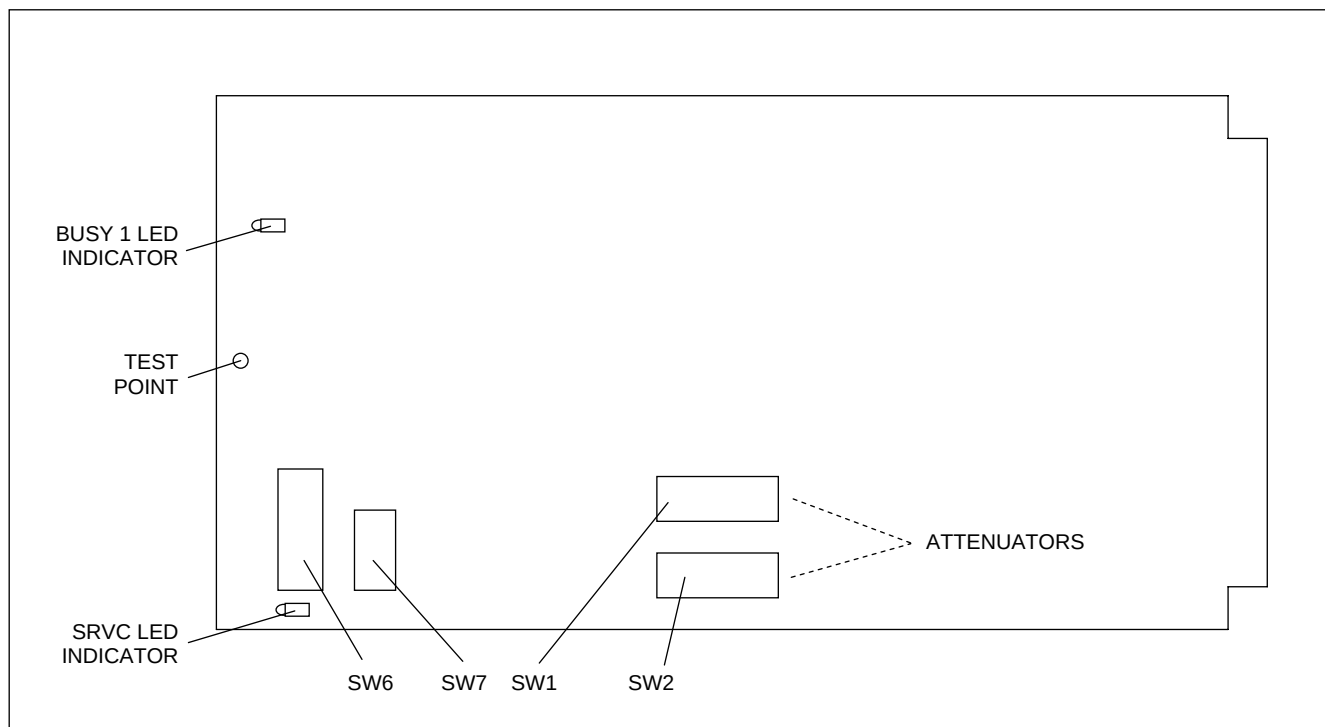


Figure 3. Controls and indicators, RFL VF-10B module

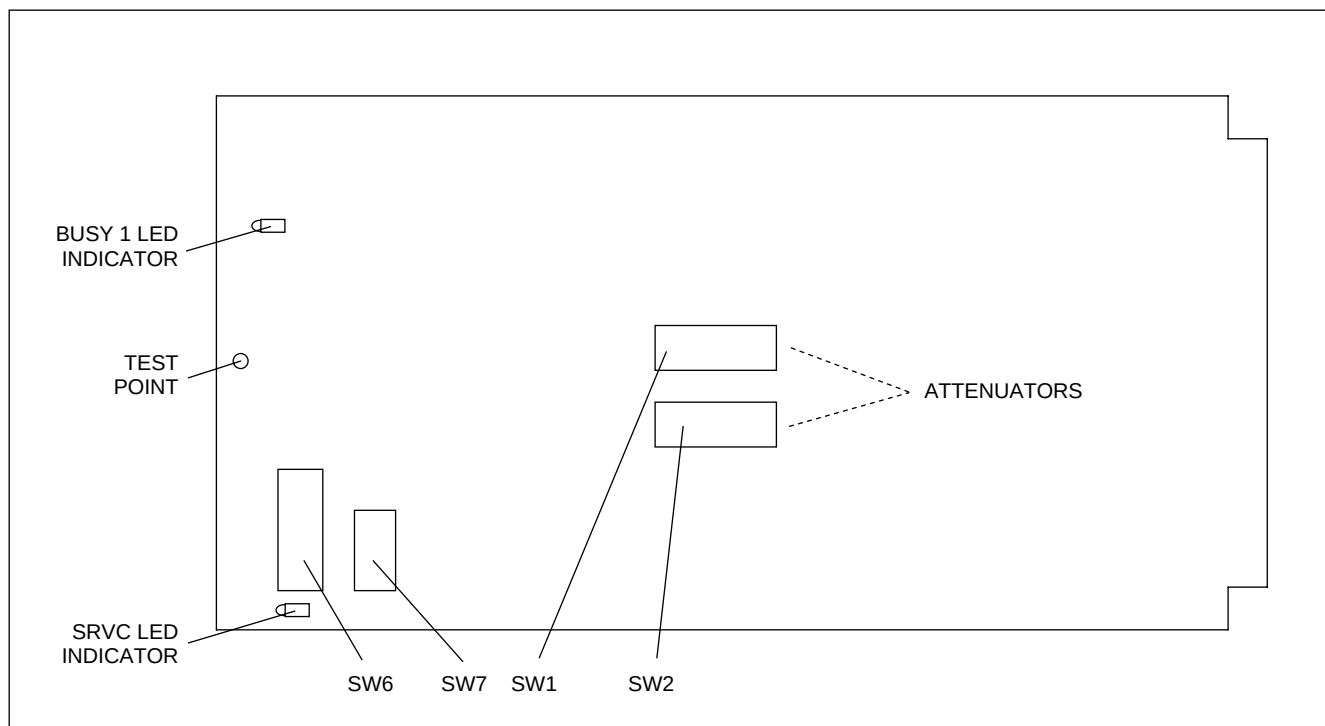


Figure 4. Controls and indicators, RFL VF-11B module

Table 2. Summary of switch settings, RFL VF-10B and RFL VF-11B modules

Switch#	Label	Setting	Description
SW1-1 to 8	CH-1 TRANSMIT	See Tables 4 thru 6	Transmit attenuator. (Not labeled on RFL VF-10B).
SW2-1 to 8	CH-1 RECEIVE	See Tables 4 thru 6	Receive attenuator. (Not labeled on RFL VF-10B).
SW6-1 to 5	TIME SLOT SELECT	See Table 7	Select the time slot for this module.
SW6-6	LOOP START 1	UP	Not used.
		DOWN	Set for loop start
SW6-7	TERM	UP	This setting may be used only in a drop/insert multiplexer. If the module is being installed in a terminal multiplexer, this switch should always be DOWN. If the module is being installed in a drop/insert multiplexer, set this switch DOWN to transmit in the A direction and receive from the B direction. Set it UP to transmit in the B direction and receive from the A direction. Refer to the IMUX 2000 Instruction Manual for guidelines on setting channel module transmit and receive directions.
		DOWN	Sets transmit direction for a terminal multiplexer.
SW6-8	AUX (RFL VF-10B) or ARD1 (RFL VF-11B)	UP	On RFL VF-10B: Normal.
			On RFL VF-11B: Set for normal operation.
		DOWN	On RFL VF-10B: Not used.
			On RFL VF-11B: Set for ARD operation.
SW6-9	REMOTE	UP	Set module for local configuration.
		DOWN	Set module for remote configuration.
SW6-10	OFF	UP	Set service on (module is active).
		DOWN	Set service off (module is inactive).
SW7-1 to 6	...	See Table 1.	Set the module address in the shelf (for remote access use).

Table 3. LED indicators, RFL VF-10B and RFL VF-11B modules

LED Identifier	Color	Description
BUSY 1	Green	On if voice circuit is busy.
SRVC	Green	On if service is turned on for the module.

Table 4. Attenuator switch values (SW1 and SW2), RFL VF-10B and RFL VF-11B modules

Position	Attenuation
1	0.1 dB
2	0.2 dB
3	0.4 dB
4	0.8 dB
5	1.5 dB
6	3.0 dB
7	6.0 dB
8	12.0 dB

12. After completing the above procedures, set up the module for local or remote operation as follows:
 - (1) For **local** control operation:
 - (a) Set to local control (SW6-9 UP)
 - (b) Turn service ON (SW6-10 UP)
 - (2) For **remote** control operation:
 - (a) Set to local control (SW6-9 UP)
 - (b) Turn service OFF (SW6-10 DOWN)
13. Slide the RFL VF-10B or RFL VF-11B module into the selected module slot until it is firmly seated and the module front panel is flush with the top and bottom of the shelf.
14. If the module will be placed under remote control, do the following:
 - a. Wait 15 seconds for the module's parameter settings to be loaded into the shelf Common Module.
 - b. Pull the module out of the shelf, place SW6-9 in the ON position, and re-insert the module into the shelf.
 - c. Verify the configuration by issuing a "CONFIG?" command.
 - d. Set service ON by issuing a "SRVC = ON" command.

**Table 5. Attenuator calibration settings,
RFL VF-10B Foreign Exchange Voice Module
(Office End)**

TX Level In	Transmit Attenuator Setting	RX Level Out	Receive Attenuator Setting
+15 dBm	24 dB	...	24 dB
+14 dBm	23 dB	...	23 dB
+13 dBm	22 dB	...	22 dB
+12 dBm	21 dB	...	21 dB
+11 dBm	20 dB	...	20 dB
+10 dBm	19 dB	...	19 dB
+9 dBm	18 dB	-9 dBm	18 dB
+8 dBm	17 dB	-8 dBm	17 dB
+7 dBm	16 dB	-7 dBm	16 dB
+6 dBm	15 dB	-6 dBm	15 dB
+5 dBm	14 dB	-5 dBm	14 dB
+4 dBm	13 dB	-4 dBm	13 dB
+3 dBm	12 dB	-3 dBm	12 dB
+2 dBm	11 dB	-2 dBm	11 dB
+1 dBm	10 dB	-1 dBm	10 dB
0 dBm	9 dB*	0 dBm	9 dB*
-1 dBm	8 dB	+1 dBm	8 dB
-2 dBm	7 dB	+2 dBm	7 dB
-3 dBm	6 dB	+3 dBm	6 dB
-4 dBm	5 dB	+4 dBm	5 dB
-5 dBm	4 dB	+5 dBm	4 dB
-6 dBm	3 dB	+6 dBm	3 dB
-7 dBm	2 dB	+7 dBm	2 dB
-8 dBm	1 dB	+8 dBm	1 dB
-9 dBm	0 dB	+9 dBm	0 dB

* = Factory setting.

**Table 6. Attenuator calibration settings,
RFL VF-11B Foreign Exchange Voice Module
(Station End)**

TX Level In	Transmit Attenuator Setting	RX Level Out	Receive Attenuator Setting
+12 dBm	24 dB	...	24 dB
+11 dBm	23 dB	...	23 dB
+10 dBm	22 dB	...	22 dB
+9 dBm	21 dB	...	21 dB
+8 dBm	20 dB	...	20 dB
+7 dBm	19 dB	-9 dBm	19 dB
+6 dBm	18 dB	-8 dBm	18 dB
+5 dBm	17 dB	-7 dBm	17 dB
+4 dBm	16 dB	-6 dBm	16 dB
+3 dBm	15 dB	-5 dBm	15 dB
+2 dBm	14 dB	-4 dBm	14 dB
+1 dBm	13 dB	-3 dBm	13 dB
0 dBm	12 dB*	-2 dBm	12 dB
-1 dBm	11 dB	-1 dBm	11 dB
-2 dBm	10 dB	0 dBm	10 dB*
-3 dBm	9 dB	+1 dBm	9 dB
-4 dBm	8 dB	+2 dBm	8 dB
-5 dBm	7 dB	+3 dBm	7 dB
-6 dBm	6 dB	+4 dBm	6 dB
-7 dBm	5 dB	+5 dBm	5 dB
-8 dBm	4 dB	+6 dBm	4 dB
-9 dBm	3 dB	+7 dBm	3 dB
-10 dBm	2 dB	+8 dBm	2 dB
-11 dBm	1 dB	+9 dBm	1 dB
-12 dBm	0 dB	+10 dBm	0 dB

* = Factory setting.

Table 7. Time slot selection, RFL VF-10B and RFL VF-11B Foreign Exchange Voice Modules

Time Slot	SW6-1	SW6-2	SW6-3	SW6-4	SW6-5
1	ON	ON	ON	ON	ON
2	ON	ON	ON	ON	OFF
3	ON	ON	ON	OFF	ON
4	ON	ON	ON	OFF	OFF
5	ON	ON	OFF	ON	ON
6	ON	ON	OFF	ON	OFF
7	ON	ON	OFF	OFF	ON
8	ON	ON	OFF	OFF	OFF
9	ON	OFF	ON	ON	ON
10	ON	OFF	ON	ON	OFF
11	ON	OFF	ON	OFF	ON
12	ON	OFF	ON	OFF	OFF
13	ON	OFF	OFF	ON	ON
14	ON	OFF	OFF	ON	OFF
15	ON	OFF	OFF	OFF	ON
16	ON	OFF	OFF	OFF	OFF
17	OFF	ON	ON	ON	ON
18	OFF	ON	ON	ON	OFF
19	OFF	ON	ON	OFF	ON
20	OFF	ON	ON	OFF	OFF
21	OFF	ON	OFF	ON	ON
22	OFF	ON	OFF	ON	OFF
23	OFF	ON	OFF	OFF	ON
24	OFF	ON	OFF	OFF	OFF

NOTE: ON = UP

OFF = DOWN

15. On the Module Record Card (located to the right of the shelf) record the channel bank type, time slot, and any other pertinent information.

If your multiplexer is set up for remote access and control, you can now change the operating parameters of the module by using simple commands. For more information on remote access and control, consult your multiplexer operation manual.

To verify the attenuator settings, apply a 1004-Hz test tone at 0 dBm to the voice input. Using a transmission measuring set (Hewlett-Packard Model 4937A or equivalent), attach a clip lead to the test point (TP1) and attach the other lead to ground. With the attenuators set to the factory settings, the reading should be 4.0 dB. If it is not, adjust the transmit attenuator accordingly (SW1).

For example, if the reading is 7.5 dB, increase the attenuation by 3.5 dB. If the reading is 2.2 dB, decrease the attenuation by 1.8 dB. This will ensure that the PCM codec operates effectively with 3.0 dB of headroom.

Once the transmit attenuator is calibrated to the desired value, do not change its setting. If the received signal at either end of the circuit requires further level adjustment, use only the receive attenuator (SW2).

FUNCTIONAL DESCRIPTION

Figure 5 shows a simplified block diagram of the RFL VF-10B and the RFL VF-11B. Both the modules use a Subscriber Line Interface Circuit (SLIC). The SLIC on the RFL VF-10B provides two-wire interfaces to PBX ports. The SLIC on the RFL VF-11B interfaces to telephone handsets.

At the RFL VF-10B (office end), the SLIC simulates a telephone line. It terminates the two-wire circuit and provides loop closure and ringing detectors. At the RFL VF-11B (station end), the SLIC simulates a Central Office, supplying loop current and ringing voltage to the external phone circuit.

In both cases, the voice signal from the SLIC passes through a user-adjustable attenuator, and then to a PCM codec for A/D conversion. The output from the codec is passed to a logic array. This array multiplexes the voice bits together with signaling bits provided by the SLIC (On-Hook, Off-Hook, Ringing, No Ringing). Once multiplexed, this combined information is placed into the user-selected time slot of the transmit bus on the multiplexer's backplane.

On the receive side, the logic array takes the incoming data from the selected time slot, demultiplexes it, and passes the voice bits to the PCM codec and the signaling bits to the SLIC.

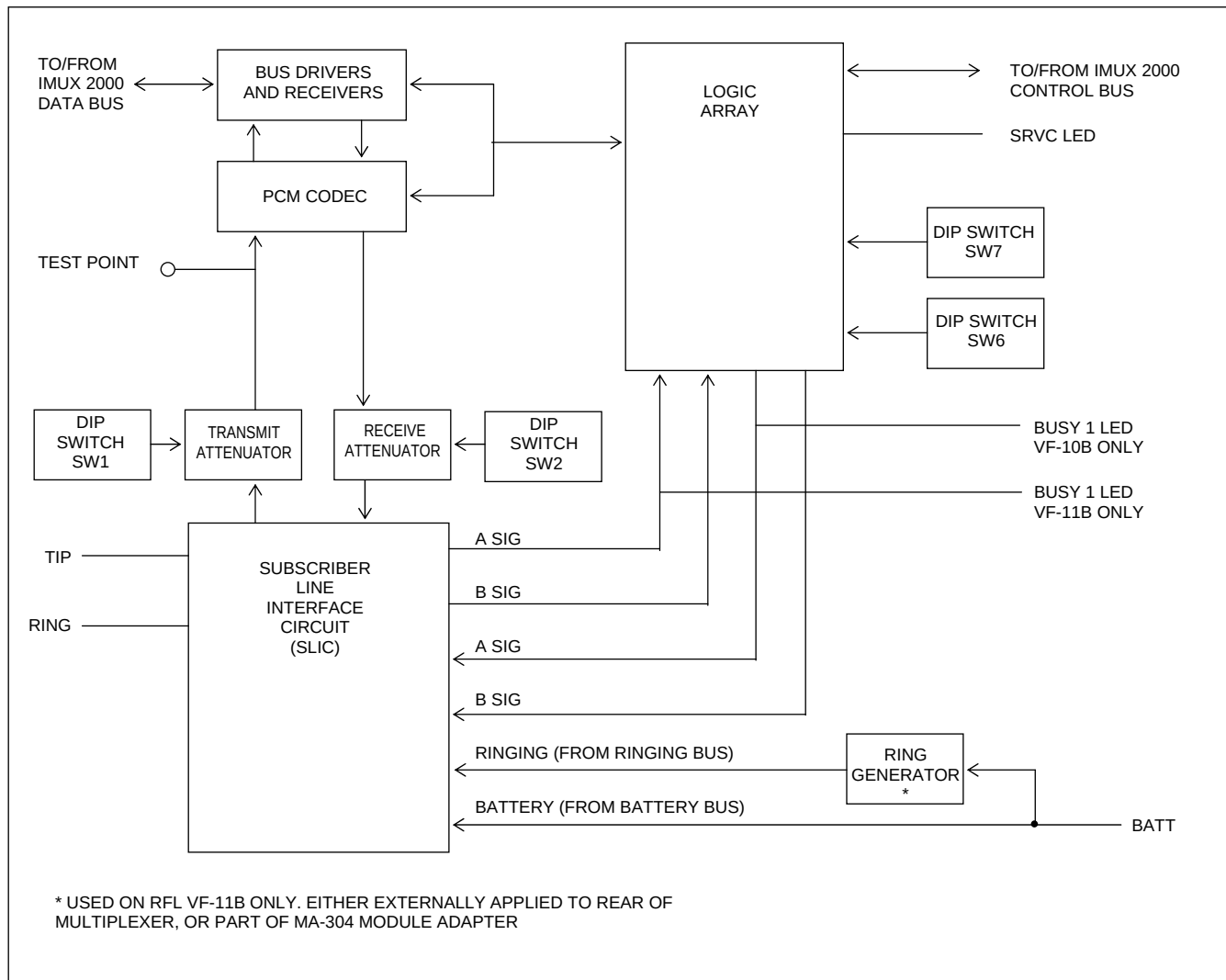


Figure 5. Functional block diagram, RFL VF-10B and RFL VF-11B modules

LOOP START CIRCUITS

Loop start circuits are normally used where the circuit operates a telephone controlled by a person. Examples of this include an Off-Premise Extension (OPX) circuit from a PBX, an Automatic Ring Down (ARD) circuit, and some Foreign Exchange (FX) circuits. Loop start is the most commonly used type of circuit.

Note: The VF-10B and VF-11B modules will not support ground start.

ALERTS/ALARMS

The RFL VF-10B and RFL VF-11B modules report no card-level ALERT or ALARM signals to the shelf Common Module.

REMOTE CONTROL INTERFACE

RFL VF-10B and RFL VF-11B modules installed in an RFL remote-controllable shelf can be operated under local or remote control. When under remote control, certain configuration parameters can only be changed through the RS-232 remote port on the multiplexer. The remote interface for these modules involves two codes: a “P” (parameter) code, and an “S” (status) code. See the IMUX 2000 instruction manual for more information on the remote control interface.

The RFL VF-10B reports itself as a “Type 75” module. The RFL VF-11B reports itself as a “Type 76” module.

“P” CODES

“P” codes, when used in the parameter field on a “SET” command, allow the user to set parameters on the module by remote control, just like setting the switches on a module under local control. “P” codes also appear in the response to a “CONFIG?” query, showing the current parameter settings on the module. There is one “P” code for the RFL VF-10B and RFL VF-11B modules: “P01”, as shown in Table 8. (In a “SET” command, this may be typed as either “P01” or “P1”.)

A typical RFL VF-10B or RFL VF-11B response to a “CONFIG?” query looks like this:

```
* OK
CHANNEL CARD 3, TYPE 75 (or 76)
UNDER REMOTE CONTROL
SVCE = ON
P01 = 3 (B00000011);
```

The “P” code is a decimal number from 0 to 255, also represented as an eight-digit binary number (in parenthesis). The binary representation is more useful for setting and interpreting the “P” code on these modules, since each binary digit (0 or 1) corresponds to the “on” or “off” setting for a particular switch on the module.

NOTE

When using binary numbers in the parameter field of a “SET” command, they must be preceded by the letter “B” as shown in the following example:

```
<multiplexer address>:<module address>:SET:P01 = B00000011;
```

Besides using the P code, it is also possible to turn module service on or off by sending one of the following in the parameter field with a SET command:

```
SRVC = ON
SRVC = OFF
```

Table 8. Remote configuration settings (“P” codes)

P Code	Digit(s) And Switch Equivalent	Value ⁽¹⁾	Description
P1	B00000000 ---↑↑↑↑↑ TIME SLOT SELECT	00001 to 11000	From left to right, these five bits represent the binary value of the desired time slot. See Table 9 for a complete list of these values.
	B00000000 --↑----- LOOP START 1	0	Not used.
		1	Set for loop start.
	B00000000 -↑----- TERM	0	This setting may be only be used when the module is installed in a drop/insert multiplexer. In terminal multiplexers, this digit must always be set to “1”. In drop/insert multiplexers, set this digit to “1” to transmit in the A direction and receive from the B direction. Set this digit to “0” to transmit in the B direction and receive from the A direction. (See the IMUX 2000 instruction manual for guidelines on setting channel module direction).
		1	Required setting when the module is installed in a terminal multiplexer.
	B00000000 ↑----- ARD1⁽²⁾	0	Set for normal operation.
		1	Set for ARD operation

1. These are the only legal values for setting the parameters. Setting any parameter to a value outside its specified range will produce an unpredictable result.
- 2 RFL VF-11B only.

Table 9. Time slot selection by remote access

Time Slot	P1-5*	P1-4*	P1-3*	P1-2*	P1-1*
1	0	0	0	0	1
2	0	0	0	1	0
3	0	0	0	1	1
4	0	0	1	0	0
5	0	0	1	0	1
6	0	0	1	1	0
7	0	0	1	1	1
8	0	1	0	0	0
9	0	1	0	0	1
10	0	1	0	1	0
11	0	1	0	1	1
12	0	1	1	0	0
13	0	1	1	0	1
14	0	1	1	1	0
15	0	1	1	1	1
16	1	0	0	0	0
17	1	0	0	0	1
18	1	0	0	1	0
19	1	0	0	1	1
20	1	0	1	0	0
21	1	0	1	0	1
22	1	0	1	1	0
23	1	0	1	0	1
24	1	1	0	0	0

* These positions represent the five least-significant digits of P1, as shown in Table 8.

“S” CODES

“S” codes appear in response to a “STATUS?” query. There is one “S” code for the RFL VF-10B and RFL VF-11B modules. Like the “P” code, this number is displayed in both decimal and binary form. Two of the digits of the binary number represent the conditions shown in Table 10. The other six digits are not used.

A typical response to a “STATUS?” query looks like this:

*** OK**
CHANNEL CARD 3, TYPE 75 (or 76)
S01 = 3 (B00000011);

Table 10. Remote status messages (“S” codes)

Position	Value	Description
B00000000	0	Voice circuit idle.
---↑	1	Voice circuit busy.
B00000000 --↑-	...	Not used.
B00000000	0	Voice circuit ringing.
-↑--	1	Voice circuit not ringing.
B00000000 ↑↑↑↑↑---	...	Not used.

TESTING

When the RFL VF-10B and RFL VF-11B modules have been configured and installed, they should be tested for proper operation before they are put into service.

EQUIPMENT REQUIRED

1. Telephone Set, Type 2500 or equivalent (one for each RFL VF-11B module).
2. PBX Station Line (RFL VF-10B only).
3. Ring Generator.
4. 48-Volt Battery.

FXO/FXS TEST PROCEDURE

1. Verify that a ring generator and –48-volt talk current battery are connected to the multiplexer containing the RFL VF-11B module, as described in the Installation section of the multiplexer manual.
2. Connect the PBX line to the RFL VF-10B module.
3. Connect the telephone line to the RFL VF-11B module.
4. Make sure that both modules are set to use the same time slot (SW6-1 through 5).
5. Set the mode to Loop Start (SW6-6 DOWN).
6. Set service on for both modules (SW6-10 UP).
7. Set both modules to local control (SW6-9 UP).
8. Take the phone connected to the RFL VF-11B off-hook and observe the presence of a dial tone from the PBX.
9. Dial an extension and verify that the extension rings.
10. Answer the extension and verify that the voice level is adequate in both directions, and that the noise level is acceptably low.

11. Place both phones back on hook. Using the extension, dial the number of the line connected to the RFL VF-11B under test. The phone connected to the RFL VF-11B should ring 2 seconds on, 4 seconds off.
12. Answer the ringing phone and verify that ringing stops and the voice quality is acceptable.
13. Change the settings on both modules, if necessary, to suit the desired circuit configuration. The circuit may now be placed in service.

ARD TEST PROCEDURE

1. Verify that a ring generator and –48-volt talk current battery are connected to the multiplexers at both ends of the circuit, as described in the multiplexer operation manual.
2. Connect telephones to the RFL VF-11B modules at both Location 1 and Location 2.
3. Make sure that both modules are set to use the same time slot (SW6, positions 1-5).
4. Set both modules to Loop Start (SW6-6 DOWN).
5. Set service on for both modules (SW6-10 UP).
6. Set both modules to local control (SW6-9 UP).
7. Set both modules to ARD operation (SW6-8 DOWN).
8. Take the phone at Location 1 off-hook and observe that the phone at Location 2 rings, 2 seconds on, 4 seconds off.
9. Observe that a ring back tone can be heard on the phone at Location 1.
10. Answer the phone at Location 2. Observe that it stops ringing.
11. Verify that the voice level is adequate in both directions, and that the noise level is acceptably low.
12. Hang up the phones and repeat Steps 8 through 11 in the other direction, from Location 2 to Location 1.
13. Change the settings on both modules, if necessary, to suit the desired circuit configuration. The circuit may now be placed in service.

TROUBLESHOOTING

If there is an apparent malfunction, first check that the configuration is appropriate for the transmission system in use, and that the transmit and receive configurations are identical.

Problems may occur at the common equipment or facility level that may affect the operation of this module. Refer to the “Maintenance” section in your multiplexer manual for system analysis procedures.

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RFL Electronics Inc.

INSTRUCTION DATA

Dual-Channel Foreign Exchange Voice Modules For RFL IMUX 2000 Intelligent T1 Multiplexers

**RFL VF-15 (Office End)
RFL VF-16 (Station End)**

DESCRIPTION

The RFL VF15 is a Two-Wire Foreign Exchange Office End (FXO) module, and the RFL VF-16 is a Two-Wire Foreign Exchange Station End (FXS) module. They are designed for use in RFL IMUX 2000 terminal and drop/insert multiplexers, and other RFL network interface products. Each accepts one or two independent voice channels as input, using PCM coding to convert each channel into a 64-Kbps digital signal. The digital signal is then transmitted over T1 and other digital communication facilities.

A circuit with an RFL VF-15 module at one end and an RFL VF-16 module at the other end can provide a Foreign Exchange (FX) line or an Off-Premise Extension (OPX) line. An Automatic Ring Down (ARD) line can be set up by using RFL VF-16 modules at both ends of the circuit.

These modules are remote-controllable when installed in an RFL IMUX 2000 remote-controllable shelf. User-adjustable switches and jumpers allow the configuration of the following parameters:

- o One-channel or two-channel operation.
- o Loop start.
- o Automatic Ring Down (ARD) usage (RFL VF-16 only).
- o Service enable/disable.
- o Remote control configuration and status reporting.
- o Selectable transmit/receive direction.
- o Extended range input/output attenuation.
- o Selectable time slot assignment.

SPECIFICATIONS

As of the date this Instruction Data Sheet was published, the following specifications apply to the RFL VF-15 Dual-Channel Foreign Exchange Office End Voice Module and the RFL VF-16 Dual-Channel Foreign Exchange Station End Voice Module. Because all of RFL products undergo constant refinement and improvement, these specifications are subject to change without notice.

Configuration: Two independent voice channels per module.

Time Slots:

One-Channel Operation: Requires one user-selectable 64-Kbps time slot.

Two-Channel Operation: Requires any two adjacent 64-Kbps time slots.

Signal Levels:

Input: -9.0 to +9.0 dBm

Output: -9.0 to +9.0 dBm

Frequency Response:

200 to 300 Hz: +0.0 to -3.0 dB

300 to 3000 Hz: +0.5 to -1.0 dB

3000 to 3300 Hz: +0.0 to -1.5 dB

Idle Channel Noise: Less than 23 dBnco

Impulse Noise Threshold Level (Maximum Counts Per 30-minute Interval):

41 dBnco: 10.0 counts

51 dBnco: 1.0 count

58 dBnco: 0.1 counts

Signal-To-Distortion (1004 Hz to 1020 Hz input):

0 to -30 dBm0: Greater than 33 dB

-40 dBm0: Greater than 27 dB

-45 dBm0: Greater than 22 dB

Impedance: 600 Ω standard; for conversion to 900 ohms, contact the factory.

Crosstalk Coupling:

400 Hz: 49 dB

700 - 1100 Hz: 59 dB

1100 - 3000 Hz: 58 dB

3700 Hz: 49 dB

Tracking (gain deviation for a 1004-Hz input):

+3 to -37 dBm0: 0.5 dB maximum

-37 to -50 dBm0: 1.0 dB maximum

Peak-To-Average Ratio (PAR): Greater Than 94

Power Dissipation:

Off-Hook: 1.2 watts from shelf power supply, plus one watt from -48 VDC talk current supply.

On-Hook: 1.2 watts from shelf power supply.

Signaling:

RFL VF-15:

Loop-Start Resistance:

Off-Hook: 1800 ohms or less.

On-Hook: 10K ohms or more.

Answering Resistance:

Off-Hook: 1800 ohms.

On-Hook: 10K ohms.

RFL VF-16:

Loop-Start:

Off-Hook: 2000 ohms or less.

On-Hook: 10K ohms or more.

Ring Voltage: 50 to 120 Vrms, 20 to 30 Hz.

Automatic Ring Down (ARD): Requires RFL VF-16 FXS modules on each end of circuit. Ring 2 seconds on, 4 seconds off. Ringback tone 300 Hz.

Interface: MA-301, MA-303, MA-303B, MA-304 or MA-304B module adapters. (See page 5 for more information.)

Testing: Input level test points for each channel.

Operating Temperature: -20°C to +55°C (-4°F to +131°F).

Relative Humidity: Zero to 90 percent, non-condensing.

INSTALLATION

Before the RFL VF-15 or RFL VF-16 can be placed in service, they must be installed in a multiplexer shelf. Installation involves determining the module slot in the Main Shelf or Expansion Shelf where the module will be installed, inserting a Module Adapter into the rear of the shelf behind the module slot, connecting all signal and power wiring to the Module Adapter, checking the settings of all switches, and inserting the module into the front of the shelf.

NOTES

1. Power supply and time slot considerations may affect the installation of this module into an existing multiplexer shelf. Refer to the multiplexer manual for more information.
2. Before installing an RFL VF-16 module, make sure that the shelf is equipped with a ring generator and a source of -48-volt talk current. Refer to the multiplexer manual for more information on connecting ring generator and talk current.

The following instructions are provided for installing RFL VF-15 and RFL VF-16 modules into existing systems. If the module was included as part of a system, installation was done at the factory. Otherwise, proceed as follows:

1. Carefully inspect the module for any visible signs of shipping damage. If you suspect damage to the module, immediately call RFL Customer Service at the number listed at the bottom of this page.
2. Determine the module slot in the Main Shelf or Expansion Shelf where the module will be installed.

RFL VF-15 and RFL VF-16 modules occupy one module slot in the Main Shelf or Expansion Shelf.

3. Determine which Module Adapter will be used to make connections to the RFL VF-15 or RFL VF-16 module.

Each module in the IMUX 2000 multiplexer requires a Module Adapter. The module adapter provides the appropriate connector for the desired interface.

There are five Module Adapters that are compatible with the RFL VF-15 and RFL VF-16:

<u>Model Number</u>	<u>Voice Connections</u>	<u>Application</u>	<u>Figure</u>
MA-301	50-pin Telco Connector	Used with multiple VF-15 or VF-16 modules	1
MA-303	RJ-11 Jack	Used with all VF-15s and all VF-16s using external ring generators.	3
MA-303B	Removable terminal block	Used with all VF-15s and all VF-16s using external ring generators.	4
MA-304	RJ-11 Jack	Used with all VF-16s <u>not</u> using external ring generators	3
MA-304B	Removable terminal block	Used with all VF-16s <u>not</u> using external ring generators	4

The MA-301 accepts a 50-pin Telco connector (Amphenol 57-30500 or equivalent, as shown in Figure 1.) One MA-301 Module Adapter can be used to connect up to three RFL VF-15 or RFL VF-16 modules, for a total of up to six voice channels. If you will be using more than one module with the MA-301, they must be inserted into adjacent slots in the multiplexer. Ribbon cables are provided with the MA-301 to make connections to it from the second and third module locations. (See Figure 2.)

The MA-303 Module Adapter is designed for use with all RFL VF-15 office-end modules, and all RFL VF-16 modules using external ring generators. Each MA-303 provides two RJ-11 jacks for connection to the voice circuits for channel 1 and channel 2, and two bantam jacks (Line and Drop) for each channel. (See Figure 3.) Each Line jack provides access to the equipment from the line side, and each Drop jack provides access to the line from the equipment side.

The MA-304 is similar to the MA-303, but it includes a ring generator. It is used with all RFL VF-16 modules in multiplexer shelves not connected to external ring generators.

The MA-303B is similar to the MA-303, except it has removable terminal blocks in place of the RJ-11 connectors for the voice connection.

The MA-304B is similar to the MA-304, except it has removable terminal blocks in place of the RJ-11 connectors for the voice connection.

Make sure the module adapter you are installing is correct for the desired application.

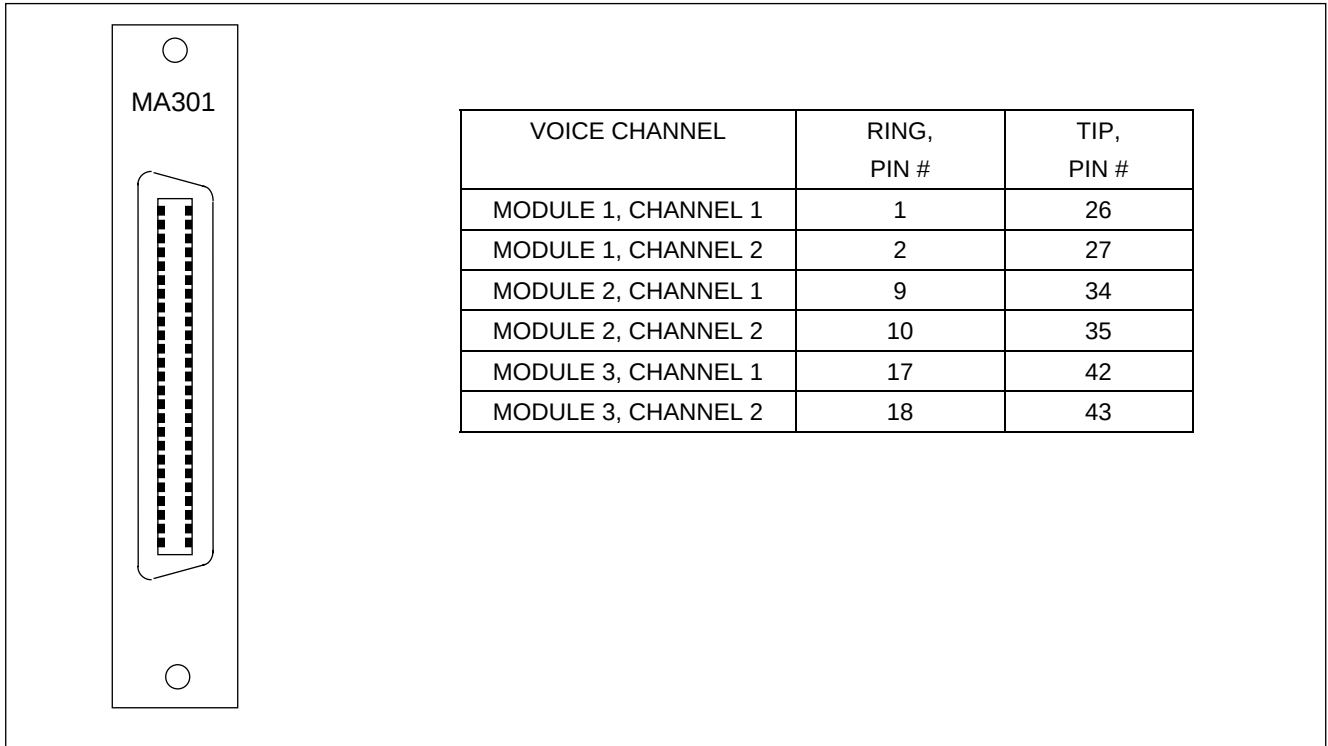


Figure 1. MA-301 Module Adapter

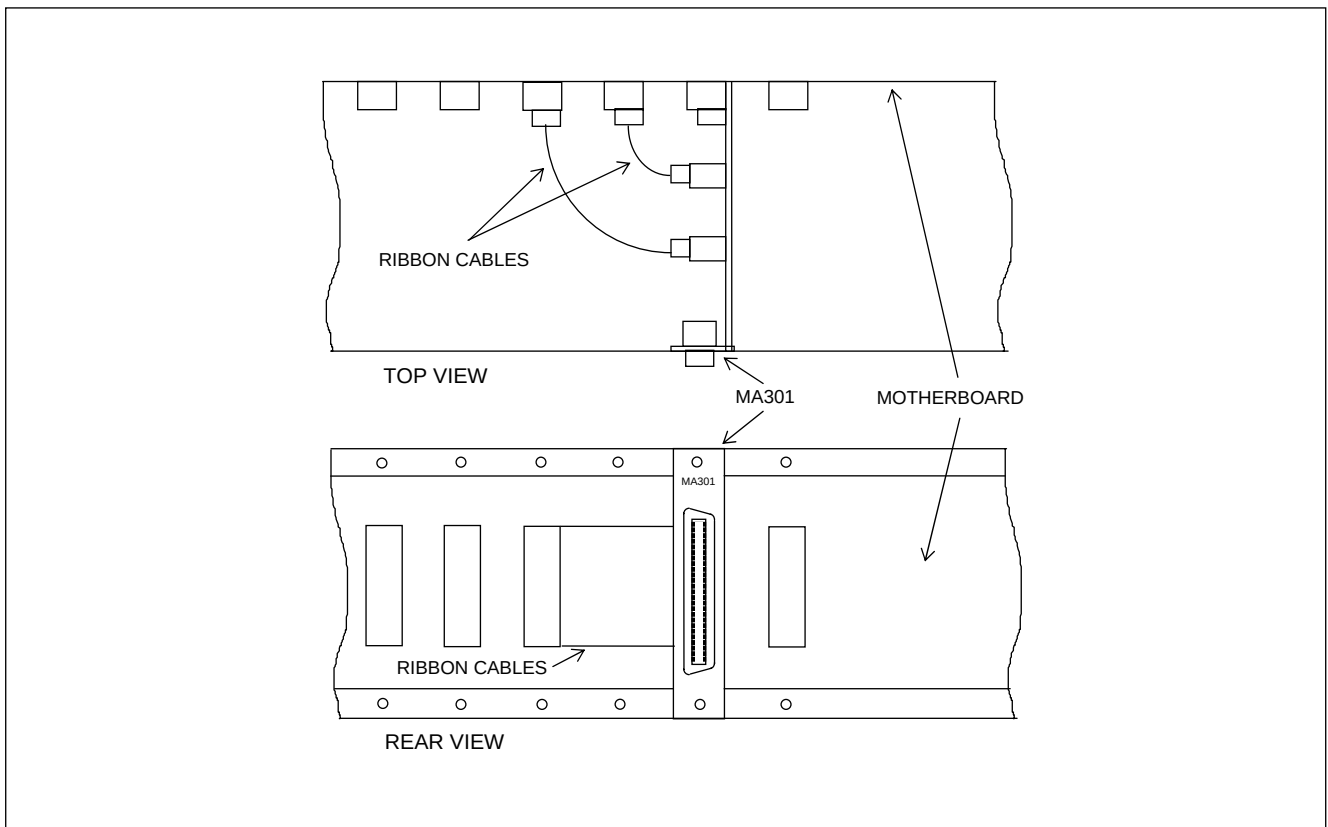


Figure 2. Using an MA-301 Module Adapter with multiple RFL VF-15 or RFL VF-16 modules

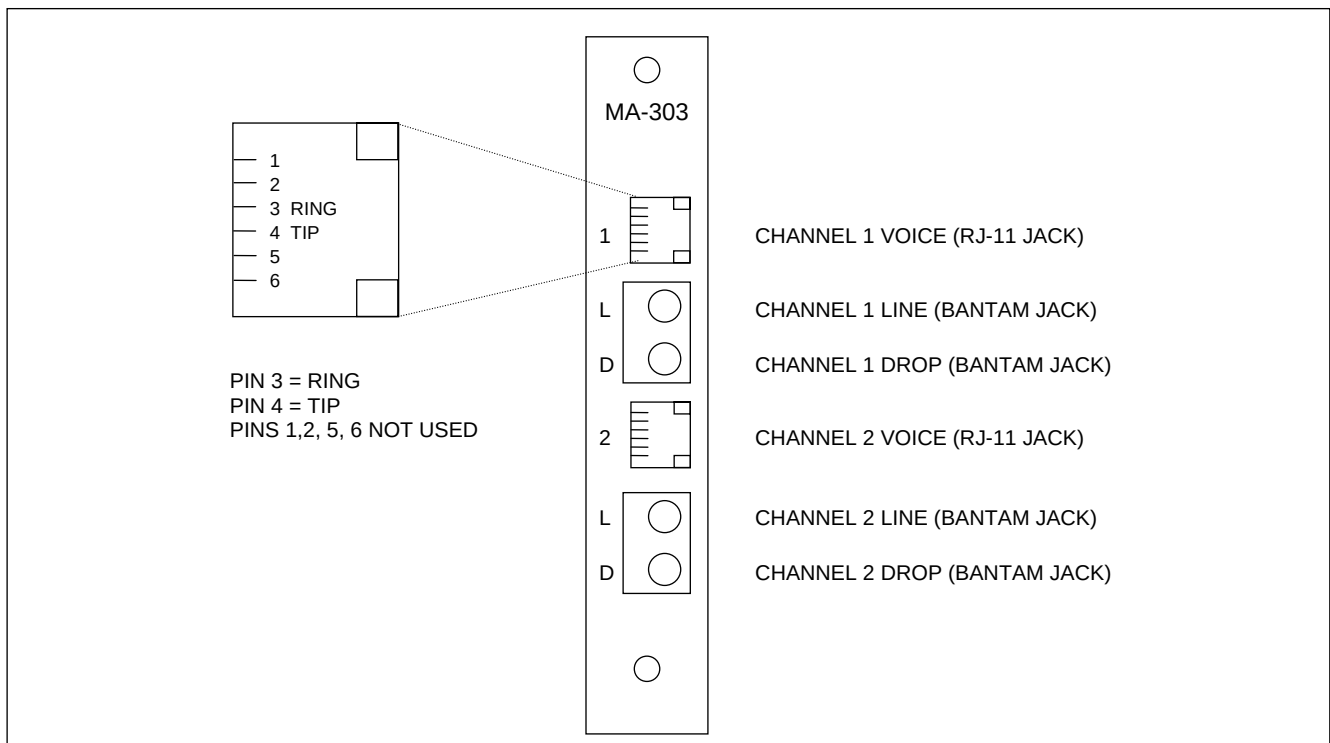


Figure 3. MA-303 Module Adapter, used with all RFL VF-15 office-end modules and all VF-16 station end modules using external ring generators. The MA-304 Module Adapter used with RFL VF-16 modules not using external ring generators is similar in appearance.

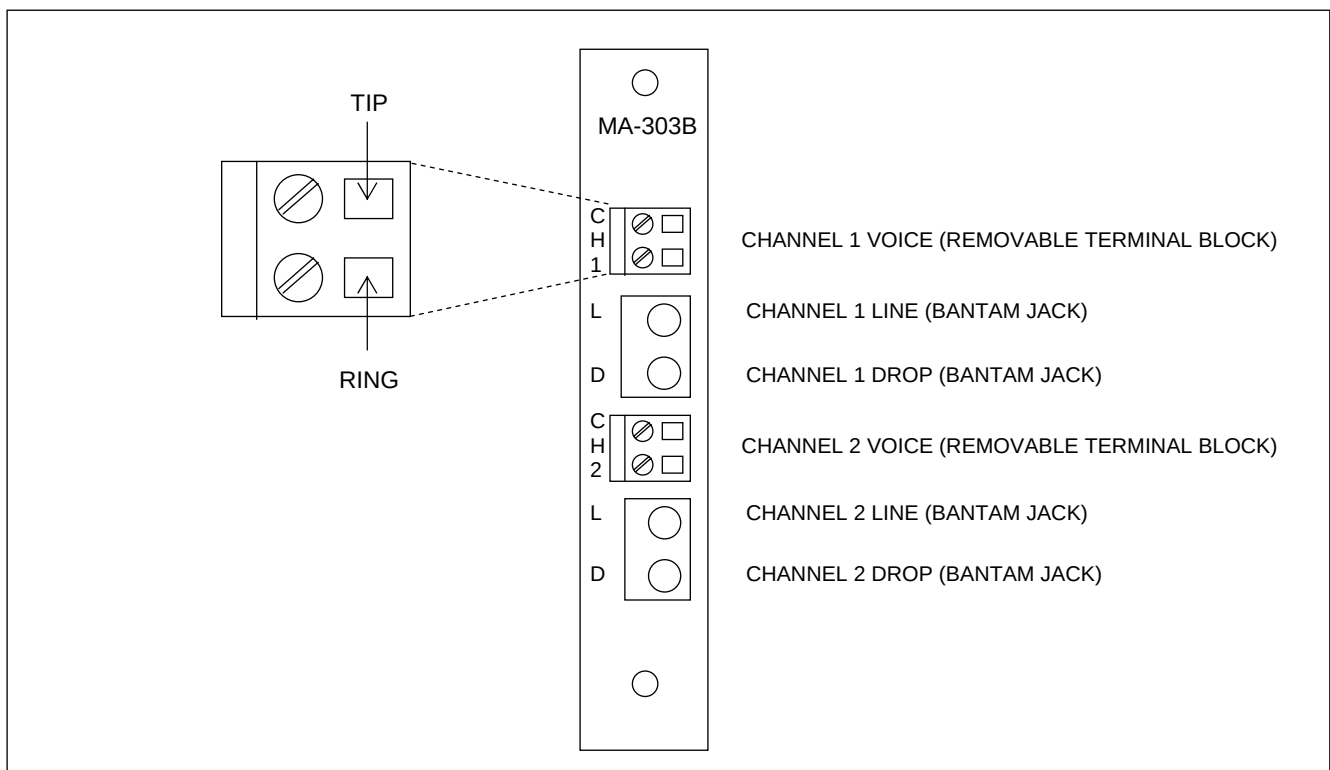


Figure 4. MA-303B Module Adapter, used with all RFL VF-15 office-end modules and all VF-16 station end modules using external ring generators. The MA-304B Module Adapter used with RFL VF-16 modules not using external ring generators is similar in appearance.

4. Insert the Module Adapter into the rear of the shelf directly behind the module slot where the RFL VF-15 or RFL VF-16 module will be installed, and make all connections to the Module Adapter.

If an MA-301 Module Adapter is being used, plug the 50-pin Telco cable end connector into its mating 50-pin connector on the module adapter.

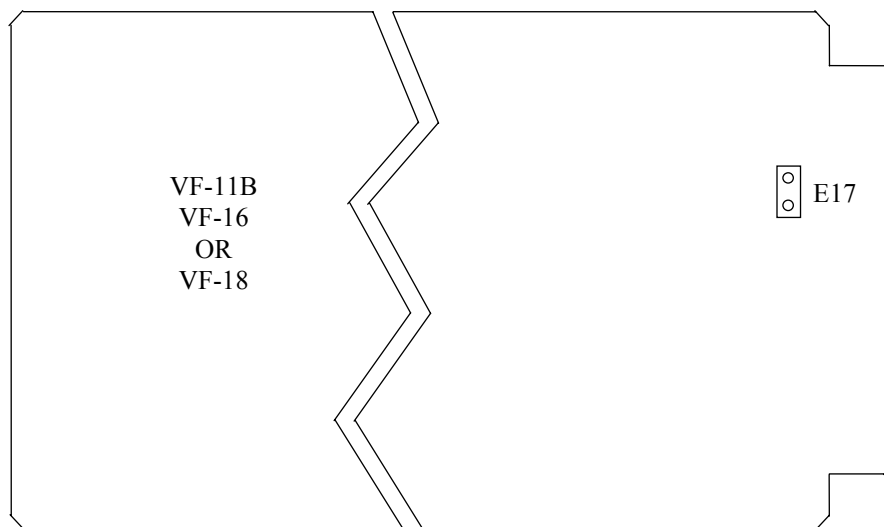
If an MA-303, MA-303B, MA-304 or MA-304B Module Adapter is being used, plug the RJ-11 connectors for the Channel 1 and Channel 2 voice circuits into the corresponding RJ-11 jacks. The only electrical interface connections that have to be made to the RFL VF-15 and RFL VF-16 are RING and TIP connections, which are made to terminals 3 and 4 on the RJ-11 connector, or to the screw terminals on the terminal block, (TIP is the top terminal, and RING is the bottom terminal) as shown in Figures 3 and 4 as applicable.

WARNING

To prevent ring generator contention use either the MA-304 or MA-304B on board ring generator or an external ring generator, but not both at the same time. This applies only to voice frequency modules at the station end, to which the telephone is connected. The effected modules are the VF-11B, VF-16 and VF-18 voice frequency foreign exchange modules.

The VF-11B, VF-16 and VF-18 each has an E17 jumper pad near the connector end of the module as shown below. When this jumper pad has a wire jumper installed, it enables an external ring generator (external to the IMUX 2000 or the RFL 9001) and should never be installed when an MA-304 or MA-304B is used. Refer to paragraph 9.2.3 of the IMUX Installation Manual for information on external ring generator connections.

Improper application of the E17 jumper will cause erratic T1 transmissions.



5. Set the address for the module using DIP switch SW7. (See Figures 5 and 6 for location.)
For remote access, each channel module in the shelf must have a distinct module address. Valid module addresses are the numbers 1 to 36, as shown in Table 2 of this Instruction Data Sheet. In a full-size shelf, this is usually set to the number of the physical slot the module will occupy. (Consult your multiplexer manual for details on using remote access and configuration features of the system.)
6. Select one-channel or two-channel operation using SW5-4. (See Figures 5 and 6 for location.)
Place SW5-4 in the ON position for two-channel operation, or in the OFF position for one-channel operation (Channel 2 turned off). Unless otherwise specified at time of order, SW5-4 is set in the ON position at the factory for two-channel operation.
7. Set transmit/receive attenuator switches SW1 through SW4, if settings other than factory standard are desired. (See Figures 5 and 6 for location.)
The transmit and receive attenuators can be set to any desired value up to 24 dB, in 0.1 dB increments. The values for these switch positions are as follows:

<u>Channel 1</u> <u>Transmit</u> <u>Attenuator</u>	<u>Channel 1</u> <u>Receive</u> <u>Attenuator</u>	<u>Channel 2</u> <u>Transmit</u> <u>Attenuator</u>	<u>Channel 2</u> <u>Receive</u> <u>Attenuator</u>	<u>Value</u>
S1-1	S2-1	S3-1	S4-1	0.1 dB
S1-2	S2-2	S3-2	S4-2	0.2 dB
S1-3	S2-3	S3-3	S4-3	0.4 dB
S1-4	S2-4	S3-4	S4-4	0.8 dB
S1-5	S2-5	S3-5	S4-5	1.5 dB
S1-6	S2-6	S3-6	S4-6	3.0 dB
S1-7	S2-7	S3-7	S4-7	6.0 dB
S1-8	S2-8	S3-8	S4-8	12.0 dB

Switch settings are cumulative. For example, to set attenuation to 19.0 dB, turn on switch positions 2, 4, 7 and 8; to set attenuation to 7.6 dB, turn on switch positions 1, 5 and 7.

The attenuators are set at the factory to provide levels of 0 dBm in, 0 dBm out. See Tables 3 and 4 on page 12 for attenuator calibration settings for various input and output levels.

8. Select any unused time slot using SW6-1 through SW6-5. (See Figures 5 and 6 for location.)
The digitized voice signal of the RFL VF-15 or RFL VF-16 module occupies one 64-Kbps digital time slot within the multiplexer's aggregate rate. Use the settings shown in Table 5 to select which time slot the module uses. Consult your multiplexer manual for guidelines on time slot selection.

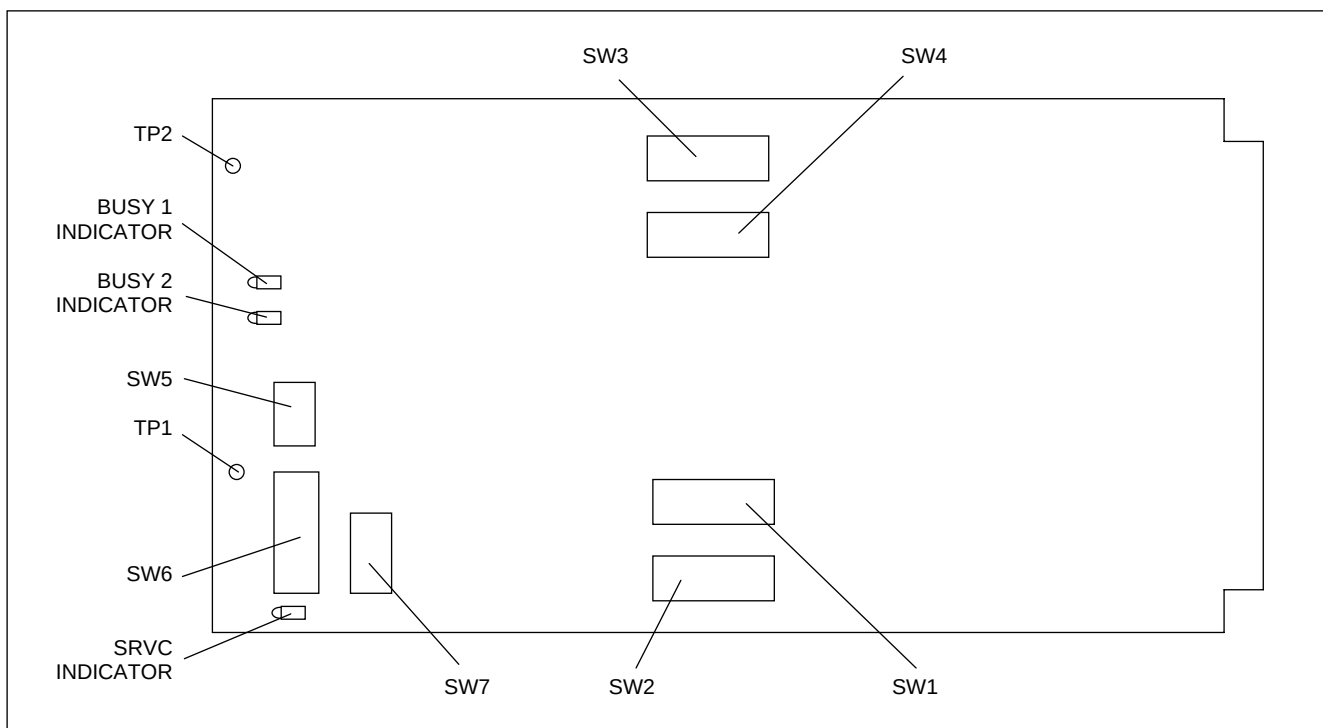


Figure 5. Controls and indicators, RFL VF-15

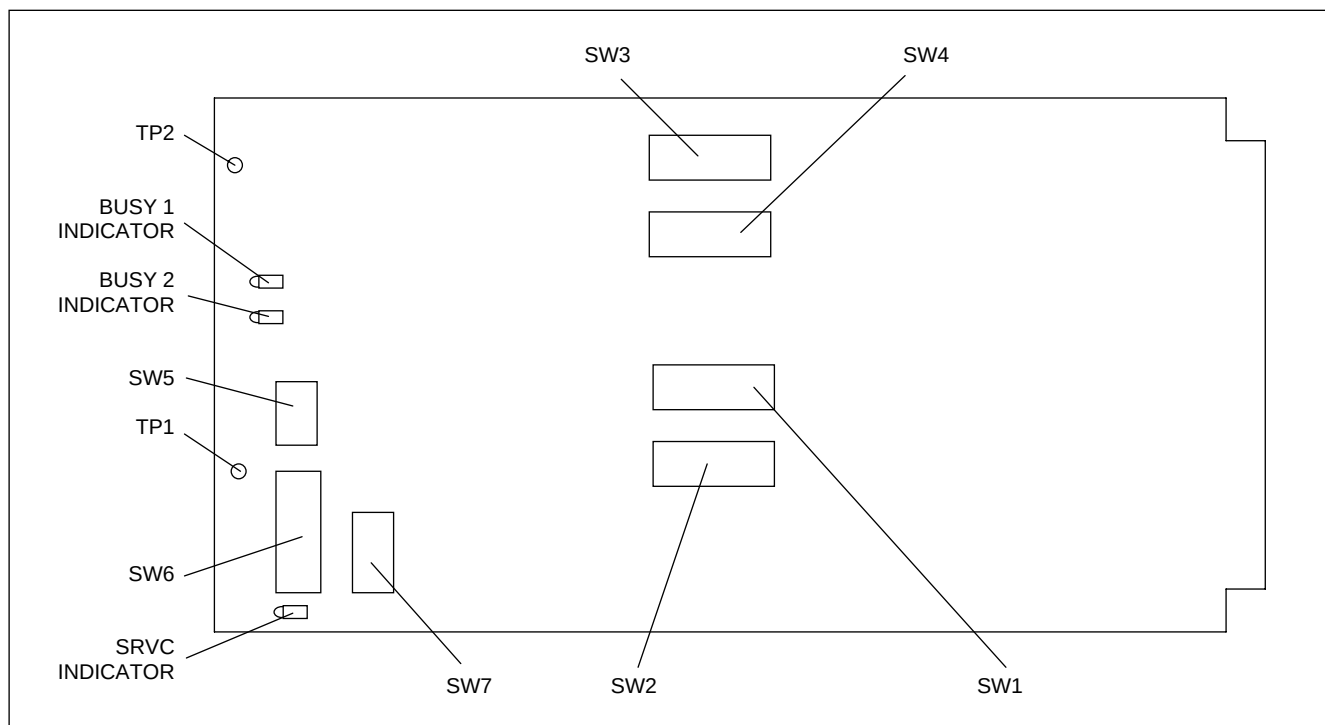


Figure 6. Controls and indicators, RFL VF-16

Table 1. Summary of switch settings and LED indicators, RFL VF-15 and RFL VF-16 modules

Switch#	Label	Setting	Description
...	BUSY 1 indicator	...	Lights if Channel 1 voice circuit is busy.
...	BUSY 2 indicator	...	Lights if Channel 2 voice circuit is busy.
...	SRVC indicator	...	Lights if module service is turned on.
SW1-1 to 8	CH-1 TRANSMIT	See Tables 3 and 4	Channel 1 Transmit attenuator. (Not labeled on RFL VF-15).
SW2-1 to 8	CH-1 RECEIVE	See Tables 3 and 4	Channel 1 Receive attenuator. (Not labeled on RFL VF-15).
SW3-1 to 8	CH-2 TRANSMIT	See Tables 3 and 4	Channel 2 Transmit attenuator. (Not labeled on RFL VF-15).
SW4-1 to 8	CH-2 RECEIVE	See Tables 3 and 4	Channel 2 Receive attenuator. (Not labeled on RFL VF-15).
SW5-1	LOOP START 2	UP	Not used.
		DOWN	Set Channel 2 for loop start
SW5-2	ARD2 (RFL VF-16 only)	UP	On RFL VF-15: MUST BE SET IN THIS POSITION.
			On RFL VF-16: Set Channel 2 for normal operation.
		DOWN	On RFL VF-15: THIS POSITION MUST NOT BE USED.
			On RFL VF-16: Set Channel 2 for ARD operation.
SW5-3	...	...	Not used.
SW5-4	CH2 OFF	UP	Channel 2 on; both channels active.
		DOWN	Channel 2 off; single-channel operation.
SW6-1 to 5	TIME SLOT SELECT	See Table 5	Select the time slot for this module.
SW6-6	LOOP START 1	UP	Not used.
		DOWN	Set Channel 1 for loop start.
SW6-7	TERM	UP	This setting may be used only in a drop/insert multiplexer. *
		DOWN	Sets transmit direction in a terminal multiplexer.
SW6-8	AUX (RFL VF-15) or ARD1 (RFL VF-16)	UP	On RFL VF-15: MUST BE SET IN THIS POSITION.
			On RFL VF-16: Set Channel 1 for normal operation.
		DOWN	On RFL VF-15: THIS POSITION MUST NOT BE USED.
			On RFL VF-16: Set Channel 1 for ARD operation.
SW6-9	REMOTE	UP	Set module for local configuration.
		DOWN	Set module for remote configuration.
SW6-10	OFF	UP	Set service on (module is active).
		DOWN	Set service off (module is inactive).
SW7-1 to 6	...	See Table 2.	Set the module address in the shelf (for remote access use).

* If the module is being installed in a terminal multiplexer, this switch should always be DOWN. If the module is being installed in a drop/insert multiplexer, set this switch DOWN to transmit in the A direction and receive from the B direction. Set it UP to transmit in the B direction and receive from the A direction. Refer to the IMUX 2000 instruction manual for guidelines on setting channel module transmit and receive directions.

Table 2. Module address settings, RFL VF-15 and RFL VF-16 modules

Module Address	SW7-1	SW7-2	SW7-3	SW7-4	SW7-5	SW7-6
1	OFF	OFF	OFF	OFF	OFF	ON
2	OFF	OFF	OFF	OFF	ON	OFF
3	OFF	OFF	OFF	OFF	ON	ON
4	OFF	OFF	OFF	ON	OFF	OFF
5	OFF	OFF	OFF	ON	OFF	ON
6	OFF	OFF	OFF	ON	ON	OFF
7	OFF	OFF	OFF	ON	ON	ON
8	OFF	OFF	ON	OFF	OFF	OFF
9	OFF	OFF	ON	OFF	OFF	ON
10	OFF	OFF	ON	OFF	ON	OFF
11	OFF	OFF	ON	OFF	ON	ON
12	OFF	OFF	ON	ON	OFF	OFF
13	OFF	OFF	ON	ON	OFF	ON
14	OFF	OFF	ON	ON	ON	OFF
15	OFF	ON	ON	ON	ON	ON
16	OFF	ON	OFF	OFF	OFF	OFF
17	OFF	ON	OFF	OFF	OFF	ON
18	OFF	ON	OFF	OFF	ON	OFF
19	OFF	ON	OFF	OFF	ON	ON
20	OFF	ON	OFF	ON	OFF	OFF
21	OFF	ON	OFF	ON	OFF	ON
22	OFF	ON	OFF	ON	ON	OFF
23	OFF	ON	OFF	ON	ON	ON
24	OFF	ON	ON	OFF	OFF	OFF
25	OFF	ON	ON	OFF	OFF	ON
26	OFF	ON	ON	OFF	ON	OFF
27	OFF	ON	ON	OFF	ON	ON
28	OFF	ON	ON	ON	OFF	OFF
29	OFF	ON	ON	ON	OFF	ON
30	OFF	ON	ON	ON	ON	OFF
31	OFF	ON	ON	ON	ON	ON
32	ON	OFF	OFF	OFF	OFF	OFF
33	ON	OFF	OFF	OFF	OFF	ON
34	ON	OFF	OFF	OFF	ON	OFF
35	ON	OFF	OFF	OFF	ON	ON
36	ON	OFF	OFF	ON	OFF	OFF

**Table 3. Attenuator calibration settings,
RFL VF-15 modules**

TX Level Input	Transmit Attenuator Setting	RX Level Output	Receive Attenuator Setting
+15 dBm	24 dB	...	24 dB
+14 dBm	23 dB	...	23 dB
+13 dBm	22 dB	...	22 dB
+12 dBm	21 dB	...	21 dB
+11 dBm	20 dB	...	20 dB
+10 dBm	19 dB	...	19 dB
+9 dBm	18 dB	-9 dBm	18 dB
+8 dBm	17 dB	-8 dBm	17 dB
+7 dBm	16 dB	-7 dBm	16 dB
+6 dBm	15 dB	-6 dBm	15 dB
+5 dBm	14 dB	-5 dBm	14 dB
+4 dBm	13 dB	-4 dBm	13 dB
+3 dBm	12 dB	-3 dBm	12 dB
+2 dBm	11 dB	-2 dBm	11 dB
+1 dBm	10 dB	-1 dBm	10 dB
0 dBm	9 dB*	0 dBm	9 dB*
-1 dBm	8 dB	+1 dBm	8 dB
-2 dBm	7 dB	+2 dBm	7 dB
-3 dBm	6 dB	+3 dBm	6 dB
-4 dBm	5 dB	+4 dBm	5 dB
-5 dBm	4 dB	+5 dBm	4 dB
-6 dBm	3 dB	+6 dBm	3 dB
-7 dBm	2 dB	+7 dBm	2 dB
-8 dBm	1 dB	+8 dBm	1 dB
-9 dBm	0 dB	+9 dBm	0 dB

* = Factory settings: 0 dBm in and out

**Table 4. Attenuator calibration settings,
RFL VF-16 modules**

TX Level Input	Transmit Attenuator Setting	RX Level Output	Receive Attenuator Setting
+12 dBm	24 dB	...	24 dB
+11 dBm	23 dB	...	23 dB
+10 dBm	22 dB	...	22 dB
+9 dBm	21 dB	...	21 dB
+8 dBm	20 dB	...	20 dB
+7 dBm	19 dB	-9 dBm	19 dB
+6 dBm	18 dB	-8 dBm	18 dB
+5 dBm	17 dB	-7 dBm	17 dB
+4 dBm	16 dB	-6 dBm	16 dB
+3 dBm	15 dB	-5 dBm	15 dB
+2 dBm	14 dB	-4 dBm	14 dB
+1 dBm	13 dB	-3 dBm	13 dB
0 dBm	12 dB*	-2 dBm	12 dB
-1 dBm	11 dB	-1 dBm	11 dB
-2 dBm	10 dB	0 dBm	10 dB*
-3 dBm	9 dB	+1 dBm	9 dB
-4 dBm	8 dB	+2 dBm	8 dB
-5 dBm	7 dB	+3 dBm	7 dB
-6 dBm	6 dB	+4 dBm	6 dB
-7 dBm	5 dB	+5 dBm	5 dB
-8 dBm	4 dB	+6 dBm	4 dB
-9 dBm	3 dB	+7 dBm	3 dB
-10 dBm	2 dB	+8 dBm	2 dB
-11 dBm	1 dB	+9 dBm	1 dB
-12 dBm	0 dB	+10 dBm	0 dB

* = Factory settings: 0 dBm in and out

Table 5. Time slot selection, RFL VF-15 and RFL VF-16 modules

One-Channel Operation (SW5-4 in OFF position)	Two-Channel Operation (SW5-4 in ON position)	SW6-1	SW6-2	SW6-3	SW6-4	SW6-5
1	1 and 2	ON	ON	ON	ON	ON
2	2 and 3	ON	ON	ON	ON	OFF
3	3 and 4	ON	ON	ON	OFF	ON
4	4 and 5	ON	ON	ON	OFF	OFF
5	5 and 6	ON	ON	OFF	ON	ON
6	6 and 7	ON	ON	OFF	ON	OFF
7	7 and 8	ON	ON	OFF	OFF	ON
8	8 and 9	ON	ON	OFF	OFF	OFF
9	9 and 10	ON	OFF	ON	ON	ON
10	10 and 11	ON	OFF	ON	ON	OFF
11	11 and 12	ON	OFF	ON	OFF	ON
12	12 and 13	ON	OFF	ON	OFF	OFF
13	13 and 14	ON	OFF	OFF	ON	ON
14	14 and 15	ON	OFF	OFF	ON	OFF
15	15 and 16	ON	OFF	OFF	OFF	ON
16	16 and 17	ON	OFF	OFF	OFF	OFF
17	17 and 18	OFF	ON	ON	ON	ON
18	18 and 19	OFF	ON	ON	ON	OFF
19	19 and 20	OFF	ON	ON	OFF	ON
20	20 and 21	OFF	ON	ON	OFF	OFF
21	21 and 22	OFF	ON	OFF	ON	ON
22	22 and 23	OFF	ON	OFF	ON	OFF
23	23 and 24	OFF	ON	OFF	OFF	ON
24	...	OFF	ON	OFF	OFF	OFF

NOTE: Each active time slot on an RFL VF-15 or RFL VF-16 module occupies one 64-Kbps digital time slot within the multiplexer's aggregate rate. Consult the IMUX 2000 instruction manual for guidelines on time slot selection.

NOTE: ON = UP

OFF = DOWN

9. Select loop-start using SW6-6. (See Figures 5 and 6 for location.)
The factory setting is DOWN for loop start.
10. If the module is set up for two-channel operation (SW5-4 in the ON position), select loop-start or ground-start for channel 2 using DIP switch SW5-1. (See Figures 5 and 6 for location.)
Place SW5-1 in the ON position for ground-start operation, or in the OFF position for loop-start operation. Unless otherwise specified at time of order, SW5-1 is set in the OFF position at the factory for loop-start operation.
11. Select transmit direction using SW6-7. (See Figures 5 and 6 for location.)
Place SW6-7 in the ON position to transmit in the B direction and receive from the A direction. Place SW6-7 in the OFF position to transmit in the A direction and receive from the B direction. Unless otherwise specified at time of order, SW6-7 is set in the OFF position at the factory.
12. Enable or disable Automatic Ringdown (ARD) on Channel 1 by using DIP switch SW6-8. (See Figures 5 and 6 for location.)
If you are configuring an RFL VF-15 module, SW6-8 must be placed in the ON position. If you are configuring an RFL VF-16 module, place SW6-8 in the ON position for normal operation, or in the OFF position for ARD operation. Unless otherwise specified at time of order, SW6-8 is set in the ON position at the factory.
13. Enable or disable Automatic Ringdown (ARD) on Channel 2 by using DIP switch SW5-2. (See Figures 5 and 6 for location.)
If you are configuring an RFL VF-15 module, SW5-2 must be placed in the ON position. If you are configuring an RFL VF-16 module, place SW5-2 in the ON position for normal operation, or in the OFF position for ARD operation. Unless otherwise specified at time of order, SW5-2 is set in the ON position at the factory.
14. If you plan to operate the RFL VF-15 or RFL VF-16 module under **local** control, perform the following steps; otherwise go to step 15.
 - a. Set to local control by placing DIP switch SW6-9 in the ON position.
 - b. Turn service on by placing DIP switch SW6-10 in the ON position.
 - c. Slide the module into the selected slot until it is firmly seated and the module front panel is flush with the top and bottom of the shelf.
 - d. Go to step 16.

15. If you plan to operate the RFL VF-15 or RFL VF-16 module under **remote** control, perform the following steps:
 - a. Set to local control by placing DIP switch SW1-5 in the ON position.
 - b. Turn service off by placing DIP switch SW1-6 in the OFF position.
 - c. Slide the module into the selected slot until it is firmly seated and the module front panel is flush with the top and bottom of the shelf.
 - d. Wait 15 seconds for the module's parameter settings to be loaded into the shelf Common Module.
 - e. Pull the module out of the shelf, and place DIP switch SW6-9 in the OFF position.
Do not move SW6-10.
 - f. Slide the module back into the shelf.
 - g. Verify the module configuration through remote control by issuing a "CONFIG?" query. See page 18 of this Instruction Data Sheet for an explanation of the "CONFIG?" response.
 - h. Turn service on through remote control by issuing a "SRVC = ON" command.
The RFL VF-15 or RFL VF-16's operating parameters can now be changed by remote control. See page 18 of this Instruction Data Sheet for more information.
 - i. Go to step 16.
16. On the Module Record Card (located to the right of the shelf) record the channel bank type, time slot, and any other pertinent information.

The RFL VF-15 or RFL VF-16 is now installed. If your multiplexer is set up for remote access and control, you can now change the operating parameters of the module by using simple commands. For more information on remote access and control, consult your multiplexer operation manual.

To verify the attenuator settings, apply a 1004-Hz test tone at 0 dBm to the voice input. Using a transmission measuring set (Hewlett-Packard Model 4937A or equivalent), attach a clip lead to test point (TP1) and attach the other lead to ground. With the attenuators set to the factory settings, the reading should be 4.0 dB. If not, adjust the transmit attenuator, SW1, accordingly. For example, if the reading is 7.5 dB, increase the attenuation by 3.5 dB. If the reading is 2.2 dB, decrease the attenuation by 1.8 dB. This will ensure that the PCM codec operates effectively with 3.0 dB of headroom.

Once the transmit attenuator is calibrated to the desired value, do not change its setting. If the received signal at either end of the circuit requires further level adjustment, use only the receive attenuator (SW2).

FUNCTIONAL DESCRIPTION

Figure 7 is a functional block diagram of the RFL VF-15 and the RFL VF-16. Both modules use a Subscriber Line Interface Circuit (SLIC). The SLIC on the RFL VF-15 provides two-wire interfaces to PBX ports. The SLIC on the RFL VF-15 interfaces to telephone handsets.

At the RFL VF-15 (office end), the SLIC simulates a telephone line. It terminates the two-wire circuit and provides loop closure and ringing detectors. At the RFL VF-16 (station end), the SLIC simulates a Central Office, supplying loop current and ringing voltage to the external phone circuit.

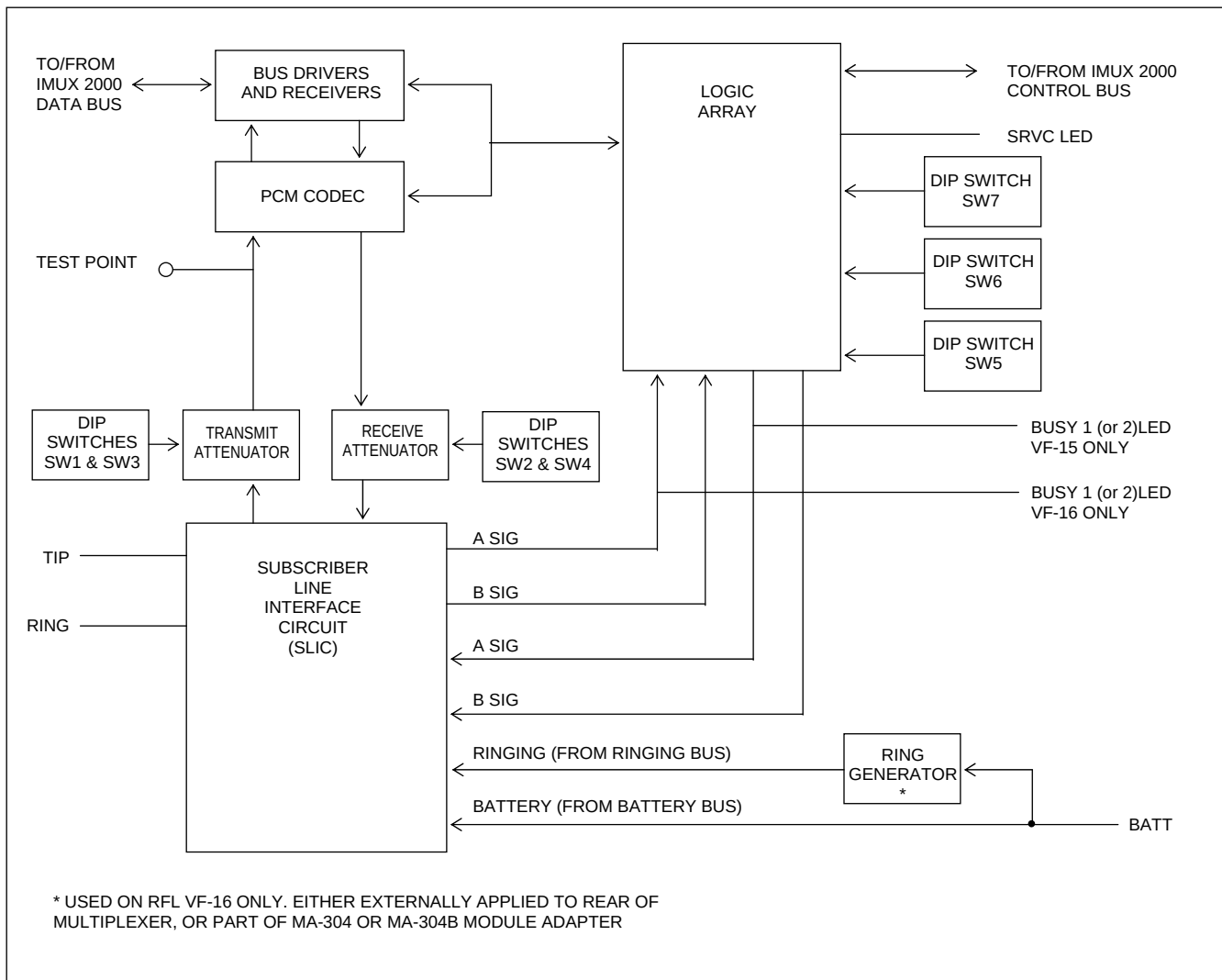


Figure 7. Functional block diagram, RFL VF-15 and RFL VF-16 modules

In both cases, the voice signal from the SLIC passes through a user-adjustable attenuator, and then to a PCM codec for A/D conversion. The output from the codec is passed to a logic array. This array multiplexes the voice bits together with signaling bits provided by the SLIC (On-Hook, Off-Hook, Ringing, No Ringing). Once multiplexed, this combined information is placed into the user-selected time slot of the transmit bus on the multiplexer's backplane.

On the receive side, the logic array takes the incoming data from the selected time slot, demultiplexes it, and passes the voice bits to the PCM codec and the signaling bits to the SLIC.

LOOP START CIRCUITS

Loop start circuits are normally used where the circuit operates a telephone controlled by a person. Examples of this include an Off-Premise Extension (OPX) circuit from a PBX, an Automatic Ring Down (ARD) circuit, and some Foreign Exchange (FX) circuits. Loop start is the most commonly used type of circuit.

Note: Ground start is not supported in the VF-15 and VF-16 modules.

ALERTS/ALARMS

The RFL VF-15 and RFL VF-16 modules report no card-level ALERT or ALARM signals to the shelf Common Module.

REMOTE CONTROL INTERFACE

RFL VF-15 and RFL VF-16 modules installed in an RFL remote-controllable shelf can be operated under local or remote control. When under remote control, certain configuration parameters can only be changed through the RS-232 remote port on the multiplexer. The remote interface for these modules involves two codes: a “P” (parameter) code, and an “S” (status) code. See the IMUX 2000 instruction manual for more information on the remote control interface.

The RFL VF-15 reports itself as a “Type 69” module. The RFL VF-16 reports itself as a “Type 70” module.

“P” CODES

“P” codes, when used in the parameter field on a “SET” command, allow the user to set parameters on the module by remote control, just like setting the switches on a module under local control. “P” codes also appear in the response to a “CONFIG?” query, showing the current parameter settings on the module.

There are two “P” codes for the RFL VF-15 and RFL VF-16: “P1” and “P2. Each is a number from 0 to 255, also represented as an eight-digit binary number (in parenthesis). The binary representation is more useful for setting and interpreting the “P” codes, since each binary digit (0 or 1) corresponds to the on or off setting of a particular switch on the module. (Actually only eleven of these sixteen digits correspond to switches; the other five are not used). Table 6 describes the meanings of the “P” codes.

A typical RFL VF-15 or RFL VF-16 response to a “CONFIG?” query looks like this:

*** OK**
CHANNEL CARD 3, TYPE 69 (or 70)
UNDER REMOTE CONTROL
SVCE = ON
P01 = 3 (B00000011)
P02 = 1 (B00000001);

NOTE

When using binary numbers in the parameter field of a “SET” command, they must be preceded by the letter “B” as shown in the following example:

<multiplexer address>:<module address>:SET:P01 = B00000011;

Besides using the P code, it is also possible to turn module service on or off by sending one of the following in the parameter field with a SET command:

SRVC = ON
SRVC = OFF

“S” CODES

“S” codes appear in response to a “STATUS?” query. There is one “S” code for the RFL VF-15 and RFL VF-16 modules. Like the “P” code, this number is displayed in both decimal and binary form. The four least-significant digits of the binary number represent the conditions shown in Table 8. The four most-significant digits are not used.

A typical response to a “STATUS?” query looks like this:

*** OK**
CHANNEL CARD 3, TYPE 69 (or 70)
S01 = 3 (B00000011);

Table 6. Remote configuration settings (“P” codes)

P Code	Digit(s) And Switch Equivalent	Value ⁽¹⁾	Description
P1	B00000000 ---↑↑↑↑↑ TIME SLOT SELECT	00001 to 11000	From left to right, these five bits represent the binary value of the desired time slot. See Table 7 for a complete list of these values.
	B00000000 --↑----- LOOP START 1	0	Not used.
		1	Set for loop start.
	B00000000 -↑----- TERM	0	This setting may be only be used when the module is installed in a drop/insert multiplexer. In terminal multiplexers, this digit must always be set to “1”. In drop/insert multiplexers, set this digit to “1” to transmit in the A direction and receive from the B direction. Set this digit to “0” to transmit in the B direction and receive from the A direction. (See the IMUX 2000 instruction manual for guidelines on setting channel module direction).
		1	Required setting when the module is installed in a terminal multiplexer.
	B00000000 ↑-----	0	Set for normal operation.
	ARD1⁽²⁾	1	Set for ARD operation
P2	B00000000 -----↑ LOOP START 2	0	Not used.
		1	Sets Channel 2 for loop start
	B00000000 -----↑- ARD2⁽²⁾	0	Sets Channel 2 for normal operation
		1	Sets Channel 2 for ARD operation
	B00000000 -----↑--	...	Not used.
	B00000000 ----↑--- CH2 OFF	0	Sets both channels on for dual-channel operation.
		1	Sets Channel 2 off for single-channel operation
	B00000000 ↑↑↑↑----	...	Not used.

1. These are the only legal values for setting the parameters. Setting any parameter to a value outside its specified range will produce an unpredictable result.

2 RFL VF-16 only.

Table 7. Time slot selection by remote access

Single-Channel Time Slot	Dual-Channel Time Slot	P1-5*	P1-4*	P1-3*	P1-2*	P1-1*
1	1 and 2	0	0	0	0	1
2	2 and 3	0	0	0	1	0
3	3 and 4	0	0	0	1	1
4	4 and 5	0	0	1	0	0
5	5 and 6	0	0	1	0	1
6	6 and 7	0	0	1	1	0
7	7 and 8	0	0	1	1	1
8	8 and 9	0	1	0	0	0
9	9 and 10	0	1	0	0	1
10	10 and 11	0	1	0	1	0
11	11 and 12	0	1	0	1	1
12	12 and 13	0	1	1	0	0
13	13 and 14	0	1	1	0	1
14	14 and 15	0	1	1	1	0
15	15 and 16	0	1	1	1	1
16	16 and 17	1	0	0	0	0
17	17 and 18	1	0	0	0	1
18	18 and 19	1	0	0	1	0
19	19 and 20	1	0	0	1	1
20	20 and 21	1	0	1	0	0
21	21 and 22	1	0	1	0	1
22	22 and 23	1	0	1	1	0
23	23 and 24	1	0	1	0	1
24	...	1	1	0	0	0

* These positions represent the five least-significant digits of P1, as shown in Table 6. As with the physical time slot selection switches, if the module is set for single-channel operation, these settings will only activate the time slot listed in the first column. If the module is set for dual-channel operation, these settings activate the time slots listed in the second column.

Table 8. Remote status messages (“S” codes)

Position	Value	Description
B00000000 -----↑	0	Channel 1 idle.
	1	Channel 1 busy.
B00000000 -----↑-	0	Channel 2 idle.
	1	Channel 2 busy.
B00000000 -----↑--	0	Channel 1 ringing.
	1	Channel 1 not ringing.
B00000000 ----↑---	0	Channel 2 ringing.
	1	Channel 2 not ringing.
B00000000 ↑↑↑↑↑---	...	Not used.

TESTING

When the RFL VF-15 and RFL VF-16 modules have been configured and installed, they should be tested for proper operation before they are put into service. If a module is set up for two-channel operation, test each channel separately.

EQUIPMENT REQUIRED

1. Telephone Set, Type 2500 or equivalent (one for each RFL VF-16 module).
2. PBX Station Line (RFL VF-15 only).
3. Ring Generator.
4. 48-Volt Battery.

FXO/FXS TEST PROCEDURE

1. Verify that a ring generator and –48-volt talk current battery are connected to the multiplexer containing the RFL VF-16 module, as described in the Installation section of the multiplexer manual.
2. Connect the PBX line to the channel under test on the RFL VF-15 module.
3. Connect the telephone line to the channel under test on the RFL VF-16 module.
4. Check the settings of DIP switches SW6-1 through SW6-5 to make sure that both modules are set to use the same time slots.
5. Set both channels on both modules to Loop Start (DIP switches SW6-6 and SW5-1 in the OFF position).
6. Set service on for both modules (DIP switch SW6-10 in the ON position).
7. Set both modules to local control (DIP switch SW6-9 in the ON position).
8. Take the phone connected to the RFL VF-16 off-hook and observe the presence of a dial tone from the PBX.
9. Dial an extension and verify that the extension rings.

10. Answer the extension and verify that the voice level is adequate in both directions, and that the noise level is acceptably low.
11. Place both phones back on hook. Using the extension, dial the number of the line connected to the RFL VF-16 under test.
The phone connected to the RFL VF-16 should ring 2 seconds on, and 4 seconds off.
12. Answer the ringing phone and verify that ringing stops and the voice quality is acceptable.
13. Change the settings on both modules, if necessary, to suit the desired circuit configuration. The circuit may now be placed in service.

ARD TEST PROCEDURE

1. Verify that a ring generator and -48-volt talk current battery are connected to the multiplexers at both ends of the circuit, as described in the multiplexer operation manual.
2. Connect telephones to the channel under test on the RFL VF-16 modules at both Location 1 and Location 2.
3. Check the settings of DIP switches SW6-1 through SW6-5 to make sure that both modules are set to use the same time slots.
4. Set both channels on both modules to Loop Start (DIP switches SW6-6 and SW5-1 in the OFF position).
5. Set service on for both modules (DIP switch SW6-10 in the ON position).
6. Set both modules to local control (DIP switch SW6-9 in the ON position).
7. Set both channels on both modules to ARD operation (SW6-8 DOWN).
8. Lift the handset on the phone at Location 1.
The phone at Location 2 will ring (2 seconds on, and 4 seconds off).
9. Listen to the handset on the phone at location 1.
A ringback tone will be heard.
10. Answer the phone at Location 2.
The phone will stop ringing.

11. Verify that the voice level is adequate in both directions, and that the noise level is acceptably low.
12. Hang up the phones and repeat Steps 8 through 11 in the other direction, from Location 2 to Location 1.
13. Change the settings on both modules, if necessary, to suit the desired circuit configuration.

The circuit may now be placed in service.

TROUBLESHOOTING

If there is an apparent malfunction, first check that the configuration is appropriate for the transmission system in use, and that the transmit and receive configurations are identical.

Problems may occur at the common equipment or facility level that may affect the operation of this module. Refer to the “Maintenance” section in your multiplexer manual for system analysis procedures.

NOTES

NOTES

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RFL Electronics Inc.

INSTRUCTION DATA

Dual-Channel Foreign Exchange Voice Module For RFL IMUX 2000 Intelligent T1 and E1 Multiplexers

RFL VF-15C (Office End)

DESCRIPTION

The RFL VF-15C is a Two-Wire Foreign Exchange Office End (FXO) module designed for use in IMUX 2000 terminal and drop/insert multiplexers. It accepts one or two independent voice channels as input, and converts each channel into a 64 kbps digital signal which can be transmitted over T1, E1 or other digital communications facilities. It does this using μ -law PCM coding for T1 systems and A-law PCM coding for E1 systems. The VF-15C automatically detects if the system is T1 or E1 and configures itself appropriately.

A circuit with an RFL VF-15C module at one end and an RFL VF-16A module at the other end can provide a Foreign Exchange (FX) line or an Off-Premise Extension (OPX) line.

The VF-15C is remote-controllable when installed in an RFL remote controllable shelf. User-adjustable switches allow local configuration of the following parameters:

- o One or two channel operation.
- o Loop start.
- o Service enable/disable.
- o Remote control configuration and status reporting.
- o Selectable transmit/receive direction.
- o Extended range input/output level compensation.
- o Selectable time slot assignment.
- o Signaling delay on/off.
- o Normal or enhanced mode.

SPECIFICATIONS

As of the date this Instruction Data Sheet was published, the following specifications apply to the RFL VF-15C Dual-Channel Foreign Exchange Office End (FXO) Voice Module. Because all of RFL products undergo constant improvement and refinement, these specifications are subject to change without notice.

Configuration: One or two independent voice channels per module.

Time Slots:

One-Channel operation: Requires one user-selectable 64-Kbps time slot.

Two-Channel operation: Requires any two adjacent 64-Kbps time slots.

Signal Levels:

Input: -26 dBm to 0 dBm

Output: -26 dBm to 0 dBm

Frequency Response:

200 Hz to 300 Hz: +0.5 dBm to -2.0 dBm.

300 Hz to 3000 Hz: +0.5 dBm to -0.5 dBm.

3000 Hz to 3300 Hz: +0.5 dBm to -1.0 dBm.

Idle Channel Noise: Less than 23 dBmC0.

Impulse Noise:

Maximum counts per 30-Minute Interval. (Input data level of -36 dBm @ 1004 Hz.

Level adjustments set for 0 dBm IN and 0 dBm OUT.)

38 dBmC: 10.0 Counts

44 dBmC: 1.0 Count

50 dBmC: 0.1 Counts

Phase Hits $\pm 10^\circ$: 0 Counts

Gain Hits ± 3 dB: 0 Counts

Drop Outs -12 dB: 0 Counts

Signal-to-Noise Ratio: Greater than 33 dB.

Signal-to-Distortion (1004 Hz input):

0 dBmO to -30 dBmO: Greater than 33 dB.

-40 dBmO: Greater than 27 dB.

-45 dBmO: Greater than 22 dB.

Near-end and Far-end Crosstalk (0 dBm0 @ 1004 Hz tone applied to any channel):

Less than -70 dBm0 @ 1004 Hz for adjacent channels.

Channel Differential Delay/Envelope Delay (900 Hz to 2800 Hz @ 1804 Hz ref.):

Less than 200 μ S.

Tracking (gain deviation for a 1004 Hz input):

0 dBm0 to -40 dBm0: 0.5 dB maximum.

-40 dBm0 to -50 dBm0: 1.0 dB maximum.

Peak-to-Average Ratio (P/AR): Greater than 94.

Power Requirements:

+5V: 75mA

+15V: 53mA

-15V: 30mA

-48V: <1ma (Ground-Start only)

Signaling Format:

T1 systems: RBS (Robbed-Bit Signaling)

E1 systems: CAS (Channel-Associated Signaling)

Network Interface:

Loop-Start:

Leakage current (Tip-Ring, On-Hook): Less than 10 μ A @ -50V.

Loop Current (Off-Hook): 15 to 80mA.

Ring Voltage Threshold: 30 Vrms, 20/30 Hz

Interface: MA-301, MA-301C, MA-303 or MA-303B Module Adapters.

Testing: Input and output level test points for each channel.

Operating Temperature: -20°C to +55°C (-4°F to +131°F).

Humidity: 0 to 90 %, non-condensing.

INSTALLATION

Before the RFL VF-15C can be placed in service, it must be installed in a multiplexer shelf. Installation involves determining the module slot in the Main Shelf or Expansion Shelf where the module will be installed, inserting a Module Adapter into the rear of the shelf behind the module slot, connecting all signal and power wiring to the Module Adapter, checking the settings of all switches, and inserting the module into the front of the shelf.

NOTES

Power supply and time slot considerations may affect the installation of this module into an existing multiplexer shelf. Refer to the multiplexer manual for more information.

The following instructions are provided for installing an RFL VF-15C module into an existing system. If the module was included as part of a system, installation was done at the factory. Otherwise, proceed as follows:

1. Carefully inspect the module for any visible signs of shipping damage. If you suspect damage to the module, immediately call RFL Customer Service at the number listed at the bottom of this page.
2. Determine the module slot in the Main Shelf or Expansion Shelf where the module will be installed.

RFL VF-15C module occupies one module slot in the Main Shelf or Expansion Shelf.

3. Determine which Module Adapter will be used to make connections to the RFL VF-15C module.

Each module in the IMUX 2000 multiplexer requires a Module Adapter. The module adapter provides the appropriate connector for the desired interface.

There are four Module Adapters compatible with the RFL VF-15C:

<u>Model Number</u>	<u>Voice Connections</u>	<u>Application</u>	<u>Figure</u>
MA-301	50-pin Telco Connector	Used with multiple VF-15C modules	1
MA-301C	50-pin Telco Connector	Used with multiple VF-15C modules	1
MA-303	RJ-11 Jack	Used with VF-15C module	3
MA-303B	Removable terminal block	Used with VF-15C module	4

The MA-301 accepts a 50-pin Telco connector (Amphenol 57-30500 or equivalent, as shown in Figure 1.) One MA-301 Module Adapter can be used to connect up to three RFL VF-15C modules, for a total of up to six voice channels. If you will be using more than one module with an MA-301, they must be inserted into adjacent slots in the multiplexer. Ribbon cables are provided with the MA-301 to make connections to it from the second and third module locations. (See Figure 2.) The MA-301 does not contain the input protection circuits that are on the MA-303. If the input signals are subject to transients, protection must be added prior to the MA-301.

The MA-301C is similar to the MA-301, except it has different connector pinouts.

The MA-303 provides two RJ-11 jacks for connection to the voice circuits, and two bantam jacks (Line and Drop) for each channel as shown in Figure 3. When used with the RFL VF-10D, only the connectors for Channel 1 are used. The bantam jacks may be used for test access. Each LINE jack provides access to the line from the equipment side.

The MA-303B, shown in Figure 4, is similar to the MA-303, except it has removable terminal blocks in place of the RJ-11 connectors for the voice connection.

Make sure the module adapter you are installing is correct for the desired application.

4. Insert the Module Adapter into the rear of the shelf directly behind the module slot where the RFL VF-15C module will be installed, and make all connections to the module adapter.

If an MA-301 or MA-301C Module Adapter is being used, plug the 50-pin Telco cable end connector into its mating 50-pin connector on the module adapter.

If an MA-303 or MA-303B Module adapter is being used, plug in the RJ-11 connector or the removable terminal block, as applicable, into the Channel 1 jack on the module adapter. The only electrical interface connections that have to be made to the RFL VF-15C are RING and TIP connections, which are made to terminals 3 and 4 on the RJ-11 connector, or to the screw terminals on the terminal block. TIP is the top terminal, and RING is the bottom terminal. Refer to Figures 3 and 4 as applicable.

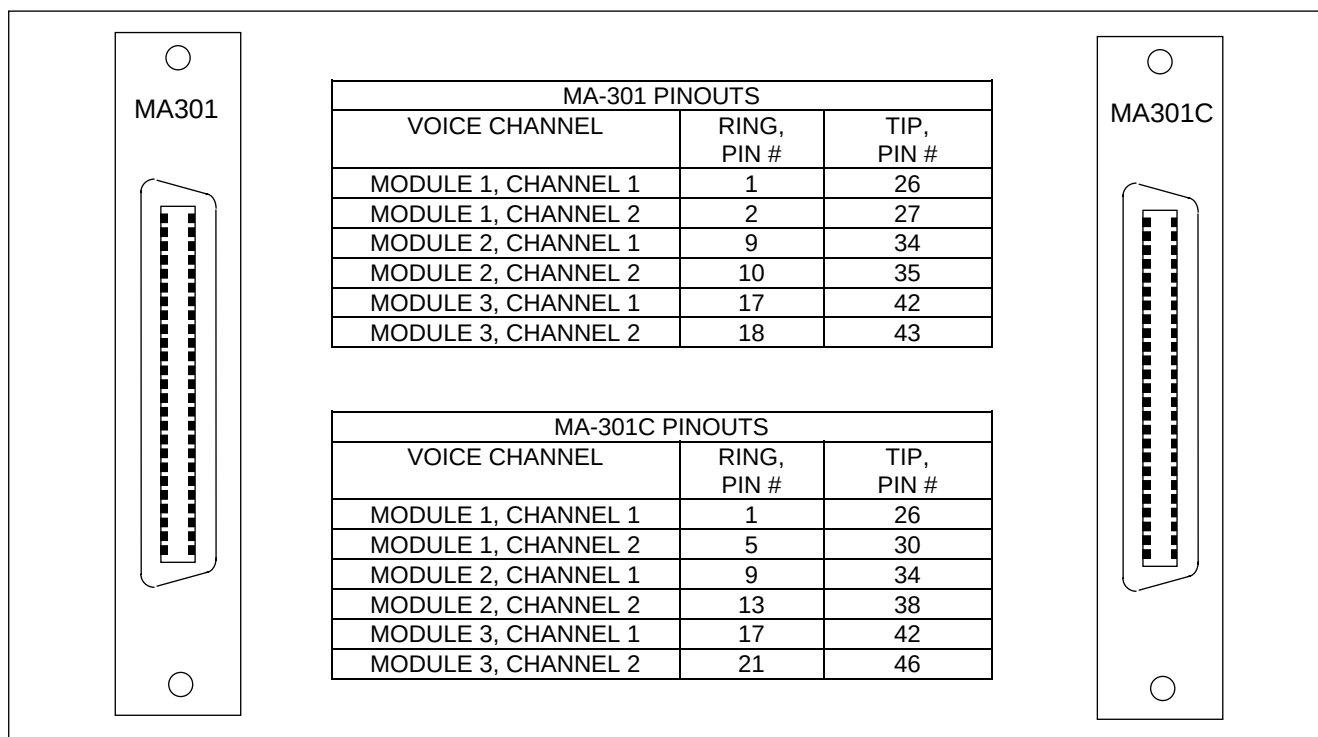


Figure 1. MA-301 and MA-301C Module Adapters

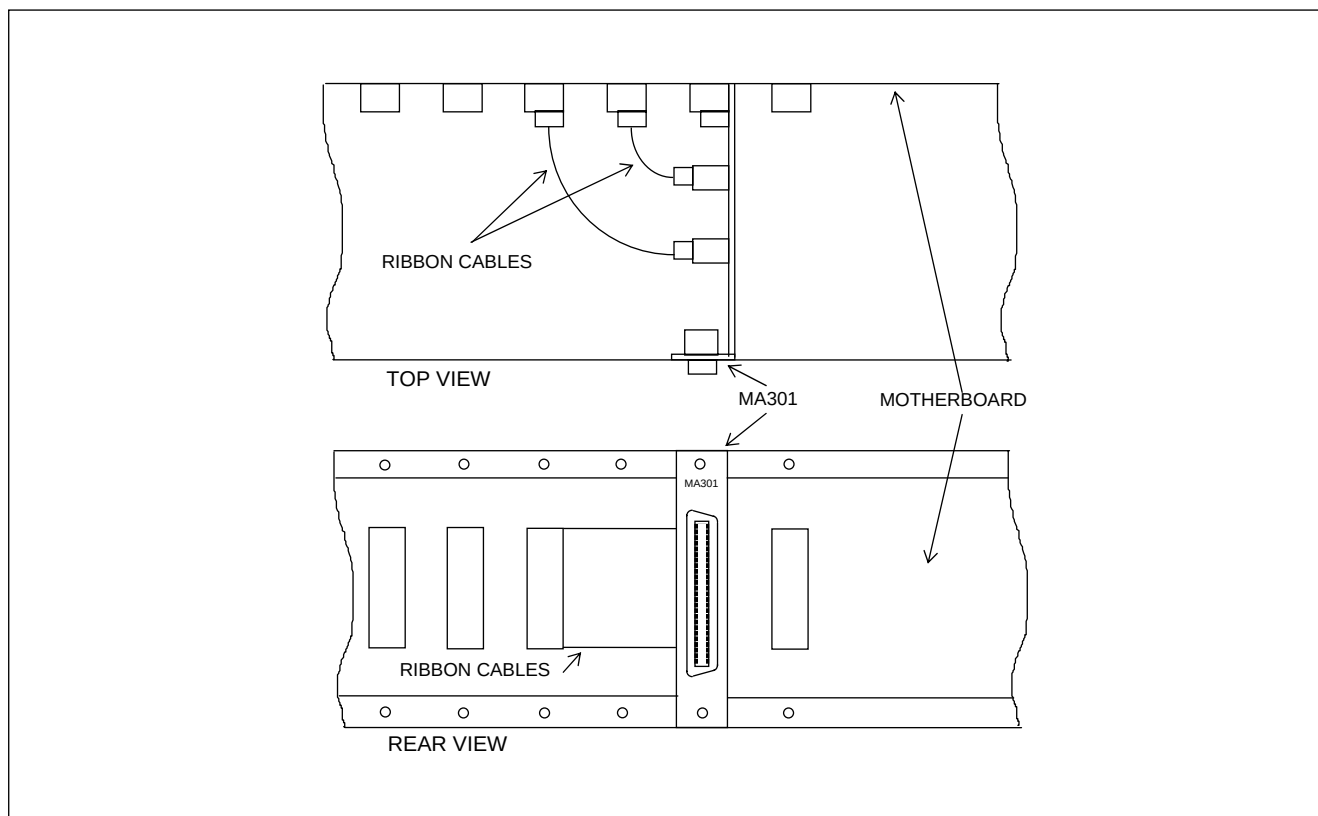


Figure 2. Using an MA-301 Module Adapter with multiple RFL VF-15C modules.

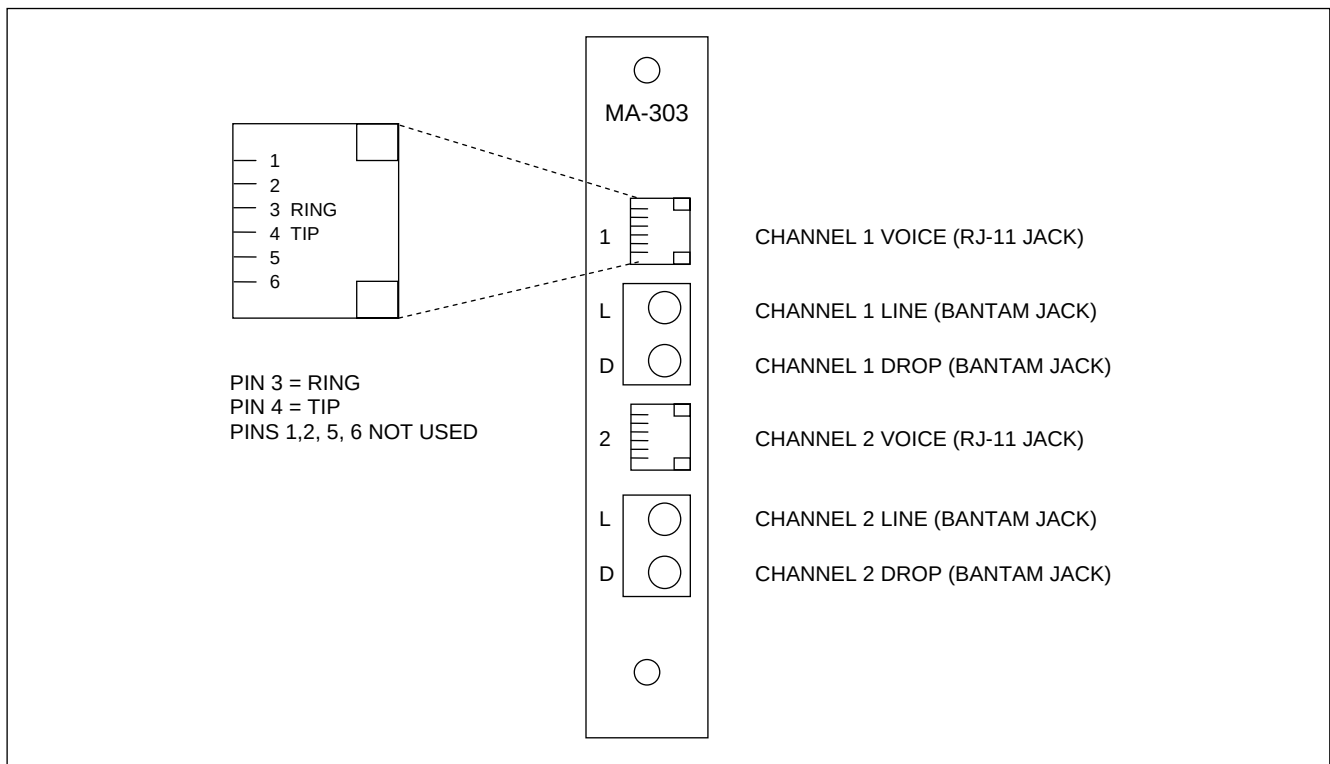


Figure 3. MA-303 Module Adapter, used with RFL VF-15C office-end module.

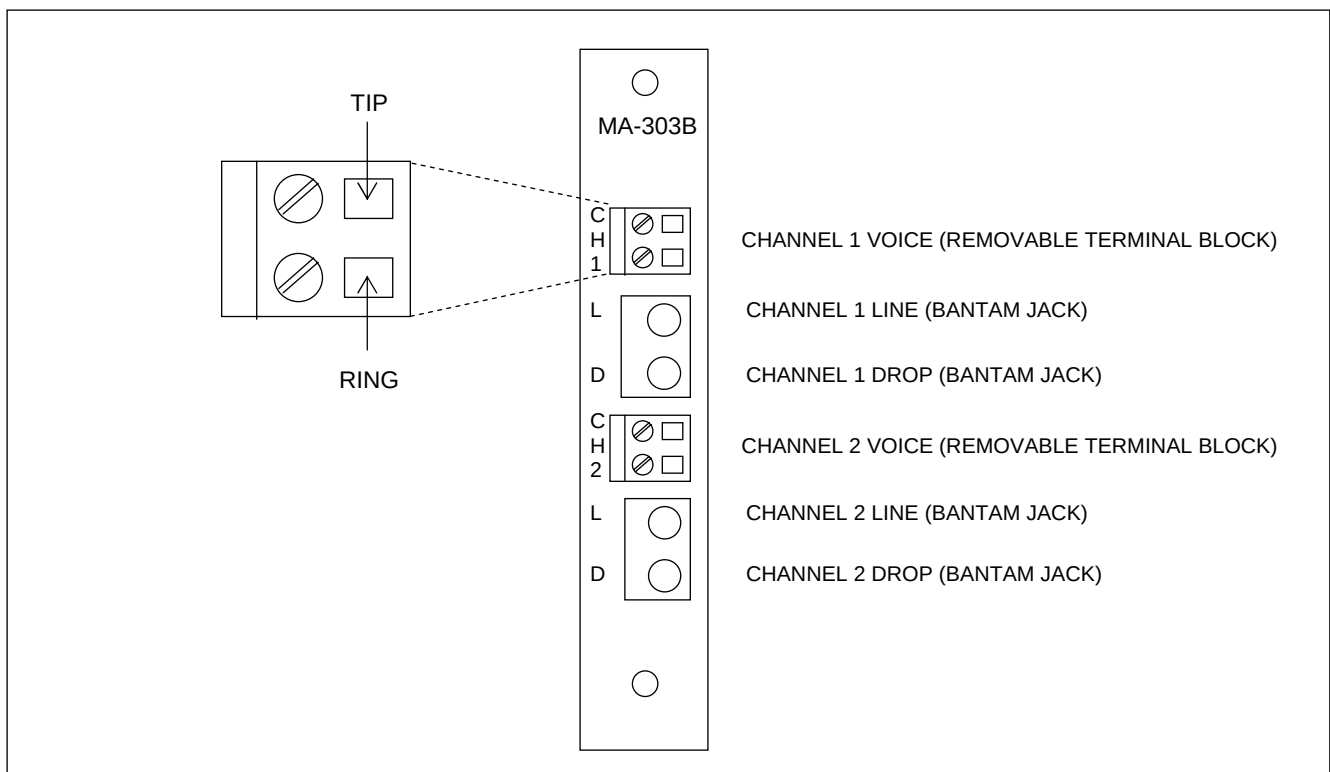


Figure 4. MA-303B Module Adapter, used with RFL VF-15C office-end module.

6. Set the module address using DIP switches SW9-1 through SW9-6 for the desired remote address (SCB address).
For remote access, each channel module in the IMUX 2000 must have a distinct module address. Valid addresses are the numbers “1” to “36”. In most installations the address will be set to the number of the slot the module is occupying. Table 2 shows the switch settings for the module address. (Consult your multiplexer manual for details on using the remote access and configuration features of the system.)
7. Select normal or enhanced mode using DIP switch SW9-7.
Place SW9-7 in the DOWN position for normal mode, or in the UP position for enhanced mode. In normal mode the VF-15C emulates the parameters of the older VF-15 series of modules. Enhanced mode allows remote programming of Tx and Rx levels as shown in Table 3. It also allows a user to program signaling delay for each channel remotely.
8. Select one-channel or two-channel operation using “CH2 OFF” DIP switch SW9-8.
Place SW9-8 in the UP position for two-channel operation, or in the DOWN position for one-channel operation (Channel 2 turned off). Unless otherwise specified at time of order, SW9-8 is set in the UP position at the factory for two-channel operation.
9. Select the Tx and Rx audio levels using DIP switches SW1-2 through SW1-8, SW2-2 through SW2-8, SW3-2 through SW3-8, and SW4-2 through SW4-8. These switches are used to alter the translation between analog signal levels and digital data. Optimum performance is realized when full scale analog swings are converted to nearly full-scale digital swings. The VF-15C is designed to make this process simple if the analog input signal level and the desired analog output signal levels are known.

The switches are binary coded with a minimum step size of 0.5 dB. An offset of 32 dB is included to allow the signals to be attenuated or amplified. Table 3 shows the switch settings for both the Tx and Rx level adjustments. The table only includes full dB steps for clarity. Adjustments can be made in 0.5 dB increments by changing switch position 8 on the appropriate switch. A Tx or Rx level can be set 0.5 dB lower by placing switch SWX-8 to the UP position. For example, to set -25.5 dB, set SWX-2 through SWX-8 as follows: U, U, U, D, D, U, U. Note that the level used to determine the switch setting should allow for the maximum anticipated signal, or clipping may occur.

The switch encoding scheme is as follows;

- a. Take the negative of the signal level. Most signal levels will be negative.
- b. Multiply by two. This is to compensate for the 1/2 dB step size.
- c. Add 40 hex (64 decimal).
- d. Convert to binary, and then set the switches.

Note that for typical audio signals (for example -16 dBm) all that is required is to set the switches for 32 (20 hex) while leaving switch 2 up (adding 40 hex). To maintain consistency with earlier VF-15 modules, the factory default level setting is 0 dBm in and 0 dBm out (switches set for 40 hex).

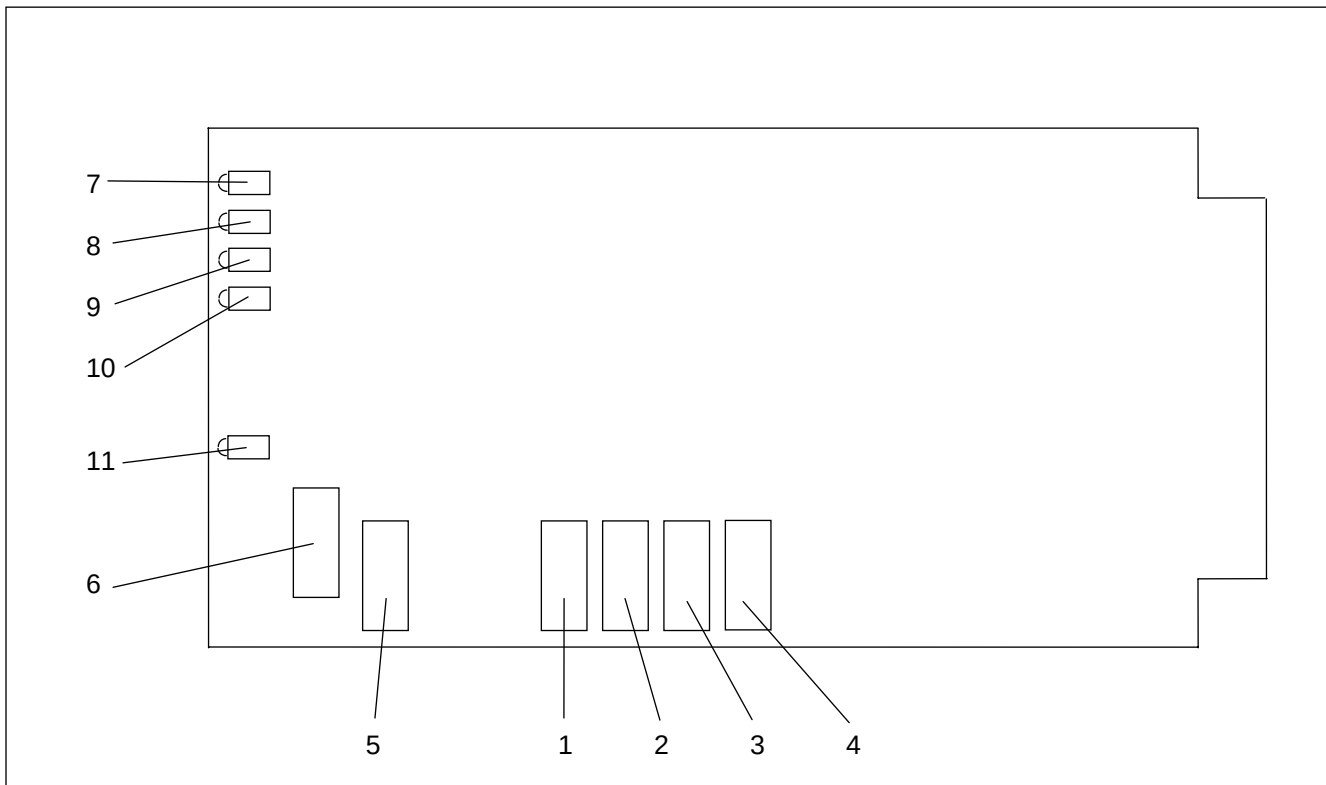


Figure 5. Controls and indicators, RFL VF-15C Foreign Exchange Office-End Voice Module

10. Select an unused time slot for channel 1 using DIP switches SW10-1 through SW10-5. Each active voice channel uses one 64 Kbps digital time slot within the multiplexer's aggregate rate. Set the time slot using direct binary coding as shown in Table 4. Selecting a time slot for channel 1 will automatically cause a channel 2 time slot to be selected only if channel 2 is enabled. If enabled, the channel 2 time slot selected will be the next higher available time slot. For example, if a user selects time slot 8 for channel 1, then time slot 9 will be automatically selected for channel 2 if channel 2 is enabled. This can be seen by viewing the time slot columns for channels 1 and 2 in Table 4. Refer to the multiplexer manual for guidelines on time slot selection.

Note that selecting an invalid time slot will disable the module. In T1 systems, only time slots 1 through 24 are allowed. If channel 1 is set for time slot 24, channel 2 will automatically be disabled. Time slot 24 is not available for a T1 system using fast reframing.

In E1 systems, time slots 1 through 31 are allowed, however, time slots 0 and 16 are reserved and cannot be used. If time slot 15 is selected, channel 2, if enabled, will automatically be bumped up to time slot 17. This can be seen by viewing the time slot columns for channels 1 and 2 in Table 4. If time slot 31 is selected, channel 2 will be automatically disabled. Time slot 30 is not available for an E1 system using fast reframing. Time slot 31 is not available if inter-node communications (NMX) is used.

>> text continues on page 13 <<

Table 1. Controls and indicators, RFL VF-15C Foreign Exchange Voice Module

Item	Name/Description	Function	Setting
1	DIP switch SW1	SW1-1 Sets chan 1 for loop start	UP: Not used
			DOWN: Loop Start
		(SW1-2 Sets chan 1 TX circuit audio level thru -8)	See Table 3
2	DIP switch SW2	SW2-1 Enables/Disables chan 1 signaling delay *	UP: Signaling delay disabled
			DOWN: Signaling delay enabled
		(SW2-2 Sets chan 1 RX circuit audio level thru -8)	See Table 3
3	DIP switch SW3	SW3-1 Sets chan 2 for loop start	UP: Not used
			DOWN: Loop Start
		(SW3-2 Sets chan 2 TX circuit audio level thru -8)	See Table 3
4	DIP switch SW4	SW4-1 Enables/Disables chan 2 signaling delay *	UP: Signaling delay disabled
			DOWN: Signaling delay enabled
		(SW4-2 Sets chan 2 RX circuit audio level thru -8)	See Table 3
5	DIP Switch SW9	(SW9-1 Selects the SCB address thru -6)	See Table 2
		SW9-7 Selects Normal or Enhanced mode	UP: Enhanced Mode
			DOWN: Normal Mode
		SW9-8 Enables or Disables Channel 2	UP: Channel 2 Enabled
6	DIP Switch SW10		DOWN: Channel 2 Disabled
		(SW10-1 Time Slot Select thru -5)	See Table 4
		SW10-6 Selects bus transmit direction	UP: "B" direction (D&I only)
			DOWN: "A" direction (required for terminal multiplexer)
		SW10-7 Selects Local or Remote control	UP: Local control (using switches)
			DOWN: Remote Control (over SCB)
		SW10-8 Turns module service ON or OFF	UP: Service ON (over-ridden if improperly configured)
			DOWN: Service OFF
7	LED Indicator DS1	Lights when the line connected to Chan 1 is ringing	NA
8	LED Indicator DS2	Lights when the line connected to Chan 1 is busy (in use)	NA
9	LED Indicator DS3	Lights when the line connected to Chan 2 is ringing	NA
10	LED Indicator DS4	Lights when the line connected to Chan 2 is busy (in use)	NA
11	LED Indicator DS5	Lights when the modules service is enabled	NA

* SW2-1 enables Signaling Delay for both channel 1 and channel 2 in an E1 system configured for normal mode.
SW4-1 has no effect in E1 normal mode.

Table 2. Module address settings, RFL VF-15C module

Module Address	SW9-1	SW9-2	SW9-3	SW9-4	SW9-5	SW9-6
1	OFF	OFF	OFF	OFF	OFF	ON
2	OFF	OFF	OFF	OFF	ON	OFF
3	OFF	OFF	OFF	OFF	ON	ON
4	OFF	OFF	OFF	ON	OFF	OFF
5	OFF	OFF	OFF	ON	OFF	ON
6	OFF	OFF	OFF	ON	ON	OFF
7	OFF	OFF	OFF	ON	ON	ON
8	OFF	OFF	ON	OFF	OFF	OFF
9	OFF	OFF	ON	OFF	OFF	ON
10	OFF	OFF	ON	OFF	ON	OFF
11	OFF	OFF	ON	OFF	ON	ON
12	OFF	OFF	ON	ON	OFF	OFF
13	OFF	OFF	ON	ON	OFF	ON
14	OFF	OFF	ON	ON	ON	OFF
15	OFF	OFF	ON	ON	ON	ON
16	OFF	ON	OFF	OFF	OFF	OFF
17	OFF	ON	OFF	OFF	OFF	ON
18	OFF	ON	OFF	OFF	ON	OFF
19	OFF	ON	OFF	OFF	ON	ON
20	OFF	ON	OFF	ON	OFF	OFF
21	OFF	ON	OFF	ON	OFF	ON
22	OFF	ON	OFF	ON	ON	OFF
23	OFF	ON	OFF	ON	ON	ON
24	OFF	ON	ON	OFF	OFF	OFF
25	OFF	ON	ON	OFF	OFF	ON
26	OFF	ON	ON	OFF	ON	OFF
27	OFF	ON	ON	OFF	ON	ON
28	OFF	ON	ON	ON	OFF	OFF
29	OFF	ON	ON	ON	OFF	ON
30	OFF	ON	ON	ON	ON	OFF
31	OFF	ON	ON	ON	ON	ON
32	ON	OFF	OFF	OFF	OFF	OFF
33	ON	OFF	OFF	OFF	OFF	ON
34	ON	OFF	OFF	OFF	ON	OFF
35	ON	OFF	OFF	OFF	ON	ON
36	ON	OFF	OFF	ON	OFF	OFF

NOTE: For SW-9, ON = UP and OFF = DOWN.

Table 3. Tx and Rx level settings, RFL VF-15C module (Ensure SW9-7 is in the UP position)

Tx Input and Rx output Level (dBm) ⁽¹⁾	P-Codes 3,4,5,6 (Decimal)	Switch Settings	VNMS Settings (dB)	Physical Switch Settings SW1 thru SW4						
				2	3	4	5	6	7	8 ⁽²⁾
-26	116	58	26	U	U	U	D	U	D	D
-25	114	57	25	U	U	U	D	D	U	D
-24	112	56	24	U	U	U	D	D	D	D
-23	110	55	23	U	U	D	U	U	U	D
-22	108	54	22	U	U	D	U	U	D	D
-21	106	53	21	U	U	D	U	D	U	D
-20	104	52	20	U	U	D	U	D	D	D
-19	102	51	19	U	U	D	D	U	U	D
-18	100	50	18	U	U	D	D	U	D	D
-17	98	49	17	U	U	D	D	D	U	D
-16	96	48	16	U	U	D	D	D	D	D
-15	94	47	15	U	D	U	U	U	U	D
-14	92	46	14	U	D	U	U	U	D	D
-13	90	45	13	U	D	U	U	D	U	D
-12	88	44	12	U	D	U	U	D	D	D
-11	86	43	11	U	D	U	D	U	U	D
-10	84	42	10	U	D	U	D	U	D	D
-9	82	41	9	U	D	U	D	D	U	D
-8	80	40	8	U	D	U	D	D	D	D
-7	78	39	7	U	D	D	U	U	U	D
-6	76	38	6	U	D	D	U	U	D	D
-5	74	37	5	U	D	D	U	D	U	D
-4	72	36	4	U	D	D	U	D	D	D
-3	70	35	3	U	D	D	D	U	U	D
-2	68	34	2	U	D	D	D	U	D	D
-1	66	33	1	U	D	D	D	D	U	D
0 ⁽³⁾	64	32	0	U	D	D	D	D	D	D
1	62	31	-1	D	U	U	U	U	U	D
2	60	30	-2	D	U	U	U	U	D	D
3	58	29	-3	D	U	U	U	D	U	D
4	56	28	-4	D	U	U	U	D	D	D
5	54	27	-5	D	U	U	D	U	U	D
6	52	26	-6	D	U	U	D	U	D	D
7	50	25	-7	D	U	U	D	D	U	D
8	48	24	-8	D	U	U	D	D	D	D
9	46	23	-9	D	U	D	U	U	U	D
10	44	22	-10	D	U	D	U	U	D	D
11	42	21	-11	D	U	D	U	D	U	D
12	40	20	-12	D	U	D	U	D	D	D
13	38	19	-13	D	U	D	D	U	U	D
14	36	18	-14	D	U	D	D	U	D	D
15	34	17	-15	D	U	D	D	D	U	D
16	32	16	-16	D	U	D	D	D	D	D
17	30	15	-17	D	D	U	U	U	U	D
18	28	14	-18	D	D	U	U	U	D	D
19	26	13	-19	D	D	U	U	D	U	D
20	24	12	-20	D	D	U	U	D	D	D
21	22	11	-21	D	D	U	D	U	U	D
22	20	10	-22	D	D	U	D	U	D	D
23	18	9	-23	D	D	U	D	D	U	D
24	16	8	-24	D	D	U	D	D	D	D
25	14	7	-25	D	D	D	U	U	U	D
26	12	6	-26	D	D	D	U	U	D	D

Default

See notes for Table 3 on top of next page.

Notes for Table 3:

1. The maximum analog level for transmit and receive is 0dBm. The TX Input Level may be increased to a value greater than 0dBm to provide additional offset attenuation. The RX Input Level may be increased to a value greater than 0dBm to provide additional offset gain.
2. Note: 0.5 dB increments can also be used by SW1, 2, 3 and 4.
3. Factory default of 0dB.

Table 4. Time Slot Select for RFL VF-15C module.

Switch Code (Decimal)	Physical Switch Settings SW10-					T1		E1	
	1	2	3	4	5	Channel 1 Time Slot	Channel 2 Time Slot	Channel 1 Time Slot	Channel 2 Time Slot
0	D	D	D	D	D	*	*	*	*
1	D	D	D	D	U	1	2	1	2
2	D	D	D	U	D	2	3	2	3
3	D	D	D	U	U	3	4	3	4
4	D	D	U	D	D	4	5	4	5
5	D	D	U	D	U	5	6	5	6
6	D	D	U	U	D	6	7	6	7
7	D	D	U	U	U	7	8	7	8
8	D	U	D	D	D	8	9	8	9
9	D	U	D	D	U	9	10	9	10
10	D	U	D	U	D	10	11	10	11
11	D	U	D	U	U	11	12	11	12
12	D	U	U	D	D	12	13	12	13
13	D	U	U	D	U	13	14	13	14
14	D	U	U	U	D	14	15	14	15
15	D	U	U	U	U	15	16	15	17
16	U	D	D	D	D	16	17	*	*
17	U	D	D	D	U	17	18	17	18
18	U	D	D	U	D	18	19	18	19
19	U	D	D	U	U	19	20	19	20
20	U	D	U	D	D	20	21	20	21
21	U	D	U	D	U	21	22	21	22
22	U	D	U	U	D	22	23	22	23
23	U	D	U	U	U	23	24	23	24
24	U	U	D	D	D	24	N/A	24	25
25	U	U	D	D	U	*	*	25	26
26	U	U	D	U	D	*	*	26	27
27	U	U	D	U	U	*	*	27	28
28	U	U	U	D	D	*	*	28	29
29	U	U	U	D	U	*	*	29	30
30	U	U	U	U	D	*	*	30	31
31	U	U	U	U	U	*	*	31	N/A

Notes: * This setting is not allowed . Setting switches to this code will cause the module's service to be disabled.
D = down, U = up.

11. Select Signaling Delay or No Delay for each channel by using DIP switches SW2-1 and SW4-1.
 - T1/E1 enhanced mode or T1 normal mode:**
 - For channel 1, set DIP switch SW2-1 to UP position for no delay, or set switch to DOWN position for Signaling Delay.**
 - For channel 2, set DIP switch SW4-1 to UP position for no delay, or set switch to DOWN position for Signaling Delay.**
 - E1 normal mode:**
 - Set DIP switch SW2-1 to UP position for no delay on both channels, or set switch to DOWN position for Signaling Delay on both channels.**
 - Signaling Delay is the factory default.**
12. Select loop start for Channel 1 by using DIP switch SW1-1.
 - The factory setting is DOWN for loop start.**
13. Select loop start for Channel 2 by using DIP switch SW3-1.
 - The factory setting is DOWN for loop start.**
14. Select transmit direction by using DIP switch SW10-6.
 - Place SW10-6 in the UP position to transmit in the B direction and receive from the A direction. To transmit in the A direction and receive from the B direction, place SW10-6 in the DOWN position. Unless otherwise specified at time of order, SW10-6 is set in the DOWN position at the factory to transmit in the A direction, and receive from the B direction.**
15. If you plan to operate the RFL VF-15C module under local control, perform the following steps; otherwise, go to step 16 for remote control.
 - a. Set to local control by placing DIP switch SW10-7 in the UP position.
 - b. Turn service on by placing DIP switch SW10-8 in the UP position.
 - c. Slide the module into the selected module slot until it is firmly seated and the module front panel is flush with the top and bottom of the shelf.
 - d. Go to step 17.
16. If you plan to operate the RFL VF-15C module under remote control, perform the following steps:
 - a. Set to local control by placing DIP switch SW10-7 in the UP position.
 - b. Select normal or enhanced mode using DIP switch SW9-7.
 - c. Turn service off by placing DIP switch SW10-8 in the DOWN position.
 - d. Slide the module into the selected module slot until it is firmly seated and the module front panel is flush with the top and bottom of the shelf.

- e. Wait 15 seconds for the RFL VF-15C module's parameter settings to be loaded into the shelf Common Module.
 - f. Pull the module out of the shelf and place DIP switch SW10-7 in the DOWN position.
Do not move SW10-8.
 - g. Slide the module back into the shelf.
 - h. Verify the module configuration through remote control by issuing a "CONFIG?" query. See the Remote Control Interface section of this Instruction Data Sheet for an explanation of the "CONFIG?" response.
 - i. Turn service on through remote control by issuing a "SRVC=ON" command.
The RFL VF-15C's operating parameters can now be changed by remote control. See the Remote Control Interface section of this Instruction Data Sheet for more information.
 - j. Go to step 17.
17. On the Module Record Card located to the right of the shelf, record the channel bank type, time slot, and any other pertinent information.
18. Verify that the signal levels are set for optimum performance as follows: If the input signal level and desired output signal level are known, the level setting switches can be easily set as described in step 9 on page 7. If the levels are not known, this paragraph will aid the user in selecting the appropriate settings.

The two major purposes of the level switches is to:

- 1. make the best use of the dynamic range in the digital domain and
- 2. set the desired output level.

The VF-15C allows for low-level audio signals to be amplified prior to their conversion to digital signals (A/D). Setting the level controls as described in Step 9 on page 7 will make use of most of the available dynamic range in the digital domain. With maximum signal applied to the unit, the signal level at TP-4 and TP-8 for channel 1 and channel 2 respectively should be approximately 2.6 Vpp.

With the actual signal applied, measure the level at TP-4 for channel 1 or TP-8 for channel 2. The objective is to provide a nominal 2.6 Vpp signal into the A/D. Therefore, the required change in level setting is:

Level adjustment change (dB) = $20 \log (2.6 \text{ Vpp} / \text{Vpp measured at TP-4 or TP-8})$

Make the required adjustment to the Tx level setting and re-check the test point voltage.

After setting the transmit level, the receive side level adjustment can be varied to achieve the desired output level.

The RFL VF-15C is now installed. If your multiplexer is set up for remote access and control, you can now change the operating parameters of the module by using simple commands. For more information on remote access and control, consult your multiplexer operation manual.

FUNCTIONAL DESCRIPTION

Figure 5 is a simplified block diagram of the RFL VF-15C module. The module consists of two independent audio circuits which share digital interface and control logic circuitry. Each of the audio circuits contains a Data Access Arrangement (DAA) hybrid circuit which serves as the interface to the telephone line. The hybrid contains circuitry for combining the transmit and receive audio, controlling loop current, and ring voltage detection. The hybrid also provides the required isolation of the external signals.

The audio signals (both transmit and receive) are processed by a volume control circuit to adjust levels. The analog-to-digital (A/D) and digital-to-analog (D/A) conversions and companding are performed by CODECs.

The interface to the multiplexer backplane is performed by bus drivers and receivers. All of the controlling logic functions are contained in the logic array. This custom device reads the local switches, controls the LEDs and audio circuits, and interfaces to the bus and common logic module.

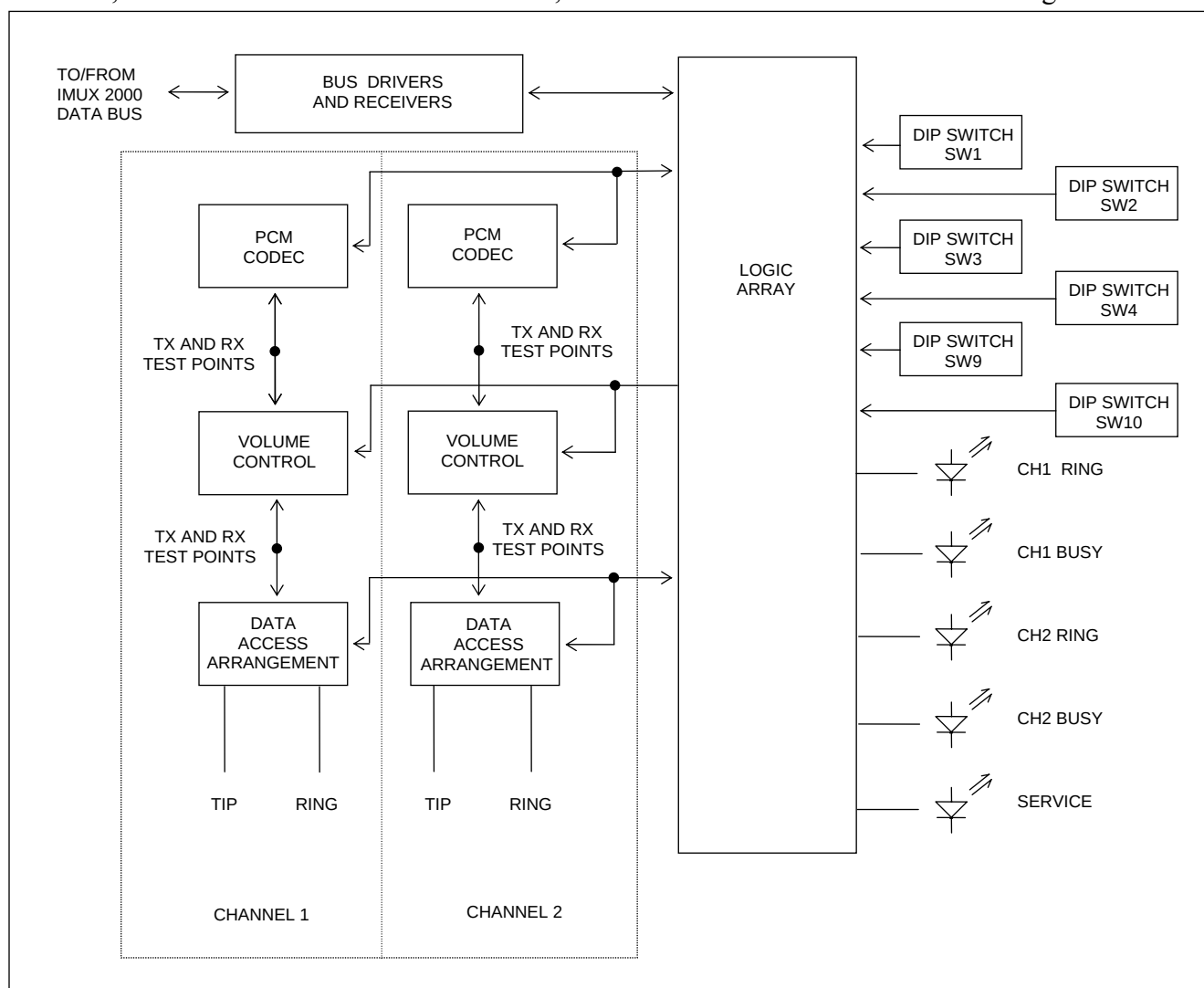


Figure 5. Functional block diagram, RFL VF-15C module.

LOOP START CIRCUITS

Loop start circuits are normally used where the circuit operates a telephone controlled by a person. Examples of this include an Off-Premise Extension (OPX) circuit from a PBX, and some Foreign Exchange (FX) circuits. Loop start is the most commonly used type of circuit.

Note: The VF-15C Voice Module will not support ground start.

ALERTS/ALARMS

The RFL VF-15C module reports no module level ALERT or ALARM signals to the shelf Common Module.

REMOTE CONTROL INTERFACE

When installed in an IMUX 2000 remote controllable shelf, the RFL VF-15C module can be operated under local or remote control. When under remote control, certain configuration parameters can only be changed through the RS-232 remote port on the multiplexer. The remote interface for these modules involves two codes: a “P” (parameter) code, and an “S” (status) code. See the IMUX 2000 instruction manual for more information on the remote control interface.

The RFL VF-15C reports itself as a “Type 78” module when installed in an E1 system, and reports itself as a “Type 69” module when installed in a T1 system.

“P” CODES

“P” codes, when used in the parameter field on a “SET” command, allow the user to set certain parameters on the module by remote control, just like setting the switches on a module under local control. “P” codes also appear in the response to a “CONFIG?” query, showing the current parameter settings on the module.

There are two “P” codes for the RFL VF-15C when operated in “normal” mode in T1 or E1 systems: P1 and P2. There are six “P” codes for the RFL VF-15C when operated in “enhanced” mode in T1 or E1 systems: P1, P2, P3, P4, P5 and P6. Each of these P codes can be a decimal number from 0 to 255, which can also be represented as an eight-digit binary number (in parenthesis). The binary representation is more useful for setting and interpreting the “P” codes, since each binary digit (0 or 1) corresponds to the ON or OFF setting for a particular switch on the module. Table 5 describes the meanings of the “P” codes for the RFL VF-15C in normal mode. Table 6 describes the meanings of the “P” codes for the RFL VF-15C in enhanced mode.

A typical RFL VF-15C response to a “CONFIG?” query of a T1 or E1 system in normal mode looks like this:

```
* OK
CHANNEL CARD 3, TYPE 78 (or 69)
UNDER REMOTE CONTROL
SVCE = ON
P01 = 3 (B00000011)
P02 = 1 (B00000001);
```

NOTE

When using binary numbers with a SET command, they must be preceded by the letter “B” as shown in the following example:

```
<MULTIPLEXER ADDRESS>:<CARD ADDRESS>:SET:P1 = B00000011;
```

Besides using the P code, it is also possible to turn module service on or off by sending one of the following in the parameter field with a SET command:

```
SRVC = ON
SRVC = OFF
```

Table 5. Remote configuration settings (“P” codes) for T1/E1 in normal mode

P Code	Digit(s) And Switch Equivalent	Value ⁽¹⁾	Description
P1	B 0 0 0 0 0 0 0 0 - - - ↑↑↑↑↑ TIME SLOT SELECT	00001 to 11000 T1 Settings	From left to right, these five bits represent the binary value of the desired time slot between 1 through 24 in a T1 network. See Table 8 for a complete list of these values.
		00001 to 11111 E1 Settings	From left to right, these five bits represent the binary value of the desired time slot between 1 through 31 in an E1 network. See Table 8 for a complete list of these values.
	B 0 0 0 0 0 0 0 0 - - ↑ - - - - LOOP START 1	0	Not used.
		1	Sets Channel 1 for loop start.
	B 0 0 0 0 0 0 0 0 - ↑ - - - - - TERM	0	This setting may be used only in a drop/insert multiplexer. If the module is installed in a terminal multiplexer, this digit should always be set to “1”. If the module is installed in a drop/insert multiplexer, set this digit to a “1” to transmit in the A direction and receive from the B direction. Set this digit to “0” to transmit in the B direction and receive from the A direction. (For guidelines on setting channel module direction, refer to the IMUX 2000 instruction manual).
		1	This setting is required when the module is installed in a terminal multiplexer.
	B 0 0 0 0 0 0 0 0 ↑ - - - - -	...	Not used.
P2	B 0 0 0 0 0 0 0 0 - - - - - ↑ LOOP START 2	0	Not used.
		1	Sets Channel 2 for loop start.
	B 0 0 0 0 0 0 0 0 - - - - ↑ - - SIGNALING DELAY ⁽²⁾	0	Sets No Delay on both channels
		1	Sets Signaling Delay on both channels
	B 0 0 0 0 0 0 0 0 - - - - ↑ - - CH2 OFF	0	Sets both channels for dual-channel operation.
		1	Sets Channel 2 off for single-channel operation.
	B 0 0 0 0 0 0 0 0 ↑↑↑↑ - - ↑ -	...	Not used.

1. These are the only legal values for setting the parameters. Setting any parameter to a value outside its specified range will produce an unpredictable result.
2. Only available for E1 in normal mode. For T1 in normal mode, use DIP switches.

Table 6. Remote configuration settings (“P” codes) for T1/E1 in enhanced mode

P Code	Digit(s) And Switch Equivalent	Value ⁽¹⁾	Description
P1	B 0 0 0 0 0 0 0 0 - - - ↑↑↑↑↑↑ TIME SLOT SELECT	00001 to 11000 T1 Settings	From left to right, these five bits represent the binary value of the desired time slot between 1 through 24 in a T1 network. See Table 8 for a complete list of these values.
		00001 to 11111 E1 Settings	From left to right, these five bits represent the binary value of the desired time slot between 1 through 31 in an E1 network. See Table 8 for a complete list of these values.
	B 0 0 0 0 0 0 0 0 - - ↑ - - - - LOOP START 1	0	Not used.
		1	Sets Channel 1 for loop start.
	B 0 0 0 0 0 0 0 0 - ↑ - - - - - TERM	0	This setting may be used only in a drop/insert multiplexer. If the module is installed in a terminal multiplexer, this digit should always be set to “1”. If the module is installed in a drop/insert multiplexer, set this digit to a “1” to transmit in the A direction and receive from the B direction. Set this digit to “0” to transmit in the B direction and receive from the A direction. (For guidelines on setting channel module direction, refer to the IMUX 2000E instruction manual).
		1	This setting is required when the module is installed in a terminal multiplexer.
	B 0 0 0 0 0 0 0 0 ↑ - - - - -	...	Not used.
P2	B 0 0 0 0 0 0 0 0 - - - - - ↑ LOOP START 2	0	Not used.
		1	Sets Channel 2 for loop start.
	B 0 0 0 0 0 0 0 0 - - - - ↑ - - SIGNALING DELAY 1	0	Sets No Delay for channel 1 in E1.
		1	Sets Signaling Delay for channel 1 in E1.
	B 0 0 0 0 0 0 0 0 - - - - ↑ - - CH2 OFF	0	Sets both channels for dual-channel operation.
		1	Sets Channel 2 off for single-channel operation.
	B 0 0 0 0 0 0 0 0 ↑↑↑↑ - - ↑ -	...	Not used.
P3	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑↑↑↑ TX LEVEL CHANNEL 1	0000000 to 1111111	Sets Transmit Level for channel 1 in 0.5 dB increments/decrements from 0 dB center at 01000000.
	B 0 0 0 0 0 0 0 0 ↑ - - - - -	...	Not used.

>> table continues on next page <<

Table 6. continued - Remote configuration settings (“P” codes) for T1/E1 in enhanced mode

P Code	Digit(s) And Switch Equivalent	Value ⁽¹⁾	Description
P4	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑↑↑↑ RX LEVEL CHANNEL 1	0000000 to 1111111	Sets Receive Level for channel 1 in 0.5 dB increments/decrements from 0 dB center at 01000000. Increment for lower Rx input levels to termination. Decrement for higher Rx input levels to termination.
	B 0 0 0 0 0 0 0 0 ↑ - - - - - SIGNALING DELAY 1	0	No delay on Channel 1 (For use in T1 only) Sets Signaling Delay for channel 1 in T1.
		1	Delay on Channel 1 - default setting (For use in T1 only) Sets No Delay for channel 1 in T1.
P5	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑↑↑↑ TX LEVEL CHANNEL 2	0000000 to 1111111	Sets Transmit Level for channel 2 in 0.5 dB increments/decrements from 0 dB center at 01000000. (40H)
	B 0 0 0 0 0 0 0 0 ↑ - - - - -	...	Not used.
P6	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑↑↑↑ RX LEVEL CHANNEL 2	0000000 to 1111111	Sets Transmit Level in 0.5 dB increments/decrements from 0 dB center at 01000000. Increment for lower input levels. Decrement for higher input levels
	B 0 0 0 0 0 0 0 0 ↑ - - - - - SIGNALING DELAY 2	0	No delay on Channel 2 (Used in T1 and E1)
		1	Delay on Channel 2 - default setting (Used in T1 and E1)

1. These are the only legal values for setting the parameters. Setting any parameter to a value outside its specified range will produce an unpredictable result.

“S” CODES

“S” codes appear in response to a “STATUS?” query. There is one “S” code for the RFL VF-15C when operated in normal or enhanced modes in T1 or E1 systems. Like the “P” code, this number is displayed in both decimal and binary form. The four least significant digits of the binary number represent the conditions shown in Table 7. The four most significant digits are not used.

A typical response to a “STATUS?” query looks like this:

*** OK**
CHANNEL CARD 3, TYPE 78 (or 69)
S01 = 3 (B00000011);

Table 7. Remote status messages (“S” codes) for T1/E1 nominal and enhanced

S CODE	Position	Value	Description
S1	B 0 0 0 0 0 0 0 0 - - - - - ↑	0	Channel 1 idle
		1	Channel 1 busy
	B 0 0 0 0 0 0 0 0 - - - - - ↑ -	0	Channel 2 idle
		1	Channel 2 busy
	B 0 0 0 0 0 0 0 0 - - - - - ↑ - -	0	Channel 1 ringing
		1	Channel 1 not ringing
	B 0 0 0 0 0 0 0 0 - - - - ↑ - - -	0	Channel 2 ringing
		1	Channel 2 not ringing
	B 0 0 0 0 0 0 0 0 - ↑ - ↑ - - - -	0	Configuration valid
		1	Configuration not valid
	B 0 0 0 0 0 0 0 0 - - ↑ - - - - -	0	Normal Mode (compatible)
		1	Enhanced Mode
	B 0 0 0 0 0 0 0 0 ↑ ↑ - - - - -	01	VF-15C (This module present)

TESTING

After the RFL VF-15C module has been configured and installed, it should be tested for proper operation before it is put into service. If a module is set up for two-channel operation, test each channel separately.

EQUIPMENT REQUIRED

1. Telephone Set, Type 2500 or equivalent (for RFL VF-16 module).
2. PBX Station Line (RFL VF-15C only).
3. Ring Generator.
4. 48-Volt Battery.

FXO/FXS TEST PROCEDURE

1. Verify that a ring generator and -48-volt talk current battery are connected to the multiplexer containing the RFL VF-16 module, as described in the Installation section of the multiplexer manual.
2. Connect the PBX line to the channel under test on the RFL VF-15C module.
3. Connect the telephone to the channel under test on the RFL VF-16 module.
4. Check the setting of DIP switches SW6-1 through SW6-5 on the VF-16 module. Check the setting of DIP switches SW10-1 through SW10-5 on the VF-15C module. Make sure that both modules are set to the same time slot.
5. Set both channels on both modules to Loop Start by setting DIP switches SW5-1 and SW6-6 in the DOWN position for the VF-16 module, and DIP switches SW1-1 and SW3-1 in the DOWN position for the VF-15C module.
6. Set both modules to local control by setting DIP switch SW6-9 in the UP position for the VF-16 module, and DIP switch SW10-7 in the UP position for the VF-15C module.
7. Set service on for both modules by setting DIP switch SW6-10 in the UP position for the VF-16 module, and DIP switch SW10-8 in the UP position for the VF-15C module.
The Service LED should be ON, on both modules. All other LEDs should be OFF.
8. Take the phone connected to the RFL VF-16 module off-hook and observe the presence of a dial tone from the PBX.

The green LEDs at the VF-16 (DS5 for channel 1, or DS6 for channel 2) and VF-15C (DS2 for channel 1 or DS4 for channel 2) should both be ON, indicating an Off-Hook condition.

9. Dial an extension and verify that the extension rings.
If your phone system requires Fast Signaling set switch SW5-3 to the UP position (for no delay) at the VF-16 location. See step 11 on page 13 for setting No Signaling Delay on VF-15C modules.
10. Answer the extension and verify that the voice level is adequate in both directions, and that the noise level is acceptably low.
11. Place both phones back on hook. Using the extension, dial the number of the line connected to the RFL VF-16 under test.
The phone connected to the RFL VF-16 should ring 2 seconds on, and 4 seconds off. While it is ringing, the amber LED on the front of the VF-15C (DS1 for channel 1, or DS3 for channel 2) should light.
12. Answer the ringing phone and verify that ringing stops and voice quality is acceptable.
The green LEDs at the VF-16 (DS5 for channel 1, or DS6 for channel 2) and VF-15C (DS2 for channel 1 or DS4 for channel 2) should both be ON. The amber LED on the VF-15C will be OFF.
13. If there is a problem with the audio signal at either end, the system may not be properly configured for the signal levels being applied. Low levels may be due to too much attenuation at either end. Clipping (distortion of the waveform) may be due to excessive gain at either end. Refer to step 18 on page 14 for additional information.
14. Change the settings on both modules, if necessary, to suit the desired circuit configuration. The circuit may now be placed in service.

TROUBLESHOOTING

If there is an apparent malfunction, first check that the configuration is appropriate for the transmission system in use, and that the transmit and receive configurations are identical.

Problems may occur at the common equipment or facility level that may affect the operation of this module. Refer to the “Maintenance “ section in your multiplexer manual for system analysis procedures.

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RFL Electronics Inc.

INSTRUCTION DATA

Dual-Channel Foreign Exchange Voice Module For RFL IMUX 2000 Intelligent T1 And E1 Multiplexers

RFL VF-16B (Station End)

WARNING

Extreme care must be used to avoid creating a safety hazard when employing long 2-wire telephone circuits which extend more than 100 feet (30 meters). Ground potential rise and/or induced AC voltages can result in injury or death under normal operating conditions and especially under fault conditions. RFL recommends against the use of this product in applications where the 2-wire telephone circuit extends beyond the perimeter of the substation ground mat. It is the installer's responsibility to ensure that all local, state, federal, and corporate safety standards and practices are complied with in any installation.

DESCRIPTION

The RFL VF-16B is a Two-Wire Foreign Exchange Station End (FXS) module. It is designed for use in RFL IMUX 2000 terminal and drop/insert T1 and E1 multiplexers, and other RFL network interface products. It accepts one or two independent voice channels as input, using PCM coding to convert each channel into a 64-Kbps digital signal. The digital signal is then transmitted over T1/E1 or other digital communication facilities.

A circuit with an RFL VF-16B module at one end and an RFL VF-15, 15C or 15E module at the other end can provide a Foreign Exchange (FX) line or an Off-Premise Extension (OPX) line. An Automatic Ring Down (ARD) line can be set up by using RFL VF-16B modules at both ends of the circuit, or by using a VF-16B at one end and a VF-16, VF-16A or VF-16E at the other end. The RFL VF-16B does not normally require an external ring generator or a -48 Volt supply. However if enhanced distance and ring capabilities are required, an external ring generator can be connected via a module adapter.

These modules are remote-controllable when installed in an RFL IMUX 2000 remote-controllable shelf. User-adjustable switches and jumpers allow the configuration of the following parameters:

- o One-channel or two-channel operation
- o Automatic Ring Down (ARD)
- o Individual channel enable/disable
- o Remote control configuration and status reporting
- o Independent selectable transmit/receive direction for each channel
- o Extended range input/output level compensation
- o Independent selectable time slot assignment for each channel
- o Variable signaling delay
- o Ring voltage level*
- o Ring voltage dc offset*
- o Loop current level
- o Line Fault Detection

* Not used with Module Adapter MA-302 and MA-302A (external ring generator).

SPECIFICATIONS

As of the date this Instruction Data Sheet was published, the following specifications apply to all RFL VF-16B Dual-Channel Foreign Exchange Station End Voice Modules. Because all of RFL products undergo constant refinement and improvement, these specifications are subject to change without notice.

Configuration: Two independent voice channels per module.

Time Slots:

One-Channel Operation: Requires one user-selectable 64-Kbps time slot.

Two-Channel Operation: Requires any two user-selectable 64-Kbps time slots.

Signal Levels:

Nominal System Gain: 0 dB

Transmit and Receive Level Adjust: +/- 9.5 dBm

Maximum Signal Level (analog or digital): 3.14 dBm

Frequency Response:

300 to 3000 Hz: +0.3 to -0.6 dB

3000 to 3300 Hz: +0.0 to -1.5 dB

Idle Channel Noise: Less than 15 dBnco

Impulse Noise Threshold Level (Maximum Counts Per 30-minute Interval):

41 dBnco: 10.0 counts

51 dBnco: 1.0 count

58 dBnco: 0.1 counts

Signal-To-Distortion (1004 Hz to 1020 Hz input):

0 to -30 dBm0: Greater than 35.5 dB

-40 dBm0: Greater than 31 dB
-45 dBm0: Greater than 25 dB

Nominal Impedance: 600 Ω standard

Crosstalk Coupling:

400 Hz: 49 dB
700 - 1100 Hz: 59 dB
1100 - 3000 Hz: 58 dB
3700 Hz: 49 dB

Tracking (gain deviation for a 1004-Hz input):

+3 to -37 dBm0: 0.5 dB maximum
-37 to -50 dBm0: 1.0 dB maximum
-50 to -60 dBm0: 2.0 dB maximum

Peak-To-Average Ratio (PAR): Greater Than 94

VF-16B Power Consumption:

Both Channels On-Hook with one phone per channel (factory default settings):
160mA@5V, 35mA@15V
Both Channels Off-Hook with one phone per channel (factory default settings):
210mA@5V, 95mA@15V
Both Channels Ringing with one phone per channel (factory default settings):
157mA@5V, 110mA@15V

Note 1: When connected to multiple phones and/or set to non-default settings, the board can draw up to a total of 255mA@5V, and 225mA per channel @15V.

Note 2: When determining the power capacity in any given IMUX 2000 shelf, the power consumption of the VF-16B is based on both channels ringing one phone per circuit with an REN=1. If multiple phones are interconnected on each channel, please consult the factory for proper power consumption that could impact the channel card capacity.

MA-302 and MA-302A Power Consumption:

TBD

Signaling Format:

T1 systems: RBS (Robbed-Bit Signaling)
E1 systems: CAS (Channel Associated Signaling)

Nominal Off-Hook Detection Threshold: 4.75 k Ω

Nominal Ringing Voltage: (Not used with external Ring Generator MA-302 and MA-302A).
Vtip to Vring

Vrms	Optional Vdc Offset	Frequency	MAX REN @ $\leq$ 100 ft.
40.5	+30	20 Hz +/- 1%	5
45	+20	20 Hz +/- 1%	5
53	+10	20 Hz +/- 1%	5
63.5	NA	20 Hz +/- 1%	3.2

Automatic Ring Down (ARD): Requires RFL VF-16, VF-16A, VF-16B or VF-16E FXS modules on each end of circuit. Ring 1.5 seconds on, 4.5 seconds off, with a ringback tone of 440 Hz. If VF-16Bs are on both ends, ringback is dual tone 440 Hz and 480 Hz.

Interface: MA-301, MA-301C, MA-303, MA-303B, MA-304, MA-304B, MA-302 or MA-302A module adapters. (See page 5 for more information.)

Testing: Two Bantam jacks (Drop/Line) provided for each channel.

Operating Temperature: -20°C to +55°C (-4°F to +131°F).

Relative Humidity: Zero to 90 percent, non-condensing.

INSTALLATION

Before the RFL VF-16B can be placed in service, it must be installed in a multiplexer shelf. Installation involves determining the module slot in the Main Shelf or Expansion Shelf where the module will be installed, inserting a Module Adapter into the rear of the shelf behind the module slot, connecting all signal wiring to the Module Adapter, checking the settings of all switches, and inserting the module into the front of the shelf.

NOTES

1. Power supply and time slot considerations may affect the installation of this module into an existing multiplexer shelf. Refer to the multiplexer manual for more information.
2. **On-Board Ring Generator:** Normally ring generators external to the chassis are not required because the VF-16B module has an on-board ring generator. However module adapter MA-302 and MA-302A use an external ring generator for enhanced distance and ring capabilities.

Although the VF-16B may be used with the MA-304 and MA-304B module adapters (which have ring generators), the VF-16B will disable the on-board ring generators.

The following instructions are provided for installing RFL VF-16B modules into existing systems. If the module was included as part of a system, installation was done at the factory. Otherwise, proceed as follows:

1. Carefully inspect the module for any visible signs of shipping damage. If you suspect damage to the module, immediately call RFL Customer Service at the number listed at the bottom of this page.
2. Determine the module slot in the Main Shelf or Expansion Shelf where the module will be installed.

The RFL VF-16B module occupies one module slot in the Main Shelf or Repeater Shelf.

3. Determine which Module Adapter will be used to make connections to the RFL VF-16B module.

Each module in the IMUX 2000 multiplexer requires a Module Adapter. The module adapter provides the appropriate connector for the desired interface.

There are eight Module Adapters that are compatible with the RFL VF-16B:

<u>Model Number</u>	<u>Voice Connections</u>	<u>Application</u>	<u>Figure</u>
MA-301	50-pin Telco Connector	Used with multiple VF-15 or VF-16 modules	1 & 2
MA-301C	50-pin Telco Connector	Used with multiple VF-15 or VF-16 modules	1 & 2
MA-303	RJ-11 Jack	Used with all VF-16B modules	3
MA-303B	Removable terminal block	Used with all VF-16B modules	4
MA-304	RJ-11 Jack	Used with all VF-16B modules (MA-304 ring generator will be automatically disabled)	3
MA-304B	Removable terminal block	Used with all VF-16B modules (MA-304 ring generator will be automatically disabled)	4
MA-302	RJ-11 Jack terminal block	Used with all VF-16B modules Requires external ring generator	5
MA-302A	RJ-11 Jack (two) terminal block	Used with all VF-16B modules Requires external ring generator	5

The MA-301 accepts a 50-pin Telco connector (Amphenol 57-30500 or equivalent, as shown in Figure 1.) One MA-301 Module Adapter can be used to connect up to three RFL VF-15 or RFL VF-16 modules, for a total of up to six voice channels. If you will be using more than one module with the MA-301, they must be inserted into adjacent slots in the multiplexer. Ribbon cables are provided with the MA-301 to make connections to it from the second and third module locations. (See Figure 2.)

The MA-301C is similar to the MA-301, except it has different connector pinouts.

The MA-303 Module Adapter is designed for use with all RFL VF-16B station-end modules. Each MA-303 provides two RJ-11 jacks for connection to the voice circuits for channel 1 and channel 2, and two bantam jacks (Line and Drop) for each channel. (See Figure 3.) Each Line jack provides access to the equipment from the line side, and each Drop jack provides access to the line from the equipment side.

The MA-303B is similar to the MA-303, except it has removable terminal blocks in place of the RJ-11 connectors for the voice connection. (See Figure 4.)

The MA-304 is similar to the MA-303, but it has a built-in ring generator. It can be used with all RFL VF-16B modules, but the MA-304 ring generator will be automatically disabled.

The MA-304B is similar to the MA-304, except it has removable terminal blocks in place of the RJ-11 connectors for the voice connection.

The MA-302 has a single channel voice connection via an RJ-11 jack. A terminal block is provided for connection to an external ring generator. Used for applications that require longer distances (up to 2 miles or 3.2 km) or higher ring voltages. (See Figure 5.)

The MA-302A has a dual channel voice connection via two RJ-11 jacks. A terminal block is provided for connection to an external ring generator. Used for applications that require longer distances (up to 2 miles or 3.2 km) or higher ring voltages. (See Figure 5.)

Make sure the module adapter you are installing is correct for the desired application.

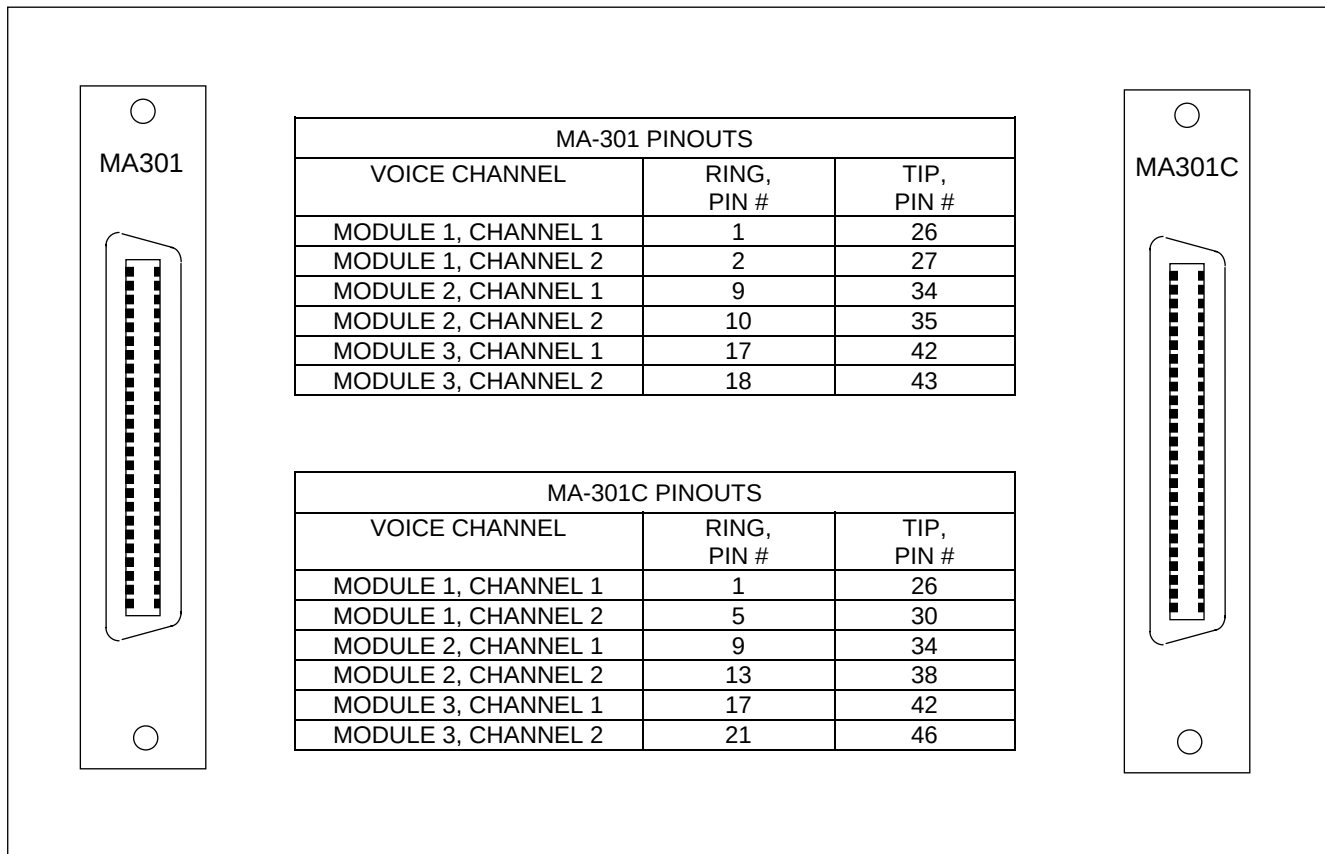


Figure 1. MA-301 and MA-301C Module Adapters

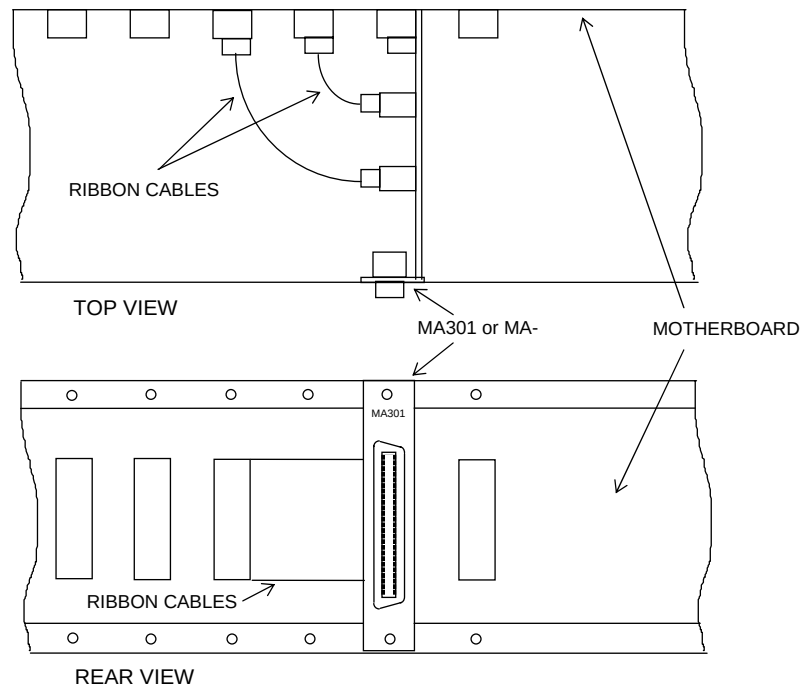


Figure 2. Using MA-301or MA-301C Module Adapters with multiple RFL VF-16B modules

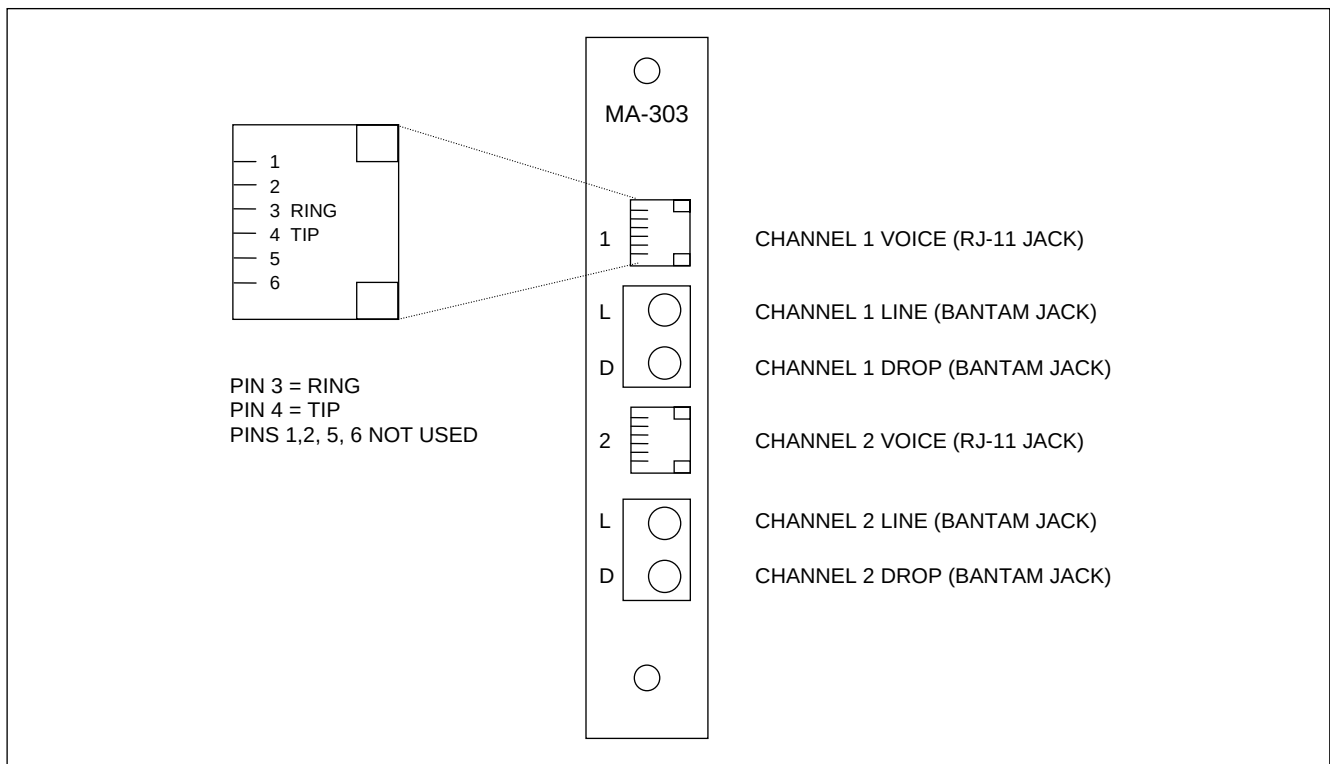


Figure 3. MA-303 Module Adapter, used with all RFL VF-16B station end modules. The MA-304 Module Adapter is similar in appearance.

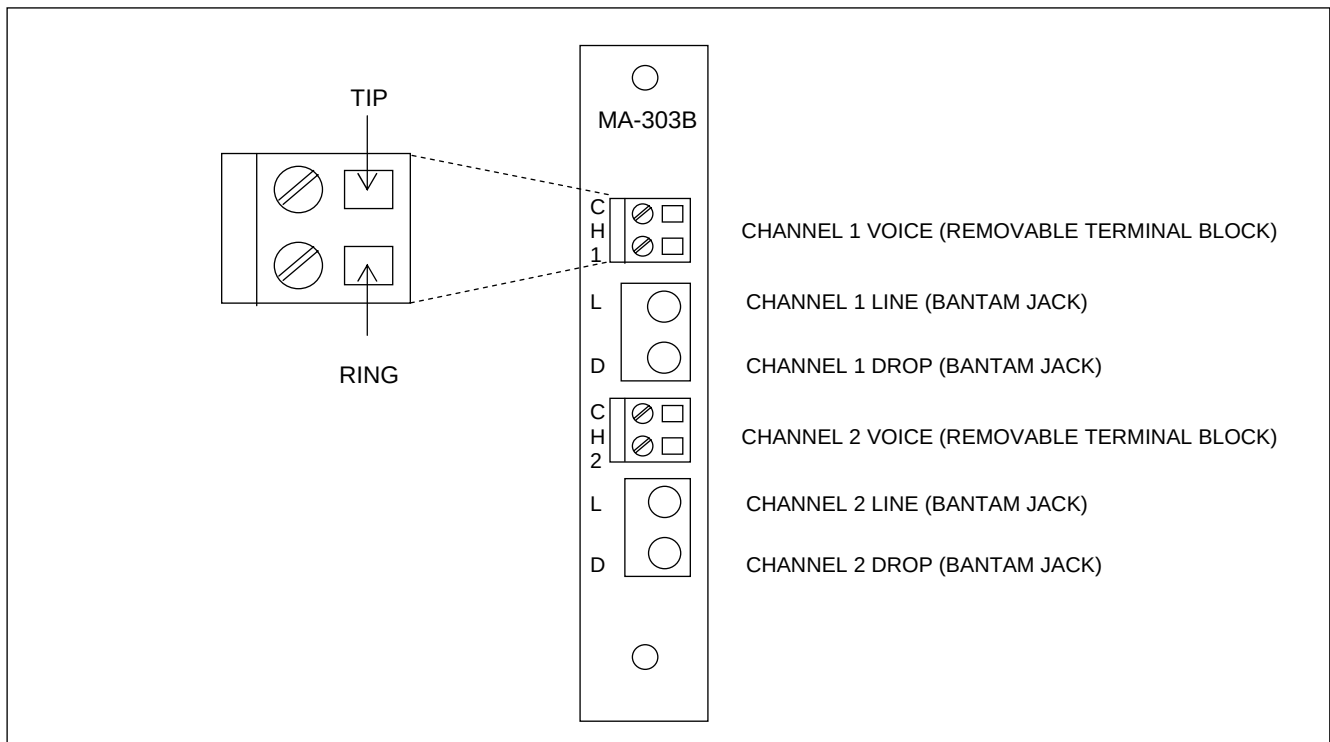


Figure 4. MA-303B Module Adapter, used with all RFL VF-16B station end modules. The MA-304B Module Adapter is similar in appearance.

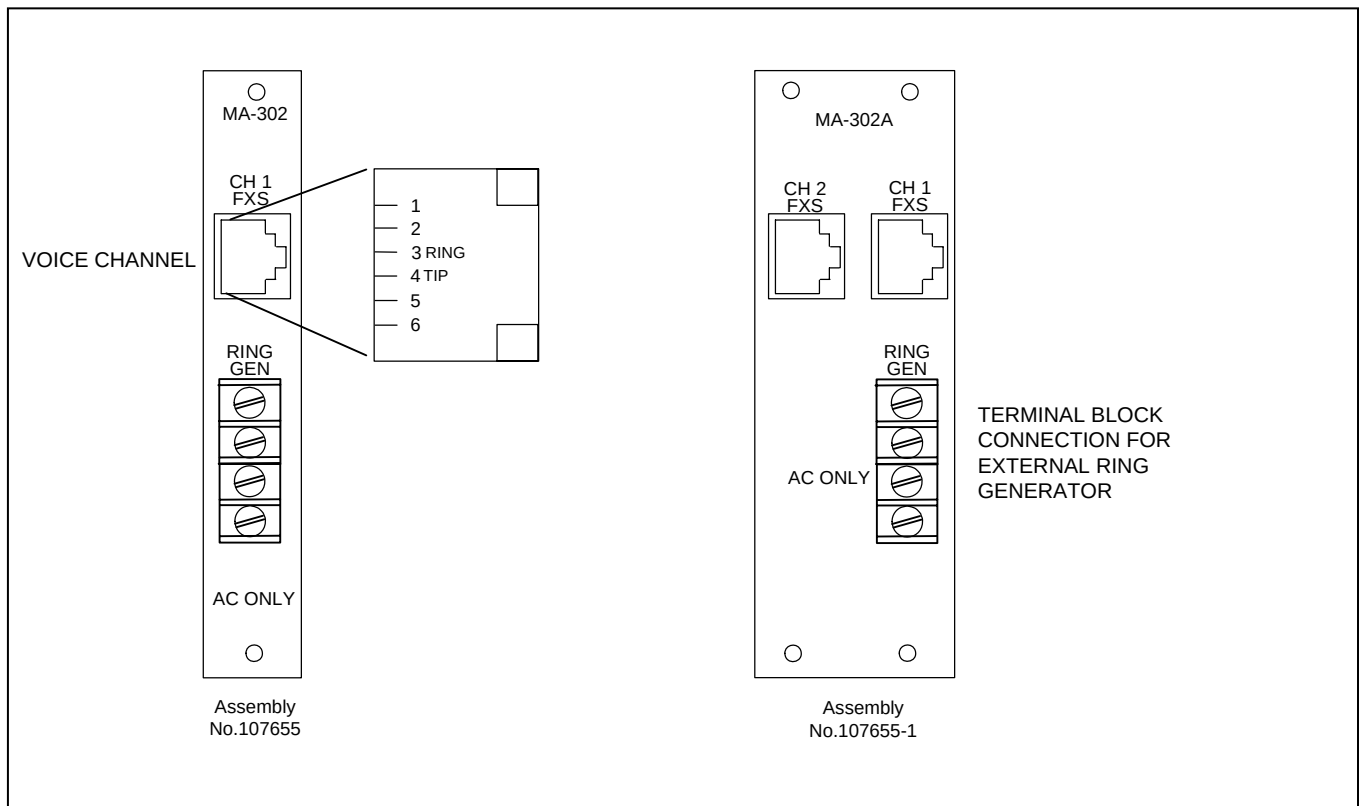


Figure 5. MA-302 and MA-302A, used with the RFL VF-16B station end modules.

4. Insert the Module Adapter into the rear of the shelf directly behind the module slot where the RFL VF-16B module will be installed, and make all connections to the Module Adapter.
 - If an MA-301 or MA-301C Module Adapter is being used, plug the 50-pin Telco cable end connector into its mating 50-pin connector on the module adapter. See Figure 1 and 2.
 - If an MA-302, MA-302A Module Adapter is being used, plug the RJ-11 connector or connectors into the appropriate jack. Connect the external ring generator to the terminal block connections as shown in Figure 5.
 - If an MA-303 or 304 Module Adapter is being used, plug the RJ-11 (voice) connectors into the appropriate jack. Connect to the bantam jacks for the LINE and DROP channels as shown in Figure 3.
 - If an MA-303B or MA-304B Adapter is being used, connect the voice channels to the terminal blocks (TIP is the top terminal and RING is the bottom terminal). Connect to the bantam jacks for the LINE and DROP channels as shown in Figure 4.

5. Refer to Figure 6 and Table 1 for switch locations.
6. Set the address for the module using DIP switch SW1.
For remote access, each channel module in the shelf must have a distinct module address. Valid module addresses are the numbers 1 to 36, as shown in Table 2 of this Instruction Data Sheet. In a full-size shelf, this is usually set to the number of the physical slot the module will occupy. (Consult your multiplexer manual for details on using remote access and configuration features of the system.)
7. Set the position of SW2-6 to enable or disable channel 1.
Place SW2-6 in the UP position to enable channel 1. Place SW2-6 in the DOWN position to disable channel 1.
8. Set the position of SW3-6 to enable or disable channel 2.
Place SW3-6 in the UP position to enable channel 2. Place SW3-6 in the DOWN position to disable channel 2.
9. Set transmit/receive level switches SW4, SW5, SW7 and SW8 if settings other than factory standard are desired.
The transmit and receive levels can be set from - 9.5dB to +9.5dB, in 0.5dB steps. The values for these switch positions are shown in Table 3.

Switch settings are cumulative. For example, to set the level to +9dB, turn off switch position 1 to select “+” and turn on switch positions 2 and 5 to select 9dB. To set the level to -7.5dB, turn on switch position 1 to select “-” and turn on switch positions 3, 4, 5, and 6 to select 7.5dB.

The switches are set at the factory to provide a transmit level of 0dB, and a receive level of 0dB.
10. Select any unused time slot for channel 1 using SW2-1 through SW2-5.
The digitized voice signal of each RFL VF-16B module occupies one 64-Kbps digital time slot within the multiplexer’s aggregate rate. Use the settings shown in Table 7 to select which time slot the module uses. Consult your multiplexer manual for guidelines on time slot selection.

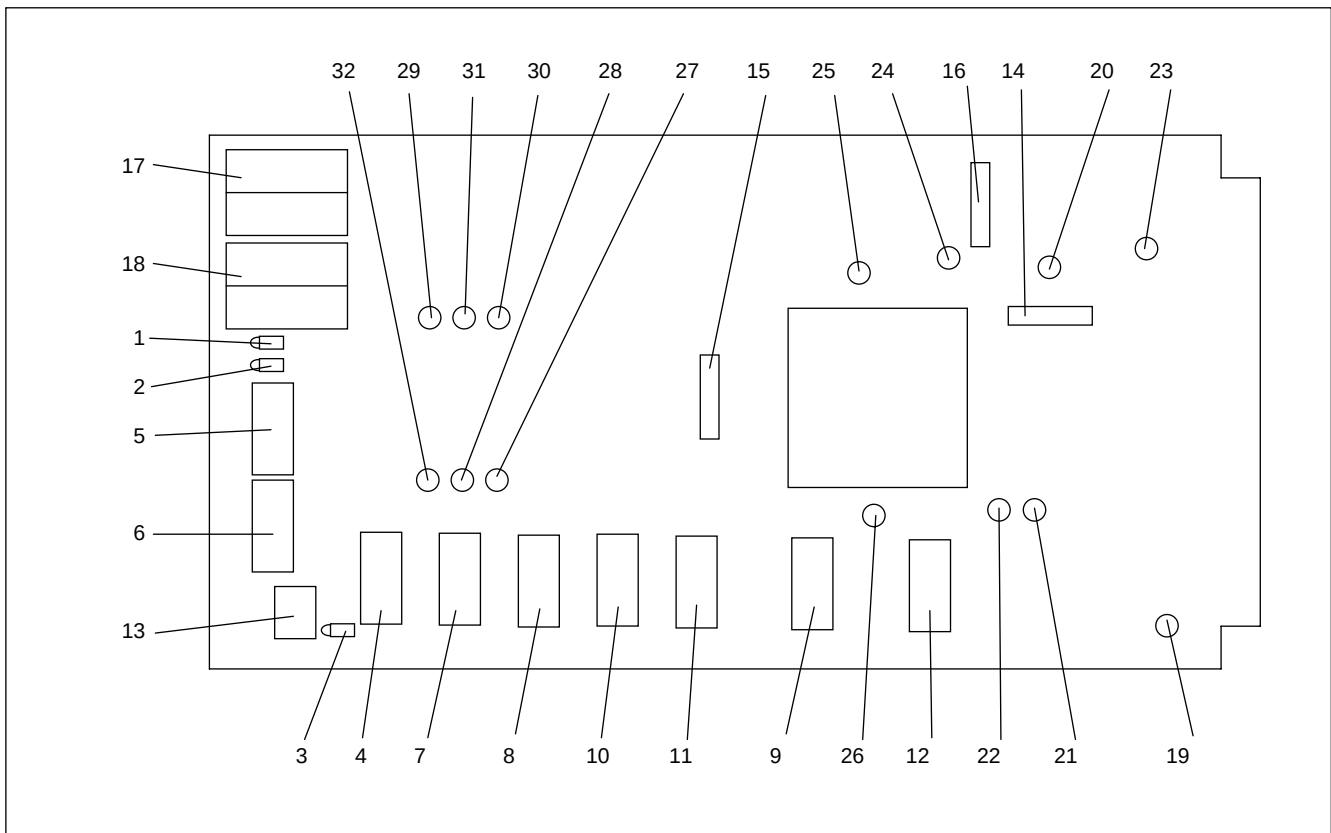


Figure 6. Controls and indicators, RFL VF-16B

11. Select any unused time slot for channel 2 using SW3-1 through SW3-5.
The digitized voice signal of each RFL VF-16B module occupies one 64-Kbps digital time slot within the multiplexer's aggregate rate. Use the settings shown in Table 7 to select which time slot the module uses. Consult your multiplexer manual for guidelines on time slot selection.
12. Select Channel 1 transmit direction using SW2-7.
Place SW2-7 in the UP position to transmit in the B direction and receive from the A direction. Place SW2-7 in the DOWN position to transmit in the A direction and receive from the B direction. Unless otherwise specified at time of order, SW2-7 is set in the DOWN position at the factory.
13. Select Channel 2 transmit direction using SW3-7.
Place SW3-7 in the UP position to transmit in the B direction and receive from the A direction. Place SW3-7 in the DOWN position to transmit in the A direction and receive from the B direction. Unless otherwise specified at time of order, SW3-7 is set in the DOWN position at the factory.
14. Enable or disable Automatic Ringdown (ARD) on Channel 1 by using DIP switch SW6-4.
Place SW6-4 in the OFF position for normal operation, or in the ON position for ARD operation. Unless otherwise specified at time of order, SW6-4 is set in the OFF position at the factory.

>> Text continues on page 17 <<

Table 1. Controls and indicators, RFL VF-16B modules

Item	Name/Description	Function
1	LED indicator (red)	Channel 1 busy (off hook). <i>See Note A at the end of this table.</i>
	LED indicator (yellow)	Channel 1 ringing.
	LED indicator (green)	Channel 1 enabled.
2	LED indicator (red)	Channel 2 busy (off hook). <i>See Note A at the end of this table.</i>
	LED indicator (yellow)	Channel 2 ringing.
	LED indicator (green)	Channel 2 enabled.
3	LED indicator (green)	Top indicates module service is ON.
	LED indicator (green)	Middle not used.
	LED indicator (green)	Bottom not used.
4	DIP Switch SW1	SW1-1 to SW1-6: Sets SCB address (Table 2) <i>See Note A at the end of this table.</i>
		SW1-7 and SW1-8: Spare
5	DIP Switch SW2	SW2-1 to SW2-5: Sets Channel 1 Timeslot (Table 7) <i>See Note A at the end of this table.</i>
		SW2-6: Channel 1 enable/disable UP: Channel 1 enabled DOWN: Channel 1 disabled
		SW2-7: Sets Channel 1 bus transmit direction UP: "B" direction (D & I only) DOWN: "A" direction (required for terminal multiplexer)
		SW2-8: Enables or disables Channel 1 loopback UP: Channel 1 loopback disabled DOWN: Channel 1 loopback enabled
6	DIP Switch SW3	SW3-1 to SW3-5: Sets Channel 2 Timeslot (Table 7)
		SW3-6: Channel 2 enable/disable UP: Channel 2 enabled DOWN: Channel 2 disabled
		SW3-7: Sets Channel 2 bus transmit direction UP: "B" direction (D & I only) DOWN: "A" direction (required for terminal multiplexer)
		SW3-8: Enables or disables Channel 2 loopback UP: Channel 2 loopback disabled DOWN: Channel 2 loopback enabled
7	DIP Switch SW4	SW4-1 to SW4-6 Sets Channel 1 Tx level (Table 3)
		SW4-7 and SW4-8 Spare
8	DIP Switch SW5	SW5-1 to SW5-6 Sets Channel 1 Rx level (Table 3)
		SW5-7 and SW5-8 Spare
9	DIP Switch SW6	SW6-1 and SW6-2 Channel 1 Ring Voltage (Table 4) <i>See Note B below</i>
		SW6-3 Channel 1 Ring DC Offset <i>See Note B below</i> ON: enables DC offset (Table 4) OFF: disables DC offset
		SW6-4 Channel 1 Automatic Ring Down ON: enables ARD OFF: disables ARD
		SW6-5 Channel 1 Loop Current ON: Loop current = 41 mA OFF: Loop current = 20 mA
		SW6-6 and SW6-7 Channel 1 Ring Delay (Table 5)
		SW6-8 Spare
10	DIP Switch SW7	SW7-1 to SW7-6 Sets Channel 2 Tx level (Table 3)
		SW7-7 and SW7-8 Spare

Note B – When using module adapter MA-302 or MA-302A always set to the factory default.

Table 1. continued - Controls and indicators, RFL VF-16B module

Item	Name/Description	Function
11	DIP Switch SW8	SW8-1 to SW8-6 Sets Channel 2 Rx level (Table 3)
		SW8-7 and SW8-8 Spare
12	DIP Switch SW9	SW9-1 and SW9-2 Channel 2 Ring Voltage (Table 4) <i>See Note B below</i>
		SW9-3 Channel 2 Ring DC Offset <i>See Note B below</i> ON: enables DC offset (Table 4) OFF: disables DC offset
		SW9-4 Channel 2 Automatic Ring Down ON: enables ARD OFF: disables ARD
		SW9-5 Channel 2 Loop Current ON: Loop current = 41 mA OFF: Loop current = 20 mA
		SW9-6 and SW9-7 Channel 2 Ring Delay (Table 5)
		SW9-8 Spare
13	DIP Switch SW10	SW10-1 and SW10-2 Loopback Mode (Table 6)
		SW10-3 Selects Local or Remote mode UP: Local mode DOWN: Remote mode
		SW10-4 Turns module service ON or OFF UP: Service is ON DOWN: Service is OFF
14	J1	U3 programming header (for factory use only)
15	J2	For factory use only (not included)
16	J3	U9 programming header (for factory use only)
17	J4	Channel 1 drop/line
18	J5	Channel 2 drop/line
19	Test point 1	Ground
20	Test point 2	+5V
21	Test point 3	+3.3V
22	Test point 4	+2.5V
23	Test point 5	+15V
24	Test point 6	+VPIC
25	Test point 7	For factory use only
26	Test point 8	For factory use only
27	Test point 9	Tip 2
28	Test point 10	Ring 2
29	Test point 11	CH1 VBAT
30	Test point 12	Tip 1
31	Test point 13	Ring 1
32	Test point 14	CH2 VBAT

Note A - If a self diagnosed line fault is detected on Channel 1, the tip-ring lines of Channel 1 will enter a high impedance state and all three Channel 1 (DS1) LEDs (off-hook[red], ringing [yellow], and CH enable [green]) will illuminate. NMS will also report off-hook and ringing for Channel 1. To exit this state, power must be cycled off and on for the board, or the channel must be disabled and then enabled, or the service to the card must be switched off and then on. The same line fault detection feature is present on Channel 2 (LEDs, DS2).

Note B – When using module adapter MA-302 or MA-302A always set to the factory default.

Table 2. Module address settings, VF-16B module

Module Address	SW1-1	SW1-2	SW1-3	SW1-4	SW1-5	SW1-6
1	OFF	OFF	OFF	OFF	OFF	ON
2	OFF	OFF	OFF	OFF	ON	OFF
3	OFF	OFF	OFF	OFF	ON	ON
4	OFF	OFF	OFF	ON	OFF	OFF
5	OFF	OFF	OFF	ON	OFF	ON
6	OFF	OFF	OFF	ON	ON	OFF
7	OFF	OFF	OFF	ON	ON	ON
8	OFF	OFF	ON	OFF	OFF	OFF
9	OFF	OFF	ON	OFF	OFF	ON
10	OFF	OFF	ON	OFF	ON	OFF
11	OFF	OFF	ON	OFF	ON	ON
12	OFF	OFF	ON	ON	OFF	OFF
13	OFF	OFF	ON	ON	OFF	ON
14	OFF	OFF	ON	ON	ON	OFF
15	OFF	ON	ON	ON	ON	ON
16	OFF	ON	OFF	OFF	OFF	OFF
17	OFF	ON	OFF	OFF	OFF	ON
18	OFF	ON	OFF	OFF	ON	OFF
19	OFF	ON	OFF	OFF	ON	ON
20	OFF	ON	OFF	ON	OFF	OFF
21	OFF	ON	OFF	ON	OFF	ON
22	OFF	ON	OFF	ON	ON	OFF
23	OFF	ON	OFF	ON	ON	ON
24	OFF	ON	ON	OFF	OFF	OFF
25	OFF	ON	ON	OFF	OFF	ON
26	OFF	ON	ON	OFF	ON	OFF
27	OFF	ON	ON	OFF	ON	ON
28	OFF	ON	ON	ON	OFF	OFF
29	OFF	ON	ON	ON	OFF	ON
30	OFF	ON	ON	ON	ON	OFF
31	OFF	ON	ON	ON	ON	ON
32	ON	OFF	OFF	OFF	OFF	OFF
33	ON	OFF	OFF	OFF	OFF	ON
34	ON	OFF	OFF	OFF	ON	OFF
35	ON	OFF	OFF	OFF	ON	ON
36	ON	OFF	OFF	ON	OFF	OFF

Table 3. Transmit/receive level settings, RFL VF-16B modules

Channel 1		Channel 2		Value
Transmit Level	Receive Level	Transmit Level	Receive Level	
SW4-1	SW5-1	SW7-1	SW8-1	+/-
SW4-2	SW5-2	SW7-2	SW8-2	8dB
SW4-3	SW5-3	SW7-3	SW8-3	4dB
SW4-4	SW5-4	SW7-4	SW8-4	2dB
SW4-5	SW5-5	SW7-5	SW8-5	1dB
SW4-6	SW5-6	SW7-6	SW8-6	0.5dB

Table 4. Ring Voltage switch settings, RFL VF-16B modules

Channel 1		Channel 2		AC Ring Voltage	Channel 1 Ring Voltage Offset		Channel 2 Ring Voltage Offset	
SW6-1	SW6-2	SW9-1	SW9-2		SW6-3 OFF	SW6-3 ON	SW9-3 OFF	SW9-3 ON
OFF	OFF	OFF	OFF	40.5	0 Vdc	30 Vdc	0 Vdc	30 Vdc
OFF	ON	OFF	ON	45	0 Vdc	20 Vdc	0 Vdc	20 Vdc
ON	OFF	ON	OFF	53	0 Vdc	10 Vdc	0 Vdc	10 Vdc
ON	ON	ON	ON	63.5	0 Vdc	0 Vdc	0 Vdc	0 Vdc

Table 5. Ring Delay switch settings, RFL VF-16B modules

Channel 1		Channel 2		Off-Hook Ring Delay	On-Hook Ring Delay
SW6-6	SW6-7	SW9-6	SW9-7		
OFF	OFF	OFF	OFF	No Delay	No Delay
OFF	ON	OFF	ON	200ms	400ms
ON	OFF	ON	OFF	300ms	600ms
ON	ON	ON	ON	400ms	800ms

Note: Ring Delay is used to avoid erroneous ringing during network disturbances. For this reason, several settings have been made available in order to maintain compatibility with certain phone system features (e.g. distinctive ringing).

Table 6. Loopback Mode Settings, RFL VF-16B modules

SW10-1	SW10-2	Loopback Mode
UP	UP	Analog
UP	DOWN	Full Analog
DOWN	UP	Digital
DOWN	DOWN	Dual Analog

Note: See page 17 and Figure 7 for a description of loopback modes.

VF-16B LOOPBACK MODES

The VF-16B has four loopback modes. Each of these is described below. Refer to Figure 7 for a pictorial description of loopback modes. See page 25 for more information on NMS. See page 26 for more information on SCL commands.

Digital Loopback

Digital loopback turns around data received from the bus, and transmits it right back onto the bus. The near end phone will still receive the signal from the bus. This is done in the digital section of the SLIC. This loopback can be activated at the near end by switch, NMS, or SCL commands.

Analog Loopback

Analog loopback exercises the VF-16B up to the SLIC's analog section. The phone connected directly to this channel will be looped onto itself. The near end phone will still transmit to the far end receiving equipment. This loopback can be activated at the near end by switch, NMS, or SCL commands.

Full Analog Loopback

Full analog loopback exercises the VF-16B up to the SLIC's digital section. The phone connected directly to this channel will be looped onto itself. The near end phone will still transmit to the far end receiving equipment. This loopback can be activated at the near end by switch, NMS, or SCL commands.

Dual Analog Loopback

Dual analog loopback connects the phone on channel one to the phone on channel two. This is done at the FPGA logic IC. If ARD is selected on for both channels, the phone will ring if the other is picked up. If only one channel has this loopback enabled it will eavesdrop on the other channel, while the other channel functions normally. The near end phones will still transmit to the far end receiving equipment. This loopback can be activated at the near end by switch, NMS, or SCL commands.

-
15. Enable or disable Automatic Ringdown (ARD) on Channel 2 by using DIP switch SW9-4.
Place SW9-4 in the OFF position for normal operation, or in the ON position for ARD operation. Unless otherwise specified at time of order, SW9-4 is set in the OFF position at the factory.
 16. Select the Loopback Mode by using DIP switches SW10-1 and SW10-2.
The four types of Loopback that can be selected are Analog, Full Analog, Digital and Dual Analog. Refer to Table 6 to determine how the switches are set for each of these modes. Unless otherwise specified at time of order, SW10-1 and SW10-2 are set in the UP position at the factory to select Analog Mode. The Loopback mode selected must be enabled or disabled by completing steps 17 and 18.
 17. Enable or disable Channel 1 Loopback by using DIP switch SW2-8.
Place SW2-8 in the UP position to disable Channel 1 Loopback, or in the DOWN position to enable Channel 1 Loopback. Unless otherwise specified at time of order, SW2-8 is set in the UP position at the factory.

>> Text continues on page 20 <<

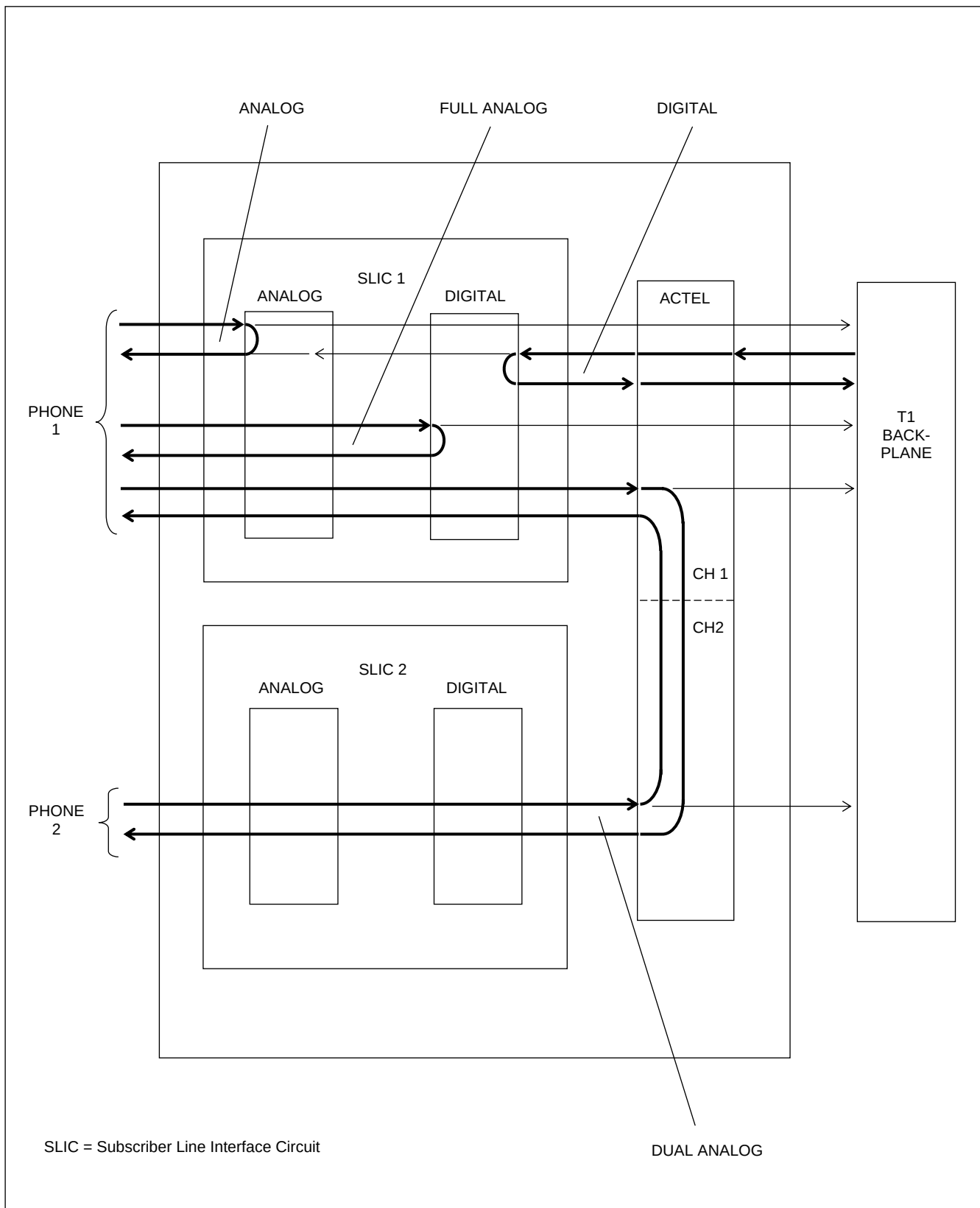


Figure 7. Pictorial description of Loopback Modes

Table 7. Time slot selection by remote access

Switch Code (Decimal)	Physical Switch Settings SW2- or SW3-					T1	E1
	1	2	3	4	5	Time Slot	Time Slot
0	D	D	D	D	D	*	*
1	D	D	D	D	U	1	1
2	D	D	D	U	D	2	2
3	D	D	D	U	U	3	3
4	D	D	U	D	D	4	4
5	D	D	U	D	U	5	5
6	D	D	U	U	D	6	6
7	D	D	U	U	U	7	7
8	D	U	D	D	D	8	8
9	D	U	D	D	U	9	9
10	D	U	D	U	D	10	10
11	D	U	D	U	U	11	11
12	D	U	U	D	D	12	12
13	D	U	U	D	U	13	13
14	D	U	U	U	D	14	14
15	D	U	U	U	U	15	15
16	U	D	D	D	D	16	*
17	U	D	D	D	U	17	17
18	U	D	D	U	D	18	18
19	U	D	D	U	U	19	19
20	U	D	U	D	D	20	20
21	U	D	U	D	U	21	21
22	U	D	U	U	D	22	22
23	U	D	U	U	U	23	23
24	U	U	D	D	D	24**	24
25	U	U	D	D	U	*	25
26	U	U	D	U	D	*	26
27	U	U	D	U	U	*	27
28	U	U	U	D	D	*	28
29	U	U	U	D	U	*	29
30	U	U	U	U	D	*	30
31	U	U	U	U	U	*	31***

D = down, U = up.

Notes: * This setting is not allowed . Setting switches to this code will cause the module's service to be disabled.

**A T1 network utilizing fast reframing cannot utilize this time slot for voice channel.

*** An E1 network utilizing inter-node communications (NMX) cannot use timeslot 31 for voice channel.

18. Enable or disable Channel 2 Loopback by using DIP switch SW3-8.
Place SW3-8 in the UP position to disable Channel 2 Loopback, or in the DOWN position to enable Channel 2 Loopback. Unless otherwise specified at time of order, SW3-8 is set in the UP position at the factory.
19. Select Channel 1 Loop Current by using DIP switch SW6-5.
Place SW6-5 in the ON position to select a loop current of 41 mA, or in the OFF position to select a loop current of 20 mA. Unless otherwise specified at time of order, SW6-5 is set in the OFF position at the factory.
20. Select Channel 2 Loop Current by using DIP switch SW9-5.
Place SW9-5 in the ON position to select a loop current of 41 mA, or in the OFF position to select a loop current of 20 mA. Unless otherwise specified at time of order, SW9-5 is set in the OFF position at the factory.
21. Select the Channel 1 Ring Delay by using switches SW6-6 and SW6-7.
There are four types of Ring Delay that can be selected. Refer to Table 5 to determine how the switches are set for each of type of Ring Delay. Unless otherwise specified at time of order, SW6-6 and SW6-7 are set in the OFF position at the factory to select No Ring Delay.
22. Select the Channel 2 Ring Delay by using switches SW9-6 and SW9-7.
There are four types of Ring Delay that can be selected. Refer to Table 5 to determine how the switches are set for each of type of Ring Delay. Unless otherwise specified at time of order, SW9-6 and SW9-7 are set in the OFF position at the factory to select No Ring Delay.

If Module Adapter MA-302 or MA-302A are being used as an interface to the VF-16B Module, in steps 23 through 26 set the Ring Voltage and Ring Voltage Offset to the factory default, otherwise proceed as follows:
23. Select the Channel 1 Ring Voltage by using switches SW6-1 and SW6-2.
There are four levels of Ring Voltage that can be selected. Refer to Table 4 to determine how the switches are set for each level of Ring Voltage. Unless otherwise specified at time of order, SW6-1 and SW6-2 are set in the OFF position at the factory to select a Ring Voltage of 40.5 volts.
24. Select the Channel 2 Ring Voltage by using switches SW9-1 and SW9-2.
There are four levels of Ring Voltage that can be selected. Refer to Table 4 to determine how the switches are set for each level of Ring Voltage. Unless otherwise specified at time of order, SW9-1 and SW9-2 are set in the OFF position at the factory to select a Ring Voltage of 40.5 volts.
25. Select the Channel 1 Ring Voltage Offset by using switch SW6-3.
There are two levels of Ring Voltage Offset that can be selected. Refer to Table 4 to determine how the switches are set for each level of Ring Voltage Offset. Unless otherwise specified at time of order, SW6-3 is set in the OFF position at the factory to select a Ring Voltage Offset of 0 Vdc.

26. Select the Channel 2 Ring Voltage Offset by using switch SW9-3.
There are two levels of Ring Voltage Offset that can be selected. Refer to Table 4 to determine how the switches are set for each level of Ring Voltage Offset. Unless otherwise specified at time of order, SW9-3 is set in the OFF position at the factory to select a Ring Voltage Offset of 0 Vdc.
27. If you plan to operate the RFL VF-16B module under **local** control, first perform steps 1 through 26, then perform the following steps; otherwise go to step 28.
- Set to local control by placing DIP switch SW10-3 in the UP position.
 - Turn service on by placing DIP switch SW10-4 in the UP position.
 - Slide the module into the selected slot until it is firmly seated and the module front panel is flush with the top and bottom of the shelf.
 - Go to step 29.
28. If you plan to operate the RFL VF-16B module under **remote** control, first perform steps 1 through 26, then perform the following steps:
- Set to local control by placing DIP switch SW10-3 in the UP position.
 - Turn service off by placing DIP switch SW10-4 in the DOWN position.
 - Slide the module into the selected slot until it is firmly seated and the module front panel is flush with the top and bottom of the shelf.
 - Wait 15 seconds for the module's parameter settings to be loaded into the shelf Common Module.
 - Pull the module out of the shelf, and place DIP switch SW10-3 in the DOWN position.
Do not move SW10-4.
 - Slide the module back into the shelf.
 - Verify the module configuration through remote control by using NMS.
 - Turn service on through remote control by using NMS.
The operating parameters of the RFL VF-16B can now be changed by remote control. See page 25 of this Instruction Data Sheet for more information.
 - Go to step 29.

29. Verify that the voice levels are adequate. If not, adjust the levels in accordance with Table 3.
30. On the Module Record Card (located to the right of the shelf) record the channel bank type, time slot, and any other pertinent information.

The RFL VF-16B is now installed. If your multiplexer is set up for remote access and control, you can now change the operating parameters of the module by using simple commands. For more information on remote access and control, consult your multiplexer operation manual.

FUNCTIONAL DESCRIPTION

Figure 8 is a functional block diagram of the RFL VF-16B. The module uses a Subscriber Line Interface Circuit (SLIC). At the RFL VF-16B (station end), the SLIC simulates a Central Office, supplying loop current and ringing voltage to the external phone circuit.

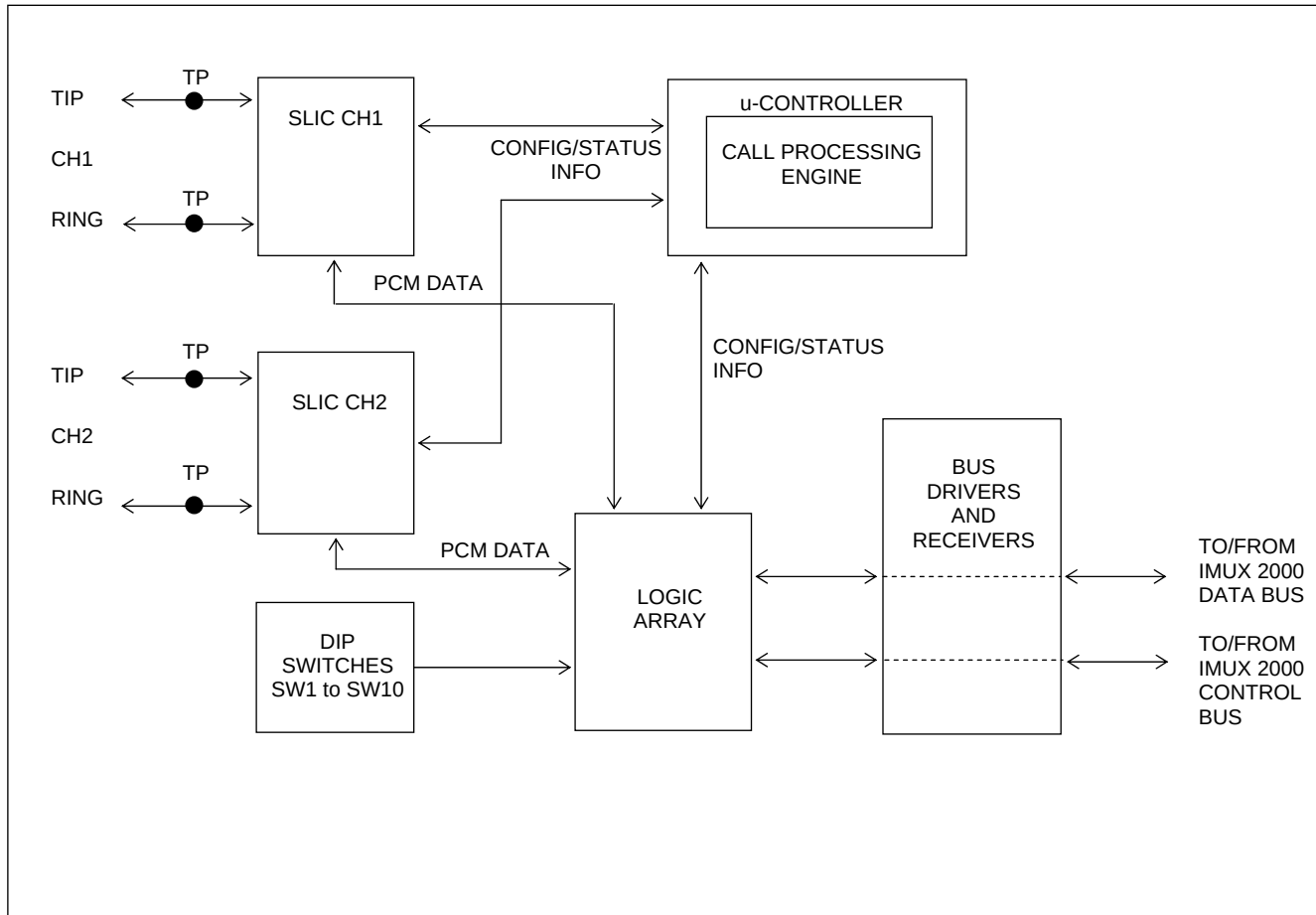


Figure 8. Functional block diagram, RFL VF-16B module

The PCM output from the SLIC is passed to a logic array. This array multiplexes the voice bits together with signaling bits provided by the microcontroller (On-Hook, Off-Hook, Ringing, No Ringing). Once multiplexed, this combined information is placed into the user-selected time slot of the transmit bus on the multiplexer's backplane.

On the receive side, the logic array takes the incoming data from the selected time slot, demultiplexes it, and passes the voice bits to the SLIC and the signaling bits to the microcontroller.

The SLIC is a highly integrated device that combines the functions of a SLIC, volume control, CODEC, DC-to-DC converter, ring generator, call progress tone generator, and loop supervision circuit. The SLIC is configured and controlled by the microcontroller.

The Logic Array interfaces with the local switches, the remote control functions, and the IMUX data bus. This configuration and control information (volume settings, ring voltage, on-/off-hook, ring control, etc) is continually sent between the Logic Array and the microcontroller. The microcontroller also continually exchanges data with the SLIC.

The audio Pulse Code Modulation (PCM) data is time critical, and is transferred directly between the Logic Array and the SLIC. The microcontroller has no contact with the PCM data.

The Logic Array provides an interface with the IMUX data bus, inserts and extracts PCM and signalling data into the appropriate time slot(s), and automatically detects if the VF-16B is installed in a T1 or E1 chassis and configures the board appropriately. It also verifies some basic signals on the data bus and checks for improper configuration information. If the Logic Array detects invalid backplane signals or the timeslots for channel 1 and 2 are the same, the service LED will blink. If a channel has an invalid timeslot configured, that channel's enable LED will blink. The other channel's operation will not be affected.

ALERTS/ALARMS

The RFL VF-16B module does not report any card-level ALERT or ALARM signals to the shelf Common Module.

REMOTE CONTROL USING NMS

PROGRAMMING THE VF-16B MODULE

Refer to the IMUX 2000 or IMUX 2000E Instruction Manuals for information on using NMS. While in NMS, select the “View or Change a Card” screen for the VF-16B module. An NMS window will be seen similar to the one shown in Figure 9. You must scroll down the parameter list to see all of the parameters. Select and set each parameter as required by double clicking on the desired parameter name. For example, double click on the “Timeslot” parameter, and a dialog box will appear with all available time slot choices. Click on the desired time slot number to make your selection. Then click on “OK” to confirm your selection. This will return you to the parameter window.

After all VF-16B parameter selections have been made they must be written to the VF-16B card in the network. This is done by using the “WRITE” operation as described in Section 7 of The IMUX 2000 Instruction Manual.

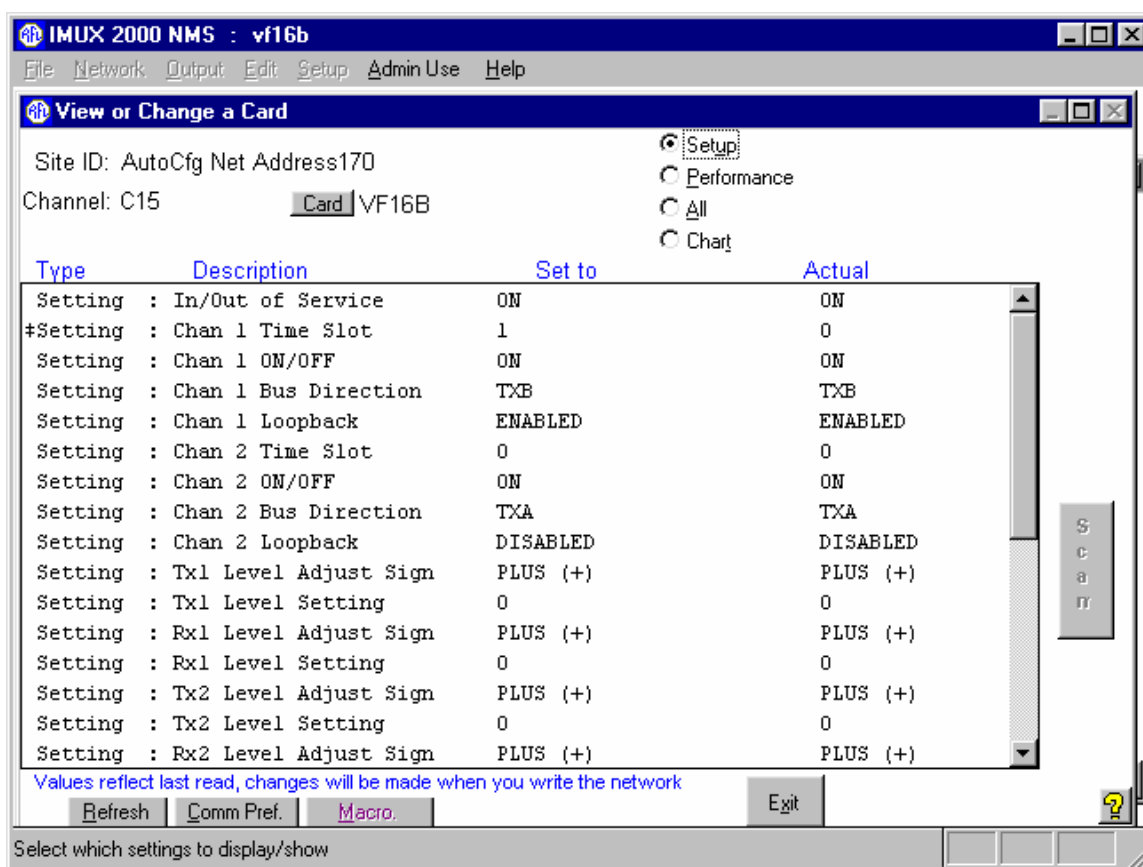


Figure 9. Typical NMS VF-16B window

REMOTE CONTROL USING SCL COMMANDS

When installed in an IMUX 2000 remote controllable shelf, the RFL VF-16B module can be operated under local or remote control. When under remote control, certain configuration parameters can only be changed through the RS-232 remote port on the multiplexer. The remote interface for these modules involves two codes: a “P” (parameter) code, and an “S” (status) code. See the IMUX 2000 instruction manual for more information on the remote control interface.

The RFL VF-16B reports itself as a “Type 182” module.

“P” CODES

“P” codes, when used in the parameter field on a “SET” command, allow the user to set certain parameters on the module by remote control, just like setting the switches on a module under local control. “P” codes also appear in the response to a “CONFIG?” query, showing the current parameter settings on the module.

There are twelve “P” codes for the RFL VF-16B, P1 through P12. Each of these P codes can be a decimal number from 0 to 255, which can also be represented as an eight-digit binary number (in parenthesis). The binary representation is more useful for setting and interpreting the “P” codes, since each binary digit (0 or 1) corresponds to the ON or OFF setting for a particular switch on the module. Table 8 describes the meanings of the “P” codes for the RFL VF-16B.

A typical RFL VF-16B response to a “CONFIG?” query looks like this:

```
* OK
CHANNEL CARD 3, TYPE 182
UNDER REMOTE CONTROL
SVCE = ON
P01 = 3 (B00000011)
P02 = 1 (B00000001)
P03 = 0 (B00000000)
P04 = 0 (B00000000)
P05 = 0 (B00000000)
P06 = 0 (B00000000)
P07 = 0 (B00000000)
P08 = 0 (B00000000)
P09 = 0 (B00000000)
P10 = 0 (B00000000)
P11 = 0 (B00000000)
P12 = 0 (B00000000);
```

NOTE

When using binary numbers with a SET command, they must be preceded by the letter “B” as shown in the following example:

<MULTIPLEXER ADDRESS>:<CARD ADDRESS>:SET:P1 = B00000011;

Besides using the P code, it is also possible to turn module service on or off by sending one of the following in the parameter field with a SET command:

SRVC = ON

SRVC = OFF

Table 8. Remote configuration settings (“P” codes)

P Code	Digit(s) And Switch Equivalent	Value ⁽¹⁾	Description
P01	B 0 0 0 0 0 0 0 0 0 ↑ - - - - - - - CH1 LOOPBACK ENABLE	0	Ch1 Loopback Disabled
		1	Ch1 Loopback Enabled
	B 0 0 0 0 0 0 0 0 0 - ↑ - - - - - - CH1 TX A DIR	0	Ch1 = DI-B
		1	Ch1 = Terminal/DI-A
	B 0 0 0 0 0 0 0 0 0 - - ↑ - - - - - CH1 DISABLE	0	Ch1 Disabled
		1	Ch1 Enabled
	B 0 0 0 0 0 0 0 0 0 - - - ↑ ↑ ↑ ↑ ↑ CH1 TIMESLOT	00001 to 11000 T1 Settings	From left to right, these five bits represent the binary value of the desired time slot from 1 through 24 in a T1 network. See Table 7 for a complete list of these values.
		00001 to 11111 E1 Settings	From left to right, these five bits represent the binary value of the desired time slot from 1 through 31 in an E1 network. See Table 7 for a complete list of these values.
P02	B 0 0 0 0 0 0 0 0 0 ↑ - - - - - - - CH2 LOOPBACK ENABLE	0	Ch2 Loopback Disabled
		1	Ch2 Loopback Enabled
	B 0 0 0 0 0 0 0 0 0 - ↑ - - - - - - CH2 TX A DIR	0	Ch2 = DI-B
		1	Ch2 = Terminal/DI-A
	B 0 0 0 0 0 0 0 0 0 - - ↑ - - - - - CH2 DISABLE	0	Ch2 Disabled
		1	Ch2 Enabled
	B 0 0 0 0 0 0 0 0 0 - - - ↑ ↑ ↑ ↑ ↑ CH2 TIMESLOT	00001 to 11000 T1 Settings	From left to right, these five bits represent the binary value of the desired time slot from 1 through 24 in a T1 network. See Table 7 for a complete list of these values.
		00001 to 11111 E1 Settings	From left to right, these five bits represent the binary value of the desired time slot from 1 through 31 in an E1 network. See Table 7 for a complete list of these values.

>> table continues on next page <<

1. These are the only legal values for setting parameters. Setting a parameter to a value outside its specified range will produce unpredictable results.

Table 8. continued - Remote configuration settings (“P” codes)

P Code	Digit(s) And Switch Equivalent	Value ⁽¹⁾	Description
P03	B 0 0 0 0 0 0 0 0 0 ↑ - - - - - - - CH1 TRANSMIT LEVEL SIGN	0	(+) Positive
		1	(-) Negative
	B 0 0 0 0 0 0 0 0 0 - ↑ ↑ ↑ ↑ ↑ - - CH1 TRANSMIT LEVEL	From 000000 To 010011	Range is from –9.5dB to +9.5dB in 0.5dB increments. For example: -2.5dB = 000101, and set sign to (-). For example: +3.5dB = 000111, and set sign to (+).
	B 0 0 0 0 0 0 0 0 0 - - - - - - ↑ -	...	For future use
	B 0 0 0 0 0 0 0 0 0 - - - - - - - ↑	...	For future use
P04	B 0 0 0 0 0 0 0 0 0 ↑ - - - - - - - CH1 RECEIVE LEVEL SIGN	0	(+) Positive
		1	(-) Negative
	B 0 0 0 0 0 0 0 0 0 - ↑ ↑ ↑ ↑ ↑ - - CH1 RECEIVE LEVEL	From 000000 to 010011	Range is from –9.5dB to +9.5dB in 0.5dB increments. For example: -2.5dB = 000101, and set sign to (-). For example: +3.5dB = 000111, and set sign to (+).
	B 0 0 0 0 0 0 0 0 0 - - - - - - ↑ -	...	For future use
	B 0 0 0 0 0 0 0 0 0 - - - - - - - ↑	...	For future use

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Table 8. continued - Remote configuration settings (“P” codes)

P Code	Digit(s) And Switch Equivalent	Value ⁽¹⁾	Description
P05	B 0 0 0 0 0 0 0 0 0 ↑ ↑ - - - - - CH1 RING VOLTAGE	00	40 Volts
		01	45 Volts
		10	53 Volts
		11	63 Volts
	B 0 0 0 0 0 0 0 0 0 - - ↑ - - - - CH1 DC OFFSET	0	DC Offset Disabled
		1	DC Offset Enabled
	B 0 0 0 0 0 0 0 0 0 - - - ↑ - - - - CH1 ARD	0	ARD Disabled
		1	ARD Enabled
	B 0 0 0 0 0 0 0 0 0 - - - - ↑ - - - CH1 LOOP CURRENT	0	20 mA
		1	41 mA
	B 0 0 0 0 0 0 0 0 0 - - - - - ↑ ↑ - CH1 RING DELAY	00	None
		01	200/400ms
		10	300/600ms
		11	400/800ms
	B 0 0 0 0 0 0 0 0 0 - - - - - - - ↑	...	For future use

>> table continues on next page <<

Table 8. continued - Remote configuration settings (“P” codes)

P Code	Digit(s) And Switch Equivalent	Value ⁽¹⁾	Description
P06	B 0 0 0 0 0 0 0 0 0 ↑ - - - - - - - CH2 TX LEVEL SIGN	0	(+) Positive
		1	(-) Negative
	B 0 0 0 0 0 0 0 0 0 - ↑ ↑ ↑ ↑ ↑ - - CH2 TRANSMIT LEVEL	From 000000 to 010011	Range is from –9.5dB to +9.5dB in 0.5dB increments. For example: -2.5dB = 000101, and set sign to (-). For example: +3.5dB = 000111, and set sign to (+).
	B 0 0 0 0 0 0 0 0 0 - - - - - - ↑ -	...	For future use
	B 0 0 0 0 0 0 0 0 0 - - - - - - - ↑	...	For Future use
P07	B 0 0 0 0 0 0 0 0 0 ↑ - - - - - - - CH2 RX LEVEL SIGN	0	(+) Positive
		1	(-) Negative
	B 0 0 0 0 0 0 0 0 0 - ↑ ↑ ↑ ↑ ↑ - - CH2 RECEIVE LEVEL	From 000000 to 010011	Range is from –9.5dB to +9.5dB in 0.5dB increments. For example: -2.5dB = 000101, and set sign to (-). For example: +3.5dB = 000111, and set sign to (+).
	B 0 0 0 0 0 0 0 0 0 - - - - - - ↑ -	...	For future use
	B 0 0 0 0 0 0 0 0 0 - - - - - - - ↑	...	For Future use

>> table continues on next page <<

Table 8. continued - Remote configuration settings (“P” codes)

P Code	Digit(s) And Switch Equivalent	Value ⁽¹⁾	Description
P08	B 0 0 0 0 0 0 0 0 0 ↑ ↑ - - - - - CH2 RING VOLTAGE	00	40 Volts
		01	45 Volts
		10	53 Volts
		11	63 Volts
	B 0 0 0 0 0 0 0 0 0 - - ↑ - - - - - CH2 DC OFFSET	0	DC Offset Disabled
		1	DC Offset Enabled
	B 0 0 0 0 0 0 0 0 0 - - - ↑ - - - - CH2 ARD	0	ARD Disabled
		1	ARD Enabled
	B 0 0 0 0 0 0 0 0 0 - - - - ↑ - - - CH2 LOOP CURRENT	0	20 mA
		1	41 mA
	B 0 0 0 0 0 0 0 0 0 - - - - - ↑ ↑ - CH2 RING DELAY	00	None
		01	200/400ms
		10	300/600ms
		11	400/800ms
	B 0 0 0 0 0 0 0 0 0 - - - - - - - ↑	...	For future use

>> table continues on next page <<

Table 8. continued - Remote configuration settings (“P” codes)

P Code	Digit(s) And Switch Equivalent	Value ⁽¹⁾	Description
P09	B 0 0 0 0 0 0 0 0 0 ↑ ↑ - - - - - - LOOPBACK MODE	00	Partial Analog mode
		01	Full Analog mode
		10	Digital mode
		11	Dual Analog mode
	B 0 0 0 0 0 0 0 0 0 - - ↑ ↑ ↑ ↑ ↑ ↑	...	For future use
P10	B 0 0 0 0 0 0 0 0 0 ↑ ↑ ↑ ↑ ↑ ↑ ↑ ↑	...	For factory use only. Should read back as: Firmware revision. DO NOT WRITE TO THIS BYTE
P11	B 0 0 0 0 0 0 0 0 0 ↑ ↑ ↑ ↑ ↑ ↑ ↑ ↑	...	For factory use only. Should read back as: 0 DO NOT WRITE TO THIS BYTE
P12	B 0 0 0 0 0 0 0 0 0 ↑ ↑ ↑ ↑ ↑ ↑ ↑ ↑	...	For factory use only. Should read back as: 1 DO NOT WRITE TO THIS BYTE

“S” CODES

“S” codes appear in response to a “STATUS?” query. There are four “S” codes for the RFL VF-16B, S1 through S4. Like the “P” codes, this number is displayed in both decimal and binary form. Table 9 describes the meanings of the “S” codes for the VF-16B.

A typical response to a “STATUS?” query looks like this:

*** OK**
CHANNEL CARD 3, TYPE 182
S01 = 3 (B00000011)
S02 = 3 (B00000011)
S03 = 0 (B00000000)
S04 = 1 (B00000001);

Table 9. Remote status messages (“S” codes)

S Code	Digit(s) And Switch Equivalent	Value ⁽¹⁾	Description
S1	B 0 0 0 0 0 0 0 0 0 ↑ - - - - -	0	Ch2 Config Valid
	CH2 CONFIG INVALID	1	Ch2 Config Invalid
	B 0 0 0 0 0 0 0 0 0 - ↑ - - - - -	0	Ch2 Disabled
	CH2 ENABLED	1	Ch2 Enabled
	B 0 0 0 0 0 0 0 0 0 - - ↑ - - - -	0	Ch2 Not Ringing
	CH2 RINGING	1	Ch2 Ringing
	B 0 0 0 0 0 0 0 0 0 - - - ↑ - - - -	0	Ch2 Not Offhook
	CH2 OFFHOOK	1	Ch2 Offhook
	B 0 0 0 0 0 0 0 0 0 - - - - ↑ - - -	0	Ch1 Config Valid
	CH1 CFG INVALID	1	Ch1 Config Invalid
	B 0 0 0 0 0 0 0 0 0 - - - - - ↑ - -	0	Ch1 Disabled
	CH1 ENABLED	1	Ch1 Enabled
	B 0 0 0 0 0 0 0 0 0 - - - - - - - ↑ -	0	Ch1 Not Ringing
	CH1 RINGING	1	Ch1 Ringing
	B 0 0 0 0 0 0 0 0 0 - - - - - - - ↑	0	Ch1 Not Offhook
	CH1 OFFHOOK	1	Ch1 Offhook

>> table continues on next page <<

Table 9. continued - Remote status messages (“S” codes)

S Code	Digit(s) And Switch Equivalent	Value ⁽¹⁾	Description
S02	B 0 0 0 0 0 0 0 0 0 ↑ ↑ ↑ ↑ ↑ ↑ ↑ ↑ ACTEL REVISION LEVEL	From 00000001 to 11111111	The ACTEL Firmware revision level.
S03	B 0 0 0 0 0 0 0 0 0 ↑ ↑ ↑ ↑ ↑ ↑ ↑ ↑	0	For factory use only. Should read back as: 0
S04	B 0 0 0 0 0 0 0 0 0 ↑ ↑ ↑ ↑ ↑ ↑ ↑ ↑	1	For factory use only. Should read back as: 1

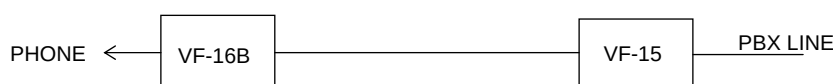
TESTING

When the RFL VF-16B module has been configured and installed, it should be tested for proper operation before it is put into service. If a module is set up for two-channel operation, test each channel separately.

EQUIPMENT REQUIRED

1. Telephone Set, Type 2500 or equivalent (one for each RFL VF-16B module).
2. PBX Station Line.

FXO/FXS TEST PROCEDURE



1. Connect the PBX line to the channel under test on the RFL VF-15 module.
2. Connect the telephone to the channel under test on the RFL VF-16B module.
3. Check the settings of the DIP switches to make sure that both modules are set to use the same time slots.
4. Set the channel under test on the VF-15 module to Loop Start.
5. Set both modules to local control.
6. Set service on for both modules.
7. Take the phone connected to the RFL VF-16B off-hook and observe the presence of a dial tone from the PBX.
8. Dial an extension and verify that the extension rings.
9. Answer the extension and verify that the voice level is adequate in both directions, and that the noise level is acceptably low.
10. Place both phones back on hook. Using the extension, dial the number of the line connected to the RFL VF-16B under test.
The phone connected to the RFL VF-16B should ring 2 seconds on, and 4 seconds off.
11. Answer the ringing phone and verify that ringing stops and the voice quality is acceptable.
12. Change the settings on both modules, if necessary, to suit the desired circuit configuration. The circuit may now be placed in service.

ARD TEST PROCEDURE



1. Connect telephones to the channel under test on the modules at both Location 1 and Location 2.
2. Check the settings of DIP switches to make sure that both modules are set to use the same time slots.
3. If location 2 uses a VF-16, VF-16A or VF-16E set the channel under test of the module at location 2 to Loop Start.
4. Set the channel under test on both modules to ARD operation.
5. Set both modules to local control.
6. Set service on for both modules.
7. Lift the handset on the phone at location 2.
The phone connected to the VF-16B at location 1 will ring (1.5 seconds on, and 4.5 seconds off).
8. Listen to the handset on the phone connected to location 2.
A ringback tone will be heard.
9. Answer the phone connected to the VF-16B at location 1.
The phone will stop ringing.
10. Verify that the voice level is adequate in both directions, and that the noise level is acceptably low.
11. Hang up the phones and repeat Steps 7 through 10 in the other direction.
12. Change the settings on both modules, if necessary, to suit the desired circuit configuration.

The circuit may now be placed in service.

TROUBLESHOOTING

If there is an apparent malfunction, first check that the configuration is appropriate for the transmission system in use, and that the transmit and receive configurations are identical.

Problems may occur at the common equipment or facility level that may affect the operation of this module. Refer to the "Maintenance" section in your multiplexer manual for system analysis procedures.

NOTES

NOTES

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RFL Electronics Inc.

INSTRUCTION DATA

RFL VF-25 Four-Port PCM, Four-Wire E&M Voice Module

INTRODUCTION

This manual describes the setup and installation procedures for the VF-25 Voice Frequency Module. Experienced users may refer directly to the tables beginning on page 8 for configuration data. Additional information about this system is contained in your multiplexer operation manual. The VF-25 is a four-port voice frequency module, designed for use in terminal and drop/insert multiplexers and other communications products. The voice interface is full duplex, four-wire E&M with PCM coding, allowing four voice channels to be carried in four 64 kbps time slots on T1 and other digital communications facilities.

Each VF-25 provides high quality voice characteristics compatible with AT&T Pub. 43801, and supports E & M signaling of Type I, II, III, and V. It has extended-range input and output signal level adjustments to facilitate interfaces in most four-wire applications.

Features of the VF-25 voice module include:

- One to four independent channels may be active simultaneously
- Remote control configuration and status reporting
- Selectable signaling format (Type I, II, III, or V)
- Selectable transmit/receive direction for use in drop/insert systems
- Input/output attenuation adjustment

FUNCTIONAL DESCRIPTION AND SET-UP

The descriptions below refer to one channel; each of the four channels on this module operates identically. Figure 1 shows a simplified block diagram of the VF-25.

Transmit Side

Voice input is via the module adapter at the rear of the shelf. The input signal goes to a balanced input transformer. The transformer output goes to an amplifier stage, and then passes through an electronic level control, which allows the input level to be adjusted up or down from the nominal setting in <0.5 dB increments. The normal factory-set input level is 0 dBm, referenced to 600 ohms, and clipping begins at input level of +3.0 dBm. Jumpers on the card allow the nominal input level to be set to -16 dBm.

The control output then passes to the PCM CODEC which converts it to an eight-bit digital signal using μ -law coding.

The M-Lead Detector responds to an IDLE or BUSY signal from the external device. For Types I, II, and III signaling, a level of -48 volts at the M-Lead equals BUSY, ground equals IDLE. For Type V signaling, ground at the M-Lead equals BUSY, open equals IDLE. The M-Lead input impedance is greater than 20K Ohms.

The Field Programmable Gate Array (FPGA) multiplexes the M-Lead signal together with the eight-bit output of the PCM encoder, and places the resulting bitstream into the user-selectable time slot on the backplane for transmission in the desired direction. Each channel occupies one time slot; the time slot for Channel 1 is selected by the user, and each additional active channel occupies the next sequential time slot.

Receive Side

The FPGA gets the input signal from the appropriate time slot on the backplane and demultiplexes it. The E-Lead signal goes to the E-Lead driver. When active, ground equals BUSY; open equals IDLE. In Type II or III signaling, the E-Lead and EB-Lead are both used. When signaling is active, the E-Lead and EB-Lead are tied together through the E-Lead relay.

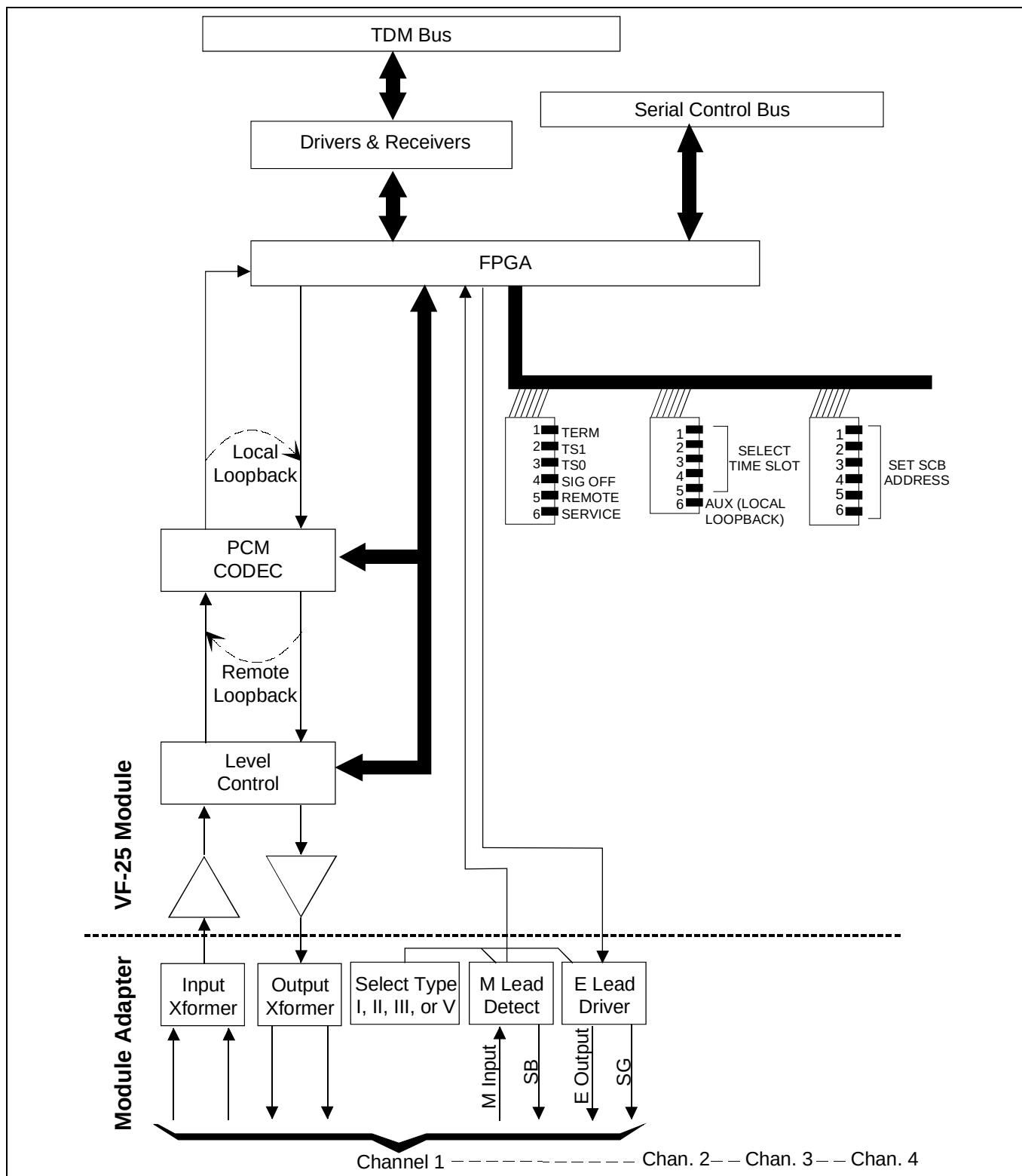


Figure 1. VF-25 Voice Module, Block Diagram

The PCM CODEC converts the eight-bit digital signal back to an analog audio signal and passes it to an electronic level control, which allows the output level to be adjusted up or down in <0.5 dB increments.

The control output passes to an amplifier stage, and finally through the output transformer to the output connectors on the module adapter. With 0 dBm at the transmitter input, the output level will be 0 dBm referenced to 600 ohms. Jumpers on the card allow the nominal output level to be set to +7 dBm.

E&M Signaling

The VF-25 supports E&M signaling Types I, II, III, and V, and can also operate in Transmission Only mode with signaling turned off. The E&M signaling type is selected by settings on the module adapter (see Appendix A). Figure 2 provides simplified block diagrams of these four signaling types.

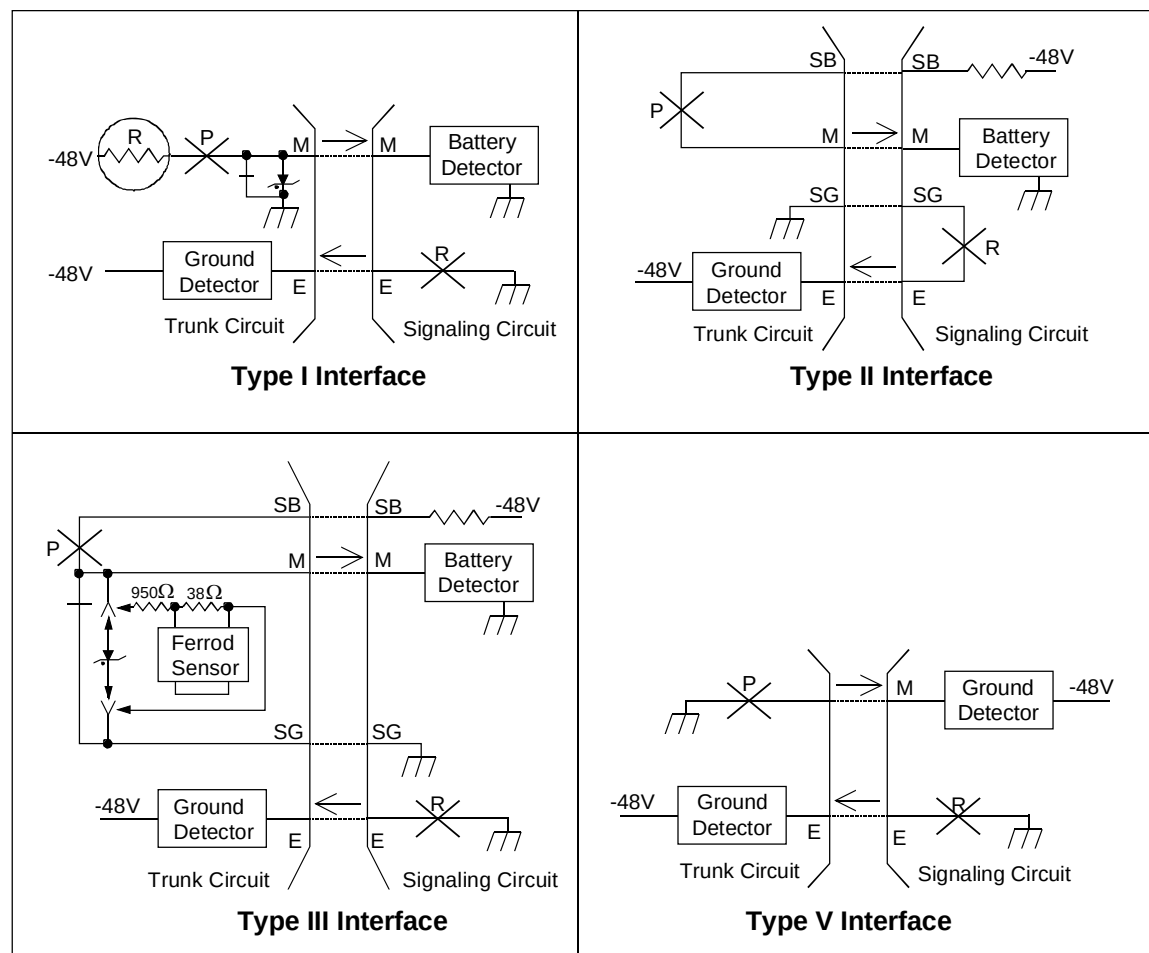


Figure 2 E&M Signaling Types

Alerts/Alarms

The VF-25 reports no card-level ALERT or ALARM signals to the shelf common card.

Loopbacks

The VF-25 provides two types of loopbacks:

1. **Local loopback** of all four channels, used for testing the operation of the module during initial installation.
2. **Remote loopback** of each channel individually, used with troubleshooting channel problems

The location of these loopbacks in relation to the signal path is shown on Figure 1.

Procedures for using these loopbacks are provided in ***Testing and Troubleshooting.***

Drop and Insert Operation

A drop and insert multiplexer operates at a central point on a three (or more) point system. In the example shown in Figure 2, Site 2 has a drop and insert multiplexer whose DI/A port is connected to the transmission line to Site 1, and whose DI/B port is connected to the transmission line to Site 3. Individual payload channels may connect Sites 1 and 2, 1 and 3, or 2 and 3.

In the drop and insert multiplexer at Site 2, a VF-25 module can be set to transmit and receive either via the DI-A port (toward Site 1) or via the DI-B port (toward Site 3), but not both.

When a VF-25 is installed in a terminal multiplexer (Site 1 or Site 3), its **TERM** switch must be set DOWN.

However, when it is installed in a drop and insert multiplexer (Site 2) the **TERM** switch setting must be DOWN to transmit or receive via the DI/A port (toward Site 1) and UP to transmit or receive via the DI/B port (toward Site 3).

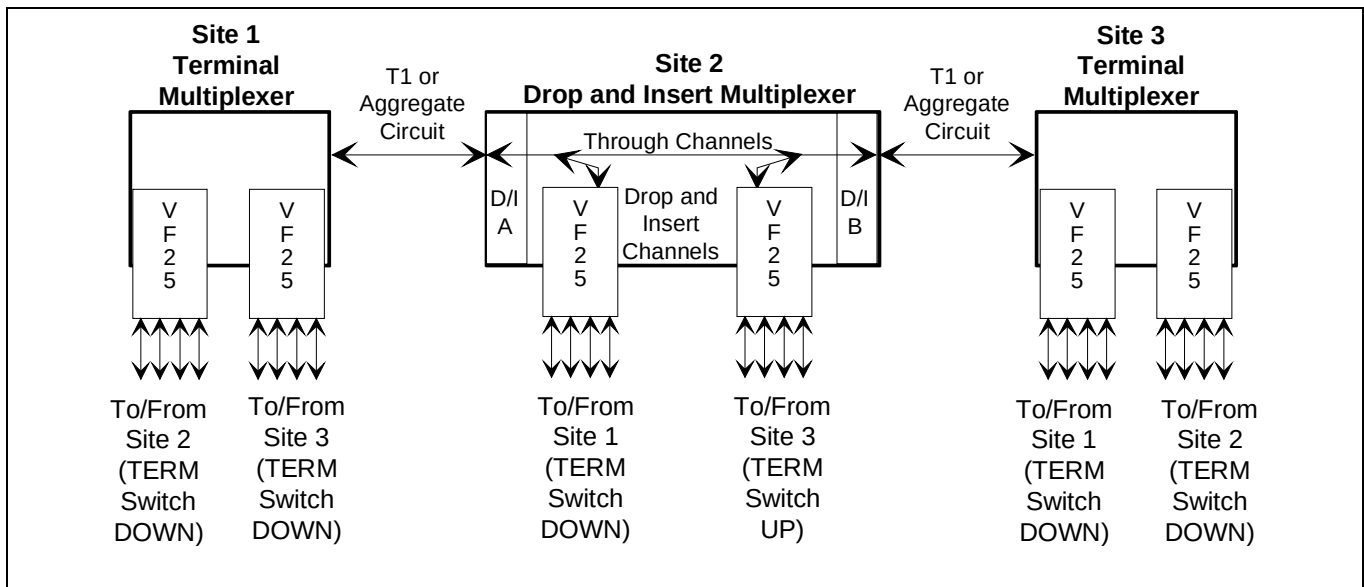


Figure 3. Example of a Three-Site System Using Drop and Insert

Controls and Indicators

The VF-25 has three switch banks, eight jumpers, and one LED indicator, shown on Figures 4 and 5.

The LED indicates Service On; when it is lit (green), the card is in service. Tables 1 through 5 describe the meaning and usage of the switches and jumpers on the card.

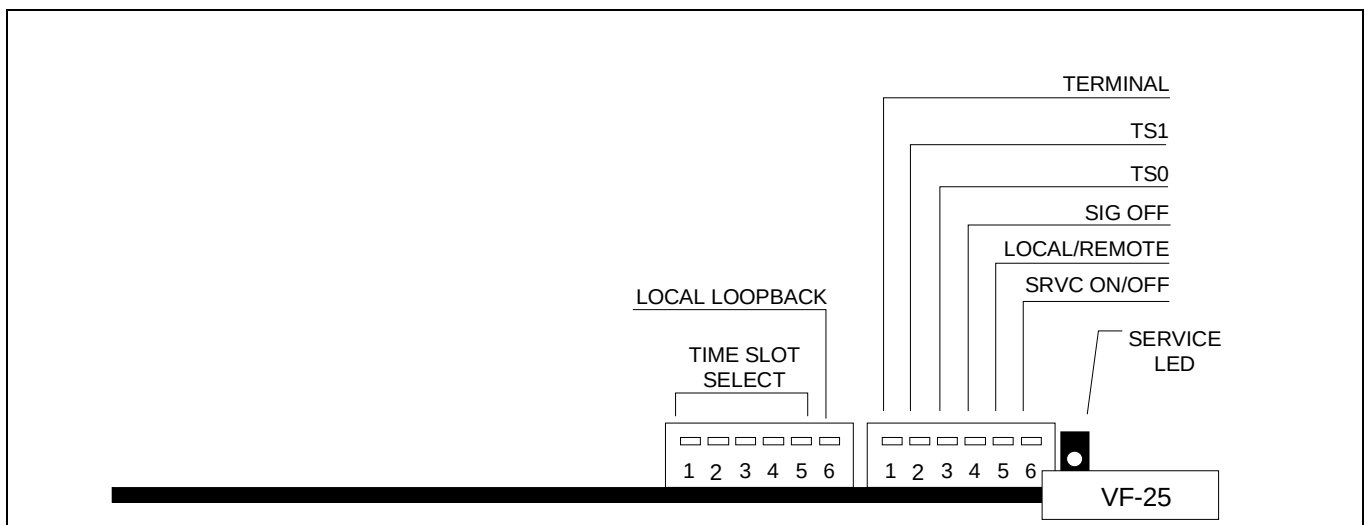


Figure 4. VF-25 Voice Module, Front View

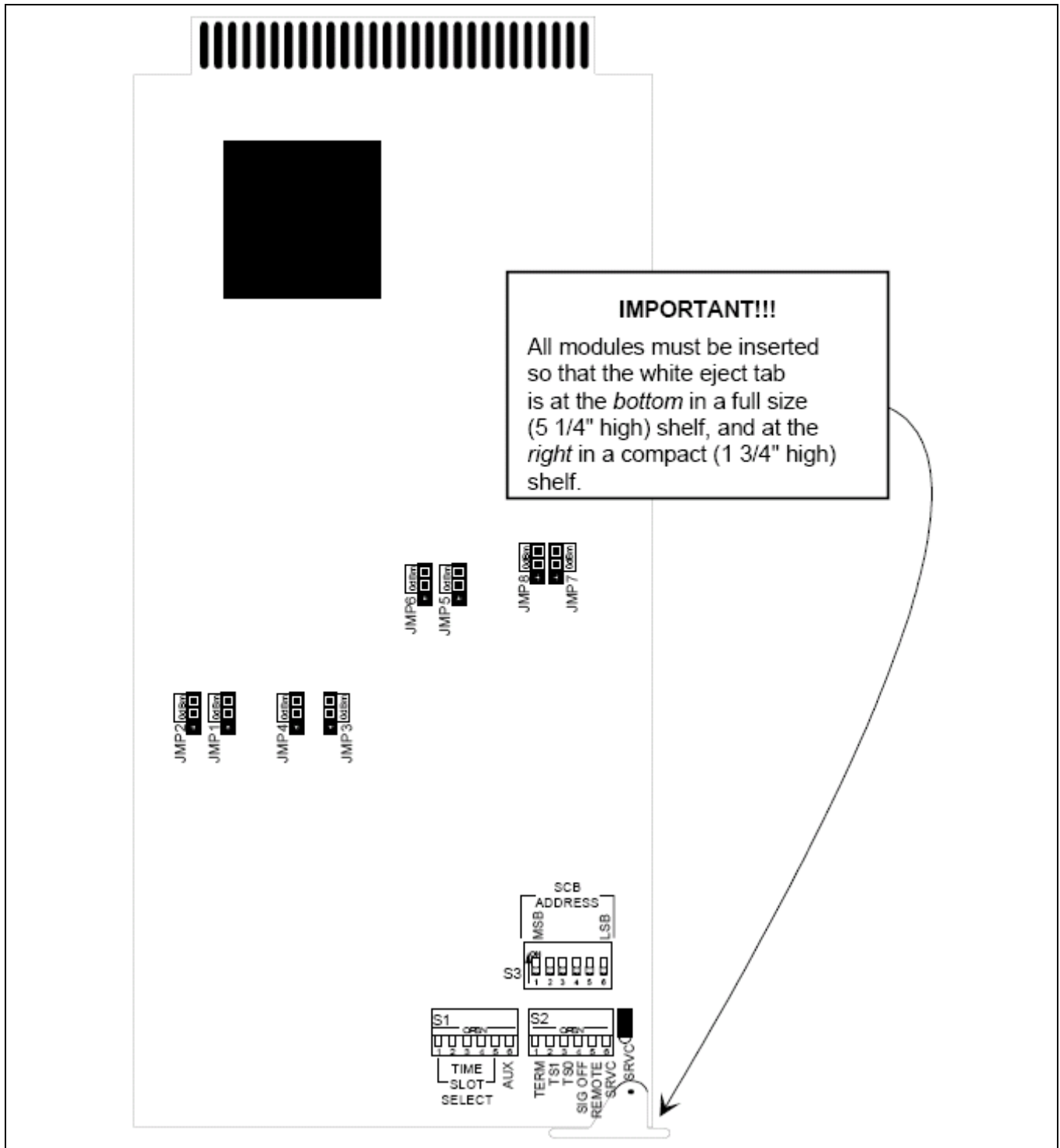


Figure 5. VF-25 Voice Module, Top View

Table 1 Configuration Switches

Switch#/Position	Label	Setting	Description
SW1/1 - 5	TIME SLOT SELECT	See Table 4	Select the desired starting time slot
SW1/6	AUX	UP	NORMAL: Local loopback off
		DOWN	Activate local loopback
SW2/1	TERM	UP	Set the module to communicate via the DI-B port in a drop/insert multiplexer (see Section 2.5, <i>Drop and Insert Operation</i>)
		DOWN	Set the module for use in a terminal multiplexer, or to communicate via the DI-A port in a drop/insert multiplexer
SW2/2 & 3	TS1, TS0	See Table 2	Select the number of active channels (1 to 4)
SW2/4	SIG OFF	UP	NORMAL: Signaling is active
		DOWN	Signaling off (Transmit Only mode)
SW2/5	REMOTE	UP	Set module for local control
		DOWN	Set module for remote control
SW2/6	OFF	UP	NORMAL: module is in service
		DOWN	Take the module out of service
SW3/1 - 6	SCB ADDRESS	See Table 5	Set the remote access address for the module

Table 2 Active Channel Selection - SW2, Positions 2 & 3

Switch Settings		Channels Active
TS1	TS0	
UP	UP	Four channels active (channels 1 - 4)
UP	DOWN	Three channels active (channels 1 - 3)
DOWN	UP	Two channels active (channels 1 - 2)
DOWN	DOWN	One channel active (channel 1 only)

Table 3. Input/Output Level Jumper Settings

 = Normal Position  = Reversed Position	
Jumper	Description
JMP1	Ch. 1 Tx input level: Normal = 0 dBm, Reversed = -16 dBm
JMP2	Ch. 1 Rx output level: Normal = 0 dBm, Reversed = +7 dBm
JMP3	Ch. 2 Tx input level: Normal = 0 dBm, Reversed = -16 dBm
JMP4	Ch. 2 Rx output level: Normal = 0 dBm, Reversed = +7 dBm
JMP5	Ch. 3 Tx input level: Normal = 0 dBm, Reversed = -16 dBm
JMP6	Ch. 3 Rx output level: Normal = 0 dBm, Reversed = +7 dBm
JMP7	Ch. 4 Tx input level: Normal = 0 dBm, Reversed = -16 dBm
JMP8	Ch. 4 Rx output level: Normal = 0 dBm, Reversed = +7 dBm

Table 4. Starting Time Slot Selection¹ - SW1, Positions 1 - 5

Time Slot	Positions* 1 2 3 4 5	Time Slot	Positions* 1 2 3 4 5
1	U U U U U	13	U D D U U
2	U U U U D	14	U D D U D
3	U U U D U	15	U D D D U
4	U U U D D	16	U D D D D
5	U U D U U	17	D U U U U
6	U U D U D	18	D U U U D
7	U U D D U	19	D U U D U
8	U U D D D	20	D U U D D
9	U D U U U	21	D U D U U
10	U D U U D	22	D U D U D
11	U D U D U	23	D U D D U
12	U D U D D	24 only	D U D D D

***U = UP, D = DOWN**

¹ Each active channel on the VF-25 module requires one time slot. The settings shown here select the *first* time slot; one to four consecutive time slots will be used depending on the number of channels active. For example, with all four channels active, selecting starting time slot 3 means this module would use time slots 3, 4, 5, and 6. Accordingly, starting time slots 22, 23, or 24 may be used only when fewer than four channels are active.

Remote Control Interface

VF-25 modules can be used under local or remote control. When under remote control, certain configuration parameters can be changed only via the RS-232 remote port on the multiplexer. See the multiplexer operation manual for details on using ISiCL, the Intraplex Simple Command Language. Before the module can receive remote commands, it must first be assigned a **card address**. The card address is used to route remote commands and queries to a specific module in a multiplexer via the Serial Control Bus (SCB). In a full size shelf, it is generally set to the physical slot number the card occupies. It may be set to any number from 1 to 36 which is not in use by another card in the same multiplexer.

The card address is determined by the **SCB ADDRESS** switch bank (SW3) settings, as shown in Table 5.

Table 5 Card Address Setting - SW3

Card Address	Switch Settings:* S3, Positions 1 2 3 4 5 6	Card Address	Switch Settings:* S3, Positions 1 2 3 4 5 6
1	0 0 0 0 0 1	19	0 1 0 0 1 1
2	0 0 0 0 1 0	20	0 1 0 1 0 0
3	0 0 0 0 1 1	21	0 1 0 1 0 1
4	0 0 0 1 0 0	22	0 1 0 1 1 0
5	0 0 0 1 0 1	23	0 1 0 1 1 1
6	0 0 0 1 1 0	24	0 1 1 0 0 0
7	0 0 0 1 1 1	25	0 1 1 0 0 1
8	0 0 1 0 0 0	26	0 1 1 0 1 0
9	0 0 1 0 0 1	27	0 1 1 0 1 1
10	0 0 1 0 1 0	28	0 1 1 1 0 0
11	0 0 1 0 1 1	29	0 1 1 1 0 1
12	0 0 1 1 0 0	30	0 1 1 1 1 0
13	0 0 1 1 0 1	31	0 1 1 1 1 1
14	0 0 1 1 1 0	32	1 0 0 0 0 0
15	0 0 1 1 1 1	33	1 0 0 0 0 1
16	0 1 0 0 0 0	34	1 0 0 0 1 0
17	0 1 0 0 0 1	35	1 0 0 0 1 1
18	0 1 0 0 1 0	36	1 0 0 1 0 0

* **0 = OFF, 1 = ON**

The VF-25 reports itself as a **TYPE 103** card. Its remote operation involves the use of “P” (parameter) codes and “S” (status) codes, as described in the following sections.

P Codes

P codes, when used in the parameter field of a SET command, allow the user to set parameters on the module via remote control, just like setting the switches on a module under local control.

There are ten P codes for the VF-25, P1 through P10. Each is a number from 0 to 255, also represented as an eight-digit binary number (in parentheses). The first two P codes, P1 and P2, provide remote access to the settings controlled by the dip switches on the card itself, as well as allowing activation of the remote loopback feature. The remaining eight codes, P3 through P8, are used to change the input and output level settings for each of the four voice channels on the card. Table 6 describes the meanings of the P codes in detail.

P codes also appear in the response to a CONFIG? query, showing the current parameter settings on the card.

IMPORTANT: When using binary numbers in the parameter field of a SET command, they must be preceded by the letter “B”, as for example:

<multiplexer address>:<card address>:SET:P02 = B00000001;

In addition to the P codes, it is also possible to turn service on or off for the card by sending **SRVC = ON** or **SRVC = OFF** in the ISiCL parameter field with a SET command.

A typical VF-25 response to a CONFIG? query looks like this:

OK CHANNEL CARD 3, TYPE 103 UNDER REMOTE CONTROL SRVC = ON P01 = 195 (B11000011) P02 = 1 (B00000001) P03 = 124 (B01111100) P04 = 124 (B01111100) P05 = 124 (B01111100) P06 = 124 (B01111100) P07 = 124 (B01111100) P08 = 124 (B01111100) P09 = 124 (B01111100) P10 = 124 (B01111100);

Table 6 Remote Configuration Settings (P Codes)

P Code	Digit(s) and Effect	Value ²	Description
P1	B00000000 ---↑↑↑↑↑ TIME SLOT SELECT	00001 to 11111	From left to right, these five bits represent the binary value of the starting time slot (see Table 7)
	B00000000 --↑-----	0 1	Normal - signaling active Signaling off (Transmit Only mode)

² These are the only legal values for setting the parameters. Setting any parameter to a value outside its specified range will produce an unpredictable result.

Table 6 Remote Configuration Settings (P Codes)

P Code	Digit(s) and Effect	Value ²	Description
	B00000000 ↑↑----- ACTIVE CHANNELS	00 Four channels active 01 Three channels active 10 Two channels active 11 One channel active	
P2	B00000000 -----↑ TERMINAL	0 Set to operate via the DI-B port in a drop/insert multiplexer 1 Set to operate in a terminal multiplexer, or via the DI-A port in a drop/insert multiplexer	
	B00000000 -----↑- LOCAL LOOPBACK	0 Normal - local loopback off 1 Local loopback active	
	B00000000 -----↑↑--	Not used	
	B00000000 ---↑----- CH. 1 REMOTE LB	0 Normal - Channel 1 remote loopback off 1 Channel 1 remote loopback active	
	B00000000 --↑----- CH. 2 REMOTE LB	0 Normal - Channel 2 remote loopback off 1 Channel 2 remote loopback active	
	B00000000 -↑----- CH. 3 REMOTE LB	0 Normal - Channel 3 remote loopback off 1 Channel 3 remote loopback active	
	B00000000 ↑----- CH. 4 REMOTE LB	0 Normal - Channel 4 remote loopback off 1 Channel 4 remote loopback active	
P3	B00000000 ↑↑↑↑↑↑↑↑ CH.1 TX LEVEL	0 - 255	Adjusts the input level for Channel 1 (see page 14, <i>Input and Output Level Adjustments</i>)
P4	B00000000 ↑↑↑↑↑↑↑↑ CH.1 RX LEVEL	0 - 255	Adjusts the output level for Channel 1
P5	B00000000 ↑↑↑↑↑↑↑↑ CH.2 TX LEVEL	0 - 255	Adjusts the input level for Channel 2
P6	B00000000 ↑↑↑↑↑↑↑↑ CH.2 RX LEVEL	0 - 255	Adjusts the output level for Channel 2
P7	B00000000 ↑↑↑↑↑↑↑↑ CH.3 TX LEVEL	0 - 255	Adjusts the input level for Channel 3

Table 6 Remote Configuration Settings (P Codes)

P Code	Digit(s) and Effect	Value ² Description
P8	B00000000 ↑↑↑↑↑↑↑↑ CH.3 RX LEVEL	0 - 255 Adjusts the output level for Channel 3
P9	B00000000 ↑↑↑↑↑↑↑↑ CH.4 TX LEVEL	0 - 255 Adjusts the input level for Channel 4
P10	B00000000 ↑↑↑↑↑↑↑↑ CH.4 RX LEVEL	0 - 255 Adjusts the output level for Channel 4

Table 7 Starting Time Slot Selection Via Remote Access³

Time Slot	P1 Positions 5 4 3 2 1	Time Slot	P1 Positions 5 4 3 2 1
1	0 0 0 0 1	13	0 1 1 0 1
2	0 0 0 1 0	14	0 1 1 1 0
3	0 0 0 1 1	15	0 1 1 1 1
4	0 0 1 0 0	16	1 0 0 0 0
5	0 0 1 0 1	17	1 0 0 0 1
6	0 0 1 1 0	18	1 0 0 1 0
7	0 0 1 1 1	19	1 0 0 1 1
8	0 1 0 0 0	20	1 0 1 0 0
9	0 1 0 0 1	21	1 0 1 0 1
10	0 1 0 1 0	22	1 0 1 1 0
11	0 1 0 1 1	23	1 0 1 1 1
12	0 1 1 0 0	24 only	1 1 0 0 0

Input and Output Level Adjustments

Each channel on the VF-25 module has nominal input and output levels determined by the jumper settings on the card (Table 3). The factory standard setting is 0 dBm input, 0 dBm output for all channels, with the option of -16 dBm input, +7 dBm output.

Eight electronic level controls allow the input and output levels for each channel to be adjusted in <0.5 dB increments. These adjustments must be made via the remote port using P codes P3 through P10.

Each of these P codes can have a decimal value of 0 through 255. A value of 124 is the factory default setting; when the P code is 124, the actual level will be within ± 0.5 dB of the nominal. Increasing the value toward 255 increases the gain, and decreasing the value toward 0 decreases the gain.

When the VF-25 card is placed into local mode (**Remote** switch off), all eight level controls reset to the factory default value of 124.

Figure 6 shows the effect of changing the P code setting. Note that on the transmit input, increasing the gain means that a lower input signal level can be accommodated, while on the receive output, increasing the gain means that a higher output level will be provided.

For example, we can see from the graph that setting the P code to 216 provides a gain increase of about +4dB; with the input/output level jumpers in the normal position, **P3 = 216** would change the nominal

³ These positions represent the five least significant digits of P1, as shown on the previous table. As with the physical time slot selection switches, the settings shown here select the *first* time slot; one to four consecutive time slots will be used depending on the number of channels active. Starting time slots 22, 23, or 24 may be used only when fewer than four channels are active.

input level for Channel 1 to -4 dBm, and **P4 = 216** would change the nominal output level for Channel 1 to +4 dBm.

P=110 gives a setting of -1.0 dB; **P=140** gives a setting of +1.0 dB. Within the range of P=110 to P=140, changing the P code setting by 3 results in approximately 0.2 dB change in level.

Caution! Do not adjust the level controls to provide input and output levels beyond the maximums specified for the VF-25 module:

Input -16 dBm to +7 dBm
Output -10 dBm to +10 dBm

Settings outside this range may overdrive the input and output amplifiers.

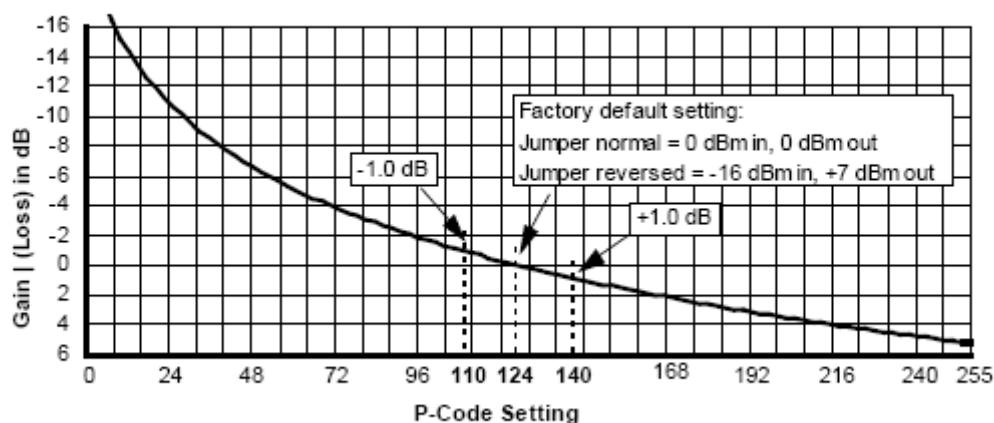


Figure 6. Attenuation Level Controls (P3 - P10)

S Codes

S codes appear in response to a STATUS? query. Like the “P” codes, they are eight-digit binary numbers. There is one S code for the VF-25 module, **S1**.

A typical VF-25 response to a STATUS? query looks like this:

- OK CHANNEL CARD 3, TYPE 103 S01 = 0 (B00000000);

The binary representation is more useful here than the digital, as each digit of the binary number represents the on/off status of one of the E- and M-Leads, as defined in Table 8.

Table 8 Remote Status Messages (S Codes)

Position	Value	Description
B00000000 -----↑	0	M-Lead for Channel 1 is idle.
	1	M-Lead for Channel 1 is busy.
B00000000 -----↑-	0	M-Lead for Channel 2 is idle.
	1	M-Lead for Channel 2 is busy.
B00000000 -----↑--	0	M-Lead for Channel 3 is idle.
	1	M-Lead for Channel 3 is busy.
B00000000 -----↑---	0	M-Lead for Channel 4 is idle.
	1	M-Lead for Channel 4 is busy.
B00000000 ---↑----	0	E-Lead for Channel 1 is idle.
	1	Signaling is turned on and the E-Lead for Channel 1 is busy.
B00000000 --↑-----	0	E-Lead for Channel 2 is idle.
	1	Signaling is turned on and the E-Lead for Channel 2 is busy.
B00000000 -↑-----	0	E-Lead for Channel 3 is idle.
	1	Signaling is turned on and the E-Lead for Channel 3 is busy.
B00000000 ↑-----	0	E-Lead for Channel 4 is idle.
	1	Signaling is turned on and the E-Lead for Channel 4 is busy.

INSTALLATION PROCEDURE

Refer to the figures and tables in the previous section as necessary during this procedure. Power supply and time slot considerations may affect the installation of this module into an existing multiplexer shelf. Refer to the sections on *Channel Module Configuration Rules* and *Adding Channel Modules to Existing Systems* in your multiplexer operation manual for more information.

INSPECTION:

Inspect the module for shipping damage. If you suspect damage to the module, call RFL Customer Service at 973.334.3100.

CONFIGURATION:

1. Choose an unused physical slot in the Intraplex multiplexer for installation of this module, and make sure that the appropriate module adapter or cross-connect panel is installed at the rear of the slot where you intend to mount this module.

Refer to Appendix A in this manual for information about selecting and installing module adapters.

2. Set for use in a terminal or drop/insert multiplexer using the **TERM** switch (SW2, position 1): UP to communicate via the DI-B port in a drop/insert multiplexer, DOWN in a terminal multiplexer or to communicate via the DI-A port in a drop/insert multiplexer.
3. Select the number of active voice channels using the **TS0** and **TS1** switches (SW2, positions 2 and 3), as described in Table 2.
4. Select the desired starting time slot using the **TIME SLOT SELECT** switches (SW1, positions 1 - 5), as described in Table 4.

IMPORTANT! This module requires one time slot for each active channel. Do not select a starting time slot that would attempt to place data in a time slot higher than 24.

5. Set the address for the card using the **SCB ADDRESS** switch bank (SW3), as described in Table 5. This step is not strictly necessary unless you will be using the remote access and control capabilities of the multiplexer, but it is advisable to set each card to a different address during installation in order to simplify the activation of remote operation in the future.
6. After completing the above procedures, set the module for local control or remote control operation using the following steps:
 - A. For *local* control:
 1. Set to local control: **REMOTE** switch (S2, position 5) UP.
 2. Turn service on: **OFF** switch (S2, position 6) UP.
 3. Install the module into the shelf (see *MOUNTING*, below).
 - B. For *remote* control operation:
 1. Set to local control: **REMOTE** switch (S2, position 5) UP.

2. Turn service off: **OFF** switch (S2, position 6) DOWN.
3. Install the module (see *MOUNTING*, below).
4. Wait 15 seconds; this loads the parameter settings for the card into the shelf common module.
5. Remove the module and set to remote control: **REMOTE** switch DOWN. Do not turn service on.
6. Reinstall the module.
7. Verify the configuration via remote control by issuing a CONFIG? query. Table 9 shows a typical VF-25 response to a CONFIG? query.
8. Set service on via remote control (ISiCL SET command, with “SRVC = ON” in the parameter field). You can now change the operating parameters for the module using ISiCL commands. For details on using the Intraplex Simple Command Language (ISiCL) for remote access and control, consult your multiplexer operation manual.

MOUNTING:

Insert the module into the selected slot in the multiplexer.

!!! IMPORTANT: The module must be inserted so that the white ejector tab is at the *bottom* in a full size (5¼” high) shelf, or at the *right* in a compact (1¾” high) shelf.

Table 9 Sample VF-25 Response To A CONFIG? Query

RESPONSE:	MEANING:
*OK	Valid command received
CHANNEL CARD 4, TYPE 103	Module in physical slot 4 is a VF-25
UNDER REMOTE CONTROL	Remote control is on
SRVC = OFF	Service is off
P01 = 12 (B00001100)	Four channels active, signaling on, using time slots 12, 13, 14, and 15
P02 = 1 (B00000001)	Terminal operation, all loopbacks off
P03 =124 (B01111100)	Ch. 1 Tx level control set to 0 dB
P04 =124 (B01111100)	Ch. 1 Rx level control set to 0 dB
P05 =124 (B01111100)	Ch. 2 Tx level control set to 0 dB
P06 =124 (B01111100)	Ch. 2 Rx level control set to 0 dB
P07 =124 (B01111100)	Ch. 3 Tx level control set to 0 dB
P08 =124 (B01111100)	Ch. 3 Rx level control set to 0 dB
P09 =124 (B01111100)	Ch. 4 Tx level control set to 0 dB
P10 =124 (B01111100)	Ch. 4 Rx level control set to 0 dB

TESTING AND TROUBLESHOOTING

Every VF-25 module is tested before it leaves the factory. In addition, each module provides local and remote loopbacks for on-site testing and troubleshooting purposes.

- The **local loopback** on the VF-25 module loops back all four channels together, and is intended for use during initial installation and testing. This loopback occurs directly after the analog-to-digital PCM conversion; that is, the analog audio enters the module, is coded to 8-bit PCM data, and is then immediately decoded and passed back out as analog.
- The **remote loopback** on the VF-25 module allows each channel to be looped back independently, making it useful for testing one channel while the other channels on the card remain in service. For this loopback, the analog signal is encoded and transmitted over the T1 circuit, is decoded by the card at the far end, and is then looped back, re-encoded, and sent back to the originating end.

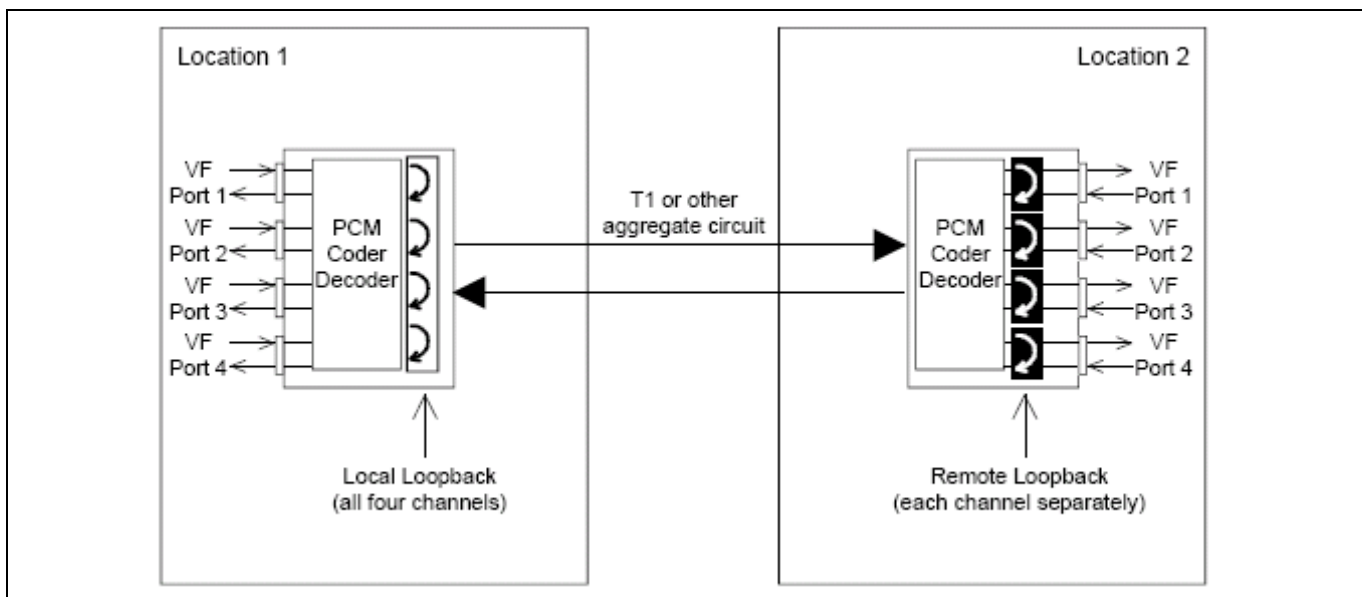


Figure 7: VF-25 Loopbacks

Procedure to Use VF-25 Loopbacks:

1. Activate the desired loopback using P code **P2**, as described in *P Codes*. A local loopback of all four channels may also be activated using the **LOOPBACK** switch (Switch 1, position 6; may be labeled **AUX** on some cards.) When doing a local loopback, test each channel sequentially.
2. Verify that the input and output level jumpers for the channel being tested are in the Normal position (see Table 3).
3. Connect the output of an audio signal generator (Hewlett-Packard HP4935A or equivalent) to the input leads for the desired channel. Insert a 1004 Hz test tone at 0 dBm referenced to 600 Ohms.

4. Measure channel output at the output leads for the channel being tested. The output should be 0 dBm referenced to 600 Ohms, ± 0.5 dB.
5. Measure signal-to-noise ratio with C message weighting. This should be greater than 33 dB S/N.
6. If you are performing a remote loopback, deactivate the loopback for this channel and activate the loopback for the next channel to be tested. If you are using a local loopback, leave the loopback up until all channels have been tested.
7. Repeat the above steps for each active channel.
8. Remove the test equipment and deactivate all loopbacks.

If there is an apparent malfunction, first check that the configuration is appropriate for the transmission system in use. If you are doing end to end testing, check that the transmit and receive configurations are identical.

Problems may occur at the common equipment or facility level which affect the operation of this card. Refer to the *Troubleshooting* section in your multiplexer operation manual for system analysis procedures.

SPECIFICATIONS

CONFIGURATION

Four independent voice frequency channels

SYSTEM COMPATIBILITY	T1 Multiplexers Variable Rate Multiplexers
FREQUENCY RESPONSE	300 to 3000 Hz, +/-0.5 dB
INPUT/OUTPUT LEVEL	Selectable: Nominal 0 dBm input, 0 dBm output, or nominal -16 dBm input, +7 dBm output
LEVEL RANGE	Adjustable in <0.5 dB steps
Input	-16.0 dBm to +7.0 dBm
Output	-10.0 dBm to +10.0 dBm
IMPEDANCE	Balanced, 600 ohms input and output
IDLE CHANNEL NOISE	Less than 23 dBncO
SIGNAL to NOISE	1004 Hz input, 0 to -30 dBm: Less than 33 dB in C Message weighting
CODING FORMAT	μ-law PCM, 64 kbps per channel
SIGNALING	Selectable, E&M Type I, II, III, or V, or Transmission Only (TO) operation
M-LEAD INPUT	Type I, II, and III: Busy = -20 to -60 Volts Idle = Ground Type V: Busy = Ground Idle = Open
E-LEAD OUTPUT	Type I, III, and V: Busy = Ground Idle = Open Type II: Busy = Contact closure to SG Idle = Open
TIME SLOTS	One to four sequential time slots (one for each active channel). Starting time slot is user-selectable.
LOOPBACKS	Local and remote analog loopbacks
LED INDICATOR	Green LED indicates Service On

ENVIRONMENTAL

Temperature:
0° - 50°C Operating
Humidity:
0% - 90% Non-condensing

POWER CONSUMPTION

2.0 Watts nominal with all four channels active

Appendix A
MODULE ADAPTERS - VF-25

The VF-25 Voice Module must be installed with an MA-305 Module Adapter.

The MA-305 accepts a 50-pin connector, Amphenol 57-30500 or equivalent (Figure A-1). Table A-1 shows the pin assignments on this connector. Plug the connector into the MA-305, and insert the MA-305 into the rear of the slot which will hold the VF-25.

Jumpers JMP1 through JMP5 are used to select the signaling type. Holding the MA-305 as illustrated below, set the jumpers as shown.

For Jumper JMP5:	For Jumpers JMP1, 2, 3, and 4:
• □ □ = Type I, II, or III □ □ • = Type V only	□ □ • = Type II only • □ □ = Type I, III, or V

Specifications Subject To Change Without Notice.

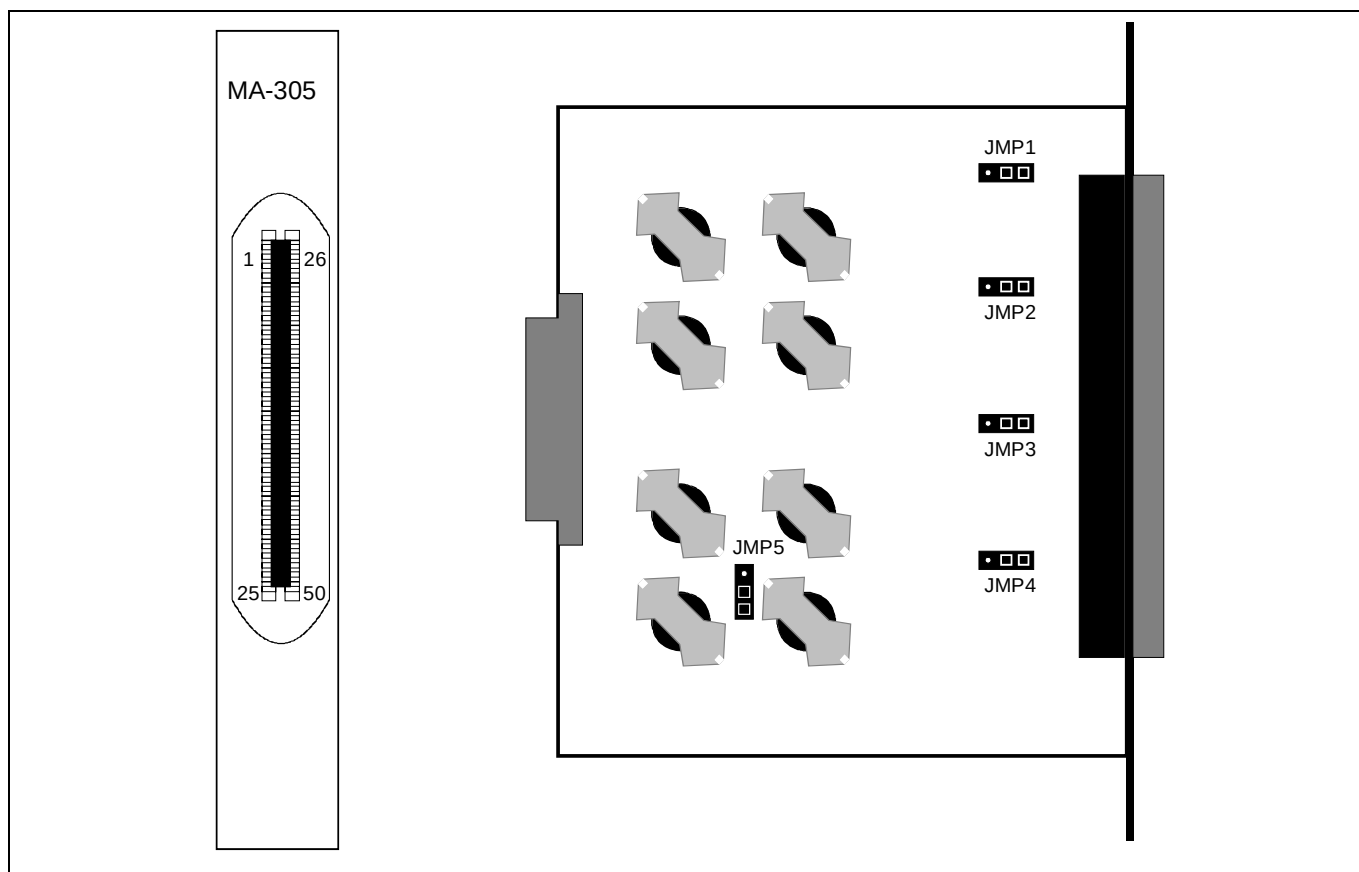


Figure A-1: MA-305

Table A-1 Pin Assignments on the MA-305

Signal	Pin Assignment			
	Ch. 1	Ch. 2	Ch. 3	Ch. 4
Input (Ring)	1	5	9	13
Input (Tip)	26	30	34	38
Output (Ring)	2	6	10	14
Output (Tip)	27	31	35	39
E-Lead	28	32	36	40
M-Lead	29	33	37	41
Signal Ground	3	7	11	15
Signal Battery	4	8	12	16

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SECTION 18. PROTECTION AND CONTROL MODULES

This section contains Instruction Data Sheets for all protection and control modules available for use with the IMUX 2000 Intelligent Multiplexer, as of the date this manual was printed:

- o **RFL DS-TT Transfer Trip Module**
- o **RFL STATUS Module**
- o **RFL TMX/TMR Telemetry Transmitter/Telemetry Receiver Modules**

Additional schematics, wiring diagrams, or other documents specific to your application may also be placed in this section.

For information on other protection modules that may be available for use with your IMUX 2000, contact the factory or an RFL Sales Representative.

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RFL Electronics Inc.

INSTRUCTION DATA

RFL DS-TT Transfer Trip Module For RFL IMUX 2000 Intelligent T1/E1 Multiplexers (Includes MTS IRIG-B Synchronization Upgrade)

DESCRIPTION

The RFL DS-TT Transfer Trip Module is a bi-directional module designed for use in RFL IMUX 2000 multiplexers. **This device is also referred to as the MTS module (Modular Teleprotection System).** It transmits and receives data via the T1/E1 serial link and generates and receives trip commands via an I/O adapter module. The RFL DS-TT can support up to four bi-directional transfer trip functions between two IMUX 2000 terminals, or can support DCB (Directional Comparison Blocking) in addition to two transfer trip functions. These terminals can operate point to point between two IMUX 2000 terminal nodes in a network. These terminal nodes can be configured as point-to-point or drop and insert terminals and can be installed at different locations in the network either at adjacent or nonadjacent nodes. The RFL DS-TT module has eight LEDs on the front to indicate the condition of the trip inputs and outputs.

NOTE

The RFL DS-TT module can also be used in RFL 9001 T1/E1 multiplexers, however, in this application the DS-TT module can only be programmed using the RS-232 port. The RS-232 port is labeled J1 and is located near the front of the DS-TT module as shown in Figure 1.

When using the DS-TT module in IMUX 2000 T1/E1 multiplexers, the user must know the CM3B software version.

If the CM3B software version is dated 3-11-96 or later, then the DS-TT module can be programmed using either the Network Management Software as described in Section 7 of the IMUX 2000 Instruction Manual, or SCL commands via the CM3B RS-232 port. See the Remote Control Interface section of this instruction data sheet.

If the CM3B software version is dated before 3-11-96, then the DS-TT module can only be programmed using the RS-232 port of the DS-TT module using SCL commands. The RS-232 port is labeled J1 and is located near the front of the DS-TT module as shown in Figure 1.

To determine the CM3B software version in your system, remove the CM3B module from the multiplexer chassis and read the date of the software label on device U3. The date on this label is the CM3B software version. The software label will be similar to the one shown below.

The RFL DS-TT works with all versions of CM3C, CM3R, CM4 or CM6 software.

U3 2/13/96 SW2000C3V001 (C) '96 RFL

FEATURES

TRIP HOLD

This is a timer function which extends the length of time that a trip output is activated after a valid trip condition occurs. For this function to engage, a valid trip condition must exist long enough to satisfy the pre-trip timer. The length of time is programmable independently for each function.

INPUT DE-BOUNCE

This is a timer function which requires that a trip input be present for a certain length of time before a trip command is transmitted. The length of time is not programmable by the user, but is set at the factory to 100 μ s.

ALARM TIMER

This is a timer function which requires that an alarm condition exists for a certain length of time before an alarm output is generated. The length of time is programmable by the user.

PRE-TRIP TIMER

This is a security timer function set on the Rx Card. It requires that a trip be present for a certain length of time before an output is generated. The length of time is programmable independently for each function. Note that the setting in NMS (Network Management Software) has a propagation delay or offset of 2 ms built in. **The NMS pre-trip timer setting takes into account an approximate 2 ms of processing delay within the module and mux. For example: To cause the Pre-Trip Timer to require 3 continuous milliseconds of Receive Trip Commands before the trip command is accepted, use an NMS pre-trip timer value of 5 ms.**

COMMUNICATION CHARACTERISTICS

This module communicates using a single bi-directional DS0. The communication includes programmable addressing to prevent misconnections. One of 32 addresses are selectable.

PROGRAMMABLE LOGIC

Trip hold	3 - 256 ms (1 ms increments)
Output Form	normal/invert
Alarm timer (delay)	0 - 2.5 Sec. (10 ms increments)
Pre-trip timer	3 - 16 ms (1 ms increments)
Unblocking	Enable/Disable
Sequence of events log	20 records
Operational modes	Transfer Trip/DCB

PING PONG

This module is capable of measuring and recording round trip delay. The measurement is run continuously and an alarm is generated if the round trip delay exceeds a user preset value. The frequency of the Ping Pong test is selectable by the user. The resolution of the test is 1 millisecond and the accuracy is 1 millisecond each way.

SPECIFICATIONS

As of the date this Instruction Data Sheet was published, the following specifications apply to the RFL DS-TT module. Because all RFL products undergo constant refinement and improvement, these specifications are subject to change without notice.

ENVIRONMENTAL

ANSI C37.90 - 1989	(service conditions)
Operating temperature	- 20°C to + 55°C
Storage temperature	- 40°C to + 75°C
Humidity	95% @ 40°C non-condensing

SWC/ FAST TRANSIENT

ANSI C37.90 - 1989	(dielectric)
ANSI C37.90.1 - 1989	(SWC & fast transient)

RFI SUSCEPTIBILITY

ANSI C37.90.2	35 V/M

OPTICAL INPUT SPECIFICATIONS

Operating voltage range:	
48 Vdc	38-60 Vdc
125 Vdc	88-150 Vdc
250 Vdc	200-280 Vdc
Input threshold	1/2 nominal station battery

SOLID STATE OUTPUT SPECIFICATIONS

Maximum continuous output current	1 Amp
Maximum surge current (100 ms)	10 Amps
Minimum output current	20 ma
Maximum open circuit voltage	280 Vdc

OPTIONAL RELAY OUTPUTS

Maximum continuous current	2 A (inductive)
Maximum surge current (100 ms)	30 A
Maximum breaking current	1 A resistive
Maximum open circuit voltage	280 Vdc
Maximum operate time	5 ms

ALARM RELAY SPECIFICATIONS

Maximum continuous current	1 A (inductive)
Maximum breaking current	1 A (resistive)
Maximum open circuit voltage	280 Vdc
Maximum operate time	10 ms

SYSTEM PERFORMANCE

Operate time (back to back)	3 ms (solid state)
Dependability (IMUX 2000 in frame)	99.99%
Security (10^{-3} BER on IMUX 2000)	1×10^{-22}

SYSTEM COMPATIBILITY

The RFL DS-TT is compatible with all RFL 9001 and IMUX 2000 T1/E1 multiplexers
(See note on page 1)

OPERATING MODES

Full duplex (transmit and receive)

POWER CONSUMPTION

2.0 watts maximum

DIMENSIONS

	<u>Transfer Trip Module</u>	<u>2 Function I/O Adapter Module</u>	<u>4 Function I/O Adapter Module</u>
Length:	9.8 in (24.8 cm)	4.7 in (11.9 cm)	4.7 in (11.9 cm)
Width:	0.6 in (1.5 cm)	2.1 in (5.3 cm)	4.2 in (10.6 cm)
Height:	4.5 in (11.4 cm)	5.0 in (12.7 cm)	5.0 in (12.7 cm)

WEIGHT

	<u>Transfer Trip Module</u>	<u>2 Function I/O Adapter Module</u>	<u>4 Function I/O Adapter Module</u>
Net:	0.62 lb (0.28 kg)	0.70 lb (0.32 kg)	1.22 lb (0.55 kg)
Shipping:	1 lb (0.45 kg)	1 lb (0.45 kg)	1.5 lb (0.68 kg)

INSTALLATION

Before the DS-TT module can be placed in service, it must be installed in a multiplexer shelf. Installation involves determining the module slot in the Main Shelf or Expansion Shelf where the module will be installed, inserting an I/O adapter module into the rear of the shelf behind the module slot, connecting all signal wiring to the I/O adapter module, checking the settings of all switches and jumpers, and inserting the module into the front of the shelf.

NOTE

Power supply and time slot considerations may affect the installation of RFL DS-TT modules into an existing multiplexer shelf. Refer to the portions of your multiplexer operation manual covering “Channel Module Configuration Guidelines” and “Adding More Channel Modules To Existing Systems” for more information.

The following instructions are provided for installing RFL DS-TT modules into existing systems. If the module was included as part of a system, installation was done at the factory, otherwise, proceed as follows:

1. Carefully inspect the RFL DS-TT and its I/O adapter module for shipping damage.
If you suspect damage to the module or its Module Adapter, immediately contact RFL’s Customer Service Department at the number shown at the bottom of this page.
2. Determine which module slot in the Main Shelf or Expansion Shelf the RFL DS-TT will be installed in.
The RFL DS-TT module occupies one module slot in the Main Shelf or Expansion Shelf. Refer to the “as supplied” drawings furnished with the equipment for more information.
3. Determine which I/O Adapter Module will be used to make connections to the RFL DS-TT module.
Each RFL DS-TT module installed in an IMUX 2000 multiplexer requires an I/O Adapter Module. The I/O Adapter Module provides the appropriate connections for the desired interface.
There are eight I/O Adapter Modules that can be used with the RFL DS-TT. These are listed below:

<u>I/O Adapter Module Type</u>	<u>Part Number</u>	<u>Output Type</u>	<u>Figure</u>
*2 function 48/125V	105770-2	solid state	3
*2 function 250V	105770-3	solid state	3
*2 function 48/125V	105740-2	relay	3
*2 function 250V	105740-3	relay	3
4 function 48/125V	105770-4	solid state	4
4 function 250V	105770-5	solid state	4
4 function 48/125V	105740-4	relay	4
4 function 250V	105740-5	relay	4

*See NOTE on page 21 for 2 function systems.

Make sure the I/O Module Adapter you are installing is the correct one for the desired application.

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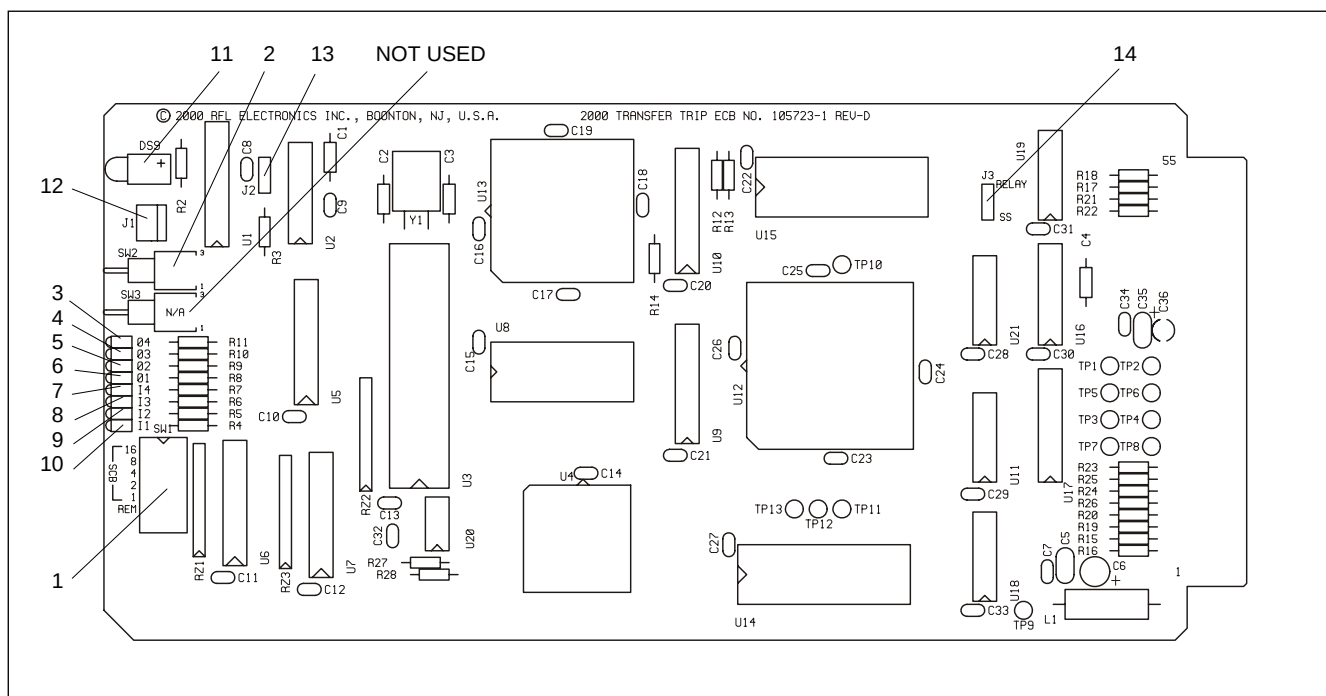


Figure 1. Controls and indicators, RFL DS-TT Transfer Trip Module.

Table 1. Controls and indicators, RFL DS-TT Transfer Trip Module

Item	Name/Description	Function
1	DIP Switch SW1	SW1-1 to SW1-5: Sets the SCB Address in accordance with Table 3.
		SW1-6: Sets Transfer Trip module to Local or Remote mode.*
		DOWN = Sets module to Local mode (settings can be made using DS-TT local RS-232 port)
		UP = Sets module to Remote mode (settings can be made using CM3 remote RS-232 port)
2	Switch SW2 (See Note 6 on page 27)	Disable Switch. Is used to disable the module. It disables all trip outputs and all communications via the T1/E1 system. UP = ENABLE, DOWN = DISABLE
3	LED indicator (red)	Lights when function 4 trip is received
4	LED indicator (red)	Lights when function 3 trip is received
5	LED indicator (red)	Lights when function 2 trip is received
6	LED indicator (red)	Lights when function 1 trip is received
7	LED indicator (red)	Lights when function 4 trip is transmitted
8	LED indicator (red)	Lights when function 3 trip is transmitted
9	LED indicator (red)	Lights when function 2 trip is transmitted
10	LED indicator (red)	Lights when function 1 trip is transmitted
11	LED indicator (red)	Lights during Alarm conditions and during programming Note: Effective with software version SW2000TT021 LED will blink slowly when module is out of service.
12	Connector J1	An RS-232 port to connect a PC, Laptop or dumb terminal to the module. The RS-232 port always operates using 8 data bits, no parity, and 1 stop bit. These parameters <u>cannot</u> be changed by the user. The baud rate is set at 9600. (See note on page 1) (See Figure 2 for cable details)
13	Jumper J2	Enables or disables the watchdog timer. Used for factory testing only. Should always be in “RUN” (DOWN) position.
14	Jumper J3	Selects Relay or Solid-State output

* SW1-6 is used only on units with software version SW2000TT008 or higher.

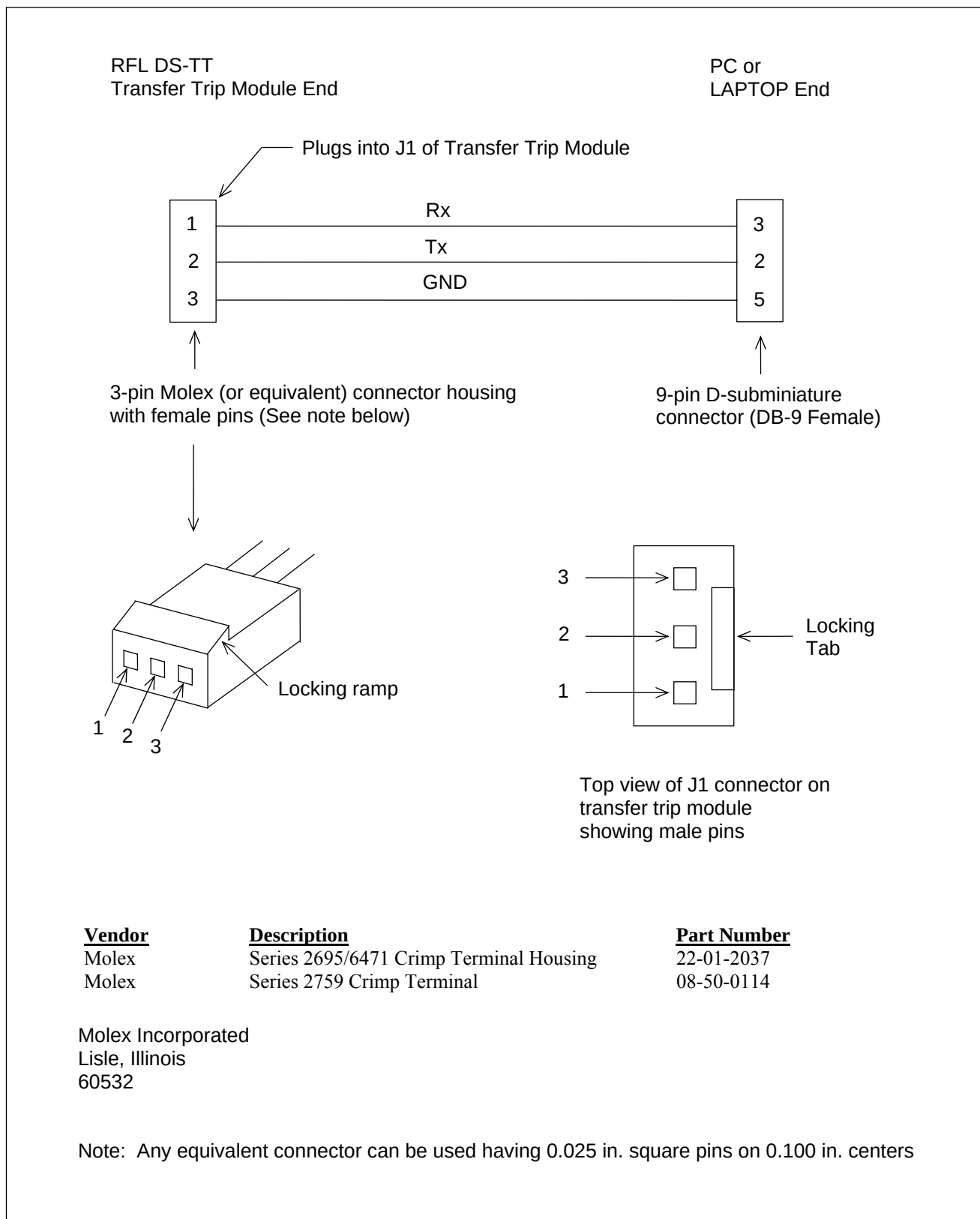


Figure 2. Cable connections between the RFL DS-TT transfer trip module (RS-232 connector, J1) and a PC or LAPTOP. (This cable is required for local mode operation only. See page 26).

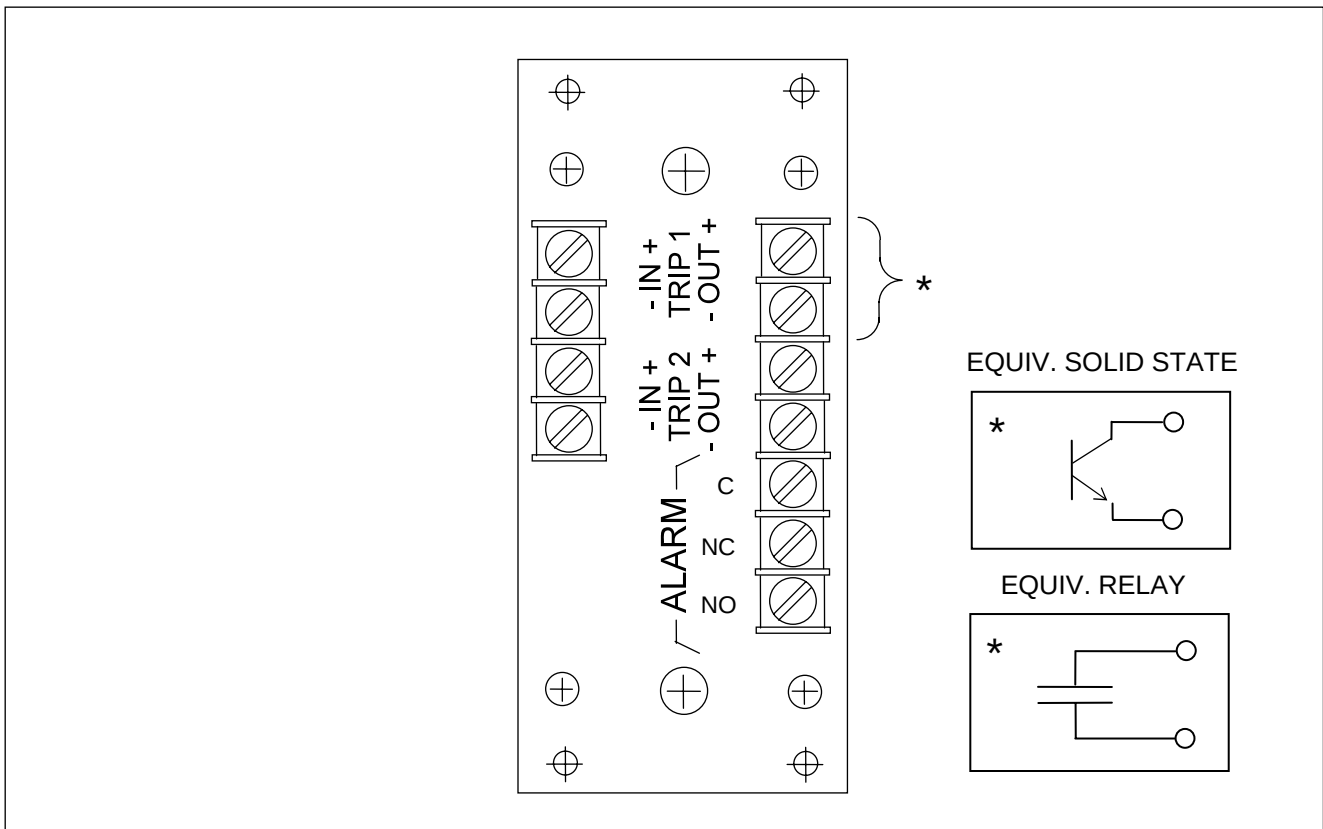


Figure 3. Rear panel view of typical 2 function RFL DS-TT Adapter Module

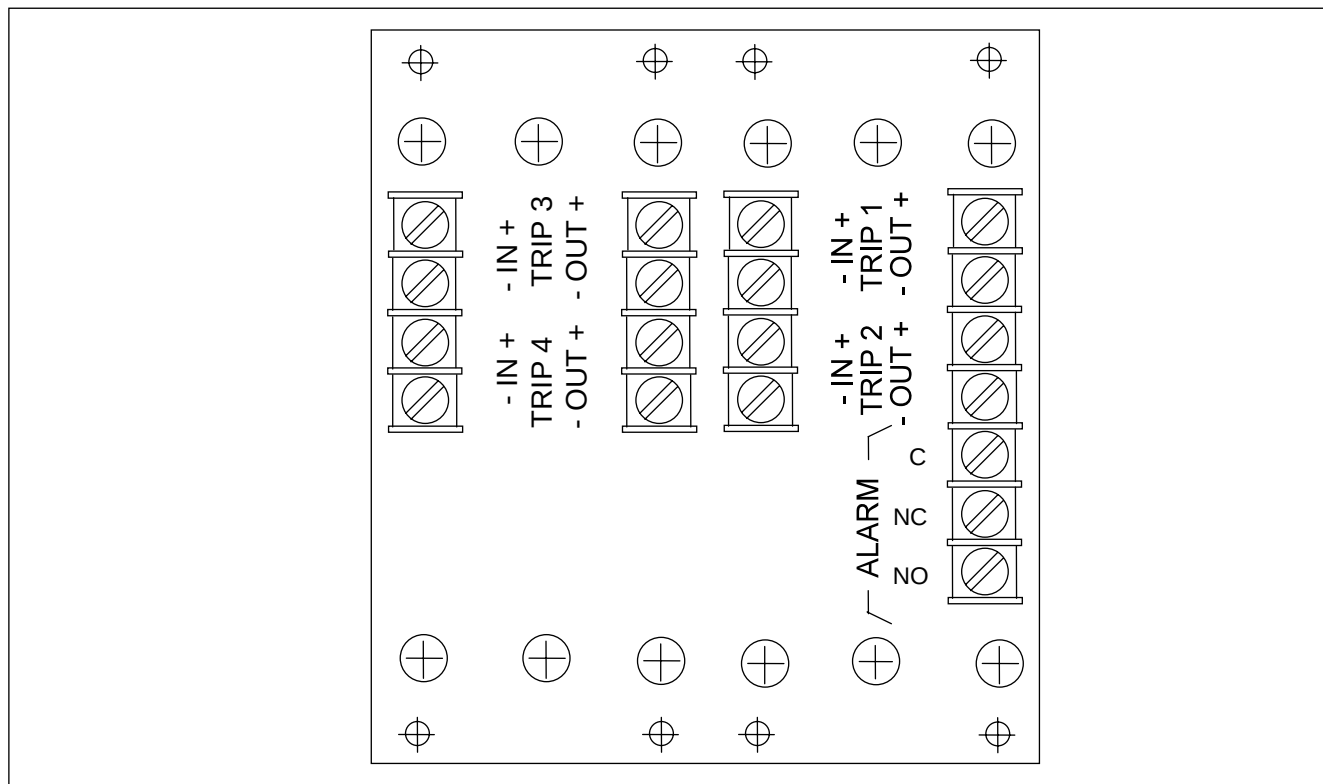


Figure 4. Rear panel view of typical 4 function RFL DS-TT Adapter Module

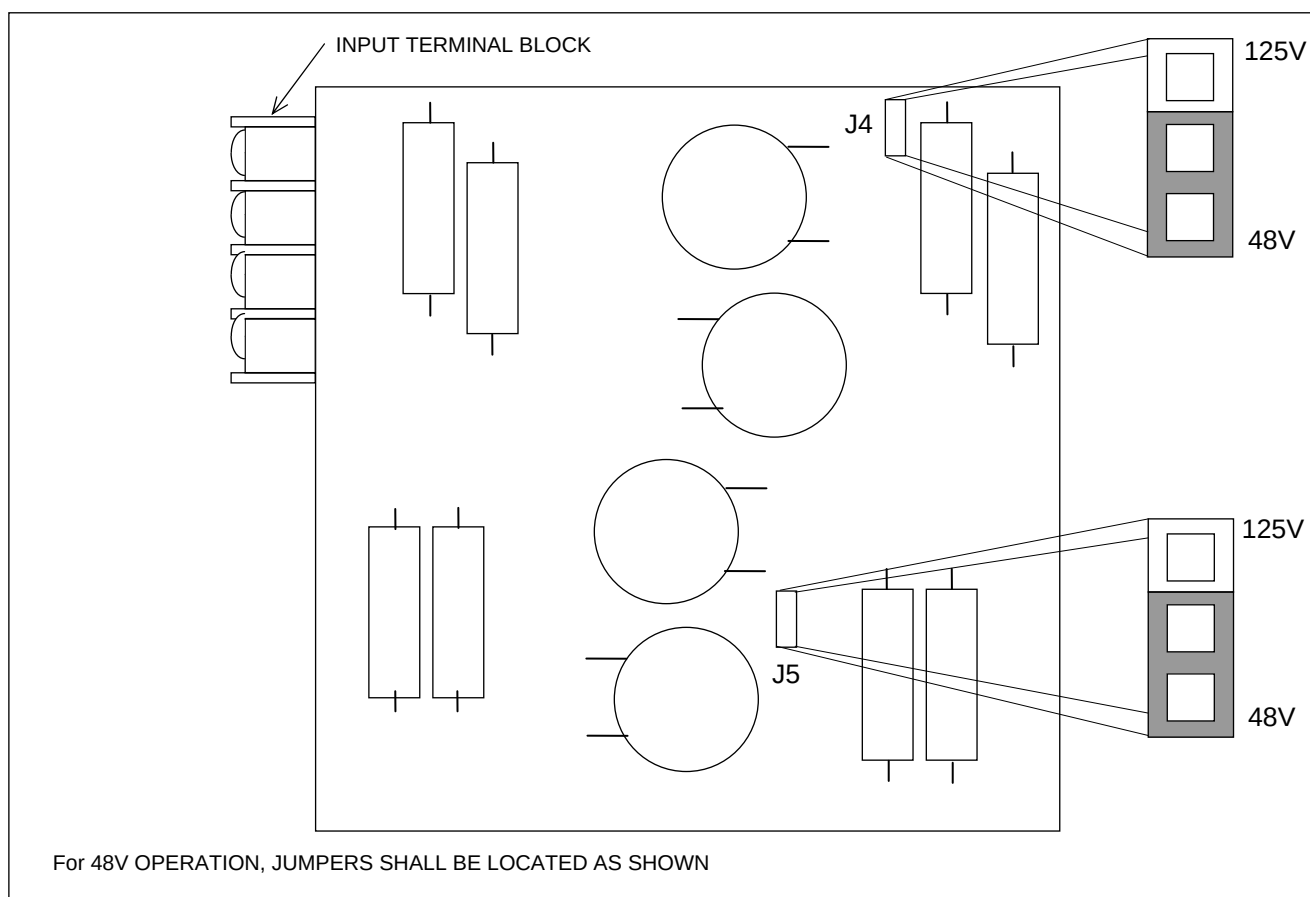


Figure 5. Location and use of voltage control jumpers on a typical I/O adapter module input board

4. Once the I/O adapter module has been selected, check the settings of the voltage control jumpers located on the I/O adapter module input board(s). All eight versions of the I/O module input boards shown in Figure 5 are identical, with the exception of the placement of the two voltage control jumpers J4 and J5. Note the location of these jumpers in Figure 5.

For 48V operation both jumpers must be in the 48V position. For 125V operation both jumpers must be in the 125V position. The 250V modules should have both jumpers in the 125V position. See Table 2.

Table 2. Voltage control jumper settings

I/O Adapter Module part number	I/O Adapter Module type	J4 and J5 jumper position
105770-2 105770-4 105740-2 105740-4	2 function 48/125V solid state* 4 function 48/125V solid state 2 function 48/125V relay* 4 function 48/125V relay	48V position for 48V operation, 125V position for 125V operation
105770-3 105770-5 105740-3 105740-5	2 function 250V solid state* 4 function 250V solid state 2 function 250V relay* 4 function 250V relay	125V position for 250V operation

* See NOTE on page 21 for 2 function systems.

5. Insert the I/O Adapter Module into the rear of the shelf directly behind the module slot where the DS-TT will be installed.
The I/O Adapter Module will take up three slots for the 2 function version, and six slots for the 4 function version. This must be taken into consideration when selecting module slots.
6. Connect all signal wiring to the rear panel of the I/O Adapter Module.
7. Using DIP switches SW1-1 to SW1-5, set the DS-TT module address.
For remote access, each channel module in an IMUX 2000 multiplexer shelf must have a distinct module address. For this module, valid module addresses are the numbers “1” to “31”, using the code shown in Table 3. The module address is usually set to the number of the physical slot in the shelf that the module will occupy; it can be set to any number from 1 to 31 that is not already being used by another module in the same multiplexer shelf.
8. Check the setting of DIP switch SW1-6.
SW1-6 sets the DS-TT module to local or remote control. UP sets the DS-TT to remote mode (settings obtained from RS-232 remote port on CM3), DOWN sets the module to local mode (settings obtained from RS-232 local port on DS-TT). Set the switch to the desired position.
9. Set toggle switch SW2 to the DOWN position to disable the module.
10. Check the setting of jumper J2. It should be in the RUN position. This will enable the watchdog timer.
11. Check the setting of jumper J3. It should be in RELAY position if the I/O Adapter Module has a relay output. It should be in SOLID STATE position if the I/O Adapter Module has a solid state output.
12. Slide the module into the selected module slot until it is firmly seated.
13. Program the module parameters using local or remote interface as applicable.
14. Turn service on by placing the SW2 toggle switch to the UP position.
15. On the module record card (located to the right of the shelf), record the time slot number and other pertinent information.

The RFL DS-TT module is now installed.

Table 3. SCB address settings, RFL DS-TT Transfer Trip Module

Module Address	SW1-1	SW1-2	SW1-3	SW1-4	SW1-5
1	DOWN	DOWN	DOWN	DOWN	UP
2	DOWN	DOWN	DOWN	UP	DOWN
3	DOWN	DOWN	DOWN	UP	UP
4	DOWN	DOWN	UP	DOWN	DOWN
5	DOWN	DOWN	UP	DOWN	UP
6	DOWN	DOWN	UP	UP	DOWN
7	DOWN	DOWN	UP	UP	UP
8	DOWN	UP	DOWN	DOWN	DOWN
9	DOWN	UP	DOWN	DOWN	UP
10	DOWN	UP	DOWN	UP	DOWN
11	DOWN	UP	DOWN	UP	UP
12	DOWN	UP	UP	DOWN	DOWN
13	DOWN	UP	UP	DOWN	UP
14	DOWN	UP	UP	UP	DOWN
15	DOWN	UP	UP	UP	UP
16	UP	DOWN	DOWN	DOWN	DOWN
17	UP	DOWN	DOWN	DOWN	UP
18	UP	DOWN	DOWN	UP	DOWN
19	UP	DOWN	DOWN	UP	UP
20	UP	DOWN	UP	DOWN	DOWN
21	UP	DOWN	UP	DOWN	UP
22	UP	DOWN	UP	UP	DOWN
23	UP	DOWN	UP	UP	UP
24	UP	UP	DOWN	DOWN	DOWN
25	UP	UP	DOWN	DOWN	UP
26	UP	UP	DOWN	UP	DOWN
27	UP	UP	DOWN	UP	UP
28	UP	UP	UP	DOWN	DOWN
29	UP	UP	UP	DOWN	UP
30	UP	UP	UP	UP	DOWN
31	UP	UP	UP	UP	UP

FUNCTIONAL DESCRIPTION

The following is a basic description of how the RFL DS-TT module operates. A simplified block diagram of the module appears in Figure 6.

SYSTEM OVERVIEW

The transfer trip module is a channel card for use in the IMUX 2000 system. It transmits and receives data via the T1/E1 serial link and generates and receives trip commands via an I/O adapter module. Up to four trip inputs and four trip outputs can be supported. The module can be setup and interrogated remotely via the SCB of the IMUX 2000. For local setup and interrogation, an RS-232 port is available. Front panel LEDs indicate the status of the trip inputs and outputs. A real time clock with sequence of events storage is also available.

The module consists of three major sections. The microcontroller section contains an 80C320 embedded microcontroller and associated support devices. The trip FPGA (field programmable gate array) and its associated circuits handles all T1/E1 communication and trip I/O. The SCB FPGA connects the processor with the SCB of the IMUX 2000. Miscellaneous other circuits are present to handle other functions. A switch is provided to disable the card for removal and insertion, and a jumper is provided to select between relay and solid state outputs.

MICROCONTROLLER CIRCUIT

The heart of the microcontroller circuit is an 80C320 8 bit embedded microcontroller. Its main purpose is to control the setup and interrogation functions of the transfer trip module. It does not do any processing of the T1/E1 data and trip signals. A PSD312 programmable device provides 2KB of RAM, 64KB of ROM, and port reconstruction for the 80C320. It is connected to ports 0 and 2 of the microcontroller. A DS1642 device provides non volatile RAM, a real time clock function, and contains an embedded clock and battery. A MAX691 device provides a reset pulse on power turn on and a watchdog timer function.

TRIP FPGA CIRCUIT

The trip FPGA interfaces directly with the T1/E1 bus of the IMUX chassis. It is also connected to the trip inputs and outputs. Supporting the trip FPGA are two EPROMs which contain the transmit and receive CRC codes.

SCB FPGA CIRCUIT

The SCB FPGA circuit is used to communicate with the CM3B via the SCB. The transfer trip module type ID of 118 is encoded into the SCB FPGA device.

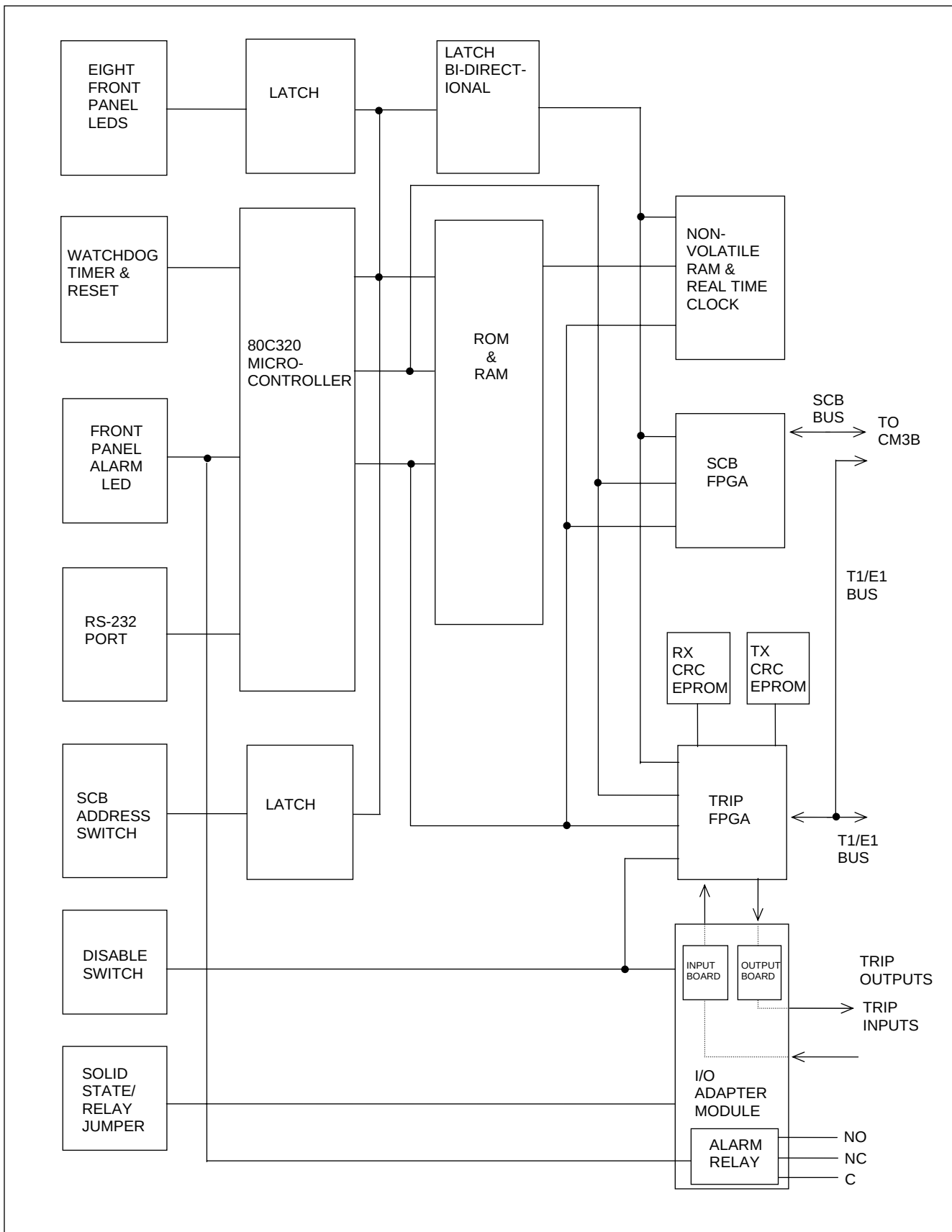


Figure 6. Transfer trip module block diagram

MISCELLANEOUS CIRCUITS

The transfer trip module has eight LEDs on the front to indicate the condition of the trip inputs and outputs. These LEDs are driven by a latch which is memory mapped off the processor. An additional LED indicates an alarm condition. This LED and a local alarm relay are directly driven by the processor. A five position DIP switch is provided to allow the user to set the SCB address of the module. The processor reads the switch to setup the SCB FPGA.

I/O ADAPTER MODULE(S)

The transfer trip module must be used with one of eight I/O Adapter Modules. There are two and four function versions, and relay and solid state versions. See Figures 3 and 4, and Table 2. The two function version is assembled from two PCBs; one for inputs and alarms, and the other for outputs. The four function version uses the same two boards as the two function version but has an additional input and output board. The boards are interconnected via a series of short cables.

INPUT BOARD

The input board contains circuitry for two optically isolated inputs and one form C alarm relay. The components consist mainly of dropping resistors, a zener diode, and an optoisolator. An LC filter is also provided to prevent SWC from triggering an input. The dropping resistors are sized to allow a safe level of current to be drawn from the keying input. The zener diode and resistors prevent any voltage less than half the nominal keying voltage from causing an input. The optoisolator provides galvanic isolation from the keying circuits.

OUTPUT BOARD

The output board can be configured for either solid state or relay outputs. Each output board provides two outputs. The solid state output takes the oscillating trip signal and feeds it across a transformer to isolate it and then rectifies and smoothes the result. This feeds the gate of a FET transistor. The transistor is rated to carry many times the rated load for short periods but thermal limitations prevent it from carrying a large load indefinitely. An LC filter protects the FET from damage caused by surges on the outputs. The relay version of the output board has two output relays with LC filters. The relays have diodes to prevent the flyback effect from creating spurious noise.

DIRECTIONAL COMPARISON BLOCKING MODE

All MTS modules with ACTEL (U12) version SW2000TTTR7 or later are capable of being used in directional comparison blocking applications. The functionality of the MTS is transformed into that of a typical single function carrier system. Inputs one and two are used as start and stop inputs. Outputs one and two are block outputs. Functions three and four remain normal transfer trip functions. Figure 7 illustrates how the unit works.

Software settable jumpers J1 and J2 allow for optional inversion of the start and stop inputs. They are controlled by the settings described below. The start input will cause function 1 trip to be sent if the stop input is not active. When Function 1 is sent, the block outputs (outputs 1 and 2) are made active. If Function 1 is received the outputs go active as well.

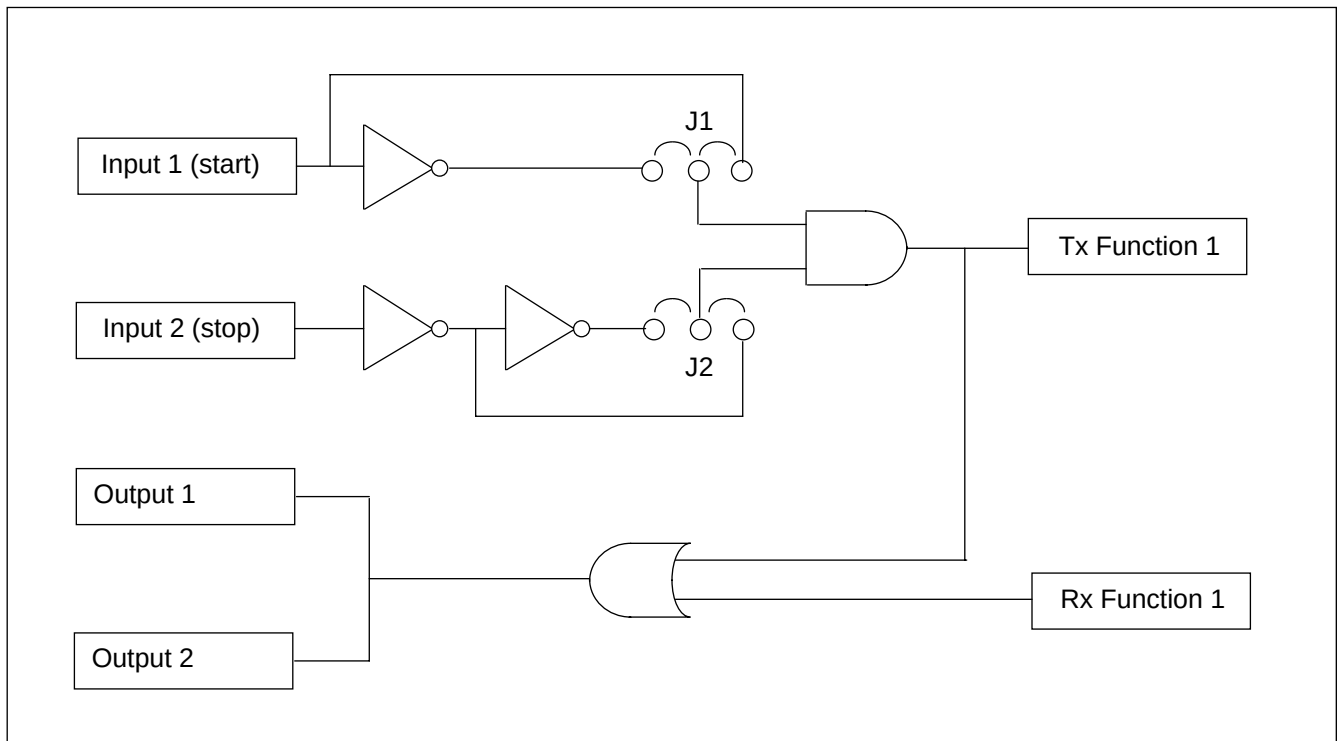


Figure 7. Directional Comparison Blocking, block diagram

The MTS module retains all of its existing functionality and operates in DCB mode only if commanded to. Otherwise the four functions operate as independent transfer trip commands. DCB mode is invoked by setting P13 bit 6 to a 1. This can be done directly or via NMS.

Once in DCB mode the meaning of P7 bit 0 and P7 bit 1 change. In normal mode these bits set the polarity of outputs 1 and 2. In DCB mode P7 bit 0 now selects the polarity of the start input and P7 bit 1 selects the polarity of the stop input. Both polarities are normal if the bit is a zero and inverted if the bit is a one. To set these bits in NMS one should select “output polarity” for output 1 or 2 and change it appropriately.

In order to have NMS support this feature the data base must be changed. In the TT card settings a new setting must be added. In the card master setting selection, the following format is required:

Dir Comp Block | setting | choose2 | on | off | default = off | P13=?1????? | P13=?0?????

This will cause the NMS to bring up the directional comparison blocking on/off choice.

ALERTS AND ALARMS

If there is a loss of CRC or addressing, or if the disable switch is down, the transfer trip module will issue a module alert signal to the shelf common module. This applies only to CM3Rs Rev H or higher, and to transfer trip modules with software version SW2000TT008 or higher.

REMOTE CONTROL INTERFACE

When the RFL DS-TT is installed in an IMUX 2000 multiplexer, it can be operated under local or remote control. When under remote control, most of the module setup parameters can only be programmed using the RS-232 remote port on the shelf Common Module. See the IMUX 2000 manual for additional information on using the remote control interface. When settings are changed, the alarm LED DS9 illuminates briefly while the data is being written to the EEROM.

The remote control interface for the RFL DS-TT involves two sets of codes: “P” (parameter) codes, and “S” (status) codes and a set of four Sequence of Events Transfer Trip commands. The RFL DS-TT reports itself as a “Type 118” module.

“P” CODES

“P” codes, when used in the parameter field on an SCL “SET” command, allow the user to set certain parameters on the RFL DS-TT by remote control, just like setting DIP switches on a module under local control. “P” codes also appear in the response to a “CONFIG?” query, providing a list of the RFL DS-TT current parameter settings. A typical RFL DS-TT response to a “CONFIG?” query looks like this:

```
*OK
CHANNEL CARD 3, TYPE 118
UNDER REMOTE CONTROL
SRVC = ON
P01 = 9 (B00001001)
P02 = 9 (B00001001)
P03 = 9 (B00001001)
P04 = 9 (B00001001)
P05 = 9 (B00001001)
P06 = 9 (B10011001)
P07 = 240 (B11110000)
P08 = 8 (B0001000)
P09 = 4 (B0000100)
P010 = 10 (B0001010)
P011 = 5 (B00000101)
P012 = 6 (B00000110)
P013 = 8 (B00001000)
P014 = 12 (B00001100);
```

There are fourteen “P” codes for the RFL DS-TT; “P1” through “P14”. Each “P” code is displayed as a decimal number from 0 to 255, followed by its eight-digit binary equivalent in parenthesis. Table 4 lists the meaning of all “P” codes for the RFL DS-TT module.

Table 4. Remote Configuration Settings

P Code	Bits Used	Value	Description
SRVC ⁽⁶⁾	...	ON	Turns service on (module enabled)
		OFF	Turns service off (module disabled)
P01 ⁽¹⁾	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑↑↑↑	3 - 256 (ms) (Setting = 2 to 255)	Function 1 trip hold timer
P02 ⁽¹⁾	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑↑↑↑	3 - 256 (ms) (Setting = 2 to 255)	Function 2 trip hold timer
P03 ⁽¹⁾	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑↑↑↑	3 - 256 (ms) (Setting = 2 to 255)	Function 3 trip hold timer
P04 ⁽¹⁾	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑↑↑↑	3 - 256 (ms) (Setting = 2 to 255)	Function 4 trip hold timer
P05 ⁽²⁾	B 0 0 0 0 0 0 0 0 ↑↑↑↑	3 - 16 (ms) (Setting = 2 to 15)	Function 1 pretrip timer
	B 0 0 0 0 0 0 0 0 ↑↑↑↑	3 - 16 (ms) (Setting = 2 to 15)	Function 2 pretrip timer
P06 ⁽²⁾	B 0 0 0 0 0 0 0 0 ↑↑↑↑	3 - 16 (ms) (Setting = 2 to 15)	Function 3 pretrip timer
	B 0 0 0 0 0 0 0 0 ↑↑↑↑	3 - 16 (ms) (Setting = 2 to 15)	Function 4 pretrip timer
P07	B 0 0 0 0 0 0 0 0 ↑	...	Function 1 output polarity in normal mode or start input polarity in DCB mode.
		0	normal
		1	invert
	B 0 0 0 0 0 0 0 0 ↑	...	Function 2 output polarity in normal mode or stop input polarity in DCB mode.
		0	normal
		1	invert
	B 0 0 0 0 0 0 0 0 ↑	...	Function 3 output polarity
		0	normal
		1	invert
	B 0 0 0 0 0 0 0 0 ↑	...	Function 4 output polarity
		0	normal
		1	invert

See notes on pages 19 through 24.

Table 4. Remote Configuration Settings - continued

P Code	Bits Used	Value	Description
P07 (Cont'd)	B 0 0 0 0 0 0 0 0 ↑	...	Function 1 unblock enable ⁽⁸⁾
		0	disable
		1	enable
	B 0 0 0 0 0 0 0 0 ↑	...	Function 2 unblock enable ⁽⁸⁾
		0	disable
		1	enable
	B 0 0 0 0 0 0 0 0 ↑	...	Function 3 unblock enable ⁽⁸⁾
		0	disable
		1	enable
	B 0 0 0 0 0 0 0 0 ↑	...	Function 4 unblock enable ⁽⁸⁾
		0	disable
		1	enable
P08	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑↑↑↑	10 - 2550 (ms) increments of 10ms	Alarm timer (delay)
P09	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑↑↑↑	10 - 2550 (ms) increments of 10ms	Ping-Pong interval
P10	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑	1.0 - 31.0 (ms) increments of 1ms	Ping-Pong time limit
		...	Long Shelf Alert (See Note 7 on page 24)
		0	disable
		1	enable
P11 ⁽³⁾	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑	1-24 for T1 1-31 for E1	Tx time slot
P12 ⁽⁵⁾	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑↑↑	0-63	Tx address
P13 ⁽⁴⁾	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑	1-24 for T1 1-31 for E1	Rx time slot
		...	Path select
	B 0 0 0 0 0 0 0 0 ↑	0	D&I B
		1	Terminal or D&I A
	B 0 0 0 0 0 0 0 0 ↑	0	Normal mode
		1	DCB mode
P14 ⁽⁵⁾	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑↑↑	0-63	Rx address

See notes on pages 19 through 27.

Note 1.

Trip Hold Timer

When a user selects a value for P01 through P04 trip hold timers, it must be in increments of 1.0 ms. In addition to this there is a negative offset of 1.0 ms. Also note that the minimum setting of P01 through P04 is 2, for security reasons. For example, if a user wants the Function 1 Trip Hold Timer to be = 7.0 ms, do the following: (7.0 ms) - 1 = 6. The 6 can be entered in either decimal or binary format. Therefore set P01 = 6 for a value of 7.0 ms in decimal format, or set P01 = B0000110 for a value of 7.0 ms in binary format. Thus enter the following SCL command:

<address>:<subaddress>:SET:P01=6;

or

<address>:<subaddress>:SET:P01=B0000110;

NOTE

The user should avoid changing settings while the module is in service, as unintended operations may occur.

Note 2.

Pretrip Timer

The pretrip timer on the MTS module provides security and determines the approximate trip time delay based on its setting. Version 5 of the Transfer Trip ACTEL changed from a 3-frame word to a 4-frame word, changing the increment of the trip time. Prior versions of the MTS module with a 3-frame word had a range of 2-12 ms for a setting range of 2-15 of the pretrip timer. Each increment was 0.75 ms.

Starting with version 5, the 4-frame word trip time range is 3-16 ms for a setting range of 2-15 of the pretrip timer. Each increment is 1.0 ms. These times are approximate and will vary up to 1 ms based on the exact timing of the trip input. The nominal trip time is the approximate expected maximum for a given setting. Settings less than 2 are ignored for security reasons and a value of 2 is used.

Version 5 of the ACTEL also supports backwards compatibility by offering a mode in which 3-frame words are used. This mode is selected by choosing TX addresses that are not recommended on previous versions. Addresses in which the fourth address bit is a one, select 3-frame mode. Conversely, addresses in which the fourth address bit is a zero, select 4-frame mode. 3-frame mode should only be employed when communicating with units with Version 4 or earlier ACTELs.

>> Note 2 continues on next page <<

Note 2
Continued.



The following table should clarify the trip times for various versions and settings:

Pretrip Timer Setting ↓	Nominal Trip Times	Nominal Trip Times
	3-Frame Mode NMS 9.0 and earlier, Version 4 and earlier, and Version 5 and later with Tx addresses 8-15, 24-31, 40-47, 56-63	4-Frame Mode NMS 9.2 and later And Version 5 and later with Tx addresses 0-7, 16-23, 32-39, 48-55
0, 1, 2	2.25	3.00
3	3.00	4.00
4	3.75	5.00
5	4.50	6.00
6	5.25	7.00
7	6.00	8.00
8	6.75	9.00
9	7.50	10.00
10	8.25	11.00
11	9.00	12.00
12	9.75	13.00
13	10.50	14.00
14	11.25	15.00
15	12.00	16.00

The NMS software provides the pretrip settings in milliseconds and converts the time to a timer setting. The values currently calculated in NMS 9.0 and earlier are for version 4 ACTEL, and NMS 9.1 and later for version 5 ACTEL.

Function 1 & 2 Pretrip Timer

When a user selects a value for P05, it must be in increments of 1.0 ms. In addition to this there is a negative offset of 1.0 ms. Also observe in Table 4 that the Function 1 pretrip timer (F1) is represented by the lower four bits of P05, and the Function 2 pretrip timer (F2) is represented by the upper four bits of P05. Therefore when you set P05 equal to a number, you are setting F1 and F2 simultaneously. Also note that the minimum setting of F1 and F2 is 2, for security reasons. For example, if a user wants F2 to be = 4.0 ms, and F1 to be = 3.0 ms, do the following:

For F2 (upper four bits): (4.0 ms) - 1 = 3 (decimal) = 0011 (binary)

For F1 (lower four bits): (3.0 ms) - 1 = 2 (decimal) = 0010 (binary)

The 3 and 2 can be entered in either decimal or binary format. Thus enter the following SCL command:

<address>:<subaddress>:SET:P05=50;

or

<address>:<subaddress>:SET:P05=B00110010;

>> Note 2 continues on next page <<

Note 2.
Continued.



Function 3 & 4 Pretrip Timer

When a user selects a value for P06, it must be in increments of 1.0 ms. In addition to this there is a negative offset of 1.0 ms. Also observe in Table 4 that the Function 3 pretrip timer (F3) is represented by the lower four bits of P06, and the Function 4 pretrip timer (F4) is represented by the upper four bits of P06. Therefore when you set P06 equal to a number, you are setting F3 and F4 simultaneously. Also note that the minimum setting of F3 and F4 is 2, for security reasons. For example, if a user wants F4 to be = 12 ms , and F3 to be = 10 ms, do the following:

For F4 (upper four bits): (12 ms) - 1 = 11 (decimal) = 1011 (binary)

For F3 (lower four bits): (10 ms) - 1 = 9 (decimal) = 1001 (binary)

The 11 and 9 can be entered in either decimal or binary format. Thus enter the following SCL command:

<address>:<subaddress>:SET:P06=185;

or

<address>:<subaddress>:SET:P06=B10111001;

NOTE

On 2 Function Systems, Function 3 and 4, pre-trip timers must be set to 3ms.

Note 3 .

Tx Time Slot

The value entered for P11 shall be 32 - the desired Tx time slot. For example, if the user wants the Tx time slot to be = 27, then P11 shall be set = 5. This can be entered in either decimal or binary format as shown in the following SCL command: (Note that for E1 systems, actual time slot 1 cannot be used for payload. The first usage time slot is considered time slot 2 for the purposes of setting P11 and P13)

<address>:<subaddress>:SET:P11=5;

or

<address>:<subaddress>:SET:P11=B00000101;

Note 4. Rx Time Slot

The value entered for P13 shall be 32 - the desired Rx time slot, + 0 (if path select is D&IB) or +32 (if path select is Terminal or D&IA), and +0 (if normal mode is selected) or +64 (if DCB mode is selected). This comes about from the way P13 is configured. Bits 1 thru 5 define the Rx time slot, bit 6 defines Path Select (either D&IB) or (Terminal or D&IA), and bit 7 Defines either normal mode or DCB mode.

Example 1: If the user wants the Rx time slot to be = 24, the path select to be D&IB, and DCB mode, then P13 shall be set = $32 - 24 + 0 + 64 = 72$. This can be entered in either decimal or binary format as shown in the following SCL command:

<address>:<subaddress>:SET:P13=72;

or

<address>:<subaddress>:SET:P13=B01001000;

Example 2: If the user wants the Rx time slot to be = 24, the path select to be Terminal or D&IA, and normal mode, then P13 shall be set = $32 - 24 + 32 + 0 = 40$. This can be entered in either decimal or binary format as shown in the following SCL command:

<address>:<subaddress>:SET:P13=40;

or

<address>:<subaddress>:SET:P13=B00101000;

See paragraph 7.7 of the IMUX 2000 instruction manual for a complete discussion of the SCL commands.

Note 5. Tx & Rx Address

The use of identical Tx and Rx addresses on the same module is not recommended since it can prevent detection of loopback conditions. This can result in unwanted local end trip outputs. See Figure 8.

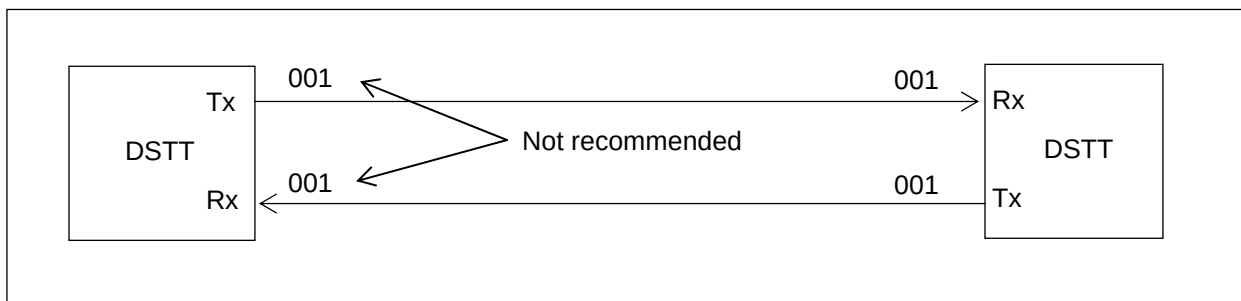


Figure 8. Identical Tx & Rx addresses at the same module is not recommended

>>Note 5 continues on next page<<

Note 5.
continued

The Transfer Trip module will accept address settings from 0 to 63, however there are certain exceptions depending on the Actel version used as described in the Table 5.

Table 5. Actel version vs. allowed addresses

Actel Version	Allowed Addresses
Actel Version 5 or higher on both sides or Actel Version 4 or lower on both sides	0-7, 16-23 32-39, 48-55
Actel Version 5 or higher on one side and Actel Version 4 or lower on the other side	Use addresses in tables 6 & 7 as applicable (Also refer to Figures 10 and 11)

As shown in Table 5, the selection of allowed Tx and Rx addressess on the DSTT module depends on the version of the Actel used at both sides (transmit end and receive end).

To determine the Actel version on a DSTT module, remove the DSTT module from the multiplexer chassis and read the software label on device U12. The last one or two digits of the SW number indicates the Actel version. The software label will be similar to the one shown in Figure 9.

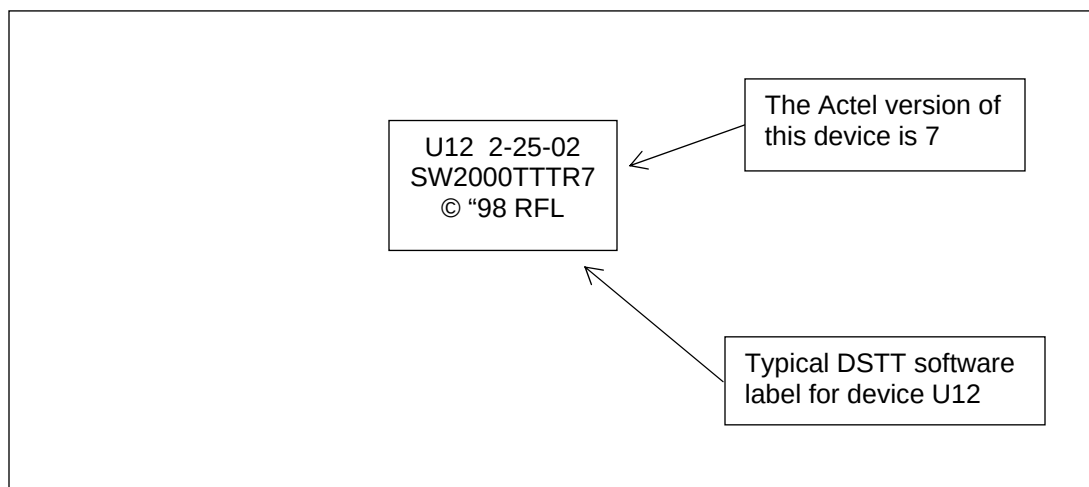


Figure 9. Typical Actel label

In most cases the Tx address at one end will match the Rx address at the other end. See Figures 10 and 11 for addressing examples.

>> Note 5 continues on next page <<

Note 5
continued.

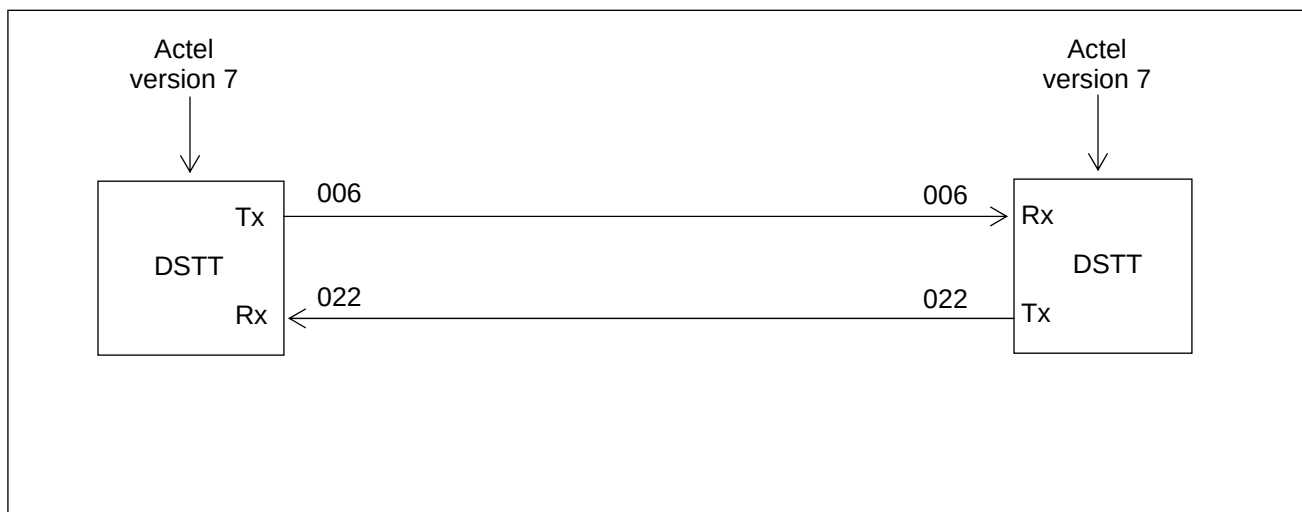


Figure 10. Example of Tx/Rx addressing showing Actel version 7 at both sides (Legal addresses are 0-7, 16-23, 32-39, 48-55)

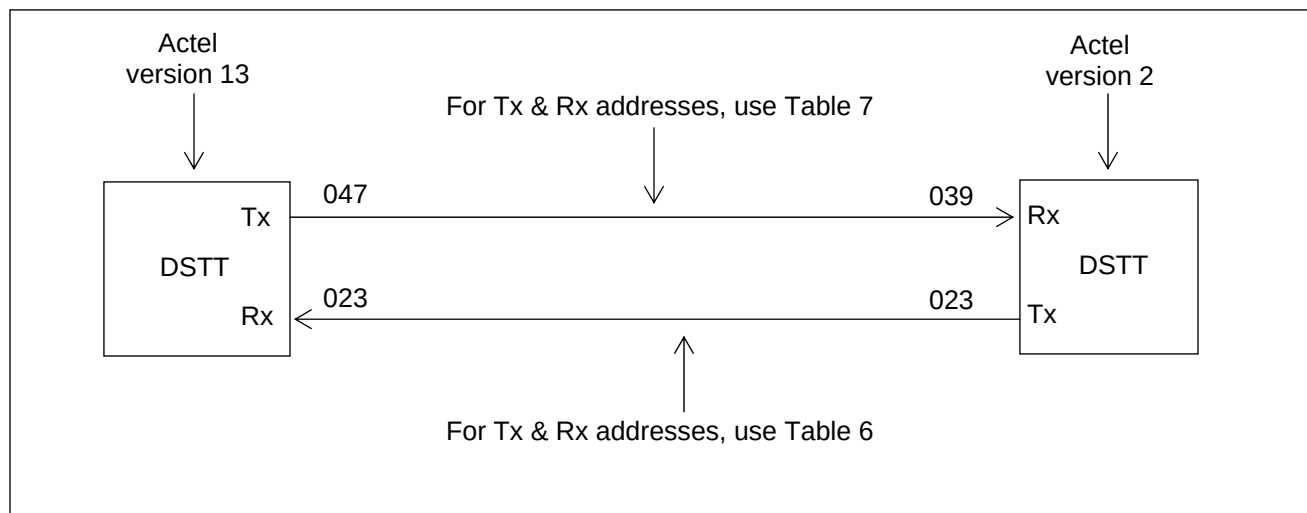


Figure 11. Example of Tx/Rx addressing showing Actel version 13 at one side and Actel version 2 at the other side (See Tables 6 and 7 for legal addresses)

Note that all systems including TTR4 or earlier on Tx or Rx end operate in Three Frame Mode. This will alter the Pretrip Timer setting as described in Note 2.

>> Note 5 continues on next page <<

Note 5
Continued.

Tables 6 & 7 are used to determine valid address selections when MTS modules with Actel versions 4 or lower are connected to modules with Actel versions 5 or higher. Both Tables are utilized; each of them pertains to one direction of the line.

Table 6. Tx address for Actel version 4 or earlier and Rx address for Actel version 5 or later

Required Tx and Rx Address settings for systems using different versions of DSTT modules	
Transmit Address (Transmitting MTS with ACTEL Version SW2000TTTR4 or lower)	Receive Address (Receiving MTS with ACTEL Version SW2000TTTR5 or higher)
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
Invalid	Invalid
Invalid	Invalid
Invalid	Invalid
Invalid	Invalid
Invalid	Invalid
Invalid	Invalid
Invalid	Invalid
Invalid	Invalid
Invalid	Invalid
16	16
17	17
18	18
19	19
20	20
21	21
22	22
23	23
Invalid	Invalid
Invalid	Invalid
Invalid	Invalid
Invalid	Invalid
Invalid	Invalid
Invalid	Invalid
Invalid	Invalid
Invalid	Invalid

32	32
33	33
34	34
35	35
36	36
37	37
38	38
39	39
Invalid	Invalid
Invalid	Invalid
Invalid	Invalid
Invalid	Invalid
Invalid	Invalid
Invalid	Invalid
Invalid	Invalid
Invalid	Invalid
Invalid	Invalid
48	48
49	49
50	50
51	51
52	52
53	53
54	54
55	55
Invalid	Invalid
Invalid	Invalid
Invalid	Invalid
Invalid	Invalid
Invalid	Invalid
Invalid	Invalid
Invalid	Invalid
Invalid	Invalid
Invalid	Invalid

>> Note 5 continues on next page <<

Note 5
continued.

Table 7. Tx address for Actel version 5 or later and Rx address for Actel version 4 or earlier

Required Tx and Rx Address settings for systems using different versions of DSTT modules	
Transmit Address (Transmitting MTS with ACTEL Version SW2000TTTR5 or higher)	Receive Address (Receiving MTS with ACTEL Version SW2000TTTR4 or lower)
Invalid	Invalid
Invalid	Invalid
Invalid	Invalid
Invalid	Invalid
Invalid	Invalid
Invalid	Invalid
Invalid	Invalid
Invalid	Invalid
8	0
9	1
10	2
11	3
12	4
13	5
14	6
15	7
Invalid	Invalid
Invalid	Invalid
Invalid	Invalid
Invalid	Invalid
Invalid	Invalid
Invalid	Invalid
Invalid	Invalid
Invalid	Invalid
24	16
25	17
26	18
27	19
28	20
29	21
30	22
31	23

Invalid	Invalid
Invalid	Invalid
Invalid	Invalid
Invalid	Invalid
Invalid	Invalid
Invalid	Invalid
Invalid	Invalid
Invalid	Invalid
40	32
41	33
42	34
43	35
44	36
45	37
46	38
47	39
Invalid	Invalid
Invalid	Invalid
Invalid	Invalid
Invalid	Invalid
Invalid	Invalid
Invalid	Invalid
Invalid	Invalid
Invalid	Invalid
56	48
57	49
58	50
59	51
60	52
61	53
62	54
63	55

Note 6. Service On/Off

The service on/off setting via the SCL interface disables local tripping but does not disable T1 transmission of data to the remote MTS. The toggle switch on the front of the card must be in the disable position to disable transmission of data to the remote MTS. The toggle switch also disables local tripping.

Note 7. Long Shelf Alert

If Long Shelf Alert is enabled, any alerts on the Transfer Trip module will be delayed in reporting to the common module for alarm timer delay x100 (i.e. P08 x 100). If alert is cleared during the delay, the shelf alert will still occur, but multiple alerts during the same period will count as one shelf alert. If disabled, the shelf alert will follow the local module alert relay.

Note 8. Unblock Enable

This function will provide a local trip during an MTS communication outage lasting 20ms or more. When activated, the local trip will last for 150ms.

“S” CODES

“S” codes appear in response to a “STATUS?” query. There are four “S” codes for the RFL DS-TT. Like the “P” codes, each “S” code is a number displayed in both decimal and binary form.

A typical response to a “STATUS?” query looks like this:

***OK**

CHANNEL CARD 3, TYPE 118

>>>(alert or alarm message here, if there is one)<<<

S01 = 3 (B00000011)

S01 = 5 (B00000101)

S01 = 4 (B00000100)

S01 = 196 (B01100100);

These codes provide information on the status of several conditions on the RFL DS-TT module. Table 8 lists the meaning of all “S” codes for the RFL DS-TT module.

Table 8. Remote status messages (“S” codes)

Code	Bits used	Value	Description
S01	B 0 0 0 0 0 0 0 0 ↑	...	Function 1 input
		0	inactive
		1	active
	B 0 0 0 0 0 0 0 0 ↑	...	Function 2 input
		0	inactive
		1	active
	B 0 0 0 0 0 0 0 0 ↑	...	Function 3 input
		0	inactive
		1	active
	B 0 0 0 0 0 0 0 0 ↑	...	Function 4 input
		0	inactive
		1	active
	B 0 0 0 0 0 0 0 0 ↑	...	Function 1 output
		0	inactive
		1	active
	B 0 0 0 0 0 0 0 0 ↑	...	Function 2 output
		0	inactive
		1	active

Table 8. Remote status messages (“S” codes) - continued

Code	Bits used	Value	Description
S01 (cont’d)	B 0 0 0 0 0 0 0 0 ↑	...	Function 3 output
		0	inactive
		1	active
	B 0 0 0 0 0 0 0 0 ↑	...	Function 4 output
		0	inactive
		1	active
S02	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑↑	0-31	Ping-Pong value in ms
S03	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑↑	0-20	# of new events since last read
S04	B 0 0 0 0 0 0 0 0 ↑	...	DS0 Alert
		0	inactive
		1	active
	B 0 0 0 0 0 0 0 0 ↑	...	Ping-pong Alert
		0	inactive
		1	active
	B 0 0 0 0 0 0 0 0 ↑	...	Disable Switch
		0	module disabled
		1	module enabled
	B 0 0 0 0 0 0 0 0 ↑	...	CRC status
		0	error
		1	no error
	B 0 0 0 0 0 0 0 0 ↑	...	Address
		0	error or disabled
		1	no error
	B 0 0 0 0 0 0 0 0 ↑	...	EEROM Write Alert
		0	inactive
		1	active

LOCAL CONTROL INTERFACE

When the RFL DS-TT is installed in an IMUX 2000 multiplexer, it can be operated under local or remote control. When under local control, the module setup parameters can only be programmed using the DS-TT local RS-232 port. The RS-232 port is labeled J1 and is located near the front of the DS-TT module as shown in Figure 1. Connections are made using the cable shown in Figure 2. Then use the SCL commands as described in the Remote Control Interface section of this instruction data sheet.

NOTE

Local mode requires transfer trip modules with software version SW2000TT008 or higher and CM3R Rev H or higher.

When settings are changed, the alarm LED “DS9” illuminates while the settings are being written to the EEROM. The card should not be removed until after the LED goes OFF.

TRANSFER TRIP SPECIFIC SCL COMMANDS

The SCL commands in this section are specific to the RFL DS-TT Transfer Trip module and are related to the sequence of events log.

There are three types of occurrences that qualify as “events” in the sequence of events log. These are; input trip, output trip and alarm conditions. There are three types of alarm conditions; received address error, CRC error, or ping-pong exceeded preset limit. If any of these events occurs, it will be entered into the sequence of events log with a date stamp (month, day, year) and time stamp (hours, minutes, seconds).

Up to twenty events can be stored in the sequence of events log. Instructions on how to access the sequence of events log, and how to program the time and date stamp is discussed below.

TIME? Command

In order to read the time and date setting of an RFL DS-TT module do the following: For example, if the module is channel 3 in shelf number 2,

```
INPUT:      2:C3:TIME?;;
RESPONSE:   *OK
            FROM NET ADDRESS = 2
            CHANNEL CARD 3, TYPE 118
            DATE = 10-12-92
            TIME = 13 Hrs.: 15 Mins.: 12 Secs.;
```

EVENT

In order to read one of the twenty sequence of events occurrences, do the following:

```
INPUT:      2:C3:EVENT:20;
RESPONSE:   *OK
            FROM NET ADDRESS = 2
            CHANNEL CARD 3, TYPE 118
            EVENT NUMBER 20
            DATE = 10-12-92
            TIME = 13 Hrs.: 15 Mins.: 12 Secs.: 034 ms.
            OUTPUT #4 ACTIVE
            INPUT #2 ACTIVE
            ADDRESS SIGNAL ERROR ACTIVE
            CRC ERROR ACTIVE
            PING PONG IS 0 ms.;
```

SET:TIME

To set the time of the TT module do the following: The time is entered as hours, minutes, seconds.

INPUT: 2:C3:SET:TIME=15-34-09;
RESPONSE: * OK
FROM NET ADDRESS = 2;

If an incorrect time is entered:

INPUT: 2:C3:SET:TIME=35-34-09;
RESPONSE: * WHAT
FROM NET ADDRESS = 2
BAD VALUE 35-34-09;

SET:DATE

To set the date of the TT module do the following: The date is entered as month, day, year.

INPUT: 2:C3:SET:DATE=05-28-96;
RESPONSE: * OK
FROM NET ADDRESS = 2;

If an incorrect date is entered:

INPUT: 2:C3:SET:DATE=15-28-96;
RESPONSE: * WHAT
FROM NET ADDRESS = 2
BAD VALUE 15-28-96;

TESTING

When the RFL DS-TT modules have been configured and installed, they should be tested for proper operation before they are placed in service.

EQUIPMENT REQUIRED

A serial terminal capable of accessing the IMUX 2000.

A source of keying voltage equal to the keying voltage to be used in service.

An indicator capable of detecting operation of the trip outputs.

TEST PROCEDURE

Once the module has been installed in an operating IMUX 2000 system, the disable switch can be placed in the enable position. **The connections to any trip outputs should be disconnected before proceeding with this test.**

The status values of the DS-TT should indicate that the module is not in CRC or Address alarm and that the ping pong value is less than the alarm limit.

The alarm LED on the front panel should be off.

When a keying voltage is applied to any input, the appropriate LEDs on the local and remote units should illuminate. The trip output contacts should close.

If the appropriate LEDs and trip outputs respond as expected, the module is ready to put into service.

TROUBLESHOOTING

If the module remains in CRC alarm, the disable switch, timeslot and direction settings should be verified. Equipment and line loopbacks can be used to determine if the modules work when looped back on themselves. If the modules work in Equipment loopback but not in Line loopback, then something in the IMUX network is preventing the data from reaching the other terminal.

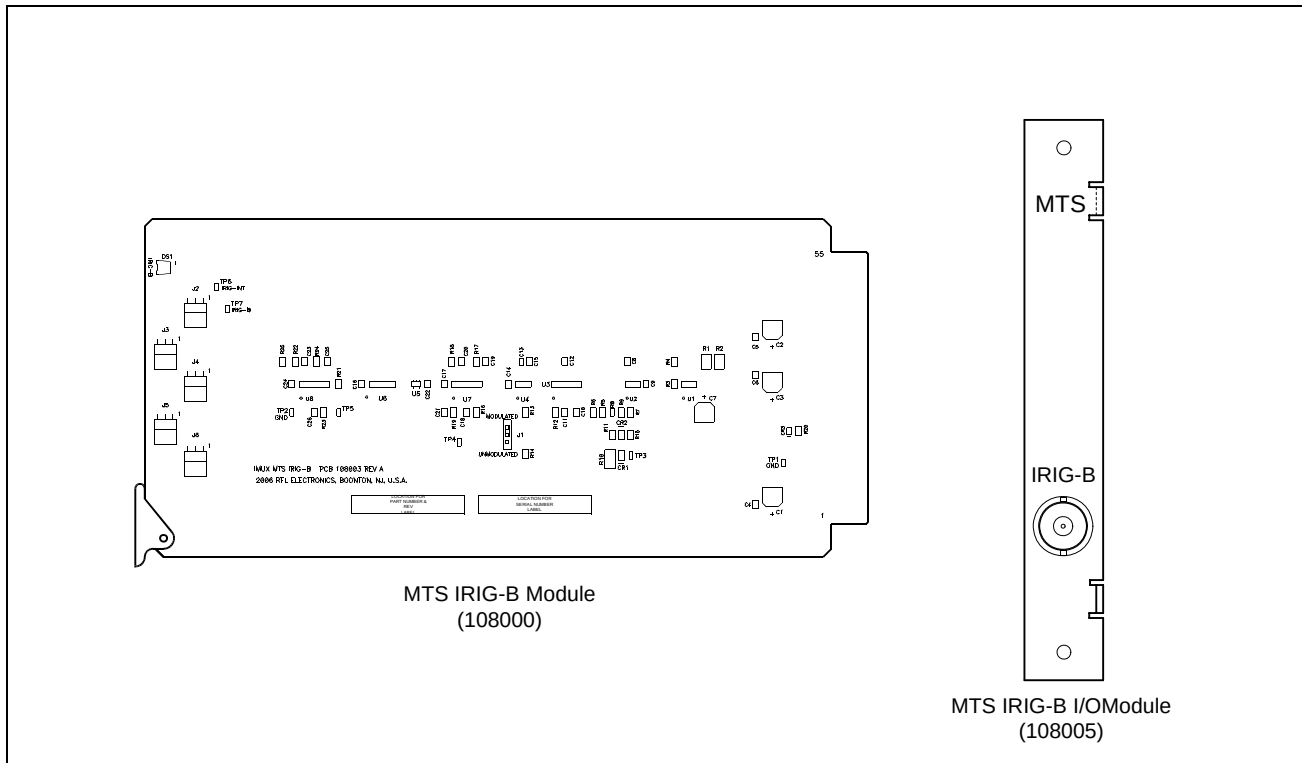
If the module does not have a CRC alarm, but does have an Address alarm, the address settings on both modules should be verified.

If the module does not have CRC or Address alarms but still lights the alarm LED, then the ping pong test is failing.

If the alarms are inactive but the trip LEDs do not activate, the programming should be checked and the location of the module adapter jumpers should be verified.

If the output LEDs light but the trip outputs do not close, the position of the solid state/relay jumper should be verified. The status of the service on/off setting should also be verified.

MTS IRIG-B Synchronization Upgrade

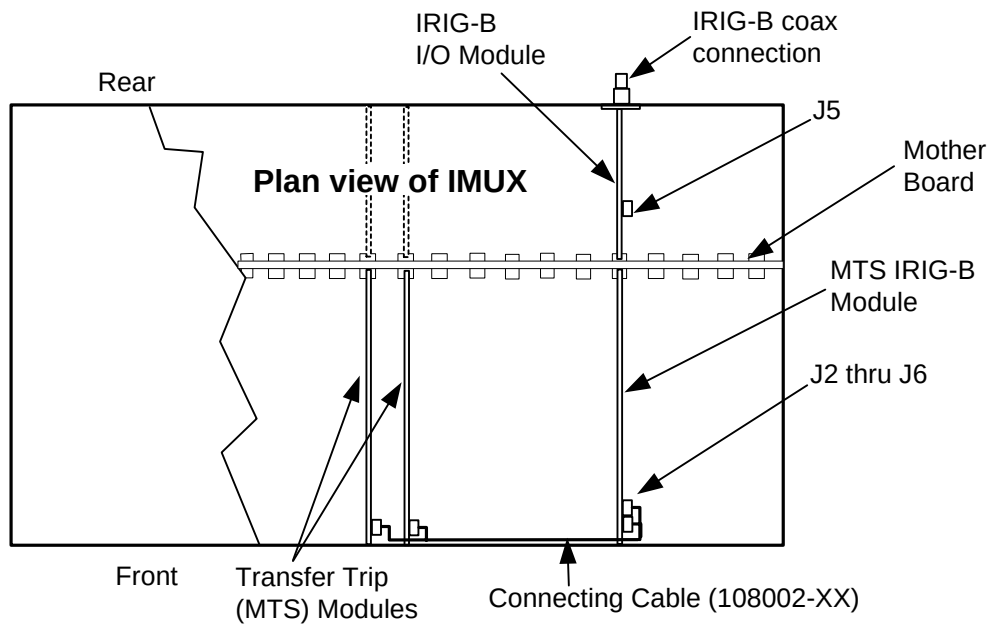


DESCRIPTION

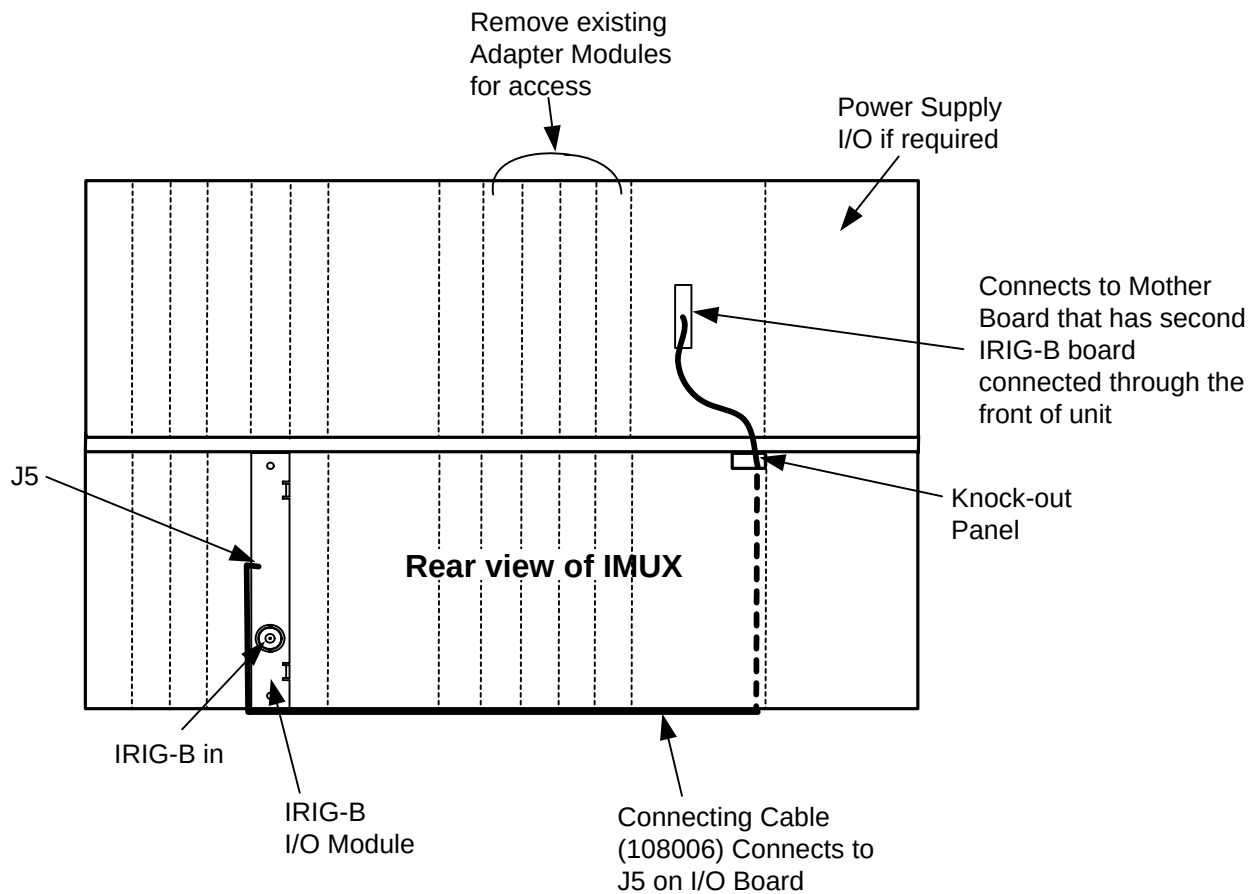
The modules shown above have been developed to give the standard IMUX chassis the ability to synchronize the MTS SOE with an external IRIG-B signal. The existing DS-TT Transfer Trip (MTS) module can be retrofitted to convert the 3-pin factory RS-232 connector into an IRIG-B connection. New Transfer Trip Modules (revision AD and later) will have an IRIG-B connection as well as the standard RS-232 connector. Upgrading existing units **MUST** include an update to SW2000TT019 software. Upgrading an existing unit should only be performed by RFL Service Engineers. Listed in Table 9 below are the items included in the MTS IRIG-B Synchronization Upgrade with a brief description of their function.

Table 9. MTS IRIG-B Synchronization Upgrade

Item	Part Number	Description
IRIG-B Module	108000	Main IRIG-B module which plugs into the front of the IMUX chassis. This board can distribute un-modulated IRIG-B to up to 5 Transfer Trip (MTS) modules.
IRIG-B I/O Module	108005	This module adapter brings the IRIG-B signal into the IMUX. The adapter plugs into the rear of the chassis connecting to the IRIG-B Module.
Cable Harness	108006	This cable plugs into the I/O board and is used to connect to a second chassis in a stacked chassis configuration.
Cable Harness	108002-xx	This cable plugs into the IRIG-B board and is used to connect to the Transfer Trip (MTS) boards. It can be provided in lengths of 10" (-10), 15"(-15) and 20" (-20).



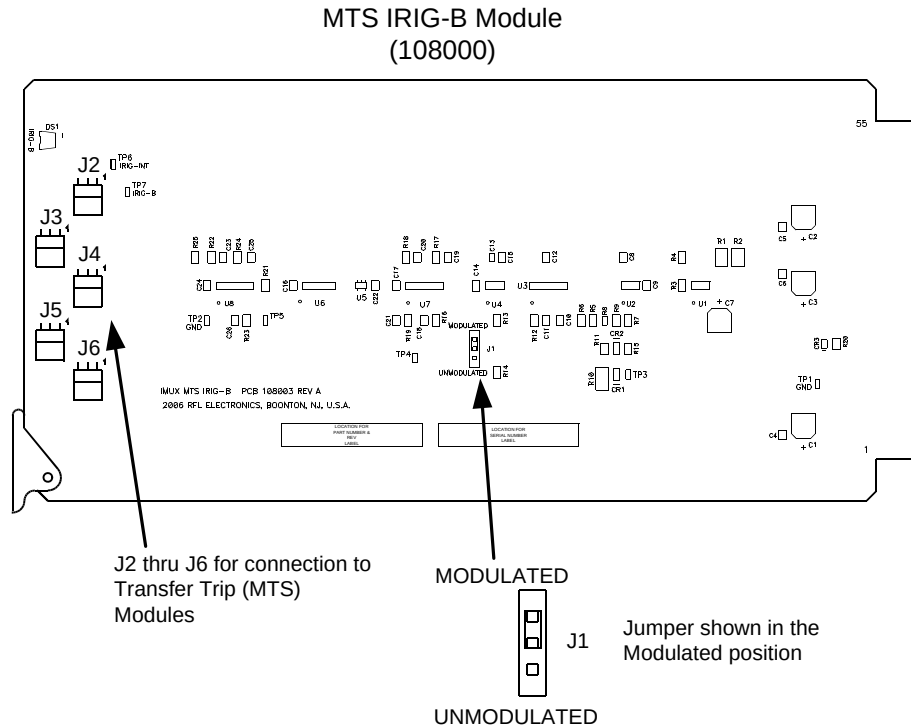
Basic Set-up and connection to Transfer Trip (MTS) Modules



Stacked Chassis Configuration

BOARD CONFIGURATION

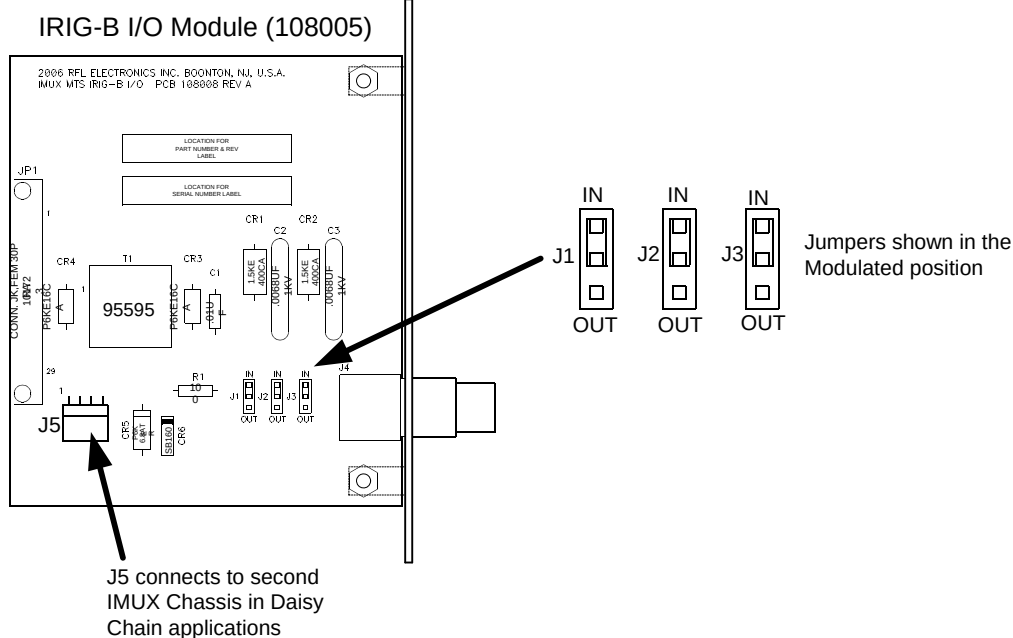
The Jumper (J1) on the MTS IRIG-B main module can be set for either Modulated or Unmodulated IRIG-B depending on the source signal. Connectors J2 thru J6 are used to distribute unmodulated IRIG-B to a maximum of five Transfer Trip (MTS) modules in the IMUX chassis.



The three Jumpers on the IRIG-B I/O Board must all be set to either of the following depending on the source signal.

IN – Modulated Signal (Bi-Polar)

OUT – Unmodulated Signal (TTL)



OPERATION

Before operation ensure that the Jumpers are set for the correct IRIG-B signal. When IRIG-B is present the indicator DS1 on the IRIG-B main module will be illuminated green to indicate that IRIG-B is active.

Notes

Notes

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RFL Electronics Inc.

INSTRUCTION DATA

Status Module For RFL IMUX 2000 Intelligent T1/E1 Multiplexers

DESCRIPTION

The RFL Status Module is designed for use in IMUX 2000 T1/E1 Terminal or Drop/Insert Multiplexers. The Status Module can be configured to be a 16 point transmitter, a 16 point receiver or an 8 point transceiver. Since each configuration requires a different module adapter, the Status Module is not remotely changeable; however, control and status information is remotely readable through the SCB or Network Management Software. In addition to this, Status Module parameters can be configured remotely via the SCB.

Six different Module Adapters are available to cover all possible combinations of inputs and outputs. The inputs are opto-isolated and the outputs are relays. For normal operation each end must have a different module adapter.

The following Status Module parameters can be configured remotely via the SCB:

o Rx timeslot	o Scan speed - 10ms/100ms
o Tx timeslot	o I/O type - Input/Output
o Bus direction	o System type - T1/E1
o Rx address	o Output polarity - Normal/Inverted
o Tx address	

SPECIFICATIONS

As of the date this Instruction Data Sheet was published, the following specifications apply to all RFL Status Modules, except as noted. Because all RFL products undergo constant refinement and improvement, these specifications are subject to change without notice.

Optically Isolated Inputs:

Input impedance:	3000 ohms
Logical "1" input:	3-10ma (10V - 30V)
Logical "0" input:	0 - 0.25ma (0 - 1V)

Relay Outputs:

Max output current:	400ma@150VDC 1A@24VDC
Max open circuit voltage:	150VDC

Installation:

Live insertion/extraction into IMUX 2000 shelf without interruption of the DS1 or any other DS0.

RFI/EMI: c.37.90.2, IEC-801-x

MTBF (calculated): bellcore tr-332 > 500,000 hours at 25°C.

Power Consumption: 2 watts maximum

Operating temperature: -20°C to + 55°C (-4°F to +131°F)

Humidity: 0 to 95 percent, non-condensing

Dimensions:

Length:	9.8 in (24.8 cm)
Width:	0.6 in (1.5 cm)
Height:	4.5 in (11.4 cm)

Weight:

Net:	10 oz (0.28 kg)
Shipping:	1 lb (0.45 kg)

INSTALLATION

Before the Status Module can be placed in service, it must be installed in a multiplexer shelf. Installation involves determining the module slot in the Main Shelf or Expansion Shelf where the Status Module will be installed, inserting a Module Adapter into the rear of the shelf behind the Status Module slot, connecting all signal wiring to the Module Adapter, checking the settings of all switches and jumpers, and inserting the Status Module into the front of the shelf.

NOTE

Power supply and time slot considerations may affect the installation of the Status Module into an existing multiplexer shelf. Refer to the portions of your multiplexer operation manual covering “Channel Module Configuration Guidelines” and “Adding More Channel Modules To Existing Systems” for more information.

The following instructions are provided for installing the Status Module into existing systems. If the module was included as part of a system, installation was done at the factory, otherwise, proceed as follows:

1. Carefully inspect the Status Module and its Module Adapter for shipping damage.
If you suspect damage to the Status Module or its Module Adapter, immediately contact RFL’s Customer Service Department at the number shown at the bottom of this page.
2. Determine which module slot in the Main Shelf or Expansion Shelf the Status Module will be installed in.
The Status Module occupies one module slot in the Main Shelf or Expansion Shelf. Refer to the “as supplied” drawings furnished with the equipment for more information.
3. Determine which Module Adapter will be used to make connections to the Status Module.
Each Status Module installed in an IMUX 2000 multiplexer requires a Module Adapter. The Module Adapter provides the appropriate connections for the desired interface.

There are six different Module Adapters that can be used with the Status Module:

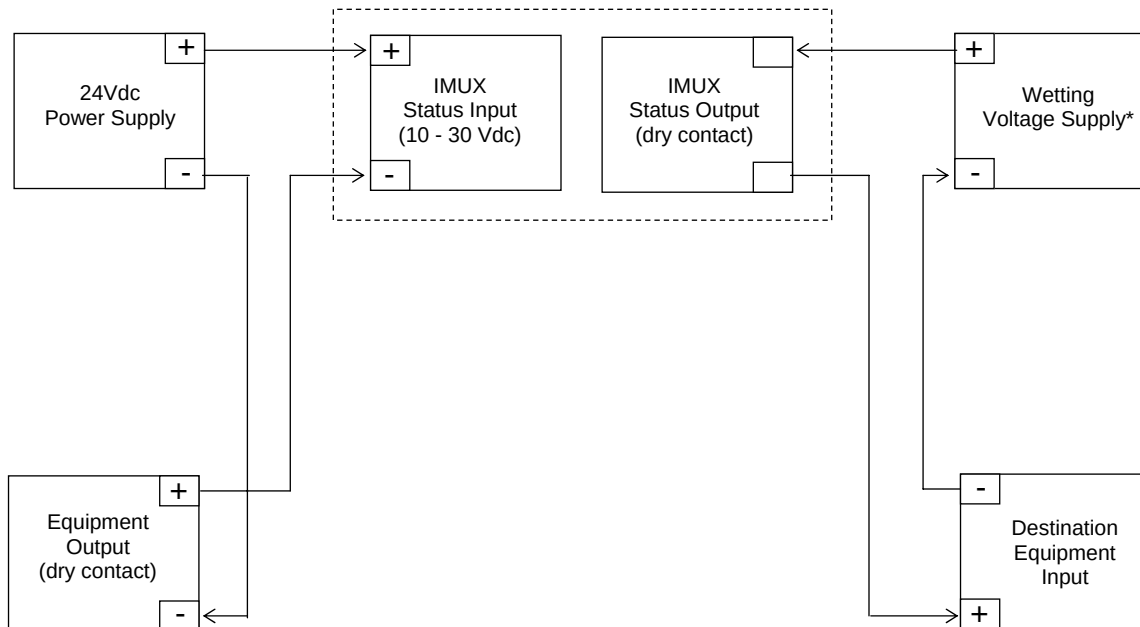
<u>Module Adapter</u>	<u>Part Number</u>	<u>Input/Output Type</u>	<u>Figures</u>
MA-601	106140-1	8 Input module	2&4
MA-602	106140-2	8 Output module	2&4
MA-603	106140-3	16 Input module	3&4
MA-604	106140-4	16 Output module	3&4
MA-605	106140-5	8 Output/8 Input (points 0-7 are outputs, 8-15 are inputs)	3&4
MA-606	106140-6	8 Input/8 Output (points 0-7 are inputs, 8-15 are outputs)	3&4

For normal operation each terminal end must have a different Module Adapter as shown below:

<u>System Type</u>	<u>End A</u>	<u>End B</u>
8-point unidirectional	106140-1 (MA-601)	106140-2 (MA-602)
16-point unidirectional	106140-3 (MA-603)	106140-4 (MA-604)
8-point bidirectional	106140-5 (MA-605)	106140-6 (MA-606)

Make sure the Module Adapters you are installing are the correct ones for the desired application.

4. Once the Module Adapters have been selected (one for each end), insert each one into the rear of the shelf directly behind the module slot where the Status Module will be installed. Secure the module with the two or four screws provided.
The Module Adapters will take up one or two slots in the multiplexer shelf depending on the Module Adapter selected. The 8 Input or 8 Output versions will take up one module slot, and all other versions will take up two module slots. This must be taken into consideration when selecting module slots.
6. Connect the user equipment to the Module Adapters using the connector pin assignments detailed in Figures 2 and 3 as applicable. Refer to Figure 1 for a typical connection diagram.
7. Refer to Figure 5 for the location of switches and jumpers on the Status Module.
8. Using DIP switch SW1, set the module address of the Status Module.
For remote access, each channel module in an IMUX 2000 multiplexer shelf must have a distinct module address. For this module, valid module addresses are the numbers “1” to “31”, which correspond to the codes shown in Table 2. The module address is usually set to the number of the physical slot in the shelf that the module will occupy; it can be set to any number from 1 to 31 that is not already being used by another module in the same multiplexer shelf.
9. Set toggle switch SW2 to the desired setting.
Set the switch in the UP position to unlock the outputs. Set the switch to the down position to lock the outputs. This will keep the outputs from changing after the switch is placed in the locked position.
10. Install the Status Logic module into the IMUX 2000 chassis and allow a few seconds for the board to complete its power-up process and to ensure that the common module has read all configuration data from the module.
11. Verify performance of the module using loopback testing.
12. When the configuration and performance of the Status Logic module has been verified, the module is ready to be placed in service.



* Wetting voltage for the Status Module output is determined by the input voltage requirements of the destination equipment. The Status Output module will work with any wetting voltage up to a maximum of 150 Vdc (400mA @ 150 Vdc, 1A @ 24 Vdc).

Figure 1. Typical connections to/from IMUX 2000 Status Module card

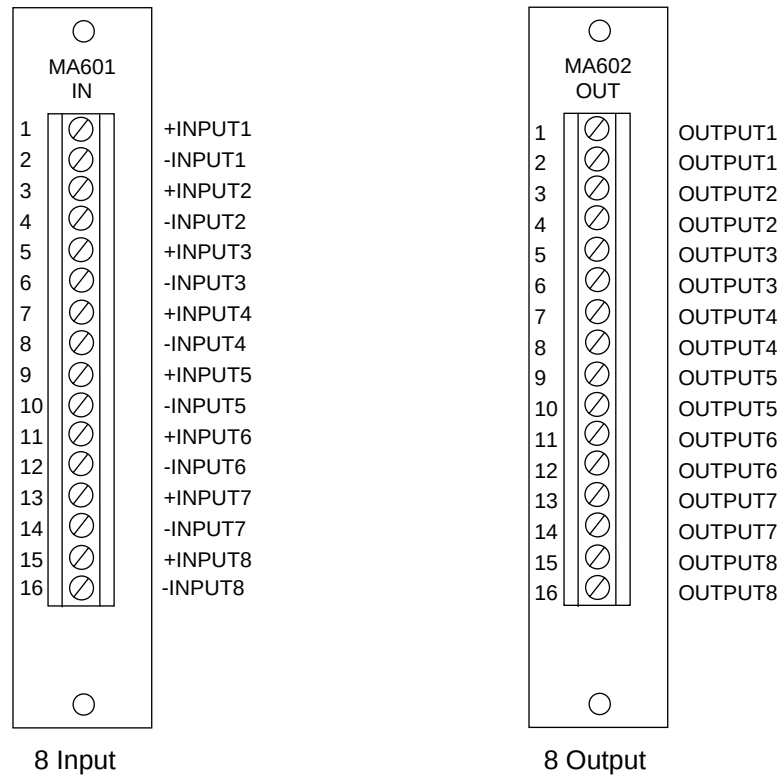


Figure 2. Panel view of Module Adapters MA-601 and MA-602

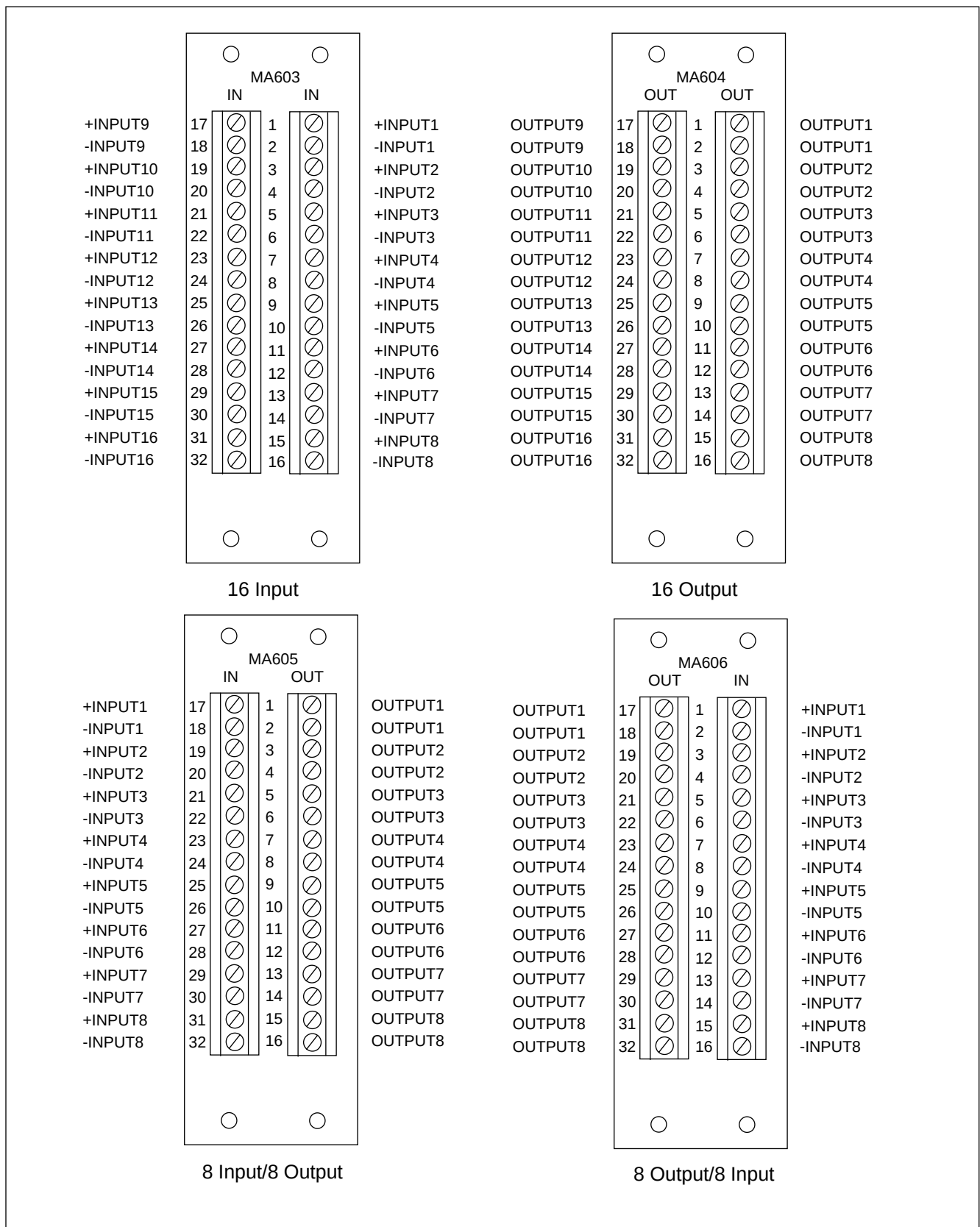
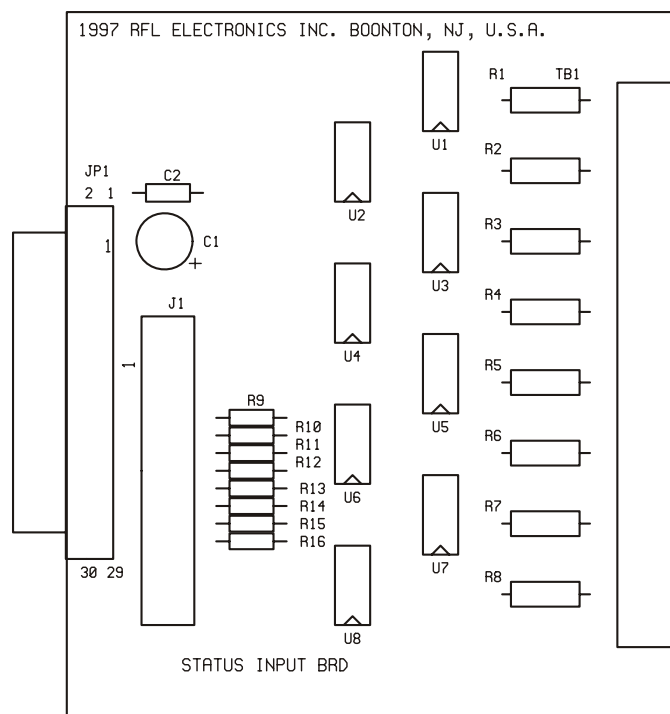


Figure 3. Panel view of Module Adapters MA-603, MA-604, MA-605 and MA-606

Status Input Board



Status Output Board

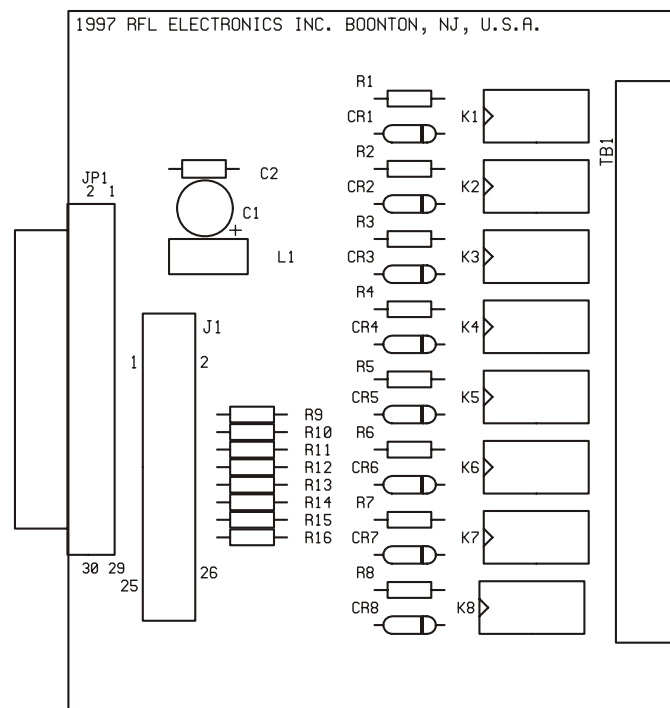


Figure 4. Component view of status input and status output, module adapter boards.

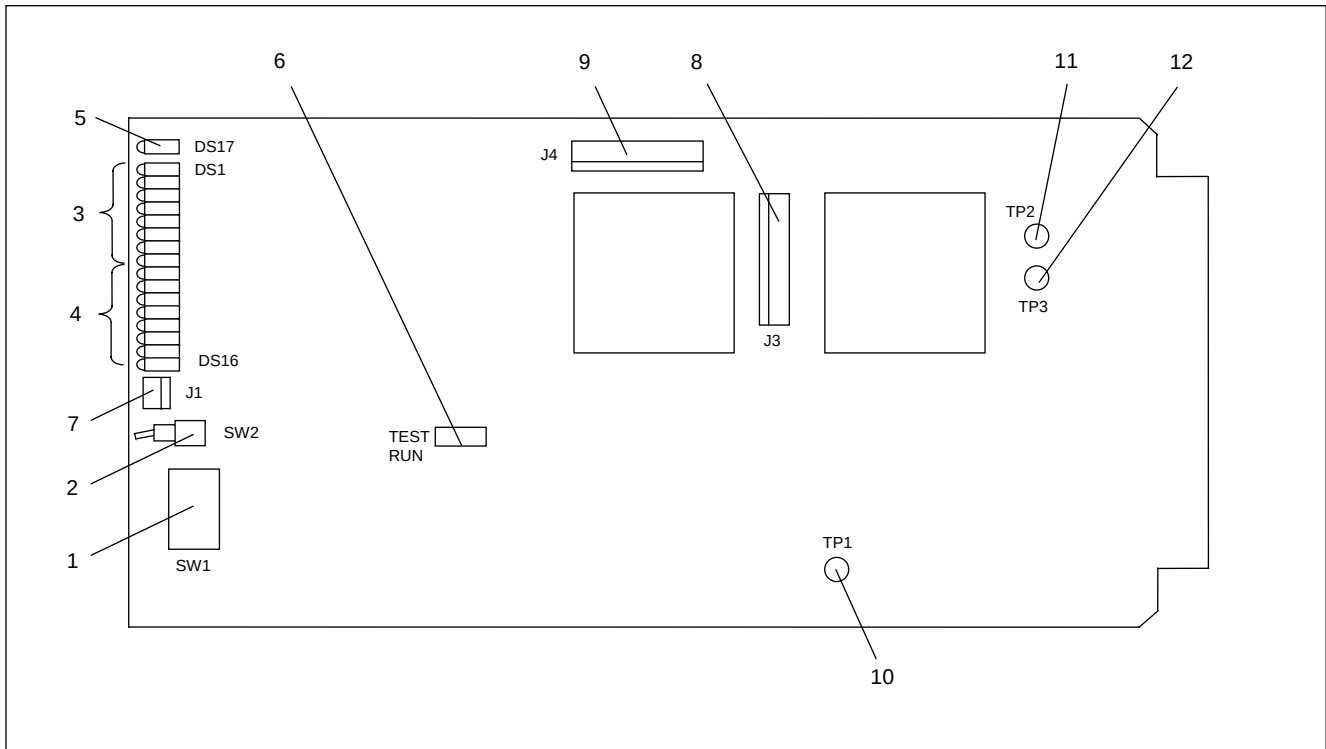


Figure 5. Controls and indicators, Status Module

Table 1. Controls and indicators, Status Module

Item	Name/Description	Function
1	DIP Switch SW1	Sets SCB address in accordance with the codes shown in Table 2.
2	Toggle Switch SW2	Keeps outputs from changing after the switch is placed in the Locked position. UP - Output Unlocked - In Operation DOWN - Output Locked - Out Of Operation
3	LED Indicators DS1 to DS7 (red)	When lit, indicates that the corresponding inputs or outputs are active.
4	LED Indicators DS8 to DS16 (red)	When lit, indicates that the corresponding inputs or outputs are active.
5	LED Indicator DS17 (red)	Turns OFF upon receipt of a properly framed and addressed message
6	Jumper J2	Used to select TEST or RUN modes RUN mode - used for normal operation TEST mode - used for factory testing
7	Jack J1	RS232 interface
8	Jack J3	Used for factory testing only
9	Jack J4	Used for factory testing only
10	Test Point TP1	Ground
11	Test Point TP2	When = 1, a valid address has been received (For factory test only)
12	Test Point TP3	When = 1, a valid frame has been received (For factory test only)

Table 2. SCB Address Settings, RFL Status Module

Module Address	SW1-1	SW1-2	SW1-3	SW1-4	SW1-5
1	DOWN	DOWN	DOWN	DOWN	UP
2	DOWN	DOWN	DOWN	UP	DOWN
3	DOWN	DOWN	DOWN	UP	UP
4	DOWN	DOWN	UP	DOWN	DOWN
5	DOWN	DOWN	UP	DOWN	UP
6	DOWN	DOWN	UP	UP	DOWN
7	DOWN	DOWN	UP	UP	UP
8	DOWN	UP	DOWN	DOWN	DOWN
9	DOWN	UP	DOWN	DOWN	UP
10	DOWN	UP	DOWN	UP	DOWN
11	DOWN	UP	DOWN	UP	UP
12	DOWN	UP	UP	DOWN	DOWN
13	DOWN	UP	UP	DOWN	UP
14	DOWN	UP	UP	UP	DOWN
15	DOWN	UP	UP	UP	UP
16	UP	DOWN	DOWN	DOWN	DOWN
17	UP	DOWN	DOWN	DOWN	UP
18	UP	DOWN	DOWN	UP	DOWN
19	UP	DOWN	DOWN	UP	UP
20	UP	DOWN	UP	DOWN	DOWN
21	UP	DOWN	UP	DOWN	UP
22	UP	DOWN	UP	UP	DOWN
23	UP	DOWN	UP	UP	UP
24	UP	UP	DOWN	DOWN	DOWN
25	UP	UP	DOWN	DOWN	UP
26	UP	UP	DOWN	UP	DOWN
27	UP	UP	DOWN	UP	UP
28	UP	UP	UP	DOWN	DOWN
29	UP	UP	UP	DOWN	UP
30	UP	UP	UP	UP	DOWN
31	UP	UP	UP	UP	UP

FUNCTIONAL DESCRIPTION

The Status Module can be programmed to be either a transmitter, a receiver, or both. This section consists of a functional description of the status transmitter and status receiver, and a circuit description of the status module. A block diagram of the Status Module is shown in Figure 6.

STATUS TRANSMITTER

The status transmitter samples and sends the condition of up to 16 points to a matching receiver over a single DSO. The transmitter is capable of sampling either eight or sixteen points depending on the type of module adapter supplied. The sampling scan rate is fixed to allow for the updating of all monitored points in less than 10ms. The module adapters plug into the multiplexer shelf directly opposite the transmitter module. The transmitter can operate in both T1 and E1 multiplexers.

The status transmitter occupies one direction of a single DS0 and has no receive capabilities, however the receive portion of the DS0 can be used by another device if needed. The transmitter employs programmable addressing to prevent misconnections and transmits its address at least every 1 millisecond. There are 64 individual addresses available.

The transmitter module uses SCB for programming and diagnostic purposes and conforms to the SCB protocol. The transmit address is set via the SCB.

STATUS RECEIVER

The status receiver works in conjunction with the status module transmitter described above. It can output up to sixteen monitored points which are updated every 10 milliseconds. The polarity of the outputs are settable through the SCB on the receiver module. The status receiver can operate in both T1 and E1 multiplexers.

The status receiver occupies one direction of a single DS0 and has no transmission capabilities, however the transmit portion of the DS0 can be used by another device if needed. The receiver employs programmable addressing to prevent misconnections. There are 64 individual addresses available. If the receiver has not accepted a valid address in the last 1ms its output will be squelched and LED DS17 will light until a valid address is received.

The receiver module uses SCB for programming and diagnostic purposes and conforms to the SCB protocol. The receive address is set via the SCB. All outputs can be monitored via the SCB and NMS.

The unit is settable to respond in 10ms or 100ms. The 100ms response samples more messages for greater security.

CIRCUIT DESCRIPTION

Status Module Overview

The Status Module is a channel card for the IMUX 2000 system. It transmits and receives data via the T1/E1 serial link and generates and receives status commands via an adapter module. Sixteen total status inputs and outputs can be supported. Setup and remote interrogation normally takes place via the SCB of the IMUX but an additional RS232 port is also available. Front panel LEDs indicate the status of the inputs and outputs.

The module consists of three major sections. The microcontroller section contains an 80C320 embedded microcontroller and associated support devices. The status FPGA and its associated circuits handles all T1/E1 communication and status I/O. The SCB FPGA connects the processor to the SCB of the IMUX. Miscellaneous other circuits are present to handle other functions

Microcontroller Circuits

The heart of the processor circuit is an 80C320 8-bit embedded microcontroller. It controls the setup and interrogation of the cards active circuits. It does not do any processing of the actual T1/E1 data or status signals. RAM and ROM provide memory and a related device provides port reconstruction for the 80C320. A watchdog timer circuit provides a processor reset pulse on power up and monitors processor timing. A TTL level converter provides an interface for the RS232 port.

Status FPGA Circuit

The status FPGA interfaces directly with the T1/E1 busses of the IMUX chassis. It is also connected to the status inputs and outputs. The FPGA has a general purpose processor interface to allow the processor to set up and interrogate the device.

SCB FPGA Circuit

This circuit is used to communicate with a common module (CM3 or CM6) over the SCB. The device has been set up for eight Config bytes and four Status bytes. A type ID of 120 has been encoded into the device.

Miscellaneous Circuits

The module has 16 LEDs on the front edge (DS1 to DS16) to indicate the condition of the status inputs and outputs. These LEDs are driven by latches which are memory mapped off the processor. A single LED (DS17) indicates an alarm condition which is driven directly off the processor. A five position DIP switch is present to allow the user to set the SCB address. The processor reads this switch to setup the SCB ACTEL.

A toggle switch enables a user to disable the changing of the status. The switch disables the outputs by interrupting the data OK signal in the ACTEL.

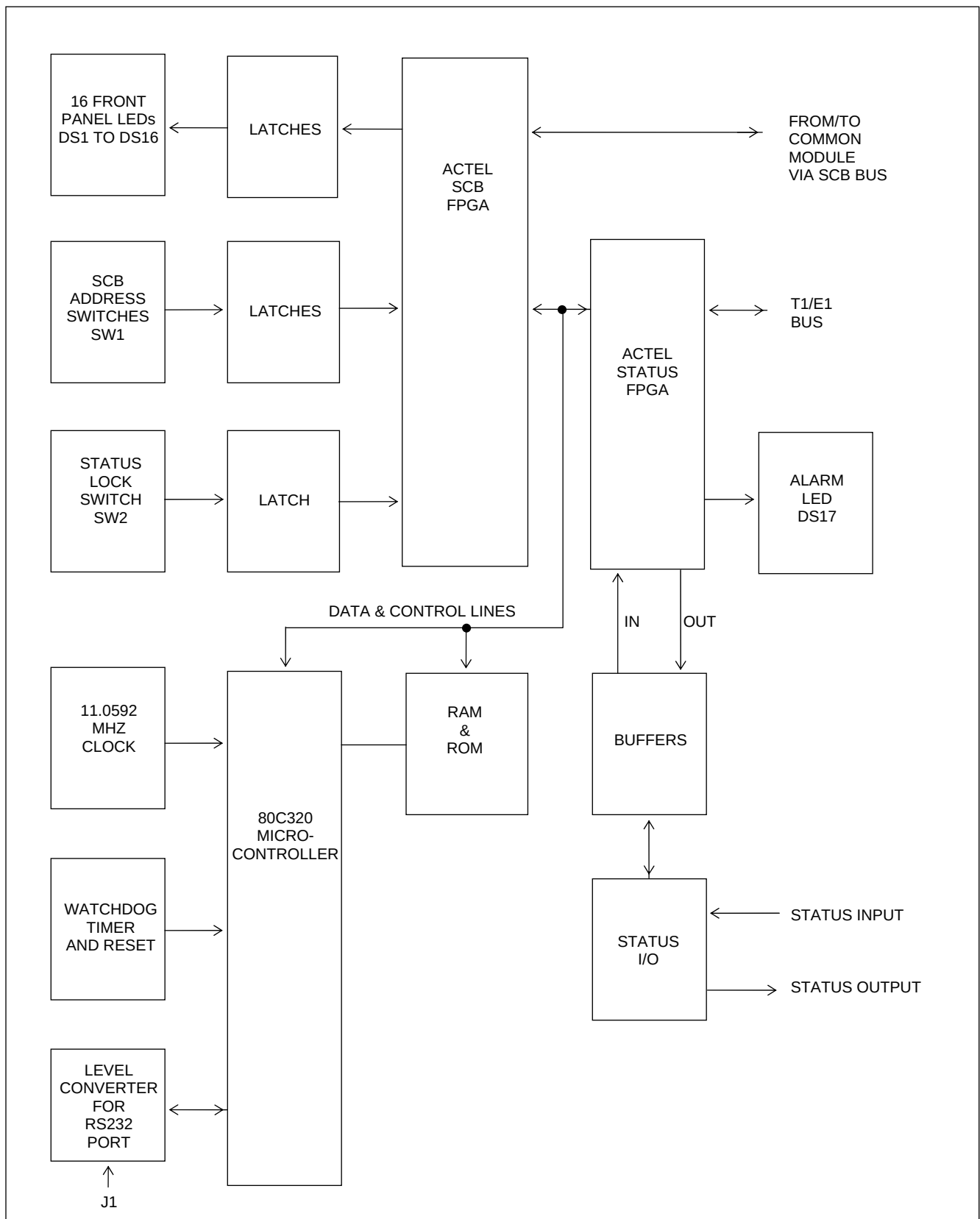


Figure 6. Status Module Block Diagram

REMOTE CONTROL INTERFACE

When the Status Module is installed in an IMUX 2000 multiplexer, it can read control and status information under local or remote control. When under remote control, most of the module setup parameters can only be changed through the RS-232 remote port on the shelf Common Module. See the IMUX 2000 manual for information on using the remote control interface.

The remote control interface for the Status Module involves two sets of codes: “P” (parameter) codes, and “S” (status) codes. The Status Module reports itself as a “Type 120” module.

“P” CODES

“P” codes, when used in the parameter field on an SCL “SET” command, allow the user to read certain parameters on the Status Module by remote control, just like setting DIP switches on a module under local control. “P” codes also appear in the response to a “CONFIG?” query, providing a list of the Status Module current parameter settings. A typical Status Module response to a “CONFIG?” query looks like this:

```
*OK  
FROM NET ADDRESS = 9  
CHANNEL CARD 10, TYPE 120  
UNDER REMOTE CONTROL  
SRVC = ON  
P01 = 13 (B00001101)  
P02 = 1 (B00000001)  
P03 = 2 (B00000010)  
P04 = 2 (B00000010)  
P05 = 0 (B00000000)  
P06 = 0 (B00000000)  
P07 = 0 (B00000000);
```

There are seven “P” codes for the Status Module; “P1” through “P7”. Each “P” code is displayed as a decimal number from 0 to 255, followed by its eight-digit binary equivalent in parenthesis. Table 3 lists the meaning of all “P” codes for the Status Module.

Table 3. Remote Configuration Settings (“P” codes)

P Code	Bits Used	Value	Description
P01 ⁽¹⁾	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑	T1: 1 to 24 E1: 1 to 31	Rx timeslot
	B 0 0 0 0 0 0 0 0 ↑	0	Receive from A direction
		1	Receive from B direction
P02 ⁽²⁾	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑↑↑	T1: 1 to 24 E1: 1 to 31	Tx timeslot
P03 ⁽³⁾	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑↑↑	0 to 63	Rx address
P04 ⁽³⁾	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑↑↑	0 to 63	Tx address
P05	B 0 0 0 0 0 0 0 0 ↑	0	Scan speed = 10ms
		1	Scan speed = 100ms
	B 0 0 0 0 0 0 0 0 ↑	0	I/O 8-15 type = output
		1	I/O 8-15 type = input
	B 0 0 0 0 0 0 0 0 ↑	0	I/O 0-7 type = output
		1	I/O 0-7 type = input
	B 0 0 0 0 0 0 0 0 ↑	0	System type = T1
		1	System type = E1
P06	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑↑↑↑	0	Output polarity of 0-7 = normal
		1	Output polarity of 0-7 = inverted
P07	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑↑↑↑	0	Output polarity of 8-15 = normal
		1	Output polarity of 8-15 = inverted

>> See next page for notes <<

Notes for Table 3:

- Note 1. The value entered for P01 shall be 32 - the desired Rx time slot, + 0 (if path select is D&IB) or +32 (if path select is Terminal or D&IA). This comes about from the way P01 is configured. Bits 1 thru 5 define the Rx time slot, and bit 6 defines Path Select (either D&IB) or (Terminal or D&IA). For example, If the user wants the Rx time slot to be = 24 and the path select to be D&IB, then P01 shall be set = $32 - 24 + 0 = 8$. This can be entered in either decimal or binary format as shown in the following SCL command:

<address>:<subaddress>:SET:P01=8;

or

<address>:<subaddress>:SET:P01=B00001000;

- Note 2. The value entered for P02 shall be 32 - the desired Tx time slot. For example, if the user wants the Tx time slot to be = 27, then P02 shall be set = 5. This can be entered in either decimal or binary format as shown in the following SCL command: (Note that for E1 systems, actual time slot 1 cannot be used for payload. The first usage time slot is considered time slot 2 for the purposes of setting P01 and P02)

<address>:<subaddress>:SET:P02=5;

or

<address>:<subaddress>:SET:P02=B00000101;

- Note 3. It is recommended that the TX and RX addresses are both set to a value other than 0 if the addressing function is being used.

“S” CODES

“S” codes appear in response to a “STATUS?” query. There are three “S” codes for the Status Module. Like the “P” codes, each “S” code is a number displayed in both decimal and binary form.

A typical response to a “STATUS?” query looks like this:

```
*OK
FROM NET ADDRESS = 9
CHANNEL CARD 10, TYPE 120
S01 = 0 (B00000000)
S02 = 0 (B00000000)
S03 = 3 (B00000011)
S04 = 0 (B00000000);
```

These codes provide information on the status of several conditions on the Status Module. Table 4 lists the meaning of all “S” codes for the Status Module.

Table 4. Remote status messages (“S” codes)

Code	Bits Used	Value	Description
S01	B 00000000 ↑	0	Point 1 status inactive
		1	Point 1 status active
	B 00000000 ↑	0	Point 2 status inactive
		1	Point 2 status active
	B 00000000 ↑	0	Point 3 status inactive
		1	Point 3 status active
	B 00000000 ↑	0	Point 4 status inactive
		1	Point 4 status active
	B 00000000 ↑	0	Point 5 status inactive
		1	Point 5 status active
	B 00000000 ↑	0	Point 6 status inactive
		1	Point 6 status active
	B 00000000 ↑	0	Point 7 status inactive
		1	Point 7 status active
	B 00000000 ↑	0	Point 8 status inactive
		1	Point 8 status active

<< table continues on next page >>

Table 4 - continued. Remote status messages (“S” codes)

Code	Bits Used	Value	Description
S02	B 00000000 ↑	0	Point 9 status inactive
		1	Point 9 status active
	B 00000000 ↑	0	Point 10 status inactive
		1	Point 10 status active
	B 00000000 ↑	0	Point 11 status inactive
		1	Point 11 status active
	B 00000000 ↑	0	Point 12 status inactive
		1	Point 12 status active
	B 00000000 ↑	0	Point 13 status inactive
		1	Point 13 status active
	B 00000000 ↑	0	Point 14 status inactive
		1	Point 14 status active
	B 00000000 ↑	0	Point 15 status inactive
		1	Point 15 status active
	B 00000000 ↑	0	Point 16 status inactive
		1	Point 16 status active
S03	B 00000000 ↑	0	Address invalid
		1	Address valid
	B 00000000 ↑	0	Data invalid
		1	Data valid
	B 00000000 ↑	0	Outputs locked (SW-2 Down)
		1	Outputs unlocked (SW-2 Up)
S04	B 00000000	0	Presently not used

TESTING

When the RFL Status Modules have been configured and installed they should be tested for proper operation before they are placed in service.

EQUIPMENT REQUIRED

DC power supply with a +5Vdc output

Volt Ohm Meter

TEST PROCEDURE

1. Install the boards in accordance with the required configuration.
2. Check the Alarm Status LED (DS17). It should be OFF. If the LED is ON, the board configurations are incorrect. Using the SCB recheck all board configuration parameters (P - codes) as shown in table 3.
3. Check the input states by connecting +5Vdc across the positive and negative terminals respectively to simulate an active logic 1 input.
4. Check the relay outputs by connecting an ohmmeter across the corresponding output terminals. the relay contacts will be opened or closed depending on the module configuration. For example if the input = logic 1, and if the output polarity = normal, then the output relay contacts will be closed.
5. Confirm the card status (S - codes) via the RS232 using Table 4 as a guide, as follows:

Verify that the remote status messages (S01 and S02) correspond to the test inputs and outputs for I/Os 1-8 and 9-16.

Verify that the remote status messages (S03) are in accordance with the following:

Address should be valid (Address bit = 1)

Data should be valid (Data bit = 1)

Outputs should be unlocked if SW2 is in the DOWN position.

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INSTRUCTION DATA

TMX Telemetry Transmitter And TMR Telemetry Receiver For RFL IMUX 2000 Intelligent T1 And E1 Multiplexers

DESCRIPTION

The RFL Telemetry System consists of an RFL TMX Telemetry Transmitter module at one end of a T1/E1 system and an RFL TMR Telemetry Receiver module at the other end. The Telemetry Transmitter accepts four independent analog channel inputs and multiplexes this data into a single T1 or E1 timeslot. The Telemetry Receiver converts this data back into four independent analog outputs. Test signals may be switched in for calibration of the analog circuits. These modules are capable of operating within wide ranges of input and output parameters and use digital techniques to produce telemetry signals having greater stability than conventional analog telemetry devices.

The TMX and TMR modules are designed for use in RFL IMUX 2000 series chassis, and each module requires one module space. All module parameters can be programmed remotely via the serial control bus using SCL or NMS. Analog signal connections are made through an RFL I/O adapter module which is installed directly behind the telemetry module in each multiplexer chassis.

The modules automatically detect if the system is T1 or E1 and configure themselves appropriately.

User-adjustable switches allow local configuration of the following parameters:

o SCB address	o TMX and TMR address
o Time slot select	o Bus Direction TXA/TXB
o Local or Remote control	o Calibration select for analog channels 1, 2, 3 or 4
o Service ON/OFF	o TMX and TMR operating parameters

NOTE

A Limited Choice Of Parameters Can Be Selected In Local Mode (See Tables 14, 18 and 19). The TMX And TMR Modules Must Be Set Up In Remote Mode For A Complete Choice Of Parameters.

TMX SPECIFICATIONS

As of the date this Instruction Data Sheet was published, the following specifications apply to all RFL TMX Telemetry Transmitter modules. Because all of RFL products undergo constant improvement and refinement, these specifications are subject to change without notice.

Analog Input:	-10V Peak to +10V Peak
Input Impedance:	Greater than 5.0 M Ω for both differential and common mode.
Calibration Input:	-10V to +10V
Main Communications:	Unidirectional DS0
Auxiliary Communications:	Proprietary Serial Control Bus (SCB)
Accuracy:	
@+25°C:	+/- 0.05 percent of Full Scale.
Drift:	0.003 percent /°C over operating temperature range. Six-month drift for identical input value and identical temperature is 0.01 percent maximum.
Resolution:	16 Bits
Frequency Response:	100 Hz Max @ 95% accuracy
Environmental Requirements:	
Operating Temperature:	Full performance (+32°F to +131 °F)
Humidity:	0 to 90 percent, non-condensing.
MTBF (Calculated):	Bellcore TR-332 > 500,000 Hours at 25°C
RFI/EMI:	C.37.90.2, IEC-801-X
Live Insertion/Extraction:	Capable of live insertion and extraction into the IMUX 2000 chassis without interruption to the DS1 or any other DS0.
Input Power Requirements (Typical):	
+5-Volt Input:	+4.75 to +5.25 volts @ 50 ma
+15-Volt Input:	+14.75 to +15.25 volts @ 70 ma
-15-Volt Input:	-14.75 to -15.25 volts @ 60 ma
Interface:	MA-700 Module Adapter.
Dimensions:	
Width:	14 mm (0.55 inches)
Height:	114 mm (4.5 inches)
Depth:	248 mm (9.76 inches)

TMR SPECIFICATIONS

As of the date this Instruction Data Sheet was published, the following specifications apply to all RFL TMR Telemetry Receiver modules. Because all of RFL products undergo constant improvement and refinement, these specifications are subject to change without notice.

Analog Output:	-50mA to +50mA
Output Compliance:	-10V to +10V
Main Communications:	Unidirectional DS0
Auxiliary Communications:	Proprietary Serial Control Bus (SCB)
Accuracy:	
@+25°C:	+/- 0.05 percent of Full Scale.
Drift:	0.003 percent/°C over operating temperature range. Six-month drift for identical input value and identical temperature is 0.01 percent maximum.
Resolution:	16 Bits
Frequency Response:	100 Hz Max @ 95% accuracy
Environmental Requirements:	
Operating Temperature:	Full performance (+32°F to +131 °F)
Humidity:	0 to 90 percent, non-condensing.
MTBF (Calculated):	Bellcore TR-332 > 500,000 Hours at 25°C
RFI/EMI:	C.37.90.2, IEC-801-X
Live Insertion/Extraction:	Capable of live insertion and extraction into the IMUX 2000 chassis without interruption to the DS1 or any other DS0.
Input Power Requirements (Typical):	
+5-Volt Input:	+4.75 to +5.25 volts @ 40 ma
+15-Volt Input:	+14.75 to +15.25 volts @ 75 ma
-15-Volt Input:	-14.75 to -15.25 volts @ 80 ma
Interface:	MA-700 Module Adapter.
Dimensions:	
Width:	14 mm (0.55 inches)
Height:	114 mm (4.5 inches)
Depth:	248 mm (9.76 inches)

INSTALLATION

Before the RFL TMX Telemetry Transmitter module and the TMR Telemetry Receiver module can be placed in service, they must be installed in their respective multiplexer shelves. Installation involves determining the module slot in the Main Shelf or Expansion Shelf where the module will be installed, inserting a Module Adapter into the rear of the shelf behind the module slot, connecting all signal wiring to the Module Adapter, checking the settings of all switches and jumpers, and inserting the module into the front of the respective shelf.

NOTES

Power supply and time slot considerations may affect the installation of this module into an existing multiplexer shelf. Refer to the multiplexer manual for more information.

TMX Telemetry Transmitter Installation

The following instructions are provided for installing an RFL TMX Telemetry Transmitter module into an existing system. If the module was included as part of a system, installation was done at the factory. Otherwise, proceed as follows:

1. Carefully inspect the module for any visible signs of shipping damage. If you suspect damage to the module, immediately call RFL Customer Service at the number listed at the bottom of this page.
2. Determine the module slot in the Main Chassis or Expansion Chassis where the TMX module will be installed. The RFL TMX Telemetry Transmitter module occupies one module slot in the Main Shelf or Expansion Shelf.
3. Each module in the IMUX 2000 multiplexer requires a Module Adapter. The module adapter provides the appropriate connector for the desired interface. The Module Adapter that is used with the TMX is the MA-700 as shown in Figure 1.
4. On the MA-700 module adapter select a single ended or differential input for analog channels 1, 2, 3 and 4 using the programmable jumpers shown in Table 3, as applicable.
5. The information in this step is provided for users who wish to modify the input ranges of the TMX through the use of external conversion resistors on the MA-700 module adapter. Table 1 describes what combinations of TMX inputs and TMR outputs require conversion resistors. If conversion resistors are not required in your installation, go to step 6.

Table 1. Conversion resistor selection for each analog channel

TMX input	TMR output	Notes
Voltage input	Current output	Conversion resistors not required
Voltage input	Voltage output	Conversion resistors required at TMR only
Current input	Voltage output	Conversion resistors required at TMX and TMR
Current input	Current output	Conversion resistors required at TMX only

The RFL TMX module accepts voltage as an input and the RFL TMR module generates current as an output. If you want to use current as an input instead of voltage, conversion resistor(s) are required at the TMX. Place conversion resistor R1 across terminals TB2-1 and TB3-4 (for analog channel 1), conversion resistor R2 across terminals TB2-2 and TB3-3 (for analog channel 2), conversion resistor R3 across terminals TB2-3 and TB3-2 (for analog channel 3), or conversion resistor R4 across terminals TB2-4 and TB3-1 (for analog channel 4), on the RFL MA-700 module adapter (See Figure 2). The conversion resistors should have a precision of 0.01% to guarantee the system accuracy of +/-0.05%. Since the system accuracy applies to a full-scale voltage input, the conversion resistor should be chosen so that the voltage across it is as high as practical and within one of the ranges shown in Table 2.

Table 2. Input gain versus input voltage range

Input Gain	Input Voltage Range
1	-10V to +10V
2	-5V to +5V
4	-2.5V to +2.5V
8	-1.25V to +1.25V

For example, if an input current range of 0 to 50 mA is required, then a conversion resistor of 200 ohms will result in an equivalent voltage input of 0 to 10 volts at the A/D converter. The resistor value is calculated as follows: $10V/50mA = 200 \text{ ohms}$, which is a readily available value for a precision resistor.

6. After its jumpers are set and conversion resistors are installed if applicable, insert the MA-700 Module Adapter into the slot at the rear of the multiplexer chassis directly behind the module slot where the RFL TMX module will be installed. Secure the module adapter with the screws provided.
7. Connect the module adapter to the user equipment using the pin assignments listed in Figure 1 as applicable.
8. Refer to Figure 3 and Table 4 for the location and function of DIP switches on the TMX module.
9. Set the SCB address using DIP switches SW1-1 through SW1-6 for the desired remote address.
For remote access, each module in the IMUX 2000 must have a distinct module address. Valid addresses are the numbers “1” to “36”. It is recommended to set the address to the number of the slot the module is occupying. Table 6 shows the switch settings for the module address. (Consult your multiplexer manual for details on using the remote access and configuration features of the system.)
10. Select local or remote mode using SW2-7. UP places the module in remote mode (settings obtained from the SCB), and DOWN places the module in local mode (settings obtained from DIP switches). Set the switch to the DOWN position.

NOTE

When the TMX module is switched to Local mode, all configuration parameters (P-codes) are set to the values determined by the present DIP-switch settings and the values of P-codes P8 through P11 are set to zero (See Table 13).

NOTE

Steps 11-17 may be performed with the module in Remote mode with applicable parameters set using NMS/SCB instead of DIP-switches. If Remote mode is used, set SW2-7 to the UP position.

11. Select an unused time slot for the TMX module using DIP switches SW2-1 through SW2-5. Each active channel uses one 64 Kbps digital time slot within the multiplexer's aggregate rate. Set the time slot using direct binary coding as shown in Table 7. Refer to the IMUX 2000 instruction manual for guidelines on time slot selection.

Note that selecting an invalid time slot will disable the TMX module. In T1 systems, only time slots 1 through 24 are allowed. Time slot 24 is not available for a T1 system using fast reframing.

In E1 systems, time slots 1 through 31 are allowed, however, time slots 0 and 16 are reserved and cannot be used. Time slot 30 is not available for an E1 system using fast reframing. Time slot 31 is not available if inter-node communications (NMX) is used.
12. Select module service on or off using SW2-8. Up sets the module service to ON (module enabled) and down sets module service to OFF (module disabled). Set the switch to the up position.
13. Select the TMX transmit address using switches SW3-1 through SW3-6 in accordance with Table 8. The TMR receive address must be set to the same value. An address of zero disables address checking by the TMR receiver.
14. Select the bus direction using SW3-8. OFF selects transmit on B and receive on A (for drop and insert B). ON selects transmit on A and receive on B (for drop and insert A or terminal end). Set the switch to the desired setting.
15. Select calibration input using SW4-1 through SW4-3 using Table 4 as a guide. Normal operation is selected with all three switches set to the OFF position. This places live data on all 4 analog channels. If the module is being calibrated, calibration data can be placed on any one of the four analog channels.
16. Select which analog channel(s) you want to output live data or a fixed value using switches SW4-5 through SW4-8 as applicable. OFF selects live data (normal operation). ON selects a fixed value of zero and is used for factory testing. Set these switches to the OFF position.

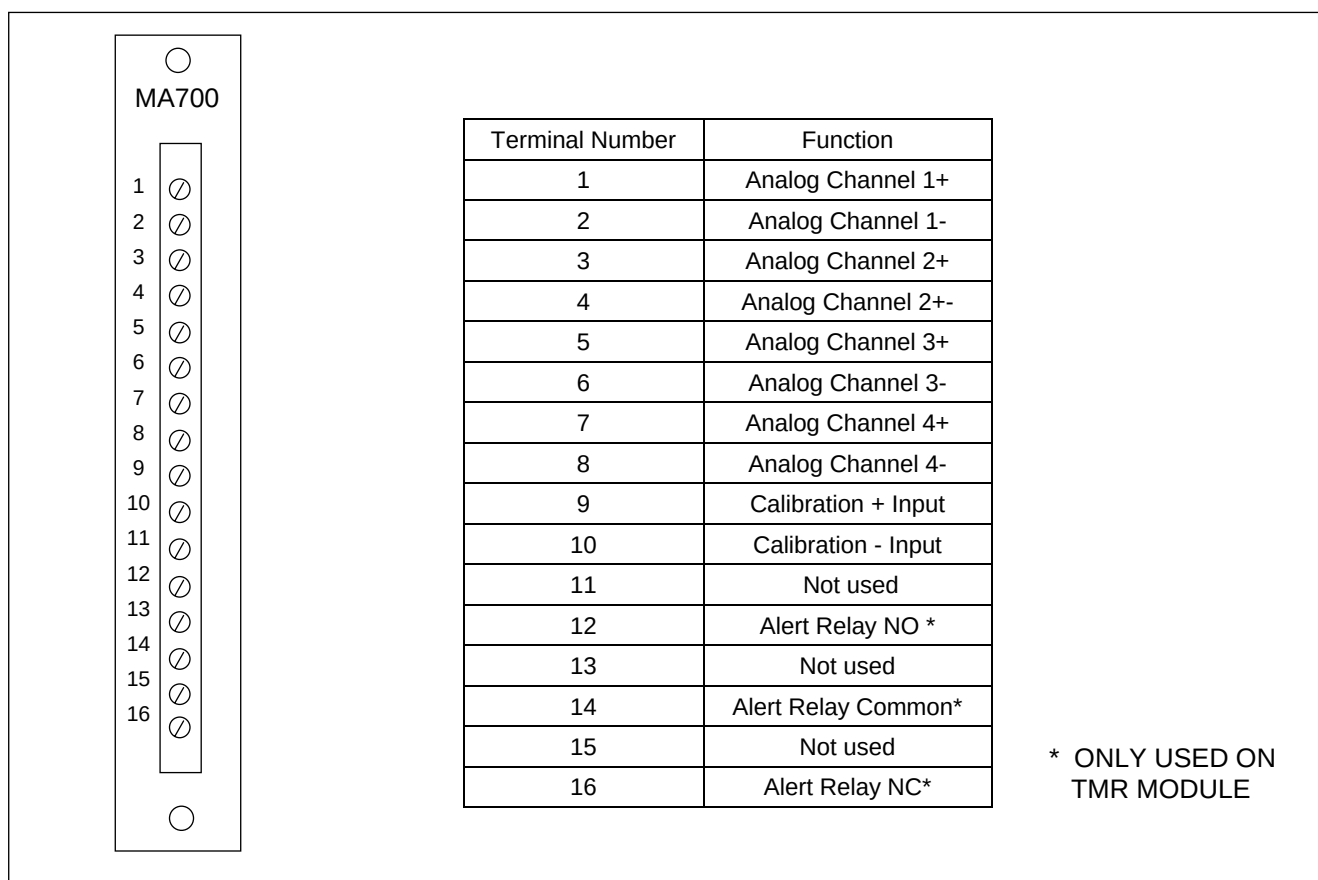


Figure 1. MA-700 Module Adapter for RFL TMX and TMR Telemetry modules

17. Select analog channel input gain using switches SW5-1 through SW5-8 as applicable. Input gains of 1, 2, 4 or 8 can be selected for each analog channel in accordance with Table 4. Also refer to Tables 11 and 12 for recommended settings.
18. Input offset is always “0” when programming the TMX using DIP-switches.
19. Install the TMX module into the IMUX 2000 chassis and allow about 15 seconds for the board to complete its power up process. This insures that the common module has read all configuration data from the TMX module.
20. Proceed to install the TMR module in accordance with the instructions starting on page 15 of this document. After the TMR module is installed verify TMX/TMR system operation by performing the verification test at the end of this document. After performance has been verified, set both modules to remote mode.

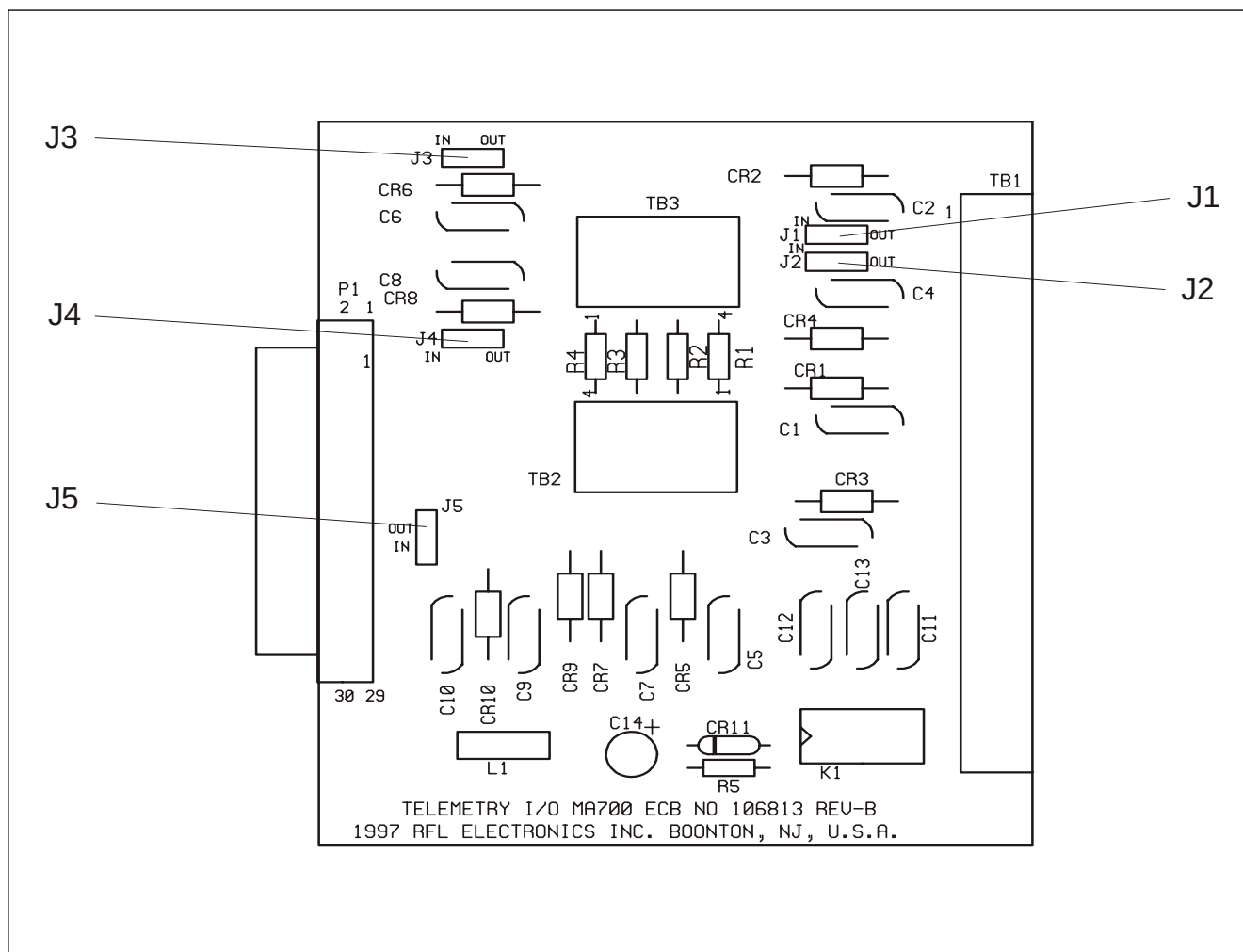


Figure 2. Location of programmable jumpers and external conversion resistors on the MA-700

Table 3. Function of MA-700 programmable jumpers

Jumper	Function
J1	IN: Selects single ended input for analog channel 1
	OUT: Selects differential input for analog channel 1
J2	IN: Selects single ended input for analog channel 2
	OUT: Selects differential input for analog channel 2
J3	IN: Selects single ended input for analog channel 3
	OUT: Selects differential input for analog channel 3
J4	IN: Selects single ended input for analog channel 4
	OUT: Selects differential input for analog channel 4
J5	IN: Selects single ended input for calibration input
	OUT: Selects differential input for calibration input

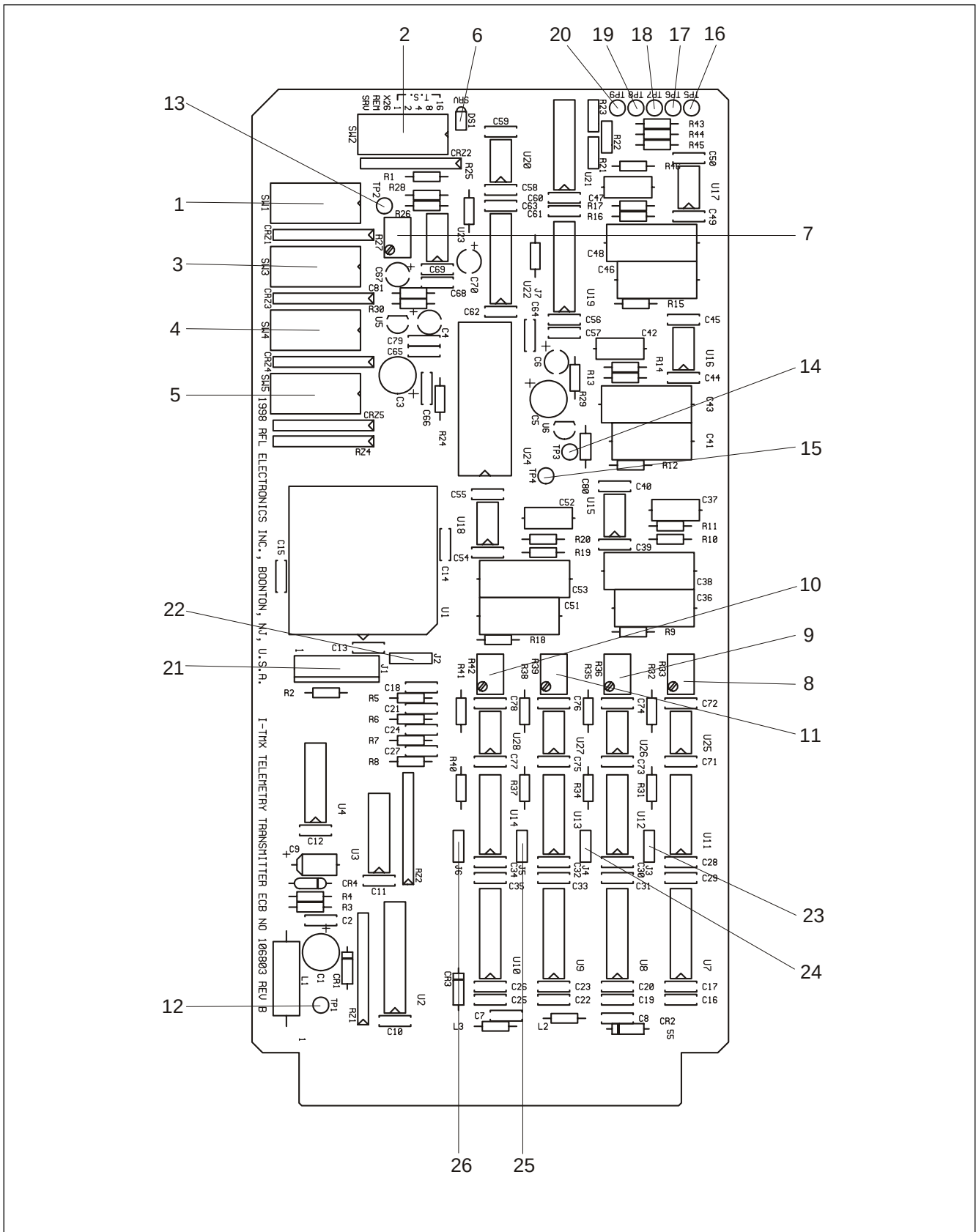


Figure 3. Controls and indicators, RFL TMX Telemetry Transmitter module

Table 4. Controls and indicators, RFL TMX Telemetry Transmitter module

Item	Name/Description	Function	Setting
1	DIP switch SW1	(SW1-1 thru - 6) Selects SCB address	See Table 6
		SW1-7 Spare	NA
		SW1-8 Spare	NA
2	DIP switch SW2	(SW2-1 thru - 5) Time slot select	See Table 7
		SW2-6 Spare	NA
		SW2-7 Selects Local or Remote control	UP: Remote control
			DOWN: Local control
		SW2-8 Sets module service ON or OFF	UP: Service ON
			DOWN: Service OFF
3	DIP Switch SW3	(SW3-1 thru -6) Selects TMX address	See Table 8
		SW3-7 Spare	NA
		SW3-8 Selects Term/DIA or DIB	OFF: DIB
			ON : Terminal/DIA
4	DIP Switch SW4	(SW4-1 thru -3) Calibrator Select	See Table 5
		SW4-4 Spare	NA
		SW4-5 Selects live data or fixed value for analog channel 4 A/D converter output	OFF: Live data
			ON: Fixed value = 0
		SW4-6 Selects live data or fixed value for analog channel 3 A/D converter output	OFF: Live data
			ON: Fixed value = 0
		SW4-7 Selects live data or fixed value for analog channel 2 A/D converter output	OFF: Live data
			ON: Fixed value = 0
5	DIP Switch SW5	(SW5-1 and -2) Analog channel 4 input gain select	<u>SW5-1</u> <u>SW5-2</u> <u>input gain</u>
			ON ON 8
			ON OFF 4
			OFF ON 2
			OFF OFF 1
		(SW5-3 and -4) Analog channel 3 input gain select	<u>SW5-3</u> <u>SW5-4</u> <u>input gain</u>
			ON ON 8
			ON OFF 4
			OFF ON 2
			OFF OFF 1
		(SW5-5 and -6) Analog channel 2 input gain select	<u>SW5-5</u> <u>SW5-6</u> <u>input gain</u>
			ON ON 8
			ON OFF 4
			OFF ON 2
			OFF OFF 1
		(SW5-7 and -8) Analog channel 1 input gain select	<u>SW5-7</u> <u>SW5-8</u> <u>input gain</u>
			ON ON 8
			ON OFF 4
			OFF ON 2
			OFF OFF 1
6	LED Indicator DS1	Lights when TMX service is ON	NA

Table 4. continued - Controls and indicators, RFL TMX Telemetry Transmitter module

Item	Name/Description	Function	Setting
7	Potentiometer R27	Trim for reference voltage at TP2	+10.240 volts +/-500 μ v at TP2
8	Potentiometer R33	Null calibration adjust for analog channel 1 (J3 must be jumpered)	Logic 1 at J2-1 when A/D converter output is 0 or +/- one bit away from zero.
9	Potentiometer R36	Null calibration adjust for analog channel 2 (J4 must be jumpered)	Logic 1 at J2-2 when A/D converter output is 0 or +/- one bit away from zero.
10	Potentiometer R39	Null calibration adjust for analog channel 3 (J5 must be jumpered)	Logic 1 at J2-3 when A/D converter output is 0 or +/- one bit away from zero.
11	Potentiometer R42	Null calibration adjust for analog channel 4 (J6 must be jumpered)	Logic 1 at J2-4 when A/D converter output is 0 or +/- one bit away from zero.
12	Test point TP1	Digital ground	Digital ground
13	Test point TP2	Reference voltage	+10.240 volts +/-500 μ v
14	Test point TP3	+12VDC	+12VDC
15	Test point TP4	-12VDC	-12VDC
16	Test point TP5	Channel 1 filtered analog input signal	NA
17	Test point TP6	Channel 2 filtered analog input signal	NA
18	Test point TP7	Channel 3 filtered analog input signal	NA
19	Test point TP8	Channel 4 filtered analog input signal	NA
20	Test point TP9	Analog ground	Analog ground
21	Connector J1	ACTEL access pins	For factory use only
22	Jumper J2-1	Zero null access point for channel 1	Logic 1 when A/D converter output is 0 or +/- one bit away from zero.
	Jumper J2-2	Zero null access point for channel 2	Logic 1 when A/D converter output is 0 or +/- one bit away from zero.
	Jumper J2-3	Zero null access point for channel 3	Logic 1 when A/D converter output is 0 or +/- one bit away from zero.
	Jumper J2-4	Zero null access point for channel 4	Logic 1 when A/D converter output is 0 or +/- one bit away from zero.
23	Jumper J3	Enables null calibration for channel 1	Enabled when J3 is set away from fingers.
24	Jumper J4	Enables null calibration for channel 2	Enabled when J4 is set away from fingers.
25	Jumper J5	Enables null calibration for channel 3	Enabled when J5 is set away from fingers.
26	Jumper J6	Enables null calibration for channel 4	Enabled when J6 is set away from fingers.

Table 5. Calibration data switch settings

SW4-1	SW4-2	SW4-3	Function
OFF	OFF	OFF	Live data on all analog channels
OFF	OFF	ON	Calibration data on analog channel 1 only
OFF	ON	OFF	Calibration data on analog channel 2 only
OFF	ON	ON	Calibration data on analog channel 3 only
ON	OFF	OFF	Calibration data on analog channel 4 only

Table 6. SCB address settings for RFL TMX and TMR modules

Module Address	SW1-1	SW1-2	SW1-3	SW1-4	SW1-5	SW1-6
1	OFF	OFF	OFF	OFF	OFF	ON
2	OFF	OFF	OFF	OFF	ON	OFF
3	OFF	OFF	OFF	OFF	ON	ON
4	OFF	OFF	OFF	ON	OFF	OFF
5	OFF	OFF	OFF	ON	OFF	ON
6	OFF	OFF	OFF	ON	ON	OFF
7	OFF	OFF	OFF	ON	ON	ON
8	OFF	OFF	ON	OFF	OFF	OFF
9	OFF	OFF	ON	OFF	OFF	ON
10	OFF	OFF	ON	OFF	ON	OFF
11	OFF	OFF	ON	OFF	ON	ON
12	OFF	OFF	ON	ON	OFF	OFF
13	OFF	OFF	ON	ON	OFF	ON
14	OFF	OFF	ON	ON	ON	OFF
15	OFF	OFF	ON	ON	ON	ON
16	OFF	ON	OFF	OFF	OFF	OFF
17	OFF	ON	OFF	OFF	OFF	ON
18	OFF	ON	OFF	OFF	ON	OFF
19	OFF	ON	OFF	OFF	ON	ON
20	OFF	ON	OFF	ON	OFF	OFF
21	OFF	ON	OFF	ON	OFF	ON
22	OFF	ON	OFF	ON	ON	OFF
23	OFF	ON	OFF	ON	ON	ON
24	OFF	ON	ON	OFF	OFF	OFF
25	OFF	ON	ON	OFF	OFF	ON
26	OFF	ON	ON	OFF	ON	OFF
27	OFF	ON	ON	OFF	ON	ON
28	OFF	ON	ON	ON	OFF	OFF
29	OFF	ON	ON	ON	OFF	ON
30	OFF	ON	ON	ON	ON	OFF
31	OFF	ON	ON	ON	ON	ON
32	ON	OFF	OFF	OFF	OFF	OFF
33	ON	OFF	OFF	OFF	OFF	ON
34	ON	OFF	OFF	OFF	ON	OFF
35	ON	OFF	OFF	OFF	ON	ON
36	ON	OFF	OFF	ON	OFF	OFF

NOTE: For SW-1, ON = UP and OFF = DOWN.

Table 7. Time Slot Select for RFL TMX and TMR modules.

Switch Code (Decimal)	Physical Switch Settings SW2-					Equivalent “P” Code	T1	E1
	1	2	3	4	5		Channel 1 Time Slot	Channel 1 Time Slot
0	D	D	D	D	D	00000	*	*
1	D	D	D	D	U	00001	1	1
2	D	D	D	U	D	00010	2	2
3	D	D	D	U	U	00011	3	3
4	D	D	U	D	D	00100	4	4
5	D	D	U	D	U	00101	5	5
6	D	D	U	U	D	00110	6	6
7	D	D	U	U	U	00111	7	7
8	D	U	D	D	D	01000	8	8
9	D	U	D	D	U	01001	9	9
10	D	U	D	U	D	01010	10	10
11	D	U	D	U	U	01011	11	11
12	D	U	U	D	D	01100	12	12
13	D	U	U	D	U	01101	13	13
14	D	U	U	U	D	01110	14	14
15	D	U	U	U	U	01111	15	15
16	U	D	D	D	D	10000	16	*
17	U	D	D	D	U	10001	17	17
18	U	D	D	U	D	10010	18	18
19	U	D	D	U	U	10011	19	19
20	U	D	U	D	D	10100	20	20
21	U	D	U	D	U	10101	21	21
22	U	D	U	U	D	10110	22	22
23	U	D	U	U	U	10111	23	23
24	U	U	D	D	D	11000	24	24
25	U	U	D	D	U	11001	*	25
26	U	U	D	U	D	11010	*	26
27	U	U	D	U	U	11011	*	27
28	U	U	U	D	D	11100	*	28
29	U	U	U	D	U	11101	*	29
30	U	U	U	U	D	11110	*	30
31	U	U	U	U	U	11111	*	31

- Notes: 1. * This setting is not allowed . Setting switches to this code will cause the module’s service to be disabled.
2. D = down, U = up.
3. DIP-switch settings are used in local control, and P-codes are used in remote control. See Tables 13 and 17 for P1-codes.

Table 8. Address Settings for RFL TMX and TMR modules

TMX/TMR Address	SW3-1	SW3-2	SW3-3	SW3-4	SW3-5	SW3-6
0 *	OFF	OFF	OFF	OFF	OFF	OFF
1	OFF	OFF	OFF	OFF	OFF	ON
2	OFF	OFF	OFF	OFF	ON	OFF
3	OFF	OFF	OFF	OFF	ON	ON
4	OFF	OFF	OFF	ON	OFF	OFF
5	OFF	OFF	OFF	ON	OFF	ON
6	OFF	OFF	OFF	ON	ON	OFF
7	OFF	OFF	OFF	ON	ON	ON
8	OFF	OFF	ON	OFF	OFF	OFF
9	OFF	OFF	ON	OFF	OFF	ON
10	OFF	OFF	ON	OFF	ON	OFF
11	OFF	OFF	ON	OFF	ON	ON
12	OFF	OFF	ON	ON	OFF	OFF
13	OFF	OFF	ON	ON	OFF	ON
14	OFF	OFF	ON	ON	ON	OFF
15	OFF	OFF	ON	ON	ON	ON
16	OFF	ON	OFF	OFF	OFF	OFF
17	OFF	ON	OFF	OFF	OFF	ON
18	OFF	ON	OFF	OFF	ON	OFF
19	OFF	ON	OFF	OFF	ON	ON
20	OFF	ON	OFF	ON	OFF	OFF
21	OFF	ON	OFF	ON	OFF	ON
22	OFF	ON	OFF	ON	ON	OFF
23	OFF	ON	OFF	ON	ON	ON
24	OFF	ON	ON	OFF	OFF	OFF
25	OFF	ON	ON	OFF	OFF	ON
26	OFF	ON	ON	OFF	ON	OFF
27	OFF	ON	ON	OFF	ON	ON
28	OFF	ON	ON	ON	OFF	OFF
29	OFF	ON	ON	ON	OFF	ON
30	OFF	ON	ON	ON	ON	OFF
31	OFF	ON	ON	ON	ON	ON
32	ON	OFF	OFF	OFF	OFF	OFF
33	ON	OFF	OFF	OFF	OFF	ON
34	ON	OFF	OFF	OFF	ON	ON
35	ON	OFF	OFF	OFF	ON	ON
36	ON	OFF	OFF	ON	OFF	OFF
37	ON	OFF	OFF	ON	OFF	ON
38	ON	OFF	OFF	ON	ON	OFF
39	ON	OFF	OFF	ON	ON	ON
40	ON	OFF	ON	OFF	OFF	OFF
41	ON	OFF	ON	OFF	OFF	ON
42	ON	OFF	ON	OFF	ON	OFF
43	ON	OFF	ON	OFF	ON	ON
44	ON	OFF	ON	ON	OFF	OFF
45	ON	OFF	ON	ON	OFF	ON

* 0 = Address checking by the TMR is disabled. NOTE: For SW-3, ON = UP and OFF = DOWN.

Table 8. continued - Address Settings for RFL TMX and TMR modules

TMX/TMR Address	SW3-1	SW3-2	SW3-3	SW3-4	SW3-5	SW3-6
46	ON	OFF	ON	ON	ON	OFF
47	ON	OFF	ON	ON	ON	ON
48	ON	ON	OFF	OFF	OFF	OFF
49	ON	ON	OFF	OFF	OFF	ON
50	ON	ON	OFF	OFF	ON	OFF
51	ON	ON	OFF	OFF	ON	ON
52	ON	ON	OFF	ON	OFF	OFF
53	ON	ON	OFF	ON	OFF	ON
54	ON	ON	OFF	ON	ON	OFF
55	ON	ON	OFF	ON	ON	ON
56	ON	ON	ON	OFF	OFF	OFF
57	ON	ON	ON	OFF	OFF	ON
58	ON	ON	ON	OFF	ON	OFF
59	ON	ON	ON	OFF	ON	ON
60	ON	ON	ON	ON	OFF	OFF
61	ON	ON	ON	ON	OFF	ON
62	ON	ON	ON	ON	ON	OFF
63	ON	ON	ON	ON	ON	ON

TMR Telemetry Receiver Installation

The following instructions are provided for installing an RFL TMR Telemetry Receiver module into an existing system. If the module was included as part of a system, installation was done at the factory. Otherwise, proceed as follows:

1. Carefully inspect the module for any visible signs of shipping damage. If you suspect damage to the module, immediately call RFL Customer Service at the number listed at the bottom of this page.
2. Determine the module slot in the Main Chassis or Expansion Chassis where the TMR module will be installed. The RFL TMR Telemetry Transmitter module occupies one module slot in the Main Shelf or Expansion Shelf.
3. Each module in the IMUX 2000 multiplexer requires a Module Adapter. The module adapter provides the appropriate connector for the desired interface. The Module Adapter that is used with the TMR is the MA-700 as shown in Figure 1.
4. On the MA-700 module adapter select a single ended or differential input for analog channels 1, 2, 3 and 4 using the programmable jumpers shown in Table 3 as applicable.
5. The information in this step is provided for users who wish to modify the output ranges of the TMR through the use of external conversion resistors on the MA-700 module adapter. Table 1 describes what combinations of TMX inputs and TMR outputs require conversion resistors. If conversion resistors are not required in your installation, go to step 6.

The RFL TMX module accepts voltage as an input and the RFL TMR module generates current as an output. If you want to use voltage as an output instead of current, conversion resistor(s) are required at the TMR. Place conversion resistor R1 across terminals TB2-1 and TB3-4 (for analog channel 1), conversion resistor R2 across terminals TB2-2 and TB3-3 (for analog channel 2), conversion resistor R3 across terminals TB2-3 and TB3-2 (for analog channel 3), or conversion resistor R4 across terminals TB2-4 and TB3-1 (for analog channel 4), on the RFL MA-700 module adapter (See Figure 2). The conversion resistors should have a precision of 0.01% to guarantee the system accuracy of +/-0.05%. Since the system accuracy applies to a full-scale current output, the conversion resistor should be chosen so that the current through it is as high as practical and within one of the ranges shown in Table 9.

Table 9. Output gain versus output current range

Output Gain	Output Current Range
1	-50 mA to +50 mA
1/2	-25 mA to +25 mA
1/4	-12.5 mA to +12.5 mA
1/8	-6.25 mA to +6.25 mA

For example, if an output voltage range of 0 to 10 volts is required, then a conversion resistor of 200 ohms will result in an equivalent current output of 0-50 mA at the D/A converter. The resistor value is calculated as follows: $10V/50mA = 200$ ohms, which is a readily available value for a precision resistor.

6. After its jumpers are set and conversion resistors are installed if applicable, insert the MA-700 Module Adapter into the slot at the rear of the multiplexer chassis directly behind the module slot where the RFL TMR module will be installed. Secure the module adapter with the screws provided.
7. Connect the module adapter to the user equipment using the pin assignments listed in Figure 1 as applicable.
8. Refer to Figure 4 and Table 10 for the location and function of DIP switches on the TMR module.
9. Set the SCB address using DIP switches SW1-1 through SW1-6 for the desired remote address.

For remote access, each module in the IMUX 2000 must have a distinct module address. Valid addresses are the numbers “1” to “36”. It is recommended to set the address to the number of the slot the module is occupying. Table 6 shows the switch settings for the module address. (Consult your multiplexer manual for details on using the remote access and configuration features of the system.)

10. Select local mode by setting SW2-7 to the DOWN position.

NOTE

Steps 11-20 may be performed with the module in Remote mode with applicable parameters set using NMS/SCB instead of DIP-switches. When Remote mode is used, set SW2-7 to the UP position.

11. Select an unused time slot for the TMR module using DIP switches SW2-1 through SW2-5. Each active channel uses one 64 Kbps digital time slot within the multiplexer's aggregate rate. Set the time slot using direct binary coding as shown in Table 7. Refer to the multiplexer manual for guidelines on time slot selection.

Note that selecting an invalid time slot will disable the TMR module. In T1 systems, only time slots 1 through 24 are allowed. Time slot 24 is not available for a T1 system using fast reframing.

In E1 systems, time slots 1 through 31 are allowed, however, time slots 0 and 16 are reserved and cannot be used. Time slot 30 is not available for an E1 system using fast reframing. Time slot 31 is not available if inter-node communications (NMX) is used.

12. Select module service on or off using SW2-8.
13. Select the TMR address using switches SW3-1 through SW3-6. The TMR address selected must be the same as the TMX address.
14. Select analog channel 1 transfer ratio using SW4-1 and SW4-2.
15. Select analog channel 1 offset using SW4-3.
16. Select analog channel 1 loss of signal output using SW4-4.
17. Select analog channel 1 fixed or live output using SW4-5.
18. Select analog channel 1 fixed output level using SW4-6.
19. Select analog channel 1 output gain using SW4-7 and SW4-8.
20. Repeat steps 14 through 19 for analog channels 2-4 as applicable.
21. Install the TMR module into the IMUX 2000 chassis and allow about 15 seconds for the board to complete its power up process. This insures that the common module has read all configuration data from the TMR module.
22. Verify TMX/TMR system performance by using the recommended procedure in the testing section of this publication. After performance has been verified, set both modules to remote mode if applicable.

The RFL TMX and TMR modules are now installed. If your multiplexer is set up for remote access and control, you can now change the operating parameters of the module by using SCL (simple command language) or NMS (network management software). For more information on remote access and control, consult the IMUX 2000 instruction manual and the Remote Control Interface section of this document.

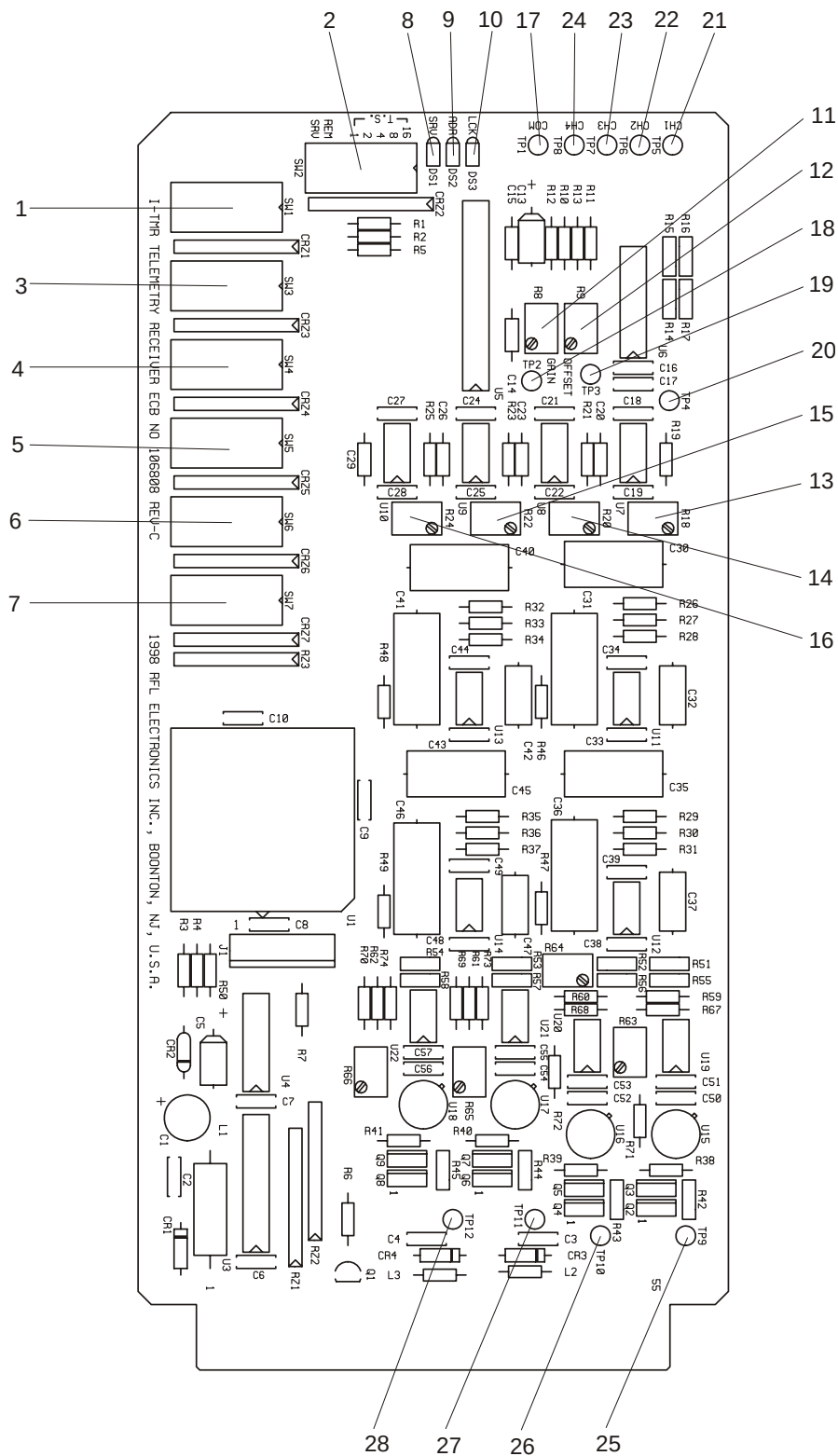


Figure 4. Controls and indicators, RFL TMR Telemetry Receiver module

Table 10. Controls and indicators, RFL TMR Telemetry Receiver module

Item	Name/Description	Function	Setting
1	DIP switch SW1	(SW1-1 thru - 6) Selects SCB address	See Table 6
		SW1-7 Spare	NA
		SW1-8 Spare	NA
2	DIP switch SW2	(SW2-1 thru - 5) Time slot select	See Table 7
		SW2-6 Spare	NA
		SW2-7 Selects Local or Remote control	UP: Remote control
			DOWN: Local control
		SW2-8 Sets module service ON or OFF	UP: Service ON
			DOWN: Service OFF
3	DIP Switch SW3	(SW3-1 thru -6) Selects TMR address	See Table 8
		SW3-7 Spare	NA
		SW3-8 Selects Term/DIA or DIB	0 = DIB
			1 = Terminal/DIA
4	DIP Switch SW4	(SW4-1 and –2) Selects analog channel 1 transfer ratio	<u>SW4-1</u> <u>SW4-2</u> <u>transfer ratio</u> <u>NMS values</u>

Table 10. continued - Controls and indicators, RFL TMR Telemetry Receiver module

Item	Name/Description	Function	Setting																														
6	DIP Switch SW6	(SW6-1 and –2) Selects analog channel 3 transfer ratio	<table><tr><th>SW5-1</th><th>SW5-2</th><th>transfer ratio</th><th colspan="2">NMS values</th></tr><tr><th></th><th></th><th></th><th>MS byte</th><th>LS byte</th></tr><tr><td>0</td><td>0</td><td>1</td><td>8</td><td>0</td></tr><tr><td>0</td><td>1</td><td>2</td><td>16</td><td>0</td></tr><tr><td>1</td><td>0</td><td>4</td><td>32</td><td>0</td></tr><tr><td>1</td><td>1</td><td>½</td><td>4</td><td>0</td></tr></table>	SW5-1	SW5-2	transfer ratio	NMS values					MS byte	LS byte	0	0	1	8	0	0	1	2	16	0	1	0	4	32	0	1	1	½	4	0
		SW5-1	SW5-2	transfer ratio	NMS values																												
					MS byte	LS byte																											
		0	0	1	8	0																											
		0	1	2	16	0																											
		1	0	4	32	0																											
		1	1	½	4	0																											
		SW6-3 Selects analog channel 3 offset	0 = 0 % (0 mA at D/A) 1 = +16 % (8 mA at D/A)																														
		SW6-4 Selects analog channel 3 loss of signal output	0 = previous value 1 = 0 %																														
		SW6-5 Selects analog channel 3 output set to fixed value	0 = live data 1 = forces output to fixed value																														
SW6-6 Selects analog channel 3 output level when fixed value is selected	0 = - 100 % 1 = + 100 %																																
(SW6-7 and –8) Selects analog channel 3 output gain	<table><tr><th>SW6-7</th><th>SW6-8</th><th>output gain</th></tr><tr><td>0</td><td>0</td><td>1</td></tr><tr><td>0</td><td>1</td><td>1/2</td></tr><tr><td>1</td><td>0</td><td>1/4</td></tr><tr><td>1</td><td>1</td><td>1/8</td></tr></table>	SW6-7	SW6-8	output gain	0	0	1	0	1	1/2	1	0	1/4	1	1	1/8																	
SW6-7	SW6-8	output gain																															
0	0	1																															
0	1	1/2																															
1	0	1/4																															
1	1	1/8																															
7	DIP Switch SW7	(SW7-1 and –2) Selects analog channel 4 transfer ratio	<table><tr><th>SW5-1</th><th>SW5-2</th><th>transfer ratio</th><th colspan="2">NMS values</th></tr><tr><th></th><th></th><th></th><th>MS byte</th><th>LS byte</th></tr><tr><td>0</td><td>0</td><td>1</td><td>8</td><td>0</td></tr><tr><td>0</td><td>1</td><td>2</td><td>16</td><td>0</td></tr><tr><td>1</td><td>0</td><td>4</td><td>32</td><td>0</td></tr><tr><td>1</td><td>1</td><td>½</td><td>4</td><td>0</td></tr></table>	SW5-1	SW5-2	transfer ratio	NMS values					MS byte	LS byte	0	0	1	8	0	0	1	2	16	0	1	0	4	32	0	1	1	½	4	0
		SW5-1	SW5-2	transfer ratio	NMS values																												
					MS byte	LS byte																											
		0	0	1	8	0																											
		0	1	2	16	0																											
		1	0	4	32	0																											
		1	1	½	4	0																											
		SW7-3 Selects analog channel 4 offset	0 = 0 % (0 mA at D/A) 1 = +16 % (8 mA at D/A)																														
		SW7-4 Selects analog channel 4 loss of signal output	0 = previous value 1 = 0 %																														
		SW7-5 Selects analog channel 4 output set to fixed value	0 = live data 1 = forces output to fixed value																														
SW7-6 Selects analog channel 4 output level when fixed value is selected	0 = - 100 % 1 = + 100 %																																
(SW7-7 and –8) Selects analog channel 4 output gain	<table><tr><th>SW7-7</th><th>SW7-8</th><th>output gain</th></tr><tr><td>0</td><td>0</td><td>1</td></tr><tr><td>0</td><td>1</td><td>1/2</td></tr><tr><td>1</td><td>0</td><td>1/4</td></tr><tr><td>1</td><td>1</td><td>1/8</td></tr></table>	SW7-7	SW7-8	output gain	0	0	1	0	1	1/2	1	0	1/4	1	1	1/8																	
SW7-7	SW7-8	output gain																															
0	0	1																															
0	1	1/2																															
1	0	1/4																															
1	1	1/8																															
8	LED indicator DS1 (green)	Service indicator	Lit when module is in service																														
9	LED indicator DS2 (green)	Address indicator	Lit when TMX address matches TMR address or if address test is disabled (local address = 0)																														
10	LED indicator DS3 (green)	Lock indicator	Lit when data frame lock is achieved																														
11	Potentiometer R8	D/A converter gain adjust	Factory adjustment																														
12	Potentiometer R9	D/A converter offset adjust	Factory adjustment																														
13	Potentiometer R18	Channel 1 offset adjust	Factory adjustment																														
14	Potentiometer R20	Channel 2 offset adjust	Factory adjustment																														
15	Potentiometer R22	Channel 3 offset adjust	Factory adjustment																														
16	Potentiometer R24	Channel 4 offset adjust	Factory adjustment																														
17	Test point TP1	Ground	Ground																														
18	Test point TP2	D/A reference ground	D/A reference ground																														
19	Test point TP3	Output of D/A converter	Factory use only																														
20	Test point TP4	Output of attenuator	Factory use only																														
21	Test point TP5	Output of channel 1 low pass filter	Reading depends on signal																														
22	Test point TP6	Output of channel 2 low pass filter	Reading depends on signal																														
23	Test point TP7	Output of channel 3 low pass filter	Reading depends on signal																														
24	Test point TP8	Output of channel 4 low pass filter	Reading depends on signal																														
25	Test point TP9	High side of current output for channel 1	Reading depends on load																														
26	Test point TP10	High side of current output for channel 2	Reading depends on load																														
27	Test point TP11	High side of current output for channel 3	Reading depends on load																														
28	Test point TP12	High side of current output for channel 4	Reading depends on load																														

FUNCTIONAL DESCRIPTION

The IMUX 2000 Telemetry System consists of a Telemetry Transmitter (TMX) and a Telemetry Receiver (TMR) and uses digital controls to set its operating parameters. A full range of parameters can be set in remote mode using Network Management software, however, some selected parameter values are available through DIP switches when operating in local mode. Each of the four analog channels can have independent settings. A block diagram of the IMUX 2000 Telemetry System is shown in Figure 5.

The analog input to the transmitter can originate either at the analog channel input port or at the common calibration input. Each of the four analog channels can be connected to the calibration port one at a time. The analog signal is passed through a gain stage to bring the signal as close to internal full scale as possible. This allows taking full advantage of the A/D converter resolution. The internal full scale is +/-10 volts nominal. After the signal is digitized by the A/D converter, an offset value is subtracted from the resulting code. This is done to allow proper processing by the digital multiplier in the receiver. The offset is used to bring unipolar signals to zero or to center bipolar signals around zero.

In the receiver, the incoming data is fed into a digital multiplier where it is multiplied by the transfer ratio. This allows arbitrary and almost continuous adjustment to the input-to-output gain in the system. The input and output gain stages each have four discrete values. Following the digital multiplier, an output offset value is added to the data which is then fed to the D/A converter. The internal full scale current is +/- 50 mA nominal. Finally, the analog signal is passed to an output gain stage before appearing at the output port.

Alerts/Alarms

The RFL TMR module reports three types of ALERTS to the shelf Common Module:

1. Loss of telemetry frame synchronization
2. Non-matching TMX/TMR addresses
3. TPU alert (loss of communication)

Any one of these alerts causes the digital controller on the TMR module to drive the relay on the MA-700 module adapter.

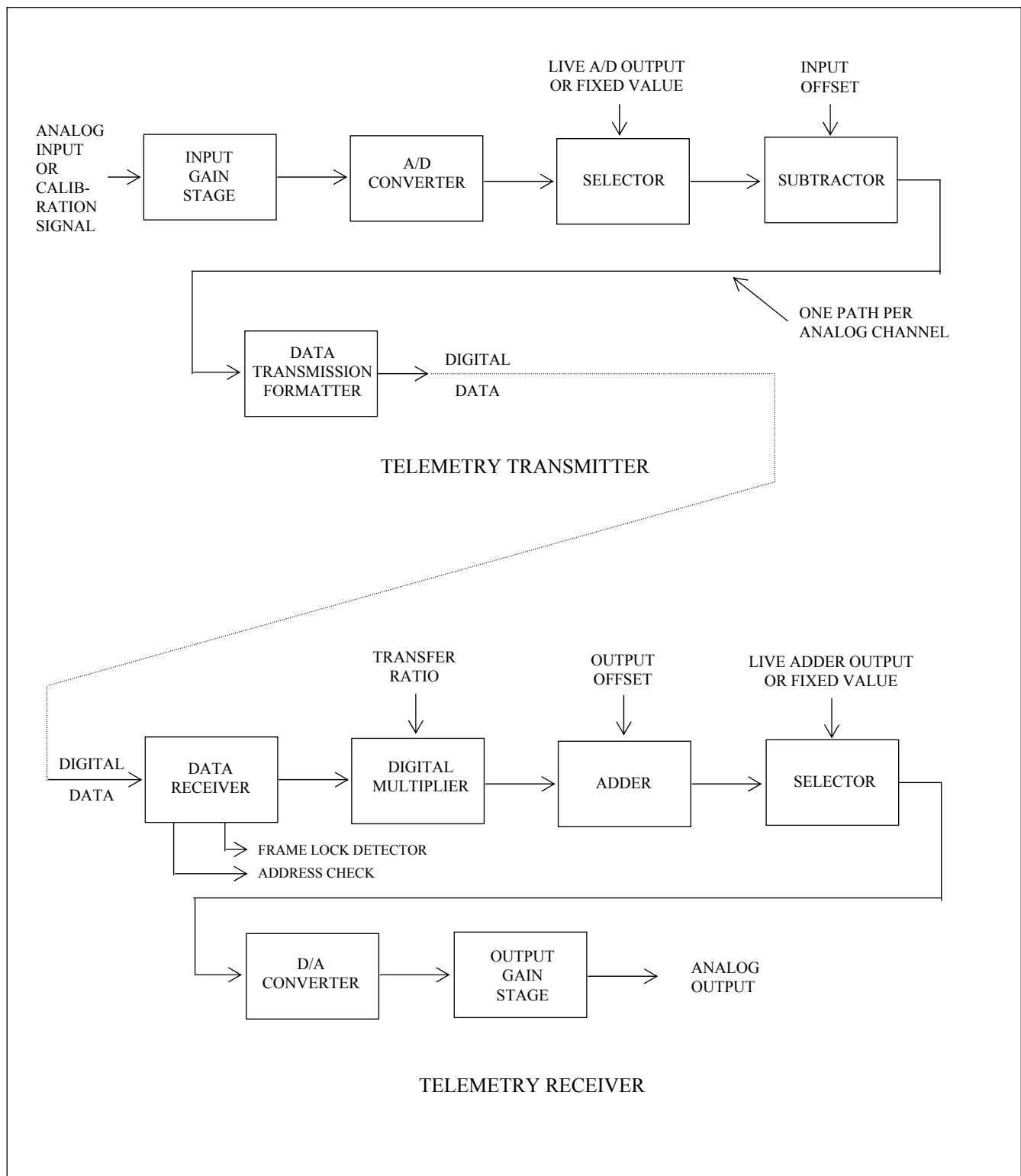


Figure 5. Functional block diagram, RFL TMX/TMR system.

RECOMMENDED GUIDELINES FOR THE SELECTION OF PARAMETER VALUES

The telemetry system operates as a voltage-to-current converter. The input signals must be presented in the form of voltage, while the output signals are generated in the form of current. The maximum input range is -10V to +10V and the maximum output range is -50mA to +50mA. This equates to an internal conversion factor of 5mA/V as the signal passes from the TMX to the TMR.

If you want to use current as an input instead of voltage, the input current must be passed through a conversion resistor R_{in} in order to obtain input voltage for the TMX Transmitter. If you want to use voltage as an output instead of current, the output current must be passed through a conversion resistor R_{out} in order to obtain output current for the TMX Transmitter.

Transfer Function

The telemetry system processes signals according to the following transfer function:

$$[\text{Output Signal, mA}] = \{([\text{Input Signal, Volts}] * G_{in} - OS_{in}) * XFR * 5\text{mA/V} + OS_{out}\} * G_{out}$$

See page 24 of this document for symbol definitions.

Recommended Input Gain For TMX

Use the highest possible gain which results in the largest possible voltage at the A/D which fits within the -10V to +10V maximum input range.

For example, consider the 4-20mA input current range with $R_{in}=200\Omega$, resulting in an input voltage range of 0.8-4V at the terminals. The highest possible gain is $G_{in}=2$, resulting in an input signal of 1.6-8V at the A/D converter. The next highest gain, $G_{in}=4$, would cause the voltage at the A/D to exceed the maximum input range.

Recommended Input Offset For TMX

Use an offset which causes the effective unipolar voltage after the A/D converter to have a “left scale” of 0, or to center a bipolar signal around zero.

For example, for the input range of 4-20mA with $R_{in}=200\Omega$, and with input gain $G_{in}=2$, the effective voltage is 1.6-8V at the A/D converter. Using offset $OS_{in}=+1.6\text{V}$ will subtract this value from the signal, causing the range to begin at zero. Note that magnitude and polarity of offsets are set separately.

Recommended Output Gain For TMR

Use the lowest possible gain (highest attenuation) which causes the D/A to generate as large a current as possible which still fits within the -50mA to +50mA maximum output range.

For example, consider the 4-20mA output range. The lowest possible gain is $G_{out}=1/2$, resulting in an output signal of 8-40mA required at the D/A converter. The next lowest gain, $G_{out}=1/4$, would cause the current at the D/A to exceed the maximum output range.

Recommended Transfer Ratio

The Transfer Ratio (XFR) is a multiplier used by the internal digital math processor in the TMR. It is applied to the signal in addition to the 5mA/V conversion factor resulting from the fact that the full-scale input at the A/D converter is -10V to +10V and that the full-scale output at the D/A converter is -50mA to +50mA.

The transfer ratio XFR is calculated as follows:

$$\text{XFR} = \{ \text{output signal span at the D/A} \} / \{ (\text{input signal span at the A/D}) \times 5\text{mA/V} \}$$

In the above examples (4-20mA on input and output), the signals at the converters have these spans:

$$\begin{array}{ll} \text{input: } 1.6 \text{ to } 8\text{V}; & \text{span} = 6.4\text{V} \\ \text{output: } 8 \text{ to } 40\text{mA}; & \text{span} = 32\text{mA} \end{array}$$

$$\text{Therefore, XFR} = \{ 32\text{mA} \} / \{ 6.4\text{V} \times 5\text{mA/V} \} = 1$$

For additional information, refer to RFL Telemetry Application Note 1.

Recommended Output Offset For TMR

If an Input Offset was set as recommended above, use an Output Offset equal to the desired value of the left scale of a unipolar signal or of the center scale of a bipolar signal at the D/A converter. This is required because the input offset has an opposite effect at the Transmitter and the digital data which passes from the Transmitter to the Receiver represents either a unipolar signal starting at zero or a bipolar signal centered around zero.

For example, for an output range of 4-20mA with output gain $G_{\text{out}}=1/2$, the effective current required is 8-40mA at the D/A converter. If the internal digital data starts at zero as a result of input offset OS_{in} , then using an offset $OS_{\text{out}}=+8\text{mA}$ will add 8 mA to the internal digital data. This will cause the internal range to start at 8 mA. For additional information refer to Application Note 1.

Parameter Values for Common Input-Output Combinations

Tables 11 and 12 contain recommended configuration parameter values for the TMX and TMR modules. The parameters shown were calculated for the most commonly used input and output signal ranges.

The tables contain values, not settings. For example, the table may indicate a required transfer ratio of $\text{XFR} = 1.5625$. A configuration setting resulting in that value is: $\text{MSB} = 0001100$ binary, $\text{LSB} = 10000000$ binary.

For directions on how to determine parameter SCB or DIP-Switch settings resulting in desired values, refer to the Remote Control Interface section of this publication and to Telemetry Application Note 1.

The symbols used in the Transfer Function and in Tables 11 and 12 are defined as follows:

- R_{in} - input current-to-voltage conversion resistor.
- R_{out} - output voltage-to-current conversion resistor.
- G_{in} - input gain value.
- OS_{in} - input offset value: polarity and magnitude.
- XFR - transfer ratio value
- OS_{out} - output offset value: polarity and magnitude.
- G_{out} - output gain value.

Table 11. Recommended configuration parameter values for TMX and TMR

Input Range (TMX) ↓	Output Range (TMR)					
	0 to 1 mA	-1 to 1 mA	0 to 20 mA	0 to 50 mA	4 to 20 mA	10 to 50 mA
0 to 1 mA @ $R_{in}=200\Omega$	$G_{in} = 8$ $OS_{in} = +0$ $XFR = 1$ $OS_{out} = +0$ $G_{out} = 1/8$	$G_{in} = 8$ $OS_{in} = +0$ $XFR = 2$ $OS_{out} = -8mA$ $G_{out} = 1/8$	$G_{in} = 8$ $OS_{in} = +0$ $XFR = 5$ $OS_{out} = +0$ $G_{out} = 1/2$	$G_{in} = 8$ $OS_{in} = +0$ $XFR = 6.25$ $OS_{out} = +0$ $G_{out} = 1$	$G_{in} = 8$ $OS_{in} = +0$ $XFR = 4$ $OS_{out} = +8mA$ $G_{out} = 1/2$	$G_{in} = 8$ $OS_{in} = +0$ $XFR = 5$ $OS_{out} = +10mA$ $G_{out} = 1$
-1 to 1 mA @ $R_{in}=200\Omega$	$G_{in} = 8$ $OS_{in} = +0$ $XFR = 0.5$ $OS_{out} = +4mA$ $G_{out} = 1/8$	$G_{in} = 8$ $OS_{in} = +0$ $XFR = 1$ $OS_{out} = +0$ $G_{out} = 1/8$	$G_{in} = 8$ $OS_{in} = +0$ $XFR = 2.5$ $OS_{out} = +20mA$ $G_{out} = 1/2$	$G_{in} = 8$ $OS_{in} = +0$ $XFR = 3.125$ $OS_{out} = +25mA$ $G_{out} = 1$	$G_{in} = 8$ $OS_{in} = +0$ $XFR = 2$ $OS_{out} = +20mA$ $G_{out} = 1/2$	$G_{in} = 8$ $OS_{in} = +0$ $XFR = 2.5$ $OS_{out} = +30mA$ $G_{out} = 1$
0 to 20 mA @ $R_{in}=200\Omega$	$G_{in} = 2$ $OS_{in} = +0$ $XFR = 0.2$ $OS_{out} = +0$ $G_{out} = 1/8$	$G_{in} = 2$ $OS_{in} = +0$ $XFR = 0.4$ $OS_{out} = -8mA$ $G_{out} = 1/8$	$G_{in} = 2$ $OS_{in} = +0$ $XFR = 1$ $OS_{out} = +0$ $G_{out} = 1/2$	$G_{in} = 2$ $OS_{in} = +0$ $XFR = 1.25$ $OS_{out} = +0$ $G_{out} = 1$	$G_{in} = 2$ $OS_{in} = +0$ $XFR = 0.8$ $OS_{out} = +8mA$ $G_{out} = 1/2$	$G_{in} = 2$ $OS_{in} = +0$ $XFR = 1$ $OS_{out} = +10mA$ $G_{out} = 1$
0 to 50 mA @ $R_{in}=200\Omega$	$G_{in} = 1$ $OS_{in} = +0$ $XFR = 0.16$ $OS_{out} = +0$ $G_{out} = 1/8$	$G_{in} = 1$ $OS_{in} = +0$ $XFR = 0.32$ $OS_{out} = -8mA$ $G_{out} = 1/8$	$G_{in} = 1$ $OS_{in} = +0$ $XFR = 0.8$ $OS_{out} = +0$ $G_{out} = 1/2$	$G_{in} = 1$ $OS_{in} = +0$ $XFR = 1$ $OS_{out} = +0$ $G_{out} = 1$	$G_{in} = 1$ $OS_{in} = +0$ $XFR = 0.64$ $OS_{out} = +8mA$ $G_{out} = 1/2$	$G_{in} = 1$ $OS_{in} = +0$ $XFR = 0.8$ $OS_{out} = +10mA$ $G_{out} = 1$
4 to 20 mA @ $R_{in}=200\Omega$	$G_{in} = 2$ $OS_{in} = +1.6V$ $XFR = 0.25$ $OS_{out} = +0$ $G_{out} = 1/8$	$G_{in} = 2$ $OS_{in} = +1.6V$ $XFR = 0.5$ $OS_{out} = -8mA$ $G_{out} = 1/8$	$G_{in} = 2$ $OS_{in} = +1.6V$ $XFR = 1.25$ $OS_{out} = +0$ $G_{out} = 1/2$	$G_{in} = 2$ $OS_{in} = +1.6V$ $XFR = 1.5625$ $OS_{out} = +0$ $G_{out} = 1$	$G_{in} = 2$ $OS_{in} = +1.6V$ $XFR = 1$ $OS_{out} = +8mA$ $G_{out} = 1/2$	$G_{in} = 2$ $OS_{in} = +1.6V$ $XFR = 1.25$ $OS_{out} = +10mA$ $G_{out} = 1$
10 to 50 mA @ $R_{in}=200\Omega$	$G_{in} = 1$ $OS_{in} = +2V$ $XFR = 0.2$ $OS_{out} = +0$ $G_{out} = 1/8$	$G_{in} = 1$ $OS_{in} = +2V$ $XFR = 0.4$ $OS_{out} = -8mA$ $G_{out} = 1/8$	$G_{in} = 1$ $OS_{in} = +2V$ $XFR = 1$ $OS_{out} = +0$ $G_{out} = 1/2$	$G_{in} = 1$ $OS_{in} = +2V$ $XFR = 1.25$ $OS_{out} = +0$ $G_{out} = 1$	$G_{in} = 1$ $OS_{in} = +2V$ $XFR = 0.8$ $OS_{out} = +8mA$ $G_{out} = 1/2$	$G_{in} = 1$ $OS_{in} = +2V$ $XFR = 1$ $OS_{out} = +10mA$ $G_{out} = 1$
0 to 1 mA @ $R_{in}=10k\Omega$	$G_{in} = 1$ $OS_{in} = +0$ $XFR = 0.16$ $OS_{out} = +0$ $G_{out} = 1/8$	$G_{in} = 1$ $OS_{in} = +0$ $XFR = 0.32$ $OS_{out} = -8mA$ $G_{out} = 1/8$	$G_{in} = 1$ $OS_{in} = +0$ $XFR = 0.8$ $OS_{out} = +0$ $G_{out} = 1/2$	$G_{in} = 1$ $OS_{in} = +0$ $XFR = 1$ $OS_{out} = +0$ $G_{out} = 1$	$G_{in} = 1$ $OS_{in} = +0$ $XFR = 0.64$ $OS_{out} = +8mA$ $G_{out} = 1/2$	$G_{in} = 1$ $OS_{in} = +0$ $XFR = 0.8$ $OS_{out} = +10mA$ $G_{out} = 1$
-1 to 1 mA @ $R_{in}=10k\Omega$	$G_{in} = 1$ $OS_{in} = +0$ $XFR = 0.08$ $OS_{out} = +4mA$ $G_{out} = 1/8$	$G_{in} = 1$ $OS_{in} = +0$ $XFR = 0.16$ $OS_{out} = +0$ $G_{out} = 1/8$	$G_{in} = 1$ $OS_{in} = +0$ $XFR = 0.4$ $OS_{out} = +20mA$ $G_{out} = 1/2$	$G_{in} = 1$ $OS_{in} = +0$ $XFR = 0.5$ $OS_{out} = +25mA$ $G_{out} = 1$	$G_{in} = 1$ $OS_{in} = +0$ $XFR = 0.32$ $OS_{out} = +16mA$ $G_{out} = 1/2$	$G_{in} = 1$ $OS_{in} = +0$ $XFR = 0.4$ $OS_{out} = +30mA$ $G_{out} = 1$
0 to 2.5 V	$G_{in} = 4$ $OS_{in} = +0$ $XFR = 0.16$ $OS_{out} = +0$ $G_{out} = 1/8$	$G_{in} = 4$ $OS_{in} = +0$ $XFR = 0.32$ $OS_{out} = -8mA$ $G_{out} = 1/8$	$G_{in} = 4$ $OS_{in} = +0$ $XFR = 0.8$ $OS_{out} = +0$ $G_{out} = 1/2$	$G_{in} = 4$ $OS_{in} = +0$ $XFR = 1$ $OS_{out} = +0$ $G_{out} = 1$	$G_{in} = 4$ $OS_{in} = +0$ $XFR = 0.64$ $OS_{out} = +8mA$ $G_{out} = 1/2$	$G_{in} = 4$ $OS_{in} = +0$ $XFR = 0.8$ $OS_{out} = +10A$ $G_{out} = 1$
0 to 5 V	$G_{in} = 2$ $OS_{in} = +0$ $XFR = 0.16$ $OS_{out} = +0$ $G_{out} = 1/8$	$G_{in} = 2$ $OS_{in} = +0$ $XFR = 0.32$ $OS_{out} = -8mA$ $G_{out} = 1/8$	$G_{in} = 2$ $OS_{in} = +0$ $XFR = 0.8$ $OS_{out} = +0$ $G_{out} = 1/2$	$G_{in} = 2$ $OS_{in} = +0$ $XFR = 1$ $OS_{out} = +0$ $G_{out} = 1$	$G_{in} = 2$ $OS_{in} = +0$ $XFR = 0.64$ $OS_{out} = +8mA$ $G_{out} = 1/2$	$G_{in} = 2$ $OS_{in} = +0$ $XFR = 0.8$ $OS_{out} = +10mA$ $G_{out} = 1$
-5 to 5 V	$G_{in} = 2$ $OS_{in} = +0$ $XFR = 0.08$ $OS_{out} = +4mA$ $G_{out} = 1/8$	$G_{in} = 2$ $OS_{in} = +0$ $XFR = 0.16$ $OS_{out} = +0$ $G_{out} = 1/8$	$G_{in} = 2$ $OS_{in} = +0$ $XFR = 0.4$ $OS_{out} = +20mA$ $G_{out} = 1/2$	$G_{in} = 2$ $OS_{in} = +0$ $XFR = 0.5$ $OS_{out} = +25mA$ $G_{out} = 1$	$G_{in} = 2$ $OS_{in} = +0$ $XFR = 0.32$ $OS_{out} = +16mA$ $G_{out} = 1/2$	$G_{in} = 2$ $OS_{in} = +0$ $XFR = 0.4$ $OS_{out} = +30mA$ $G_{out} = 1$
0 to 10 V	$G_{in} = 1$ $OS_{in} = +0$ $XFR = 0.16$ $OS_{out} = +0$ $G_{out} = 1/8$	$G_{in} = 1$ $OS_{in} = +0$ $XFR = 0.32$ $OS_{out} = -8mA$ $G_{out} = 1/8$	$G_{in} = 1$ $OS_{in} = +0$ $XFR = 0.8$ $OS_{out} = +0$ $G_{out} = 1/2$	$G_{in} = 1$ $OS_{in} = +0$ $XFR = 1$ $OS_{out} = +0$ $G_{out} = 1$	$G_{in} = 1$ $OS_{in} = +0$ $XFR = 0.64$ $OS_{out} = +8mA$ $G_{out} = 1/2$	$G_{in} = 1$ $OS_{in} = +0$ $XFR = 0.8$ $OS_{out} = +10mA$ $G_{out} = 1$

Table 12. Recommended configuration parameter values for TMX and TMR

Input Range (TMX) ↓	Output Range (TMR)			
	0 to 2.5 V @ $R_{in}=200\Omega$	0 to 5 V @ $R_{in}=200\Omega$	-5 to 5 V @ $R_{in}=200\Omega$	0 to 10 V @ $R_{in}=200\Omega$
0 to 1 mA @ $R_{in}=200\Omega$	$G_{in} = 8$ $OS_{in} = +0$ $XFR = 6.25$ $OS_{out} = +0$ $G_{out} = 1/4$	$G_{in} = 8$ $OS_{in} = +0$ $XFR = 6.25$ $OS_{out} = +0$ $G_{out} = 1/2$	$G_{in} = 8$ $OS_{in} = +0$ $XFR = 12.5$ $OS_{out} = -50mA$ $G_{out} = 1/2$	$G_{in} = 8$ $OS_{in} = +0$ $XFR = 6.25$ $OS_{out} = +0$ $G_{out} = 1$
-1 to 1 mA @ $R_{in}=200\Omega$	$G_{in} = 8$ $OS_{in} = +0$ $XFR = 3.125$ $OS_{out} = +25mA$ $G_{out} = 1/4$	$G_{in} = 8$ $OS_{in} = +0$ $XFR = 3.125$ $OS_{out} = +25mA$ $G_{out} = 1/2$	$G_{in} = 8$ $OS_{in} = +0$ $XFR = 6.25$ $OS_{out} = +0$ $G_{out} = 1/2$	$G_{in} = 8$ $OS_{in} = +0$ $XFR = 3.125$ $OS_{out} = +25mA$ $G_{out} = 1$
0 to 20 mA @ $R_{in}=200\Omega$	$G_{in} = 2$ $OS_{in} = +0$ $XFR = 1.25$ $OS_{out} = +0$ $G_{out} = 1/4$	$G_{in} = 2$ $OS_{in} = +0$ $XFR = 1.25$ $OS_{out} = +0$ $G_{out} = 1/2$	$G_{in} = 2$ $OS_{in} = +0$ $XFR = 2.5$ $OS_{out} = -50mA$ $G_{out} = 1/2$	$G_{in} = 2$ $OS_{in} = +0$ $XFR = 1.25$ $OS_{out} = +0$ $G_{out} = 1$
0 to 50 mA @ $R_{in}=200\Omega$	$G_{in} = 1$ $OS_{in} = +0$ $XFR = 1$ $OS_{out} = +0$ $G_{out} = 1/4$	$G_{in} = 1$ $OS_{in} = +0$ $XFR = 1$ $OS_{out} = +0$ $G_{out} = 1/2$	$G_{in} = 1$ $OS_{in} = +0$ $XFR = 2$ $OS_{out} = -50mA$ $G_{out} = 1/2$	$G_{in} = 1$ $OS_{in} = +0$ $XFR = 1$ $OS_{out} = +0$ $G_{out} = 1$
4 to 20 mA @ $R_{in}=200\Omega$	$G_{in} = 2$ $OS_{in} = +1.6V$ $XFR = 1.5625$ $OS_{out} = +0$ $G_{out} = 1/4$	$G_{in} = 2$ $OS_{in} = +1.6V$ $XFR = 1.5625$ $OS_{out} = +0$ $G_{out} = 1/2$	$G_{in} = 2$ $OS_{in} = +1.6V$ $XFR = 3.125$ $OS_{out} = -50mA$ $G_{out} = 1/2$	$G_{in} = 2$ $OS_{in} = +1.6V$ $XFR = 1.5625$ $OS_{out} = +0$ $G_{out} = 1$
10 to 50 mA @ $R_{in}=200\Omega$	$G_{in} = 1$ $OS_{in} = +2V$ $XFR = 1.25$ $OS_{out} = +0$ $G_{out} = 1/4$	$G_{in} = 1$ $OS_{in} = +2V$ $XFR = 1.25$ $OS_{out} = +0$ $G_{out} = 1/2$	$G_{in} = 1$ $OS_{in} = +2V$ $XFR = 2.5$ $OS_{out} = -50mA$ $G_{out} = 1/2$	$G_{in} = 1$ $OS_{in} = +2V$ $XFR = 1.25$ $OS_{out} = +0$ $G_{out} = 1$
0 to 1 mA @ $R_{in}=10k\Omega$	$G_{in} = 1$ $OS_{in} = +0$ $XFR = 1$ $OS_{out} = +0$ $G_{out} = 1/4$	$G_{in} = 1$ $OS_{in} = +0$ $XFR = 1$ $OS_{out} = +0$ $G_{out} = 1/2$	$G_{in} = 1$ $OS_{in} = +0$ $XFR = 2$ $OS_{out} = -50mA$ $G_{out} = 1/2$	$G_{in} = 1$ $OS_{in} = +0$ $XFR = 1$ $OS_{out} = +0$ $G_{out} = 1$
-1 to 1 mA @ $R_{in}=10k\Omega$	$G_{in} = 1$ $OS_{in} = +0$ $XFR = 0.5$ $OS_{out} = +25mA$ $G_{out} = 1/4$	$G_{in} = 1$ $OS_{in} = +0$ $XFR = 0.5$ $OS_{out} = +25mA$ $G_{out} = 1/2$	$G_{in} = 1$ $OS_{in} = +0$ $XFR = 1$ $OS_{out} = +0$ $G_{out} = 1/2$	$G_{in} = 1$ $OS_{in} = +0$ $XFR = 0.5$ $OS_{out} = +25mA$ $G_{out} = 1$
0 to 2.5 V	$G_{in} = 4$ $OS_{in} = +0$ $XFR = 1$ $OS_{out} = +0$ $G_{out} = 1/4$	$G_{in} = 4$ $OS_{in} = +0$ $XFR = 1$ $OS_{out} = +0$ $G_{out} = 1/2$	$G_{in} = 4$ $OS_{in} = +0$ $XFR = 2$ $OS_{out} = -50mA$ $G_{out} = 1/2$	$G_{in} = 4$ $OS_{in} = +0$ $XFR = 1$ $OS_{out} = +0$ $G_{out} = 1$
0 to 5 V	$G_{in} = 2$ $OS_{in} = +0$ $XFR = 1$ $OS_{out} = +0$ $G_{out} = 1/4$	$G_{in} = 2$ $OS_{in} = +0$ $XFR = 1$ $OS_{out} = +0$ $G_{out} = 1/2$	$G_{in} = 2$ $OS_{in} = +0$ $XFR = 2$ $OS_{out} = -50mA$ $G_{out} = 1/2$	$G_{in} = 2$ $OS_{in} = +0$ $XFR = 1$ $OS_{out} = +0$ $G_{out} = 1$
-5 to 5 V	$G_{in} = 2$ $OS_{in} = +0$ $XFR = 0.5$ $OS_{out} = +25mA$ $G_{out} = 1/4$	$G_{in} = 2$ $OS_{in} = +0$ $XFR = 0.5$ $OS_{out} = +25mA$ $G_{out} = 1/2$	$G_{in} = 2$ $OS_{in} = +0$ $XFR = 1$ $OS_{out} = +0$ $G_{out} = 1/2$	$G_{in} = 2$ $OS_{in} = +0$ $XFR = 0.5$ $OS_{out} = +25mA$ $G_{out} = 1$
0 to 10 V	$G_{in} = 1$ $OS_{in} = +0$ $XFR = 1$ $OS_{out} = +0$ $G_{out} = 1/4$	$G_{in} = 1$ $OS_{in} = +0$ $XFR = 1$ $OS_{out} = +0$ $G_{out} = 1/2$	$G_{in} = 1$ $OS_{in} = +0$ $XFR = 2$ $OS_{out} = -50mA$ $G_{out} = 1/2$	$G_{in} = 1$ $OS_{in} = +0$ $XFR = 1$ $OS_{out} = +0$ $G_{out} = 1$

REMOTE CONTROL INTERFACE

When installed in an IMUX 2000 remote controllable shelf, the RFL TMX and TMR modules can be operated under local control using DIP switches, or remote control using either Simple Command Language (SCL) or Network Management Software (NMS). When under remote control, certain configuration parameters can only be changed through the RS-232 remote port on the multiplexer. The remote interface for these modules involves two codes: a “P” (parameter) code, and an “S” (status) code. See the IMUX 2000 instruction manual for more information on the remote control interface.

The RFL TMX reports itself as a “Type 122” module when installed in a T1 or E1 system.
The RFL TMR reports itself as a “Type 123” module when installed in a T1 or E1 system.

REMOTE CONTROL USING SCL

“P” CODES

“P” codes, when used in the parameter field on a “SET” command, allow the user to set certain parameters on the module by remote control, just like setting the switches on a module under local control. “P” codes also appear in the response to a “CONFIG?” query, showing the current parameter settings on the module.

There are eleven “P” codes for the RFL TMX module: P1 through P11 . There are eighteen “P” codes for the RFL TMR module: P1 through P18. Each of these P codes can be a decimal number from 0 to 255, which can also be represented as an eight-digit binary number (in parenthesis). Table 13 describes the meanings of the “P” codes for the RFL TMX module and Table 17 describes the meanings of the “P” codes for the RFL TMR module.

A typical TMX or TMR response to a “CONFIG?” query of a T1 or E1 system looks like this:

*** OK**
CHANNEL CARD 3, TYPE 122 (or 123)
UNDER REMOTE CONTROL
SVCE = ON
P01 = 3 (B00000011)

NOTE

When using binary numbers with a SET command, they must be preceeded by the letter “B” as shown in the following example:

<MULTIPLEXER ADDRESS>:<CARD ADDRESS>:SET:P1 = B00000011;

Besides using the P code, it is also possible to turn module service on or off by sending one of the following in the parameter field with a SET command:

SRVC = ON
SRVC = OFF

For example: **15:C6:SET:SRVC = ON**

Table 13. Remote configuration settings (“P” codes) for RFL TMX module

P Code	Digit(s) And Switch Equivalent	Value *	Description
P1	B 0 0 0 0 0 0 0 0 - - - ↑↑↑↑↑ TIME SLOT SELECT	00001 to 11000 T1 Settings	With LSB on the right, these five bits represent the binary value of the desired time slot between 1 and 24 in a T1 network. See Table 7 for a complete list of these values.
		00001 to 11111 E1 Settings	With LSB on the right, these five bits represent the binary value of the desired time slot between 1 and 31 in an E1 network. See Table 7 for a complete list of these values.
	B 0 0 0 0 0 0 0 0 ↑↑↑ - - - - SPARE	...	Not used.
P2	B 0 0 0 0 0 0 0 0 - - ↑↑↑↑↑↑ TRANSMITTER ADDRESS	000000 to 111111	See Table 8 (TMX address is embedded in transmitted data stream)
	B 0 0 0 0 0 0 0 0 - ↑ - - - - - SPARE	...	Not used.
	B 0 0 0 0 0 0 0 0 ↑ - - - - - TERMINAL/DIA or DIB	0	DIB
		1	Terminal/DIA
P3	B 0 0 0 0 0 0 0 0 - - - - - ↑↑↑ CALIBRATOR SELECT	000	Live data on all analog channels
		001	Calibration data on analog channel 1 only
		010	Calibration data on analog channel 2 only
		011	Calibration data on analog channel 3 only
		100	Calibration data on analog channel 4 only
	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑ - - - SPARE	...	Not used.
P4	B 0 0 0 0 0 0 0 0 - - - - - ↑↑↑ ANALOG CHANNEL 1 INPUT GAIN SELECT	000	Input gain = 1
		001	Input gain = 2
		010	Input gain = 4
		011	Input gain = 8
	B 0 0 0 0 0 0 0 0 - - - - ↑ - - - ANALOG CHANNEL 1 OFFSET POLARITY	0	Positive polarity
		1	Negative polarity
	B 0 0 0 0 0 0 0 0 - ↑↑↑ - - - - ANALOG CHANNEL 2 INPUT GAIN SELECT	000	Input gain = 1
		001	Input gain = 2
		010	Input gain = 4
		011	Input gain = 8
	B 0 0 0 0 0 0 0 0 ↑ - - - - - ANALOG CHANNEL 2 OFFSET POLARITY	0	Positive polarity
		1	Negative polarity

Table 13. continued - Remote configuration settings (“P” codes) for RFL TMX module

P Code	Digit(s) And Switch Equivalent	Value *	Description
P5	B 0 0 0 0 0 0 0 0 - - - - - ↑↑↑	000	Input gain = 1
	ANALOG CHANNEL 3 INPUT GAIN SELECT	001	Input gain = 2
		010	Input gain = 4
		011	Input gain = 8
	B 0 0 0 0 0 0 0 0 - - - - - ↑ - - -	0	Positive polarity
	ANALOG CHANNEL 3 OFFSET POLARITY	1	Negative polarity
	B 0 0 0 0 0 0 0 0 - ↑↑↑ - - - -	000	Input gain = 1
	ANALOG CHANNEL 4 INPUT GAIN SELECT	001	Input gain = 2
		010	Input gain = 4
		011	Input gain = 8
	B 0 0 0 0 0 0 0 0 ↑ - - - - -	0	Positive polarity
	ANALOG CHANNEL 4 OFFSET POLARITY	1	Negative polarity
P6	B 0 0 0 0 0 0 0 0 - - - - - ↑↑↑	000 to 111	See table 14
	ANALOG CHANNEL 1 FIXED DATA LEVEL SELECTOR		
	B 0 0 0 0 0 0 0 0 - - - - - ↑ - - -	0	Connects analog channel 1 to live data
	ANALOG CHANNEL 1 FIXED LEVEL SWITCH	1	Forces analog channel 1 data to fixed level at A/D converter.
	B 0 0 0 0 0 0 0 0 - ↑↑↑ - - - -	000 to 111	See table 14
	ANALOG CHANNEL 2 FIXED DATA LEVEL SELECTOR		
P7	B 0 0 0 0 0 0 0 0 - - - - - ↑↑↑	000 to 111	See table 14
	ANALOG CHANNEL 3 FIXED DATA LEVEL SELECTOR		
	B 0 0 0 0 0 0 0 0 - - - - - ↑ - - -	0	Connects analog channel 3 to live data
	ANALOG CHANNEL 3 FIXED LEVEL SWITCH	1	Forces analog channel 3 data to fixed level at A/D converter.
	B 0 0 0 0 0 0 0 0 - ↑↑↑ - - - -	000 to 111	See table 14
	ANALOG CHANNEL 4 FIXED DATA LEVEL SELECTOR		
	B 0 0 0 0 0 0 0 0 ↑ - - - - -	0	Connects analog channel 4 to live data
	ANALOG CHANNEL 4 FIXED LEVEL SWITCH	1	Forces analog channel 4 data to fixed level at A/D converter.

Table 13. continued - Remote configuration settings (“P” codes) for RFL TMX module

P Code	Digit(s) And Switch Equivalent	Value ^(1, 2)	Description
P8	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑↑↑↑ ANALOG CHANNEL 1 OFFSET MAGNITUDE AFTER GAIN	00000000 to 11111111 (0 decimal to 255 decimal)	See Table 15
P9	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑↑↑↑ ANALOG CHANNEL 2 OFFSET MAGNITUDE AFTER GAIN	00000000 to 11111111 (0 decimal to 255 decimal)	See Table 15
P10	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑↑↑↑ ANALOG CHANNEL 3 OFFSET MAGNITUDE AFTER GAIN	00000000 to 11111111 (0 decimal to 255 decimal)	See Table 15
P11	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑↑↑↑ ANALOG CHANNEL 1 OFFSET MAGNITUDE AFTER GAIN	00000000 to 11111111 (0 decimal to 255 decimal)	See Table 15

1. These are the only legal values for setting the parameters. Setting any parameter to a value outside its specified range will produce an unpredictable result.
2. When the module is switched to local mode, the values of P-Codes P8 through P11 are set to zero.

Table 14. TMX Fixed selector parameter values for analog channels 1, 2, 3 and 4

Fixed selector in REMOTE mode	000	001	010	011	100	101	110	111
Fixed selector in LOCAL mode				DIP=1 *				
% bipolar of -10V to +10V	-100%	-80%	-50%	0	+16%	+50%	+80%	+100%
Equivalent input at gain=1 in Volts	-10V	-8V	-5V	0V	+1.6V	+5V	+8V	+10V

* This is the only selection available in local mode. It is set using DIP switch SW4-8 for analog channel 1, SW4-7 for analog channel 2, SW4-6 for analog channel 3, and SW4-5 for analog channel 4 (See Table 2).

Table 15. Analog channel 1, 2, 3 & 4 input offset magnitudes for TMX

Offset setting in binary								Decimal Equivalent Of setting	Multiplier	Offset Magnitude In mV ^(1,2)
bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0			
0	0	0	0	0	0	0	0	0	x 40 mV	0
0	0	0	0	0	0	0	1	1	x 40 mV	40
0	0	0	0	0	0	1	0	2	x 40 mV	80
0	0	0	0	0	0	1	1	3	x 40 mV	120
0	0	0	0	0	1	0	0	4	x 40 mV	160
0	0	0	0	0	1	0	1	5	x 40 mV	200
⋮ ↓										⋮ ↓
1	1	1	1	1	0	1	0	250	x 40 mV	10,000
1	1	1	1	1	0	1	1	251	x 40 mV	10,040
1	1	1	1	1	1	0	0	252	x 40 mV	10,080
1	1	1	1	1	1	0	1	253	x 40 mV	10,120
1	1	1	1	1	1	1	0	254	x 40 mV	10,160
1	1	1	1	1	1	1	1	255	x 40 mV	10,200

Table 16. Analog channel 1, 2, 3 & 4 output offset magnitudes for TMR

Offset setting in binary								Decimal Equivalent Of setting	Multiplier	Offset Magnitude In mA ^(1,2)
bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0			
0	0	0	0	0	0	0	0	0	x 200 μ A	0
0	0	0	0	0	0	0	1	1	x 200 μ A	0.2
0	0	0	0	0	0	1	0	2	x 200 μ A	0.4
0	0	0	0	0	0	1	1	3	x 200 μ A	0.6
0	0	0	0	0	1	0	0	4	x 200 μ A	0.8
0	0	0	0	0	1	0	1	5	x 200 μ A	1.0
⋮ ↓										⋮ ↓
1	1	1	1	1	0	1	0	250	x 200 μ A	50.0
1	1	1	1	1	0	1	1	251	x 200 μ A	50.2
1	1	1	1	1	1	0	0	252	x 200 μ A	50.4
1	1	1	1	1	1	0	1	253	x 200 μ A	50.6
1	1	1	1	1	1	1	0	254	x 200 μ A	50.8
1	1	1	1	1	1	1	1	255	x 200 μ A	51.0

Notes for Tables 15 and 16:

1. In the TMX, the offset value (magnitude and polarity) will be subtracted from the data generated by the A/D converter. The input offset magnitude setting equals the number of 40mV increments.
2. In the TMR, the offset value (magnitude and polarity) will be added to the data sent to the D/A converter. The output offset magnitude setting equals the number of 200 μ A increments.

Table 17. Remote configuration settings (“P” codes) for RFL TMR module

P Code	Digit(s) And Switch Equivalent	Value ⁽¹⁾	Description
P1	B 0 0 0 0 0 0 0 0 - - - ↑↑↑↑↑ TIME SLOT SELECT	00001 to 11000 T1 Settings	With LSB on the right, these five bits represent the binary value of the desired time slot between 1 and 24 in a T1 network. See Table 7 for a complete list of these values.
		00001 to 11111 E1 Settings	With LSB on the right, these five bits represent the binary value of the desired time slot between 1 and 31 in an E1 network. See Table 7 for a complete list of these values.
	B 0 0 0 0 0 0 0 0 ↑↑↑ - - - - - SPARE	...	Not used.
P2	B 0 0 0 0 0 0 0 0 - - ↑↑↑↑↑↑ TRANSMITTER ADDRESS	000000 to 111111	See Table 8 (000000 = address test disabled) TMR address to be compared to address embedded in received data stream.
	B 0 0 0 0 0 0 0 0 - ↑ - - - - - SPARE	...	Not used.
	B 0 0 0 0 0 0 0 0 ↑ - - - - - - TERMINAL/DIA or DIB	0	DIB
		1	Terminal/DIA

1. These are the only legal values for setting the parameters. Setting any parameter to a value outside its specified range will produce an unpredictable result.

Table 17. continued - Remote configuration settings (“P” codes) for RFL TMR module

P Code	Digit(s) And Switch Equivalent	Value ⁽¹⁾	Description
P3	B 0 0 0 0 0 0 0 0 - - - - - ↑ ↑ ↑ ANALOG CHANNEL 1 FIXED DATA LEVEL SELECTOR	000 to 111	See Table 18
	B 0 0 0 0 0 0 0 0 - - - - - ↑ - - - ANALOG CHANNEL 1 FIXED LEVEL SWITCH	0	Connects analog channel 1 to live data
		1	Forces analog channel 1 data to fixed level at the D/A converter
	B 0 0 0 0 0 0 0 0 - - ↑ ↑ - - - - ANALOG CHANNEL 1 LOSS OF SIGNAL OUTPUT SELECTOR	00 to 11	See Table 19
	B 0 0 0 0 0 0 0 0 ↑ ↑ - - - - - ANALOG CHANNEL 1 OUTPUT GAIN SELECTOR	00	Output gain = 1
		01	Output gain = 1/2
		10	Output gain = 1/4
		11	Output gain = 1/8
P4	B 0 0 0 0 0 0 0 0 ↑ ↑ ↑ ↑ ↑ ↑ ↑ ↑ ANALOG CHANNEL 1 LS BYTE OF TRANSFER RATIO	00000000 to 11111111 (0 to 255 decimal)	See Table 20
P5	B 0 0 0 0 0 0 0 0 - ↑ ↑ ↑ ↑ ↑ ↑ ↑ ANALOG CHANNEL 1 MS BYTE OF TRANSFER RATIO	00000000 to 11111111 (0 to 127 decimal)	See Table 20
	B 0 0 0 0 0 0 0 0 ↑ - - - - - - ANALOG CHANNEL 1 POLARITY OF OUTPUT OFFSET	0	Positive polarity offset
		1	Negative polarity offset
P6	B 0 0 0 0 0 0 0 0 ↑ ↑ ↑ ↑ ↑ ↑ ↑ ↑ ANALOG CHANNEL 1 MAGNITUDE OF OUTPUT OFFSET	00000000 to 11111111 (0 to 255 decimal)	See Table 16

Table 17. continued - Remote configuration settings (“P” codes) for RFL TMR module

P Code	Digit(s) And Switch Equivalent	Value ⁽¹⁾	Description
P7	B 0 0 0 0 0 0 0 0 - - - - - ↑↑↑ ANALOG CHANNEL 2 FIXED DATA LEVEL SELECTOR	000 to 111	See Table 18
	B 0 0 0 0 0 0 0 0 - - - - - ↑ - - - ANALOG CHANNEL 2 FIXED LEVEL SWITCH	0	Connects analog channel 1 to live data
		1	Forces analog channel 1 data to fixed level at the D/A converter.
	B 0 0 0 0 0 0 0 0 - - ↑↑ - - - - ANALOG CHANNEL 2 LOSS OF SIGNAL OUTPUT SELECTOR	00 to 11	See Table 19
	B 0 0 0 0 0 0 0 0 ↑↑ - - - - - ANALOG CHANNEL 2 OUTPUT GAIN SELECTOR	00	Output gain = 1
		01	Output gain = 1/2
		10	Output gain = 1/4
		11	Output gain = 1/8
P8	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑↑↑↑ ANALOG CHANNEL 2 LS BYTE OF TRANSFER RATIO	00000000 to 11111111 (0 to 255 decimal)	See Table 20
P9	B 0 0 0 0 0 0 0 0 - ↑↑↑↑↑↑↑↑ ANALOG CHANNEL 2 MS BYTE OF TRANSFER RATIO	00000000 to 11111111 (0 to 127 decimal)	See Table 20
	B 0 0 0 0 0 0 0 0 ↑ - - - - - ANALOG CHANNEL 2 POLARITY OF OUTPUT OFFSET	0	Positive polarity offset
		1	Negative polarity offset
P10	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑↑↑↑ ANALOG CHANNEL 2 MAGNITUDE OF OUTPUT OFFSET	00000000 to 11111111 (0 to 255 decimal)	See Table 16

Table 17. continued - Remote configuration settings (“P” codes) for RFL TMR module

P Code	Digit(s) And Switch Equivalent	Value ⁽¹⁾	Description
P11	B 0 0 0 0 0 0 0 0 - - - - - ↑↑↑ ANALOG CHANNEL 3 FIXED DATA LEVEL SELECTOR	000 to 111	See Table 18
	B 0 0 0 0 0 0 0 0 - - - - - ↑ - - - ANALOG CHANNEL 3 FIXED LEVEL SWITCH	0	Connects analog channel 1 to live data
		1	Forces analog channel 1 data to fixed level at the D/A converter
	B 0 0 0 0 0 0 0 0 - - ↑↑ - - - - ANALOG CHANNEL 3 LOSS OF SIGNAL OUTPUT SELECTOR	00 to 11	See Table 19
	B 0 0 0 0 0 0 0 0 ↑↑ - - - - - ANALOG CHANNEL 3 OUTPUT GAIN SELECTOR	00	Output gain = 1
		01	Output gain = 1/2
		10	Output gain = 1/4
		11	Output gain = 1/8
P12	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑↑↑↑ ANALOG CHANNEL 3 LS BYTE OF TRANSFER RATIO	00000000 to 11111111 (0 to 255 decimal)	See Table 20
P13	B 0 0 0 0 0 0 0 0 - ↑↑↑↑↑↑↑↑ ANALOG CHANNEL 3 MS BYTE OF TRANSFER RATIO	00000000 to 11111111 (0 to 127 decimal)	See Table 20
	B 0 0 0 0 0 0 0 0 ↑ - - - - - ANALOG CHANNEL 3 POLARITY OF OUTPUT OFFSET	0	Positive polarity offset
		1	Negative polarity offset
P14	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑↑↑↑ ANALOG CHANNEL 3 MAGNITUDE OF OUTPUT OFFSET	00000000 to 11111111 (0 to 255 decimal)	See Table 16

Table 17. continued - Remote configuration settings (“P” codes) for RFL TMR module

P Code	Digit(s) And Switch Equivalent	Value ⁽¹⁾	Description
P15	B 0 0 0 0 0 0 0 0 - - - - - ↑↑↑ ANALOG CHANNEL 4 FIXED DATA LEVEL SELECTOR	000 to 111	See Table 18
	B 0 0 0 0 0 0 0 0 - - - - - ↑ - - - ANALOG CHANNEL 4 FIXED LEVEL SWITCH	0	Connects analog channel 1 to live data
		1	Forces analog channel 1 data to fixed level at the D/A converter.
	B 0 0 0 0 0 0 0 0 - - ↑↑ - - - - ANALOG CHANNEL 4 LOSS OF SIGNAL OUTPUT SELECTOR	00 to 11	See Table 19
	B 0 0 0 0 0 0 0 0 ↑↑ - - - - - ANALOG CHANNEL 4 OUTPUT GAIN SELECTOR	00	Output gain = 1
		01	Output gain = 1/2
		10	Output gain = 1/4
		11	Output gain = 1/8
P16	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑↑↑↑ ANALOG CHANNEL 4 LS BYTE OF TRANSFER RATIO	00000000 to 11111111 (0 to 255 decimal)	See Table 20
P17	B 0 0 0 0 0 0 0 0 - ↑↑↑↑↑↑↑↑ ANALOG CHANNEL 4 MS BYTE OF TRANSFER RATIO	00000000 to 11111111 (0 to 127 decimal)	See Table 20
	B 0 0 0 0 0 0 0 0 ↑ - - - - - ANALOG CHANNEL 4 POLARITY OF OUTPUT OFFSET	0	Positive polarity offset
		1	Negative polarity offset
P18	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑↑↑↑ ANALOG CHANNEL 4 MAGNITUDE OF OUTPUT OFFSET	00000000 to 11111111 (0 to 255 decimal)	See Table 16

Table 18. TMR Fixed selector parameter values for analog channels 1, 2, 3 and 4

Fixed selector in REMOTE mode	000	001	010	011	100	101	110	111
Fixed selector in LOCAL mode	DIP=0 *							DIP=1 *
% bipolar of -50 mA to +50 mA	-100%	-80%	-50%	0	+16%	+50%	+80%	+100%
Equivalent output at gain=1 in mA	-50 mA	-40 mA	-25 mA	0 mA	+8 mA	+25 mA	+40 mA	+50 mA

* These are the only selections available in local mode, and are set using DIP switch SW4-6 for analog channel 1, SW5-6 for analog channel 2, SW6-6 for analog channel 3, and SW7-6 for analog channel 4 (See Table 10).

Table 19. TMR loss of signal parameter values

LOS Remote	00	01	10	11
LOS Local	DIP=0 *		DIP=1 *	
% bipolar of -50 mA to +50 mA	Previous value	-100%	0%	+100%
Equivalent output at gain=1 in mA	Previous value	-50 mA	0 mA	+50 mA

* These are the only selections available in local mode, and are set using DIP switch SW4-4 for analog channel 1, SW5-4 for analog channel 2, SW6-4 for analog channel 3, and SW7-4 for analog channel 4 (See Table 10).

Table 20. Analog channel transfer ratio values

Transfer Ratio Setting in Binary ⁽¹⁾															Decimal Equiv- alent	Multi- plier	Trans- fer Ratio value
Most Significant Byte							Least Significant Byte										
bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0			
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	x 1/2048	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	x 1/2048	1/2048
0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	x 1/2048	2/2048
0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	3	x 1/2048	3/2048
0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	4	x 1/2048	4/2048
⋮ ↓																	⋮ ↓
0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1024	x 1/2048	1/2
⋮ ↓																	⋮ ↓
0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2048	x 1/2048	1
⋮ ↓																	⋮ ↓
0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	4096	x 1/2048	2
⋮ ↓																	⋮ ↓
1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	32,764	x 1/2048	15 $\frac{2044}{2048}$
1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	32,765	x 1/2048	15 $\frac{2045}{2048}$
1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	32,766	x 1/2048	15 $\frac{2046}{2048}$
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	32,767	x 1/2048	15 $\frac{2047}{2048}$

1. The actual transfer ratio setting is a 15-bit value made up of a 7-bit section (MSB) and an 8-bit section (LSB).
2. The transfer ratio setting represents the number of 1/2048 increments.

“S” CODES

“S” codes appear in response to a “STATUS?” query. There are nine “S” codes for the RFL TMX module: S1 through S9, and five “S” codes for the RFL TMR module: S1 through S5. Like the “P” codes, these numbers are displayed in both decimal and binary form.

A typical TMX response to a “STATUS?” query looks like this:

*** OK**
CHANNEL CARD 3, TYPE 123
S01 = 3 (B00000011);

Table 21. Remote status messages (“S” codes) for the RFL TMX module

S Code	Position	Value	Description
S1	B 0 0 0 0 0 0 0 0 - - - - - ↑	0	T1 is detected
	T1/E1 AUTO DETECT	1	E1 is detected
	B 0 0 0 0 0 0 0 0 - - - - - ↑ -	0	SCB configuration errors not detected
	SCB CONFIGURATION	1	SCB configuration errors detected
S2	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑↑↑↑ ANALOG CHANNEL 1 LSB	MSB { 1111 1111 } LSB { 1111 1111 } to	LS byte of analog channel 1 data in signed magnitude format
S3	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑↑↑↑ ANALOG CHANNEL 1 MSB	0111 1111 { 1111 1111 } { ↑ MSB LSB SIGN BIT	MS byte of analog channel 1 data in signed magnitude format

Table 21. continued - Remote status messages (“S” codes) for the RFL TMX module

S Code	Position	Value	Description
S4	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑↑↑↑ ANALOG CHANNEL 2 LSB	MSB LSB 1111 1111 1111 1111 to	LS byte of analog channel 2 data in signed magnitude format
S5	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑↑↑↑ ANALOG CHANNEL 2 MSB	0111 1111 1111 1111 MSB LSB ↑ SIGN BIT	MS byte of analog channel 2 data in signed magnitude format
S6	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑↑↑↑ ANALOG CHANNEL 3 LSB	MSB LSB 1111 1111 1111 1111 to	LS byte of analog channel 3 data in signed magnitude format
S7	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑↑↑↑ ANALOG CHANNEL 3 MSB	0111 1111 1111 1111 MSB LSB ↑ SIGN BIT	MS byte of analog channel 3 data in signed magnitude format
S8	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑↑↑↑ ANALOG CHANNEL 4 LSB	MSB LSB 1111 1111 1111 1111 to	LS byte of analog channel 4 data in signed magnitude format
S9	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑↑↑↑ ANALOG CHANNEL 4 MSB	0111 1111 1111 1111 MSB LSB ↑ SIGN BIT	MS byte of analog channel 4 data in signed magnitude format

Table 22. Remote status messages (“S” codes) for the RFL TMR module

S Code	Position	Value	Description
S1	B 0 0 0 0 0 0 0 0 - - - - - ↑	0	T1 is detected
	T1/E1 AUTO DETECT	1	E1 is detected
	B 0 0 0 0 0 0 0 0 - - - - - ↑ -	0	SCB configuration correct
	SCB CONFIGURATION	1	SCB configuration errors detected
	B 0 0 0 0 0 0 0 0 - - - - - ↑ - -	0	TMX and TMR addresses do not match
	ADDRESS TEST RESULT	1	TMX and TMR addresses do match or address test disabled (See P2 TMR code)
	B 0 0 0 0 0 0 0 0 - - - - ↑ - - -	0	Data frame lock not achieved
	TELEMETRY FRAME SYNC	1	Data frame lock achieved
	B 0 0 0 0 0 0 0 0 - - - ↑ - - - -	0	Correct status
	TPU SIGNAL (common module loss of frame alignment signal)	1	Incorrect status
S2	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑↑↑↑	1111 1111 to 0111 1111	MS byte of received analog channel 1 transmitter data in signed magnitude format.
S3	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑↑↑↑	1111 1111 to 0111 1111	MS byte of received analog channel 2 transmitter data in signed magnitude format.
S4	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑↑↑↑	1111 1111 to 0111 1111	MS byte of received analog channel 3 transmitter data in signed magnitude format.
S5	B 0 0 0 0 0 0 0 0 ↑↑↑↑↑↑↑↑	1111 1111 to 0111 1111	MS byte of received analog channel 4 transmitter data in signed magnitude format.

REMOTE CONTROL USING NMS

PROGRAMMING THE TMX MODULE

Refer to the IMUX 2000 or IMUX 2000E Instruction Manuals for information on using NMS. While in NMS, select the “View or Change a Card” screen for the TMX module. An NMS window will be seen similar to the one shown in Figure 6. You must scroll down the parameter list to see all of the parameters. Select and set each parameter as required by double clicking on the desired parameter name. For example, double click on the “Timeslot” parameter, and a dialog box will appear with all available time slot choices. Click on the desired time slot number to make your selection. Then click on “OK” to confirm your selection. This will return you to the parameter window.

Note that the “Input Offset Magnitude” dialog box accepts numbers from 0 to 255. Each number represents an increment of 40mV. For reference see Table 15.

After all TMX parameter selections have been made they must be written to the TMX card in the network. This is done by using the “WRITE” operation as described in Section 7 of The IMUX 2000 Instruction Manual.

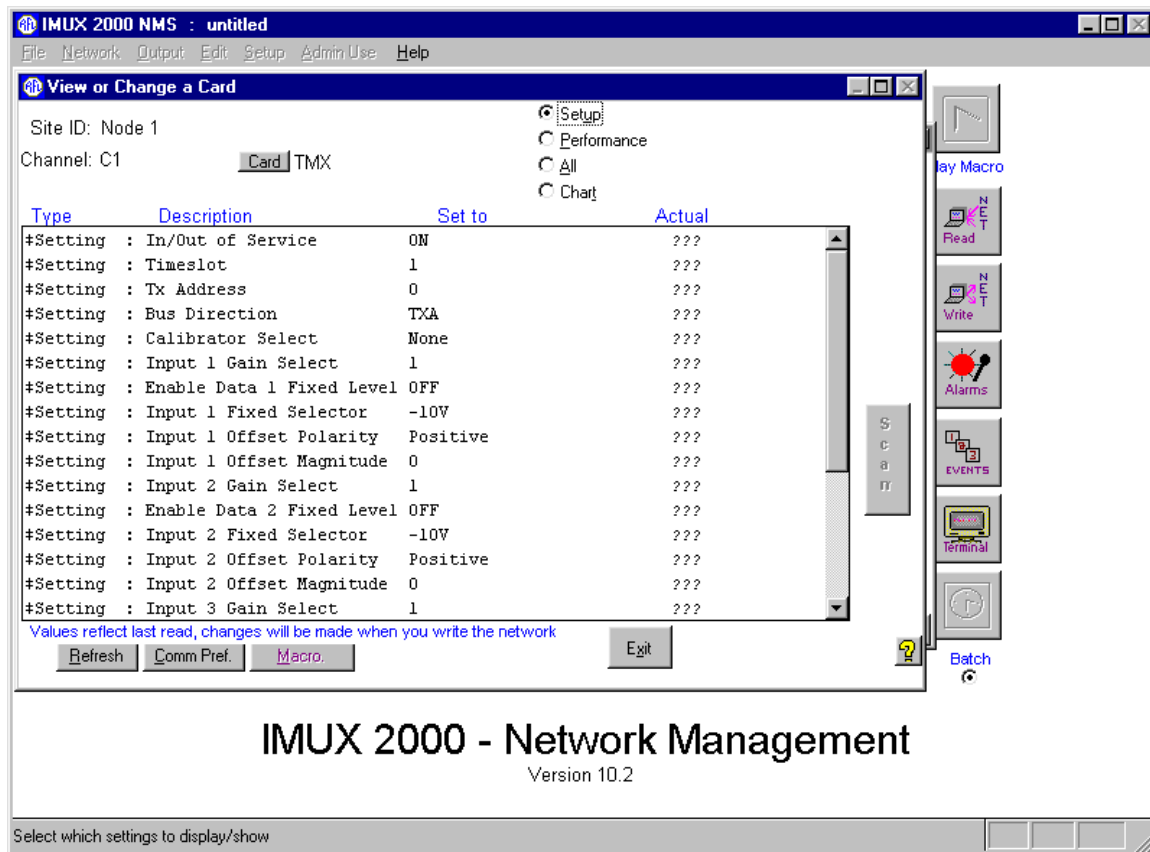


Figure 6. Typical NMS TMX window

PROGRAMMING THE TMR MODULE

Refer to the IMUX 2000 or IMUX 2000E Instruction Manuals for information on using NMS. While in NMS select the “View or Change a Card” screen for the TMR module. An NMS window will be seen similar to the one shown in Figure 7. You must scroll down the parameter list to see all of the parameters. Select and set each parameter as required by double clicking on the desired parameter name. For example, double click on the “Timeslot” parameter, and a dialog box will appear with all available time slot choices. Click on the desired time slot number to make your selection. Then click on “OK” to confirm your selection. This will return you to the parameter window.

Note that the “Output Offset Magnitude” dialog box accepts numbers from 0 to 255. Each number represents an increment of 200 μ A. For reference see Table 16.

To select the “Output XFR Ratio” parameter proceed as follows:

Let’s say that you want to select a Transfer Ratio Value (XFR) of 2. By referring to Table 20 you will see that an XFR of 2 is equivalent to $4096 \times (1/2048)$. The equivalent parameter setting = 4096 increments, where each increment is = $1/2048$. This number (4096) must be converted to 15-bit binary format. For this example the binary representation of 4096 is (001 0000 0000 0000). Divide this number into a 7-bit MSB section and an 8-bit LSB section. The MSB section = (010 0000) and the LSB section = (0000 0000).

The MSB must be entered into the “Output 1 XFR Ratio MS Byte” dialog box in decimal format. For this example enter the number “16” for the MSB.

The LSB must be entered into the “Output 1 XFR Ratio LS Byte” dialog box in decimal format. For this example enter the number “0” for the MSB.

After all TMR parameter selections have been made they must be written to the TMR card in the network. This is done by using the “WRITE” operation as described in Section 7 of The IMUX 2000 Instruction Manual.

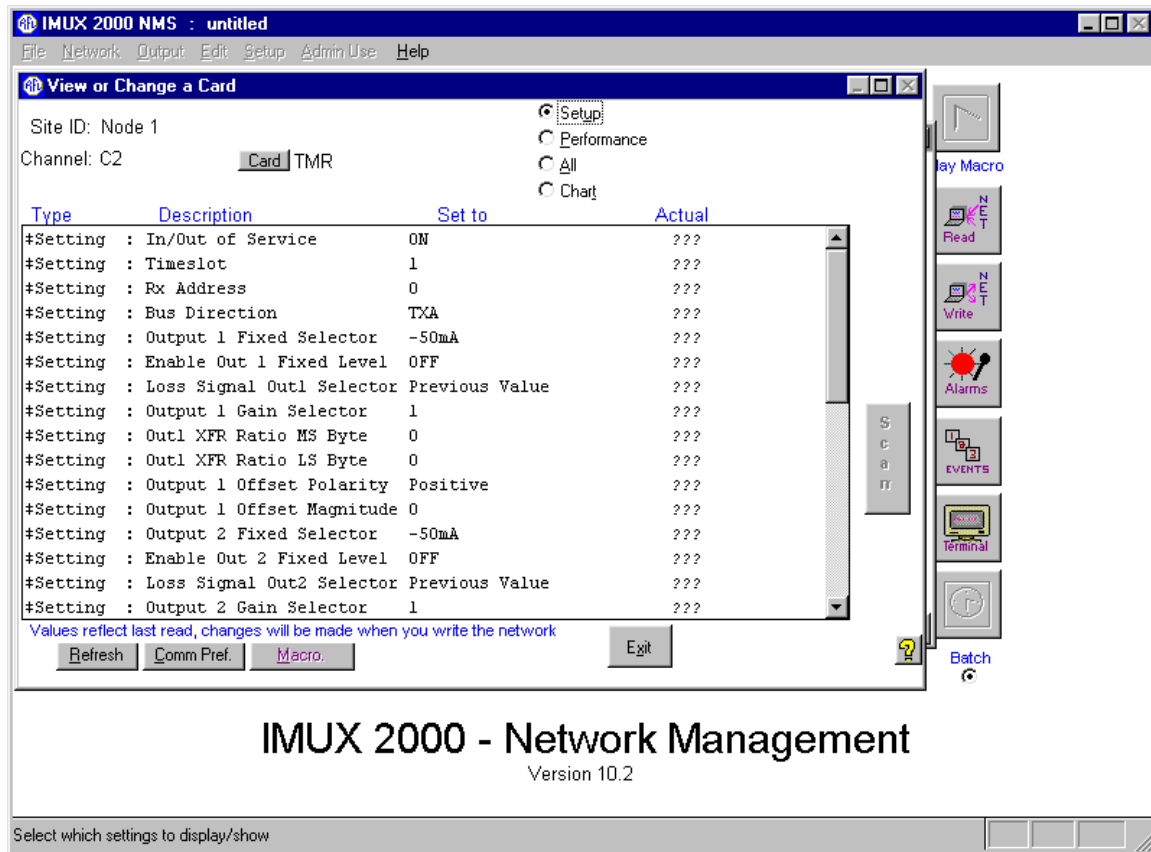


Figure 7. Typical NMS TMR window

TESTING

After the RFL TMX and TMR modules have been configured, they should be tested for proper operation before they are put into service. Since the TMX transmits only and the TMR receives only the verification test must be performed with both modules installed in their respective IMUX 2000 equipment shelves.

EQUIPMENT SETUP

1. Install the TMX and TMR modules into their respective RFL IMUX 2000 shelves.
2. Activate both IMUX 2000 chassis and verify that the Common Modules are communicating with each other.
3. Program all required TMX and TMR operating parameters.

VERIFICATION TEST

1. Place both modules in service and confirm that the modules communicate with each other by verifying that all status LEDs on both modules are green.
2. Interrupt communications by either setting the TMX service to OFF or by disconnecting the communication link between the IMUX 2000 shelves.
3. Verify on the TMR that the “Address” and “Lock” LEDs turn off and the Frame Alert Relay picks up when the communication link is broken.
4. Verify that the opposite happens when the link is re-established.
5. Verify individually each analog channel in use by doing the following:
 - a. At the TMX, apply at least two different values of input signal within the operating range, preferably at both extremes of the input range.
 - b. Calculate the expected output values at the TMR corresponding to these input signals.
 - c. Compare the calculated output value with the measured output value at the TMR. They should be the same.
6. The TMX and TMR modules may now be placed in service.

TROUBLESHOOTING

If there is an apparent malfunction, first check that the configuration is appropriate for the transmission system in use, and that the transmit and receive configurations are compatible.

Problems may occur at the common equipment or facility level that may affect the operation of this module. Refer to the “Maintenance “ section in your multiplexer manual for system analysis procedures.

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SECTION 19. VIDEO MODULES

This section contains Instruction Data Sheets for all video modules available for use with the IMUX 2000 Intelligent Multiplexer, as of the date this manual was printed:

- o **IMUX 2000 Variable Video System**

Additional schematics, wiring diagrams, or other documents specific to your application may also be placed in this section.

For information on other protection modules that may be available for use with your IMUX 2000, contact the factory or an RFL Sales Representative.

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RFL Electronics Inc.

INSTRUCTION DATA

IMUX 2000 Variable Video System

OVERVIEW

The IMUX Variable Video System is a two module set that allows transmission of standard video signals over the IMUX 2000. One of the modules, the VS-100, accepts standard NTSC or PAL video and compresses it for transmission. The other module, the DS64NC, multiplexes the signal onto the T1 path and provides for remote programmability of the data rate. A matching set of modules at the receiver demultiplexes and uncompresses the video. The output of the receiver can be connected to any standard video monitor.

The VVS occupies up to 3 card slots and can use from 1 to 31 timeslots on the T1 or E1 stream. The resolution and quality of the video is set using switches on the VS 100 module. The bandwidth occupied by the system determines the frame rate and is set either through switches on the DS64NC or remotely using the NMS software. The data rate can be changed dynamically to match the requirements of the user.

COMPONENTS

The IMUX Variable Video System contains the following components:

VS100 (106870)

An IMUX channel card (two slots wide) that carries the video Codec. It is a mounting and interconnection board. There is one bank of switches on the board to select video settings. In addition there are two toggle switches. These settings are not remotely programmable.

MA800 (106875)

This Module Adapter plugs in opposite the VS100. It is also a double width module. It has 3 BNC connectors, one DB9, and a two position terminal block. Only one BNC is currently active. It is the video input or output depending on the Codec settings. The DB9 is the RS449 connection into the DS64NC. The terminal block will be for external power when required.

DS64NC (9547-1686)

The DS64NC is used to transport the RS449 data over the T1. The speed of the video will be set by the settings on this module (remotely programmable).

MA412 (9547-1731)

This is the standard RS449 Module Adapter for the DS64NC.

Video System Cable (106880)

A cable is supplied for inter connection between the MA800 and MA412. It is about 6' long with a DB9 on one end and a DB37 on the other end.

CONTROLS & INDICATORS

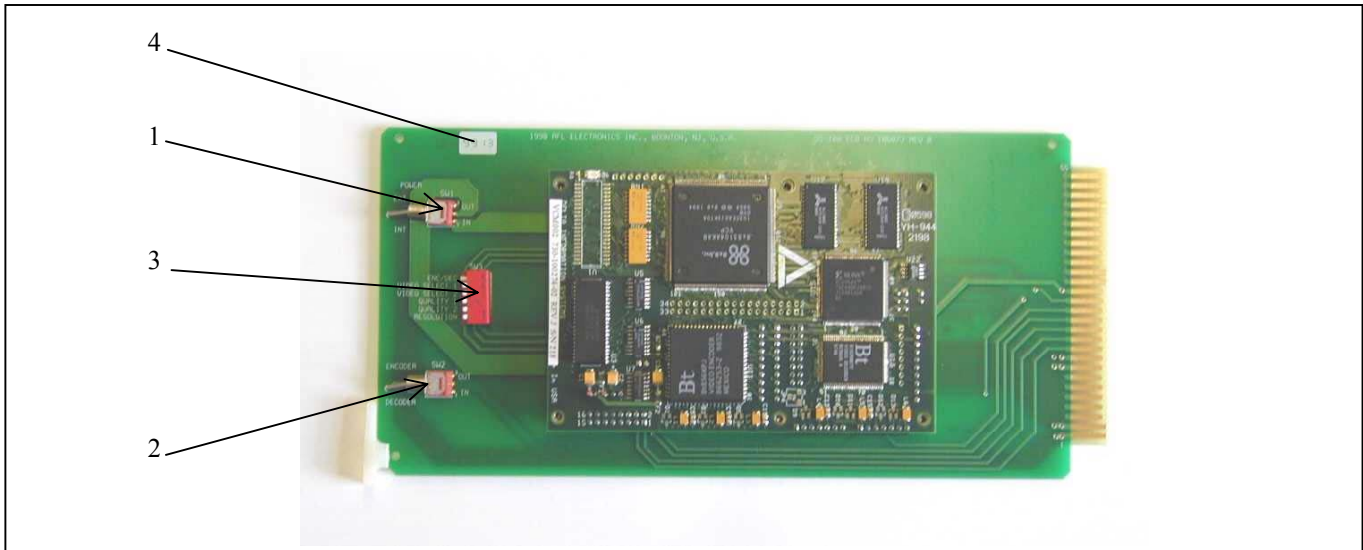


Figure 1. Location of controls and indicators on VS100 module

Table 1. Controls and indicators on the VS100

Item	Name/Description	Function
1	External Power SW1	Up configures unit for external +5V power Down configures unit to use internal power
2	Encoder/Decoder SW2 Must be set before power is applied	Up configures unit as an encoder Down configures unit as a decoder
3	Configuration SW3 ENC/DEC SW3-1 Must be set before power is applied	Position closest to PCB is closed Closed configures unit as a decoder (must match SW2)
	Configuration SW3 VIDEO SELECT 1 SW3-2 VIDEO SELECT 2 SW3-3 Set only on encoder, settings have no effect on decoder unit.	Position closest to PCB is closed Future use (must be open) Future use (must be open)
	Configuration SW3 QUALITY 1 SW3-4 QUALITY 2 SW3-5 Settings affect low speed operation only. Set only on encoder, settings have no effect on decoder unit.	Position closest to PCB is closed – see following table IMAGE QUALITY SW3-4 SW3-5 BEST closed closed BETTER open closed GOOD closed open FAIR open open
	Configuration SW3 RESOLUTION SW3-6 Settings affect low speed operation only. Set only on encoder, settings have no effect on decoder unit.	Position closest to PCB is closed Closed = 176x144, Open = 352x288
4	Green LED “D6”	There is only one indicator on the VS-100. The green LED “D6” on the daughter board will illuminate steadily when the module is working correctly. If the LED is off the module is defective or is not receiving power. If the LED is blinking then an error condition exists.

The controls and indicators on the DS64NC are described in the IMUX 2000 Operators Manual.

SPECIFICATIONS

Configuration	One video channel per card
Video Input	NTSC Composite / PAL Composite
Frame rate	1-20 fps dependent on bandwidth
Bandwidth required	64-2048 kb/s
Resolution	352x288
Compression Algorithm	ITU H.261
Power Consumption	1.75A @5V
Chassis Space required	3 IMUX module slots
Video Interface	1 BNC Connector
External Power Option	5V +/- 5% pluggable terminal block
Temperature & Humidity	-20 °C to +55°C, 0-95% relative humidity, non-condensing

EXTERNAL POWER REQUIREMENTS

The Codec and therefore the VS100 draws a lot of current from the +5V. Users must ensure that at least 1.75 A is available in the IMUX chassis for each VS100. External +5V connections are available on the MA800 for systems where the draw exceeds the power supply capability.

SYSTEM DIAGRAM

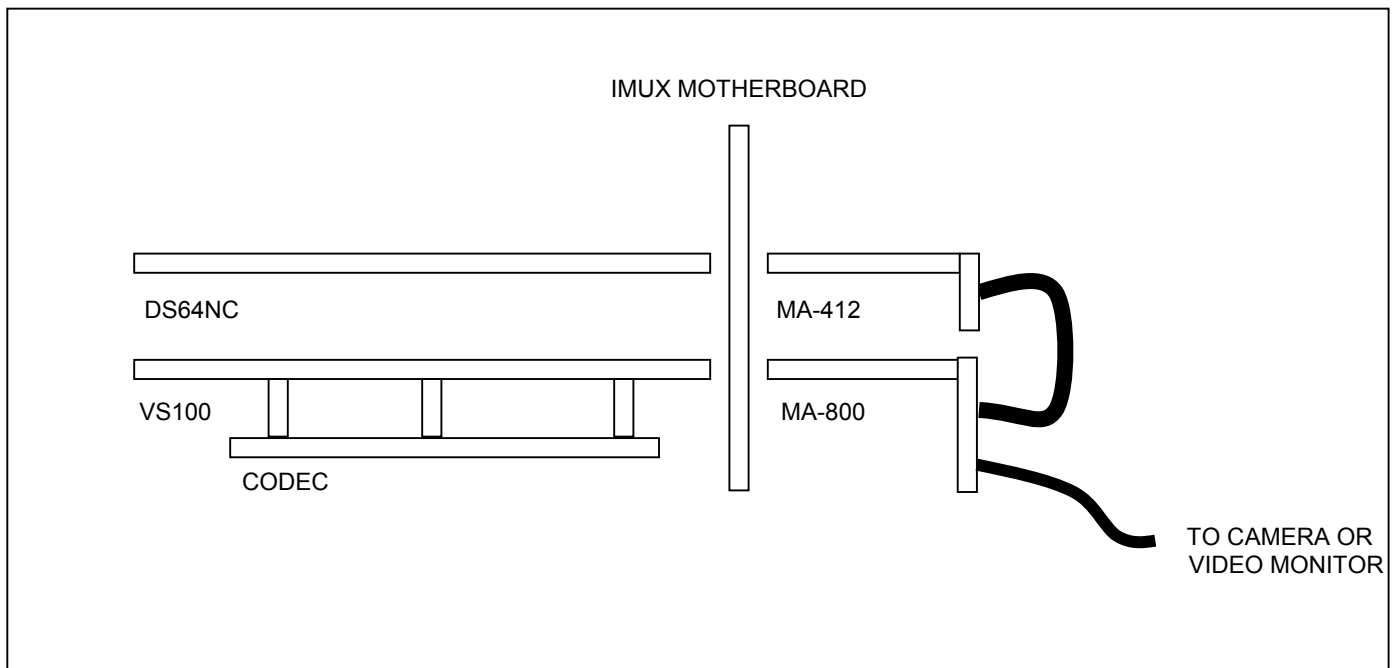


Figure 2. Hardware configuration, top view.

DS64NC SETUP

The DS64NC provides the point to point communications circuit for the VS100 Module. The VS100 will operate with any bandwidth from 64 kb/s to 2.048 mb/s. The setup of the DS64NC is covered in detail in its data sheet. The MA412 must be set for an external clock (TT) for use with a VS-100.

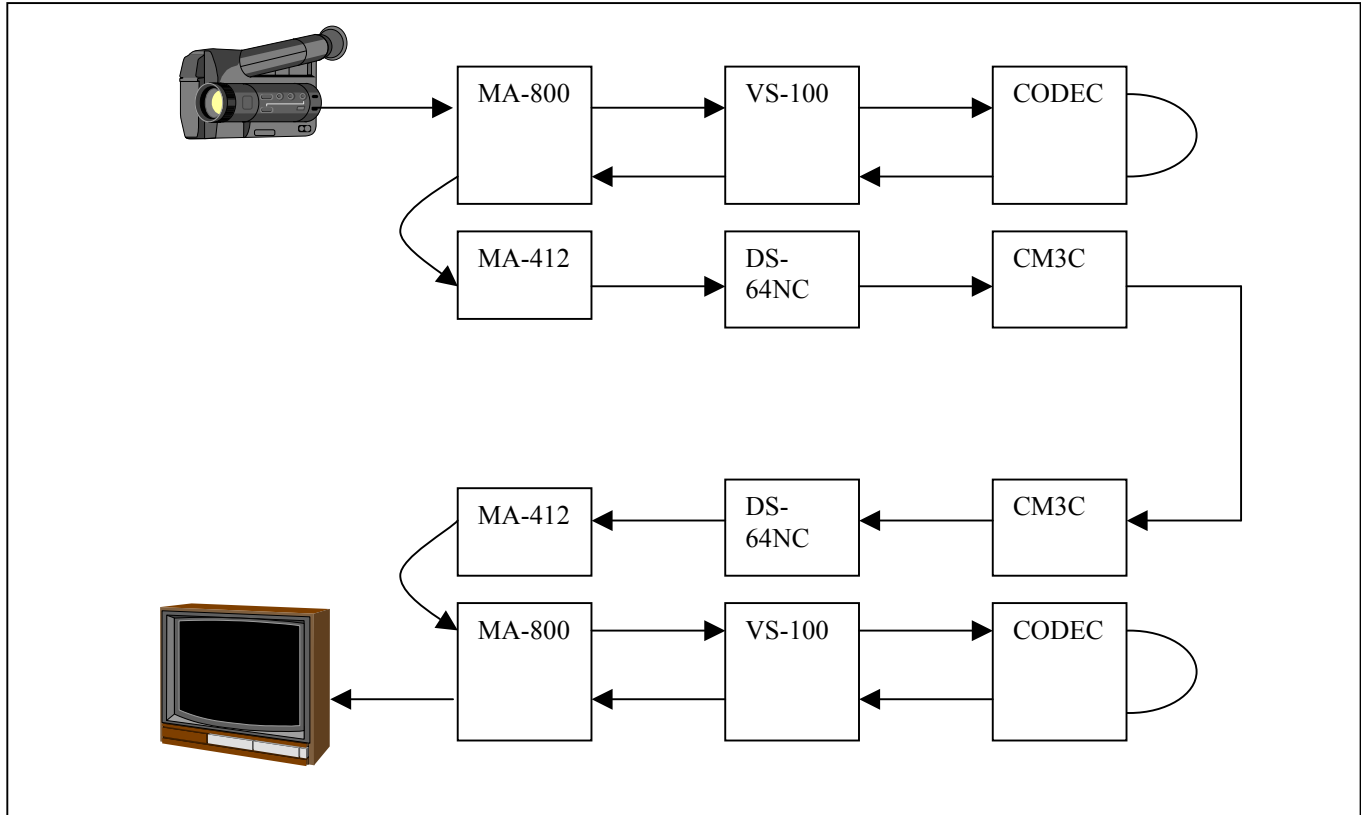


Figure 3. System block diagram

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SECTION 20. SPECIAL INTERFACES

This section contains Instruction Data Sheets for all special interfaces available for use with the IMUX 2000 Intelligent Multiplexer, as of the date this manual was printed:

- o **MA-490 Telnet I/O**
- o **NCM**
- o **SNMP Access Gateway (SAG)**

Additional schematics, wiring diagrams, or other documents specific to your application may also be placed in this section.

For information on other protection modules that may be available for use with your IMUX 2000, contact the factory or an RFL Sales Representative.

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RFL Electronics Inc.

INSTRUCTION DATA

**RFL MA-490
Telnet I/O Module
For IMUX 2000 And RFL 9745
(Includes External Telnet Adapter)
DESCRIPTION**

The RFL MA-490, is an RS232/Telnet I/O adapter module used in systems that have an RS232 port and that require Telnet link capability. This module contains one Ethernet port and two RS232 ports. The basic function of this module is to exchange messages between the Ethernet port and the Data port. One of the RS-232 ports is the Craft port and the other is the Data port. These ports are RS232 ports with DB9 connectors. The Craft port is used to set up TCP/IP parameters and Data port communications parameters. The Craft port communication parameters are always 9600 baud, no parity, 8 data bits, and 1 stop bit. The Data port is used to connect the MA-490 to the Common Module or other external equipment.

As shown in Figure 1, there are three types of MA-490 Telnet I/Os. One unit is used in the IMUX 2000; another unit is used in the RFL 9745. Optionally, a third unit is provided as an external adapter (107495-20). This unit will only connect to external equipment via the Data port and has no connection to the Common Module in the IMUX 2000. A special data cable is provided for this unit (107486-10). All the units are functionally identical except the packaging is different.

When used in the IMUX 2000, the MA-490 can provide an ethernet interface for the NCM module, or can provide a stand-alone ethernet interface for any external equipment that has an RS-232 port. Several MA-490 modules can be plugged into a single IMUX 2000 chassis, each providing an ethernet interface for external equipment. When used as an ethernet interface for the NCM module, refer to the NCM Product Information sheet (publication Number ID2000NCM) for more information. When used as a stand-alone interface, the MA-490 occupies one module slot at the rear of the IMUX 2000 chassis. It can be plugged into any rear slot that has a corresponding blank slot at the front of the chassis. When used as an ethernet interface for the RFL 9745, it is installed at the rear left of the chassis. The 9745 chassis must have either a blank panel or a generic Redundant Power Supply I/O in this location or the unit will not fit.

Table 1. Telnet I/O Applications

Assembly Number	Nomenclature	Application	Installation Information
107495	MA-490 Telnet I/O	IMUX 2000	See page 6
107495-20	External Telnet Adapter	-	See page 9
105120-3	9745 Telnet I/O	RFL 9745	See page 12

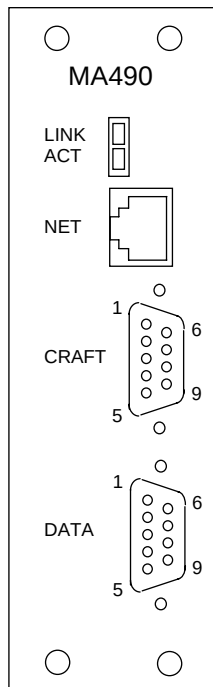


Figure 1a.
Rear Panel view of
MA-490 Telnet I/O
(107495)
Used in IMUX 2000

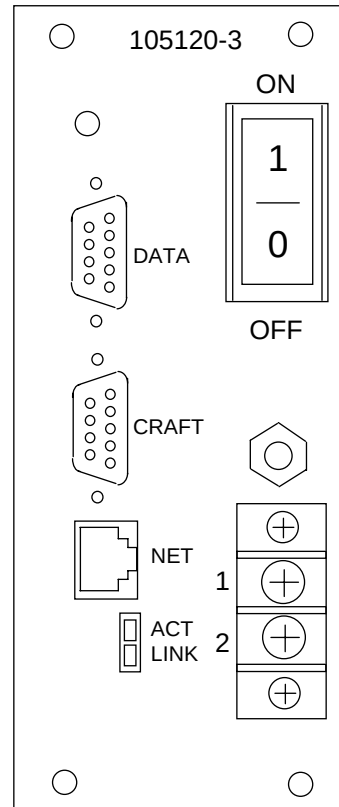


Figure 1b.
Rear Panel view of
9745 Telnet I/O (105120-3)
Used in RFL 9745

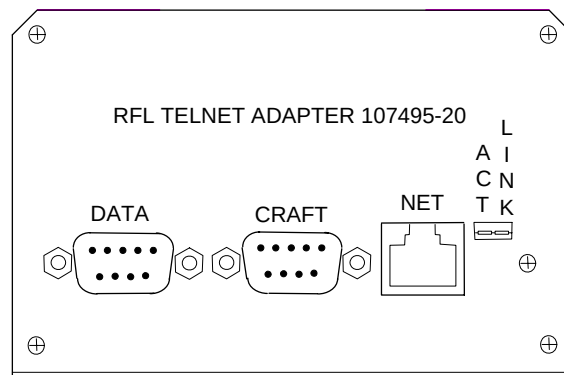


Figure 1c.
Front Panel view of
External Telnet Adapter (107495-20)

Figure 1. Rear panel views of 107495 and 105120-3 Telnet I/Os including External Telnet Adapter

As shown in Figure 2, the MA-490 is made up of three boards, consisting of Board A, Board B and Board C. Board A contains two DB9 connectors and has some signals that are needed in other applications. Board B, contains a 3.3-volt regulator, an octal bi-directional transceiver, and a 5.0-volt, ramp power supply circuit with a hot swap controller. The hot swap controller allows safe board insertion and removal from a live IMUX backplane without interruption of the DS1 or any other DS0. The hot swap controller also provides a reset signal to the Rabbit 3000 processor after the MA490 is powered up. Board C is an Ethernet Core Module RCM3010 board with a Rabbit 3000 microprocessor with a fully integrated 10Base-T Ethernet interface. Refer to Figure 3 for additional information.

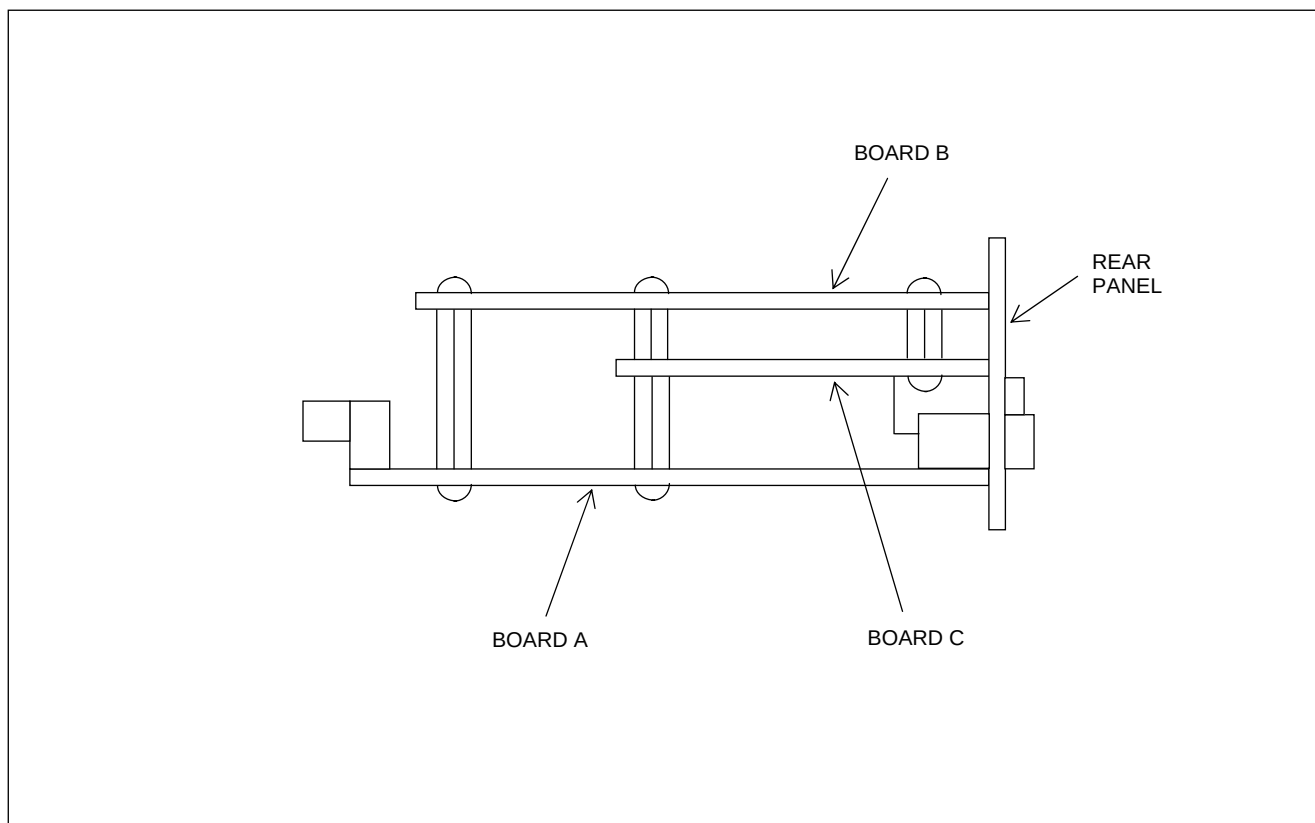


Figure 2. Side view of MA-490 showing location of Boards A, B and C.

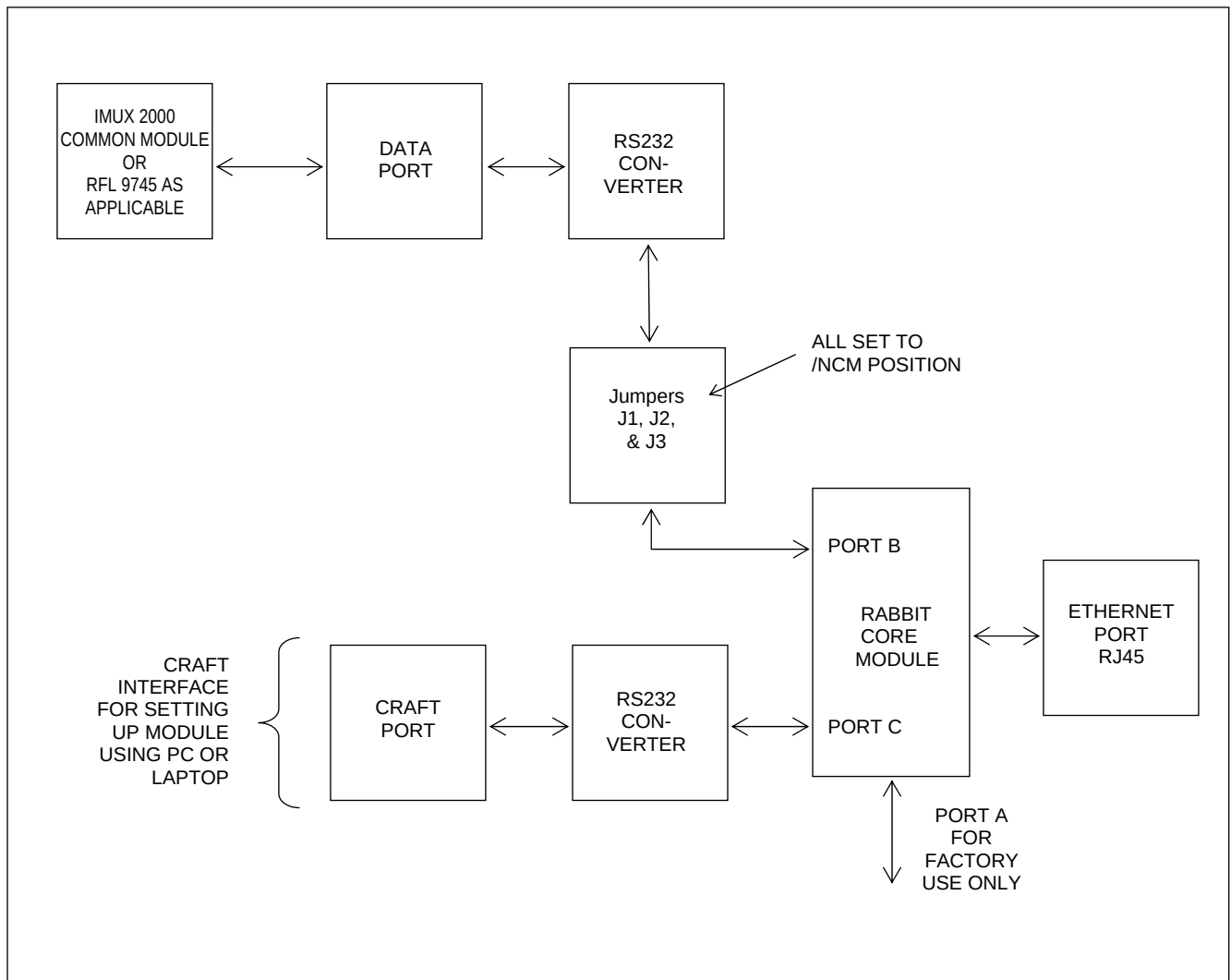
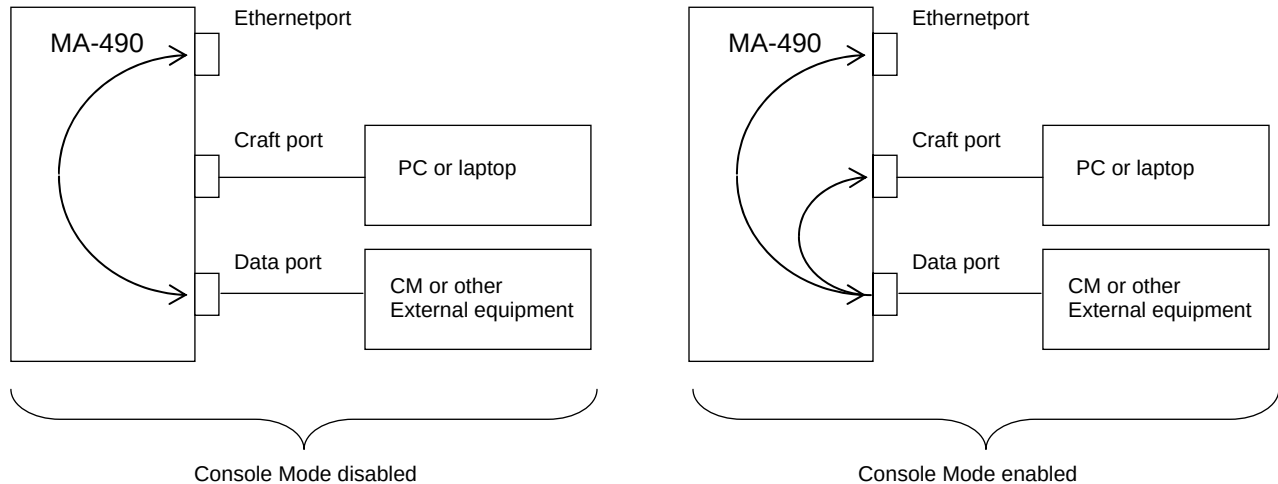


Figure 3. MA-490 Telnet I/O Block Diagram

OPERATION

The MA-490's Data Port is used to connect to the Common Module's or other equipment's serial port. The MA-490's Craft Port is used to connect to the PC's serial port. The Craft Port has two different modes: April mode and Console mode. April mode is used to setup the MA-490's configuration parameters. Console mode is used to tie the Craft Port and the Data Port together so they behave like one serial port as shown in the figures below. When the MA490 is in the Console mode, the user can type a "Ping" command through the Craft Port to ping a remote PC.



The ping command has the following format:

ping 195.195.85.253

The Craft Port will enter the Console mode after 10 seconds of inactivity if the Console mode is enabled. Once in Console mode, hit the "Escape" key 3 times to return to the April mode.

The April User Interface is used to setup the Data port parameters, Ethernet port parameters and some other parameters.

These parameters are listed as follows:

999	System Label
053	IP Address
054	Network Mask
055	Default Router
058	Data Port Baud
059	Data Port Setup
060	Console Mode
061	Telnetimeout(s)

INSTALLING THE 107495 IN AN IMUX 2000

MOUNTING

The MA-490 Telnet I/O is packaged in a plug-in module, for mounting in an IMUX 2000 chassis.

When installing the MA-490 Telnet I/O module in stand alone mode (without an NCM module), a location should be selected at the rear of the IMUX 2000 chassis which is directly in line with a blank slot at the front of the chassis. Make sure the DATA port cable can reach the Common Module remote port or the external equipment RS-232 port as applicable. This cable should have enough slack so it is not in danger of being pulled out of place. Refer to Figures 4 and 5 for additional information.

Before plugging the module into the IMUX 2000 chassis make sure the programmable jumpers J1, J2 and J3 are properly positioned. In stand alone mode, these three jumpers must be in the /NCM position.

POWER INPUT

The 107495 is powered through the IMUX 2000 motherboard. The current drawn from the IMUX 2000, 5-volt power supply is approximately 0.175 Amps.

DATA PORT

Use the supplied ribbon cable to connect the MA-490 Data port to the Common Module RS-232 connector or to the external equipment RS-232 connector as applicable.

CRAFT PORT

Connect a PC or laptop to the Craft port on the MA-490 using the cable shown in Figure 7. Then program the MA-490 TCP/IP parameters and Data port parameter in accordance with your requirements. The instructions for doing this start on page 15.

ETHERNET

Connect the MA-490 to the ethernet hub or switch. The ethernet connector is an RJ-45 which is the commonly used 10BaseT connector for this application.

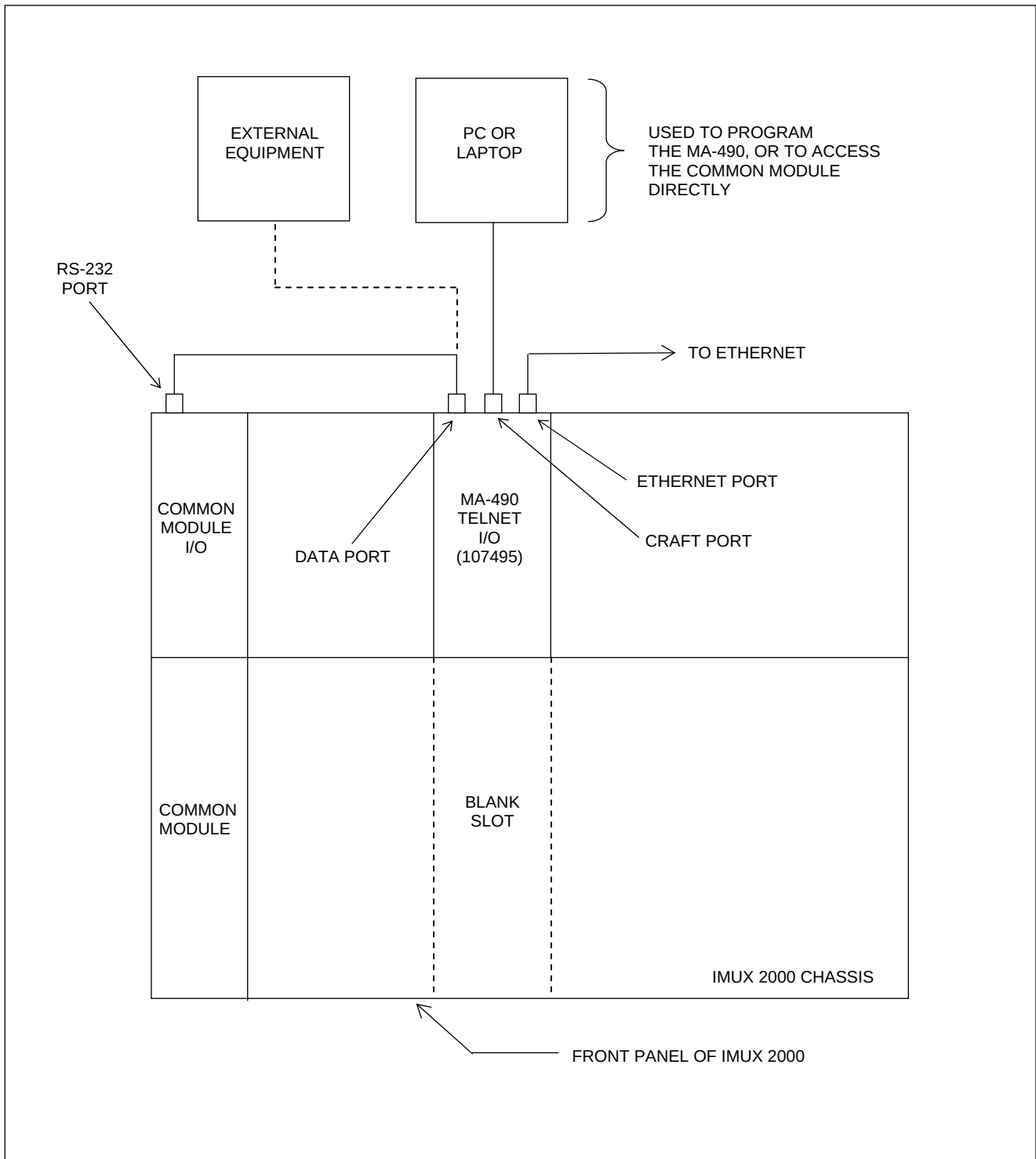


Figure 4. Top view of IMUX 2000 showing MA-490 Telnet I/O installed

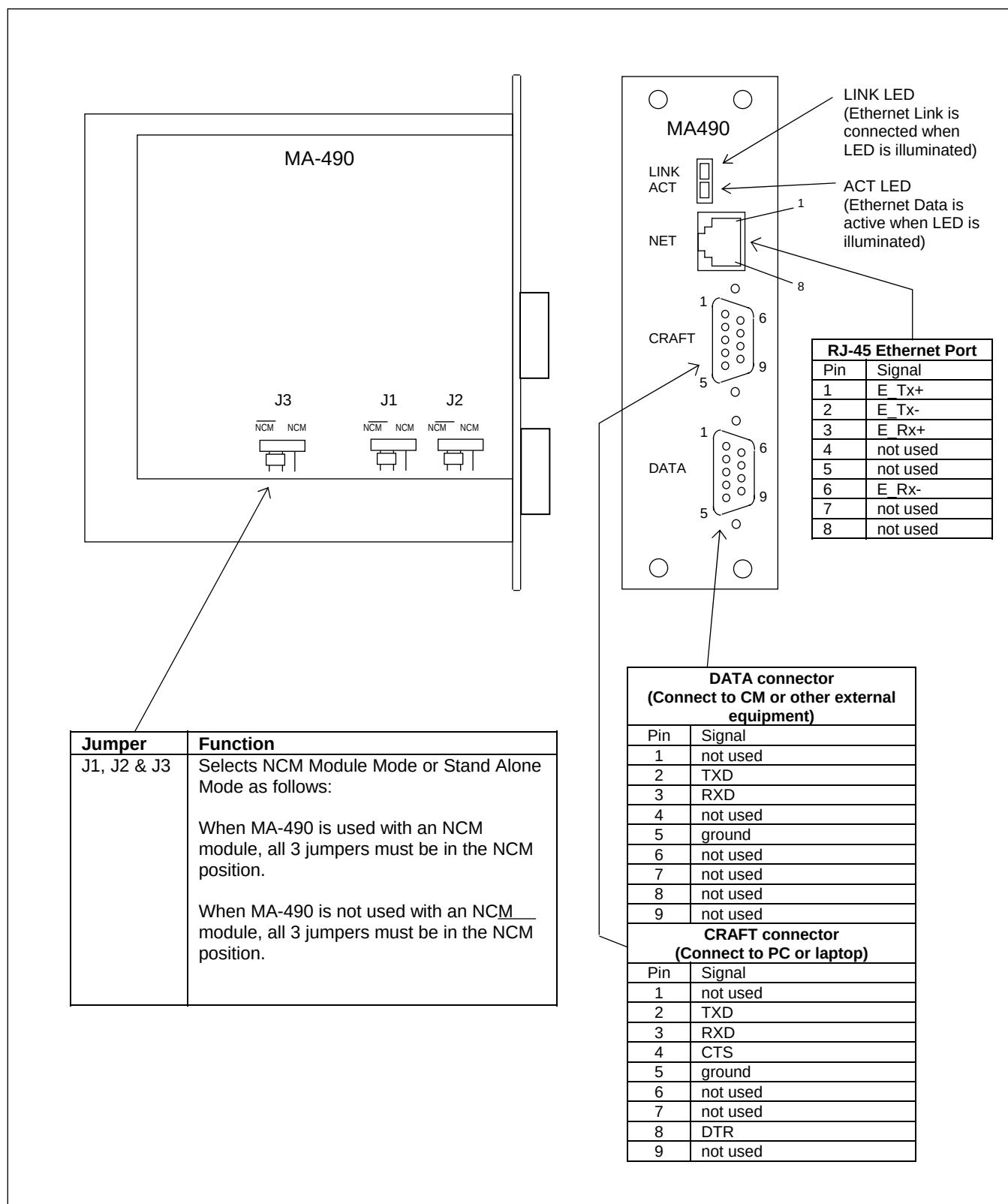


Figure 5. MA-490 Telnet I/O Module adapter, jumper functions, LED functions and connector pinouts

INSTALLING THE EXTERNAL TELNET ADAPTER (107495-20)

MOUNTING

The External Telnet Adapter is used in place of the standard MA-490 Telnet I/O. TCP/IP and Data port parameters can be sent to the Telnet Adapter in a remote mode.

Make sure the special Data port cable can reach the external equipment RS-232 port. This cable should have enough slack so it is not in danger of being pulled out of place.

POWER INPUT

Power is supplied through pin 1. at the Data port connection. Ensure that the external equipment connected to the Data port is capable of providing +5V with a current draw of approximately 0.175 Amps. (See Figure 7).

DATA PORT

Use the supplied special cable to connect the External Telnet Adapter Data port to the external equipment RS-232 connector.

CRAFT PORT

Connect a PC or laptop to the Craft port on the External Telnet Adapter using a standard (straight-through) cable as shown below.

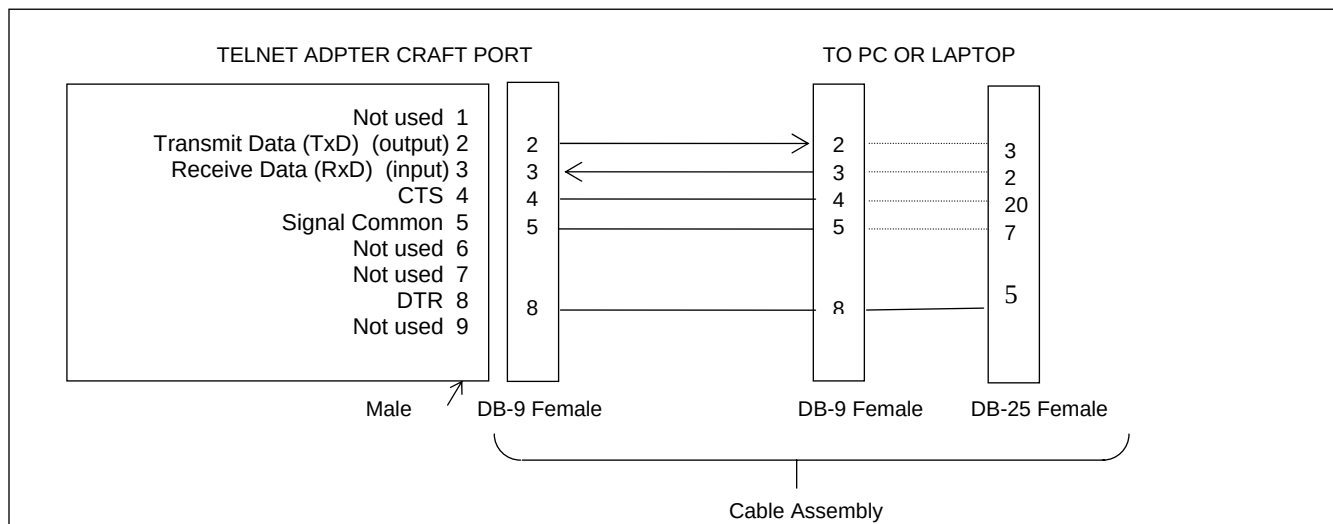


Figure 6. External Telnet Adapter, Craft Port

ETHERNET

Connect the External Telnet Adapter to the ethernet hub or switch. The ethernet connector is an RJ-45 which is the commonly used 10BaseT connector for this application.

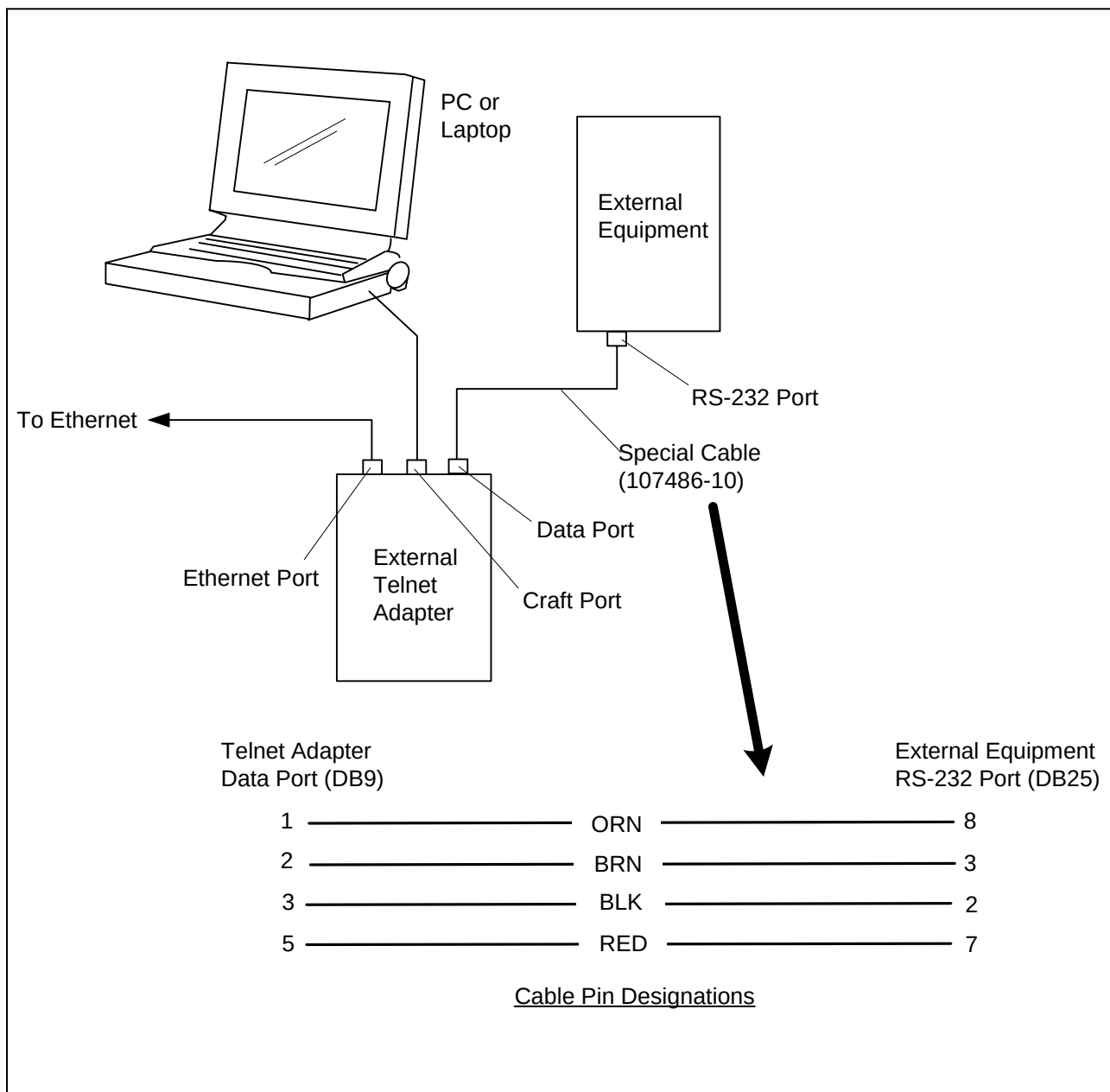


Figure 7. View of External Telnet Adapter showing connections

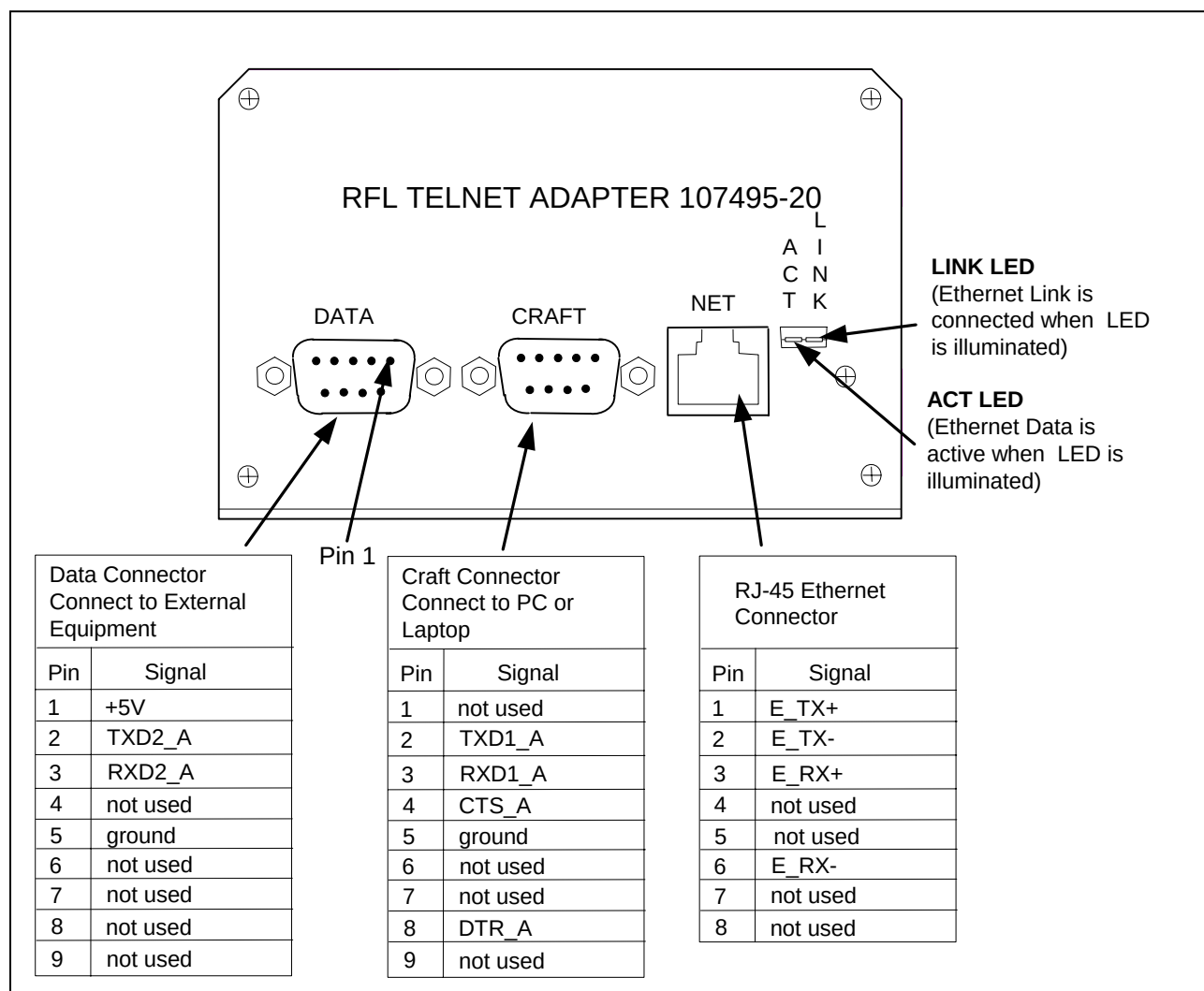


Figure 8. View of External Telnet Adapter showing LED Functions and connector pinouts

INSTALLING THE 105120-3 IN AN RFL 9745

MOUNTING

The 9745 Telnet I/O module is packaged in a plug-in module, for mounting in an RFL 9745 chassis.

The 9745 Telnet I/O module is mounted at the left rear of the RFL 9745 chassis. The chassis must have a blank panel or a generic Redundant Power Supply I/O in this location or the 105120-3 will not fit. In addition to this, make sure the DATA port cable can reach the RS-232 remote port at the rear of the 9745 chassis.

Before installing the module into the RFL 9745 chassis make sure the programmable jumpers J1, J2 and J3 are properly positioned. These three jumpers must be in the /NCM position.

POWER INPUT

The 105120-3 is powered through the RFL 9745 chassis motherboard. The current drawn from the RFL 9745, 5-volt power supply is approximately 0.175 Amps.

REDUNDANT POWER SUPPLY I/O, REMOVAL INSTRUCTIONS

If your RFL 9745 has a Redundant Power Supply I/O module installed, proceed as follows:

1. Disconnect power from the RFL 9745.
2. Open the RFL 9745 front panel.
3. Disconnect the front RS-232 port cable from the communications module.
4. Remove the CPU board, driver board, and the communications module.
5. Using a screwdriver blade or a sharp pointed tool, pry open the two locking tabs on the black rectangular shaped EMI choke which is attached to the interior wall. This may be difficult to do due to limited access. Once the tabs are unlocked, hinge open the choke and remove the wiring harness.
6. Unplug the white connector from the motherboard.
7. Remove the two side screws and four rear screws, which hold the Redundant Power Supply I/O in the 9745 chassis.
8. Carefully slide out the Redundant Power Supply I/O from the 9745 chassis while snaking the white connector through the oval shaped hole in the side wall of the card cage.

9745 TELNET INSTALLATION INSTRUCTIONS

1. Disconnect power from the RFL 9745.
2. Remove the Redundant Power Supply I/O if one is present, from the right rear of the RFL 9745 chassis as described in the previous paragraph.
3. Carefully slide the 9745 Telnet I/O into the rear left of the RFL 9745 chassis while at the same time snaking the white connector through the oval shaped hole in the sidewall of the card cage.
4. Place the wiring harness into the EMI choke, which is attached to the rear wall, and snap the EMI choke cover closed. Plug the white connector into the motherboard.
5. Make sure the 9745 Telnet I/O module is fully seated into the Redundant Power Supply I/O if one is present.
6. Install the two side screws and four rear screws, which hold the 9745 Telnet I/O in the 9745 chassis.
7. Install the CPU board, driver board, and the communications module.
8. Connect the front RS-232 port cable to the communications module.
9. Close the RFL 9745 front cover.

DATA PORT

Use the supplied ribbon cable to connect the MA-490 Data port to the RFL 9745 rear panel RS-232 connector.

CRAFT PORT

Connect a PC or laptop to the Craft port on the MA-490 using the cable shown in Figure 10. Then program the MA-490 TCP/IP parameters and Data port parameters in accordance with your requirements. The instructions for doing this start on page 15.

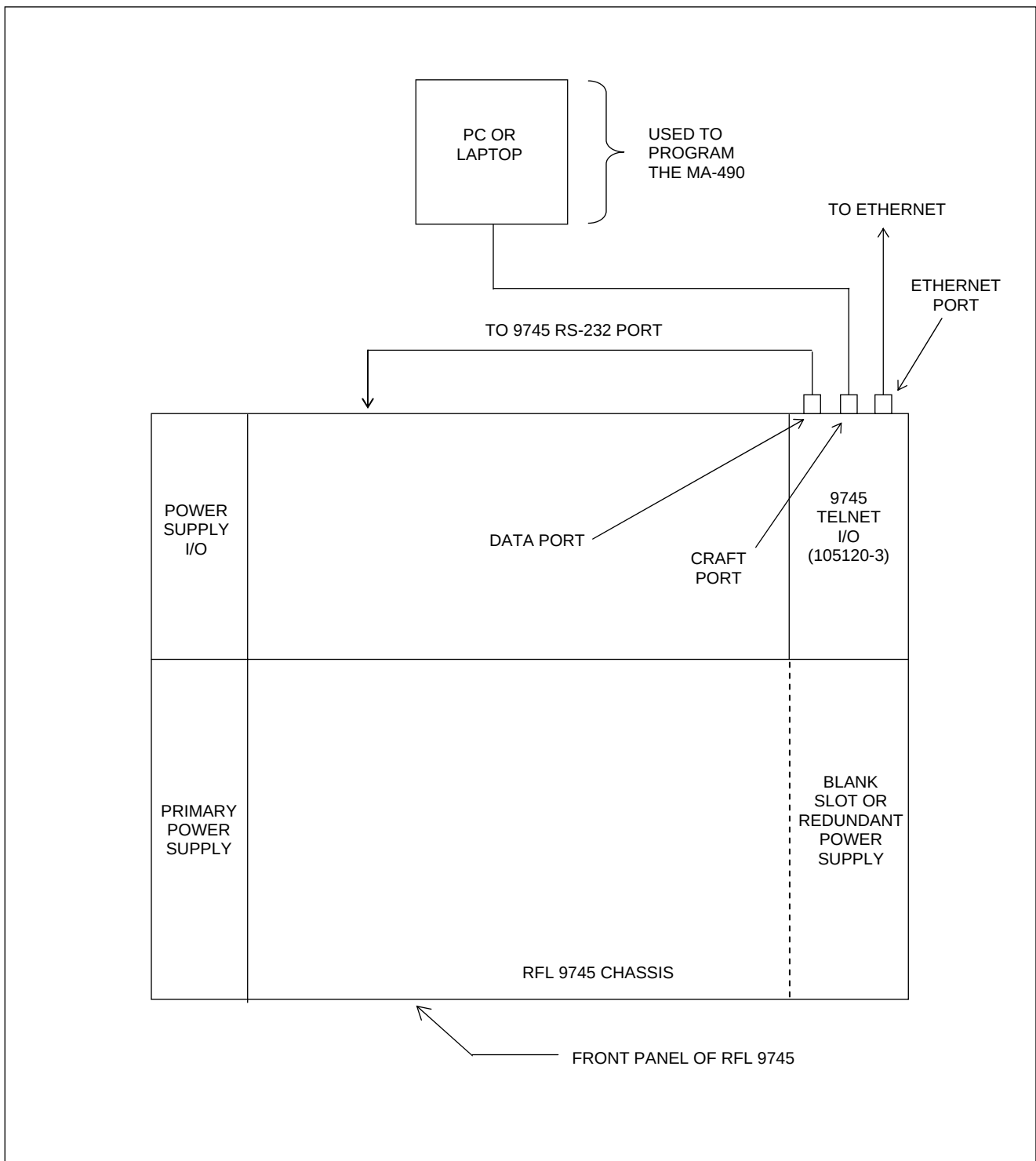


Figure 9. Top view of RFL 9745 showing 9745 Telnet I/O installed

USING THE CRAFT PORT TO SETUP THE MA-490

INTRODUCTION

This section contains information on how to set up the MA-490 module.

ESTABLISHING COMMUNICATIONS

A user can communicate with the MA-490 through the Craft port on the rear panel of the module. Either a PC or laptop equipped with terminal emulation software such as HyperTerminal or Procom can be used for communication. Once connected, APRIL (Asynchronous Programming and Remote Interrogation Language) can be used to view the configuration parameters of the MA-490. Because APRIL is menu based, memorization of commands is not required. Help screens can always be displayed by pressing the **[H]** key.

PHYSICAL CONNECTIONS

The Craft port on the MA-490 is typically connected directly to a PC or laptop using a standard (straight-through) connector as shown in Figure 10. The Data port of the MA-490 is connected to the Common Module or other external equipment using a null modem cable as shown in Figure 11.

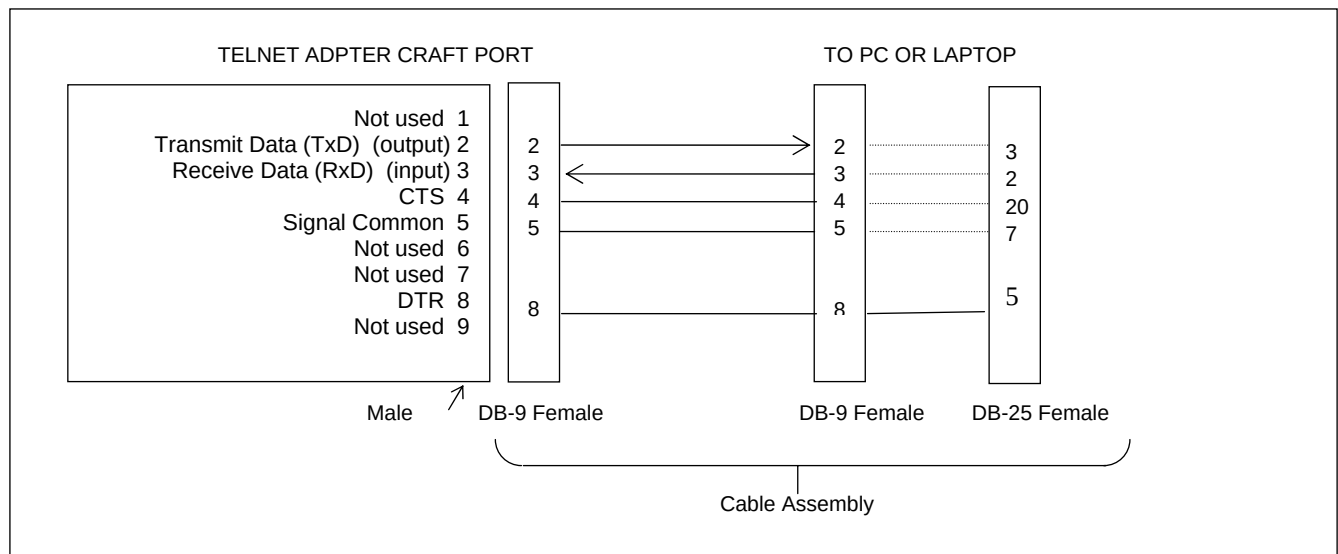


Figure 10. Making connections from the MA-490 rear connector to the PC or laptop

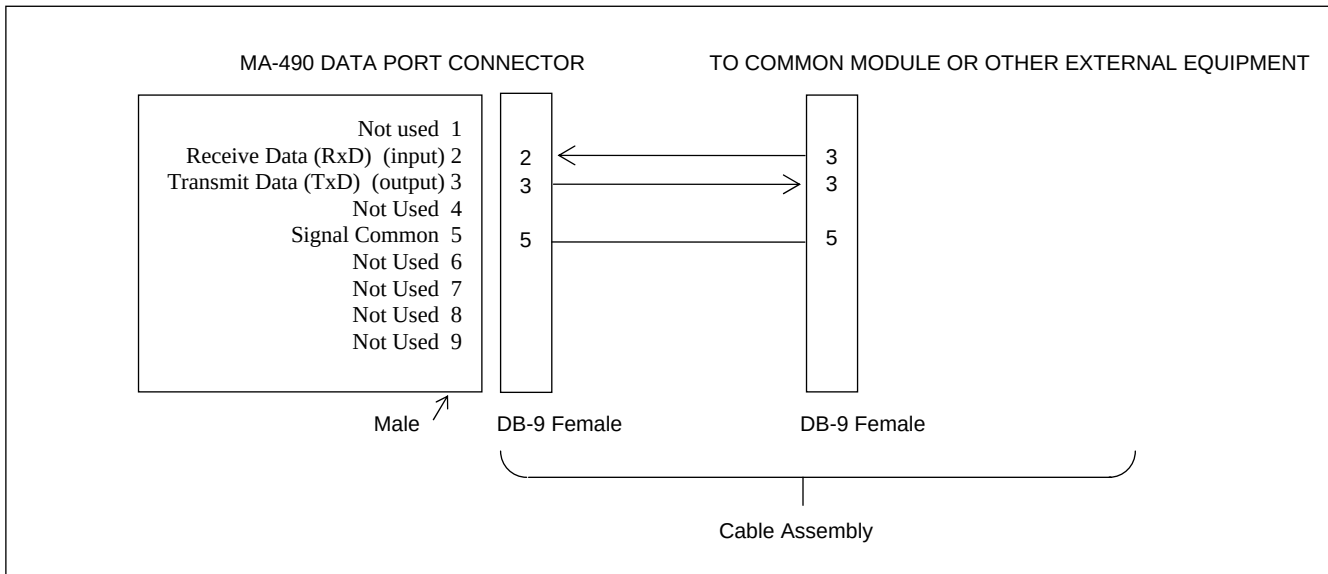


Figure 11. Making connections from the MA-490 Data Port to the CM or other external equipment

COMMUNICATIONS INFORMATION

The serial communications port on the PC or laptop must be configured to match the MA-490 Craft port as follows:

Data Bits	8
Stop Bits	1
Parity	None
Baud Rate	9600 baud

VIEWING APRIL COMMANDS

Once you have connected a PC or laptop to the MA-490 and pressed the **[ENTER]** key, the MA-490 will send the following prompt to your terminal:

MA-490>

This means that you have accessed the MA-490, and can now use APRIL commands to view lists of parameter settings and other information.

To view a list of the APRIL commands, press the **[H]** and **[ENTER]** keys:

MA-490 >H [ENTER]

This tells the MA-490 to send a list of APRIL commands called the "main menu" to your terminal. The main menu appears in Figure 9.

```
RFL Electronics APRIL(t) Remote Communications, Version 2.1 (c)1993,1999

H - Display the main menu
P - Go to the programming menu (password required)
D - Go to the read settings menu
F - Go to the software version display
Craft port will enter console mode after 10 seconds of inactivity,
If enabled. Hit "Escape" key 3 times to return to APRIL.
MA-490>
```

Figure 12. APRIL main menu

For more information on each APRIL command, refer to the paragraph numbers listed below.

Command	Meaning	Page
H	Display the main menu	14
P	Go to the programming menu (password)	16
D	Go to the read settings menu	18
F	Go to the software version display	19

DISPLAYING APRIL HELP

To see a list of APRIL commands while the "MA-490>" prompt is displayed, use the "H" command.

MA-490>H [ENTER]

When you invoke the "H" command, the APRIL command main menu shown in Figure 9 will re-appear on your screen.

THE PROGRAMMING MODE

You can use APRIL and your PC or laptop to program the MA-490. To use your PC or laptop to program the MA-490, use the "P" command.

MA-490>P [ENTER]

The "P" command tells the MA-490 to send a list of all programming commands to your PC or laptop. The "P" command is password-protected.

If the proper password is entered, a programming menu similar to the one shown below will appear.

```
H - Display programming help
Q - Leave programming menu
SV - Save new settings
C - Change password (superuser authorization required)
D - Display present settings and parameter numbers
## - Edit this specific number parameter
MA-490-P>
```

Figure 13. Typical programming menu

You are now in the programming mode, as indicated by the "MA-490-P>" prompt on your screen. You may now use the programming commands to re-program the MA-490. For more information on each programming command, refer to the paragraph numbers listed below.

Command	Meaning	Page
H	Display programming help	17
Q	Leave programming menu	17
SV	Save new settings	17
C	Change password	20
D	Display current settings and parameter numbers	18
##	Edit the parameter number “##”	18

DISPLAYING PROGRAMMING HELP

To see a list of all programming commands, use the "H" command.

MA-490-P>H [ENTER]

When you invoke the "H" command, the programming menu shown in Figure 10 will re-appear on your screen.

LEAVING THE PROGRAMMING MODE

NOTE

Before leaving the Programming Mode, use the "SV" command or your changes will be lost.

Whenever you are finished programming the MA-490, use the "Q" command:

MA-490-P>Q [ENTER]

The "Q" command tells the MA-490 to leave the programming mode and return to the normal "MA-490>" prompt. If you changed any setting while in the programming mode, be sure to use the "SV" command described above to save the changes before invoking the "Q" command; otherwise, your changes will be lost.

SAVING NEW PROGRAMMING SETTINGS

The "SV" command saves any new settings you made while in the programming mode:

MA-490-P>SV [ENTER]

The "SV" command tells the MA-490 to store all the changes in its non-volatile memory. Once the changes are stored, the "MA-490-P>" prompt will reappear.

Before you enter the "SV" command, the MA-490 operates according to the old parameter settings. Once the "SV" command is entered, the new settings will be in effect.

The new parameter settings can be verified by re-issuing the "D" command to display the parameter settings list. (For more information on the "D" command, go to page 20.)

DISPLAYING AND EDITING PARAMETER SETTINGS

To view a list of all current parameter settings, use the "D" command.

MA-490-P>D [ENTER]

When you invoke the "D" command, the MA-490 sends a list of all current parameter settings to your PC or laptop. A typical parameter settings display is shown below.

#	PARAMETER	SETTING
999	System Label	DEMO UNIT
053	IP Address	195.195.085.254
054	Network Mask	255.255.255.000
055	Default Router	195.195.085.007
058	Data Port Baud	9600
059	Data Port Setup	N/8/1
060	Console Mode	N
061	Telnettimeout(s)	10

MA-490-P>

Figure 14. Typical parameter settings display

Parameters 053 - 061 are normally pre-set at the factory, or can be set in the field by the user. These parameters must be set, before the MA-490 can be put into service.

053 – IP Address	The IP Address Specifies a unique 32-bit number for each host on a network such as the MA-490. This number is known as the Internet Protocol Address, the IP Address, or the Internet Address. These terms are interchangeable. Each packet sent across the internet contains the IP Address of the source of the packet and the IP Address of its destination.
054 – Network Mask	The Network Mask or Netmasks are used to identify which part of the address is the Network ID and which part is the Host ID. This is done by a logical bitwise-AND of the IP Address and the Netmask.
055 – Default Router	The Default Router is the Router IP Address. Each IP datagram travels from its source to its destination by means of routers. All hosts and routers on an internet contain IP protocol software and use a routing table to determine where to send a packet next.
058 – Data Port Baud	The Data Port Baud is the baud rate of the Data Port. The choices of baud rates are as follows: 300, 1200, 2400, 4800, 9600, 19.2k, 38.4k and 57.6k.

059 – Data Port Setup	The Data Port Setup indicates the setup parameters of the Data Port which includes the parity, the number of data bits, and the number of stop bits. There are only three choices of setup parameters as follows: N/8/1, E/7/1 and O/7/1. The first number is the parity where N = no parity, E = even parity and O = odd parity. The second number is the number of data bits where 8 = eight data bits and 7 = seven data bits. The third number is the number of stop bits which always = 1.
060 – Console Mode	The console mode can be enabled (Y) or disabled (N). When enabled, the Craft port is tied to the Data Port so the user can use the Craft port to “talk to” the external equipment such as the Common Module or the RFL 9745.
061 – Telnetimeout(s)	After a finite period of time has elapsed with no activity on the MA-490 Ethernet port, the Ethernet port will shut down. This finite period of time is the Telnetimeout value, and can be set by the user from 10 seconds to 10,000 seconds in one second increments.
999 – System Label	A label which can be set by user using any string of letters or numbers.

To re-program any of the values shown on the parameter settings display, type in the number in the "#" column, and then press **[ENTER]**. The parameter will be displayed, with information about its setting below it. Type in the new setting, and then press **[ENTER]**.

Example 1: Editing the IP Address parameter setting.

1. Enter the number for the IP Address parameter (53) on your PC or laptop keyboard, and then press the **[ENTER]** key.

The IP Address parameter will be displayed, with information about its setting below it.

```
053 IP Address      195.195.085.254
[ddd.ddd.ddd.ddd]>
```

2. Type in the desired IP Address, (for example: 195.195.085.253) and then press the **[ENTER]** key.

The IP Address parameter will be re-displayed, set to the new value.

```
053 IP Address      195.195.085.253
```

3. Enter the "SV" command to save your new system label:

```
MA-490-P>SV
```

READING PARAMETER SETTINGS

The "D" command tells the MA-490 to send a list of all parameter settings to your terminal. This list of settings is called the "read settings" menu.

MA-490>D [ENTER]

A typical read settings menu appears in Figure 15. These settings cannot be changed in this menu. To change these values, you will have to enter the programming mode. (See page 16 for more information.) The programming mode is password-protected, so only authorized persons can change the MA-490's parameter settings.

#	PARAMETER	SETTING
999	System Label	DEMO UNIT
053	IP Address	195.195.085.254
054	Network Mask	255.255.255.000
055	Default Router	195.195.085.007
058	Data Port Baud	9600
059	Data Port Setup	N/8/1
060	Console Mode	N
061	Telnet timeout(s)	10

MA-490-P>

Figure 15. Typical read settings menu

VIEWING THE SOFTWARE VERSION

The "F" command tells the MA-490 to send a software version display to your PC or laptop. This display tells you what software version is being used in the MA-490. This parameter cannot be changed by the user and is for display only.

MA-490>F [ENTER]

A typical software version display is shown in below.

```
MA-490 Module Configuration:
001      Type      MA-490
002      Firmware Version  2.0
MA-490>
```

Figure 16. Typical software version display

The software version display shows the code number for each item, and, and its value. Full descriptions for each item are as follows:

001 – Type	This identifies the basic model and configuration of the system (MA-490)
002 – Firmware	This gives the version number of the software presently running in the MA-490 module.

PASSWORD PROTECTION

NOTE

This is the only page where the superuser password is discussed.
The superuser password cannot be changed. Only the user password can be changed.

Password protection is required to prevent unauthorized personnel from gaining access to the MA-490 settings and parameters. The only menu that is password protected is the Programming Menu.

ENTERING THE PROGRAMMING MENU

When you invoke the "P" command, the following prompt appears:

enter password:

Enter the password that has been stored in the MA-490's flash memory. The MA-490 gives you three chances to enter the correct password. After the third incorrect password is entered, the MA-490 enters a lock-out mode. This mode will last for about five minutes, during which you will not be able to enter the programming mode.

CHANGING THE USER PASSWORD

You can use the "C" command to change the user password that can be used to enter the programming, mode.

MA-490>C [ENTER]

When you invoke the "C" command, the MA-490 sends the following prompt to your terminal:

enter super-user:

Enter the super-user password ("MA490"), and then press **[ENTER]**. The following prompt will appear:

**Current password is (current password)
enter new password:**

Enter the new user password, and then press **[ENTER]**. The following prompt will appear:

repeat new password:

Enter the new user password again, and then press **[ENTER]**. The following prompt will appear:

password modified

The new user password is now stored in the MA-490 flash memory. The user password can have a maximum of six alphanumeric characters including spaces. The software only allows one user password. If a new user password is entered it will write over the old password.

HOW TO ACCESS THE IMUX 2000 USING TELNET

1. Open NMS version 10.3.
2. Click on the “New” Icon.
3. Change the “Com1” connection to “TCP”.
4. Click on the “NetView” Icon.
5. Click on the upper left empty box. This will bring you to the “Display/Change Node” window.
6. Enter a name in the “Site ID” box. This entry is optional.
7. Change the node address to match the Common Module address in the IMUX 2000 that you want to communicate with.
8. A default IP address will be displayed. Change the default IP address to match the IP address of the MA-490 Telnet I/O that you want to communicate with.
9. Change the “Node Type” to match the node type where the MA-490 is located. For example if the MA-490 is located at a Terminal node, then change the Node type to “Terminal”.
10. You can now access the node using NMS through the MA-490. Refer to Section 7 of the IMUX 2000 Instruction Manual for guidance on how to use NMS.

HOW TO ACCESS THE RFL 9745 USING TELNET

1. From your desktop, click on Start, Programs, Accessories, Communications, HyperTerminal.
2. Setup a new connection.
3. Connect using TCP/IP (Winsock).
4. Enter the "Host address" which is the IP address of the 9745 Telnet I/O (MA-490).
5. The MA-490 will always use "Port number 23".
6. Click on "OK".
7. The software will indicate "Connection Established".
8. Hit "Enter" to bring you to the "9745>" menu.
9. You can now access the node using APRIL through the MA-490. Refer to Section 6 of the RFL 9745 Instruction Manual for additional information.

NOTICE

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INSTRUCTION DATA

RFL NCM Network Communications Module

DESCRIPTION

The Network Communications Module (NCM) is an Asynchronous Data Module designed for use in RFL IMUX 2000 T1 and E1 multiplexers. It provides one DCE Half/Full-Duplex channel between an unlimited number of locations using a single 64 kbps DS0 time slot. The NCM provides a fast and reliable NMS communication path between nodes of a T1 or E1 network, and can also be used for party-line applications such as DNP and Modbus networking.

The NCM is remote-controllable when installed in an RFL remote controllable shelf. The following module parameters can be configured remotely via NMS or locally via DIP switches. A DIP switch setting selects whether the card is in remote or local mode.

o	TX/RX Time Slot	1-31
o	TX Bus Direction	TX-A(RX-B) / TX-B(RX-A)
o	Service enable/disable	On/Off
o	Equipment Loopback	On/Off
o	Payload Loopback	On/Off
o	Block timeslot 16 for CAS in E1 operation	On/Off
o	Port 2	On/Off
o	Rogue Control	On/Off
o	CM Address	Any, Greater Than, Less Than
o	Baud Rate	2400, 4800, 9600, 19.2k, 38.4k
o	Parity	None, Odd, Even, Mark, Space
o	Word Length	7 or 8 data bits
o	Application Modes	Broadcast, NMS, Master, D&I slave, End slave
o	Remote Operation	On/Off

SPECIFICATIONS

As of the date this Instruction Data Sheet was published, the following specifications apply to the RFL NCM Module. Because all of RFL products undergo constant improvement and refinement, these specifications are subject to change without notice.

Live Insertion/Extraction: The NCM Module is capable of live insertion and extraction into the IMUX 2000 shelf without interruption to the DS1 or any other DS0.

Asynchronous Data Interface: Full duplex or half duplex, one channel operation, one or two data ports.

Data Rate: 2400, 4800, 9600, 19.2kbps and *38.4kbps. (*38.4kbps may require character pacing and/or additional stop-bits)

Start-Stop Distortion: Referenced to actual Rx Baud <9%

Gross Start-Stop Distortion: Referenced to nominal Baud <50%

Character Delay: 16 characters max (delay is dependant on input frequency deviation from nominal data rate)

Frequency Deviation: Allowable input Frequency Deviation from nominal data rate is $\pm 4\%$. (Stop bit reduction is used to compensate for frequencies greater than local oscillator generated baud).

NMS Mode ASCII Character Addressing Format: [0-9][0-9][0-9] [:]
Example: NMS sends "215:"

Time Slots: Occupies one selectable DS0 time slot.

Jitter: Excluding Stop bit <1%

Rogue Detectors: One minute pick-up, two minute drop-out

RS-232 DCE Interface:

Supports: Tx Data, Rx Data, and Signal Ground. Receive Line Signal Detect and Clear to Send are always held active.

RS-485 DCE Interface:

Two-wire: Supports half-duplex, transmit data or receive data, and ground.

Four-wire: Supports full-duplex transmit data, receive data, and ground.

Telnet Interface: Supports: Tx Data and Rx Data over ethernet.

Connector:

For RS-232 the NCM module uses an MA-402I Module Adapter, which provides two DB-9 female connectors.

For RS-485 the NCM module uses an MA-485 Module Adapter, which provides a single, six position terminal block.

For Telnet the NCM module uses a shielded RJ45 connector.

Power Dissipation: 0.5 Watt nominal

MTBF (Calculated): TBD

Operating Temperature: -20°C to +55°C (-4°F to +131°F).

Humidity: 0 to 95 %, non-condensing.

INSTALLATION

Before the RFL NCM module can be placed in service, it must be installed in a multiplexer shelf. Installation involves determining the module slot in the Main Shelf or Expansion Shelf where the module will be installed, inserting a Module Adapter into the rear of the shelf behind the module slot, connecting all signal and power wiring to the Module Adapter, checking the settings of all switches, and inserting the module into the front of the shelf.

NOTES

Power supply and time slot considerations may affect the installation of this module into an existing multiplexer shelf. Refer to the multiplexer manual for more information.

The following instructions are provided for installing an RFL NCM module into an existing system. If the module was included as part of a system, installation was done at the factory. Otherwise, proceed as follows:

1. Carefully inspect the module for any visible signs of shipping damage. If you suspect damage to the module, immediately call RFL Customer Service at the number listed at the bottom of this page.
2. Determine the module slot in the Main Shelf or Expansion Shelf where the module will be installed.
The RFL NCM module occupies one module slot in the Main Shelf or Expansion Shelf.
3. Determine which module adapter will be used to make connections to the RFL NCM module.
Each module in the IMUX 2000 multiplexer requires a Module Adapter. The module adapter provides the appropriate connector for the desired interface. There are three Module Adapters that are compatible with the RFL NCM:

<u>Module Adapter</u>	<u>Part Number</u>	<u>Interface Type</u>	<u>Connector</u>	<u>Figure</u>
MA-402I	9547-16921	2-Port RS-232	9-pin D-subminiature	1
MA-485	107470	1-Port RS-485	Removable terminal block	2
MA-490 Telnet I/O	107495	2-Port RS-232 1-ethernet port	9-pin D-subminiature* RJ-45 jack	3

***One 9-pin connector is the RS-232 port. The other 9-pin connector is the local port.**

The MA-402I module adapter is shown in Figure 1. This module is a two-port RS-232 I/O which has two 9-pin D-subminiature (DC-9) connectors on its rear panel. Each of these 9-pin connectors is wired in a standard RS-232 configuration as shown in the table at the bottom of the figure. Each connector is labeled to show the corresponding port on the NCM module.

The MA-485 module adapter shown in Figure 2 supports both 2-wire and 4-wire RS-485 applications. The 2-wire mode supports *only* half-duplex, and the 4-wire mode supports *both* half *and* full duplex. The MA-485 is typically used for party-line applications such as DNP and Modbus networking, or simple point-to-point applications. This module has one 6-position removable terminal block on its rear panel, which is wired in accordance with the table in Figure 2.

The MA-490 module adapter shown in Figure 3 is an RS-232/Telnet I/O module adapter used for systems that have an RS-232 port which needs Telnet link capability. This module has two RS-232 ports using DB9 connectors and one Ethernet port using an RJ-45 jack on its rear panel. One of the RS-232 ports is the Craft port and the other is the Data port. The Craft port is used to set up TCP/IP parameters, and the Data port is used for communications. Refer to the tables in Figure 3 for wiring information.

Make sure the module adapter you are installing is correct for the desired application. Make sure the programmable jumpers on these modules are set to the desired configuration, as applicable.

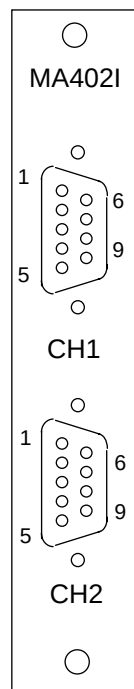
4. Insert the Module Adapter into the rear of the shelf directly behind the module slot where the RFL NCM module will be installed. Secure the module with the screws provided.
5. Connect the Module Adapter to the user equipment using the connector pin assignments detailed in Figures 1, 2, or 3 as applicable.
6. Refer to Figures 4 & 5, and Table 1 for the location of DIP switches on the NCM module.
7. Set the module address using DIP switches SW1-1 through SW1-6 for the desired remote address (SCB address).

For remote access, each channel module in the IMUX 2000 must have a distinct module address. Valid addresses are the numbers “1” to “36”. In most installations the address will be set to the number of the slot the module is occupying. Table 3 shows the switch settings for the module address. (Consult your multiplexer manual for details on using the remote access and configuration features of the system.)

8. In E1 systems, set DIP switch SW2-8 to enable or disable CAS (channel associated signaling). In T1 systems, this switch setting is ignored.

Place SW2-8 in the UP position to disable CAS.

Place SW2-8 in the DOWN position to enable CAS.



Pin No.	Function
1	Receive Line Signal Detect*
2	Receive Data
3	Transmit Data
4	Not used
5	Signal Ground
6	Not used
7	Data Set Ready*
8	Clear To Send*
9	Not used

* These signals always active

Figure 1. MA-402I Module adapter, connector pinouts

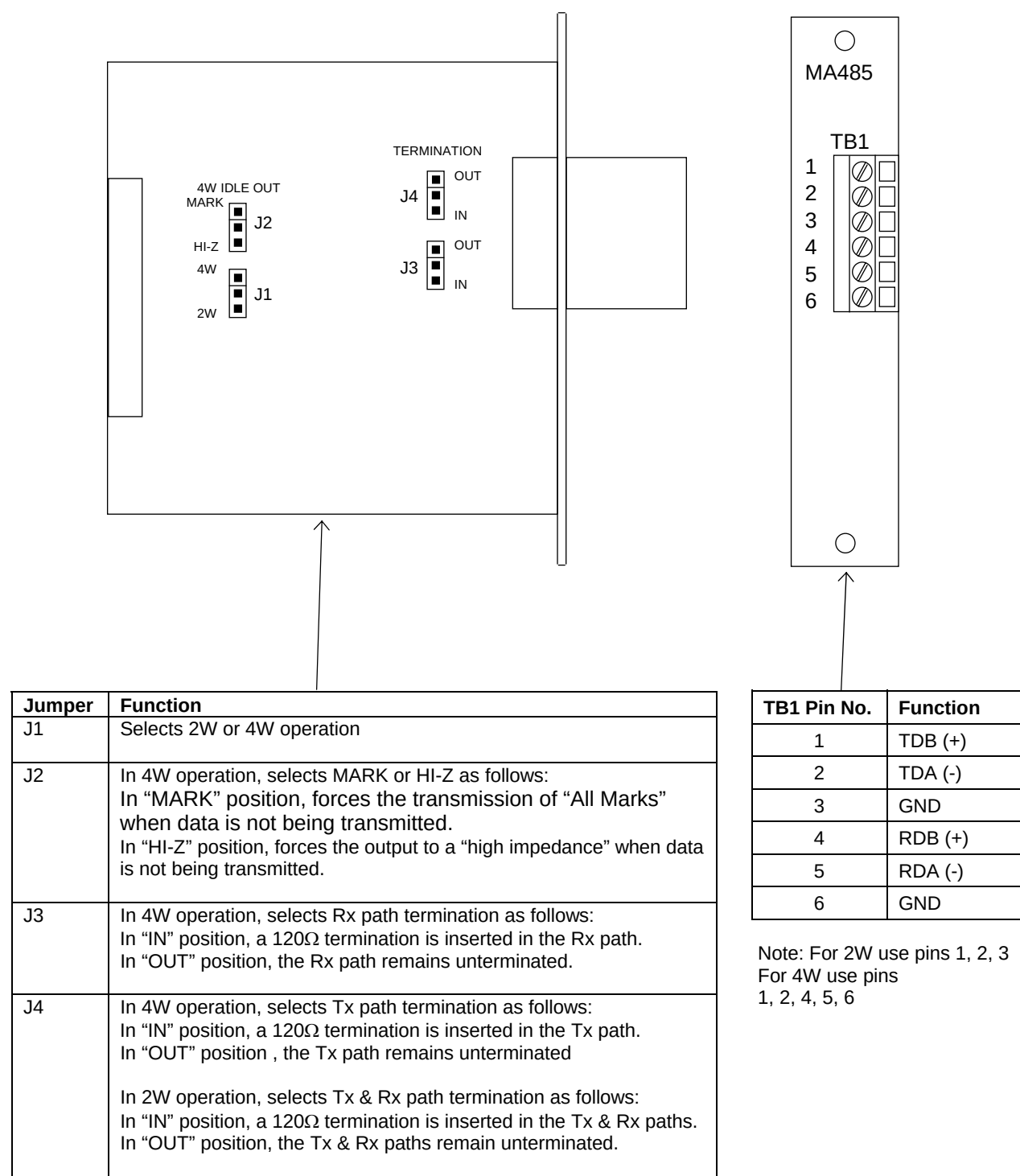


Figure 2. MA-485 Module adapter, jumper functions and TB1 pinouts

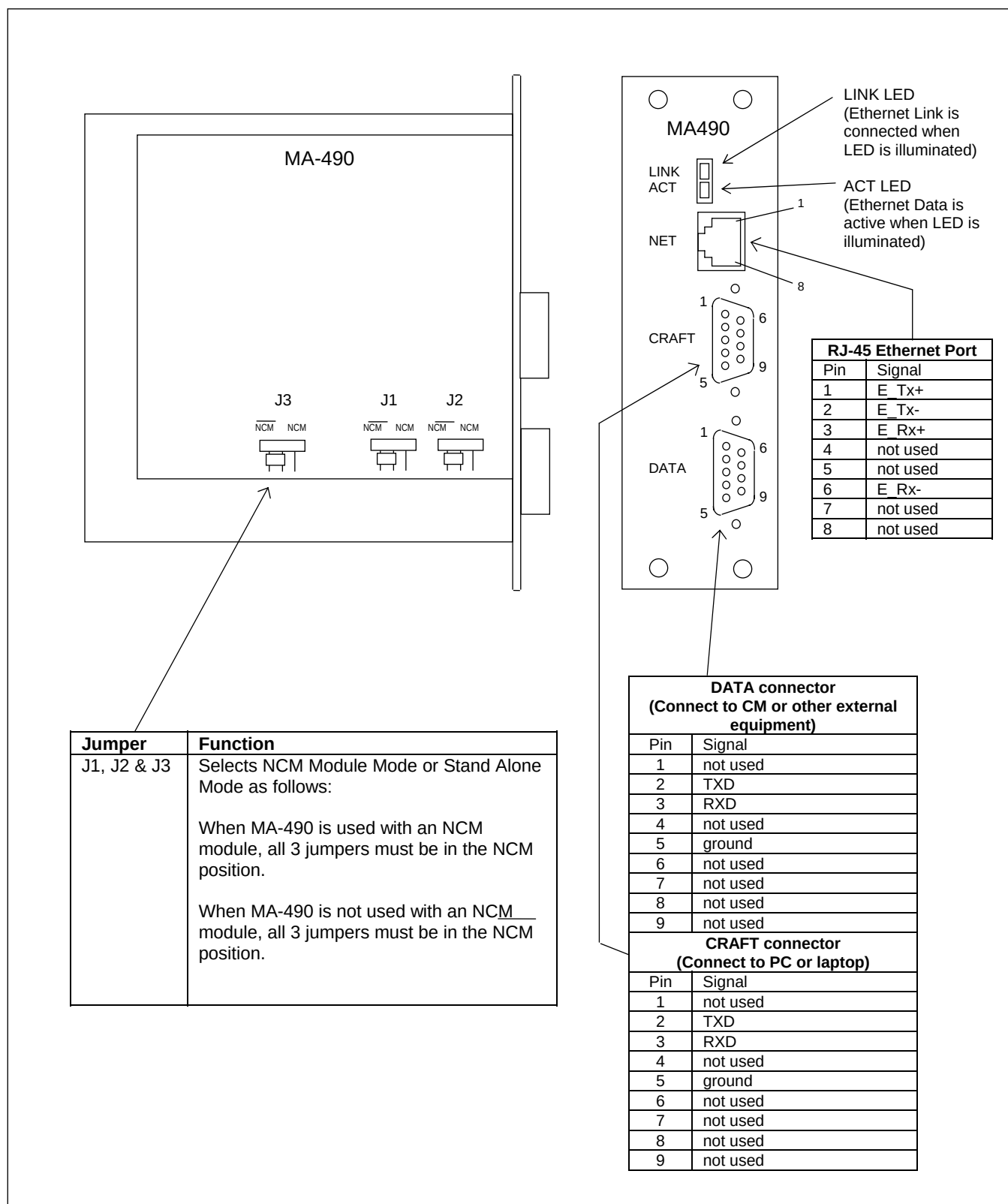


Figure 3. MA-490 Telnet I/O Module adapter, jumper functions, LED functions and connector pinouts

9. Select an unused time slot for the NCM using DIP switches SW2-1 through SW2-5. The NCM uses one 64 Kbps digital time slot within the multiplexer's aggregate rate. Set the time slot using direct binary coding as shown in Table 4. Refer to the multiplexer manual for guidelines on time slot selection.

Note that selecting an invalid time slot will disable the module. In T1 systems, only time slots 1 through 24 are allowed.

In E1 systems, time slots 1 through 31 are allowed, however, time slot 0 is reserved and cannot be used. Time slot 16 is also reserved and cannot be used if CAS is enabled in E1.

10. Select Bus direction by using DIP switches SW2-6 and SW2-7.
Place SW2-6 in the DOWN position to transmit in the A direction and receive from the B direction. Place SW2-6 in the UP position to disable transmit in the A direction and receive from the B direction.

Place SW2-7 in the DOWN position to transmit in the B direction and receive from the A direction. Place SW2-7 in the UP position to disable transmit in the B direction and receive from the A direction.
11. Switches SW3, SW4 and SW5 are only used when the NCM module is in the NMS application mode. In all other application modes these switch settings are ignored. Set Rotary Switches SW3, SW4, and SW5 to the local CM address. SW3 sets the hundreds position, SW4 sets the tens position, and SW5 sets the units position. The NCM supports CM addresses from 001 to 999. The "local CM address" must be set to the same address as the local Common Module (CM3B, CM3C, CM3R, CM6B, or CM4).
12. Set DIP switches SW6-1, -2, and -3 to set the baud rate in accordance with Table 1. If the system application mode is NMS, the baud rate must be set to the same baud rate as the local common module. Otherwise, any baud rate can be used.
13. Set DIP switches SW6-4, -5, and -6 to set the parity in accordance with Table 1. If the system application mode is NMS, the parity must be set to the same parity as the local common module. Otherwise, any parity can be used.

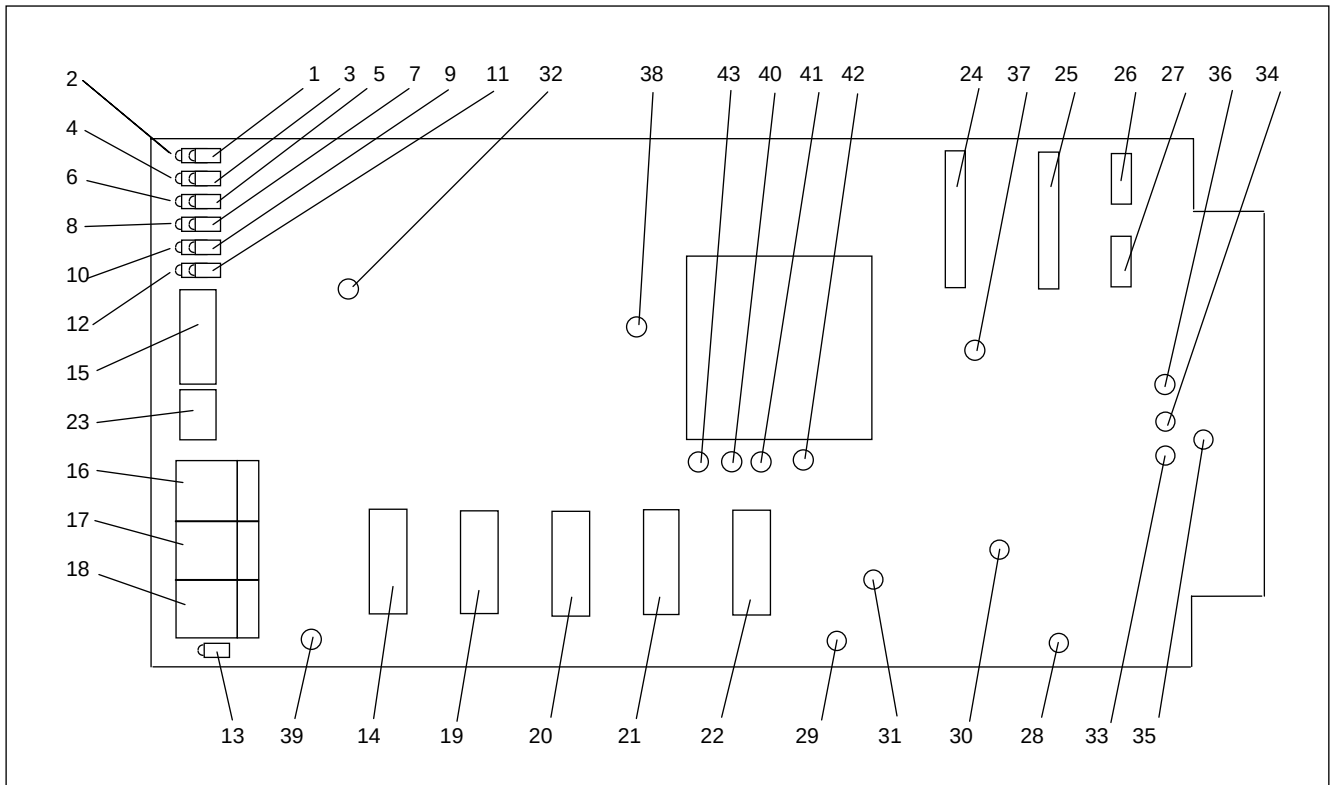


Figure 4. Controls and indicators, RFL NCM, Network Communications Module

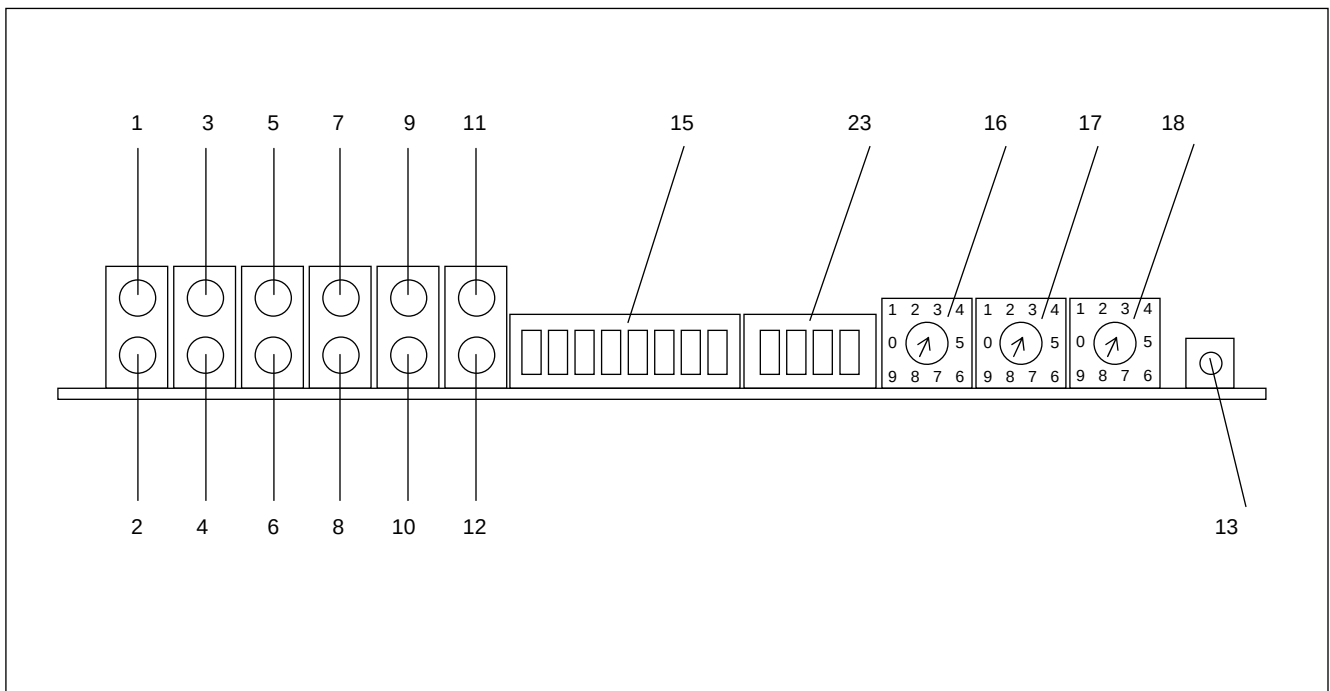


Figure 5. Front Panel View of RFL NCM, Network Communications Module

14. Set DIP switches SW6-7 and SW6-8 to set the word length (number of bits per character) in accordance with Table 1. If the system application mode is NMS, the word length must be set to the same word length as the local common module. Otherwise, any word length can be used.

NOTE

In any Application Mode, the Baud Rate, Parity and Word Length settings of the NCM must match at all nodes in the network. Additionally, In the NMS application mode, the Baud Rate, Parity and Word Length settings of the NCM and CM must match at all nodes in the network.

15. Switches SW7-1 and SW7-2 are only used when the NCM module is in the NMS application mode. In all other application modes these switch settings are ignored. Use DIP switches SW7-1 and SW7-2 to set the CM address Pass Setting in accordance with Table 1. Typically, if all the nodes in a T1/E1 network have an NCM as shown in Figure 6, the address Pass Setting will be set to only pass messages with addresses equal to the local CM address of the NCM. This feature prevents the local node from responding to queries sent to remote nodes.

Place SW7-1 in the DOWN position

Place SW7-2 in the UP position

In this example, all inter-node communication is done via the NCM path and FDL (Facility Data Link) is not used.

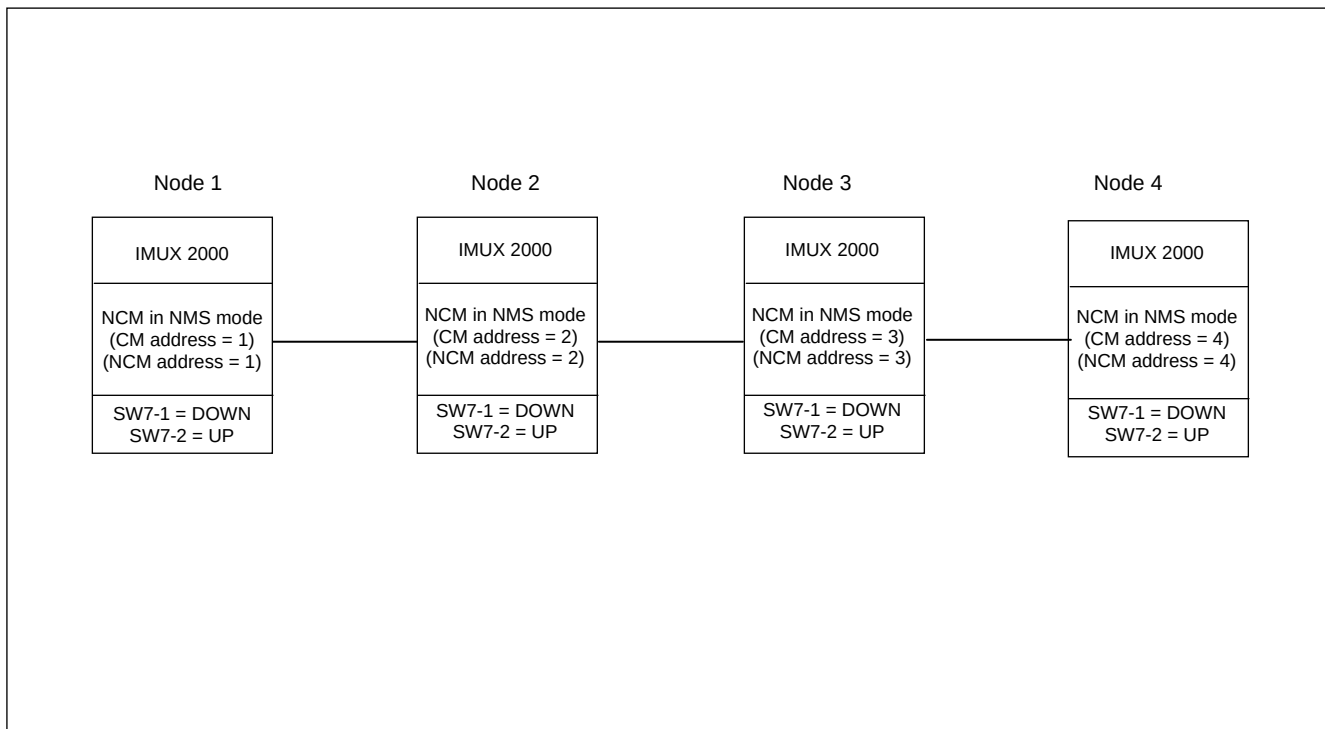


Figure 6. Typical network example with all nodes having an NCM module

15. (continued).

If some of the nodes in a T1/E1 network have an NCM, and others do not as shown in Figure 7, the address Pass Setting will be set differently at some of the nodes. In Figure 7, nodes 1, 2 and 3 have NCM modules, and nodes 4 and 5 do not have NCM modules. This network requires that at nodes 1 and 2, SW7 is set as follows:

Place SW7-1 in the DOWN position

Place SW7-2 in the UP position

And at node 3, SW7 is set as follows:

Place SW7-1 in the UP position

Place SW7-2 in the DOWN position

Additionally all 5 nodes must have the CM setting UNIV = ON to enable the FDL path. This allows a user to “transparently” communicate to all nodes regardless of which node the PC is connected to. If the PC is connected to node 1, 2 or 3, a user can “talk to” nodes 1, 2 or 3 via the NCM path, and “talk to” nodes 4 and 5 over the FDL path. If the PC is connected to nodes 4 or 5, communication to all nodes is over FDL.

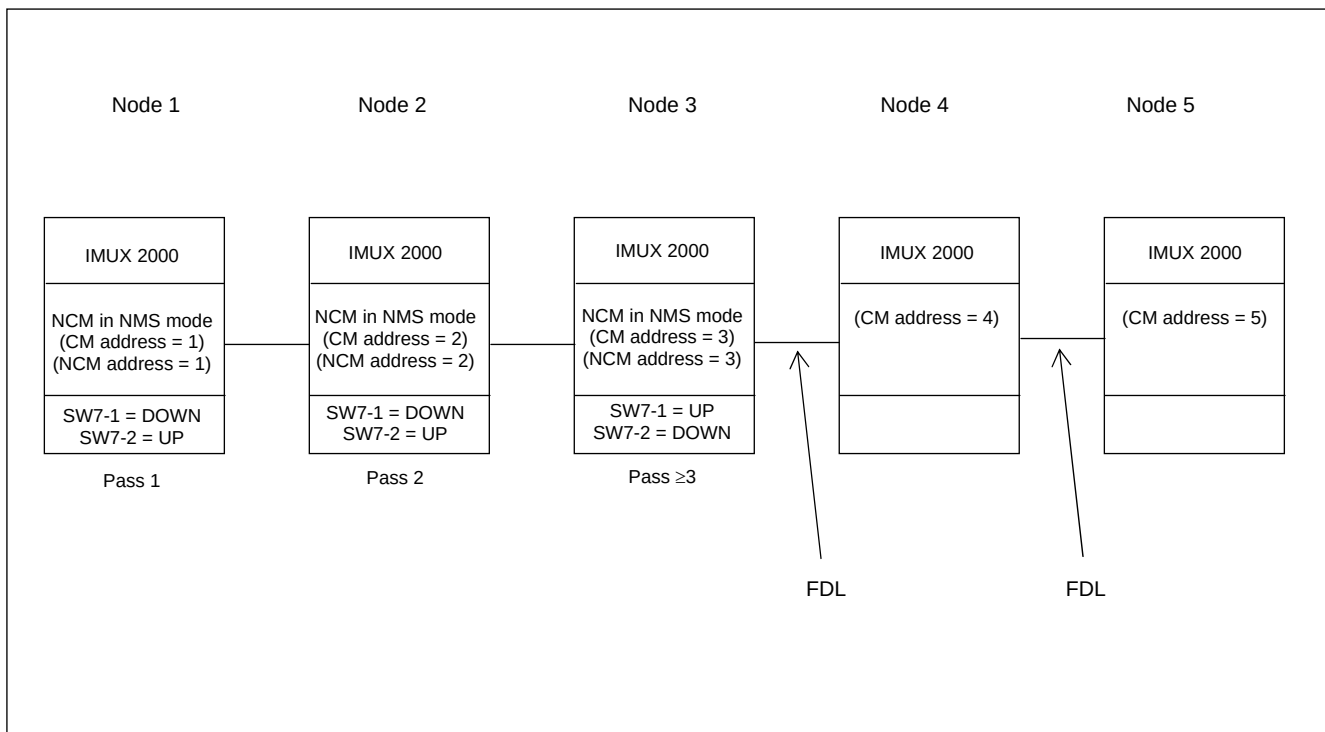


Figure 7. Network example with nodes 1, 2 and 3 having an NCM module, and nodes 4 and 5 without NCM modules

Table 1. Controls and indicators, RFL NCM Module

Item	Name/Description	Function
1	IN1 LED DS1	Lights (GREEN) when Port 1 Input Data is active and no errors detected
		Lights (RED) when Port 1 Input Data is active and errors are detected
		Lights (flashing RED) when Port 1 Rogue detector is active
		LED is (OFF) when Port 1 Input Data is idle
2	OUT1 LED DS2	Lights (GREEN) when Port 1 Output Data is active and no errors detected
		Lights (RED) when Port 1 Output Data is active and errors are detected
		LED is (OFF) when Port 1 Output Data is idle
3	IN2 LED DS3	Lights (GREEN) when Port 2 Input Data is active and no errors detected
		Lights (RED) when Port 2 Input Data is active and errors are detected
		Lights (flashing RED) when Port 2 Rogue detector is active
		LED is (OFF) when Port 2 Input Data is idle
4	OUT2 LED DS4	Lights (GREEN) when Port 2 Output Data is active and no errors detected
		Lights (RED) when Port 2 Output Data is active and errors are detected
		LED is (OFF) when Port 2 Output Data is idle
5	RXB LED DS5	Lights (GREEN) when T1/E1 Receive Data from BUS B is active and no errors detected
		Lights (RED) when T1/E1 Receive Data from BUS B is active and errors are detected
		Lights (flashing RED) when Receive BUS B Rogue detector is active
		LED is (OFF) when T1/E1 Receive Data from BUS B is idle
6	TXA LED DS6	Lights (GREEN) when T1/E1 Transmit Data to BUS A is active
		LED is (OFF) when T1/E1 Transmit Data to BUS A is idle
7	RXA LED DS7	Lights (GREEN) when T1/E1 Receive Data from BUS A is active and no errors detected
		Lights (RED) when T1/E1 Receive Data from BUS A is active and errors are detected
		Lights (flashing RED) when Receive BUS A Rogue detector is active
		LED is (OFF) when T1/E1 Receive Data from BUS A is idle
8	TXB LED DS8	Lights (GREEN) when T1/E1 Transmit Data to BUS B is active
		LED is (OFF) when T1/E1 Transmit Data to BUS B is idle
9	EQLB LED DS9	Lights (YELLOW) when Equipment Loopback for ports 1 and 2 is active
		LED is OFF when Equipment Loopback for ports 1 and 2 is inactive
10	PALB LED DS10	Lights (YELLOW) when Payload Loopback for ports 1 or 2 is active
		LED is OFF when Payload Loopback for ports 1 and 2 is inactive
11*	ADRA LED DS11	Lights (GREEN) when NCM is receiving any CM address except its own from Bus A. (This will occur during T1/E1 Line and Payload Loopbacks) Lights (YELLOW) when NCM is receiving only its own CM address from Bus A. Lights (RED) when NCM is not receiving any CM address from Bus A.
12*	ADRB LED DS12	Lights (GREEN) when NCM is receiving any CM address except its own from Bus B. (This will occur during T1/E1 Line and Payload Loopbacks) Lights (YELLOW) when NCM is receiving only its own CM address from Bus B. Lights (RED) when NCM is not receiving any CM address from Bus B.
13	Service ON LED DS13	Lights (GREEN) when service is ON
14	DIP Switch, SW1	SW1-1 to SW1-6 Selects SCB Address (See Table 3)
		SW1-7 For RFL use
		SW1-8 For RFL use

*Used in NMS application mode only.

Table 1. - continued, Controls and indicators, RFL NCM Module

Item	Name/Description	Function			
15	DIP Switch, SW2	SW2-1 to SW2-5	Selects Time Slot (See Table 4)		
		SW2-6	Selects Transmit on A Receive on B DOWN = enables Transmit on A, Receive on B UP = disables Transmit on A, Receive on B		
		SW2-7	Selects transmit on B receive on A DOWN = enables Transmit on B, Receive on A UP = disables Transmit on B, Receive on A		
		SW2-8	In E1 Systems, Selects CAS ON or OFF In T1 Systems (ignored) DOWN = CAS ON UP = CAS OFF		
16	Rotary Switch, SW3 (Hundreds)	SW3-1 to SW3-10	Selects Hundreds position of “Local CM Address” (Used in NMS application mode only. In all other application modes this switch setting is ignored.)		
17	Rotary Switch, SW4 (Tens)	SW4-1 to SW4-10	Selects Tens position of “Local CM Address” (Used in NMS application mode only. In all other application modes this switch setting is ignored.)		
18	Rotary Switch, SW5 (Units)	SW5-1 to SW5-10	Selects Units position of “Local CM Address” (Used in NMS application mode only. In all other application modes this switch setting is ignored.)		
19	DIP Switch, SW6	SW6-1 to SW6-3	Selects Baud Rate in accordance with the table below:		
			SW6-1 (Baud 2)	SW6-2 (Baud 1)	SW6-3 (Baud 0)
		Down	Down	Down	2400
		Down	Down	Up	4800
		Down	Up	Down	9600
Down	Up	Up	19,200		
Up	Down	Down	38,400		
Up	Down	Up	Undefined		
Up	Up	Down	Undefined		
Up	Up	Up	Undefined		
SW6-4 to SW6-6	Selects Parity in accordance with the table below:				
	SW6-4 (PEN)	SW6-5 (SP)	SW6-6 (EPS)	Parity	
Down	Down	Down	No Parity		
Up	Down	Down	Odd Parity		
Up	Down	Up	Even Parity		
Up	Up	Down	Mark Parity		
Up	Up	Up	Space Parity		
SW6-7 to SW6-8	Selects Word Length (Number of data bits per character) in accordance with the table below:				
	SW6-7 (WLS1)	SW6-8 (WLS0)	Word Length		
Down	Down	7 data bits			
Down	Up	8 data bits			
Up	Down	undefined			
Up	Up	undefined			

Table 1. - continued, Controls and indicators, RFL NCM Module

Item	Name/Description	Function			
20	DIP Switch, SW7	SW7-1 to SW7-2		Selects CM address pass setting in NMS application mode only in accordance with the table below. In all other application modes, these switch settings are ignored.	
		SW7-1 (ADR1)	SW7-2 (ADR0)	<u>Pass Setting</u>	
		Down	Down	Will pass any messages regardless of the “Local CM Address” setting of the NCM. Messages without address headers are also passed.	
		Down	Up	Will only pass messages with addresses equal to the “Local CM Address” setting of the NCM as defined by SW3, SW4 & SW5.	
		Up	Down	Will only pass messages with addresses greater than or equal to the “Local CM Address” setting of the NCM as defined by SW3, SW4 & SW5.	
		Up	Up	Will only pass messages with addresses less than or equal to the “Local CM Address” setting of the NCM as defined by SW3, SW4 & SW5.	
		SW7-3		Not Used	
		SW7-4 to SW7-6		Selects “Application Mode Setting” in accordance with the table below:	
		SW7-4 (Mode 2)	SW7-5 (Mode 1)	SW7-6 (Mode 0)	<u>Application Mode Setting</u>
		Down	Down	Down	broadcast mode
Down	Down	Up	NMS mode		
Down	Up	Down	master mode		
Down	Up	Up	D&I slave mode		
Up	Down	Down	End, slave mode		
Up	Down	Up	Undefined		
Up	Up	Down	Undefined		
Up	Up	Up	Undefined		
Note: Refer to Table 2 for additional switch setting information.					
SW7-7		Enables or disables Port 2 UP = Port 2 enabled DOWN = Port 2 disabled			
Note: Port 2 not available when MA-485 I/O is used.					
SW7-8		Enables or disables Rogue Control UP = Rogue Control enabled DOWN = Rogue Control disabled			
21	DIP Switch, SW8	SW8-1 to SW8-8	Not Used		
22	DIP Switch, SW9	SW9-1 to SW9-8	Not Used		

Table 1. - continued, Controls and indicators, RFL NCM Module

Item	Name/Description	Function															
23	DIP Switch, SW10	SW10-1 to SW10-2 Selects Loopback operation in accordance with the table below: <table><tr><td>SW10-1 (LB1)</td><td>SW10-2 (LB2)</td><td><u>Loopback Setting</u></td></tr><tr><td>Down</td><td>Down</td><td>Enable port 2 payload loopback</td></tr><tr><td>Down</td><td>Up</td><td>Enable ports 1 & 2 equipment loopback</td></tr><tr><td>Up</td><td>Down</td><td>Enable port 1 payload loopback</td></tr><tr><td>Up</td><td>Up</td><td>Disable loopbacks</td></tr></table>	SW10-1 (LB1)	SW10-2 (LB2)	<u>Loopback Setting</u>	Down	Down	Enable port 2 payload loopback	Down	Up	Enable ports 1 & 2 equipment loopback	Up	Down	Enable port 1 payload loopback	Up	Up	Disable loopbacks
		SW10-1 (LB1)	SW10-2 (LB2)	<u>Loopback Setting</u>													
		Down	Down	Enable port 2 payload loopback													
		Down	Up	Enable ports 1 & 2 equipment loopback													
Up	Down	Enable port 1 payload loopback															
Up	Up	Disable loopbacks															
SW10-3* Enables or disables Remote operation UP = Local Operation DOWN = Remote Operation																	
SW10-4 Enables or disables Service On UP = Service On DOWN = Service Off																	
24	J1 Header	For RFL Use (used to program the Lattice Device U6)															
25	J2 Header	For RFL Use (used for JTAG Interface and ACTEL Probe)															
26	J5 Jumper	For RFL Use (selects J1 or J2 Header)															
27	J6 Jumper	For RFL Use (selects J1 or J2 Header)															
28	Test Point TP1	+5Vdc															
29	Test Point TP2	Ground															
30	Test Point TP3	2.5Vdc															
31	Test Point TP4	3.3Vdc															
32	Test Point TP5	Not Used															
33	Test Point TP6	Port 1 Input Data															
34	Test Point TP7	Port 2 Input Data															
35	Test Point TP8	Port 1 Output Data															
36	Test Point TP9	Port 2 Output Data															
37	Test Point TP10	PRA (ACTEL probe A)															
38	Test Point TP11	PRB (ACTEL probe B)															
39	Test Point TP12	Ground															
40	Test Point TP13	For RFL use															
41	Test Point TP14	For RFL use															
42	Test Point TP15	For RFL use															
43	Test Point TP16	For RFL use															

* If your NCM module is to be used in NMS Application Mode, this switch should be in the Local (UP) position, otherwise you may lose NMS communications if settings are changed.

Table 2. Application Modes And Bus Settings

NMS Application Mode (SW7-4, SW7-5 & SW7-6)	Transmit on A Receive on B (SW2-6)	Transmit on B Receive on A (SW2-7)	Application
Broadcast	enabled	disabled	The NCM mode will be Terminal broadcast or DI-A broadcast
	disabled	enabled	The NCM mode will be DI-B broadcast
	enabled	enabled	The NCM mode will be D&I broadcast
	disabled	disabled	(Not a valid setting. The NCM module is disabled)
NMS	enabled	disabled	The NCM mode will be Terminal NMS or DI-A NMS
	disabled	enabled	The NCM mode will be DI-B NMS
	enabled	enabled	The NCM mode will be D&I NMS
	disabled	disabled	(Not a valid setting. The NCM module is disabled)
Master	enabled	disabled	The NCM mode will be Terminal Master or DI-A Master
	disabled	enabled	The NCM mode will be DI-B Master
	enabled	enabled	The NCM mode will be D&I Master
	disabled	disabled	(Not a valid setting. The NCM module is disabled)
D&I Slave	enabled	disabled	The NCM mode will be D&I Slave and the Master NCM node is in the A direction.
	disabled	enabled	The NCM mode will be D&I Slave and the Master NCM node is in the B direction.
	enabled	enabled	(Not a valid setting. The NCM module is disabled)
	disabled	disabled	(Not a valid setting. The NCM module is disabled)
D&I End	enabled	disabled	The NCM mode will be Terminal End Slave or DI-A End Slave
	disabled	enabled	The NCM mode will be DI-B End Slave
	enabled	enabled	(Not a valid setting. The NCM module is disabled)
	disabled	disabled	(Not a valid setting. The NCM module is disabled)

Note: enabled = DOWN, disabled = UP

Table 3. SCB address settings, RFL NCM module

Module Address	SW1-1	SW1-2	SW1-3	SW1-4	SW1-5	SW1-6
1	DOWN	DOWN	DOWN	DOWN	DOWN	UP
2	DOWN	DOWN	DOWN	DOWN	UP	DOWN
3	DOWN	DOWN	DOWN	DOWN	UP	UP
4	DOWN	DOWN	DOWN	UP	DOWN	DOWN
5	DOWN	DOWN	DOWN	UP	DOWN	UP
6	DOWN	DOWN	DOWN	UP	UP	DOWN
7	DOWN	DOWN	DOWN	UP	UP	UP
8	DOWN	DOWN	UP	DOWN	DOWN	DOWN
9	DOWN	DOWN	UP	DOWN	DOWN	UP
10	DOWN	DOWN	UP	DOWN	UP	DOWN
11	DOWN	DOWN	UP	DOWN	UP	UP
12	DOWN	DOWN	UP	UP	DOWN	DOWN
13	DOWN	DOWN	UP	UP	DOWN	UP
14	DOWN	DOWN	UP	UP	UP	DOWN
15	DOWN	DOWN	UP	UP	UP	UP
16	DOWN	UP	DOWN	DOWN	DOWN	DOWN
17	DOWN	UP	DOWN	DOWN	DOWN	UP
18	DOWN	UP	DOWN	DOWN	UP	DOWN
19	DOWN	UP	DOWN	DOWN	UP	UP
20	DOWN	UP	DOWN	UP	DOWN	DOWN
21	DOWN	UP	DOWN	UP	DOWN	UP
22	DOWN	UP	DOWN	UP	UP	DOWN
23	DOWN	UP	DOWN	UP	UP	UP
24	DOWN	UP	UP	DOWN	DOWN	DOWN
25	DOWN	UP	UP	DOWN	DOWN	UP
26	DOWN	UP	UP	DOWN	UP	DOWN
27	DOWN	UP	UP	DOWN	UP	UP
28	DOWN	UP	UP	UP	DOWN	DOWN
29	DOWN	UP	UP	UP	DOWN	UP
30	DOWN	UP	UP	UP	UP	DOWN
31	DOWN	UP	UP	UP	UP	UP
32	UP	DOWN	DOWN	DOWN	DOWN	DOWN
33	UP	DOWN	DOWN	DOWN	DOWN	UP
34	UP	DOWN	DOWN	DOWN	UP	DOWN
35	UP	DOWN	DOWN	DOWN	UP	UP
36	UP	DOWN	DOWN	UP	DOWN	DOWN

NOTE: For SW1, UP = ON and DOWN = OFF.

Table 4. Time Slot Select for RFL NCM module

Switch Code (Decimal)	Switch Settings					T1	E1
	SW2-1	SW2-2	SW2-3	SW2-4	SW2-5		
0	DOWN	DOWN	DOWN	DOWN	DOWN	*	*
1	DOWN	DOWN	DOWN	DOWN	UP	1	1
2	DOWN	DOWN	DOWN	UP	DOWN	2	2
3	DOWN	DOWN	DOWN	UP	UP	3	3
4	DOWN	DOWN	UP	DOWN	DOWN	4	4
5	DOWN	DOWN	UP	DOWN	UP	5	5
6	DOWN	DOWN	UP	UP	DOWN	6	6
7	DOWN	DOWN	UP	UP	UP	7	7
8	DOWN	UP	DOWN	DOWN	DOWN	8	8
9	DOWN	UP	DOWN	DOWN	UP	9	9
10	DOWN	UP	DOWN	UP	DOWN	10	10
11	DOWN	UP	DOWN	UP	UP	11	11
12	DOWN	UP	UP	DOWN	DOWN	12	12
13	DOWN	UP	UP	DOWN	UP	13	13
14	DOWN	UP	UP	UP	DOWN	14	14
15	DOWN	UP	UP	UP	UP	15	15
16	UP	DOWN	DOWN	DOWN	DOWN	16	16****
17	UP	DOWN	DOWN	DOWN	UP	17	17
18	UP	DOWN	DOWN	UP	DOWN	18	18
19	UP	DOWN	DOWN	UP	UP	19	19
20	UP	DOWN	UP	DOWN	DOWN	20	20
21	UP	DOWN	UP	DOWN	UP	21	21
22	UP	DOWN	UP	UP	DOWN	22	22
23	UP	DOWN	UP	UP	UP	23	23
24	UP	UP	DOWN	DOWN	DOWN	24**	24
25	UP	UP	DOWN	DOWN	UP	*	25
26	UP	UP	DOWN	UP	DOWN	*	26
27	UP	UP	DOWN	UP	UP	*	27
28	UP	UP	UP	DOWN	DOWN	*	28
29	UP	UP	UP	DOWN	UP	*	29
30	UP	UP	UP	UP	DOWN	*	30**
31	UP	UP	UP	UP	UP	*	31****

Notes: * This setting is not allowed . Setting switches to this code will cause the module's service to be disabled.

**This setting is not valid in a T1 or E1 network utilizing fast reframing.

*** This setting is not valid in an E1 network utilizing inter-node communications (NMX).

**** This setting is not valid if signaling CAS is enabled in E1.

16. If you plan to operate the NCM module under local control, perform the following steps; otherwise, go to step 17 for remote control. Local control is recommended for NMS application mode.
 - a. Set to local control by placing DIP switch SW10-3 in the UP position.
 - b. Turn service on by placing DIP switch SW10-4 in the UP position.
 - c. Slide the module into the selected module slot until it is firmly seated and the module front panel is flush with the top and bottom of the shelf.
 - d. Go to step 18.
17. If you plan to operate the NCM module under remote control, perform the following steps:
 - a. Set to local control by placing DIP switch SW10-3 in the UP position.
 - b. Turn service off by placing DIP switch SW10-4 in the DOWN position.
 - c. Slide the module into the selected module slot until it is firmly seated and the module front panel is flush with the top and bottom of the shelf.
 - d. Wait 15 seconds for the NCM module's parameter settings to be loaded into the shelf Common Module.
 - e. Pull the module out of the shelf and set to remote control by placing DIP switch SW10-3 in the DOWN position.
Do not move SW10-4.
 - f. Slide the module back into the shelf.
 - g. Verify the module configuration through remote control by issuing a "CONFIG?" query. See the Remote Control Interface section of this Instruction Data Sheet for an explanation of the "CONFIG?" response.
 - h. Turn service on through remote control by issuing a "SRVC=ON" command.
The operating parameters of the NCM module can now be changed by remote control. See the Remote Control Interface section of this Instruction Data Sheet for more information.
 - i. Go to step 18.
18. On the Module Record Card located to the right of the shelf, record the channel bank type, time slot, and any other pertinent information.
19. The NCM module is now installed. If your multiplexer is set up for remote access and control, you can now change the operating parameters of the module by using simple commands. For more information on remote access and control, consult your multiplexer operation manual.

FUNCTIONAL DESCRIPTION

Figure 8 is a block diagram of the RFL NMS module. It is provided to familiarize the user with the NMS signal flow and interfacing. The figure shows signal flow in the transmit and receive modes of operation.

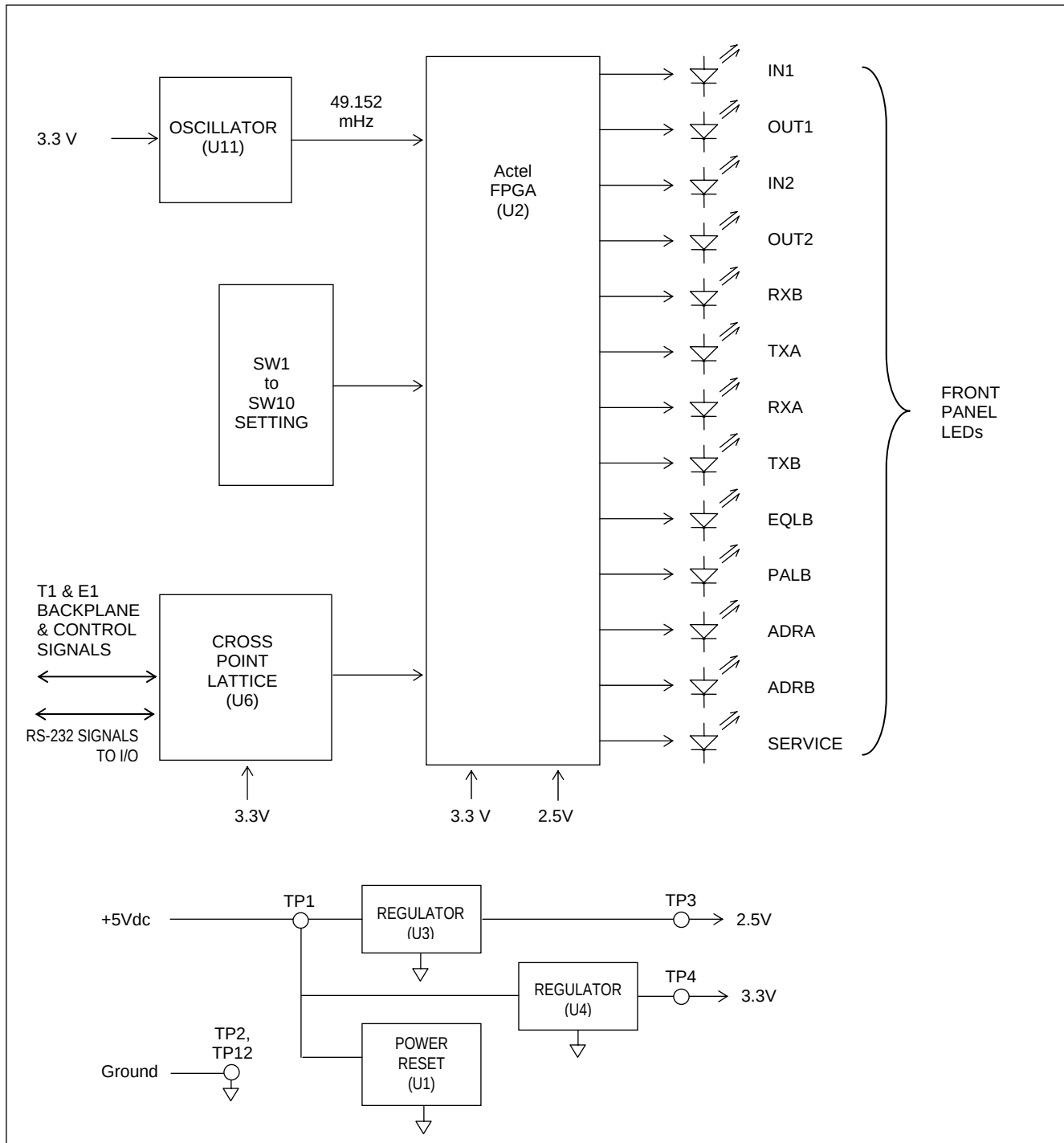


Figure 8. Block diagram, RFL NCM module.

SYSTEM OVERVIEW

The Network Communications Module (NCM) is an Asynchronous Data Module designed for RFL IMUX 2000 T1 and E1 Multiplexers. The NCM provides one DCE Half/Full-Duplex channel between an unlimited number of locations using a single 64 kbps DS0 time slot. The NCM provides an NMS communication path between nodes of a T1 or E1 network, and can also be used for party-line applications such as DNP and Modbus networking. The NCM automatically detects if the system is T1 or E1 and configures itself appropriately.

The NCM in NMS application mode is *not* required for T1, but could be utilized to speed up network communications, or provide a communication path to remote locations. The NCM is required for E1 systems, because an out of network communication path does not exist.

The NCM supports RS-232, RS-485 (2W and 4W), and Telnet interfaces with the MA-402I, MA-485 and MA-490 Telnet I/O respectively, and supports Equipment and Payload Loop-backs. The NCM does not support handshaking of any kind, and does not respond to RTS. The NCM uses Stop-bit reduction during transmission of asynchronous data as a means to compensate for received baud slightly greater than normal. For RS-232 applications, the NCM does keep CTS, RLSD and DSR active at all times for external equipment requiring these to be active.

The NCM supports either one or two ports depending on the interface installed. Each port includes a UART, and can transmit to and receive from the T1/E1 bus, and transmit to and receive from one another, depending on the configuration and application. The ports support 38.4k, 19.2k, 9600, 4800 and 2400 baud, support 7 or 8 data bits, and support Even, Odd, Mark Space and No Parity.

The NCM utilizes a proprietary communication protocol over T1/E1 consisting of two data and two idle/address frames. The two data frames make up the entire data package, and are transmitted and received in consecutive frames. The idle/address frames occur only during idle-time between data packages, and are also transmitted and received in consecutive frames. Only the NMS Mode currently supports addressing.

The NCM does not support signaling bits within the T1/E1 data stream, however, the CAS setting on the NCM module will “block” the selection of timeslot 16 for an E1 multiplexer using CAS, preventing the NCM from potentially disrupting other modules in the network.

The NCM supports “Address Passing” and “Character Pacing” in the NMS Mode of operation. “Address Passing” qualifies messages prior to sending them out of port (#2) to the CM-X module. “Character Pacing” emulation is done as a result of the “Address Passing” requirement.

A Rogue Control feature is available which prevents a rogue PC program or another module from “stepping” on the NCM time slot, and bringing down the entire NCM Path.

NCM BACKPLANE AND POWER CONNECTIONS

The NCM occupies a single slot in the multiplexer chassis and conforms to the RFL IMUX 2000 back plane signal format. All T1 and E1 signals, and control signals passing through the back plane, interface with the cross point Lattice device (U6). All inputs and outputs of the Lattice Device are pulled up to 3.3V through approximately 50K Ohms.

The NCM requires digital +5Vdc and digital ground connections to the back plane. TP2 and TP12 are the ground test points. The digital +5V from the back plane is routed to the Hot Swap Controller (U1, which controls the ramp of the power to all of the ICs. The ramped digital +5V supply is only directly used to provide power to the LEDs, DS1 through DS13, and can be monitored at TP1.

Linear voltage regulators U3 and U4 step-down the +5V digital supply to produce +2.5V and +3.3V supplies respectively. The +2.5V is used exclusively to power the Actel FPGA (U2). The 3.3V is used to power the Lattice device (U6), the I/O of the Actel (U2), the 49.152mHz oscillator (U11), and the pull-up resistors on the module. The +2.5V and 3.3V supplies can be monitored at TP3 and TP4 respectively. All pins which connect to the back plane, except for voltages and grounds, are cut back to prevent components from being driven before the module is fully powered.

TX INPUT PORTS

The NCM module supports one or two TX input ports depending on the interface adapter installed (i.e. MA-402I, MA-485, or MA-490). An asynchronous data signal is applied to a TX input of the appropriate interface adapter. The data signal is converted from RS-232, MA-485, or Ethernet to a logic signal on the interface adapter before being fed through the back plane to the NCM module. These logic signals pass through the Lattice device (U6), and are applied to the Actel's (U2) UART receive section. Indication of TX input activity can be observed at the IN1 and IN2 LEDs, and via the NMS software.

RX OUTPUT PORTS

The asynchronous logic data signal is transmitted by the UART Transmit section of the Actel (U2), and passes through the Lattice device and back plane to the interface adapter. The interface adapter converts the logic signal to the appropriate interface format (i.e. RS-232, RS-485, or Ethernet), depending on the interface adapter installed. The CTS and RLSD are always active for RS-232 applications (MA-402I) that require these to be active. Indication of RX output activity can be observed at OUT1 and OUT2, and via the NMS software.

LOGIC ARRAY (ACTEL DESIGN)

The Actel FPGA controls, processes, and coordinates all functions of the NCM. It interfaces switches, LEDs, SCB bus signals, T1/E1 bus signals, and I/O control lines. The Actel design can be broken down into the following nine functions: SCB, Application Modes and Interfaces, UART Receive, UART Transmit, T1 Transmit, T1 Receive, Rogue Control, Loop-backs, and Baud and Clock Generator.

1. SCB MODULE

The SCB circuit is used to generate the read, write, and address data necessary to transfer control and status data to and from the SCB bus. The SCB address is configured externally via SW1 and is selectable between 1 and 36. The SCB circuit also communicates to the Common Module the following information: Card Type (117), number of configuration bytes, and number of status bytes.

In LOCAL mode the position of configuration switches (SW1 through SW9) are “read” by the Common Module, and then converted into standard P code and S code format.

In REMOTE mode, the NCM module does not rely on the position of configuration switches (SW2 through SW9). Instead, the Common Module “writes” the configuration to the NCM. The NCM requires that it receives exactly the same information three consecutive times before it accepts the updated configuration information as correct.

NCM “Service” is qualified in order to minimize user setup error, and prevents operation if the quality of the bus signal prevents the logic from determining whether the multiplexer is T1 or E1. In general, E1 does not allow the use of TS0 and TS16 if CAS is enabled, and T1 does not allow the setting of TS0 or any setting greater than TS24. It is the users responsibility to be aware of the network setup before selecting a channel to use. This qualification does not detect or prevent “stepping” on a time slot previously in use, including those that may be used for Fast Reframing, or network communications (NMX in E1). NCM “Service” is also qualified for non-existent and invalid modes of operation.

2. APPLICATION MODES AND INTERFACES

NCM operation depends on the selected Application Mode, and the type of I/O interface installed. The NCM uses an I/O type ID to determine which I/O is installed. If the installed I/O is the MA-485, an additional bit is used to indicate whether it includes one or two ports. The two port version does not currently exist.

The NMS includes the following Application Mode settings, and I/O types

Application Mode settings

- NMS Mode
- Broadcast Mode
- Master Mode
- D&I Slave Mode
- End Slave Mode

The purpose of the NMS Mode is to provide a high-speed communication path between nodes for NMS. The other application modes provide a communication path between an MTU and several RTUs. The NMS Mode of operation requires the use of the MA-402I with two RS-232 ports, or the MA-490 with two RS-232 ports and an Ethernet port. In respect to the NCM, Port 1 is the “Local” port and Port 2 is the “CM” port. The additional RS-232 port on the MA-490 is used to configure the local Ethernet Port. The NMS mode is a Broadcast-type application but includes “Address Passing” and “Character Pacing” circuits for the “CM” port.

In the Broadcast Mode of operation, all nodes receive the same data regardless of who is transmitting. The broadcasting applies to both ports of a two-port I/O.

The Master Mode of operation designates a particular NCM at a node, as the master. If the NCM is set up for TERM/DI-A or DI-B operation, and the I/O has only one port, the actual functionality is the same as the broadcast mode. If the NCM is set up for both DI-A and DI-B operation, the data received from either bus is terminated and is not passed back onto the bus. If the I/O has two ports, Port 2 is always the slave to the Port 1 master, and cannot transmit onto or receive from the T1 bus. Typically, the master transmits to and receives from all of the slave locations. Only one slave can transmit onto the T1 bus any time, otherwise the data received by the master will be corrupted.

The D&I Slave Mode of operation designates an NCM at a D&I node as slave that must pass data thru but only transmits to and receives from the master. Set for TERM/DI-A or DI-B operation towards the master location. Only one slave can transmit onto the T1 bus any time, otherwise the data received will be corrupted.

The End Slave Mode of operation designates the particular NCM at a node as the terminating point of a network that is not the master. The NCM is setup for TERM/DI-A or DI-B operation depending on the direction to be terminated. If the I/O has only one port, the actual functionality is the same as the broadcast mode. If the I/O has two ports, both ports are slaves that transmit to and receive from the master, but not with one another.

The NMS uses the following I/O Interface types:

I/O Types/Module Adapter
RS-232 (or none)/ MA-402I
Ethernet/ MA-490
RS-485 4W/ MA-485
RS-485 2W/ MA-485

The MA-485 I/O is used for both 2W and 4W RS-485 applications, and will support all of the NCM Application Modes except NMS mode. The jumper position on the I/O is set to either “2W” or “4W”, and sets the Type ID accordingly. The input and output serial data is routed as required for the selected RS-485 type. In “4W” mode, a jumper on the I/O will force the driver to always be enabled so that an idle condition produces a MARK output. The “2W” mode only supports half-duplex operation, while the “4W” mode supports both half and full duplex operation.

3. UART RECEIVE SECTION

The UART receivers are programmed for the appropriate baud, number of data bits, and parity for the input data expected to be received. The input data, including start, stop, and parity, is sampled by a 64X nominal baud internal clock. The received parity bit is compared to the parity calculated by the UART. Once the data is recognized as valid, the data is latched and is ready for transmission. The UART receiver is reset if a framing error, parity error, or break indication is detected.

UART TRANSMIT SECTION

The UART transmitters are programmed for the appropriate baud, number of data bits, and whether or not parity is to be enabled for the output data to be transmitted. This circuit reacts to a “Data Ready” flag, and latches the data into its 16-byte FIFO. The data is then loaded into the transmitter shift register, and is then shifted out. The parity is transmitted as received from the T1 receiver, and is not checked or regenerated. The end equipment is responsible for parity checking.

The NCM module utilizes two additional transmitter circuits that interface with the Common Module exclusively in NMS mode of operation. These circuits include “Address Passing” and “Character Pacing”. Typically, the NCM will allow messages meant for the particular node in which it is physically installed, to pass, and block all others. However, the NCM can be configured to pass “any address”, or a wide-range of addresses greater than or less than a specified address.

The Common Module is also given permission to talk to the bus in response to a message qualified as an address match. All other Common Modules in the network will be forced off the bus as a result of any valid address header but no address match. The most recent addressed Common Module will have control of the bus until any other Common Module is addressed.

“Character Pacing” is required so that the NCM does not saturate the Common Module port with a continuous data stream of characters following an address match. This prevents the Common Module processor from “missing” characters if they are received without idle time between consecutive characters.

5. T1 TRANSMIT MODULE

The T1 transmit module acknowledges the “Data Ready” flag set by either local UART receivers, and latches the (character) data. The data is then transmitted in consecutive T1 frames at the proper time slot on the positive edge of the T1 clock. Indication of T1 transmit can be observed at the TXA and/or TXB LEDs, and via the NMS software.

If the NCM has both busses enabled, the data received from a T1 bus is re-transmitted back onto the same bus on the next frame. This pass-thru data has higher priority over the data from the local UART receivers.

The NCM, for all modes except NMS mode, transmits an idle pattern when data is not active at either UART receiver, or the T1 bus (if applicable). The idle pattern may be interrupted at any time when data is ready to be transmitted.

In NMS mode only, the NCM transmits an address pattern when data is not active at either UART receiver, or the T1 bus (if applicable). The address pattern may be interrupted at any time when data is ready to be transmitted. The address frames are received and terminated at the adjacent NCM in the network.

6. T1 RECEIVE MODULE

The T1 receive module clocks in the receive data at the proper time slot on the negative edge of the T1 clock, and latches it one clock following the time slot. The data is decoded as being either data or idle/address frame, and as being low or high frame.

In NMS mode, the NCM will block all data until low and high address frames are received in consecutive T1 frames, decoded, and then determined to be a valid BCD address. Once low and high address frames are latched, the “Address Valid” signal is activated. Indication of “Address Valid” can be observed at the ADRA and/or ADRB LEDs, and via the NMS software. Indication of T1 receive can be observed at the RXA and/or RXB LEDs, and via the NMS software

7. ROGUE CONTROL

The Rogue Control feature is used to prevent a rogue PC program or another module from “stepping” on the NCM time slot and bringing down the entire NCM path. If enabled, both the local input(s) and T1 receive inputs will monitor for rogue activity. The local port is squelched for at least two minutes once a continuous data stream lasting for greater than 60 seconds is detected. The T1 receive data is squelched for at least two minutes once a continuous data stream lasting for greater than 64 seconds is detected on the bus. The T1 rogue threshold is set intentionally higher than the local port to prevent all the nodes from reacting to a rogue at any of the local ports. However, a rogue occurring on the T1 can (initially) trip several of the rogue detectors because all of the nodes downstream “see” the same data pattern. (Note that the T1 received data is also squelched on a frame-by-frame basis if the T1 data/addressing protocol is not maintained. In the NMS mode, the data would remain squelched until valid a address is once again detected.) The 0.5 seconds RED/0.5 seconds OFF cadence indicates an active rogue at RXA, RXB, IN1 or IN2 LEDs. An active rogue status is also indicated for each input via the NMS software.

8. LOOP-BACKS

When the NCM is enabled for Equipment loop-back, the serial data received at IN1 and/or IN2 is re-clocked by the UART receiver(s) and then re-transmitted out of OUT1 and/or OUT2 by the UART transmitter(s) respectively. The error status conditions are inactive, parity is not checked or re-generated, data is not transmitted onto the T1 bus, and the EQLB LED will be illuminated orange.

When the NCM is enabled for Payload loop-back, the UART transmitter is internally connected to the UART receiver input. The IN1 or IN2 local inputs are ignored. The OUT1 or OUT2 is held high. The error status conditions are active, parity is checked, and the data is re-transmitted back onto the T1 bus. The PALB LED will be illuminated orange. Only one port is activated for Payload Loop-back at a time. Note: In broadcast or NCM mode, all ports not in the test loop may receive corrupted data because data is received simultaneously from two sources.

9. BAUD AND CLOCK GENERATOR

The Baud and Clock Generator module divides down the 49.152MHz frequency provided by the external board oscillator (U11). It generates the 64X Baud required for the UARTS, and clock frequencies used for synchronous timers by other modules in the Logic Array.

TESTING

After the NCM module has been configured and installed, it should be tested for proper operation before it is put into service. At present, the only test necessary to verify NCM performance is the loop test in NMS mode. This test is performed when the module is installed to verify operational performance in terminal, DI-A, or DI-B configurations.

TEST EQUIPMENT REQUIRED

1. PC with version 10.3 or greater of NMS.
2. IMUX 2000 Multiplexer.
3. Patch cord terminated in bantam jacks (2 required).
4. Male to female null modem RS-232 cable (RFL part number 303366-2 or equivalent)

LOOP TEST PROCEDURE FOR RFL NCM MODULES IN NMS MODE INSTALLED IN TERMINAL MULTIPLEXERS

The following procedure is used to test NCM modules installed in IMUX 2000 terminal multiplexers.

1. Connect the male to female null modem RS-232 cable from CH2 of the MA-401I to the DB9 male connector on the CM I/O.
2. Open the door on the front of the IMUX 2000 multiplexer.
3. Connect a patch cord between the EQUIP-T1-OUT and EQUIP-T1-IN jacks on the front of the IMUX 2000 chassis. The jacks are located on the Common Module.
4. With power applied to the IMUX 2000, check the indicators on the front of the power supply module.

The POWER indicator should be lit.

5. Check the Service LED (DS13) on the front panel of the NCM. See Figure 4 and Table 1 for location.

The Service LED should be illuminated green.

6. Check the ADRB LED (DS12) on the front panel of the NCM. See Figure 4 and Table 1 for location.

**The ADRB LED should be illuminated solid orange. (should not be red or green)
Orange indicates the NCM is receiving its own address.**

7. Check the RXB LED (DS5) on the front panel of the NCM. See Figure 4 and Table 1 for location.

The RXB LED should be illuminated red.

8. Connect the PC to the CH1 RS-232 connector using the male to female RS-232 connector. At this point, the equipment should be connected as shown in Figure 9. Run the RFL NMS communications software and set the parameters exactly the same as the CM and the NCM.

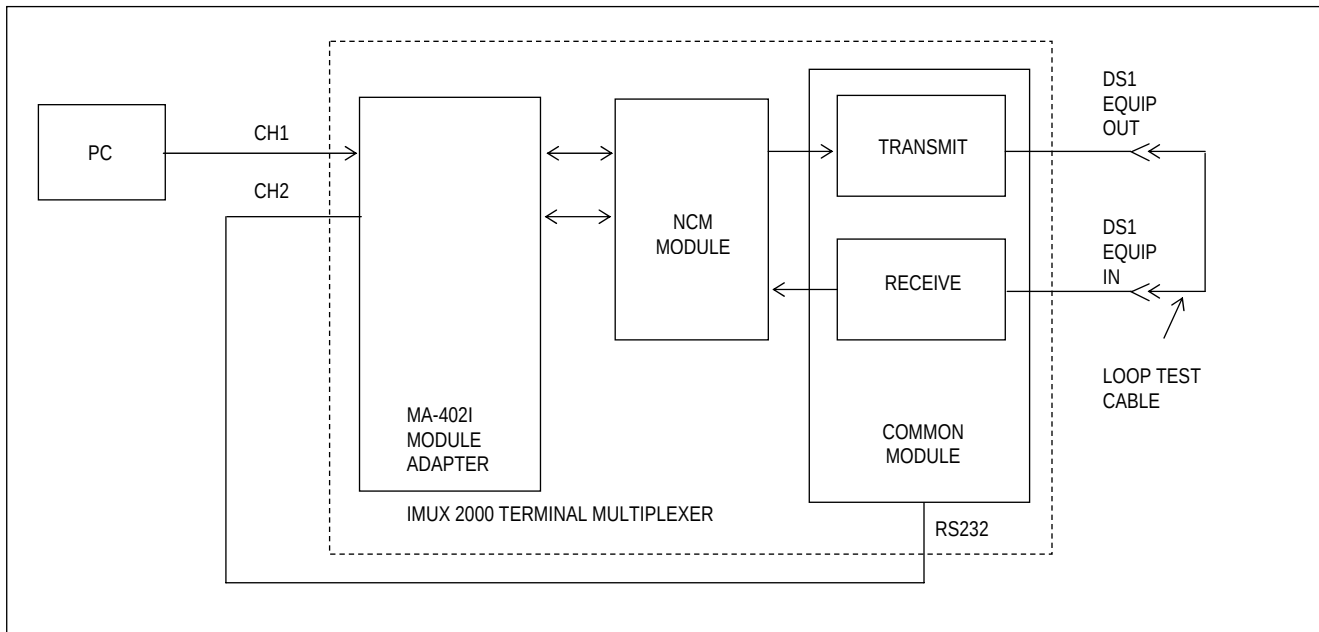


Figure 9. Simplified block diagram, loop test for RFL NCM module in NMS mode, installed in a terminal multiplexer.

9. Go to “Setup” on the toolbar in NMS, and select “Communication Preferences”. Check the “Change Advanced Settings” box, and enter the NCM/CM address into the “Assume Communication Works/Comm to node #”. Click “OK”.
10. Check “Read” Icon and check the “Auto Configure” box. Then select Method 3 and then click “OK”. Then click “OK” again and proceed with the read. Commands sent to and responses from the CM (via the NCM) should be evident in the communications window. IN1 (DS1), OUT2 (DS2), IN2 (DS3), and OUT2 (DS4) will illuminate green when data is present at the respective port.
12. Once the Read of the node has concluded, click the NetVw Icon. The node corresponding to the NCM/CM address should be present. Select this node by clicking on it. Verify that the “NCM” module is present in the list.
12. Select “NCM” and click the view button. Verify that all NCM settings are correctly set. (i.e. address passing mode)
13. Disconnect the patch cord from the DS1 EQUIP OUT and DS1 EQUIP IN jacks on the front of the IMUX 2000, and close the front door.

If the above test procedure can be successfully completed, the RFL NCM module is functioning properly. If not, use standard troubleshooting procedures to isolate the problem to the module itself, to another module in the IMUX 2000, or to the T1 or E1 channel. If the problem lies in the RFL NCM module, replace it with a spare.

LOOP TEST PROCEDURE FOR RFL NCM MODULES IN NMS MODE INSTALLED IN DI-A CONFIGURED MULTIPLEXERS

The following procedure is used to test RFL NCM modules installed in IMUX 2000, DI-A configured multiplexers. To test NCM modules installed in IMUX 2000 terminal multiplexers, use the procedure on page 27 of this instruction data sheet. Before performing this procedure, make sure the system is on-line and out-of-service.

1. Connect the male to female null modem RS-232 cable from CH2 of the MA-401I to the DB9 male connector on the CM I/O.
2. Open the door on the front of the IMUX 2000 multiplexer.
3. Connect a patch cord between the DS1-A EQUIP OUT and DS1-A-EQUIP IN jacks on the front of the IMUX 2000 chassis. The jacks are located on the Common Module.
4. With power applied to the IMUX 2000, check the indicators on the front of the power supply module.
The POWER indicator should be lit.
5. Check the Service LED (DS13) on the front panel of the NCM. See Figure 4 and Table 1 for location.
The Service LED should be illuminated green.
6. Check the ADRB LED (DS12) on the front panel of the NCM. See Figure 4 and Table 1 for location.
**The ADRB LED should be illuminated solid orange. (should not be red or green)
Orange indicates the NCM is receiving its own address.**
7. Check the RXB LED (DS5) on the front panel of the NCM. See Figure 4 and Table 1 for location.
The RXB LED should be illuminated red.
8. Connect the PC to the CH1 RS-232 connector using the male to female RS-232 connector. At this point, the equipment should be connected as shown in Figure 10. Run the RFL NMS communications software and set the parameters exactly the same as the CM and the NCM.

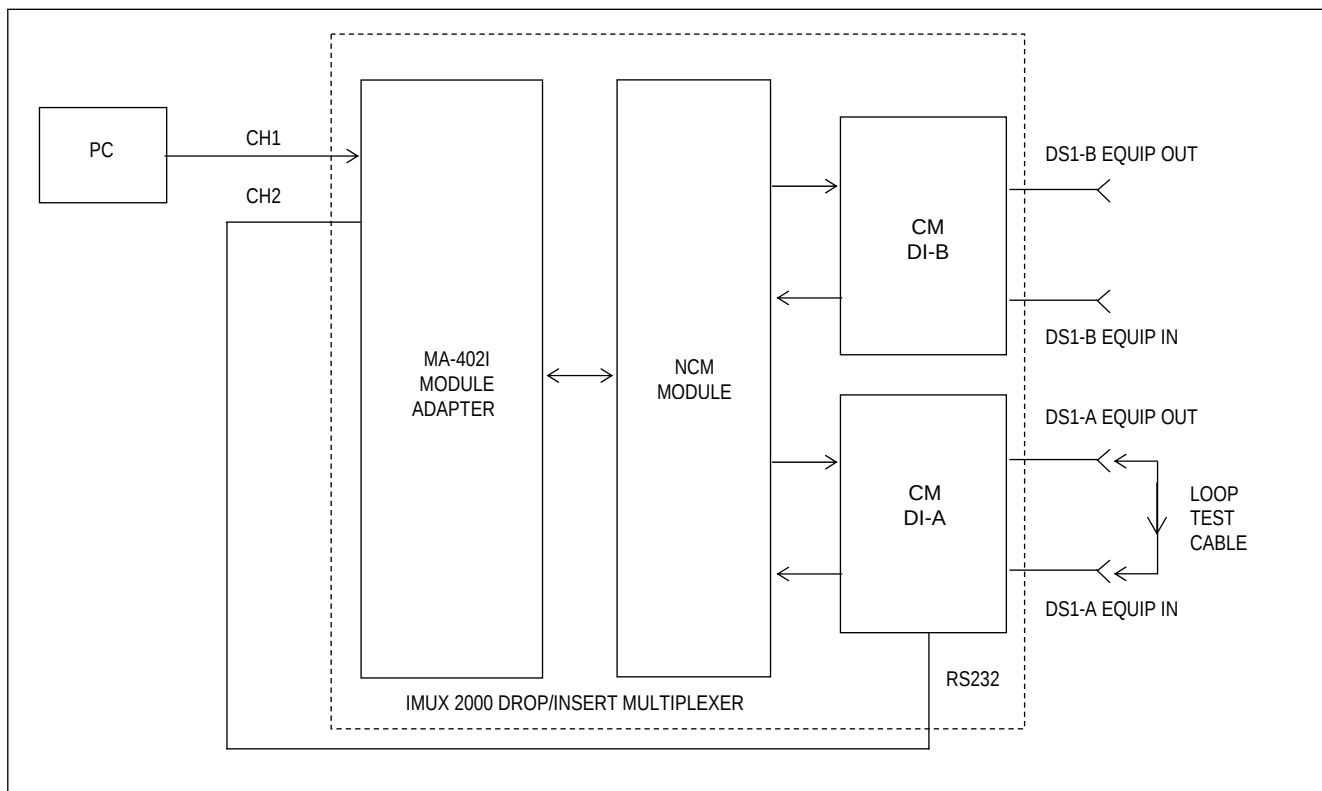


Figure 10. Simplified block diagram, loop test for RFL NCM module in NMS mode, installed in a DI-A configured multiplexer.

9. Go to “Setup” on the toolbar in NMS, and select “Communication Preferences”. Check the “Change Advanced Settings” box, and enter the NCM/CM address into the “Assume Communication Works/Comm to node #”. Click “OK”.
10. Check “Read” Icon and check the “Auto Configure” box. Then select Method 3 and then click “OK”. Then click “OK” again and proceed with the read. Commands sent to and responses from the CM (via the NCM) should be evident in the communications window. IN1 (DS1), OUT2 (DS2), IN2 (DS3), and OUT2 (DS4) will illuminate green when data is present at the respective port.
11. Once the Read of the node has concluded, click the NetVw Icon. The node corresponding to the NCM/CM address should be present. Select this node by clicking on it. Verify that the “NCM” module is present in the list.
12. Select “NCM” and click the view button. Verify that all NCM settings are correctly set. (i.e. address passing mode)
13. Disconnect the patch cord from the DS1-A EQUIP OUT and DS1-A EQUIP IN jacks on the front of the IMUX 2000, and close the front door.

If the above test procedure can be successfully completed, the RFL NCM module is functioning properly. If not, use standard troubleshooting procedures to isolate the problem to the module itself, to another module in the IMUX 2000, or to the T1 or E1 channel. If the problem lies in the RFL NCM module, replace it with a spare.

LOOP TEST PROCEDURE FOR RFL NCM MODULES IN NMS MODE INSTALLED IN DI-B CONFIGURED MULTIPLEXERS

The following procedure is used to test RFL NCM modules installed in IMUX 2000, DI-B configured multiplexers. To test NCM modules installed in IMUX 2000 terminal multiplexers, use the procedure on page 27 of this instruction data sheet. Before performing this procedure, make sure the system is on-line and out-of-service.

1. Connect the male to female null modem RS-232 cable from CH2 of the MA-401I to the DB9 male connector on the CM I/O.
2. Open the door on the front of the IMUX 2000 multiplexer.
3. Connect a patch cord between the DS1-B EQUIP OUT and DS1-B EQUIP IN jacks on the front of the IMUX 2000 chassis. The jacks are located on the Common Module.
4. With power applied to the IMUX 2000, check the indicators on the front of the power supply module.
The POWER indicator should be lit.
5. Check the Service LED (DS13) on the front panel of the NCM. See Figure 4 and Table 1 for location.
The Service LED should be illuminated green.
6. Check the ADRA LED (DS11) on the front panel of the NCM. See Figure 4 and Table 1 for location.
**The ADRA LED should be illuminated solid orange. (should not be red or green)
Orange indicates the NCM is receiving its own address.**
7. Check the RXA LED (DS7) on the front panel of the NCM. See Figure 4 and Table 1 for location.
The RXA LED should be illuminated red.
8. Connect the PC to the CH1 RS-232 connector using the male to female RS-232 connector. At this point, the equipment should be connected as shown in Figure 11. Run the RFL NMS communications software and set the parameters exactly the same as the CM and the NCM.

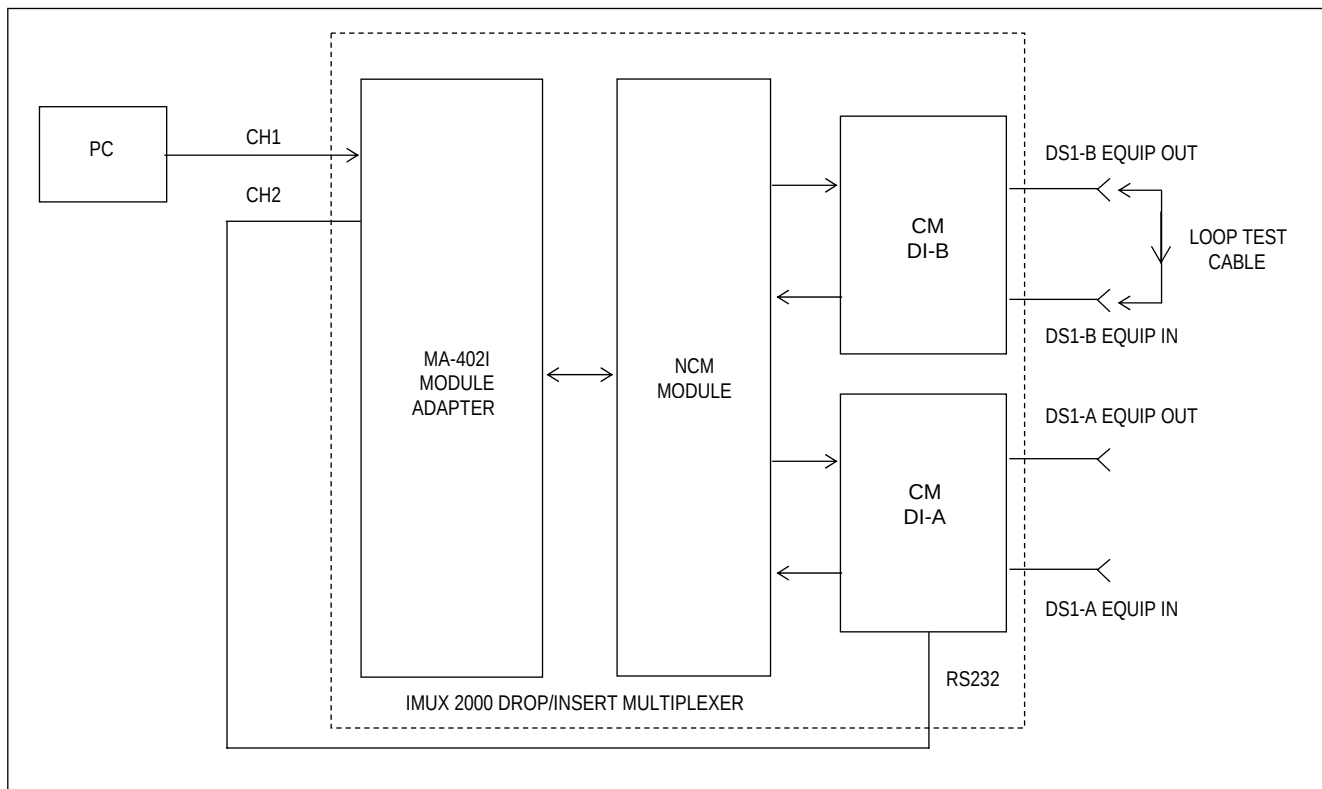


Figure 11. Simplified block diagram, loop test for RFL NCM module in NMS mode, installed in a DI-B configured multiplexer.

9. Go to “Setup” on the toolbar in NMS, and select “Communication Preferences”. Check the “Change Advanced Settings” box, and enter the NCM/CM address into the “Assume Communication Works/Comm to node #”. Click “OK”.
10. Check “Read” Icon and check the “Auto Configure” box. Then select Method 3 and then click “OK”. Then click “OK” again and proceed with the read. Commands sent to and responses from the CM (via the NCM) should be evident in the communications window. IN1 (DS1), OUT2 (DS2), IN2 (DS3), and OUT2 (DS4) will illuminate green when data is present at the respective port.
11. Once the Read of the node has concluded, click the NetVw Icon. The node corresponding to the NCM/CM address should be present. Select this node by clicking on it. Verify that the “NCM” module is present in the list.
12. Select “NCM” and click the view button. Verify that all NCM settings are correctly set. (i.e. address passing mode)
13. Disconnect the patch cord from the DS1-B EQUIP OUT and DS1-B EQUIP IN jacks on the front of the IMUX 2000, and close the front door.

If the above test procedure can be successfully completed, the RFL NCM module is functioning properly. If not, use standard troubleshooting procedures to isolate the problem to the module itself, to another module in the IMUX 2000, or to the T1 or E1 channel. If the problem lies in the RFL NCM module, replace it with a spare.

REMOTE CONTROL USING NMS

There are two ways to program the NCM module, locally using DIP switches, or Remotely using NMS (Network Management Software). If your NCM module is to be used in NMS application mode, it is highly recommended to set-up the NCM module using the DIP switches only, since the NCM card in the NMS application mode is the vehicle for NMS communication.

Refer to the IMUX 2000 or IMUX 2000E Instruction Manuals for information on using NMS. Go to the NCM module using NMS. Go to the NCM General Configurations and Status window for node 1.

The NCM General Configurations and Status window for node 1 of a T1 system is shown in Figure 12. The General Configurations window is on the left and the Status window is on the right. The General Configurations window, on the left, is where the user can change the NCM configuration parameters. This window has three top-level pages selectable by the tabs at the top of the window as follows: General, Address and Serial Port. The following discussion covers the settings on the “General” page.

Note that there is one check box and six parameters that must be set. The box can be checked or unchecked and each of the six parameters must be set. The selections for each parameter can be viewed by using the up and down arrows. Then click on the desired parameter to make your selection.

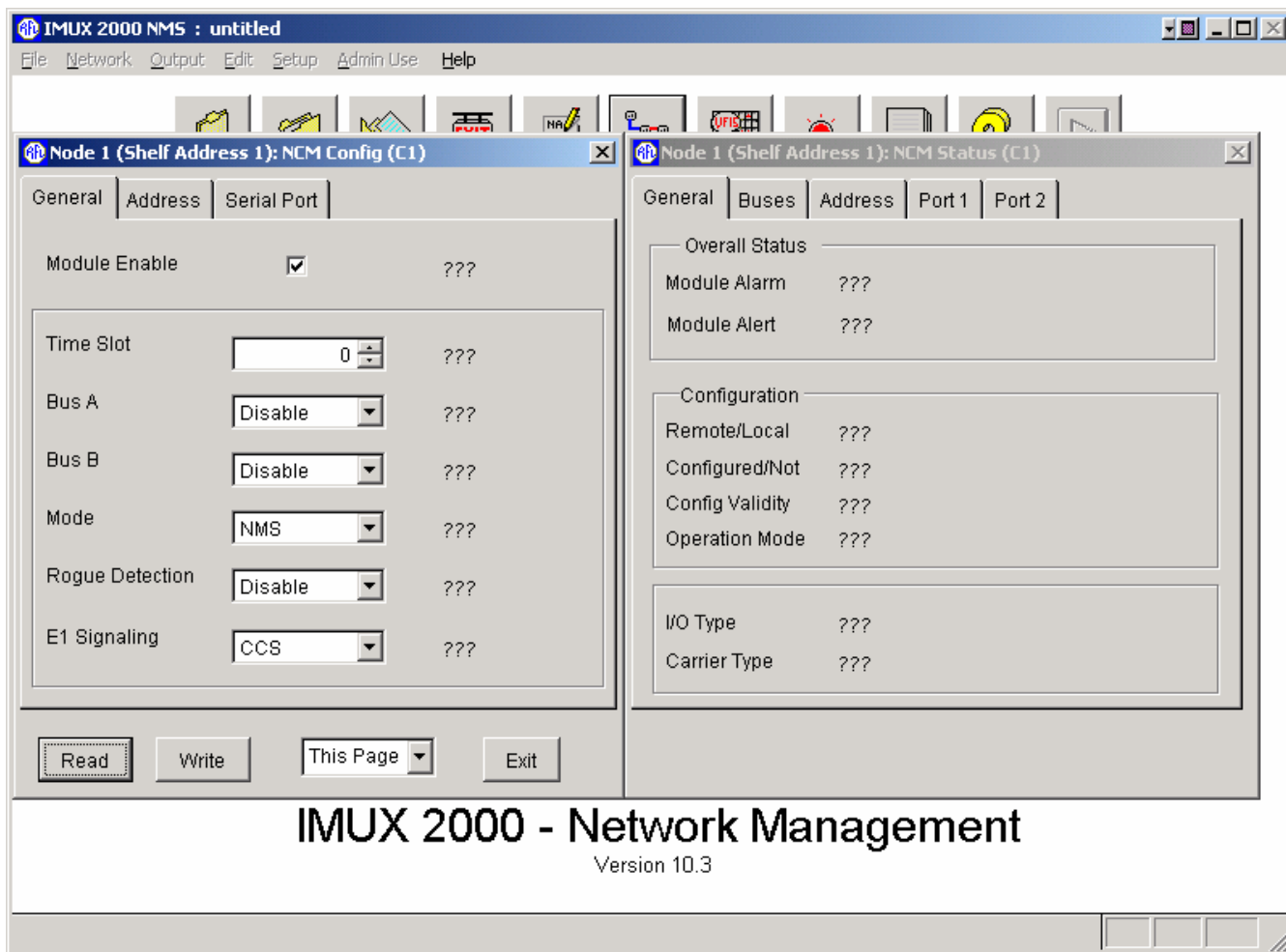


Figure 12. NCM General Configurations and Status window for Node 1

1. Module Enable

The Module Enable box can be checked or unchecked.

For the NCM module to be In Service, check the Module Enable box.

For the NCM module to be Out Of Service, uncheck the Module Enable box.

2. Time Slot

The Time Slot can be set from 1-24 for T1 networks and from 1-31 for E1 networks. Click on the up or down arrows to make the selection.

3. Mode

There are three basic types of network modes:

1. Broadcast mode
2. NMS mode
3. A combination of Master, D&I Slave and End Slave modes.

Each of these modes is described in the table below.

Mode		Description
1	Broadcast	In Broadcast mode each node transmits to and receives from all other nodes in the network. Typically when Broadcast mode is used, all nodes in the network are set to Broadcast mode. Refer to Figure 13a for more information.
2	NMS	Typically when NMS mode is used, all nodes in the network are set to NMS mode. In NMS mode each node transmits to all other nodes and each node selectively receives messages from all other nodes in the network based upon addressing. In addition to this, each node transmits its address to adjacent nodes during idle network time. Refer to Figure 13b for more information.
3	Master	Typically, when one of the nodes in a network is a master, the other nodes are slave nodes. There are two types of slave nodes: D&I slave nodes and End slave nodes. Refer to Figure 13c for a typical network using Master and Slave nodes. The Master node transmits to all other nodes in the network.
4	D&I Slave	The D&I slave node only receives from and transmits to the master node, and it also allows messages from the master to pass through to all other slaves. It also allows messages from other slaves to pass through to the master.
5	End Slave	The End slave node only receives messages from and transmits messages to the master node

4. E1 Signaling

E1 Signaling can be set to CCS or CAS. If this is a T1 network, the E1 Signaling setting is ignored. If this is an E1 network, set the E1 Signaling to match the local E1 multiplexer setting. For example, if the local E1 multiplexer is set to CCS, set the E1 Signaling to CCS. If the local E1 multiplexer is set to CAS, set the E1 Signaling to CAS. This locks out the use of time slot 16 for CAS (channel associated signaling).

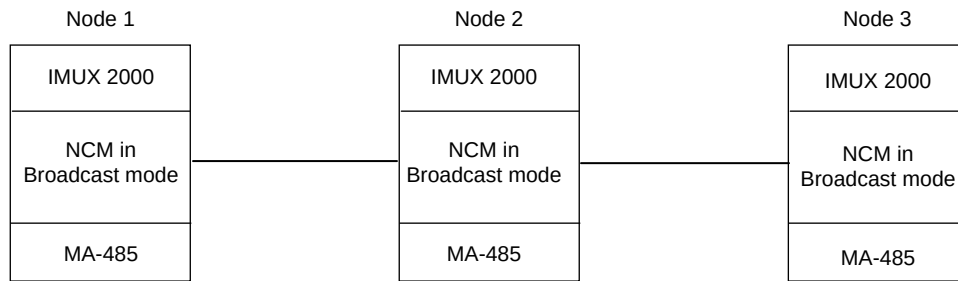


Figure 13a. Typical 3-node network using MA-485s (1 RS-485 port)

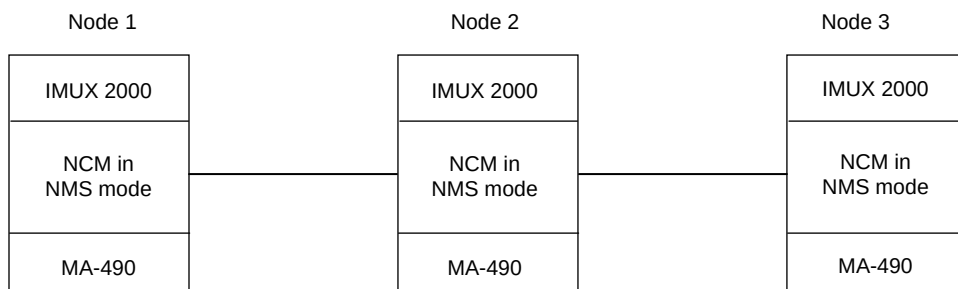


Figure 13b. Typical 3-node network using MA-490s (1 RS-232 port, and 1 Ethernet port)

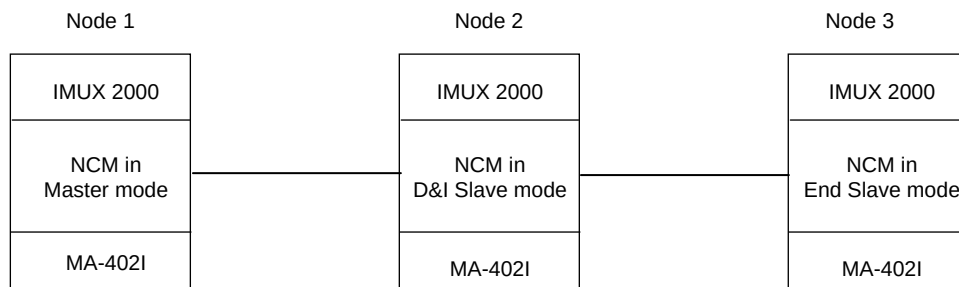


Figure 13c. Typical 3-node network using MA-402Is (2 RS-232 ports)

Figure 13. Typical networks showing NCM module configured as Master, D&I Slave, End Slave, Broadcast and NMS.

5. Bus A & Bus B

Bus A can be enabled or disabled, and Bus B can be enabled or disabled. Enabling or disabling Bus A and Bus B is mode dependent in accordance with the table below.

Mode	Bus A	Bus B	Application
Broadcast	enabled	disabled	The NCM mode will be Terminal broadcast or DI-A broadcast
	disabled	enabled	The NCM mode will be DI-B broadcast
	enabled	enabled	The NCM mode will be D&I broadcast
	disabled	disabled	(Not a valid setting. The NCM module is disabled)
NMS	enabled	disabled	The NCM mode will be Terminal NMS or DI-A NMS
	disabled	enabled	The NCM mode will be DI-B NMS
	enabled	enabled	The NCM mode will be D&I NMS
	disabled	disabled	(Not a valid setting. The NCM module is disabled)
Master	enabled	disabled	The NCM mode will be Terminal Master or DI-A Master
	disabled	enabled	The NCM mode will be DI-B Master
	enabled	enabled	The NCM mode will be D&I Master
	disabled	disabled	(Not a valid setting. The NCM module is disabled)
D&I Slave	enabled	disabled	The NCM mode will be D&I Slave and the Master NCM node is in the A direction.
	disabled	enabled	The NCM mode will be D&I Slave and the Master NCM node is in the B direction.
	enabled	enabled	(Not a valid setting. The NCM module is disabled)
	disabled	disabled	(Not a valid setting. The NCM module is disabled)
D&I End	enabled	disabled	The NCM mode will be Terminal End Slave or DI-A End Slave
	disabled	enabled	The NCM mode will be DI-B End Slave
	enabled	enabled	(Not a valid setting. The NCM module is disabled)
	disabled	disabled	(Not a valid setting. The NCM module is disabled)

5. Rogue Detection

Rogue Detection can be enabled or disabled, and can be used in any mode but is typically used in NMS mode. When enabled it monitors the local ports and the receive T1 messages. Rogue Detection is used to prevent a rogue PC program or another module from “stepping on” the NCM time slot and bringing down the entire NCM path. If enabled, both the local input(s) and T1 receive inputs will monitor for rogue activity. The local input port is squelched for at least 2 minutes once a continuous data stream lasting for greater than 60 seconds is detected. The T1 receive data is squelched for 2 minutes once a continuous data stream greater than 64 seconds is detected on the bus. The T1 rogue threshold is set intentionally higher than the local port to prevent all the nodes from reacting to a rogue at any of the local ports.

After all settings are made on the General page (Figure 12), click on the Address tab to get to the Address window as shown in Figure 14.

The Address window has two major selections, CM Address Passing and Local CM Address. Both of these settings apply to NMS mode only. Set the local CM address first.

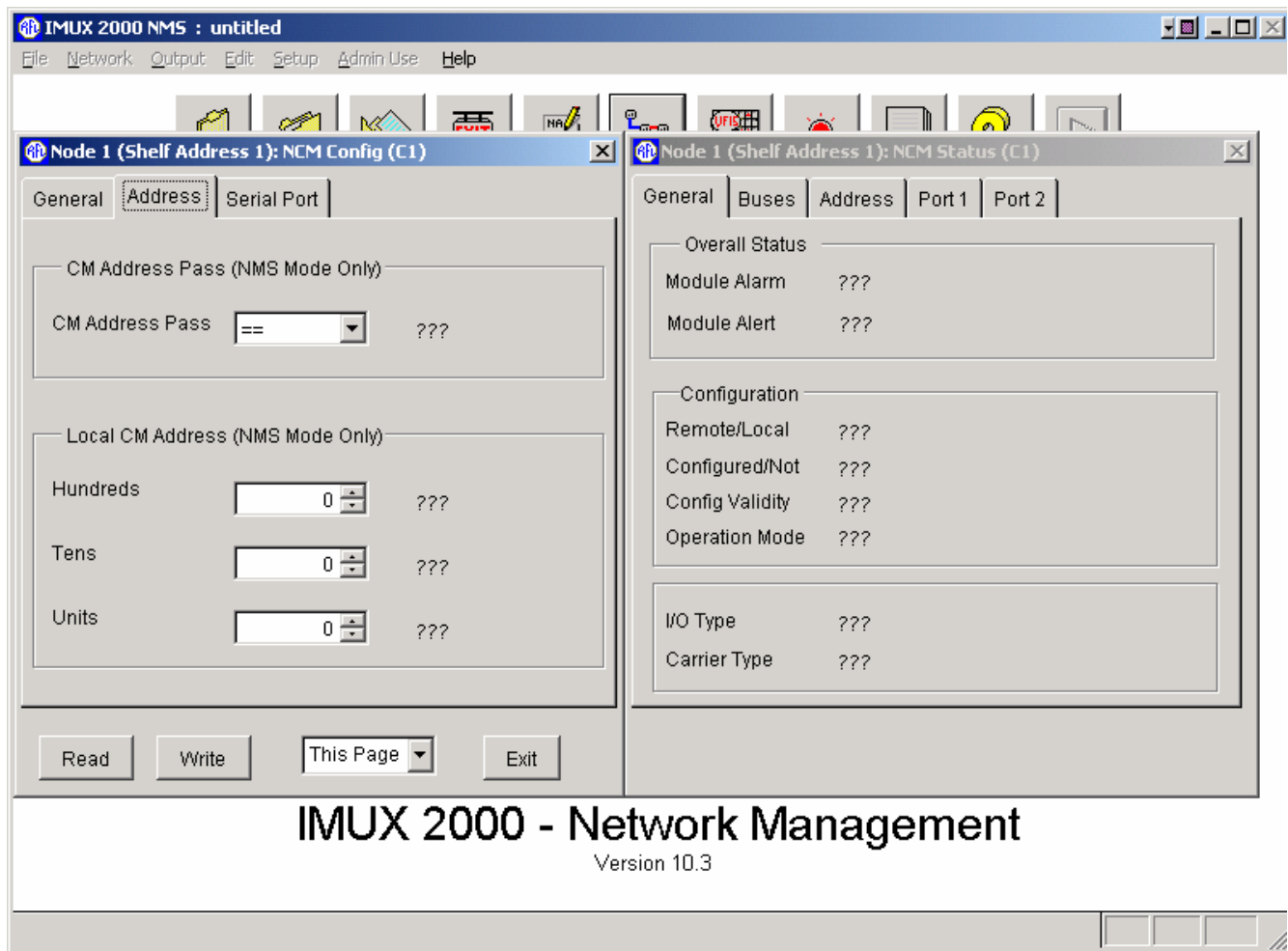


Figure 14. NCM Address Configurations and Status window for Node 1

Local CM Address

The “Local CM Address” for the NCM module must be set to the same address as the local Common Module (CM3B, CM3C, CM3R, CM6B, or CM4). The NCM supports addresses from 1 to 999 (see note below) and is set by using the up and down arrows in the hundreds, tens and units boxes as shown in Figure 14. For example, if your CM4 is set to Address 351, the “CM Address” of the NCM must be set to 351. The next step is to set CM Address Passing.

NOTE

The CM3B, CM3C and CM6B support addresses from 1 to 99. The CM4 and CM6B support addresses from 1 to 500.

CM Address Passing

The CM Address Pass setting controls the range of addressed messages that are allowed to pass from the NCM to the local common module in accordance with the table below. There are four CM Address Passing settings as follows, Any, =, >, and <.

CM Address Pass		Description
1	Any	Will pass any messages regardless of the “Local CM Address” setting of the NCM. Messages without address headers are also passed.
2	=	Will only pass messages with addresses equal to the “Local CM Address” setting of the NCM
3	>	Will only pass messages with addresses greater than or equal to the “Local CM Address” setting of the NCM
4	<	Will only pass messages with addresses less than or equal to the “Local CM Address” setting of the NCM

After all settings are made on the Address page, (Figure 14), click on the Serial Port tab to get to the Serial Port window as shown in Figure 15.

The Serial Port window shown in Figure 15 has three major settings, Serial Port Settings, Port 2 Enable and Loopback.

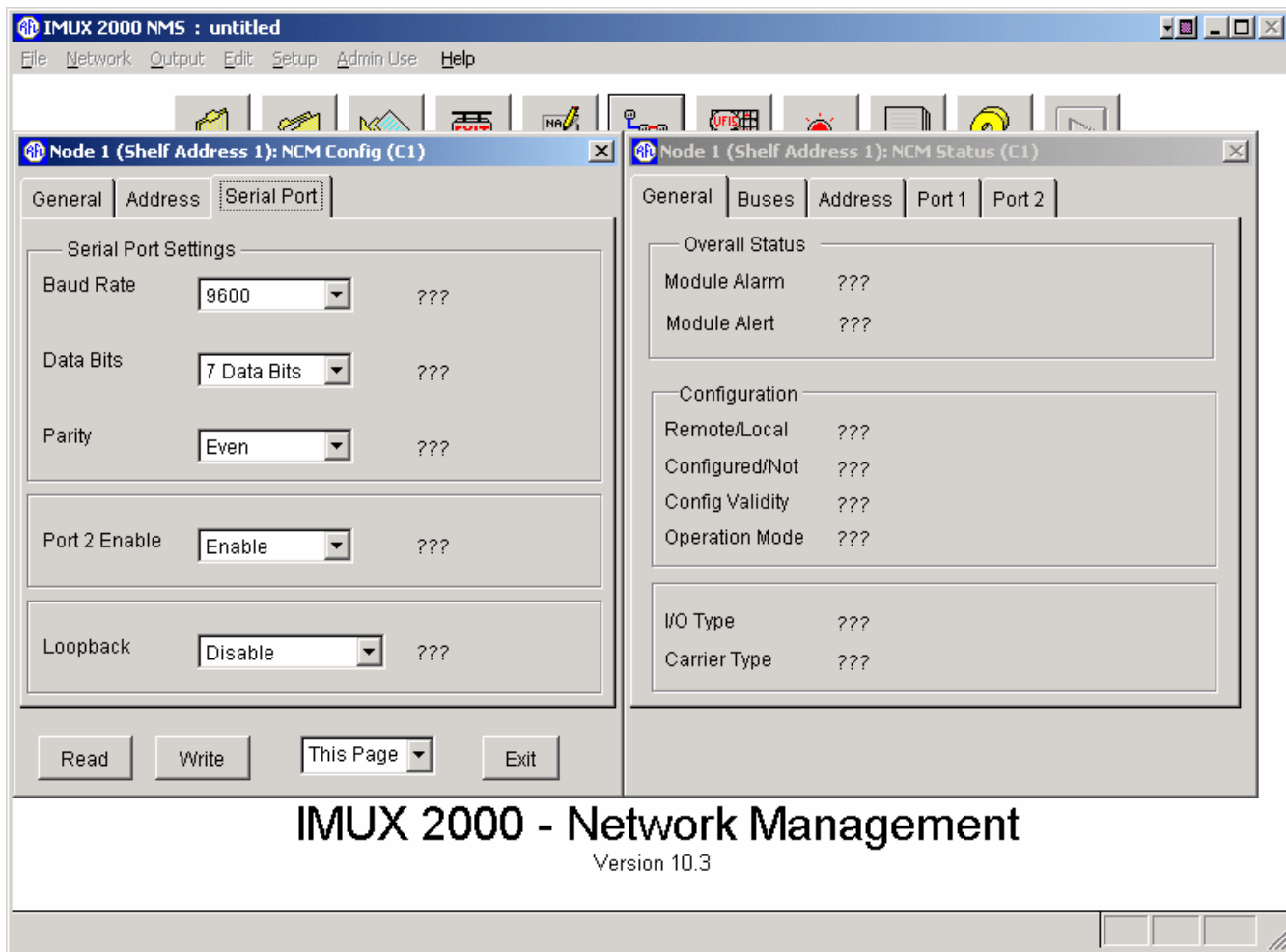


Figure 15. NCM Serial Port Configurations and Status window for Node 1

Baud Rate

There are five Baud Rate settings (2400, 4800, 9600, 19200 and 38400) which can be viewed by clicking on the down arrow. Then click on the desired Baud Rate.

Data Bits

There are two choices for the NCM Data Bit setting, 7 bits or 8 bits. These are set in accordance with Table 5.

Parity

There are five choices for the NCM Parity setting, Even, Odd, Space, None or Mark. These are set in accordance with the table below. For Even, Odd or Mark parity, set the NCM parity to the same parity as the Common Module parity, and for seven Data Bits.

Table 5. Valid NCM Parity and Data Bit Settings in NMS application mode

Common Module Parity Setting	NCM Parity Setting	NCM Data Bits Setting
Even	Even	7
Odd	Odd	7
Space	Space	7
	None	8
Mark	Mark	7

Port 2 Enable

For the interfaces that physically have two ports, port 2 can be enabled or disabled. The MA402I has two RS232 ports, one on port 1 and one on port 2. The MA490 has one RS485 port on port 1. The MA490 has one Ethernet port on port 1 and one RS232 port on port 2. For example if you are using an MA402I, you can disable port 2 if it is not being used.

Loopback

In normal operation all loopbacks are disabled. Loopback settings are used for troubleshooting purposes. There are four loopback settings as follows:

1. Disable all loopbacks
2. Enable port 1 and port 2 equipment loopback
3. Enable port 1 payload loopback
4. Enable port 2 payload loopback

If the MA485 is configured as two wire, it does not support loopback.

After all NCM parameter selections have been made they must be written to the NCM card in the network. This is done by using the “WRITE” operation as described in Section 7 of The IMUX 2000 Instruction Manual.

TROUBLESHOOTING

If there is an apparent malfunction, first check that the configuration is appropriate for the transmission system in use, and that transmit and receive configurations are identical.

Problems may occur at the common equipment or facility level that may affect the operation of this module. Refer to the “Maintenance” section in your multiplexer manual for system analysis procedures.

REMOTE CONTROL USING SCL COMMANDS

When installed in an IMUX 2000 remote controllable shelf, the NCM module can be operated under local or remote control. When under remote control, certain configuration parameters can only be changed through the RS-232 remote port on the multiplexer. The remote interface for this module involves two codes: a “P” (parameter) code, and an “S” (status) code. See the IMUX 2000 instruction manual for more information on the remote control interface.

The NCM module reports itself as a “Type 117” module.

“P” CODES

“P” codes, when used in the parameter field on a “SET” command, allow the user to set certain parameters on the module by remote control, just like setting the switches on a module under local control. “P” codes also appear in the response to a “CONFIG?” query, showing the current parameter settings on the module.

There are ten “P” codes for the NCM module: P01 through P10. Each of these P codes can be a decimal number from 0 to 255, which can also be represented as an eight-digit binary number (in parenthesis). The binary representation is more useful for setting and interpreting the “P” codes, since each binary digit (0 or 1) corresponds to the ON or OFF setting for a particular switch on the module. Table 6 describes the meanings of the “P” codes for the NCM module.

A typical NCM module response to a “CONFIG?” query looks like this:

```
* OK
CHANNEL CARD 3, TYPE 117
UNDER REMOTE CONTROL
SVCE = ON
P01 = 3 (B00000011)
P02 = 1 (B00000001)
P03 = 1 (B00000001)
P04 = 1 (B00000001)
P05 = 1 (B00000001)
P06 = 1 (B00000001)
P07 = 1 (B00000001)
P08 = 1 (B00000001)
P09 = 1 (B00000001)
P10 = 1 (B00000001);
```

NOTE

When using binary numbers with a SET command, they must be preceded by the letter “B” as shown in the following example:

<MULTIPLEXER ADDRESS>:<CARD ADDRESS>:SET:P1 = B00000011;

Besides using the P code, it is also possible to turn module service on or off by sending one of the following in the parameter field with a SET command:

SRVC = ON

SRVC = OFF

Table 6. Remote configuration settings (“P” codes)

P Code	Digit(s) And Switch Equivalent	Value ⁽¹⁾	Description
P01	B 0 0 0 0 0 0 0 0 0 ↑ - - - - - BUS A SETTING	0	Bus A Disabled
		1	Bus A Enabled
	B 0 0 0 0 0 0 0 0 0 - ↑ - - - - - BUS B SETTING	0	Bus B Disabled
		1	Bus B Enabled
	B 0 0 0 0 0 0 0 0 0 - - ↑ - - - - - CAS SETTING (E1 MUX ONLY)	0	CAS Disabled for E1 MUX
		1	CAS Enabled for E1 MUX
	B 0 0 0 0 0 0 0 0 0 - - - ↑ ↑ ↑ ↑ ↑ TIMESLOT SELECTION T1/E1	00001 to 11000 T1 Settings	From left to right, these five bits represent the binary value of the desired time slot between 1 through 24 in a T1 network. See Table 4 for a complete list of these values.
		00001 to 11111 E1 Settings	From left to right, these five bits represent the binary value of the desired time slot between 1 through 31 in an E1 network. See Table 4 for a complete list of these values.
P02	B 0 0 0 0 0 0 0 0 0 - - - - ↑ ↑ ↑ ↑ LOCAL CM ADDRESS (HUNDREDS POSITION)	From 0000 (0) to 1001 (9)	BCD Number (0 to 9) Local CM Address, Hundreds Position
	B 0 0 0 0 0 0 0 0 0 ↑ ↑ ↑ ↑ - - - -	...	Not used
P03	B 0 0 0 0 0 0 0 0 0 ↑ ↑ ↑ ↑ - - - - LOCAL CM ADDRESS (TENS POSITION)	From 0000 (0) to 1001 (9)	BCD Number (0 to 9) Local CM Address, Tens Position
	B 0 0 0 0 0 0 0 0 0 - - - - ↑ ↑ ↑ ↑ LOCAL CM ADDRESS (UNITS POSITION)	From 0000 (0) to 1001 (9)	BCD Number (0 to 9) Local CM Address, Units Position

>> table continues on next page <<

1. These are the only legal values for setting parameters. Setting a parameter to a value outside its specified range will produce unpredictable results.

Table 6. continued - Remote configuration settings (“P” codes)

P Code	Digit(s) And Switch Equivalent	Value ⁽¹⁾	Description
P04	B 0 0 0 0 0 0 0 0 ↑ ↑ - - - - PORT LOOPBACK SETTINGS	00	Disable Loopbacks
		01	Enable Ports 1 & 2 Equipment Loopbacks
		10	Enable Port 1 Payload Loopback
		11	Enable Port 2 Payload Loopback
	B 0 0 0 0 0 0 0 0 - - ↑ ↑ ↑ ↑ ↑ ↑	...	Not used
P05	B 0 0 0 0 0 0 0 0 ↑ ↑ ↑ - - - - BAUD SETTINGS	000	2400
		001	4800
		010	9600
		011	19,200
		100	38,400
		101	Undefined
		110	Undefined
		111	Undefined
	B 0 0 0 0 0 0 0 0 - - - ↑ ↑ ↑ - - PARITY SETTINGS	000	None
		001	Undefined
		010	Undefined
		011	Undefined
		100	Odd
		101	Even
		110	Mark
		111	Space
	B 0 0 0 0 0 0 0 0 - - - - - - ↑ ↑ WORD LENGTH SETTINGS	00	7 Data Bits
		01	8 Data Bits
		10	Undefined
		11	Undefined

>> table continues on next page <<

Table 6. continued - Remote configuration settings (“P” codes)

P Code	Digit(s) And Switch Equivalent	Value ⁽¹⁾	Description
P06	B 0 0 0 0 0 0 0 0 0 ↑ ↑ - - - - -	00	Any CM Address
	CM ADDRESS PASS SETTINGS (NMS MODE ONLY)	01	Equal To
		10	Equal To Or Greater Than (Force FDL Search)
		11	Equal To Or Less Than (Force FDL Search)
	B 0 0 0 0 0 0 0 0 0 - - - ↑ ↑ ↑ - - APPLICATION MODE SETTINGS	000	Broadcast
		001	NMS
		010	Master
		011	D&I Slave (Bus Direction Points Towards Master)
		100	End Slave (Bus Direction Points Towards Master)
		101	Mode is undefined
		110	Mode is undefined
		111	Mode is undefined
	B 0 0 0 0 0 0 0 0 0 - - - - - ↑ - PORT 2 ENABLE SETTINGS	0	Port 2 Disabled
		1	Port Enabled
	B 0 0 0 0 0 0 0 0 0 - - - - - - ↑ ROGUE SETTINGS	0	T1/E1 and Port Rogue Detection Disabled
		1	T1/E1 and Port Rogue Detection Enabled
	B 0 0 0 0 0 0 0 0 0 - - ↑ - - - - -	...	Not used
P07	B 0 0 0 0 0 0 0 0 0 ↑ ↑ ↑ ↑ ↑ ↑ ↑ ↑	...	Not used
P08	B 0 0 0 0 0 0 0 0 0 ↑ ↑ ↑ ↑ ↑ ↑ ↑ ↑	...	Not used
P09	B 0 0 0 0 0 0 0 0 0 ↑ ↑ ↑ ↑ ↑ ↑ ↑ ↑	...	Not used
P10	B 0 0 0 0 0 0 0 0 0 ↑ ↑ ↑ ↑ ↑ ↑ ↑ ↑	...	Not used

“S” CODES

“S” codes appear in response to a “STATUS?” query. There are eleven “S” codes for the NCM module: S01 through S11. Like the “P” code, this number is displayed in both decimal and binary form. The four least significant digits of the binary number represent the conditions shown in Table 7. The four most significant digits are not used.

A typical response to a “STATUS?” query looks like this:

*** OK**

CHANNEL CARD 3, TYPE 117

S01 = 3 (B00000011)

S02 = 3 (B00000011)

S03 = 3 (B00000011)

S04 = 3 (B00000011)

S05 = 3 (B00000011)

S06 = 3 (B00000011)

S07 = 3 (B00000011)

S08 = 3 (B00000011)

S09 = 3 (B00000011)

S10 = 3 (B00000011)

S11 = 3 (B00000011);

Table 7. Remote status messages (“S” codes)

S Code	Digit(s) And Switch Equivalent	Value ⁽¹⁾	Description
S01	B 0 0 0 0 0 0 0 0 0 ↑ ↑ ↑ ↑ ↑ ↑ ↑ ↑ I/O TYPE ID	111xxxxx	RS-232 Not Installed
		110xxxxx	Ethernet
		101xxxxx	RS-485 4-Wire
		100xxxxx	RS-485 2-Wire
	PORT 1 AVAILABILITY	xxx0xxxx	Port 1 Available
		xxx1xxxx	Port 1 Not Available
	PORT 2 AVAILABILITY	xxx0xxxx	Port 2 Available
		xxx1xxxx	Port 2 Not Available
	PORT 1 EQUIPMENT LOOPBACK STATUS	xxxx01xx	Port 1 Equipment Loopback Active
		xxxx00xx	Port 1 Equipment Loopback Inactive
		xxxx11xx	Port 1 Equipment Loopback Inactive
		xxxx10xx	Port 1 Equipment Loopback Inactive
	PORT 1 PAYLOAD LOOPBACK STATUS	xxxx10xx	Port 1 Payload Loopback Active
		xxxx01xx	Port 1 Payload Loopback Inactive
		xxxx00xx	Port 1 Payload Loopback Inactive
		xxxx11xx	Port 1 Payload Loopback Inactive
	PORT 2 EQUIPMENT LOOPBACK STATUS	xxx001xx	Port 2 Equipment Loopback Active
		xxx000xx	Port 2 Equipment Loopback Inactive
		xxx010xx	Port 2 Equipment Loopback Inactive
		xxx011xx	Port 2 Equipment Loopback Inactive
		xxx100xx	Port 2 Equipment Loopback N/A
		xxx101xx	Port 2 Equipment Loopback N/A
		xxx110xx	Port 2 Equipment Loopback N/A
	PORT 2 PAYLOAD LOOPBACK STATUS	xxx111xx	Port 2 Equipment Loopback N/A
		xxx011xx	Port 2 Payload Loopback Active
		xxx001xx	Port 2 Payload Loopback Inactive
		xxx000xx	Port 2 Payload Loopback Inactive
		xxx010xx	Port 2 Payload Loopback Inactive
		xxx100xx	Port 2 Payload Loopback N/A
		xxx101xx	Port 2 Payload Loopback N/A
		xxx110xx	Port 2 Payload Loopback N/A
	MUX TYPE & CONFIGURATION STATUS	xxxxxxx1x	E1 Mux
		xxxxxxx0x	T1 Mux
		xxxxxxx1	Configuration is Valid
		xxxxxxx0	Configuration is Invalid/MUX Problems

>> table continues on next page <<

Table 7. continued - Remote status messages (“S” codes)

S Code	Digit(s) And Switch Equivalent	Value ⁽¹⁾	Description
S02	B 0 0 0 0 0 0 0 0 0	xxx00	Both Busses Disabled – Mode Undefined
	- - - ↑ ↑ ↑ ↑ ↑	00001	Term/DI-A Broadcast Mode
	APPLICATION CONFIGURATION STATUS	00010	DI-B Broadcast Mode
		00011	D&I Broadcast Mode
		00101	Term/DI-A NMS Mode
		00110	DI-B NMS Mode
		00111	D&I NMS Mode
		01001	Term/DI-A Master
		01010	DI-B Master
		01011	D&I Master
		01101	D&I Slave - Master is in direction A
		01110	D&I Slave - Master is in direction B
		10001	End Slave - Master is in direction A
		10010	Slave End - Master is in direction B
		10011	Mode is undefined
		01111	Mode is undefined
		101xx	Mode is undefined
		11xxx	Mode is undefined
	CM ADDRESSING SUPPORT	000xx	CM Addressing Not Supported
		010xx	CM Addressing Not Supported
		011xx	CM Addressing Not Supported
		001xx	CM Addressing Is Supported
	PORT 1 APPLICATION STATUS	000xx	Port 1 is Broadcast Port
		001xx	Port 1 is Local User Port (Use RS-232 Only)
		010xx	Port 1 is Master Port
		011xx	Port 1 is a Slave Port
		100xx	Port 1 is a Slave Port
		101xx	Port 1 is Undefined
		11xxx	Port 1 is Undefined
	PORT 2 APPLICATION STATUS	000xx	Port 2 is Broadcast Port (If Available)
		001xx	Port 2 is CM Port (Use RS-232 Only)
		010xx	Port 2 is Slave of Port 1 Master (If Available)
		011xx	Port 2 is a Slave Port (If Available)
		100xx	Port 2 is a Slave Port (If Available)
		101xx	Port 2 is Undefined
		11xxx	Port 2 is Undefined
	B 0 0 0 0 0 0 0 0 0 ↑ ↑ ↑ - - - - -	...	Not used

>> table continues on next page <<

Table 7. continued - Remote status messages (“S” codes)

S Code	Digit(s) And Switch Equivalent	Value ⁽¹⁾	Description
S03	B 0 0 0 0 0 0 0 0 0 - - - - - ↑ ↑ RXA REMOTE CM ADDRESS	11	RXA CM Address is Valid
		10	RXA CM Address is Not Valid
		0x	RXA CM Address is Not Applicable
	B 0 0 0 0 0 0 0 0 0 - - - - ↑ ↑ - - APPLICATION CONFIGURATION STATUS	11	RXB CM Address is Valid
		10	RXB CM Address is Not Valid
		0x	RXB CM Address is Not Applicable
	B 0 0 0 0 0 0 0 0 0 ↑ ↑ ↑ ↑ - - - - CURRENT ACTEL REV	From 0001 To 1111	From Rev 1 to Rev 15
S04	B 0 0 0 0 0 0 0 0 0	...	For RFL Use Only
S05	B 0 0 0 0 0 0 0 0 0	...	For RFL Use Only
S06	B 0 0 0 0 0 0 0 0 0	...	For RFL Use Only
S07	B 0 0 0 0 0 0 0 0 0	...	For RFL Use Only

>> table continues on next page <<

Table 7. continued - Remote status messages (“S” codes)

S Code	Digit(s) And Switch Equivalent	Value ⁽¹⁾	Description
S08	B 0 0 0 0 0 0 0 0 0 - - - ↑ ↑ ↑ ↑ ↑ PORT 1 INPUT/OUTPUT STATUS	xxxx0	Port 1 Output Idle
		xxxx1	Port 1 Output Active
		xxx0x	Port 1 Output Data Status - No Errors
		xxx1x	Port 1 Output Data Status - Errors
		xx0xx	Port 1 Input Idle
		xx1xx	Port 1 Input Active
		x0xxx	Port 1 Input Rogue Control Not Active
		x1xxx	Port 1 Input Rogue Control Active
		0xxxx	Port 1 Input Data Status - No Errors
		1xxxx	Port 1 Input Data Status - Errors
	B 0 0 0 0 0 0 0 0 0 ↑ ↑ ↑ - - - - -	...	Not used
S09	B 0 0 0 0 0 0 0 0 0 - - - ↑ ↑ ↑ ↑ ↑ PORT 2 INPUT/OUTPUT STATUS	xxxx0	Port 2 Output Idle
		xxxx1	Port 2 Output Active
		xxx0x	Port 2 Output Data Status - No Errors
		xxx1x	Port 2 Output Data Status - Errors
		xx0xx	Port 2 Input Idle
		xx1xx	Port 2 Input Active
		x0xxx	Port 2 Input Rogue Control Not Active
		x1xxx	Port 2 Input Rogue Control Active
		0xxxx	Port 2 Input Data Status - No Errors
		1xxxx	Port 2 Input Data Status - Errors
	B 0 0 0 0 0 0 0 0 0 ↑ ↑ ↑ - - - - -	...	Not used

>> table continues on next page <<

Table 7
. continued - Remote status messages (“S” codes)

S Code	Digit(s) And Switch Equivalent	Value ⁽¹⁾	Description
S10	B 0 0 0 0 0 0 0 0 0 - - - ↑ ↑ ↑ ↑ ↑ TXA/RXB STATUS FOR T1/E1	xxxx0	TXA Data Path Idle
		xxxx1	TXA Data Path Active
		xx0xx	RXB Data Path Idle
		xx1xx	RXB Data Path Active
		x0xxx	RXB Rogue Control Not Active
		x1xxx	RXB Rogue Control Active
		0xxxx	RXB Data Status – No Errors
		1xxxx	RXB Data Status - Errors
	B 0 0 0 0 0 0 0 0 0 ↑ ↑ ↑ - - - - -	...	Not used
S11	B 0 0 0 0 0 0 0 0 0 - - - ↑ ↑ ↑ ↑ ↑ TXB/RXA STATUS FOR T1/E1	xxxx0	TXB Data Path Idle
		xxxx1	TXB Data Path Active
		xx0xx	RXA Data Path Idle
		xx1xx	RXA Data Path Active
		x0xxx	RXA Rogue Control Not Active
		x1xxx	RXA Rogue Control Active
		0xxxx	RXA Data Status – No Errors
		1xxxx	RXA Data Status - Errors
	B 0 0 0 0 0 0 0 0 0 ↑ ↑ ↑ - - - - -	...	Not used

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I M U X 2 0 0 0

SNMP Access Gateway

User's Manual

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Chapter 1 - Product Overview

1.1 - Introduction

The SNMP Access Gateway monitors serial (RS232) data streams for alarm conditions, and provides notification of alarm conditions by audible alarm, pager messages and SNMP traps. The SNMP Access Gateway may be used to provide legacy (non-network) equipment with the ability to generate SNMP traps when alarm conditions occur. Additionally, the SNMP Access Gateway can provide pass-through access to devices connected to the serial ports of the SNMP Access Gateway, thereby providing remote access to programming or maintenance ports of equipment.

The SNMP Access Gateway has two serial ports, and one ethernet 10BaseT network port. Front panel LEDs provide status information about the ethernet connection, serial port activity, and power status.

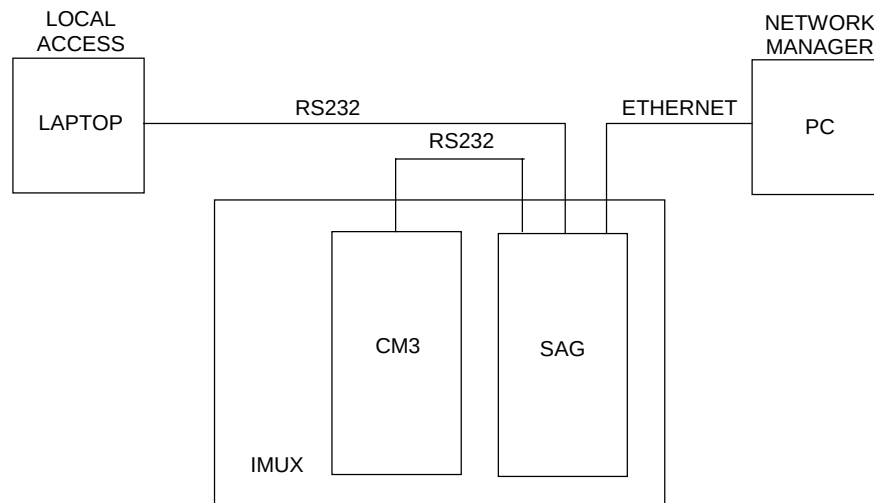


Figure 1. - SNMP Access Gateway Connectivity Overview

The serial ports can operate from 300 to 19,200 baud, and are used to monitor serial data streams and/or provide remote pass-through access to connected equipment. These serial ports are labeled IMUX (I/O 1) and REMOTE (I/O 2). An alarm configuration file can be loaded into the memory of the SNMP Access Gateway, and the SNMP Access Gateway can then monitor the data received on the serial ports for alarm conditions.

The two serial ports may also be used in a 'console' mode, in which the SNMP Access Gateway is placed in-line between two pieces of equipment. In this mode the alarm configuration file may still be used to monitor the data streams for alarm conditions, but the SNMP Access Gateway, in this case, passes data received on each serial port to the other port, so that the SNMP Access Gateway does not disrupt the data flowing between the two devices.

The serial ports may be used for pass-through access to connected serial devices, similar to a terminal server. A TCP/IP connection is made to the SNMP Access Gateway, and then characters received from the network connection is passed to the serial port, and characters received on the serial port are passed to the network connection. This pass-through mode may be used to remotely access the maintenance ports of equipment, etc.

When more than one connection is made to the SNMP Access Gateway for access to the same pass-through port, then users may be allowed to 'join' connections. This feature can be useful in providing technical support in the use of the connected equipment. Two remote users, at different locations, can both have access to the same pass-through port. This allows a person providing technical support to see what commands or data is actually being sent and received, which can be quite useful when providing technical support.

One of the serial ports (I/O 2) may also be used as a local command port, for configuration or checking on the status of the device. 'Local Command Port Mode' may be entered by using either a push-button located on the front panel of the SNMP Access Gateway or by entering a pre-defined escape sequence on the serial port itself. This local command port is especially useful when performing static allocation of network IP addresses, in which case the SNMP Access Gateway needs to be configured with an IP address prior to its use on the network.

An Events file is maintained by the SNMP Access Gateway which contains logged events, such as received alarm records, etc. Each type of item which may be recorded in the events log is enabled by its own configuration setting, so that the events file usage can be customized as appropriate for the installation site.

All settings and configuration of the SNMP Access Gateway may be made remotely, using either commands via a TCP/IP or modem connection, or by SNMP. The SNMP Access Gateway contains a customized management information base (MIB) which may be used to configure and control the SNMP Access Gateway. Configuration settings are stored in non-volatile memory for preservation in the event of a power loss.

1.2 - IMUX 2000 Information

When used with the IMUX 2000 the SNMP Access Gateway connects to the remote port of the IMUX using port 1. Port 2 is used as a craft interface to both the IMUX and SNMP Access Gateway. A serial cable is supplied for connection from I/O 1 to the REMOTE port on the IMUX CM3R. The power for the gateway is supplied via the IMUX motherboard.

The unit is programmed from the factory for the proper setup for most IMUX applications. The only required setup by the user is to program in the proper IP address for the gateway and the destination IP address for the SNMP traps.

The gateway has been designed to work specifically with version 23 of the IMUX CM3C software or any version of the CM3R software. When used with any of these versions, RS232 trap messages are created by the IMUX. This allows the gateway to generate SNMP traps as a result of a message from the IMUX. These traps will contain data that defines the fault condition on the IMUX. More information on these traps is contained in Application note C.

Chapter 2 - Installation

2.1 - Mounting

The SNMP Access Gateway module is packaged in a plug-in module, for mounting in an IMUX 2000 chassis.

When installing the SNMP Access Gateway module, a location should be selected in the front of the IMUX 2000 chassis which is directly in line with the MA-810 module adapter which is mounted in the back of the chassis. Make sure the serial port cable can reach the CM3R remote port. This cable should have enough slack so it is not in danger of being pulled out of place. Some serial port cables, especially hanging cables of any significant length, may have enough hanging weight to pull the SNMP Access Gateway out of place. In such a case, the serial port cables may need to be tied in place to provide the SNMP Access Gateway with relief from such strain.

2.2 - Power Input

The SNMP is powered through the IMUX 2000 chassis motherboard. The SNMP Access Gateway uses a maximum power input of approximately 5 watts, so the maximum current from the IMUX 2000 power supply is about 1 amp.

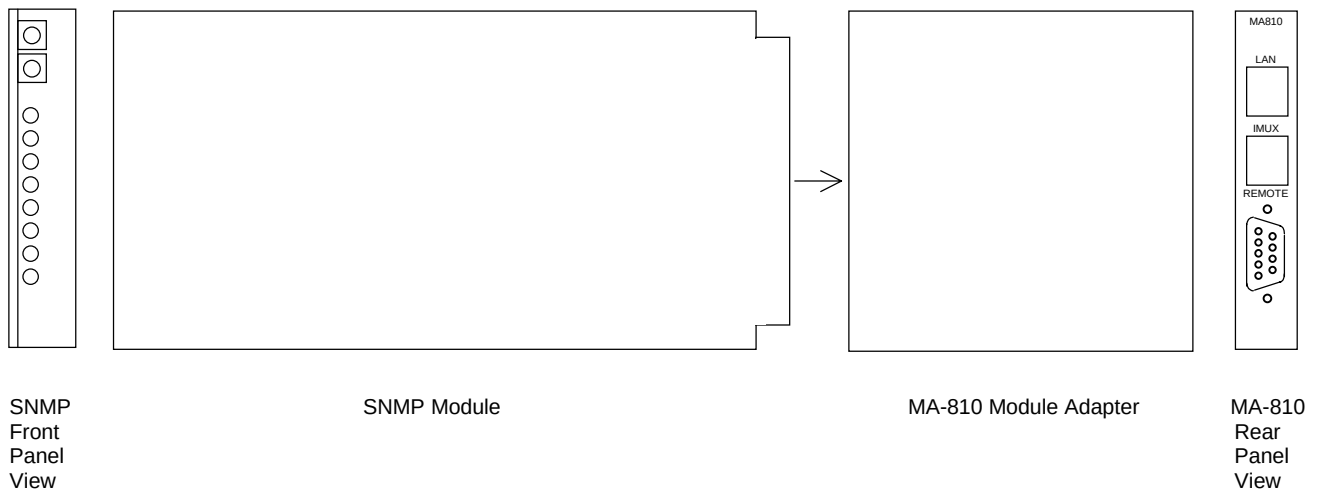


Figure 2A. – SNMP Access Gateway Module and MA-810 Module Adapter

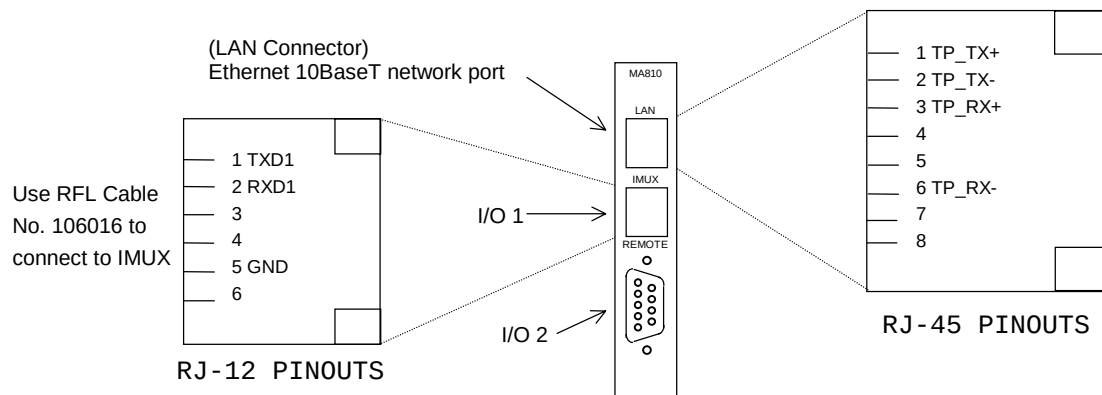


Figure 2B. – MA-810 Module Adapter Connectors

2.3 - Serial Ports

The I/O 2 serial port is configured as a DTE port using a male, DB-9 connector. The I/O 1 serial port is configured as a DTE port using an RJ-12 connector which is similar to that used on the COM ports of an IBM-compatible personal computer. Figure 3 shows the pin configuration of the I/O 2 port. Figure 2B shows the pin configuration of the I/O 1 port.

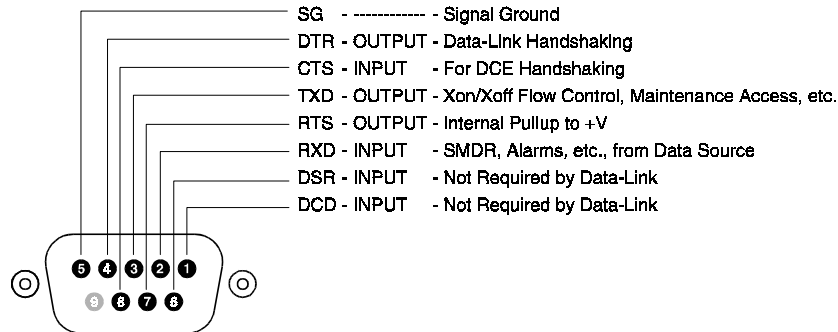


Figure 3. - SNMP Access Gateway DB9 Pin Out

The main pins which must be noted are the received data signal line on pin 2 and the signal ground on pin 5. When receiving serial data, these are the only two connections which the SNMP Access Gateway needs. However, if pass-through access to connected serial devices is required, then the transmitted data signal line on pin 3 must be connected as well. Additionally, some equipment may require an RS-232 high signal on one or more of its signal lines in order to transmit or accept data. Consult the manual for your other equipment as needed.

The DCE, DB-9 female cable ends which mate with the serial port connectors of the SNMP Access Gateway will often have a pair of screw-down cable locks. These cable locks should be used to assure a solid connection of the cable with the SNMP Access Gateway serial port connectors.

2.4 - Ethernet

The ethernet 10BaseT connector is an RJ-45 connector. This connector is the commonly used 10BaseT connector, which would connect the SNMP Access Gateway to an ethernet hub or switch.

2.5 - Front Panel Items

The front panel of the SNMP Access Gateway module has two push-buttons and 8 LED indicators representing status information about the SNMP Access Gateway.

The reset (RST) button (S2) is used to reset the SNMP Access Gateway. After the RST button is held in for about 5 seconds, the SNMP Access Gateway will start sounding its audible alarm. At this point the RST button may be released. The SNMP Access Gateway will remain in reset while the RST button is pressed, and will begin operation again once the RST button is released.

The program (PRG) button (S1) is used to silence audible alarms and to enter local command (programming) mode. When an audible (buzzer) alarm is active, pressing the PRG button clears the alarm, so that the audible alarm is silenced. If the PRG button is held in for about 3 seconds, the SNMP Access Gateway enters local command (programming) mode. In this mode serial port I/O 2 operates as a local command port. Either a time-out of no command for five minutes, an EXIT or BYE command, or a reset will take the SNMP Access Gateway out of local command mode.



Figure 5. – SNMP Access Gateway Module Layout

The ethernet status is shown as three LEDs. The yellow Link LED lights whenever an ethernet 10BaseT network link connection is found. The green Transmit LED lights briefly whenever an ethernet frame is being transmitted. The green NET LED lights whenever a TCP socket is opened to the unit, whether telnet or FTP. SNMP activity causes this NET LED to blink once per second. These LEDs can be used to see that a network cable connection is made, and when some network activity has caused the SNMP Access Gateway to transmit on the network.

Each RS-232 port has two LEDs associated with it. The left LED is a received data (RXD) LED. The right LED is a transmitted data (TXD) LED. The TXD LED is normally on and green. The RXD LED is off when no cable is connected to the serial port, and on when a cable is connected. Normally the RXD LED will be green as well. When an RS-232 line is idle, the voltage is negative, and the LED shows green. When data is transmitted, the voltage goes between positive and negative voltages and the LED turns red and green, so when data is transmitted or received on a serial port the corresponding LED will flicker between red and green, which sometimes makes the LED look yellow. These LEDs can be used to see that a cable is connected (the LED is lit) and that data is being transmitted or received (the LEDs flicker between red and green).

The power LED has two uses. Normally the power led is lit constantly, with a quick flash once every ten seconds. This 'heartbeat' signal on the power LED provides a quick indication that the SNMP Access Gateway is operating. A second mode of use of the power LED is when the SNMP Access Gateway is in local command mode. When the local serial port is in command mode, the power led flashes on and off at about a 1/2 second on, 1/2 second off rate.

Chapter 3 - Basic Setup for Operation

3.1 - Network Setup

As with all TCP/IP- or SNMP-based devices, the SNMP Access Gateway requires an IP address to be assigned to each unit in order to send and receive TCP/IP or SNMP data. The SNMP Access Gateway may operate with either a statically or dynamically allocated IP address.

When statically allocated, the SNMP Access Gateway must be configured with an IP address, network address mask, and default router prior to being used on the network. This configuration may be made by a local command port. It can not be made via a TCP/IP (network) connection, as use of such connections would first require the setting of the IP address.

The IP address may be dynamically allocated using either BOOTP or DHCP. By default, the SNMP Access Gateway is configured to use BOOTP or DHCP to dynamically obtain its IP address, network address mask, default router, etc. When booting, the SNMP Access Gateway transmits a BOOTP/DHCP request. This request is responded to by any BOOTP or DHCP servers configured to allocate an IP address to the SNMP Access Gateway. When the SNMP Access Gateway receives its first response from the BOOTP/DHCP request, then the SNMP Access Gateway either uses the BOOTP reply or engages in a DHCP session to dynamically establish the network settings of the SNMP Access Gateway.

The SNMP Access Gateway expects to be on a local area network, or to use the default router in the case where an IP destination is determined to not be a local address. The SNMP Access Gateway uses the destination IP address and the network address mask to determine if the destination IP address is a local address or not. If so, then the IP frame is sent to the destination IP address on the local network. If not, then the IP frame is sent via the default router. If no default router is configured (the address is 0.0.0.0) then no IP frame is sent when the SNMP Access Gateway determines that the IP frame must be routed and no router exists. If an SNMP management station will be used which is not on the local network, then the configuration of the default router should be verified. See the use of the PING command in verification that a route to each management station exists and is usable.

The SNMP Access Gateway provides TCP/IP connections using ports 23 and 2000. Up to three concurrent connections may be made using these port numbers. When a port address of 23 is used, the telnet character processing (interpretation of IAC codes, option negotiation, etc.) is performed in both directions of data flow. When a port address of 2000 is used, no telnet character processing is performed. Other than this difference, the use of port 23 or port 2000 is identical. The SNMP Access Gateway also uses ports 20 and 21 when providing the FTP server functions.

The SNMP Access Gateway has a configurable list of IP restrictions. This list may be used to restrict IP access to the SNMP Access Gateway to only certain networks or certain IP addresses, reject connection from certain IP networks or addresses, etc. This may be used to provide greater security features than a password alone. The IP restriction table is established using the SETUP command on the NETWORKING menu. If the IP restriction table is empty, then all networks and IP addresses are allowed to connect to the SNMP Access Gateway. By entering IP restrictions in the table, then certain networks or IP addresses can be restricted. See the App Note A. Use of IP Restrictions for more information on the use of IP restrictions. By default, no IP restrictions are established.

3.2 - Local Command Mode

The serial port labeled I/O 2 may be used for local command mode. This mode is entered by either holding in the PRG button on the front panel for about five seconds, until the power LED starts flashing on at off, or by entering the (programmable) escape character three times within 3 seconds on the I/O 2 serial port.

When in local command mode, the baud rate and serial port parameters of I/O 2 remain the same.

A user may exit local command mode by four methods. Using the EXIT or BYE command will terminate local command mode. Waiting five minutes without entering a command will also terminate local command mode. Additionally, resetting the SNMP Access Gateway with the RST button will also exit local command mode.

3.3 - Connections

A connection may be made to the SNMP Access Gateway via a network connection. When a connection is made, the user is provided with a menu from which the desired mode of the connection is established. The user may select to enter a command processor mode of operation, or may select a pass-through mode of operation. The user selects the desired mode of operation from the menu, and then the user is prompted for the password for that mode of access. If the user enters the proper password, then the desired mode of the connection is established.

A connection may be in one of four states. A first state is an idle state, in which no active connection for that possible connection has been established. In the second state, a user has established a connection and the menu selection for which type of connection is desired has not yet been made. In the third state the user has entered the command processor. In the fourth state the user has entered pass-through access mode.

Three concurrent network connections, one local command port connection, plus an FTP server connection may all exist with the SNMP Access Gateway. SNMP is connectionless, and may be use concurrently with any combination of connections. The FTP server connection does not affect the other connections or use of command or pass-through mode.

Only one valid command processor connection may exist at a time. Thus, if I/O 2 is in the local command port mode, then requests to enter command processor mode via any of the network connections must be denied. Similarly, if one of the network connections has been established as a command processor connection, then other network connection cannot access the command processor until it has been made available once again. If a network connection is in command processor mode, then the local command port mode on I/O 2 is also not allowed until the command processor is available for re-assignment.

When a user opens a connection to the SNMP Access Gateway the user is provided with a menu from which the mode of operation is selected, as shown below.

SNMP Access Gateway Model Version 1.00

- 0. Enter Command Processor
- 1. Enter Pass-Through to Port 1
- 2. Enter Pass-Through to Port 2
- X. Exit (end connection)

A network connection can be broken by using the 'X' selection from the main menu. The network connection is then placed into the idle state.

A network connection may also be broken from the client side using the disconnect feature of the client software. Closing of the network connection places that connection into the idle state.

When a connection has been established and is in either the command processor or pass-through mode of operation, the current operating mode should be terminated and the user should return to the main menu before closing the connection to the SNMP Access Gateway. Closing a network connection should not result in any extra characters being transmitted to either the command processor or a pass-through port.

Chapter 4 - Command Control

4.1 - Command Processor Mode

The command processor may be accessed from a network connection. A user enters command processor mode from the main menu by selecting the '0' option.

SNMP Access Gateway Model Version 1.00

```
0. Enter Command Processor
1. Enter Pass-Through to Port 1
2. Enter Pass-Through to Port 2
X. Exit (end connection)
<user enters 0>
```

```
Command Processor Password: ---- <user enters password>
Command Password Accepted
```

```
Enter Command (Setup, Events, ?, Help or other command)
>
```

The > is the command prompt. At this point the user may enter any of the commands for the SNMP Access Gateway. After a command is executed, a new prompt > is provided. The command reminder line is only provided again if a blank (enter only) line is entered.

If the command processor is currently in use by any of the other connections, then after the user has entered the command processor password the user gets a message as below:

Command Processor Currently In Use. Access Denied

Thus, only one command processor connection may be made at a time. In this case the user is returned to the main selection menu.

The EXIT command is used to exit the command processor and return to the main menu. The BYE may also be used to exit the command processor. However, the BYE command also terminates the connection after the command processor access is terminated.

If no command is entered for 4 minutes and 30 seconds then a reminder message is sent out, followed by the prompt:

```
Command Processor Time-out in 30 seconds
>_
```

If no command is entered within this 30 seconds then the BYE command is executed, terminating the command processor access and terminating the connection, due to no command in 5 minutes. This automatic logout occurs on any of the command connections, including all network connections, and the local command port.

Command may be entered in upper, lower or mixed case. Only a few commands are needed to control and manage the SNMP Access Gateway. The commands available are:

Session control commands	
EXIT	Exit command processor back to main menu
BYE	Exit command processor and close connection
Setup and status commands	
?	Shows the SNMP Access Gateway status
SETUP	Most SNMP Access Gateway setup is done with this command
EVENTS	List, clear events file
RELAYS	Setup and status of relays
DEFAULT	Set settings to defaults

COLDSTART	Clear events file, all settings to default
Other commands	
HELP	Show list of commands
PING	Ping an IP Address for testing
Pseudo-SNMP Commands	
GET	Get the value of an object with a specific object ID
GETNEXT	Get the value of the next object after an object ID
GETX	Get the value of the object last retrieved
SET	Set the value of an object
WALK	Get the value of the object after the last retrieved

4.2 - General Commands

4.2.1 - EXIT

The EXIT command terminates the command processor access and returns the user to the main menu. This command can be used if the user wants to change the access mode from command processor mode to pass-through access mode. If the user wants to simply exit the command processor and then terminate the connection, the BYE command may be used instead to perform both these actions with one command.

4.2.2 - BYE

The BYE command terminates both the command processor access and the connection being used to access the command processor. The BYE command can be used at the end of a command session to exit the command processor and terminate the command connection. Alternatively, the EXIT command could be used to exit the command processor and return to the main menu, and then the 'X' main menu command can be used to terminate the connection which was used for command access.

4.2.3 - ? (question mark)

The ? command provides a status display for the SNMP Access Gateway. This display shows the firmware version, unit ID, current date and time, setup of the serial ports, sensor and relay status, etc. This command can be used to check the operational status and configuration of the SNMP Access Gateway unit.

```
SNMP->Link V0.50m      #
Unit ID : SNMP->Link
Date    : MON 04/06/98      Time    : 17:55:38
Modem   : 33600 8,N,1
Network : Yes              FAFile   : Yes
IP Add  : 192.168.100.131
MAC Add : 00:10:A3:00:00:09
-----
                I/O 1      I/O 2
Baud Rate      19200      19200
Parity, etc.   8,N,1      8,N,1
-----
Event Records 0
Current Event Status:
Data Alarms  -----
Sensors  A1 :Open   A2 :Open   A3 :Open   A4 :Open   A5 :Open   A6 :Open
Relays   A8 :Open   A9 :Open
```

4.2.4 - SETUP

The SETUP command provides a series of menus from which the user may select configuration items for setup and configuration purposes. These setup menus include setup items for the networking settings, serial port settings,

password settings, event (alarm) definition settings, alarm action settings, and other settings. See Chapter 5 - Use of the SETUP Menu for further details of the use of the SETUP command.

4.2.5 - EVENTS

The EVENTS command is used to view the current status of the events (alarms), view the contents of the events log file, clear contents of the events log file, view the current active alarm actions, acknowledge alarms, and view the history log of alarm actions. See Chapter 12 - Use of the EVENTS Command for further details of the use of the EVENTS command.

4.2.6 - DEFAULT

The DEFAULT command resets certain variables and settings to their default values. The network settings and serial ports settings are not affected by the use of the DEFAULT command. The events log file is not cleared. The configuration variables and settings affected by the DEFAULT command are:

Setting	Value Set To
Store data record events	1 (on)
Store alarm record events	1 (on)
Store command log	1 (on)
Store reset events	1 (on)
Store sensor events	1 (on)

4.2.7 - COLDSTART

The COLDSTART command is used to completely re-initialize the SNMP Access Gateway. All network and other settings are re-initialized to their default values. The events log file is cleared.

4.2.8 - HELP

The HELP command provides a list of the command available with the SNMP Access Gateway. The display looks something like this:

```
?      SETUP  EVENTS  RELAYS  EXIT
GET    GETNEXT GETX    SET
```

4.2.9 - PING

The PING command executes an ICMP PING test to determine if an IP address is reachable and responding. The PING command may be used to test the network connectivity of the SNMP Access Gateway. For example, if a default router is used, the SNMP Access Gateway should be able to PING the default router, which demonstrates network connectivity and proper network connections.

4.3 - Pseudo-SNMP Commands

The pseudo-SNMP commands are manual commands which can be entered via a dialup or telnet connection and which may be used with the object IDs developed for SNMP for setting and retrieving the value of SNMP-manageable objects. These objects may be part of the standard (MIB-II) MIB (as described in RFC 1213), or part of the custom MIB of the SNMP Access Gateway. The pseudo-SNMP management section of this manual provides further details and examples of use of the pseudo-SNMP commands.

4.3.1 - GET

The GET command is used with a specific object ID to obtain the value of that object.

4.3.2 - GETNEXT

The GETNEXT command is used with an object ID, and the value returned is the object ID and value of the object which follows the object ID included with the GETNEXT command.

4.3.3 - GETX

The GETX command is used without an object ID, and the value returned is that of the last object retrieved by pseudo-SNMP.

4.3.4 - SET

The SET command is used with an object ID and a value, and the object with the object ID included with the command is set to the value included with the command.

4.3.5 - WALK

The WALK command is used without an object ID, and may be used to 'walk' through the MIB. The WALK command acts like the GETNEXT command, but uses the object ID of the last object retrieved by pseudo-SNMP as the included address. Thus, repeated uses of the WALK command allow the user to progress through all items of the MIB.

Chapter 5 - Use of the SETUP Menu

Upon selecting 'Enter Command Mode' from the main SNMP Access Gateway menu, the password prompt as shown below is presented for entry of the Command Mode Password.

```
Command Processor Password: ----
Command Password Accepted
```

Upon entry of a valid password the Command Mode Prompt (a 'greater than' sign) is shown and commands can be entered. The first time the command prompt is presented, an additional line is printed (as shown below) to remind the user of a few basic commands and this prompt can be redisplayed by pressing ENTER on a blank line of the command prompt. The SETUP command presents the user with a menu of basic setup functions.

```
>SETUP
```

```
Setup Main Menu
A. Networking
B. Serial/Input Ports
C. Passwords
D. Event Definitions
E. Action Definitions
F. System Date/Time
G. Other Settings
Selection?
```

Many of the above menu items have extensive sub-menus for configuration of all the possible SNMP Access Gateway settings. The following sections take each of the above menu items and go through the possible options and selections.

5.1 - Networking

Selecting the Menu Letter of NETWORKING from the Setup Main Menu presents the following submenu for setting various network related options. The Networking menu appears as follows. Each of the menu items shown below is discussed in order in this section.

```
Setup: Networking
A. Network Access Enabled [Y]
B. Get IP Address via [BOOTP/DHCP]
C. IP Address [192.168.100.131]
D. Network Mask [255.255.255.0]
E. Default Router [192.168.100.254]
F. FTP AutoDelete [N]
G. SNMP Manager Setup
H. SNMP Trap Setup
I. SNMP Community Setup
J. IP Address Restrictions
K. Ping Router every 10 Mins [N]
L. PPP Dialout Setup
M. PPP Hosting Setup
```

5.1.1 - Network Access Enabled

This option is toggled by pressing its Menu Letter. The default for this option is Y but communication via the ethernet interface can be inhibited by disabling this selection.

5.1.2 - Get IP Address

This option is toggled by pressing its Menu Letter. The default selection is BOOTP/DHCP and the alternate selection is STATIC. The default selection has the SNMP Access Gateway request and respond to BOOTP/DHCP

assignment for the unit IP Address. STATIC implies that the IP address is manually entered and in this mode the BOOTP/DHCP sequence is not initiated or allowed by the SNMP Access Gateway.

5.1.3 - IP Address

By pressing the Menu Letter of this option a prompt is presented for entry of the Static IP address. Note that after changing the IP address and exiting the SETUP menu the SNMP Access Gateway will reboot itself and any current network connections will be terminated (unless Get IP Address Via is set to Bootp/DHCP in which case the IP address change will not be accepted).

5.1.4 - Network Mask

By pressing the Menu Letter of this option a prompt is presented for entry of the Network Mask.

5.1.5 - Default Router

By pressing the Menu Letter of this option a prompt is presented for entry of the Default Router.

5.1.6 - FTP AutoDelete

This option is toggled by pressing its Menu Letter. FTP AutoDelete controls whether data is automatically deleted as TCP packets are acknowledged during an FTP transfer of the Events File data. The default is N.

5.1.7 - SNMP Manager Setup

Selecting the Menu Letter of this option presents the following submenu for entry of the IP addresses of up to eight possible SNMP managers. The addresses entered here will be referred to in other setup and alarm parameters as T1, T2, etc., to specify which managers traps should be sent to.

Setup: Networking: SNMP Managers

1. Manager 1 [192.168.100.20]
 2. Manager 2 [192.168.100.1]
 3. Manager 3 []
 4. Manager 4 []
 5. Manager 5 []
 6. Manager 6 []
 7. Manager 7 []
 8. Manager 8 []
- Selection?

5.1.8 - SNMP Trap Setup

Selecting the Menu Letter of this option presents the following submenu for selection of various options relating to sending SNMP traps.

Setup: Networking: SNMP Traps

- A. SNMP Traps Enabled? [Y]
 - B. SNMP Authentication Failure Traps Enabled? [Y]
 - C. SNMP Traps Repeat Time (0 for no repeat) [2]
 - D. Enterprise-Specific Traps Enabled? [Y]
- Selection?

A. This selection enables/disables the sending of SNMP Traps in general. The default is 'Y'.

This selection enables the sending of a trap to all SNMP Managers if an invalid community name is used in an SNMP GET or SET. The default is 'N'.

C. This selection enables and selects the interval at which SNMP Traps will repeat being sent until the alarm generating the trap is explicitly acknowledged. See Chapter 12 - Use of the EVENTS Command for more on Acknowledging Alarms.

D. This selection enables/disables sending traps relating to SNMP Access Gateway contact closures and data alarms. The default is 'Y'.

5.1.9 - SNMP Community Setup

Selecting the Menu Letter of this option presents the following submenu for specifying SNMP Community Names. Whenever you do an SNMP operation, whether a SET or a GET, the community name needs to be included as part of that operation. Additionally the community name is sent within any SNMP traps. While the default for all of these community names is 'public', these can be individually changed by using this menu.

Setup: Networking: SNMP Community Names

- A. Read Community [public]
 - B. Write Community [public]
 - C. Trap Community [public]
- Selection?

5.1.10 - IP Address Restrictions

Selecting the Menu Letter of this option presents the following submenu for selection of various options relating to IP Address Restrictions. Essentially, if there are no addresses entered in this table then connection from any IP address is allowed. Entries in this table will limit and explicitly allow connection from various IP addresses. For further information see the Application Note - Using IP Restrictions at the end of this manual

1. 192.169.100.0

- A. Add Item to Table
 - B. Delete Item From Table
 - X. Delete All Items From Table
- Selection?

5.1.11 - Ping Router every 10 Mins

This option enables pinging the Default Router's IP address every 10 minutes.

5.1.12 - PPP Dialout Setup

This option leads to a sub-menu which is described in the PPP chapter. The sub-menu contains the options to setup PPP dialout functionality for actions such as sending traps.

5.1.13 - PPP Hosting Setup

This option leads to a sub-menu which is described in the PPP chapter. The sub-menu contains the options to setup the Data-Link as a PPP Host.

5.2 - Serial/Input Ports

Selecting the Menu Letter of SERIAL/INPUT PORTS from the Setup Main Menu presents the following submenu for setting the baud rate and parity settings of the SNMP Access Gateway serial ports. The following two menus are displayed in order. The default settings for both serial ports is 19200 Baud, 8 Bits, No Parity, 1 Stop Bit.

Setup: Serial Ports

- 1. I/O 1: 19200,8,N,1
 - 2. I/O 2: 19200,8,N,1
- Selection? 1

Setup: Serial Ports: I/O 1 Baud Rate

- A. 300
- B. 600

C. 1200
 D. 2400
 E. 4800
 F. 9600
 G. 19200
 Selection [G]?

Setup: Serial Ports: I/O 1 W,P,S
 A. 8,N,1
 B. 7,E,1
 C. 7,0,1
 D. 7,N,1
 Selection [A]?
 DTR Low Except When Pass-Through Active [N]?

This last option turns on or off DTR handshaking with the device connected to I/O port 1 or 2 that one is accessing directly. In its default state, DTR is always high to the device on the respective port. With this option set to Y(es), DTR will go low to the device when no direct serial access is occurring. This is useful if one wants the device to close any maintenance or administrative session automatically in the case where a connection was not terminated properly.

5.3 - Passwords

Selecting the Menu Letter of PASSWORDS from the Setup Main Menu presents the following submenu for setting the SNMP Access Gateway passwords. The menu below shows the default passwords.

Setup: Passwords
 A. Command Password [SL60]
 B. Pass-Through Port 1 Password [ACCESS1]
 C. Pass-Through Port 2 Password [ACCESS2]
 D. FTP Server Password [SL60]
 Selection?

5.4 - Event Definitions

Selecting the Menu Letter of EVENT DEFINITIONS from the Setup Main Menu presents the following submenu for setting up the various events and alarm capabilities of the SNMP Access Gateway.

Setup: Event Definitions
 A. Set up Sensor / Analog Events
 B. UpLoad New Filter and Alarm File
 C. View Current Filter and Alarm File
 D. Alarm Evaluator Enabled [Y]
 E. Store Data Record Events [Y]
 F. Store Alarm Record Events [Y]
 G. Store Sensor Events [N]
 H. Store Reset Events [N]
 I. Store Command Log Events [N]

5.4.1 - Set Up Sensor/Analog Events

Selecting the Menu Letter of this option presents the following submenu for selection of various options relating to enabling and configuring the Contact Closure/Analog inputs for use.

Setup: Event Definitions: Sensor Events

Sensor	Set Type	Name	Active	Thrsh	Actions
1. Sensor 1	Y CC	fire	Closed	1	(T)12

2. Sensor 2	Y	CC	smoke	Closed	3 (T)1, (P)2
3. Sensor 3	Y	CC	flood	Closed	3 (T)1, (P)3
4. Sensor 4	Y	CC	famine	Closed	3 (T)1, (P)4
5. Sensor 5	Y	CC	pestilence	Closed	3 (T)1, (P)5
6. Sensor 6	Y	CC	layoffs	Closed	3 (T)1, (P)6

Selection?

Selection of any one of the sensors displayed on this list presents the following menu for sensor configuration.

```

Setup: Event Definitions: Sensor Events
Sensor 1
Enable Event [Y]?
Sensor Type, (C=Contact Closure, A=Analog) [CC]?
Sensor Event Name [fire]?
Sensor Event State (0-Open C-Closed) [Closed ]?
Sensor Event Threshold in Seconds [1]?
(T)rap Actions [12]?
(P)ager Actions []?
(B)uzzer Action []?
(R)elay Actions []?

```

Enable Event - This enables/disables any alarm action occurring from this sensor changing states.

Sensor Type - This selects whether the input type is a dry contact closure or an analog voltage.

Sensor Event Name - This is the name assigned to this sensor by the user.

Sensor Event State - This selects whether the alarm state, if selected as a contact closure, is open or closed.

Sensor Event Threshold in Seconds - This selects how long the contact closure sensor must be in the alarm state before it is considered an alarm. The default is 3 seconds.

(T)rap Actions - This assigns which traps should occur if this sensor changes to the alarm state. The numbers 1 through 8 may be entered indicating the SNMP Manager addresses 1 through 8 set up elsewhere.

(P)ager Actions - This assigns which pager numbers should be called when this alarm state occurs.

(B)uzzer Action - This allows specification of buzzer noise one or two (beeping or solid) when this alarm state occurs.

(R)elay Actions - This assigns which relays will activate when this alarm state occurs. The relay must be configured to be in Individual-Controlled mode as described in the chapter on Relay Management for this option to work.

5.4.2 - Upload New Alarm File

For uploading an alarm file over TCP/IP see the section on FTP.

5.4.3 - View Alarm File

Selecting the Menu Letter of this option displays any existing alarm file resident in the memory, looking something like this:

```

[fields]
flag=1,1
number=2,3
lastdigit=5,1
therest=6,95

[dataalarms]
equalfour=all,1,T1,A1hours

```

```

equalfour_1=lastdigit="4"
greatfour=all,1,T1,A1hours
greatfour_1=lastdigit>"4"
lessfour=all,1,T1,A1hours
lessfour_1=lastdigit<"4"
notfour=all,1,T1,A1hours
notfour_1=lastdigit!="4"

```

[end]

5.4.4 - Alarm Evaluator Enabled

Selecting the Menu Letter of this option enables/disables the operation of any existing alarm file loaded into the memory.

5.4.5 - Store Data Record Events

Selecting the Menu Letter of this option enables/disables the storage in the Events file of 'Data' records. A Data record is classified as any serial string received by the . (Note that for a string to be accepted as a 'record' it must a) be terminated by a CR, CL/LF, 03, or b) exceeds 200 characters or c) resides without meeting the previous two conditions for 10 seconds). Therefore, enabling this feature will cause all records received by the UNIT to be stored in the Events File.

5.4.6 - Store Alarm Record Events

Selecting the Menu Letter of this option enables/disables the storage in the Events file of 'Alarm' records. An Alarm record is classified as any serial string received by the UNIT which matches any existing alarm definition. Enabling this feature will cause Alarm records received by the UNIT to be stored in the Events File. Note that if 'Store Data Records' is also enabled the records matching alarm formulas will be stored twice, once as a data record and once as an alarm record.

5.4.7 - Store Sensor Events

Selecting the Menu Letter of this option enables/disables the storage in the Events file of Sensor Event records. A Sensor Event is classified as any sensor moving from a 'non-alarm' condition to an alarm condition. In this case a message will be placed in the Events File registering this occurrence.

5.4.8 - Store Reset Events

Selecting the Menu Letter of this option enables/disables the storage in the Events file of Reset Event records. A Reset Event is classified as any reboot of the UNIT. In this case a message will be placed in the Events File registering this occurrence.

5.4.9 - Store Command Log Events

Selecting the Menu Letter of this option enables/disables the storage in the Events file of Command Events. A Command Event is the sending of a command to the UNIT via command mode. In this case a message will be placed in the Events File registering each command which is sent to the UNIT.

5.5 - Action Definitions

Selecting the Menu Letter of ACTION DEFINITIONS from the Setup Main Menu presents the following submenu for setting up the various event notifications which can be associated with SNMP Access Gateway events and alarms.

```

Setup: Action Definitions
A. Traps
B. Pagers
Selection?

```

5.5.1 - Traps

Selecting the Menu Letter of this option presents a set of options to define the 'payload' variable which is included in all SNMP traps when sent. The current trap configuration is illustrated at the top of this menu. The default configuration is shown below.

Setup: Action Definitions: Trap Format
MM/DD HH:MM Type AlarmName Number Alarm Text String or Alarm Record

- A. Include Date/Time [Y]
- B. Include Alarm Type [Y]
- C. Include Alarm Name [Y]
- D. Include Alarm Number [Y]
- E. Include Alarm String [Y]

5.5.2 - Pagers

Selecting the Menu Letter of this option presents a set of options to define the phone numbers and other parameters for the eight possible pagers which can be associated with SNMP Access Gateway events and alarms. Note that the amount of information for each pager is too long to display on a single line, so two lines are used for the information for each pager definition.

Setup: Action Definitions: Pagers

#	Type	Retry #	Delay	Repeat	Delay	TxID	TxRSN	DialDly	HangupDly
	PagerID		Message				Phone Number		
1.	Numeric	01	05 345#	N	05	N	N 9,6480769	15	10
2.	Numeric	01	05 456#	N	05	Y	Y 9,6480769	15	10
3.	Numeric	01	05 567#	N	05	N	Y 9,6480769	15	10
4.	Numeric	01	05 678#	N	05	N	Y 9,6480769	15	10
5.	Numeric	01	05 789#	N	05	N	Y 9,6480769	15	10
6.	Numeric	01	05 890#	N	05	N	Y 9,6480769	15	10
7.	Numeric	03	05	N	05	N	Y	10	10
8.	Numeric	03	05	N	05	N	Y	10	10

Selection?

By selecting any of the pager entries 1 through 8 the following prompts are displayed for selection and entry of the pager settings for that particular pager.

Setup: Action Definitions: Pagers: Callout 1
 Pager Phone Number [9,6480769]?
 Pager ID []?
 Pager Message [345#]?
 Pager Type (A-Alpha, N-Numeric) [Numeric]?
 Repeat Until Source Acked [N]?
 Time (minutes) Between Repeats [05]?
 Transmit UnitID [N]?
 Transmit Reason for Action [N]?
 Numeric Pager Dial Delay [15]?
 Numeric Pager Hangup Delay [10]?

Pager Phone Number - This is the number the modem should dial to connect to the pager service.

Pager ID - This is the ID used by the pager service to identify that specific pager.

Pager Message - In the case of an Alphanumeric pager this entry contains an optional text message which is included in the pager message whenever an alarm is sent to this pager. In the case of a numeric pager, this is the number which is transmitted as the message to the numeric pager.

Pager Type (A-Alpha, N-Numeric) - This selection indicates whether the protocol used for this pager should be numeric (numbers only, keyed in by touch-tones) or TAP protocol for sending alphanumeric messages.

Repeat Until Source Acked - This option indicates whether paging should repeat at intervals until the SNMP Access Gateway is specifically connected to and the alarm acknowledged.

Time (minutes) Between Repeats - This value indicates the duration between repeats mentioned above.

Transmit UnitID - This option selects whether the Unit ID should be included in the pager message transmitted. This only applies to alphanumeric pagers.

Transmit Reason for Action - This option selects whether a condensed code indicating the reason for the pager alarm should be transmitted as part of the alarm message. This only applies to alphanumeric pagers.

Numeric Pager Dial Delay - This value sets the number of seconds between the initial modem dialing of the numeric pager phone number and the subsequent dialing of the pager ID number.

Numeric Pager Hang-up Delay - This value indicates how long the SNMP Access Gateway waits after sending the final digits to the numeric pager before the SNMP Access Gateway disconnects.

5.6 - System Date/Time

Selecting the Menu Letter of SYSTEM DATE/TIME from the Setup Main Menu presents the following prompts for entry of the date/time information to set the SNMP Access Gateway internal clock.

```
Setup System Date/Time
MON 04/06/98 17:58:22
```

```
Time (24-Hour HH:MM) [17:58]?
Date (MM/DD/YY) [04/06/98]?
Day of Week (1-7, 1=SUN - 7=SAT) [2]?
Adjust for Daylight Savings? [Y]?
MON 04/06/98 17:58:00
```

5.7 - General Settings

Selecting the Menu Letter of GENERAL SETTINGS from the Setup Main Menu presents the following submenu for setting a number of miscellaneous operational settings of the SNMP Access Gateway.

```
Setup: General Settings
A. Set UnitID
B. Operational Settings
C. Misc. Modem-Related Settings
D. Character Mask
Selection?
```

5.7.1 - Set UnitID

By pressing the Menu Letter of this option a prompt is presented for entry of the Unit ID.

```
UnitID [SNMP Access Gateway]?
```

5.7.2 - Operational Settings

Selecting the Menu Letter of this option presents the following submenu for setting several general operational settings of the SNMP Access Gateway.

Setup: General Settings: Operational Settings

- A. Escape Character [27]
- B. Console Mode [N]
- C. Strip Pass-through LFs sent to Device on I/O Port 1 [N]
- D. Strip Pass-through LFs sent to Device on I/O Port 2 [N]
- E. Strip Pass-through LFs received from Device on I/O Port 1 [N]
- F. Strip Pass-through LFs received from Device on I/O Port 2 [N]

Escape Character - This is the ASCII value of the ESCAPE character used to exit Pass-Through mode. This value is required to be pressed three times in Pass-Through mode to escape this mode back to the main login menu.

Console Mode - This setting indicates whether the serial ports of the SNMP Access Gateway should be independent inputs or whether they should operate jointly as a transparent pass-through connection (what goes in one port comes out the other and vice versa) for inline transparent monitoring of alarm messages.

Strip Pass-through LFs - Settings C through F strip linefeeds being sent to or received from the devices connected to I/O's 1 and 2, respectively. Some devices were found that didn't tolerate linefeeds being sent to them. And sometimes, linefeeds being received from the devices were not tolerated by the telnet client being used. Therefore, these options have been added to handle these situations.

5.7.3 - Character Mask

Selecting the Menu Letter of this option presents the following submenu for setting the serial input character mask. By customizing this selection you can screen out specified characters from the serial input stream. The numbers shown in the display indicate the characters which are allowed, displayed as their ASCII values.

Setup: General Settings: Character Mask

		2		3				10				13			
32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63
64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79
80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95
96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111
112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	

- A. Mask Enabled [Y]
- B. Default Mask
- C. Add a Character
- D. Delete a Character
- E. Enter Mask Specification Selection?

Chapter 6 - Pass Through Mode

Pass-through mode may be accessed from a network connection. A user enters pass-through mode from the main menu by selecting either the '1' or '2' option. The '1' option provides pass-through access to serial port I/O 1, and the '2' option provides pass-through access to serial port I/O 2.

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```
0. Enter Command Processor
1. Enter Pass-Through to Port 1
2. Enter Pass-Through to Port 2
X. Exit (end connection)
<user enters '1'>
```

```
Pass-Through Port 1 Password: ----- <user enters password>
Pass-Through Port 1 Password Accepted
Exit Pass-Through Mode by Entering ESC-ESC-ESC
```

A pass-through connection accepts characters on the network connection and passes those characters to the selected serial I/O port. Characters received on the serial I/O port are passed to the network connection.

When pass-through mode is entered, the escape character which may be used to exit pass-through mode is displayed. In the example shown above, the ESC (27) character is shown as the escape character. The escape character may be changed by using the SETUP command. When the escape character is entered on the network connection three times within three seconds, the SNMP Access Gateway exits the pass-through mode connection and returns the connection to the main menu.

When the escape character is entered the first and second times, the SNMP Access Gateway collects these characters and does not pass them on to the serial I/O port. After the third escape character is collected, the SNMP Access Gateway exits the pass-through connection. Thus, the escape characters are not passed through to the pass-through port when the escape sequence is used to exit the pass-through mode. However, if three seconds pass between escape characters, or if one or two escape characters are collected and then a character which is not the escape character is collected, then all collected characters are passed through to the serial I/O port. The escape character could then, for example, be changed to a capital letter 'X'. Then pass-through access to the serial I/O port could be terminated with three 'X' characters entered within three seconds, with no intervening characters. But use of a single or two 'X' characters in the pass-through command session would still result in the 'X' characters being passed through to the serial I/O port.

In the case where a user establishes a connection and selects an access port from the main menu and another user is already logged into the same serial I/O port for pass-through access, the new user is given the opportunity to join in the connection. Since the new user must have entered a valid password to access the port, a joining of the ports is allowed. In this case the message which the SNMP Access Gateway sends to the new participant is:

```
Pass-Through Port 1 Password: ----- <user enters password>
Pass-Through Port 1 Password Accepted
```

```
A Session with Port 1 is Already Established with:
    Network at IP 192.168.100.118
```

```
Do You Wish to Join the Session (Y/N) y
Session Joined.
```

After the user enters a letter, the SNMP Access Gateway either joins the connection or, if the user entered anything other than a 'Y', drops the user back into the main menu. If joining the connection, the SNMP Access Gateway provides a message to the user which shows what the escape character is.

If the connection is joined, then the user becomes an active participant in the connection.

In pass-through access mode, each character the user inputs by network connection is passed to the serial I/O port, and each character which is received by the serial I/O port is passed through to the network connection. During this time, the data from the port is NOT processed by the event and alarm evaluator, so no alarm records are detected during this pass-through access.

If more than one network connection is established for a serial I/O port (the 'join' has been used) then each character which is received from the serial I/O port is sent to each participant, and each character received from each participant is sent to each other participant and the serial I/O port. Joins may be used to observe the use of the pass-through mode by another user, for technical support or other purposes.

When joined, breaking a pass-through connection only affects the connection on which the escape sequence (or network or modem disconnection) was used. The other participants in the joined connection do not have their pass-through access terminated. When the last participant in a joined connection terminates the pass-through connection, then the serial I/O port reverts to the normal data collection mode automatically.

Pass-through access to serial I/O ports in console mode may also be made. See the section on console mode for more information on how pass-through connections are handled when the serial I/O ports are in console mode.

Chapter 7 - Console Mode

When the serial I/O ports are in console mode, characters which are received on one serial I/O port are sent out the other serial I/O port. This allows the SNMP Access Gateway to be placed in-line between two piece of equipment (such as a control console and a piece of equipment, hence the console mode name), and monitor the data flow between the devices for alarm conditions.

Console mode is enabled and disabled via the menus of the SETUP command, or by SNMP. By default console mode is not enabled.

When data is received from a serial I/O port while in console mode, the data is processed by the alarm evaluator as well as being passed to the other serial I/O port. Thus, the alarm evaluator can analyze the data flow from both serial I/O ports and log alarm events while simultaneously passing the data between the two serial I/O ports.

When a user attempts to establish a pass-through access to one of the serial I/O ports when the I/O ports are in console mode, the pass-through connection is allowed, as a joined connection. In this case characters which are received on the network connection are passed to the selected serial I/O port, and characters which are received on either of the serial I/O ports are passed to the network connection, in addition to being passed to the other serial I/O port. Thus, pass-through mode may be used to monitor the activities in console mode, and also provide the user with access to the equipment being controlled by the console. However, the characters received from the network connection are not processed by the alarm evaluator, so that they do not generate any alarm events.

Chapter 8 - Management Information Base (MIB)

The following illustrates the SL-60 MIB in tree format. The function of each of these objects is explained in the chapter following this one. This MIB is supplied on a disk with your unit in ASN.1 format. The various object Ids are listed out with their complete prefixes omitted. The full prefix to use with the following object Ids is shown below.

Omnitronix Private Enterprise MIB for SNMP Access Gateway
Prefix: 1.3.6.1.4.1.3052.2

1 - productIds

- 1.1 - snmplinkThisProduct
- 1.2 - thisTrapString

2 - productConfig

- 2.1 - productname
- 2.2 - systemversion
- 2.3 - appversion
- 2.4 - hardware
 - 2.4.1 - numberports
 - 2.4.2 - nets
 - 2.4.3 - modems
 - 2.4.4 - hardware sensors
 - 2.4.5 - hardware relays
- 2.5 - factorysetup
 - 2.5.1 - modemreport
 - 2.5.2 - modemportspeed
 - 2.5.3 - modemsetupstring
 - 2.5.4 - modemcddelay
 - 2.5.5 - modemtype
 - 2.5.6 - serialnumber
 - 2.5.7 - dateofmanufacture

3 - unitIds

- 3.1 - snmplinkSiteId

4 - serialPorts

- 4.1 - numberPorts
- 4.2 - portSetupTable
 - 4.2.1 - portSetupEntry
 - 4.2.1 - portIndex
 - 4.2.2 - portBaud
 - 4.2.3 - portWord
 - 4.2.4 - portParity
 - 4.2.5 - portStopbits

5 - time

- 5.1 - currenttime
- 5.2 - autoDstAdjust

6 - snmpsetup

- 6.1 - snmpTrapsEnabled
- 6.2 - snmpManagerTable
 - 6.2.1 - snmpTableEntry

- 6.2.1.1 - snmpMgrIndex
- 6.2.1.2 - snmpManagerIp
- 6.2.1.3 - snmpManagerName
- 6.3 - snmpTrapsAutoRepeatTime
- 6.4 - snmpSendTestTrap

7 - ftpsetup

- 7.1 - ftpAutoDelete

8 - events

- 8.1 - eventsControl
 - 8.1.1 - storeDataEvents
 - 8.1.2 - storeAlarmEvents
 - 8.1.3 - storeResetEvents
 - 8.1.4 - storeCommandLog
 - 8.1.5 - storeSensorEvents
- 8.2 - alarmEvaluator
- 8.3 - dataAlarmTable
 - 8.3.1 - dataAlarmEntry
 - 8.3.1.1 - dataAlarmIndex
 - 8.3.1.2 - dataAlarmActive
 - 8.3.1.3 - dataAlarmName
 - 8.3.1.4 - dataAlarmCounter
 - 8.3.1.5 - dataAlarmThreshold
 - 8.3.1.6 - dataAlarmClearMode
 - 8.3.1.7 - dataAlarmClearTime
 - 8.3.1.8 - dataAlarmAcked
 - 8.3.1.9 - dataAlarmBeeperActions
 - 8.3.1.10 - dataAlarmPagerActions
 - 8.3.1.11 - dataAlarmTrapActions
 - 8.3.1.12 - dataAlarmString
 - 8.3.1.13 - dataAlarmPort
 - 8.3.1.14 - dataAlarmAutoClear
- 4 - sensorAlarmTable
 - 4.1 - sensorAlarmEntry
 - 4.1.1 - sensorAlarmIndex
 - 4.1.2 - sensorAlarmActive
 - 4.1.3 - sensorAlarmName
 - 4.1.4 - sensorType
 - 4.1.5 - sensorAlarmMode
 - 4.1.6 - sensorRangeMin
 - 4.1.7 - sensorRangeMax
 - 4.1.8 - sensorAlarmState
 - 4.1.9 - sensorAlarmCounter
 - 4.1.10 - sensorAlarmThreshold
 - 4.1.11 - sensorAlarmAcked
 - 4.1.12 - sensorAlarmBeeperActions
 - 4.1.13 - sensorAlarmPagerActions
 - 4.1.14 - sensorAlarmTrapActions

9 - actions

- 9.1 - actionsBuzzer
 - 9.1.1 - actionsBuzzerState
- 9.2 - actionsPagerTable
 - 9.2.1 - actionsPagerTableEntry

- 9.2.1.1 - pagerTableIndex
- 9.2.1.2 - pagerType
- 9.2.1.3 - pagerPhonenumber
- 9.2.1.4 - pagerID
- 9.2.1.5 - pagerDialDelay
- 9.2.1.6 - pagerHangupDelay
- 9.2.1.7 - pagerMessage
- 9.2.1.8 - pagerSendId
- 9.2.1.9 - pagerSendReason
- 9.2.1.10 - pagerMaxAttempts
- 9.2.1.11 - pagerAttempts
- 9.2.1.12 - pagerAttemptDelay
- 9.2.1.13 - pagerRepeat
- 9.2.1.14 - pagerRepeatDelay
- 9.3 - actionsTraps
 - 9.3.1 - actionsTrapsEntSpecific
 - 9.3.2 - trapFormat
 - 9.3.2.1 - trapDateTime
 - 9.3.2.2 - trapAlarmType
 - 9.3.2.3 - trapAlarmName
 - 9.3.2.4 - trapAlarmID
 - 9.3.2.5 - trapAlarmString
 - 9.3.3 - actionsTrapsEntSpecCount

10 - relays

- 10.1 - numberRelays
- 10.2 - relaysTable
 - 10.2.1 - relaysTableEntry
 - 10.2.1.1 - relaysTableIndex
 - 10.2.1.2 - relaysTableName
 - 10.2.1.3 - relaysTableMode
 - 10.2.1.4 - relaysTableState
 - 10.2.1.5 - relaysTableResetState

11 - controls

- 11.1 - opSettings
 - 11.1.1 - consoleMode
 - 11.1.2 - charmask
- 11.2 - modemSettings
 - 11.2.1 - modemParity
 - 11.2.2 - modemTapSetup
 - 11.2.3 - modemInactivityTimer
 - 11.2.4 - modemTimeBetweenOutbound
- 11.3 - passThrough
 - 11.3.1 - ptconn1
 - 11.3.2 - ptconn2
- 11.4 - connections
 - 11.4.1 - connectionsTable
 - 11.4.1.1 - connectionsTableEntry
 - 11.4.1.1.1 - connectionsTableIndex
 - 11.4.1.1.2 - connectionsState
 - 11.4.1.1.3 - connectionsMode
 - 11.4.1.1.4 - connectionsAddress
 - 11.4.1.2 - connectionsCmdActive
 - 11.4.1.3 - connectionsCmdConn
 - 11.4.1.4 - connctionsEndchar

11.4.1.5 - connectionsPTTimelimit

12 - alarmhistory

- 12.1 - actionQueue
 - 12.1.1 - actionCount
 - 12.1.2 - actionTable
 - 12.1.2.1 - actionTableEntry
 - 12.1.2.1.1 - actionTableIndex
 - 12.1.2.1.2 - actionAcked
 - 12.1.2.1.3 - actionReason
 - 12.1.2.1.4 - actionReasonID
 - 12.1.2.1.5 - actionReasonLevel
 - 12.1.2.1.6 - actionType
 - 12.1.2.1.7 - actionTypeID
 - 12.1.2.1.8 - actionRepeatTime
 - 12.1.2.1.9 - actionAttempts
 - 12.1.2.1.10 - actionNextAttempt
 - 12.1.2.1.11 - actionTimeStamp
- 12.2 - actionHistory
 - 12.2.1 - historyCount
 - 12.2.2 - historyTable
 - 12.2.2.1 - historyTableEntry
 - 12.2.2.1.1 - historyTableIndex
 - 12.2.2.1.2 - historyEntryType
 - 12.2.2.1.3 - historyReason
 - 12.2.2.1.4 - historyReasonID
 - 12.2.2.1.5 - historyReasonLevel
 - 12.2.2.1.6 - historyType
 - 12.2.2.1.7 - historyTypeID
 - 12.2.2.1.8 - historyTimeStamp
 - 12.2.2.1.9 - historyClearLog

13 - iprestrictions

- 13.1 - iprestrictTable
 - 13.1.1 - iprestrictTableEntry
 - 13.1.1.1 - iprestrictTableIndex
 - 13.1.1.2 - iprestrictIpAddress

99 - techsupport

- 99.1 - techsupportInt1
- 99.2 - techsupportInt2
- 99.3 - techsupportInt3
- 99.4 - techsupportInt4
- 99.5 - techsupportInt5

snmplinkMainTrap TRAP-TYPE
 ENTERPRISE snmplinkThisProduct
 VARIABLES { thisTrapString }
 DESCRIPTION

“An snmplinkMainTrap is issued when a sensor or data alarm trap is to be issued. The thisTrapString contains a string formatted using the trap format controls. The string may contain a data alarm record if the trap is a data alarm trap.”

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Chapter 9 - SNMP Configuration and Control

The following section describes in detail the contents of the custom SNMP Access Gateway MIB, including notes about how these MIB object may be used.

9.1 - productIds	Items in this section are either factory-configured or read-only.
snmplinkThisProduct	This is a text string with the product name.
thisTrapString	This string is used in traps, and the contents of this string contain the trap alarm type, name, index number, and alarm string, as configured by the trap format variables.
productConfig	Items in this section are all factory-configured.
productname	This is a text string with the product name.
systemversion	This integer is the version of the 'system' section of the SNMP Access Gateway firmware.
appversion	This text string is the version of the 'application' section of the SNMP Access Gateway firmware. It will usually have a format of V1.00, V1.01, etc.
hardware:numberports	This integer is the number of serial ports found. In the standard SNMP Access Gateway this will be 2.
hardware:nets	This integer is the number of network interfaces found. In the standard SNMP Access Gateway this will be 1.
hardware:modems	This integer is the number of modem ports found. If the optional internal modem is installed, this will be 1, otherwise it will be 0.
factorysetup:modemreport	This is the text string reported in the status display to show the type of modem installed.
factorysetup:modemportspeed	This is the baud rate used when communicating with the internal modem
factorysetup:modemsetupstring	This text string is the modem setup string used with the internal modem. It may be factory-customized for use with different internal modems.
factorysetup:cddelay	This integer is the number of seconds the SNMP Access Gateway waits after sensing an activation of carrier from the modem before recognizing the availability of the internal modem. This is used to avoid transmitting data to the internal modem before it is actually ready for the data, which can cause the modem to auto-disconnect or miss transmitting the data.
factorysetup:modemtype	This integer is a factory-assigned modem type number to track the type of modem installed in the SNMP Access Gateway.
factorysetup:serialnumber	This is a factory-assigned serial number assigned to this SNMP Access Gateway unit at final testing and configuration time.
factorysetup:dateofmanufacture	This text string is a factory-assigned date of manufacture assigned to this SNMP Access Gateway unit at final testing and configuration time.
9.2 - unitIds	This section contains objects for the user-configurable identification of a particular SNMP Access Gateway unit. Only one object is contained in this section.
snmplinkSiteId	This text string is user configured to indicate the installation site or identification of a particular SNMP Access Gateway unit.
9.3 - serialPorts	

numberPorts	This integer is the number of serial ports found installed in the SNMP Access Gateway unit. For the standard SNMP Access Gateway this will be 2.
portSetupTable	This table is used to retrieve and set the serial port settings, for the baud rate, word length and parity. This table is indexed by the serial I/O port number (i.e., 1 or 2 for the standard SNMP Access Gateway unit).
portSetupTable:portBaud	This integer is the baud rate of the port. Valid entries are 300, 600, 1200, 2400, 4800, 9600 and 19200 baud.
portSetupTable:portWord	This integer is the word length of the port. Valid entries are 7 or 8 bit word lengths.
portSetupTable:portParity	This single-character text string is the parity of the port. Valid entries are 'N' for no parity, 'E' for even parity and 'O' for odd parity.
portSetupTable:portStopbits	This integer is the number of stop bits for the port. It is always 1.
9.4 - Time	
currenttime	This text string is the current date and time of the SNMP Access Gateway clock. This read-write variable may be used to retrieve or set the system clock.
autoDstAdjust	This integer controls the automatic adjustment of the system clock for daylight savings time. If enabled, the clock is advanced one hour at 2:00 a.m. on the first Sunday in April, and turned back an hour at 2:00 a.m. on the last Sunday in October.
9.5 - snmpsetup	
snmpTrapsEnabled	This integer enables the SNMP Access Gateway to send traps. If disabled, no traps are sent by the SNMP Access Gateway. To use the trap transmission features of the SNMP Access Gateway this object should be set to 1.
snmpManagerTable	This table contains the IP addresses and optional names of SNMP managers to which the SNMP Access Gateway will send traps.
snmpManagerTable:snmpManagerIp	This IP Address is the IP address of an SNMP manager to which the SNMP Access Gateway may send traps. If the entry is not valid, it contains 0.0.0.0 as the IP address. In order for the SNMP Access Gateway to send traps to an SNMP manager, the IP address of the manager must be set in this table.
snmpManagerTable:snmpManagerName	This text string is an optional text description of the name of the SNMP manager. It is not used by the SNMP Access Gateway in transmitting traps, but may be used to keep a name associated with the IP address of an SNMP manager.
snmpTrapsAutoRepeatTime	This integer is the number of minutes between repeated transmissions of the same trap, due to an event which requires a trap to be sent. This timer is only active on enterprise-specific traps, it does not affect the transmission of the cold-start or warm-start standard traps. If this integer is set to 0, then traps are sent once and not repeated. In an environment where repetitions of traps is not desired, this object should be set to 0. If set to a value between 1 and 255, then enterprise-specific traps are repeated at the interval described by this object.

snmpSendTestTrap	When this object is set to any value, then the SNMP Access Gateway sends a 'test' trap by sending a trap to all of the managers in the snmpManagerTable. This test trap may be used to assure that the proper SNMP managers are set up in the smpManagerTable, and that each manager is properly responding to traps.
9.6 - ftpsetup	
ftpAutoDelete	This object controls the auto deletion of the events log file when it is retrieved by FTP. When set to 0, the file is not automatically deleted. When set to 1, the events file entries which were retrieved by FTP are automatically deleted from the events log file as the data is retrieved by FTP.
9.7 - events	The events section of the MIB is used to control which events are stored in the events log file, provide status information on the configuration of the data alarms, enable the processing of data alarms, retrieve and set the sensor alarm configuration.
storeDataEvents	This object, when set to 1, allows all data records received on the serial I/O ports to be stored as events. This object can be enabled to store all data records in the events log file. The storage of all data records which are received would be most useful when each data record received by the SNMP Access Gateway is an alarm record, a no data alarm processing is performed by the SNMP Access Gateway.
storeAlarmEvents	This object, when set to 1, allows all data alarm records to be stored in the events log file. A received data record is determined to be a data alarm record if the alarm evaluator determines that the data record matches any of the defined alarm criteria, regardless of the count of such data alarm records received.
storeResetEvents	This object, when set to 1, allows all resets from any source to be stored as events in the events log file. This may be useful in detecting power outages which might affect the operation of the SNMP Access Gateway or other equipment.
storeCommandLog	This object, when set to 1, allows all command lines entered at the command processor to be stored in the events log file. This allows a system administrator to examine the usage of the commands.
storeSensorEvents	This object, when set to 1, allows all sensor activation and in-activation events to be stored in the events log.
alarmEvaluator	This object enables and disables the alarm evaluator. When set to 0, no alarm evaluation is performed on data records, so no data alarm records are stored in the events file, and no data alarms are activated. When set to 1, the alarm evaluator is used to detect data alarm records and sense when data alarm events must be performed.
dataAlarmTable	This table provides retrievable information on the status and configuration of the data alarms. The data alarms are configured using an alarms configuration file, so objects in the dataAlarmTable are read-only. The number of table entries provided is equal to the number of defined data alarms in the alarms configuration file.
dataAlarmActive	This object shows that a particular data alarm is active. This object always reads as 1

dataAlarmName	This object is a text string which is the name associated with the data alarm, as defined in the alarms configuration file.
dataAlarmCounter	This integer is the current count of received alarm records which match the data alarm equation corresponding to this data alarm. This counter is reset at some pre-determined time interval, as determined by the dataAlarmClearMode and dataAlarmClearTime. The counter counts up as data alarm records are detected which match the corresponding data alarm equation. When the dataAlarmThreshold is reached, the data alarm actions are performed and the dataAlarmCounter is also reset.
dataAlarmThreshold	When a data record is received and matches the data alarm equation corresponding to this data alarm, and the dataAlarmCounter is incremented and now is equal to the dataAlarmThreshold, then the data alarm actions are taken.
dataAlarmClearMode	This integer represents the frequency of clearing of the dataAlarmCounter. Accepted values are 0 - every hour, 1 - every 2 hours, 2 - every 4 hours, 3 - every 6 hours, 4 - every 8 hours, 5 - every 12 hours, 6 - every 24 hours (daily) and 8 - cleared daily, but at a specified time (this time is specified in the dataAlarmClearTime object).
dataAlarmClearTime	This text string holds a time (e.g., "01:20") at which the dataAlarmCounter is cleared each day if the dataAlarmClearMode is set to 8.
dataAlarmAcked	Setting this object to any value acknowledges the data alarm actions associated with the current activity of this data alarm, which stops the repetitions of traps and pager actions, and silences the buzzer if this data alarm is the reason why the buzzer is active. This is the only read-write object in this section of the MIB.
dataAlarmBeeperActions	This object indicates the buzzer (audible alarm) actions associated with this data alarm. The object value may be 0 - no action, 1 - beep once every 10 seconds or 2 - beep continuously.
dataAlarmPagerActions	This object shows which pagers are to be paged when the actions associated with the data alarm are activated. Each bit in this integer is assigned to one of the pagers 1-8. Bit 0 (value of 1) is assigned to pager 1, bit 1 (value of 2) is assigned to pager 2, etc. If a bit in the dataAlarmPagerActions integer is cleared, then that pager is not activated by this data alarm. If a bit in the dataAlarmPagerActions is set, then that pager is activated by this data alarm.
dataAlarmTrapActions	This object shows which SNMP managers are sent traps when the actions associated with the data alarm are activated. Each bit in this integer is assigned to one of the SNMP managers 1-8. Bit 0 (value of 1) is assigned to SNMP manager 1, bit 1 (value of 2) is assigned to SNMP manager 2, etc. If a bit in the dataAlarmTrapActions integer is cleared, then that SNMP manager is not sent a trap based on this data alarm. If a bit in the dataAlarmTrapActions is set, then that SNMP manager is sent a trap based on this data alarm.

dataAlarmString	This text string object contains the last data record which was received which matched the data alarm equation associated with this data alarm. Since data records may be received after a data alarm initiates its actions, retrieval of this object after a data alarm is activated may not result in the retrieval of the data record which activated the data alarm. However, this object will contain the last data record which was received which did match the alarm equation associated with this data alarm.
dataAlarmPort	This integer object contains the serial I/O port number upon which the text string contained in the dataAlarmString was received.
sensorAlarmTable	This table contains the configuration objects for the sensor alarms. This table always has as many entries as there are sensors available to configure in the SNMP Access Gateway.
sensorAlarmActive	When this object is set to a value of 0, the associated sensor is not enabled for activating alarms. When this object is set to a value of 1, the associated sensor is enabled for activating alarms.
sensorAlarmName	This text string object holds a name associated with this sensor alarm.
sensorType	When this integer object is set to a value of 0, the sensor is processed as a contact closure sensor, with states of Opened and Closed. The sensor is normally opened, and is treated as closed when the sensor contact is connected to ground. When this object is set to a value of 1, the sensor is processed as an analog voltage sensor. In this case the sensor takes on values from 0-255, when the analog input voltage goes from 0 to 5 volts.
sensorAlarmMode	This integer object controls the mode of activation of the sensor. When the sensorType is 0 (a contact closure sensor) then the sensorAlarmMode may be set by the user to values of 0 (active when contact is opened) or 1 (active when contact is closed). When the sensorType is 1 (analog sensor) then the sensorAlarmMode may be set by the user to values of 0 (active when voltage drops below normal range minimum), 1 (active when voltage goes above normal range maximum) and 2 (active when voltage goes outside of normal range). The current sensor state is then reflected in sensorAlarmState.
sensorRangeMin	This integer is the minimum A/D value for the 'normal' operating range for the sensor attached to an analog input. For an analog sensor alarm which is triggered by dropping below the minimum A/D value the sensorRangeMin object sets the A/D value under which the voltage must drop.
sensorRangeMax	This integer is the maximum A/D value for the 'normal' operating range for the sensor attached to an analog input. For an analog sensor alarm which is triggered by exceeding the maximum A/D value the sensorRangeMax object sets the A/D value which the voltage must exceed.
sensorAlarmState	The sensorAlarmState object is a read-only object which holds the current state of the sensor (opened or closed when in contact closure mode, or the current A/D value being read if in analog mode).

sensorAlarmCounter	This read-only object holds the number of seconds that the sensor alarm has been in its active state. For a contact closure input this counter is the number of seconds that the contact closure has been sensed in the (opened or closed) active state. For an analog sensor this counter is the number of seconds that the sensor has been in the (overmax, undermin, outsidersrange) active state.
sensorAlarmThreshold	This object holds the number of seconds that the sensor alarm must be in the active state to trigger the sensor alarm actions.
sensorAlarmAcked	This object, when set to any value, acknowledges the active state of this sensor alarm, and stops the repeating of any traps or pager actions, and turns off the buzzer if the buzzer activation is based on the active state of this sensor.
sensorAlarmBeeperActions	This object indicates the buzzer (audible alarm) actions associated with this sensor alarm. The object value may be 0 - no action, 1 - beep once every 10 seconds or 2 - beep continuously.
sensorAlarmPagerActions	This object shows which pagers are to be paged when the actions associated with this sensor alarm are activated. Each bit in this integer is assigned to one of the pagers 1-8. Bit 0 (value of 1) is assigned to pager 1, bit 1 (value of 2) is assigned to pager 2, etc. If a bit in the sensorAlarmPagerActions integer is cleared, then that pager is not activated by this sensor alarm. If a bit in the sensorAlarmPagerActions is set, then that pager is activated by this sensor alarm.
sensorAlarmTrapActions	This object shows which SNMP managers are sent traps when the actions associated with this sensor alarm are activated. Each bit in this integer is assigned to one of the SNMP managers 1-8. Bit 0 (value of 1) is assigned to SNMP manager 1, bit 1 (value of 2) is assigned to SNMP manager 2, etc. If a bit in the sensorAlarmTrapActions integer is cleared, then that SNMP manager is not sent a trap based on this sensor alarm. If a bit in the sensorAlarmTrapActions is set, then that SNMP manager is sent a trap based on this sensor alarm.
9.8 - actions	
actionsBuzzerState	This object holds the current operating state of the buzzer. Values for this object may be 0 - no buzzer action, 1 - buzzer active one second out of each 10 seconds, 2 - buzzer on continuously.
actionsPagerTable	This table holds the settings for the 8 pagers. Each pager may have a different phone number, pagerID, etc., so that a combination of pagers may be used to manage the alarms generated by the SNMP Access Gateway.
pagerType	The pager may be either an alphanumeric pager, or a numeric pager. If the pager is numeric, this object should be set to a value of 0, if the pager is alphanumeric this object should be set to a value of 1.
pagerPhonenumber	This text string is the phone number what is dialed to reach the paging service.
sensor pagerID	When the pager is alphanumeric, the pagerID is a text string which must match the pager ID as assigned by the pager company. When the pager is a numeric pager, the pagerID is the second number sequence which is sent, to activate the page.

pagerDialDelay	This integer is the number of seconds that the SNMP Access Gateway waits for modem carrier after dialing the pagerPhonenumber when the pager is in alphanumeric mode, or the number of seconds the SNMP Access Gateway waits after dialing the pagerPhonenumber to transmit the pagerID when in numeric mode.
pagerHangupDelay	This integer is the number of seconds the SNMP Access Gateway waits before hanging up the modem after transmitting the pagerID or pagerMessage when in numeric pager mode.
pagerMessage	This text object is a text message transmitted to an alphanumeric pager by the SNMP Access Gateway, or a second pager message which is transmitted by the SNMP Access Gateway when in numeric mode.
pagerSendId	When this integer object is set to 0, the SNMP Access Gateway does not transmit the unitId to the alphanumeric pager, and when set to 1 the SNMP Access Gateway does transmit the unitId to the alphanumeric pager when performing an alphanumeric page
pagerSendReason	When this integer object is set to 0, the SNMP Access Gateway does not transmit the reason for the pager to the alphanumeric pager, and when set to 1 the SNMP Access Gateway does transmit the reason for the page to the alphanumeric pager when performing an alphanumeric page.
pagerMaxAttempts	This integer is the maximum number of pager attempts which are allowed before the pager action is automatically retried. If set to 0, then the pager action is never automatically retried.
pagerAttempts	This integer is the number of pager attempts which have been made for this pager.
pagerAttemptDelay	This integer holds the number of minutes which must expire before the pager action will again be attempted.
pagerRepeat	This object controls if a successful page is repeated at some time interval, to ensure that the alarm is serviced. When set to 0, no pager repeats are performed for this pager. When set to 1, pager repeats are performed for this pager. These repeats only are done on a successful pager action.
pagerRepeatDelay	This integer controls the number of minutes which must pass after a successful page before the page is repeated, when pager repeat mode is active.
9.9 - actionsTraps	The actionsTraps section of the MIB controls enterprise-specific traps sent by the SNMP Access Gateway, and the format of these traps.
trapDateTime	When the trapDateTime object is set to 0, then the date and time of the activation of the alarm which caused the trap to be issued are not included in the trap alarm string. When the trapDateTime object is set to 1, then the date and time of the activation of the alarm which caused the trap to be issued are included in the trap alarm string.
trapAlarmType	When the trapAlarmType object is set to 0, then the type of alarm (sensor, data alarm) which caused the trap to be issued is not included in the trap alarm string. When the trapAlarmType object is set to 1, then the type of alarm which caused the trap to be issued is included in the trap alarm string.

trapAlarmName	When the trapAlarmName object is set to 0, then the name associated with the alarm (sensor, data alarm) which caused the trap to be issued is not included in the trap alarm string. When the trapAlarmName object is set to 1, then the name associated with the alarm which caused the trap to be issued is included in the trap alarm string.
trapAlarmID	When the trapAlarmID object is set to 0, then the identifier number for the of alarm (sensor, data alarm) which caused the trap to be issued is not included in the trap alarm string. When the trapAlarmID object is set to 1, then the identifier number for the alarm which caused the trap to be issued is included in the trap alarm string.
trapAlarmString	When the trapAlarmString object is set to 0, then the alarm string associated with the alarm (for a data alarm, this is the alarm record) is not included in the trap alarm string. When the trapAlarmType object is set to 1, then the type of alarm which caused the trap to be issued is included in the trap alarm string.
actionsTrapsEntSpecCount	This integer is the number of enterprise-specific traps which have been sent by the SNMP Access Gateway since its last reset.
9.10 - Relays	
numberRelays	This integer is the number of controllable relays which the SNMP Access Gateway has installed.
RelaysTable	This table is used to retrieve and set the operating modes for the relays.
relaysTableName	This text string holds a name which is associated with this relay.
relaysTableMode	This integer controls the operating mode of the relay. Valid settings are 0 - command-controlled mode, 1 - sensor-controlled mode, and 2 - anyalarm-controlled mode.
relaysTableState	This integer is used to retrieve the current relay state and open and close the relays when they are in sensor-controlled mode. When this object has a value of 0, the relay is opened. Setting the value of this object to 0, when in command-controlled mode, opens the relay. When this object has a value of 1, the relay is closed. Setting the value of this object to 1, when in command-controlled mode, closes the relay.
relaysTableResetState	This integer controls the state into which the relay is placed when the SNMP Access Gateway is reset. This may be used to ensure that a relay powers up in the proper state. Another use for this may be to have a management station field a trap from the SNMP Access Gateway indicative of an alarm, close the relay using the relaysTableState object, and then set the relaysTableResetState object to the same value as that of the relaysTableState, to ensure that if the SNMP Access Gateway is reset the relay will still maintain its state.
9.11 - Controls	
consoleMode	This integer object controls if console mode is enabled or not. When set to 0, console mode is disabled. When set to 1, console mode is enabled.
charmask	The charmask holds a text string which is an ASCII HEX representation of the character masking which is performed on incoming characters.

modemParity	This integer controls the parity of the modem port. Values are 1 - 7 bits, even parity, 2 - 7 bits, odd parity, and 3 - 8 bits, no parity. The value of 3 would normally be used with the SNMP Access Gateway.
modemTapSetup	This text string is sent to the modem when executing the TAP (alphanumeric) paging protocol. This string may be used to custom-configure the dialing settings of the modem to ensure successful alphanumeric paging.
modemInactivityTimer	This integer object controls the number of minutes that the SNMP Access Gateway waits during an idle modem connection before automatically closing the modem connection.
modemTimeBetweenOutbound	This integer object controls the number of seconds that the SNMP Access Gateway waits between outbound call uses of the modem. Normally this is set to 60 seconds. This timer ensures that some intervening time exists between modem outbound calls, so that attempts to connect to the SNMP Access Gateway by modem have a chance of making a connection.
ptconn1	This read-only integer indicates the current connection status of any pass-through connections to serial I/O port 1. One bit of this integer is used for each possible connection. The three network connections are assigned bit positions 0, 1 and 2, with values of 1, 2 and 4, respectively. The modem connection is assigned bit 3, with a value of 8. The serial I/O port 1 (for a joined connection) is assigned bit 4, with a value of 16, and serial I/O port 2 if assigned bit 5, with a value of 32. A bit is set if that connection has an active pass-through (or join) connection with serial I/O port 1, and is otherwise cleared.
ptconn2	This read-only integer indicates the current connection status of any pass-through connections to serial I/O port 2. One bit of this integer is used for each possible connection. The three network connections are assigned bit positions 0, 1 and 2, with values of 1, 2 and 4, respectively. The modem connection is assigned bit 3, with a value of 8. The serial I/O port 1 (for a joined connection) is assigned bit 4, with a value of 16, and serial I/O port 2 if assigned bit 5, with a value of 32. A bit is set if that connection has an active pass-through (or join) connection with serial I/O port 2, and is otherwise cleared.
9.12 - ConnectionsTable	The connectionsTable provides status information on the network and modem connections to the SNMP Access Gateway.
connectionsTableState	This integer indicates what state this connection is in. The states are 0 - waiting for a connection, 1 - sending the main menu, 2 - getting a menu item selection, 3 - unused, 4 - sending password prompt, 5 - collecting a password, 6 - doing command processor actions, 7 - doing pass-through actions, 8 - dropping the connection, 9 - disconnecting, and 10 waiting after carrier for a modem connection.
connectionsMode	This integer shows what connection mode the connection is in. 0 - command connection, 1 - pass-through to port 1, 2 - pass-through to port 2.

connectionsAddress	This object holds the IP address of the remote end of a connection. If the connection is a modem connection, this will show in the object as 0.0.0.0.
connectionsCmdActive	This object shows if any command connection is active. When this object is 0, no command processor session is active. When set to 1, some command processor connection session is active.
connectionsCmdConn	This object shows the connection number (1-3 are network connections, 4 is the modem connection and 5 is a the local command port) for an ongoing command processor session.
connectionsEndchar	This object holds the character which acts as the escape character for ending pass-through connections and initiating a local command port command session.
connectionsPTTimelimit	This object controls the number minutes the SNMP Access Gateway waits during an idle pass-through connection before automatically terminating the connection to due to lack of activity.
9.13 - Alarmhistory	The alarmhistory section of the MIB provides information on the currently active alarm actions, and the history log of actions which have been taken by the SNMP Access Gateway.
actionCount	This integer holds the count of active action entries in the action queue.
actionAcked	This object, when set to any value, acknowledges the active alarm action, removing the alarm action from the alarm action queue.
actionReason	This object contains an integer which indicates the reason for the alarm action.
actionReasonID	This integer object contains an identifier for which alarm reason (e.g., data alarm 3 vs. data alarm 4) was the source for the alarm action.
actionReasonLevel	If more than one alarm level is associated with an alarm, this object can report the level of the alarm. In the SNMP Access Gateway, this will always be 1.
actionType	This integer value indicates the type of action which will be performed.
actionTypeID	This integer object holds the identifier of which pager is to be used, which management stations are to receive traps, or which buzzer level is to be activated.
actionRepeatTime	This integer object holds a counter for the number of minutes left until the next repeated attempt to perform this alarm action.
actionAttempts	This integer holds a counter of the number of attempts which have been performed for this alarm action.
actionNextAttempt	This integer holds a counter of the number of minutes until the next attempt of this action, where a repeated action which was successful or another attempt of the action when it was not successful.
actionTimeStamp	This text string object holds the date and time of the sensing of the alarm which is causing this alarm action to be performed.
historyCount	This integer object holds the number of entries in the action history table.
historyEntryType	This integer object indicates the type of history entry (e.g., pager OK, pager FAIL, etc.).
historyReason	This integer object indicates the reason why the action was taken, as is shown in the actionReason object.

historyReasonID	This integer object indicates the identifier for the reason why the action was taken as shown in the actionReasonID object.
historyReasonLevel	This integer object indicates the alarm level for the reason why the action was taken as shown in the actionReasonLevel object.
historyType	This integer object indicates the type of action which is logged in the history log table (e.g., pager, trap, etc.).
historyTypeID	This integer object indicates the which of the historyType objects was used in relation to this history log entry.
historyTimeStamp	This text string contains the date and time at which the history log entry was made.
historyClearLog	When this integer object is set to any value, the history log entries are all cleared.
9.14 - IPRestrictions	This section of the MIB contains IP access restriction entries.
iprestrictIpAddress	Each IpAddress type entry in this table contains an IP restriction. See the section on network setup and IP restrictions on more information on using the IP restriction table.
9.15 - Tech Support	The techsupport section of the MIB contains objects which are used for technical support of the SNMP Access Gateway. These objects should not be set by the user. Contents of these objects when retrieved are not defined for public use. These objects will read with integer values, which allows these objects to be read by SNMP managers.
	<pre> 99 techsupport 1 techsupportInt1 2 techsupportInt2 3 techsupportInt3 4 techsupportInt4 5 techsupportInt5 </pre>

Chapter 10 - Using FTP

The SNMP Access Gateway contains an FTP server which may be used with TCP/IP FTP client software. The FTP server may be used to retrieve or delete the events log file, load or retrieve the alarms configuration file, load a settings file, and load new application software into the SNMP Access Gateway.

The FTP server requires the use of a User ID and password to log into the server. The User ID is collected but not presently used. The password must match the FTP server password, which may be changed using the SETUP command menus.

The FTP server supports the DIR command, which indicates the events log file exists and the number of records in the events log file. The FTP Get and Delete commands may be used with the events log file, using the filename of EVENTS. Thus, GET EVENTS will retrieve the current contents of the events log file.

The alarms configuration file does not show up in the directory listing via the FTP server. However, the alarms configuration file may be loaded into the SNMP Access Gateway and retrieved from the SNMP Access Gateway using the filename of 'ALMFILE'.

A settings file contains pseudo-SNMP set instructions and may also contain the contents of an alarm configuration file. A settings file may be loaded into the SNMP Access Gateway using the filename of 'SETTINGS'.

A new software application may be loaded into the SNMP Access Gateway by loading a file named 'NEWAPP' into the SNMP Access Gateway. Only an application program file made available by RFL should ever be loaded into the SNMP Access Gateway as an application file. Other files will not properly execute, and will thus result in the SNMP Access Gateway simply entering load mode, awaiting the loading of a valid application.

Chapter 11 - Programming Data Alarms

Data Alarms (or Alarm Formulas) are formulas set up to define what record(s) constitute an alarm condition. Alarm Formulas can be defined to activate upon the receipt of a single record, or only after X number of matching records have been received within X duration.

A Data Alarm defines a record pattern to watch for in incoming data received by the SNMP Access Gateway. A good example of a data alarm would be to watch PBX SMDR records for any call with 900 in the area code or 976 in the prefix. When the SNMP Access Gateway receives an a matching record, the assigned action(s) for that alarm can be taken.

11.1 - Alarms are the same as Events

An 'Event' is an occurrence which the SNMP is designed to monitor and log, and on which in some cases a notification action occurs. The word Event is used in some places in the manual and in other places the word Alarm is used. Some circumstances which are Events are not strictly speaking Alarms. For example, an SNMP Access Gateway reboot occurrence is logged in the Events Log. However, in most cases the terms Event and Alarm can be used interchangeably.

11.2 - Alarm Actions

The SNMP Access Gateway supports the definition of up to 8 pager definitions and up to 8 SNMP Managers for trap addresses, plus 2 Buzzer tones. Each of these is considered an 'Action' for a total of 18 possible actions which can be assigned to any individual alarm event. For example, one single Toll-Fraud alarm (someone made a call to 976-GIRL) can be set to call 6 pagers and send Data Alarm traps to 3 SNMP Managers, and to beep the SNMP Access Gateway beeper also.

11.3 - How Data Alarms Are Set Up

All settings of the SNMP Access Gateway can be entered manually using a terminal connected to the SNMP Access Gateway, with the exception of Data Alarms. Data Alarms are written into a text file as defined below and then uploaded into the SNMP Access Gateway. Two methods are provided to upload an alarm file to the SNMP Access Gateway.

Once a file has been created in accordance with the guidelines below, it can be uploaded into the SNMP Access Gateway over a modem using an Xmodem Protocol by selecting the Upload a New Alarm File found under Event Definitions, or by using FTP over the TCP/IP connection, as further explained in the section Using FTP.

This same alarm file, once uploaded, can be viewed using the View Alarm File option found under Event Definitions in the Setup Menu.

11.4 - Defining Data Alarms

The SNMP Access Gateway has a setup within the uploadable text file which looks similar to Windows INI file. In this text file the field names and positions to be used in the alarm formulas are defined. Once fields are defined, the alarm formulas and parameters for each alarm are individually defined. A sample alarm text file is shown below:

```
[fields]
outext=12,6
inext=18,6
outtrunk=18,7
intrunk=12,7
date=38,5
time=44,5
duration=50,8
phone=63,7
onefield=63,1
```

```

areacode=64,3
localprefix=63,3
anyphrase=*,10

[macros]
Outgoing=
Incoming=intrunk="DN===="
LongDistance=onefield="1"

[dataalarms]
TollFraud1=all,1,P12B1S3C1256,2Hours
TollFraud1_1= areacode="900" or (longdistance=FALSE and localprefix="976")
TollFraud2=12,20,T12,1Hours
TollFraud2_1=Outgoing=FALSE and duration<"00:00:01"

[end]

```

This sample alarm text file shows the definition of Fields, Macros, and Data Alarms. In all cases, the above text entry is not case sensitive, except for the literal text specified for record matching (if you say `xyz="cat"` it will not match `xyz="CAT"`).

11.5 - Field Section

The above field definitions were designed for some sample SL1 CDR records. Field definitions must be the first section in the definition text file. The field definition section starts with the definition header `[fields]`. After the field definition header comes all the field definitions. Up to 30 fields can be defined. The syntax for a field definition is:

fieldname = startpos , length

Fieldname is whatever you want to call that field. Only the first 12 characters of the field name are significant. *Startpos* is the starting character position for the field (with the first character of the record considered to be 1). *Length* is the length of the field specified. If an asterisk is placed in the *startpos* entry then use of the field will result in the record being searched for a match in any position of the record. Examples:

```

Field1=30,5      (Field1 starts at position 30 and ends at position 34)
Field2=*,5       (Field2 is 5 characters long and a match anywhere in the record will be valid)

```

11.6 - Operators for Formulas

Valid operators for use in writing formulas are:

Operator	Definition
>	Greater Than
<	Less Than
>=	Greater Than or Equal To
<=	Less Than or Equal To
! or <>	Not Equal To
=	Equal To
*	Wildcard (note this wildcard character is intended to be changed later to *)
()	(Parenthesis) Used to Combine Operations
OR	Logical OR
AND	Logical AND

11.7 - Macro Section

Macros are similar to alarm formulas, in that they are designed to test conditions against an incoming record. Before the evaluation of any alarm formulas, all defined macros are evaluated against the incoming record, resulting in a TRUE or FALSE evaluation of each macro. Macro definitions which are referenced in alarm formulas then use the TRUE or FALSE results of those tests to evaluate if an alarm has occurred. Macros eliminate the need to retest for the same conditions more than once.

Macro definitions, if used, must be the second section in the definition text file. The macro definition section starts with the definition header [macros]. After the macro definition header comes all the macro definitions. Up to 30 macros can be defined. The syntax for a macro definition is:

macroname = formula

The *macroname* is the name you want to use to reference this macro condition in later formulas. The *formula* is the formula which defines the condition being tested for.

So, how are macros used? If you wanted several alarms which tested for a group of identical conditions, your formulas might look like:

```
Alarm1_e=(ext="103" OR ext="107" OR ext="111" OR ext="114" OR ext="116" OR
ext="121" OR ext="133" OR ext="140" OR ext="145" OR ext="167") AND
(localprefix="976" or areacode="900")
Alarm2_e=( ext="103" OR ext="107" OR ext="111" OR ext="114" OR ext="116" OR
ext="121" OR ext="133" OR ext="140" OR ext="145" OR ext="167") AND
duration>"00:00:10"
```

All the extensions tested for in the first alarm formula are retested in the second formula, resulting in duplicate testing for the same conditions. By defining a macro, these extensions can be tested for once, and then the resulting TRUE or FALSE condition can be referenced in your formulas without having to retest the record. For example:

```
[macros]
MyExtensions= ext="103" OR ext="107" OR ext="111" OR ext="114" OR ext="116" OR
ext="121" OR ext="133" OR ext="140" OR ext="145" OR ext="167"

[dataalarms]
Alarm1_e=MyExtensions=TRUE AND (localprefix="976" or areacode="900")
Alarm2_e=MyExtensions=TRUE AND duration>"00:00:10"
```

Not only is this easier to type, its is much more efficient within the SNMP Access Gateway as the test for extensions only has to be done once. The above data alarm formulas are not complete, see the next section.

11.8 - Data Alarm Section

Data Alarm definitions, if used, must follow the Macro section. The Data Alarm section of the alarm file starts with the definition header [dataalarms]. After the definition header comes all the data alarm definitions. Up to 30 data alarms can be defined. The syntax for a data alarm definition is:

alarmname = applicableports , threshold , actions, cleartime
alarmname_e = formula

To prevent alarm definitions from becoming too long, each data alarm is split into two lines. The first line of the data alarm definition contain the following entries:

alarmname - This entry specifies the name of the alarm, whatever you want to call it. This name will be used as part of the alarm action process to inform you what event you are being notified about.

applicableports - This entry specifies the I/O ports to which this data alarm will apply. Either or both of the 2 SNMP Access Gateway serial I/O ports can be listed here, for example:

ports=1 - Only Port 1
ports=12 - Ports 1 and 2
ports=all - Ports 1 and 2

threshold - This entry specifies how many matching records must be received before the alarm action is initiated. With most alarms this entry will usually be 1, but you may wish with other alarms to have a value of 30 or more.

actions - This entry specifies one or more actions to be taken when this alarm occurs. The syntax for specifying what alarm actions to take is covered later in the following section Defining Alarm Actions.

cleartime - This entry specifies when to clear the counters on the alarm back to zero occurrences. Options include:

1Hours - Clears every hour
2Hours - Clears every other hour
4Hours - Clears every four hours
6Hours - Clears every six hours
8Hours - Clears every eight hours
12hours - Clears every twelve hours
24hours - Clears every twenty-four hours
daily - Same as 24Hours
nn:nn - Clears at the specified time every day

Important Note: If you add an 'A' before any of the above clearing parameters (as in 'A24Hours'), this will also select the alarm counters to AUTOCLEAR to zero each time the alarm occurs. Otherwise an alarm notification can occur only once within the designated period.

The second line of the alarm definition is the formula itself, with the following requirements:

alarmname_e - This is the same name as specified in the prior line with the addition of an 'underscore' and letter e (for 'equation') after the name.

formula - This formula

11.9 - End Section

The alarm text file must end in the text [end].

11.10 - Defining Alarm Actions

When an alarm occurs, one or more alarm actions can be initiated by the SNMP Access Gateway. Any alarm can include any one or all of the following actions (except only one beeper action):

Action	ActionKey	Options
Pagers	P	1 to 8 different pager callouts
SNMP Traps	T	1 to 8 different SNMP Managers
Beeper	B	1 of 2 different beeper severity's

Multiple actions are defined by using 'action keys' as shown above, plus the numbers to indicate which of those actions should be done. For example, if you wanted to specify calling pagers 1 and 2, plus traps 1 and 3 you would use specify alarm actions P12T13. By using this syntax each alarm can easily be assigned multiple alarm actions.

Chapter 12 - Use of the EVENTS Command

The EVENTS command enters a menu which allows you to view and control matters relating to existing or past Event (Alarm) conditions. Within this section you can view the current condition of sensor inputs and serial alarm parameters, records of all past events, and view and clear currently outstanding alarm conditions.

Events Main Menu

- A. List Events File (0 Records)
- B. Clear Events File
- C. View Active Alarms
- D. Acknowledge Active Alarms
- E. View Alarm Action Detail
- F. View Data Alarm Counters
- G. View Action History
- H. Clear Action History

12.1 - List Events File

Selecting the Menu Letter of this option allows you to view and optionally or clear the Events File. The Events File is a stored log of all events recorded by the SNMP Access Gateway. This log can also be transferred and deleted using FTP, which is covered in another chapter. Upon selection of this menu item the events log will be listed out as shown below and a prompt will allow you to pause and clear the records which have been shown. Below is an example of an Events File listing. Notice that the last 'DATA' record which was received also matched an Alarm Formula and so this record was stored in the events file twice, once as a data record and once as an alarm record.

```
04/08/98 11:59 DATA          2  N 021 00 T002014 DN6502 02/25 09:22 00:00:10
04/08/98 11:59 DATA          2  N 022 00 T007002 DN5700 02/25 09:19 00:02:36
04/08/98 11:59 DATA          2  E 023 00 T002024 DN1006 02/25 09:22 00:00:58
04/08/98 11:59 DATA          2  N 024 00 T002042 DN6000 02/25 09:21 00:00:46
04/08/98 11:59 ALARM equalfour 2  N 024 00 T002042 DN6000 02/25 09:21 00:00:46
```

<enter>-More C-Clear Events X-Exit

12.2 - Clear Events File

Selecting the Menu Letter of this option clears any existing records currently logged in the Events File. Upon selection of this menu item you are prompted with a Sure prompt, and answering 'Y' to this prompt clears the log.

Sure? (Y/N) Y

12.3 - View Active Alarms

Selecting the Menu Letter of this option shows the following display representing the current state and alarm status of sensor inputs and data alarms. Note the asterisks in the display below. These indicate an active alarm condition for the associated alarm. Since there can potentially be more data alarms than can be displayed on a screen, this display is intended to give a quick indication of the presence of data alarms which can then be queried in more detail using another option in this section. The position of the asterisks in the display below correspond to the order of the data alarm formulas as defined in the Alarm File (covered in another section herein).

```
Data Alarms      :          *-----*-----*-----
Sensor Alarms    :
 1 fire          CC Closed  *
 2 smoke         CC Closed  *
 3 flood         CC Open    -
 4 famine        CC Open    -
 5 pestilence    CC Open    -
 6 layoffs       CC Open    -
```

12.4 - Acknowledge Active Alarms

Selecting the Menu Letter of this option acknowledges any and all alarms currently in the queue for alarm notification. These are alarms for which the associated alarm actions are in the Action Queue for handling, whether in progress or not. This also applies to acknowledgment of 'Repeat' alarms (which are marked to repeat until explicitly acknowledged) which are also acknowledged using this selection. Acknowledging Alarms will remove all actions them from the Action Queue. Any alarm action which is in progress at the time such as a pager callout will complete and then clear. Before the Alarms are acknowledged you will be presented with a Sure prompt.

Sure? (Y/N) Y

12.5 - View Alarm Action Detail

Selecting the Menu Letter of this option shows the following display representing all of the actions currently in the Alarm Queue. An explanation of the meaning of each column follows.

#	Date	Time	Type	Name	Level	Action	ID	Try	NXt	Rpt
01:	04/08	11:59	DA	greatfour	01	Pager	001	00	05	N
02:	04/08	11:59	DA	greatfour	01	Trap	001	02	02	Y
03:	04/08	11:59	DA	equalfour	01	Trap	001	02	02	Y

<END - Hit any Key>

Date - The date the action was entered into the queue.

Time - The time the action was entered into the queue.

Type. The alarm type. DA for Data Alarm, ES for Sensor Alarm.

Name - The alarm name as assigned in the Alarm File or elsewhere in the Setup Menu.

Level - This parameter indicates the escalation level of the alarm. At this time there are no levels above 1 and so this value will always indicate '1', except when the buzzer alarm is used which has the 'severity' levels of 1 and 2.

Action - This indicates the type of action, either Pager, Trap, or Buzzer.

ID - This indicates which pager or trap alarm, from 1 to 8, this action is registered to go to.

Try - This indicates how many times this alarm has been attempted and failed, typically useful for pager callouts.

Nxt - Indicates the duration which will be waited if a failure occurs, assuming Tries is greater than one.

Rpt - This indicates whether this alarm is set to repeat after successfully completing.

12.6 - View Data Alarm Counters

This section displays the current counter thresholds for any programmed data alarms. These thresholds indicate how many such alarms have been received since the last 'Clearing' period as specified within the data alarm formula for that alarm.

Alarm Name	Count	Threshold	Alarm Name	Count	Threshold
equalfour	0	1	greatfour	0	1

12.7 - View Action History

This display indicates the past history of alarm actions which have occurred.

#	Date	Time	Type	Name	Level	Action	ID

01:	04/08	12:01	DA	equalfour	01	Trap	OK	01
02:	04/08	12:01	DA	greatfour	01	Trap	OK	01
03:	04/08	12:00	DA	greatfour	01	Pager	OK	01
04:	04/08	12:00	DA	equalfour	01	Buzzer		02
05:	04/08	11:59	DA	greatfour	01	Trap	OK	01
06:	04/08	11:59	DA	greatfour	01	Trap	OK	01
07:	04/08	11:59	DA	equalfour	01	Trap	OK	01
08:	04/08	11:59	DA	greatfour	01	Trap	OK	01
09:	04/06	10:41	DA	greatfour	01	Trap	OK	01
10:	04/06	10:41	DA		01	Trap	OK	01
11:	04/06	10:41	DA	greatfour	01	Trap	OK	01
12:	04/06	10:40	DA		01	Trap	OK	01
13:	04/06	10:40	DA		01	Trap	OK	01
14:	04/06	10:39	DA	greatfour	01	Trap	OK	01
15:	04/06	10:39	DA		01	Trap	OK	01
16:	04/06	10:39	DA	greatfour	01	Trap	OK	01

12.8 - Clear Action History

Selecting the Menu Letter of this option clears all entries in the Action History. Before clearing you will be prompted with a Sure Prompt.

Sure? (Y/N) Y

Chapter 13 - Resetting the SNMP Access Gateway

There are several methods for resetting the SNMP Access Gateway to various degrees.

The RST (RESET) button is located on the front panel. The RST button “reboots” the SNMP Access Gateway when you press the button for three seconds. Valid data in the SNMP Access Gateway will be preserved and SNMP Access Gateway configuration will not be changed.

If you have an alarm going off and you want to shut the alarm off, one quick press of the PRG button while acknowledge the alarm.

The RESTART command “reboots” the SNMP Access Gateway as if you had pressed the RESET button. Valid data present in the SNMP Access Gateway and configuration settings will be preserved.

The DEFAULT command sets all the settings back to their default values with the following exceptions: a) Network settings including the IP address and IP Restrictions, and b) any existing data and event or history logs.

The COLDSTART command causes a complete SNMP Access Gateway reset. The SNMP Access Gateway will be re-booted and all data will be cleared from memory. The settings in the SNMP Access Gateway will be restored to their factory defaults as per the DEFAULT command. This excludes network settings including the IP address and IP Restrictions but does include any existing data and event or history logs.

Chapter 14 - Application Notes

The following chapter contains various articles which discuss in more technical detail specific application examples and peculiarities in using the SNMP Access Gateway. This section may be frequently updated as new articles are written covering various subjects. Inquire with RFL Technical Support regarding ensuring you have all current Application Notes for use of the SNMP Access Gateway.

App Note A. Use of IP Restrictions

IP Restrictions can be established to limit which IP Addresses are allowed access to the SNMP Access Gateway. The IP Restrictions menu can be found in the Networking section of the SETUP menu. By using this menu you can enter in IP addresses into a table to specify which addresses are allowed access and which addresses are denied access to the unit.

The following rules apply to IP addresses entered into this table.

1) By default, there are no entries in the IP Restriction table. With no entries in the table, all IP addresses are allowed access to the unit. However, once any entry is placed into the IP Restriction table, only those IP addresses which are explicitly specified in the table will be allowed access to the unit. For this reason you should be very careful with this feature to avoid accidentally prohibiting your own network access to the unit.

1) A ZERO placed anywhere in the IP address acts as a wildcard to ALLOW access to any IP address matching the other values of that table entry. For example, 192.168.100.0 entered into the table will allow access to any IP address starting with 192.168.100 and prohibiting access in any form from ALL other IP addresses.

2) A 255 placed anywhere in the IP address acts as a wildcard to PROHIBIT access to any IP address matching the other values of that table entry. For example, 192.168.200.255 entered into the table will prohibit access to any IP address starting with 192.168.200.

3) A full address entered into the table will explicitly allow access to that IP address. For example, entering 192.168.200.001 explicitly allows that address access to the unit.

4) Each IP address attempting access to the unit is evaluated against the table of entries, from the first entry down to the last entry of the table. The first match which explicitly PROHIBITS an IP address will immediately cause access to the unit to be denied. The first match found which explicitly ALLOWS an IP address will immediately cause access to be allowed. You need to be careful that the logical order of your entries does not cause an earlier entry to deny access to a latter entry which you allow access to, and vice versa.

5) If no match is found by the time all entries of the table have been examined, the IP address will be denied access to the unit. However, you can approach it in the opposite fashion if you place 0.0.0.0 as the last entry in the table. Then, all prior entries can be those for which access is specifically denied, with all other addresses being allowed access.

6) If you make a mistake and deny your own IP address access, you will have to fix this using the dialup connection or the local command mode connection to change the IP restriction back so you can have access again.

App Note B: Monitoring RS232 Levels as Alarms

The following diagram shows the circuit design of the Sensor Inputs. This design allows these inputs to be used either as a dry contact closure input, or as an analog input.

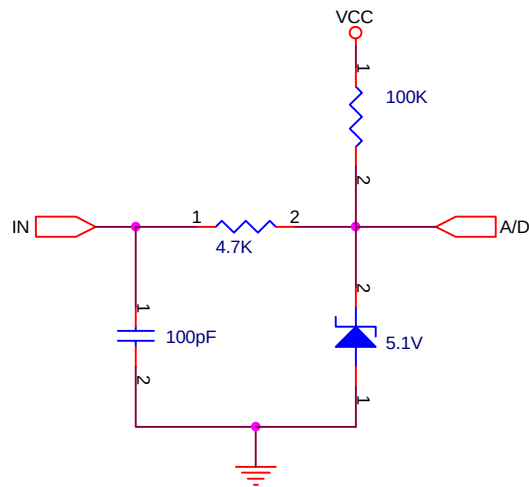


Figure 8. Schematic for Sensor Inputs

Sensor inputs can be used to monitor the state of an RS232 control line such as DTR. A wire can be attached to the line to be monitored and routed to one of the sensor inputs. The Sensor Input should be set to operate as a 'Contact Closure', not an 'Analog Input'. When the control line is LOW the contact input will be seen as OPEN. When the control line is HIGH the contact input will be seen as CLOSED.

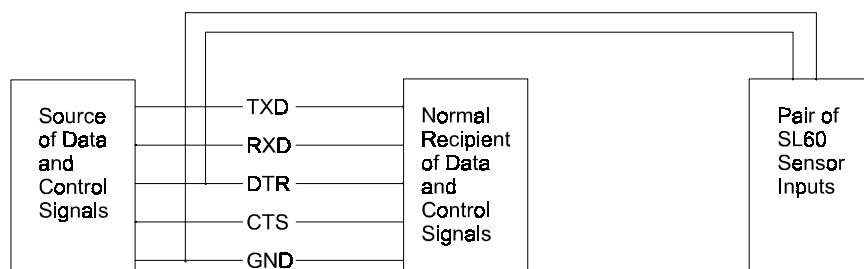


Figure 9. Illustration of Connecting for Monitoring RS232 Control Lines

Note that RS232 control signal lines are not specifically designed to drive more than one input, therefore connecting the output signal to two input connections will cause the overall voltage level of the RS232 control line to be lower than it otherwise would be if connected to a single input. This circumstance will vary from device to device and in 19 out of 20 cases should not present any problem. However you should be aware of this factor if you experience any problems with the other device which would normally be the single device receiving the RS232 output signal you are monitoring.

App Note C: IMUX TRAP messages

C.1 Trap Format

The gateway has been designed to work specifically with all versions of CM-4 software. RS232 trap messages are created by the IMUX and sent to the SAG. This allows the gateway to generate SNMP traps as a result of a message from the IMUX. These traps will contain data that defines the fault condition on the IMUX.

The trap messages contain the following information, which is unique to the IMUX

- Generic trap number 6
- Specific trap number 1-9999 (from serial data string)
- Enterprise ID 1.3.6.1.4.1.2743
- Varbind (including)
 - Trap ID 1.3.6.1.4.1.2743.1.1.1.3
 - Community string x|y|z (from serial string, x=network(1),y=node address(1-999), z=interface(1-99))
 - Message string text (from serial string)

C.2 Interface Codes

The following codes represent interfaces within the IMUX

- 1-36 IMUX channel cards with a matching SCB address
- 37 Terminal CM-4
- 38 D&I-A CM-4
- 39 D&I-B CM-4
- 40 Term or D&I-A standby CM-4
- 41 D&I-B standby CM-4
- 43 R-DACS or MDACS

C.2 Trap Codes

The table provided below lists all of the possible traps from the system.. Alarm numbering begins at 100 and is structured as follows:

NO.	SOURCE	DESCRIPTION	O/VIEW STATUS	VARBIND	
				Variable	Value Range
101	Interface	ALERT AT CHANNEL CARD #	CRITICAL	Channel #	1-36, 40, 41, 43
102	Interface	Reset ALERT AT CHANNEL CARD #	CRITICAL	Channel #	1-36, 40, 41, 43
103	Interfaces	ALERT AT MULTIPLE CARDS	CRITICAL	# of Cards	2-36
104	Interfaces	Reset ALERT AT MULTIPLE CARDS	CRITICAL	# of Cards	2-36
105	CM-4	Redundant power supply failure	CRITICAL	n/a	
106	CM-4	Reset Redundant power supply failure	CRITICAL	n/a	
107	CM-4	Shelf status (alert)	CRITICAL	n/a	
108	CM-4	Reset Shelf status (alert)	CRITICAL	n/a	
109	CM-4	Shelf status (alarm)	CRITICAL	n/a	
110	CM-4	Reset Shelf status (alarm)	CRITICAL	n/a	
111	CM-4	D&I-B Configuration alarm	CRITICAL	n/a	
112	CM-4	Reset D&I-B Configuration alarm	CRITICAL	n/a	
113	CM-4	XMIT timing not correct	CRITICAL	n/a	
114	CM-4	Reset XMIT timing not correct	CRITICAL	n/a	
115	CM-4	RCV carrier loss	CRITICAL	n/a	
116	CM-4	Reset RCV carrier loss	CRITICAL	n/a	
117	CM-4	Excess receive jitter	CRITICAL	n/a	
118	CM-4	Reset Excess receive jitter	CRITICAL	n/a	
119	CM-4	RCV out of frame	CRITICAL	n/a	
120	CM-4	Reset RCV out of frame	CRITICAL	n/a	
121	CM-4	Other side (DI-A) out of frame	CRITICAL	n/a	
122	CM-4	Reset Other side (DI-A) out of frame	CRITICAL	n/a	
123	CM-4	Other side (DI-B) out of frame	CRITICAL	n/a	
124	CM-4	Reset Other side (DI-B) out of frame	CRITICAL	n/a	
125	CM-4	RCV all ones	CRITICAL	n/a	
126	CM-4	Reset RCV all ones	CRITICAL	n/a	
127	CM-4	RCV remote alarm	CRITICAL	n/a	
128	CM-4	Reset RCV remote alarm	CRITICAL	n/a	
129	CM-4	XMIT clock free-running	CRITICAL	n/a	
130	CM-4	Reset XMIT clock free-running	CRITICAL	n/a	
131	CM-4	XMIT using fallback timing	CRITICAL	n/a	
132	CM-4	Reset XMIT using fallback timing	CRITICAL	n/a	
2000	CM-4	Power Up	NORMAL	0	
2005	Interfaces	Clear All Alarms for Subaddress	NORMAL	Subaddress	1-43

Chapter 15 - Warranty Information

Except where noted, all RFL Electronics Inc. products come with a one-year warranty from date of delivery for replacement of any part which fails during normal operation. RFL will repair or, at its option, replace components that prove to be defective at no cost to the Customer. All equipment returned to RFL Electronics Inc. must have an RMA (Return Material Authorization) number, obtained by calling the RFL Customer Service Department. A defective part should be returned to the factory, shipping charges prepaid, for repair or replacement FOB Boonton, N.J.

RFL Electronics Inc. is not responsible for warranty of peripherals, such as printers and external computers. The warranty for such devices is as stated by the original equipment manufacturer. If you have purchased peripheral equipment not manufactured by RFL, follow the written instructions supplied with that equipment for warranty information and how to obtain service.

WARRANTY STATEMENT

The RFL SNMP Access Gateway is warranted against defects in material and workmanship for twelve months from date of shipment. This warranty does not apply if the equipment has been damaged by accident, neglect, misuse, or causes other than performed or authorized by RFL Electronics Inc. This warranty specifically excludes damage incurred "in shipment" to or from RFL. In the event that an item is received in damaged condition, the carrier should be notified immediately. All claims for such damage should be filed with the carrier.

NOTE

If you do not intend to use the product immediately, it is recommended that it be opened immediately after receiving and inspected for proper operation and signs of impact damage.

This warranty is in lieu of all other warranties, whether expressed, implied or statutory, including but not limited to implied warranties of merchantability and fitness for a particular purpose. In no event shall RFL be liable, whether in contract, in tort, or on any other basis, for any damages sustained by the customer or any other person arising from or related to loss of use, failure or interruption in the operation of any products, or delay in maintenance or for incidental, consequential, indirect or special damages or liabilities, or for loss of business or other financial loss arising out of or in connection with the sale, lease, maintenance, use, performance, failure or interruption of the products.

Chapter 16 - Canadian Dept. of Comm. Notice

NOTICE: The Canadian Department of Communications Label identifies certified equipment. This certification means that the equipment meets certain telecommunications network protective, operational and safety requirements. The Department does not guarantee the equipment will operate to the user's satisfaction.

Before installing this equipment, users should ensure that it is permissible to be connected to the facilities of the local telecommunications company. The equipment must also be installed using an acceptable method of connection. In some cases, the company's inside wiring associated with a single line individual service may be extended by means of a certified connector assembly (telephone extension cord). The customer should be aware that compliance with the above conditions may not prevent degradation of service in some situations.

Repairs to certified equipment should be made by an authorized Canadian maintenance facility designated by the supplier. Any repairs or alterations made by the user to this equipment, or equipment malfunctions, may give the telecommunications company cause to request the user to disconnect the equipment.

Users should ensure for their own protections that the electrical ground connections of the power utility, telephone lines and internal metallic water pipe system, if present, are connected together. This precaution may be particularly important in rural areas.

Caution: Users should not attempt to make such connections themselves, but should contact the appropriate electric inspection authority, or electrician, as appropriate.

The Load Number (LN) assigned to each terminal device denotes the percentage of total load to be connected to a telephone loop which is used by the device, to prevent overloading. The termination of a loop may consist of any combination of devices subject only to the requirement that the total of the Load Numbers of all the devices does not exceed 100. The load number of this unit is 5.

This digital apparatus does not exceed the Class A limits for Radio noise emissions from digital apparatus set out in the interference-causing equipment standard entitled "Digital Apparatus", ICES-003 of the Department of Communications.

AVIS: - L'étiquette du ministère des Communications du Canada identifie le matériel homologué. Cette étiquette certifie que le matériel est conforme à certaines normes de protection, d'exploitation et de sécurité des réseaux de télécommunications. Le Ministère n'assure toutefois pas que le matériel fonctionnera à la satisfaction de l'utilisateur.

Avant d'installer ce matériel, l'utilisateur doit s'assurer qu'il est permis de le raccorder aux installations de l'entreprise locale de télécommunication. Le matériel doit également être installé en suivant une méthode acceptée de raccordement. Dans certains cas, les fils intérieurs de l'entreprise utilisés pour un service individuel à ligne unique peuvent être prolongés au moyen d'un dispositif homologué de raccordement (cordon prolongateur téléphonique interne). L'abonné ne doit pas oublier qu'il est possible que la conformité aux conditions énoncées ci-dessus n'empêchent pas la dégradation du service dans certaines situations. Actuellement, les entreprises de télécommunication ne permettent pas que l'on raccorde leur matériel à des jacks d'abonné, sauf dans les cas précis prévus par les tarifs particuliers de ces entreprises.

Les réparations de matériel homologué doivent être effectuées par un centre d'entretien Canadien autorisé désigné par le fournisseur. La compagnie de télécommunications peut demander à l'utilisateur de débrancher un appareil à la suite de réparations ou de modifications effectuées par l'utilisateur ou à cause de mauvais fonctionnement.

Pour sa propre protection, l'utilisateur doit s'assurer que tous les fils de mise à la terre de la source d'énergie électrique, des lignes téléphoniques et des canalisations d'eau métalliques, s'il y en a, sont raccordés ensemble. Cette précaution est particulièrement importante dans les régions rurales.

Avertissement. - L'utilisateur ne doit pas tenter de faire ces raccordements lui-meme; il doit avoir recours a un service d'inspection des installations électriques, ou a electricien, selon le cas.

L'indice de charge (IC) assigné a chaque dispositif terminal indique, pour éviter toute surcharge, le pourcentage de la charge totale qui peut etre raccodée a un circuit téléphonique bouclé utilisé par ce dispositif. La terminaison du circuit bouclé peut etre constituée de n'import quelle combinaison de dispositif, pourvu que la somme des indices de charge de l'ensemble des dispositifs ne dépasse pas 100. L'indice de charge de cet produit est 5.

Cet appereil numérique respecte les limites de bruits radioélectriques applicables aux appareils numériques de Classe A prescrites dans la norme sur le matériel brouilleur : "Appareils Numériques", NMB-003 édictée par le ministre des Communications.

SECTION 21. APPLICATION NOTES

This section contains application notes, which are intended to assist users in configuring IMUX 2000 systems. The following application notes are included in this section:

Application Notes	Pages	Revision
Application Note 3. IMUX 2000 DACS & ILS Configuration Parameters	27	4-17-97
Application Note 4. IMUX 2000 ILS Signal Routing Principles	31	7-22-96
Application Note 5. IMUX 2000 DACS Clock Selection	5	8-14-96
Application Note 6. IMUX 2000 Robbed-Bit Signaling And Network Disturbances	3	2-27-97
Application Note 7. IMUX 2000 Fast Reframe Principles	3	2-27-97
Application Note 8. IMUX 2000 DACS/ILS Action On Loss Of Ports 5 & 6	3	4-10-97
Application Note 9. IMUX 2000 Fallback Timing	3	4-10-97
Application Note 10. IMUX 2000/2000E Switching & Path Delays	6	2-4-99
Application Note 11. IMUX 2000E E1 DACS Configuration Parameters	16	2-8-99
Application Note 12. IMUX 2000 CM-3R Common Module Redundant Mode Diagnostics	8	9-21-00
Application Note 13. IMUX 2000 CM-3X FDL Node Location Mapping	7	10-31-00
Application Note 19. IMUX 2000 Alarm Configuration Module for Mother Board to Power Supply I/O	2	5-10-07

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RFL Electronics, Inc.

DACS / ILS Application Note 03.

Rev. 04.17.1997 rdw

IMUX 2000

DACS & ILS CONFIGURATION PARAMETERS

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Appendix

DACS and ILS switch triggering

A. Introduction

DACS and ILS modules are configured by means of a set of parameters, stored in non-volatile memory of the DACS/ILS Processor. Configuration may be accomplished through the Network Management Software or by direct input to the processor module.

The initial configuration can be accomplished only at the local node of a system, since Network management cannot access other nodes until communication paths are functioning.

When using the direct method of parameter input through a CM3B unit controlling local node, the proper format of an SCL command is:

:*[module]*:set:*[parameter]*=*[value]*;

where *[module]* is *dacs* or *ils*, as required, *[parameter]* and *[value]* are shown below.

For example, to turn AIS detection on some ILS unit off, use:

:ILS:SET:EAIS=OFF;

When communicating through a direct connection to the processor module, the *[module]* selection may be omitted and the whole command shortened to:

::set:*[parameter]*=*[value]*;

Unless specifically mentioned, parameter values apply globally to all ports on the module.

As a troubleshooting hint, one should note that the performance of an ILS or DACS system depends also on the behavior of CM3B common modules located in the terminals and drop-and-inserts of the network. Parameters controlling the common modules should be carefully reviewed with regard to compatibility with DACS/ILS settings.

For example, most common interface problems stem from inappropriate encoding (B8ZS vs. AMI) or framing (ESF vs. SF) settings on ports on both ends of a T1 link. Even though within a network there may be different configurations used (such as when a DACS is used to translate ESF-B8ZS to AMI-SF), on the same link both ports must be set identically.

Sometimes, inexplicable behavior of a system can be corrected by simply resetting the CM3B's to factory settings (from DIAG menu) and then re-entering any settings required for the particular application. This is due to the fact that even one wrong value in a rarely reviewed parameter can cause very subtle changes in performance, as opposed to an outright failure.

B. DACS Modules

1. General DACS Settings.

SRVC values: **ON , OFF** **DACS enable std operation of module**

This parameter allows selection of standard or non-standard initialization of the module.

When SRVC is set to ON, the DACS/ILS processor after initialization will check the status of T1 ports. If a port failure is indicated, the processor will switch the DACS or ILS module to a map/routing configuration appropriate for the first bad port detected. If another port indicates failure, no action will be taken until the first port recovers.

When SRVC is set to OFF, upon initialization the processor will set the DACS to map 0 and the ILS to normal routing. No action will be taken until all monitored ports recover fully.

ACTx values: **ON , OFF** **DACS enable port monitoring**
where x=[1..6]

Parameter ACTx allows disabling of status monitoring of individual ports on a DACS module. Ports are always initialized and set according to current configuration.

When ACTx is set to OFF, status of port x is not monitored and no actions are taken upon communications failure. Front panel LED corresponding to port x is extinguished. Effectively, port x is ignored - both with regard to alarms and to switching of maps.

This situation is different from that created by setting LOSDLY,x=1000, in which the status of port x is still monitored, although no actions are taken upon failure.

When ACTx is set to ON, status of port x is monitored and appropriate actions are taken upon communications failure. LED corresponding to port x reflects port status. It is lit when no signal errors are detected and it is extinguished when errors are present - regardless whether map switching occurs (map switching will happen only if errors satisfy certain configurational and timing constraints).

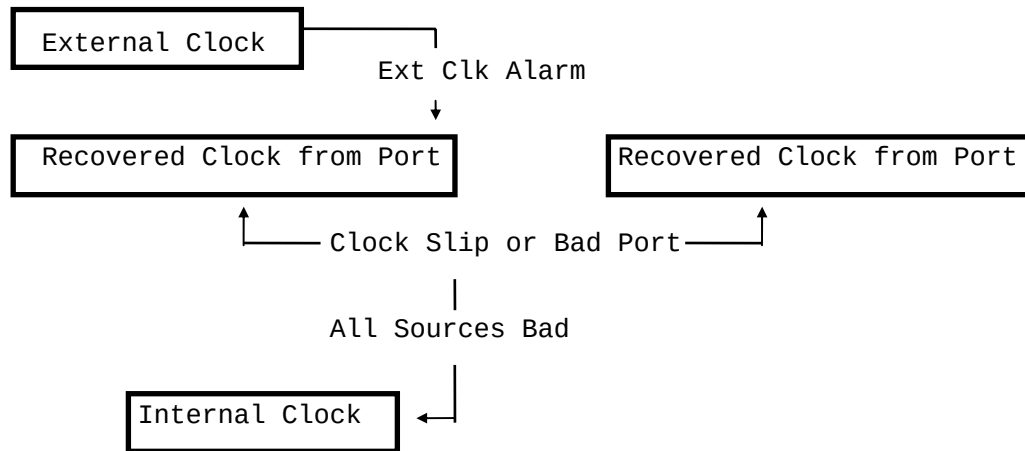
CLOCK values: [primary],[alternate] **DACS primary and alternate clock source**
 where [primary] or [alternate] = [1..6], [M1..M6], INT, EXT, NONE

The DACS module will use clock sources selected by CLOCK parameter to drive the internal DS0 grooming process and to serve as the T1 transmit clock. External clock and/or any of the 6 ports and/or the internal oscillator can serve as a clock source. Only up to 2 sources can be selected by this parameter.

External clock, if present and if enabled by CLOCK parameter, takes precedence over any other sources. Internal clock, even if not selected, will be used if all other clock sources are not available.

If a problem is detected at the current source of clock, DACS will use the alternate source. If the problem clears, DACS will not switch back unless there is a problem with the alternate.

If clock slippage is detected, the processor will switch between port sources specified in CLOCK parameter.



Clock source hierarchy.

The **M** qualifier is used to address the issue of loss of master timing node in the system by setting up a secondary master.

In the next node "downstream" after the master, the port facing the master should be denoted as **M**. For example, if port 1 in next node after master is facing the master, the following command may be issued:

```
node:dacs:set:clock=M1,4;
```

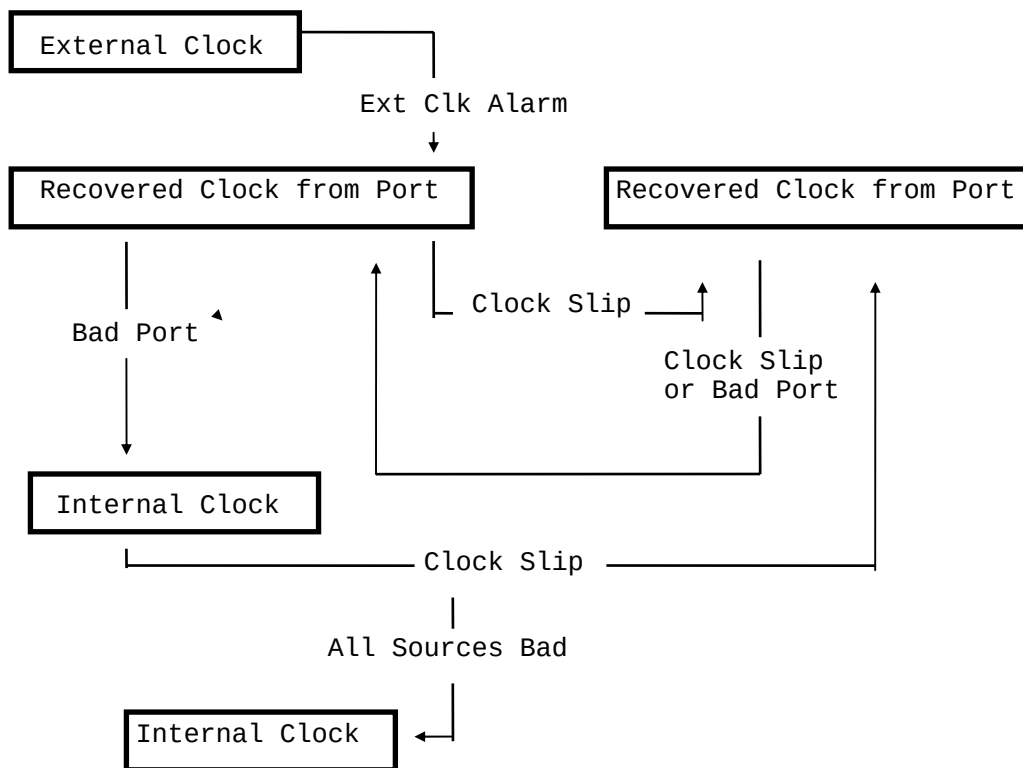
Such command results in following sequence of events:

If a problem is detected at port 1, the clock is first sourced from internal oscillator, regardless of what the other alternate source is. The processor will monitor the alternate source for clock slippage.

If no slip is present, the processor assumes that its own clock propagated through the system. This indicates that master node is lost. The processor will remain in internal timing, assuming the function of a secondary master, until clock slip occurs.

If clock slip occurs, then the processor knows that another source of timing is present in the system. DACS will switch to the alternate source specified in CLOCK parameter.

Note that only a port and only one port can be selected as **M**.



Clock source hierarchy for secondary master.

FTYPE,x values: **SF, ESF** **DACS framing type, ports 1 to 4**
where x=[1..4]

The FTYPE,x parameter is used to select superframe or extended superframe mode on specified port, 1 through 4.

FTYPx values: **SF, ESF** **DACS framing type, ports 5 and 6**
where x=[5,6]

The FTYPx parameter is used to select superframe or extended superframe mode on specified port, 5 or 6.

CODE,x values: **AMI, B8ZS** **DACS coding type, ports 1 through 4**
where x=[1..4]

The CODEx parameter is used to select AMI or B8ZS encoding mode on specified port, 1 through 4.

CODEx values: **AMI, B8ZS** **DACS coding type, ports 5 and 6**
where x=[5,6]

The CODEx parameter is used to select AMI or B8ZS encoding mode on specified port, 5 or 6.

2. Fault Detection - DACS.

Parameters listed below determine methods by which a DACS module determines the quality of communication paths attached to its ports.

ELOS values: **ON , OFF** **DACS enable Loss of Sync detection**

T1 transceiver ("framer") chips indicate loss of synchronization with incoming T1 stream via the LOS (Los Of Sync) flag. When ELOS is set to ON, appearance of this flag will cause the processor to assume a failure on the T1 port. After expiration of delays such as LOSDLY, the processor will take an appropriate action, such as switching of the maps.

When ELOS is set to OFF, the processor will ignore the state of the LOS flag.

Since LOS is based on the internal state of synchronization of a framer, it may appear delayed by several tens of milliseconds following an actual failure of communication path. Correspondingly, similar delays may occur when the paths are restored. Even more difficulties may be created by a brief disturbance of the path, since a framer could spend a long time re-synchronizing, again in the range of a few tens of milliseconds.

To prevent unnecessary switching of maps, it is imperative to apply a timing delay, LOSDLY. Only if the LOS flag persists longer than LOSDLY, can signal routing maps be switched. LOSDLY should be selected to be longer than any expected random losses of sync, caused by single spurious errors in communication paths. A suggested value for LOSDLY is 200ms in a non-Fast-Reframe system. A large number of nodes may require an increase in LOSDLY.

As mentioned above, LOS needs to be slowed down by LOSDLY to prevent misoperation of the system. In a system applications where fast switching is required, Fast Reframe should be used throughout the system. In such situation, ELOS should be set to OFF. The processor will rely on Fast Reframe Loss Of Frame (FLOF) to detect problems, which is a much faster and more reliable method.

ELOD values: **ON , OFF** **DACS enable Loss of Data detection**

T1 transceiver ("framer") chips indicate loss of data within incoming T1 stream via the RCL (Receive Carrier Loss) flag and the signal level via Receive Level bits. When ELOD is set to ON, appearance of the RCL flag or a drop of signal level below value set with LEVEL parameter will cause the processor to assume a failure on the T1 port. The processor will take appropriate action.

When ELOD is set to OFF, the processor will ignore both the state of the RCL flag and the level of signal.

EAIS values: **ON , OFF** **DACS enable EAIS detection**

Problems with communication paths are often indicated by presence of a “Blue Alarm” (referred to as All-Ones, or Alarm Indication Signal, AIS) at the port.

When EAIS is set to ON, appearance of AIS will cause the processor to assume a failure on the T1 port. The processor will take appropriate action.

When ELOS is set to OFF, the processor will ignore the state of AIS.

EBER values: **ON , OFF** **DACS enable BER detection**

Bit-Error-Rate may be used to indicate problems with communication paths. It is a slow alarm, however, since BER is updated by the framer chips only once a second.

When EBER is set to ON, values exceeding those set by **BER** parameter will cause the processor to assume a failure on the T1 port. The processor will take appropriate action.

When EBER is set to OFF, the processor will ignore the bit error rate.

EFLOF values: **ON , OFF** **DACS enable Fast Loss of Frame detect**

CM3B Common Modules independently monitor the quality of T1 communication paths. When a DACS or ILS unit works attached to a chassis containing CM3B's, the common modules can inform the DACS/ILS processor about any perceived problems.

When EFLOF is set to ON, alarm on the FLOF (Fast Loss of Frame) line from the common module will cause the processor to assume a failure on the T1 port. The processor will take appropriate action.

When EFLOF is set to OFF, the processor will ignore the FLOF line.

With Fast Reframe disabled, the FLOF signal from common module(s) represents the LOS (loss of sync) from the CM3B framer chip, and thus it somewhat duplicates the LOS signal generated locally at the DACS or ILS. The FLOF is less reliable, however, and thus switching on FLOF should be disabled when Fast Reframe is not used.

With Fast Reframe enabled on the common module, FLOF line represents the status of the Fast Reframe circuitry. It is extremely reliable and very fast and is very well suited to controlling DACS/ILS switching. When Fast Reframe is used, switching on FLOF should be enabled (EFLOF=ON) and switching on the less reliable local loss of sync should be disabled (ELOS=OFF).

3. DACS Failure Levels.

Parameters listed below determine at which level of disturbance the DACS/ILS processor decides that a fault occurred.

BER values: numeric **DACS Bit Error Rate switch level**

Bit-Error-Rate parameter sets the switch-on-error level. The entry format is nE-m, where n=[0..9] and m=[4..7]. This results in value range of 0 and 1E-7 to 9E-4.

When **EBER** (enable BER switching) is set to ON, error values exceeding those set by BER parameter will cause the processor to assume a failure on the T1 port. The processor will take an appropriate action, such as switching of the maps.

When EBER is set to OFF, the processor will ignore bit error rate.

LEVEL values: numeric, dB **DACS signal strength switch level, dB**

The LEVEL parameter sets the minimum signal strength level, in decibels. If the incoming T1 signal falls below this level and **ELOD** (enable Loss-of-Data) is set to ON, the processor will assume a failure on the T1 port. The processor will take appropriate action.

LEVEL can be set to desired dB value by entering -7.5, -15 or NONE. If NONE is selected, signal strength is ignored.

When ELOD is set to OFF, the processor will ignore both signal strength and Received Carrier Level.

4. DACS Switch-on-Failure Timing.

Parameters listed below determine the delays involved in map switching following a port failure (healing process). Additionally, LOSDLY allows to disable map switching for a given port.

EFAST,x values: **ON , OFF** **DACS enable fast switching**
where **x=[1..4]**

After the processor determines that port **x** has failed (communication link broken) and if EFAST,x is set to OFF, no actions are taken for a period equal to switch delay **DLYx** or **LOSDLY,x**, depending on failure mode. After the delays pass, the processor will switch the DACS module to a map corresponding to the failed port.

If the EFAST,x parameter is set to ON, DLYx timers are bypassed for Loss of Data (LOD) and the processor switches maps and routings instantly (250us) after detecting port failure. Other failures (Fast Reframe Loss of Sync, Loss of Sync, etc.) are still buffered by their respective time delays.

DLYx values: numeric, msec **DACS error-to-switch delay, msec**
where **x=[1..4]**

After the processor determines that port **x** has failed, no actions are taken for a period equal to switch delay DLYx, in milliseconds. This pertains to failures detected by means of Carrier Loss and Level (as enabled by **ELOD** parameter), by means of Alarm Indication Signal (as enabled by **EAIS**), by means of BER (as enabled by **EBER**) or by means of Fast Loss of Frame (as enabled by **EFLOF** parameter). After the delay passes, the processor will switch the DACS module to a map corresponding to the failed port.

If the **EFAST** parameter is enabled, timer DLYx is bypassed for LOD errors and the processor switches maps and routings instantly (250us) after detecting port failure.

LOSDLY,x values: numeric, ms **DACS error-to-LOS indication delay, msec**
where **x=[1..4]** and value = **[0..995]**
LOSDLY,x values: numeric, ms **DACS map switch disable, port x**
where **x=[1..4]** and value = **1000**

After the processor determines that port **x** has failed by means of Loss of Sync (as enabled by **ELOS** parameter), no actions are taken for a period equal to switch delay LOSDLY,x, in milliseconds. After the delay passes, the processor will switch the DACS module to a map corresponding to the failed port. Any value between 0 and 999 may be entered for the delay, but the processor will round it down to nearest increment of 5.

Setting LOSDLY,x to 1000 disables switching of maps based failure of port **x**. The status of the port will be still monitored and displayed via front panel LED's. Typically, this is used for a port connected to the backup path, to prevent a switch of maps due to bad backup.

This is different from setting ACTx to OFF, which disables both monitoring port and switching of maps.

5. DACS Switch-on-Recovery Timing

Parameters listed below determine the delays involved in map and routing switching following a port recovery.

REC	values: numeric, sec	DACS recovery delay, sec

After the processor determines that a failed port is recovered (communication link restored), no actions are taken for a period equal to the recovery delay, in seconds. After the recovery delay passes, the processor will switch the DACS module back to map 0.

The recovery delay allows the system to settle following the restoration of primary links before attempting to switch to the primaries. The larger and more complex the system, the more delay is required.

REC can be set between 1 and 60s.

6. Typical Settings of DACS parameters.

Table below indicates typical settings of DACS parameters, in order in which they appear as a result of the `::config?:flags_;` statements.

Column **Fast** pertains to a system utilizing Fast Reframe, **No Fast** to a system without this feature. Asterisks highlight the differences between both arrangements.

DLY value of 1ms has been determined to be sufficient for systems including up to 4 nodes. Each additional node requires an approximate increase of 0.5ms. Actual measurements should be performed to confirm this setting.

DACS clock settings depend on the topology of the particular system.

	Fast		No Fast	
ELOS	OFF	*	ON	Switch on framer LOS
ELOD	ON		ON	Switch on framer Carrier Loss + Level
EAIS	ON		ON	Switch on AIS
EBER	OFF		OF	Switch on BER
EFLOF	ON	*	OFF	Switch on CM3B LOS / FRLOS
ACT1	ON		ON	DACS port enable
ACT2	ON		ON	DACS port enable
ACT3	ON		ON	DACS port enable
ACT4	ON		ON	DACS port enable
ACT5	ON		ON	DACS port enable
ACT6	ON		ON	DACS port enable
REC	10		10	Recover dly, signal-to-switch, sec
BER	1.E-05		1.E-05	BER switch level
DLY1	1		1	DACS error-to-switch delay, port 1, msec
DLY2	100		100	DACS error-to-switch delay, port 2, msec
DLY3	100		100	DACS error-to-switch delay, port 3, msec
DLY4	1		1	DACS error-to-switch delay, port 4, msec
CLOCK	?		?	DACS primary & alternate clock
LEVEL	-7.5dB		-7.5dB	Level switching point (via ELOD)
FTYP5	ESF		ESF	DACS port 5 framing type SF/ESF
CODE5	B8ZS		B8ZS	DACS port 5 coding AMI/B8ZS
FTYP6	ESF		ESF	DACS port 6 framing type SF/ESF
CODE6	B8ZS		B8ZS	DACS port 6 coding AMI/B8ZS
FTYPE,1	ESF		ESF	DACS port 1 framing SF/ESF
CODE,1	B8ZS		B8ZS	DACS port 1 coding AMI/B8ZS
EFAST,1	ON	*	OFF	DACS fast switch port 1 (bypasses DLY1)
LOSDLY,1	85	*	300	DACS port 1 LOS-to-switch dly, msec
FTYPE,2	ESF		ESF	DACS port 2 framing SF/ESF
CODE,2	B8ZS		B8ZS	DACS port 2 coding AMI/B8ZS
EFAST,2	OFF		OFF	DACS fast switch port 2 (bypasses DLY2)
LOSDLY,2	85	*	300	DACS port 2 LOS-to-switch dly, msec
FTYPE,3	ESF		ESF	DACS port 3 framing SF/ESF

CODE,2	B8ZS		B8ZS	DACS port 3 coding AMI/B8ZS
EFAST,3	OFF		OFF	DACS fast switch port 3 (bypasses DLY3)
LOSDLY,2	85	*	300	DACS port 3 LOS-to-switch dly, msec
FTYPE,4	ESF		ESF	DACS port 4 framing SF/ESF
CODE,4	B8ZS		B8ZS	DACS port 4 coding AMI/B8ZS
EFAST,4	ON	*	OFF	DACS fast switch port 4 (bypasses DLY4)
LOSDLY,4	85	*	300	DACS port 4 LOS-to-switch dly, msec

Figure 1.
DACS parameter setting chart.

c. ILS Modules

1. General ILS Settings

SRVC values: **ON , OFF** **ILS enable std operation of module**

This parameter allows selection of standard or non-standard initialization of module.

When SRVC is set to ON, the DACS/ILS processor after initialization will check the status of T1 ports. If a port failure is indicated, the processor will switch the ILS module to a routing configuration appropriate for the first bad port detected. If another port indicates failure, no action will be taken until the first port recovers.

When SRVC is set to OFF, upon initialization the processor will set the ILS to normal routing. No action will be taken until all monitored ports recover fully.

USE_x values: **ON , OFF** **ILS enable port monitoring**
where **x=[1] or [4]**

Parameter USE_x allows disabling of status monitoring of individual primary ports on an ILS module. Ports are always initialized and set according to current configuration.

When USE_x is set to OFF, status of port **x** is not monitored and no actions are taken upon communications failure. Front panel LED corresponding to port **x** is extinguished.

When USE_x is set to ON, status of port **x** is monitored and appropriate actions are taken upon communications failure. LED corresponding to port **x** reflects port status. It is lit when no signal errors are detected and it is extinguished when errors are present - regardless whether routing switching occurs (route switching will happen only if errors satisfy certain configurational and timing constraints).

EXCLK values: **ON, OFF** **ILS external clock enable**

If a good external clock is present, it will be used as the clock source for an ILS module if EXCLK is set to ON.

Setting of EXCLK parameter to OFF prevents external clock from being utilized. Instead, recovered clock is used for retransmission of data.

Using external clock in an ILS should be attempted only in special situations. Typically, recovered clock is recommended since an ILS has limited provisions for buffering of clock and data. Refer to DACS/ILS Application Note 04, *ILS Signal Routing Principles* for more details.

FTYPE values: **SF, ESF** **ILS framing type**

The FTYPE parameter is used to select superframe or extended superframe mode on all ports.

CODE values: **AMI, B8ZS** **ILS coding type**

The CODE parameter is used to select AMI or B8ZS encoding mode on all ports.

MODE values: **MASTER, SLAVE, HOT, THRU** **ILS mode select**

MASTER & SLAVE:

In a system consisting of only two nodes, both of which utilize an ILS module, there is no source of timing to drive backup ports while normal (primary) paths are used. In such system, one ILS module must be designated as MASTER, the other as SLAVE.

A slave node retransmits into a backup path all received data and timing. A master node transmits timing derived from local ports (i.e., 5 and 6) into backup ports 2 and 3. Also, idle data and forced FDL is driven into the backup paths, thus effectively "priming" the unused paths with good framing and FDL.

DACS & SLAVE:

In a system consisting of more than 2 nodes, at least one DACS must be used. This is required in order to absorb difference between path lengths and multiples of frame times, which would otherwise cause continuous loss of framing. (See discussion of HEAL parameter). ILS modules use no internal buffers and thus have no way of absorbing any time delays.

In such system, the DACS serves as a master and therefore all ILS modules should be set as SLAVE.

HOT STANDBY:

A system configuration utilizing only 2 paths between nodes (i.e., connected either to ports 1 and 2 or to ports 4 and 3) is known as Hot Standby. In such system, the ILS modules must be set as HOT. This setting allows T1 timing and data to be continuously driven onto both the primary and the backup path.

THROUGH-MODE:

It is possible to use an ILS module as a passive repeater or a fiber-to-wire converter, without utilizing its switching abilities. In such mode, the ILS needs to repeat the All-Ones-Signal (AIS) which originates at another node (normally, AIS cannot be passed through - it is only transmitted by the node that originates that signal). This AIS pass-through capability is enabled by setting the ILS mode to THRU. Additionally, service must be turned OFF for that mode, to disable switching.

Note that AIS pass-through cannot be enabled if the ILS is supposed to switch, since this would interfere with the switching and restoration process.

2. ILS Fault Detection

Parameters listed below determine methods by which a DACS module determines the quality of communication paths attached to its ports..

ELOS values: **ON , OFF** **ILS enable Loss of Sync detection**

T1 transceiver ("framer") chips indicate loss of synchronization with incoming T1 stream via the LOS (Los Of Sync) flag. When ELOS is set to ON, appearance of this flag will cause the processor to assume a failure on the T1 port. After expiration of delays such as LOSDLY, the processor will take an appropriate action, such as switching of the maps.

When ELOS is set to OFF, the processor will ignore the state of the LOS flag.

Since LOS is based on the internal state of synchronization of a framer, it may appear delayed by several tens of milliseconds following an actual failure of communication path. Correspondingly, similar delays may occur when the paths are restored. Even more difficulties may be created by a brief disturbance of the path, since a framer could spend a long time re-synchronizing, again in the range of a few tens of milliseconds.

To prevent unnecessary switching of maps, it is imperative to apply a timing delay, LOSDLY. Only if the LOS flag persists longer than LOSDLY, can signal routing maps be switched. LOSDLY should be selected to be longer than any expected random losses of sync, caused by single spurious errors in communication paths. A suggested value for LOSDLY is 200ms in a non-Fast-Reframe system. It may require an increase for large number of nodes in a system.

As mentioned above, LOS needs to be slowed down by LOSDLY to prevent misoperation of the system. In a system applications where fast switching is required, Fast Reframe should be used throughout the system. In such situation, ELOS should be set to OFF. The processor will rely on Fast Reframe Loss Of Frame (FLOF) to detect problems, which is a much faster and more reliable method.

ELOD values: **ON , OFF** **ILS enable Loss of Data detection**

T1 transceiver ("framer") chips indicate loss of data within incoming T1 stream via the RCL (Receive Carrier Loss) flag and the signal level via Receive Level bits. When ELOD is set to ON, appearance of RCL flag or drop of level below value set with LEVEL parameter will cause the processor to assume a failure on the T1 port. The processor will take an appropriate action.

When ELOD is set to OFF, the processor will ignore both the state of the RCL flag and the level of signal.

EAIS values: **ON , OFF** **ILS enable EAIS detection**

Problems with communication path are often indicated by presence of "Blue Alarm" (referred to as All-Ones, or Alarm Indication Signal, AIS) at the port.

When EAIS is set to ON, appearance of AIS will cause the processor to assume a failure on the T1 port. The processor will take an appropriate action.

When ELOS is set to OFF, the processor will ignore the state of AIS.

EBER values: **ON , OFF** **ILS enable BER detection**

Bit-Error-Rate may be used to indicate problems with communication paths. It is a slow alarm, however, since BER is updated by the framer chips only once a second.

When EBER is set to ON, values exceeding those set by **BER** parameter will cause the processor to assume a failure on the T1 port. The processor will take an appropriate action.

When EBER is set to OFF, the processor will ignore the bit error rate.

EFLOF values: **ON , OFF** **ILS enable Fast Loss of Frame detect**

CM3B Common Modules independently monitor the quality of T1 communication paths. When a DACS or ILS unit works attached to a terminal chassis containing CM3B's, the common modules can inform the DACS/ILS processor about any perceived problems.

When EFLOF is set to ON, alarm on FLOF (Fast Loss of frame) line from the common module will cause the processor to assume a failure on the T1 port. The processor will take an appropriate action.

When EFLOF is set to OFF, the processor will ignore the FLOF line.

With Fast Reframe disabled, the FLOF signal from common module(s) represents the LOS (loss of sync) from the CM3B framer chip, and thus it somewhat duplicates the LOS signal generated locally at the DACS or ILS. The FLOF is less reliable, however, and thus switching on FLOF should be disabled when Fast Reframe is not used.

With Fast Reframe enabled on common module, FLOF line represents the status of the Fast Reframe circuitry. It is extremely reliable and very fast and is very well suited to controlling of DACS/ILS switching. When Fast Reframe is used, switching on FLOF should be enabled (EFLOF=ON) and switching on the less reliable local loss of sync should be disabled (ELOS=OFF).

3. ILS Failure Levels

Parameters listed below determine at which level of disturbance the DACS/ILS Processor decides that a fault occurred.

BER values: numeric **ILS Bit Error Rate switch level**

Bit-Error-Rate parameter sets the switch-on-error level. The entry format is nE-m, where n=[0..9] and m=[4..7]. This results in value range of 0 and 1E-7 to 9E-4.

When **EBER** (enable BER switching) is set to ON, error values exceeding those set by BER parameter will cause the processor to assume a failure on the T1 port. The processor will take an appropriate action, such as switching of signal routings.

When EBER is set to OFF, processor will ignore bit error rate.

LEVEL values: numeric, dB **ILS signal strength switch level, dB**

The LEVEL parameter sets the minimum signal strength level, in decibels. If the incoming T1 signal falls below this level and **ELOD** (enable Loss-of-Data) is set to ON, the processor will assume a failure on the T1 port. . The processor will take appropriate action.

LEVEL can be set to desired dB value by entering -7.5, -15 or NONE. If NONE is selected, signal strength is ignored.

4. ILS Switch-on-Failure Timing.

Parameters listed below determine the delays involved in map and routing switching following a port failure (healing process).

EFAST values: **ON , OFF** **ILS enable fast switching**

After the processor determines that port **x** has failed (communication link broken) and if **EFAST** is set to **OFF**, no actions are taken for a periods equal to switch delays **DELAY** and **LOSDLY** , in milliseconds. After the delays pass, the processor will switch an ILS module to a routing appropriate for the failed port.

If the **EFAST** parameter is set to **ON**, **DELAY** value is bypassed for Loss of Data (LOD) and the processor switches maps and routings instantly (250us) after detecting port failure. Other failures (Fast Reframe Loss of Sync, Loss of Sync, etc.) are still buffered by their respective time delays.

DELAY values: numeric, msec **ILS error-to-switch delay, msec**

After the processor determines that a port has failed, no actions are taken for a period equal to switch delay **DELAY**, in milliseconds. This pertains to failures detected by means of Carrier Loss and Level (as enabled by **ELOD** parameter), by means of Alarm Indication Signal (as enabled by **EAIS**), by means of BER (as enabled by **EBER**) or by means of Fast Loss of Frame (as enabled by **EFLOF** parameter). After the delay passes, the processor will switch the ILS module to a routing appropriate for the failed port.

If the **EFAST** parameter is enabled, **DELAY** is bypassed for LOD errors and the processor switches maps and routings instantly (250us) after detecting port failure.

LOSDLY values: numeric, msec **ILS LOS-to-switch delay, msec**

After the processor determines that a port has failed by means of Loss of Sync (as enabled by **ELOS** parameter), no actions are taken for a period equal to switch delay **LOSDLY**, in milliseconds. After the delay passes, the processor will switch the ILS module to a routing appropriate for the failed port.

5. ILS Switch-on-Recovery Timing.

Parameters listed below determine the delays involved in map and routing switching following a port recovery.

REC	values: numeric, sec	ILS recovery delay, sec

After the processor determines that a failed port is recovered (communication link restored), no actions are taken for a period equal to the recovery delay, in seconds. After the recovery delay passes, the processor will switch the ILS module back to primary routing.

The recovery delay allows the system to settle following the restoration of primary links before attempting to switch to the primaries. The larger and more complex the system, the more delay is required.

REC can be set between 1s and 60s.

6. Reverting on Loss of Master

Parameters listed below are involved when a master node is lost, resulting in an ILS-only network. These are internal, hard-coded values, not accessible to the user. They are described here for reference only.

HEAL hardcoded numeric, **300ms** **ILS healing check delay, msec**

The HEAL parameter addresses the issue of loss of a master node in a network consisting of ILS modules. When the remaining network consists of only slave ILS nodes, a ring topology cannot be maintained. Slave-only ring operation would result in constant framing errors due to lack of buffering on ILS.

Each ILS and each data path has a fixed propagation delay. All these delays add up to a closed-circuit delay around the ring, which is unlikely to be a multiple of a frame length. As a frame travels around the ring, it will have to be periodically cut and re-aligned to fit into the closed-circuit time.

To allow continuing operation of the remaining section of the ring, at least one of the ILS modules must fall back into primary configuration, thus breaking the ring open into a linear topology which can handle the fixed data propagation delay through the ILS modules.

Each ILS unit, after switching into a backup mode following port failure, waits for a time determined by HEAL parameter and then checks whether the system is operational. If the communication path was healed properly, Loss-of-Sync flag should be reset or appear very infrequently.

However, if an ILS-only ring was created due to loss of a master, a series of LOS pulses should be present as the framer chips continuously re-align themselves. If density of these pulses exceeds the value set by **RATIO** parameter, the processor assumes that a master is lost and therefore reverts back to normal routing. The ILS will then remain in normal routing configuration until all ports recover fully. At that point, the processor will again monitor ports for signs of failure and switch routing accordingly.

RATIO hardcoded numeric, **15%** **ILS alarm-level ratio of LOS pulses**

The RATIO parameter is used while determining whether loss of a master node resulted in an slave-ILS-only ring network (see description of **HEAL** parameter).

If such network is created, Loss-of-Sync (LOS) appears as a train of pulses. RATIO sets a limit level for density (duty cycle) of these pulses. If LOS pulses appear more frequently than the RATIO percentage, the processor assumes that a master is lost and therefore reverts back to normal routing. The ILS will then remain in normal routing configuration until all ports recover fully. At that point, the processor will again monitor ports for signs of failure and switch routing accordingly.

7. Typical Settings of ILS parameters.

Table below indicates typical settings of ILS parameters, in order in which they appear as a result of the `::config?:flags_;` statements.

Column **Fast** pertains to a system utilizing Fast Reframe, **No Fast** to a system without this feature. Asterisks denote differences between both arrangements.

DELAY value of 1ms has been determined to be sufficient for systems including up to 4 nodes. Each additional node requires an increase of 0.5ms. Actual measurements should be taken to confirm this setting.

	Fast		No Fast	
ELOS	OFF	*	ON	Switch on framer LOS
ELOD	ON		ON	Switch on framer Carrier Loss + Level
EAIS	ON		ON	Switch on AIS
EBER	OFF		OFF	Switch on BER
EFLOF	ON	*	OFF	Switch on CM3B LOS / FRLOS
FTYPE	ESF		ESF	ILS framing type SF/ESF
MODE	SLAVE		SLAVE	ILS master/slave mode
USE1	ON		ON	ILS port enable
USE4	ON		ON	ILS port enable
EXCLK	OFF		OFF	ILS external clock enable
CODE	B8ZS		B8ZS	ILS coding AMI/B8ZS
BER	1.E-05		1.E-05	BER switch level
LEVEL	-7.5dB		-7.5dB	Level switching point (via ELOD)
EFAST	ON	*	OFF	ILS fast switch, all ports (bypasses DELAY)
DELAY	1		1	ILS error-to-switch delay, all ports, msec
REC	10		10	Recover dly, signal-to-switch, sec
LOSDLY	85	*	200	ILS LOS-to-switch debounce delay, msec

Figure 2.
ILS parameter setting chart.

Appendix A.

DACS and ILS switch triggering

DACS/ILS Processor monitors T1 communication lines connected to ports of DACS or ILS modules. If the signal reaching a port is deemed to be deficient, appropriate actions are taken, for example resulting in switching of DACS maps or ILS routings.

The determination of quality of T1 signal is based on the following parameters:

- **LOS** - **Loss of Sync** alert generated by the framer chip.
- **LOD** - **Loss of Data**, a composite alert, consisting of Received Carrier Loss generated by the framer chip or by Receive Level indication, which is below value set by **LEVEL** parameter.
- **AIS** - **Alarm Indication Signal** generated by the framer, indicating reception of Blue Alarm (unframed all-ones).
- **BER** - **Bit Error Rate** alert, set when the errors indicated by framer chip exceed level set by BER parameter.
- **FLOF** - **Fast Reframe Loss of Frame** alert, set when the CM3B Common Module attached to DACS or ILS detects framing problems. When in fast reframe mode, CM3B indicates loss of fast reframe synchronization. When not in fast reframe, CM3B forwards the Loss of Sync signal from its framer.

All these characteristics are checked independently for each of framers on ports 1 through 4. When a problem is detected, the green front panel LED indicator corresponding to the affected port is extinguished.

The DACS/ILS Processor will take further action only if enabled by the appropriate **E...** parameter (ELOS, ELOD, etc.) and only after certain time delays. LOS (Loss of Sync) is timed by the LOSDLY timer. All other failures are timed by the DLY timer for DACS and by the DELAY timer for ILS.

If EFAST (Enable FAST switching) is set, LOD (Loss of Data) needs not to be present for the whole DLY/DELAY time period. Instead, switching action will be taken if LOD is present for 2 consecutive polls, typically 125us apart.

The actual action taken by the processor depends on type of module it controls. In a DACS, the processor will activate a map corresponding to the failed port. In an ILS, failure of a primary port will cause signal routing to be switched to the backup port if it is operational. Refer to Application Note 04, "*ILS Signal Routing Principles*" for more details.

A representation of the switching logic is shown in Figure 3. Switch symbols denote enabling function. Summing nodes require that at least one of involved conditions is present.

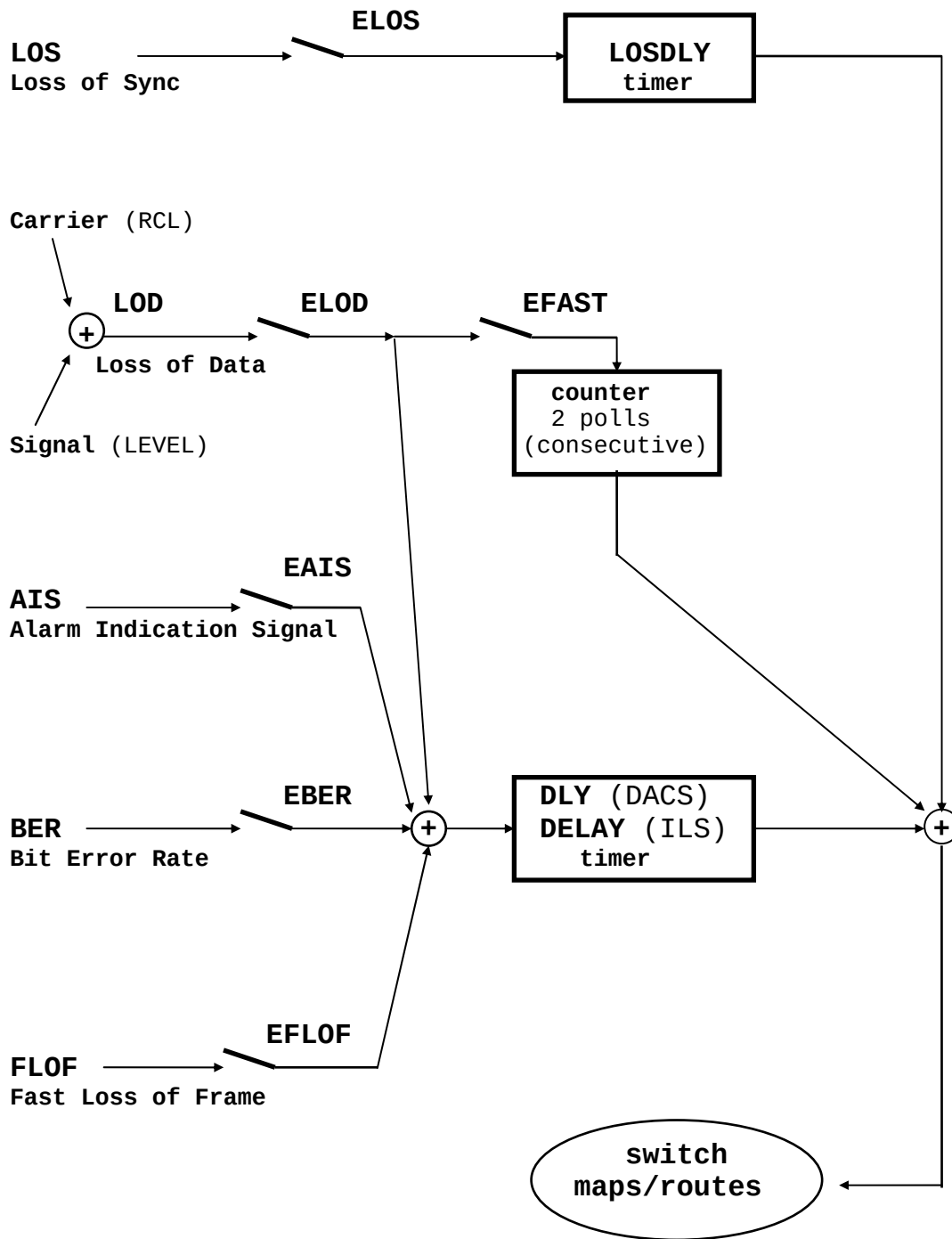


Figure 3.

Triggers of DACS and ILS switching..

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RFL Electronics, Inc.

DACS / ILS Application Note 04.

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IMUX 2000

Intelligent Line Switch

SIGNAL ROUTING PRINCIPLES

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1. Introduction.

The RFL Intelligent Line Switch (ILS) has the ability to redirect T1 signals between primary and backup communication paths. A complete ILS node on a T1 network consists, at the minimum, of an ILS and a DACS/ILS Processor. The ILS module routes T1 signals and the DACS/ILS Processor performs the control functions, monitoring signal quality and issuing route switching commands.

The ILS is designed primarily to serve the particular needs of protective relaying equipment. As such, it exhibits very short transmission delays, in the order of 30us per node. To achieve this goal, signals are routed between input and output ports without any buffering. Unlike in a Digital Access & Cross-Connect System (DACS), different input/output port pairs do not have to be synchronized with each other and may use different clocks. Incoming T1 frames and superframes are not disassembled and are retransmitted in whole, as received.

This application note deals with the issues of routing of signals and sourcing of timing in an ILS system.

2. Path configuration.

a. Routing

An **Intelligent Line Switch**, ILS, is based on operating principles differing from those of a **Digital Access and Cross-Connect System**, DACS.

In a DACS, all ports are equivalent. Information contained in any time slot (DS0) can be routed to any other time slot in any other port, without any restrictions. The processor monitors signal quality on ports 1, 2, 3 and 4 and can reconfigure the DACS in response to failure on any one of them. DACS configurations are stored in the processor as a series of maps.

In an ILS, there are no programmable maps, but rather fixed signal routing paths. Ports 5 and 6 are dedicated to be the local input/output of the device. Ports 1 and 4 are dedicated to be the primary communication paths. Port 2 serves as backup for port 1, while port 3 serves as backup for port 4.

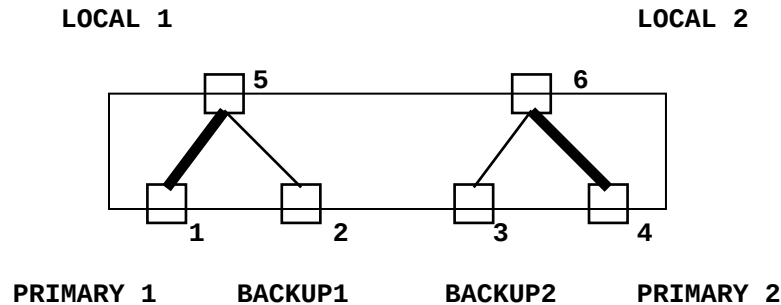


Figure 1.

Function assignments of ILS ports.

While all of ports 1 through 4 are monitored for signal quality, the processor re-routes the signals only in response to failure on either port 1 or port 4. Backup ports 2 and 3 are monitored in order to prevent switching from a failed primary into a bad backup port.

In order to improve the survivability of a T1 system, backup paths are often routed separately from the primary paths. This principle is followed in diagrams shown in the remainder of this application note, where bi-directional T1 paths external to ILS are indicated with dashed lines.

A typical system is shown on Figure 2. In this system, T1 backup path connected to port 2 is routed separately from primary path connected to port 1. Thus a failure of primary path at port 1, even if accompanied by failure at port 3 (which could possibly use a path in physical proximity to 1), will allow communications to be maintained in the other direction of the ring, through port 2.

In order to highlight this convention, the order of ports on system diagrams is usually shown as 1-3-2-4. This reinforces the principle that backups are separated from primaries.

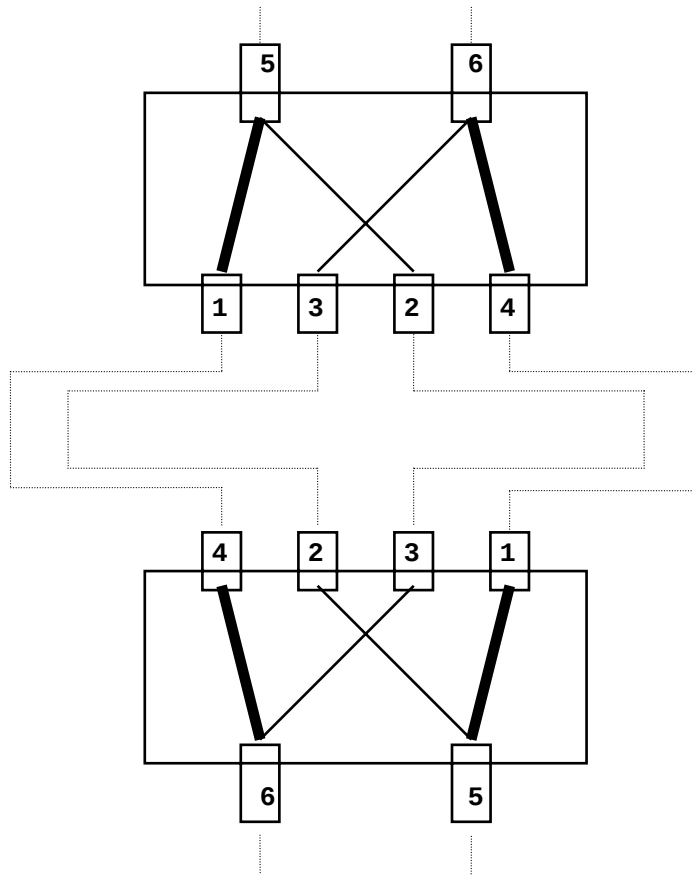


Figure 2.

Typical ILS system topography. Primary routing within ILS modules is shown with heavy lines, backup routing with thin lines.

b. Master and Slave Nodes.

Due to the principles of ILS, it is required that one master node must be present in the system. A 2-node system can consist of only ILS devices, one of them serving as a master, the other as slave.

A 3-node or larger system requires the use of at least one DACS, which serves as a master. All of the ILS modules must be configured as slaves in such system.

The differences between master and slave modes are described in this application note in section devoted to primary configuration mode.

c. Hot Standby.

A configuration which uses only one primary and one backup path (i.e., connected to either ports 1 and 2 or ports 4 and 3) is referred to as Hot Standby. Such arrangement requires that T1 timing and data is continuously present on both primary and backup pathways, regardless whether the modules are in primary or backup mode.

Refer to Hot Standby Systems section of this document for more information.

3. Control of ILS

a. Control Parameters

Switching functions of an ILS are controlled through a set of programmable parameters. These settings determine which signal errors, at what levels, will cause a transfer from primary to backup paths and determine timing of the switch-over. The parameters are stored in the non-volatile memory of the DACS/ILS Processor.

The DACS/ILS Processor interrogates framers located on board of the ILS to determine the quality of the T1 signal. The following parameters control if and when a switch of routings occurs in the event of signal problems:

ELOS enabled	switch on Loss of Sync from framers
ELOD enabled	switch on Loss of Data (carrier or signal level loss)
EAIS enabled	switch on Alarm Indication Signal (all ones)
EBER enabled	switch on excessive Bit Error Rate
EFLOF enabled	switch on Fast Reframe Loss of Sync from CM3B
LOSDLY	sets time from Loss of Sync to switch
DELAY	sets time from all other errors to switch
EFAST enabled	bypasses DELAY timing
MODE	determines Master or Slave configuration
BER	sets Bit Error Rate trip point
LEVEL	sets signal level trip point, used in ELOD

The processor monitors all signal characteristics, but takes action only on those types of failures that are enabled. The front panel LED's, on the other hand, reflect the current state of signal with respect to all characteristics. If a disturbance in signal was detected, the LED's may turn off even though the processor may not switch the ILS paths.

When observing that the LED's on the ILS front panel blink, one should not assume that the ILS switched paths. The only methods of actually determining whether a switch-over took place are by either observing the yellow ALERT LED, or by monitoring the CTL_O control lines at the edge connector or by interrogating the processor with the COUNT command.

Issuing the COUNT command will result in display of accumulated routing switch-over counts for each port. RESET command clears the counters to zero.

For more information on control parameters for the ILS, refer to RFL DACS/ILS Application Note 03, *"DACS & ILS Configuration Parameters"*.

As a troubleshooting hint, one should note that the performance of an ILS or DACS system depends also on the behavior of CM3B common modules located in the terminals and drop-and-inserts of the network. Parameters controlling the common modules should be carefully reviewed with regard to compatibility with DACS/ILS settings.

For example, most common interface problems stem from inappropriate encoding (B8ZS s. AMI) or framing (ESF vs. SF) settings on ports on both ends of a T1 link. Even though within a network there may be different configurations used (such as when a DACS is used to translate ESF-B8ZS to AMI-SF), both ports on the same link must be set identically.

Sometimes, inexplicable behavior of a system can be corrected by simply resetting the CM3B's to factory settings (from DIAG menu) and then re-entering any settings required for the particular application. This is due to the fact that even one wrong value in a rarely reviewed parameter can cause very subtle changes in performance, as opposed to an outright failure.

b. Control Word CTL-O: routing and timing

The processor changes signal and timing routing within an ILS by means of control bits comprising control word CTL_O[11:0] and appearing at the edge connector of the module. The user has no direct control over these bits. In this application note, control words associated with particular ILS configurations are shown for reference only, to aid in understanding and troubleshooting.

The words are unique for each routing. To convert a given control word pertaining to failure on port 1 to a control word appropriate for failure on port 4 and vice versa, bits [3] and [4] must be interchanged.

Bits [5] and [6], shown in this document as **, select the source of transmit timing for all ports, as follows:

CTL_O[6,5] = 00	none
CTL_O[6,5] = 01	internal
CTL_O[6,5] = 10	external
CTL_O[6,5] = 11	recovered

In internal timing mode, the on-board 1.544MHz clock is distributed to all of 6 ports as transmit clock. Similarly, in external timing mode, external clock is distributed to all ports.

Note that while internal and external timing modes are possible for some special applications, they will not be used in practice, since common timing requires that all frames arriving at all ports are in sync. Instead, signals arriving at ILS receiver ports will almost always have at least a phase difference in clocks and a random alignment in framing. An ILS has no provisions for re-alignment of frames, and thus framing errors are likely to result.

Recovered timing mode is quite different. Timing signals follow data paths for a given configuration. For example, while an ILS is in primary mode, received data and recovered clock from port 5 is used for transmission out of port 1.

As a result, up to 6 different clocks could conceivably be utilized within an ILS module, as even at the same port the transmit and receive clocks need not be the same. Nevertheless, typically all clocks within an ILS are the same, except for phase shift and some jitter. This is due to the fact that a whole network is usually driven from the same master clock and the only differences are due to the different paths taken by the signals. However, frames at various ports of the ILS do not have any relation to each other.

4. Primary Mode

The system operates in primary mode when all paths connected to primary ILS ports (i.e., ports 1 and 4) are operational. In this mode, T1 signals are routed through primary ports while backup paths may be idle.

Principles, on which ILS is based, require that some particular difficulties be overcome. Special approaches are required to address the problem of clock recovery and frame buffering.

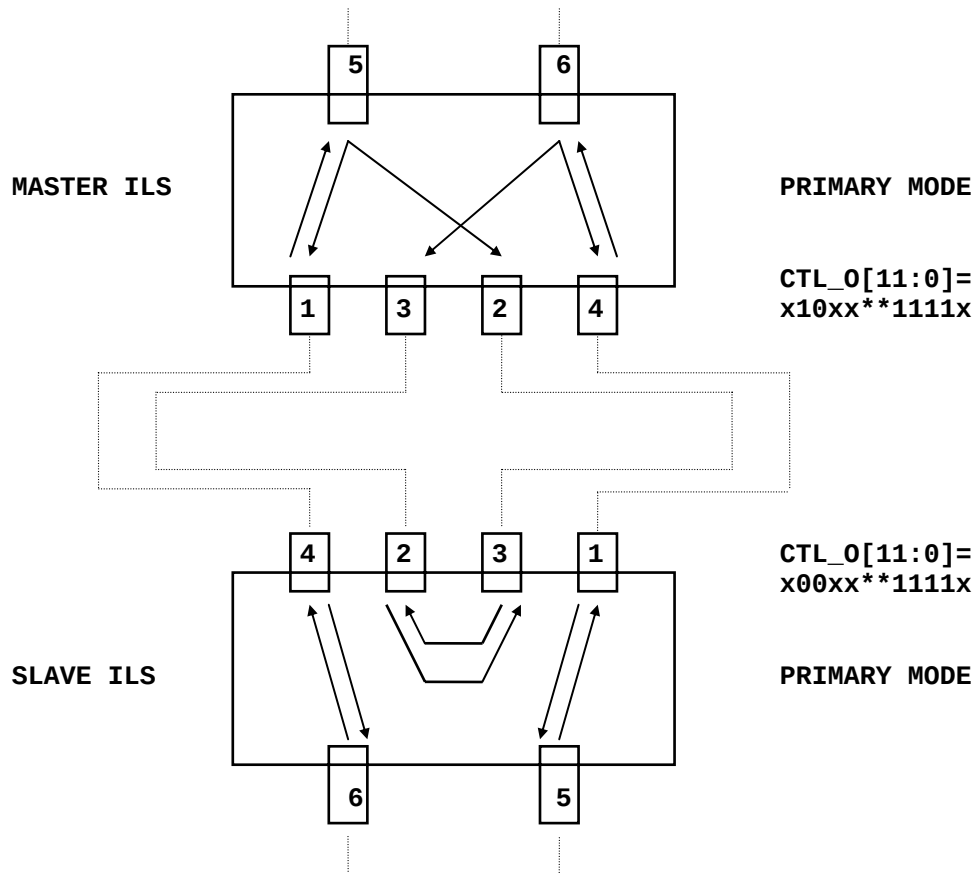


Figure 3.

An ILS system operating in primary mode: all primary paths functional.

a. Path initialization - 2-node ILS System.

When both nodes of a 2-node ILS-only system are in primary mode, the unused backup paths form a closed circuit, with no outside connections.

In a DACS module, all ports have a source of timing and frame sync signals. In an ILS, each port receives its timing and frame sync from the one port from which it routes its data. Therefore, only timing signals which are already present in the T1 stream can be passed on. If only ILS modules are present in a system, one of them must be able to initialize an idle backup circuit with some form of timing signals.

Primary routing configuration is depicted in Figure 3. When all primary ports are operational, both master and slave route T1 signals between ports 1 and 5 and between ports 4 and 6. If not forced, there would be nothing present on the backup paths. The framers on these ports would be badly out of sync, requiring long recovery times if suddenly called into duty.

To avoid that, backup paths must be initialized to keep framers locked into a T1 stream all the time. A **master** node accomplishes this task by transmitting timing and sync derived from local ports (i.e., 5 and 6) into backup ports 2 and 3. Also, in future versions, forced FDL may be driven into the backup paths.

A **slave** node retransmits all received data and timing into a backup path, i.e., routes the signals between ports 2 and 3, without any modifications.

A 2-node, ILS-only system must have one master and one slave node (in a combination DACS and ILS network, all ILS units must be set up as slaves).

Additionally, in order to provide proper signal density to keep framers in sync, it is required that the backup paths are set to B8ZS encoding mode. Primary paths can be set to AMI, as well.

b. Frame Buffering - Multi-node System

While ILS clock recovery requires the use of a timing master for backup paths, the principle of no frame buffering creates another problem.

When a network consists of 3 or more nodes, data flows over a closed-circuit path. For the system to remain framed, a frame leaving a particular node must arrive in a perfectly aligned time instance after completing the circle.

In an ILS-only system, a circular path requires a fixed time for the data to travel. This time consists of path delay and of propagation through nodes. Only due to great luck would this time be a multiple of frame length, thus allowing frame alignment by itself. In real-life situations, however, a means must be provided to buffer the signals in order to achieve the alignment. Since ILS uses no on-board storage to buffer data frames, a DACS is required.

Also, a master ILS effectively breaks the backup path through ports 2 and 3, since it provides its own timing and idle data. If a break occurred elsewhere in the system, a master would have no way of knowing about it and would not be able to release these ports for backup duty. This is yet another reason for the requirement of a DACS on a 3-node or larger system.

Therefore, it is a rule that at least one DACS is necessary in a system consisting of 3 or more nodes. This DACS should be programmed with maps emulating the routing of an ILS. It should mimic the slave mode of ILS, i.e., retransmitting in primary mode all signals between ports 2 and 3.

Since a DACS provides forced timing into backup ports, it behaves like an ILS master, resolving the issues of "priming" the backups with idle timing. Therefore, when a DACS is present, all ILS modules in the network should be set as slaves.

5. Backup Mode

a. Healing a Failed Path

The DACS/ILS Processor continuously monitors the quality of communication paths attached to ports 1, 2, 3 and 4 on the ILS module.

If a problem on port 1 or 4 is detected, satisfying criteria set by configuration parameters and if at the same time no problem is observed on corresponding backup port 2 or 3, the processor will force the signal to be routed from primary into backup port.

An ILS system can respond to only one failure at a time, i.e., only either port 1 or port 4 can be rerouted to its respective backup. If the system is already in backup mode, no action can be taken to accommodate failure on the remaining primary port.

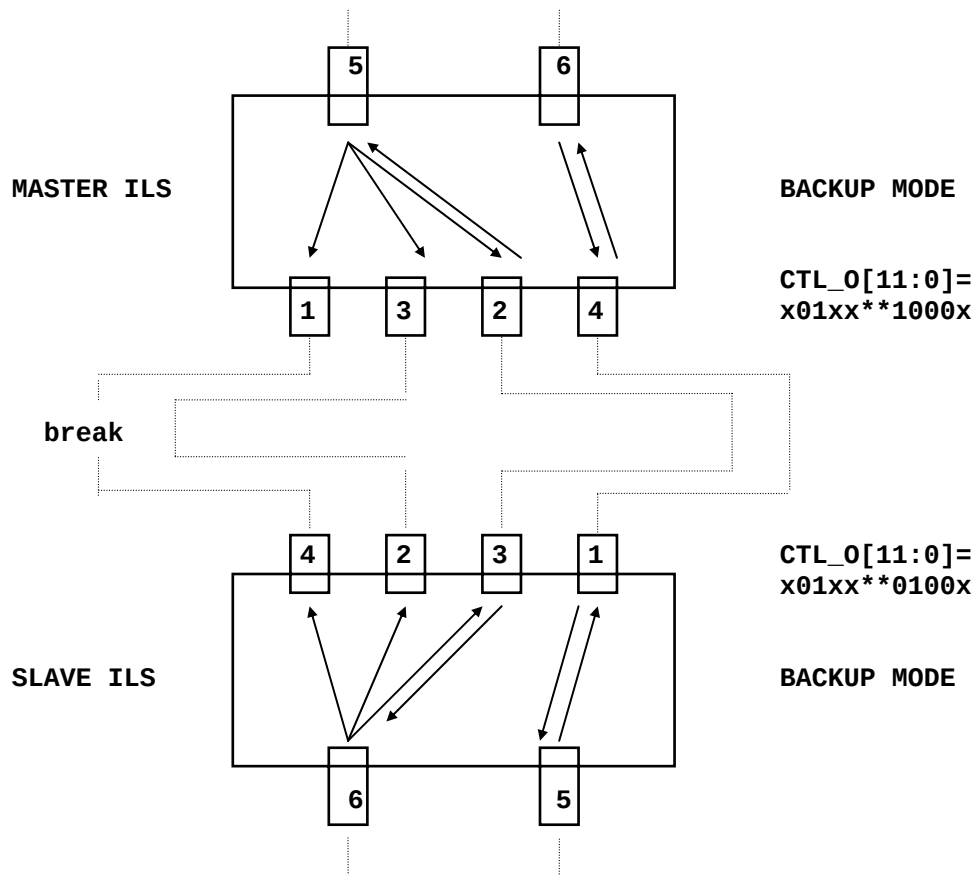


Figure 4.

Two ILS modules in backup configurations.

This situation is represented in Figure 4, where a hypothetical failure at port 1 of Master is depicted. Note that in backup (alternate) routing, when failure of one of primary ports is acted upon, both nodes behave identically, routing signals to heal the network. No idle data or forced FDL is driven onto any of the paths. Therefore, the nodes are referred to as Master and Slave for identification only.

Master and Slave will differentiate only after the primary paths are re-established and the restoration process is completed. Up to that point, all operating characteristics pertain to both units at the same time.

The switch from primary to backup mode occurs as soon as a path failure is detected by each of the affected nodes. There are no intermediate stages in the switch-over process, which takes several hundreds of microseconds. Communication will be established over the backup paths as soon as the framer synchronization process is completed. This takes as little as 3ms when fast reframing is enabled or several tens of milliseconds when it is disabled.

Often, there are multiple brief disturbances in communications as the fault and subsequent change of framing propagates through the system.

The DACS/ILS system by itself is not aware of fast reframing, but rather it simply passes the data regardless of position in frame. The CM3B common modules within drop-and-inserts or terminals in the system perform the fast synchronization. However, the Processor may use the fast reframe sync status to determine quality of communication paths, when enabled by the EFLOF parameter.

In a multi-node system, a DACS is used in place of a Master ILS. While most of the description of the Backup mode pertains to such situation as well, there are some peculiarities. Refer to section 7., *Combination DACS/ILS Systems*, for more details.

b. Restoral Process

- **Master Just Detected Good Signal**

While in backup mode, affected nodes monitor the state of the failed primary by periodically sending an AIS signal. Reception of AIS of sufficient duration indicates that primary paths are repaired.

The detection of restored primary is rather slow, since AIS recognition takes a long time, on the order of frame lengths.

In our hypothetical situation, master node just detected that the primary path is re-established. The involved principles hold also true if the slave is faster, since in backup modes there is no difference between master and slave. Throughout this note, master will be assumed to be first, strictly for convenience.

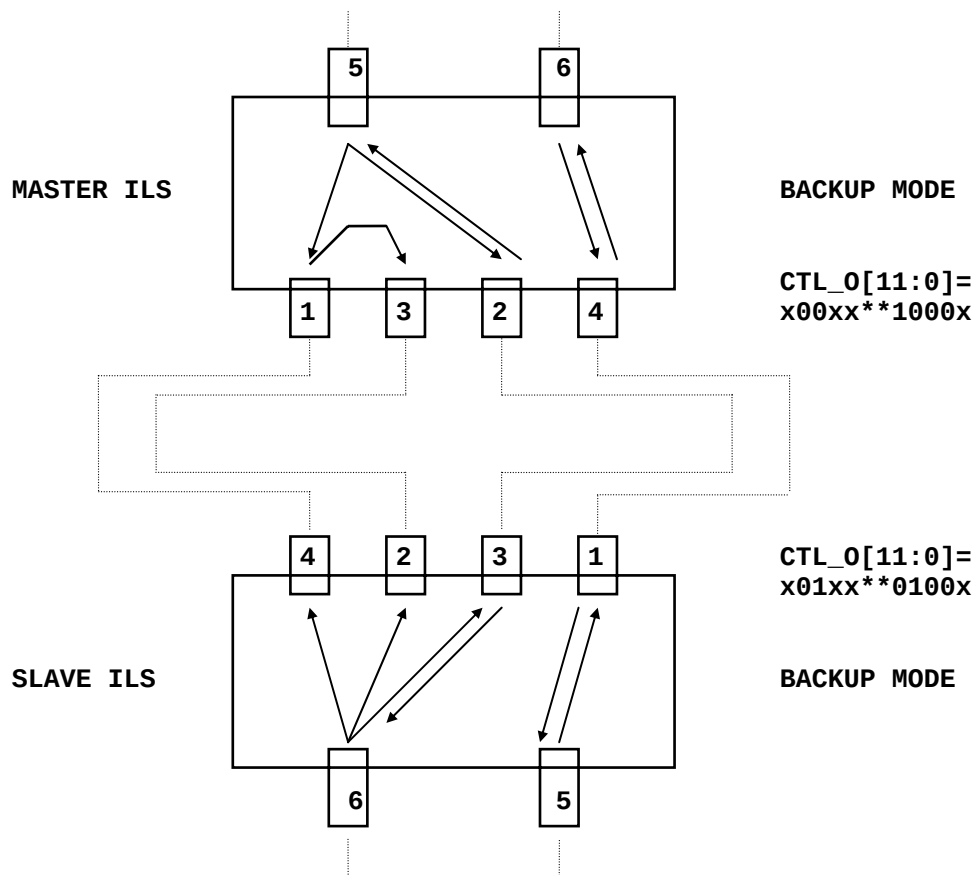


Figure 5.

2-node ILS system in backup mode: one of the nodes just detected good primary.

In Figure 5, the faster node instantly reconfigures itself in preparation for the restoral process. The actual transmission over backup paths (port 2 of master) is not affected at this instance, however port 3 is beginning to source its signals from the primary port 1 rather than from local port 5.

- **Opposite Node Just Detected Good Signal**

Both nodes monitor failed primaries independently. In situation depicted in Figure 6., the other node caught up: recognized good signal and instantly reconfigured its routings in preparation for the restoral process.

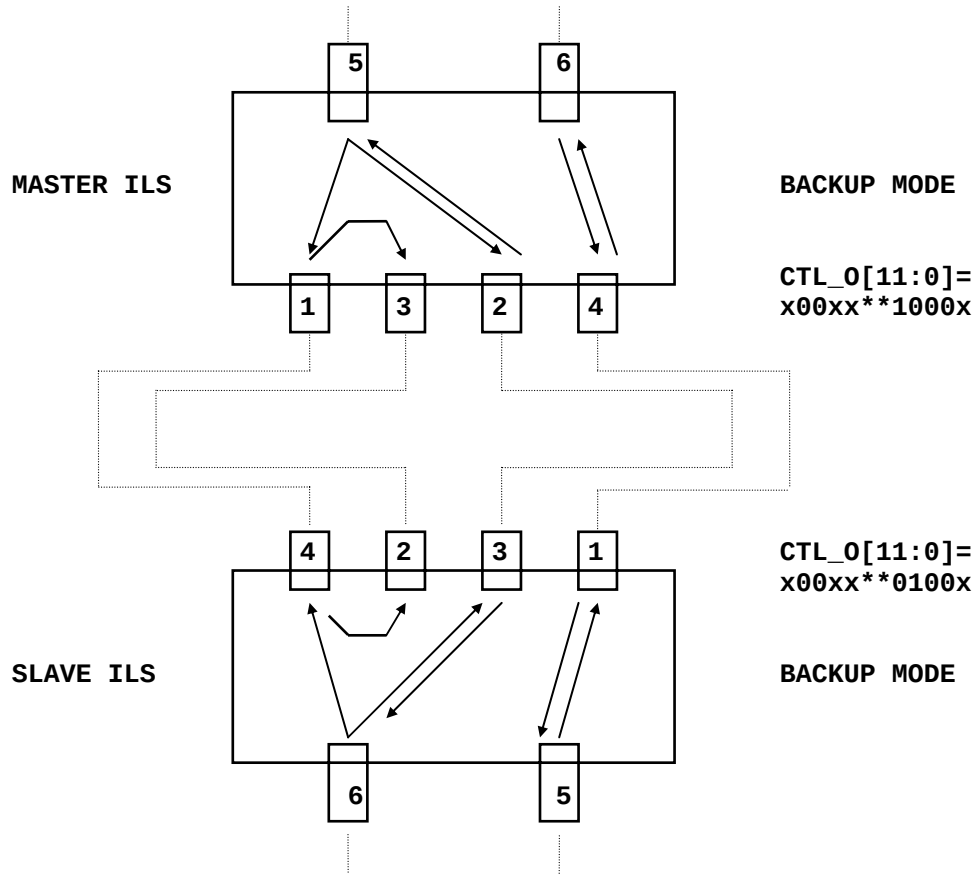


Figure 6.

2-node ILS system in backup mode: both nodes detected restored primaries.

At this point, the communication through backup pathways is still not disturbed. Both nodes are preparing for the restoral process. They are allowing the system to recover, waiting for a period of time determined by the REC parameter. This delay is on the order of seconds.

- **One Node Restores First**

After expiration of the REC delay, the faster node will switch into primary mode. The other node remains in backup configuration.

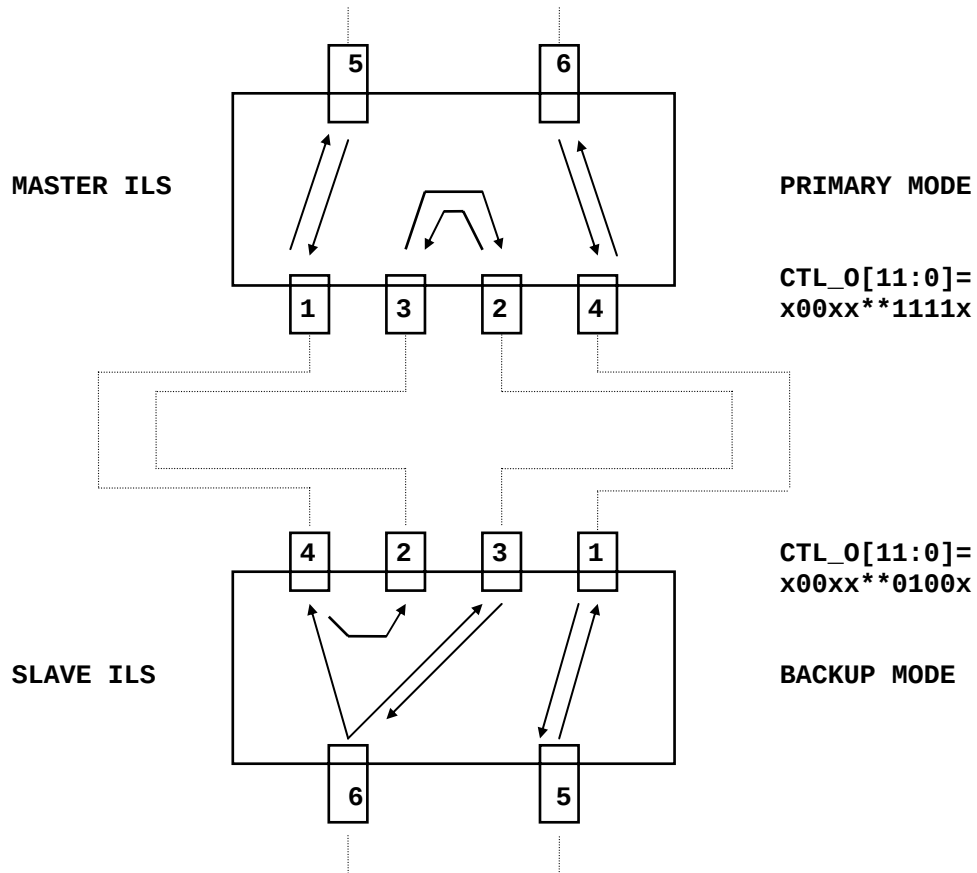


Figure 7.

2-node ILS system: one node restored into primary.

In Figure 7., it is the master ILS that switched first into primary mode. However, this node is still in slave configuration, routing signals between ports 2 and 3. As mentioned previously, all nodes remain in slave modes until the whole restoral process is completed.

The particular routing scheme which was achieved during the preparatory phase allows the data to maintain a continuous flow. In the example above, data from slave port 6 to master port 5 proceeds in a straightforward manner through the re-established primary. However, in the opposite direction, signals flow as follows:

```

master, port 5 -> master, port 1
slave, port 4 -> slave, port 2
master, port 3 -> master, port 2
slave, port 3 -> slave, port 6

```

Although this appears rather circuitous, this arrangement allows path continuity. Otherwise, if a straight switch-over was attempted directly from the steady-state backup into steady-state primary, signal paths would be interrupted. There would be no communication from the moment when faster node switched back into primary until the second node caught up - which could take several tens of milliseconds, proceeded by lengthy periods of framing losses.

Obviously, this scheme is possible only in a 4-pathway arrangement, i.e., where all 4 ports of DACS or ILS are connected to a communication route. If there is no backup available for the opposite primary port (for example, if there is no link present at port 2 when restoring failure of port 4), continuous signal path on restoral will not be maintained.

- **Opposite Node Restores**

At this moment, the slower node switches into primary mode. Again, both nodes are still operating as slaves.

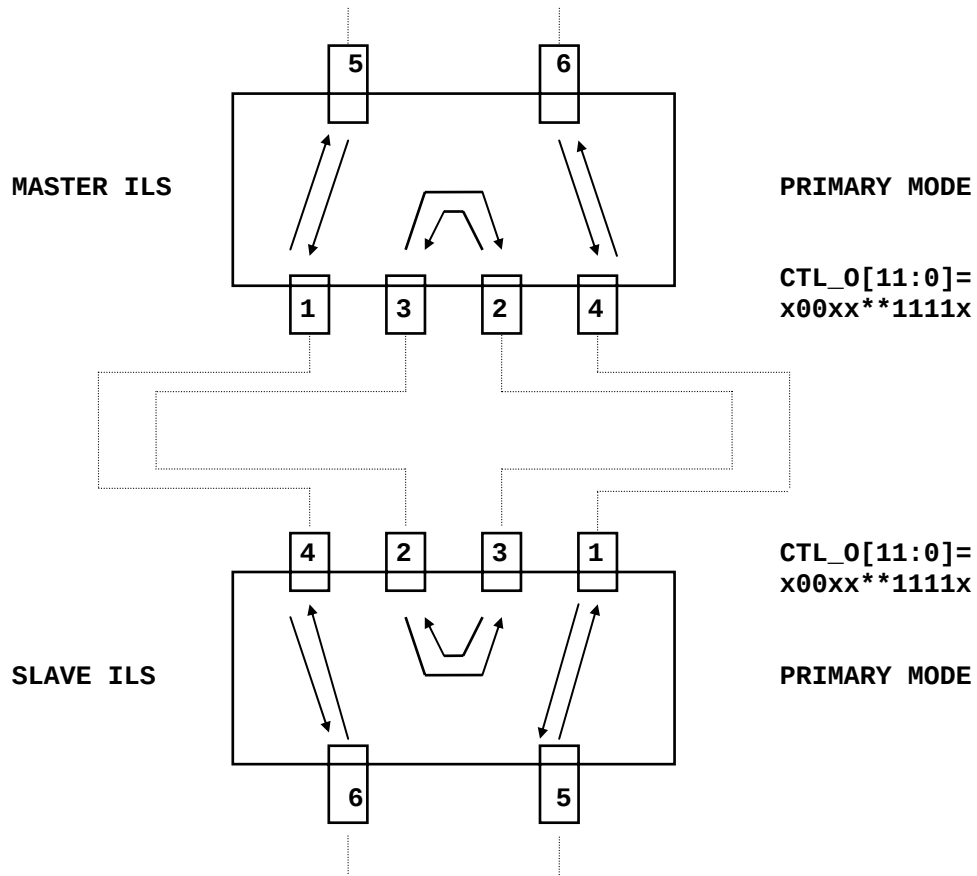


Figure 8.

2-node ILS system: both nodes restored, still in slave modes.

From this instance on, signals flow in both directions through the primary paths. The dual disturbance due to both nodes restoring propagates throughout the system, causing re-synchronization of frames.

Backup paths have no signals present in them, which causes the front panel LED to flash indicating errors on ports 2 and 3.

- **Restoral Completes**

After switching back into primary paths, both nodes wait for the system to stabilize. After about 5 seconds, master node finally returns to master configuration. This primes the backup paths with timing (as indicated by port 2 and 3 LED's lit steady).

Steady-state primary routing is achieved at this point.

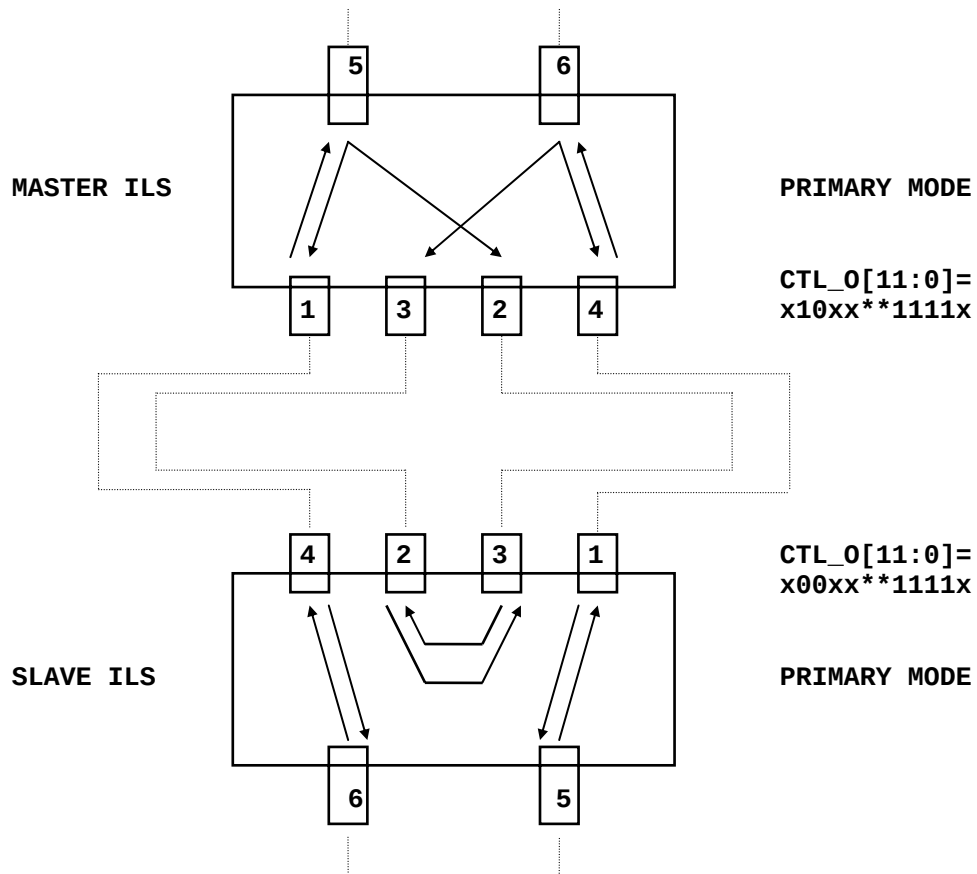


Figure 9.

2-node ILS system: restored into steady state primary mode.

Only from this moment on does the master and the primary node differentiate.

6. Hot Standby Systems.

In some system configurations, only 2 paths are used between 2 nodes. One of these paths is the primary communication link, the other the backup. No other paths exist in addition to these and thus no ring exists. This is referred to as the hot standby configuration.

If an ILS is used in a hot standby, it has to be set to the HOT mode. A DACS requires mapping that emulates the routing of an ILS in this mode.

Unlike in a ring system, hot standby does not require some of the units to provide master timing. Instead, all nodes are equivalent, whether they contain a DACS or an ILS.

Figure 10. shows an ILS-based hot standby system operating in a primary mode. All data paths and timing routing would be the same if a DACS was used.

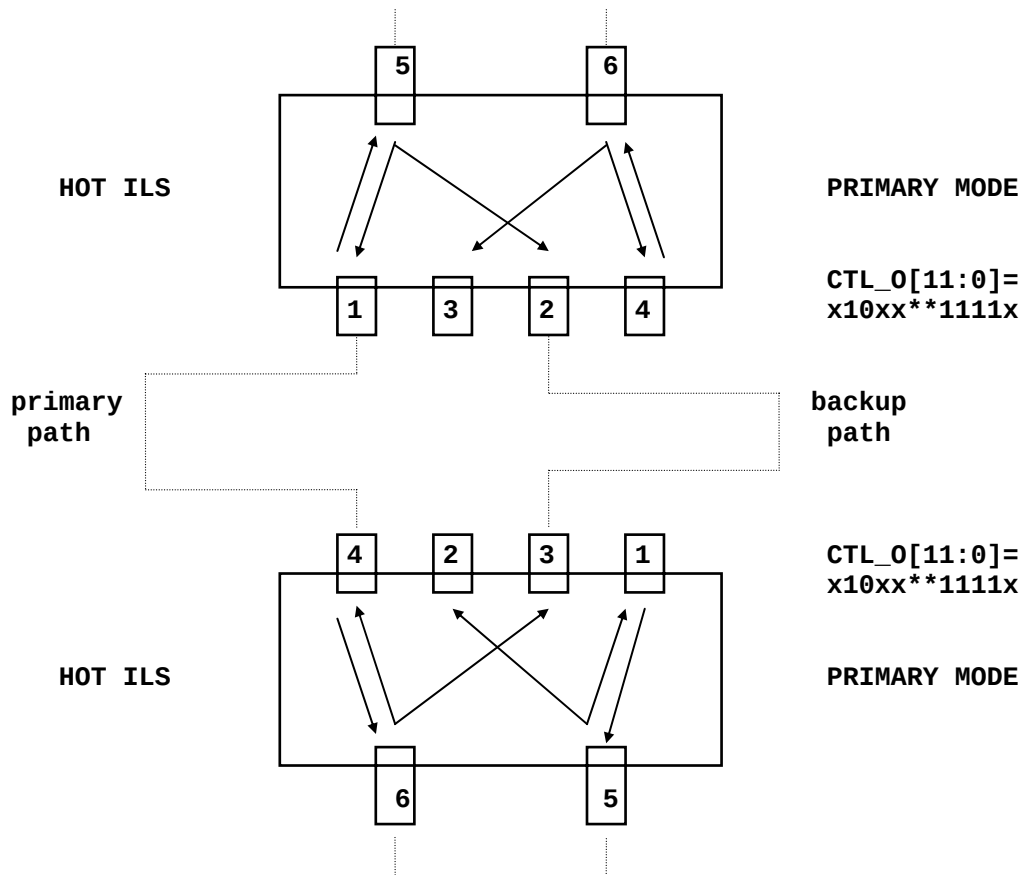


Figure 10.

2-node ILS hot-standby system: both nodes in primary mode.

Note that it does not matter whether the port pair 1 and 2 or pair 4 and 3 is used; hot standby mode is symmetrical. However, unused ports have to be disabled by setting the appropriate USEx=OFF (where x is 1 or 4).

Hot standby resembles somewhat master mode. When an ILS is configured as a master, the recovered timing from the local ports (5 and 6) is used to drive the backup ports (2 and 3). Using this timing, backup ports are transmitting an idle data pattern and a watchdog FDL stream onto the backup paths.

In hot standby, however, not only timing but also data received by the local ports (5 and 6) is used to drive the backup ports (2 and 3). As a result, the same T1 signals are transmitted from the primary and from the backup ports. Any equipment on the other end of the T1 line will receive the same signal whether it is connected to the primary or to the backup path.

a. Healing a Failed Path, Hot Standby Mode

As in the other operational modes, the DACS/ILS Processor continuously monitors the quality of communication paths attached to ports 1, 2, 3 and 4 of the ILS module.

In hot standby (as in other configurations), unused ports must be disabled by setting USE_x=OFF. This prevents the processor from monitoring the primary port *x* (1 or 4) and its associated backup port (2 or 3)

If a problem on port 1 or 4 is detected, satisfying criteria set by configuration parameters and if at the same time no problem is observed on corresponding backup port 2 or 3, the processor will force the signal to be routed from primary into backup port.

An ILS system can respond to only one failure at a time, i.e., only either port 1 or port 4 can be rerouted to its respective backup. If the system is already in backup mode, no action can be taken to accommodate failure on the remaining primary port.

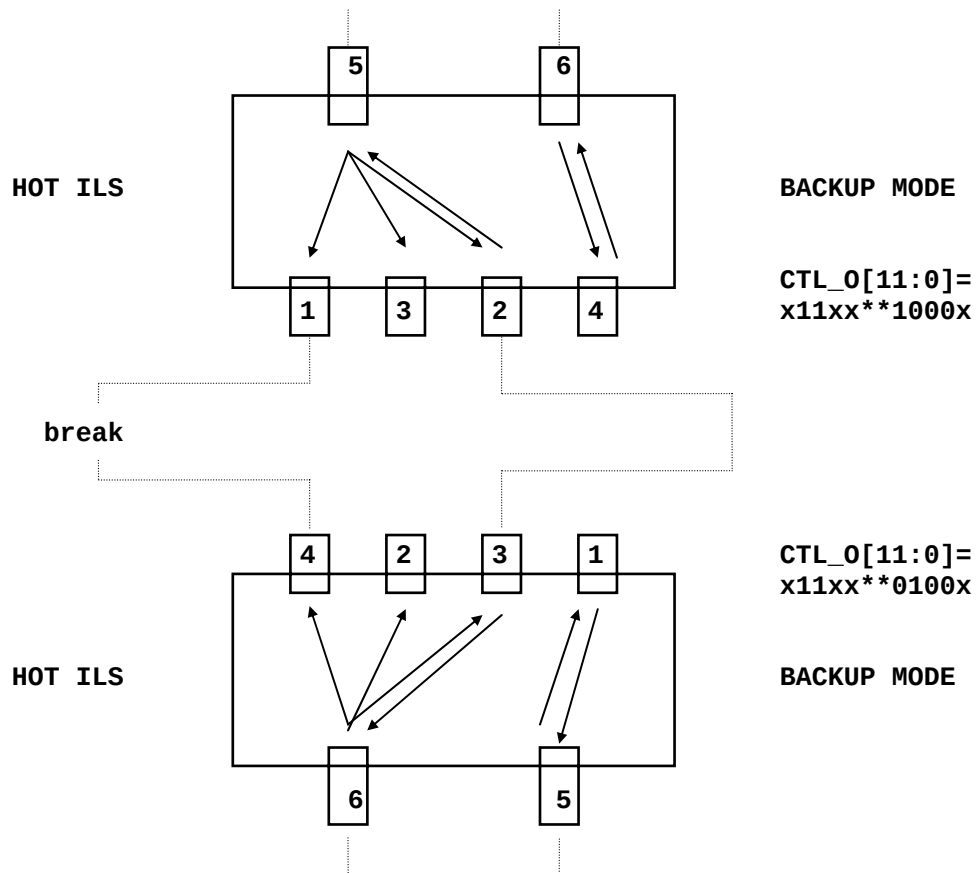


Figure 11.

2-node ILS hot-standby system: both nodes in backup mode.

A hypothetical failure at port 1 of one of the ILS modules is depicted In Figure 11. In this mode, the ILS still transmits data from all ports, but receives from the backup.

The switch from primary to backup mode occurs as soon as a path failure is detected by each of the affected nodes. There are no intermediate stages in the switch-over process, which takes several hundreds of microseconds. Communication will be established over the backup paths as soon as the framer synchronization process is completed.

While healing a failure on a multi-node system in hot standby configuration, signals are routed into the backup path only between the two affected nodes. This is unlike a “normal” system utilizing ring configuration, where the backup signals are routed in the opposite direction of the ring and are passing through all unaffected nodes.

As a result, a hot standby system can only heal a break of one of the paths between the affected nodes - the other one must stay intact. In a ring configuration, the system will heal a failure on all paths between the affected nodes.

Therefore, in a hot standby system, care must be taken to route the primary and backup paths between the same nodes separately, so that they cannot be disabled simultaneously.

As mentioned previously, for hot standby applications the system may consist of any combination of ILS and DACS modules. DACS must contain mapping which emulates ILS in hot standby. _

b. Restoral Process

• Nodes Just Detected Good Signal

While in backup mode, affected nodes monitor the state of the failed primary by periodically sending an AIS signal. Reception of AIS of sufficient duration indicates that primary paths are repaired.

In our hypothetical situation, the one of the nodes and then the other just detected that the primary path is re-established. Both nodes switched to the intermediate stage, which is included in this sequence only for compatibility with other modes. This intermediate stage is functionally identical to the backup mode (for affected port and its backup). It does not matter which node is faster - to an external observer both nodes still behave the same way as in steady-state backup mode.

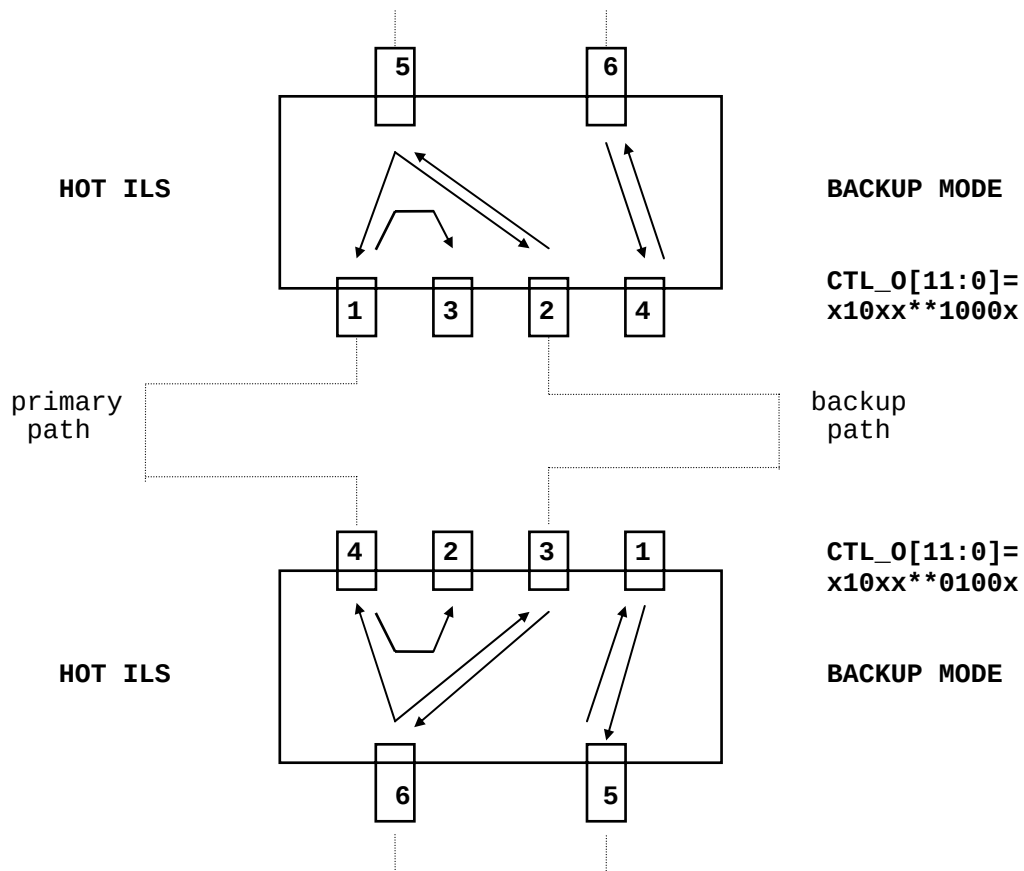


Figure 12.

2-node ILS hot-standby system: both nodes prepare for restoral.

- **One Node Restores First**

After expiration of the REC delay, the faster node will switch into primary node. The other node remains in backup configuration.

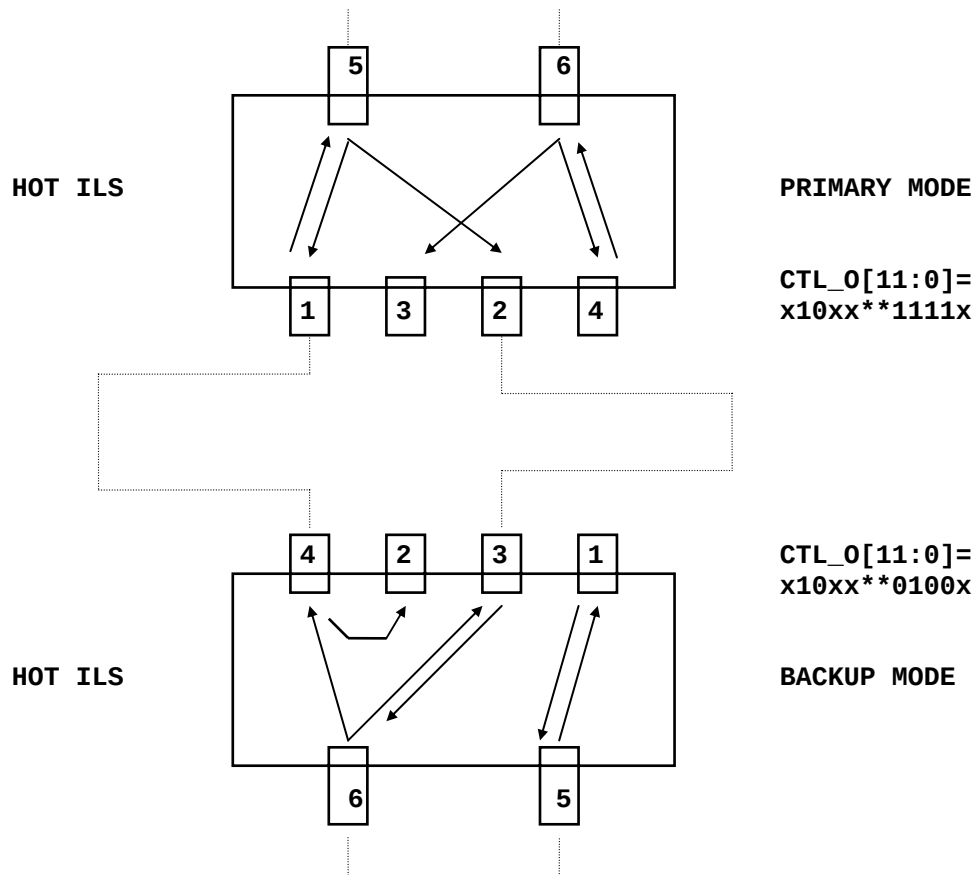


Figure 13.

2-node ILS system: one node restored into primary.

In Figure 13. the upper ILS switched first. It is now configured as a steady-state hot standby in primary mode.

Data is still being transmitted into both primary and backup paths. The upper node receives from the primary path, while the lower node receives from the backup. As a result, there is no interruption of communication even though the lower node did not switch yet.

- **Opposite Node Restores - Restoral Completes**

After expiration of its REC delay, the slower node also switches into primary mode.

Steady-state primary routing is achieved at this point.

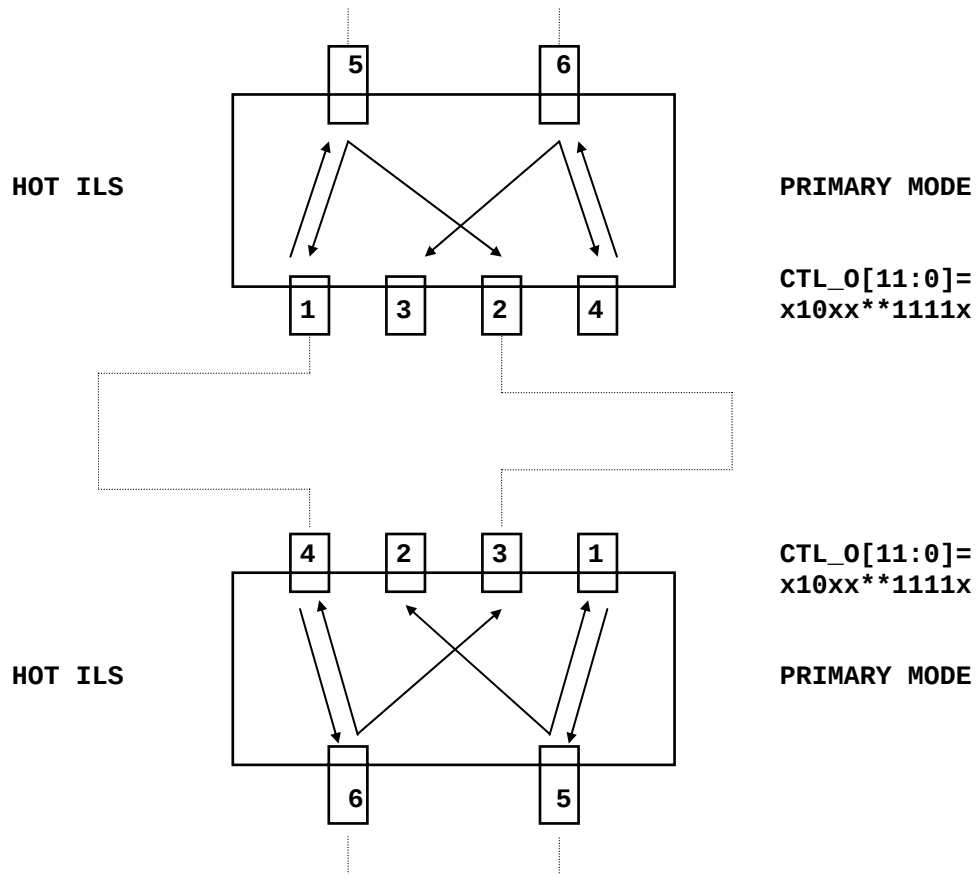


Figure 14.

2-node ILS system: restored into steady state primary mode.

7. Combination DACS/ILS Systems

If a DACS is used with an ILS (which is optional with 2 nodes and required on larger systems), the signal routing is somewhat different from that described previously. Although a DACS behaves very much like a master ILS, its backup routing differs.

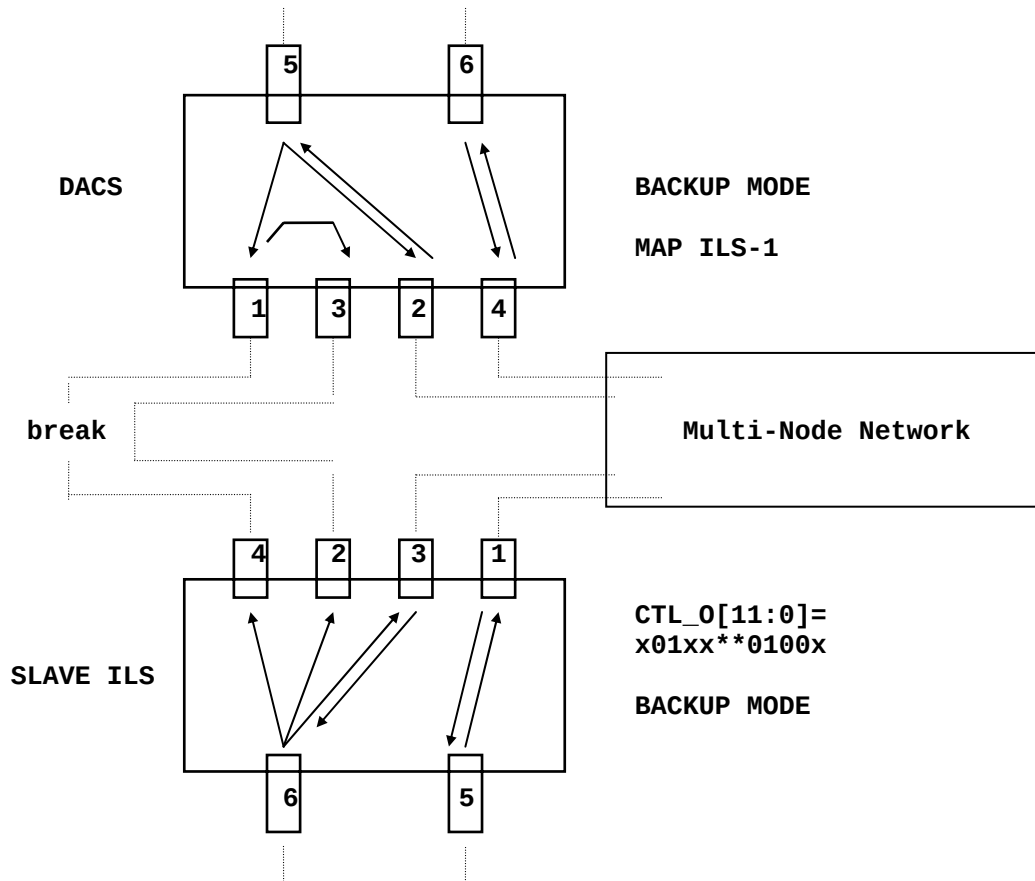


Figure 15.

Multi-node system utilizing a DACS module.

Figure 15. depicts a break at the DACS node of a multi-node system. In steady-state break healing mode, DACS already has the signal routing between failed port and backup of opposite primary, which will allow at a later time to restore without interruptions.

In this situation, as long as there is nothing received at DACS port 1, there is nothing transmitted out of DACS port 3 and therefore nothing received at ILS port 2. As a result, this and all other ILS modules in the network will indicate problems with the backup communication path even though in reality it is intact. This is a normal behavior of a multi-node system consisting of DACS and ILS modules and it is the only difference between such system and one described previously.

Once the broken communication path is re-established, the restoral process proceeds along identical steps and with the same behavior as a 2-node ILS-only system.

8. Reverting on Loss of Master

The principle of no frame buffering, on which an ILS system is based, creates one more particular problem. As mentioned previously, in a 3-node or larger system, a DACS is required in order to provide the buffering for circular data paths and to serve as a master for path timing.

However, if a DACS node fails, there is again no facility available to buffer the frames unless another DACS node is present elsewhere. When the remaining network consists of only slave ILS nodes, a ring topology cannot be maintained.

Each ILS and each data path has a fixed propagation delay. All these delays add up to a closed-circuit delay around the ring, which is unlikely to be a multiple of a frame length. As a frame travels around the ring, it will have to be periodically cut and re-aligned to fit into the closed-circuit time. Slave-ILS-only ring operation would result in constant framing errors due to lack of buffering on ILS.

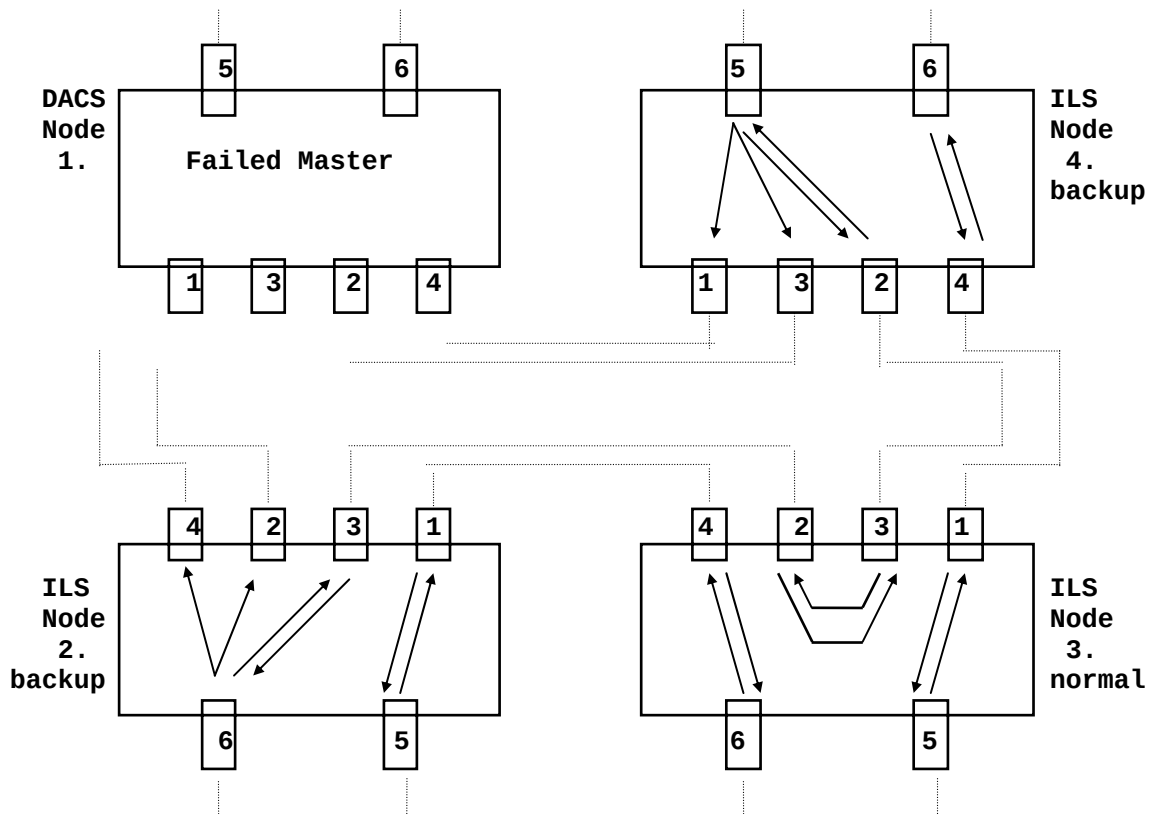


Figure 16.

4-node ILS system immediately after failure of master (DACS) node

Figure 10. depicts an example 4-node system, immediately after master node 1. has experienced a failure. The two affected neighbors, nodes 2. and 4., have detected a problem on their communication paths linking them with node 1. Initially, both affected nodes switched into backup (alternate) routing to heal the failure - which created an ILS-only ring.

To allow continuing operation of the remaining section of the ring, at least one of the ILS modules must fall back into primary configuration. This will break the ring open into a linear topology, which can handle the fixed data propagation delay through the ILS modules.

Each ILS unit, after switching into a backup routing following port failure, waits for a time determined by the HEAL parameter and then checks whether the system is operational. If the communication path is healed properly, Loss-of-Sync (LOS) flag should be reset or appear very infrequently.

However, if an ILS-only ring is created due to loss of a master, a series of LOS pulses is present, as the framer chips continuously re-align themselves. If density of these pulses exceeds the value set by the RATIO parameter, the processor assumes that a master is lost and therefore reverts back to normal routing. The ILS will then remain in normal routing configuration until all ports recover fully. At that point, the processor will again start monitoring ports for signs of failure and will switch routings accordingly.

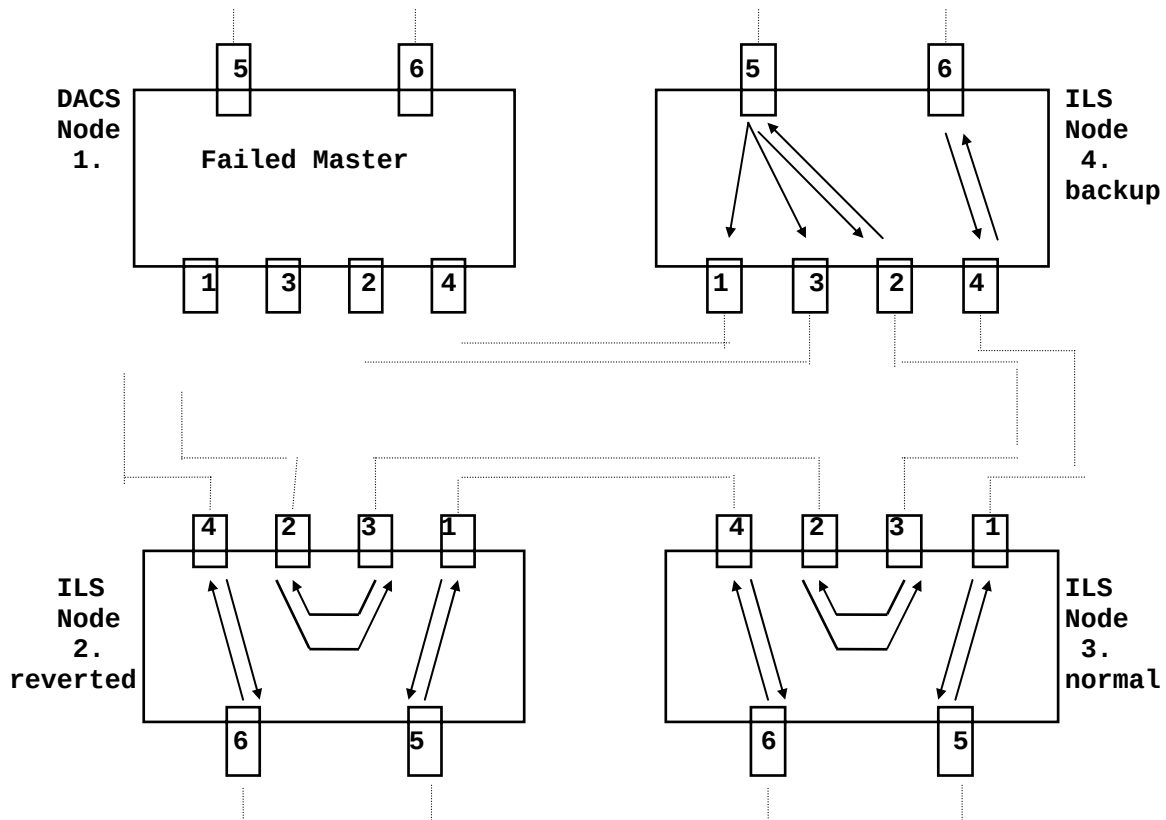


Figure 17.

4-node ILS system with a failed master (DACS) node after one ILS reverted to normal.

In the example 4-node system, framing errors continued after expiration of the HEAL time. One of the switched nodes decided first that a circular system existed without a master and thus reverted back to normal (primary) routing. In Figure 17., it is assumed that Node 2. is the one that reverted to primary.

At that point, the ring breaks into a linear system. Framing errors cease and node 4. will remain switched into backup.

Communication is still maintained between all operating nodes. In this example, data arriving at node 2., port 5, will proceed as follows:

node 2., port 5	->	node 2., port 1
node 3., port 4	->	node 3., port 6
node 3., port 5	->	node 3., port 1
node 4., port 4	->	node 4., port 6
node 4., port 5	->	node 4., port 2
node 3., port 3	->	node 3., port 2
node 2., port 3	->	node 2., port 2

and thus will pass by all drop-and-inserts attached to local ports 5 and 6 in the remaining chain.

Obviously, in order for this scheme to succeed, the terminal ends of the system ("head" and "tail") must be connected to the master node. All ILS nodes require drop-and-inserts to complete the loop.

Both HEAL and RATIO parameters are hard-coded into the ILS firmware and are currently set to 300ms and 15%, correspondingly. The user cannot access or change these values.

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RFL Electronics, Inc.

DACS / ILS Application Note 05.

Rev. 08.14.1996 rdw

IMUX 2000

DACS

CLOCK SELECTION

The DACS module of the RFL IMUX 2000 system can be configured to utilize various sources for its internal system clock.

The system clock drives the internal DS0 grooming process and serves as the T1 transmit clock. External clock and/or any of the 6 ports and/or the internal oscillator can serve as a clock source. One or two sources can be selected.

When using the SCL commands or RFL Network Management System, the following choices are available:

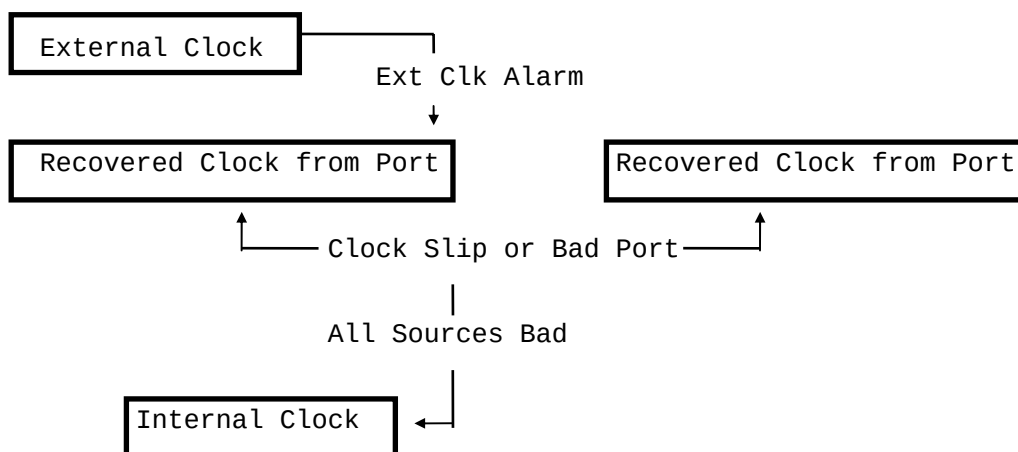
CLOCK values: [primary],[alternate] **DACS primary and alternate clock source**
 where [primary] or [alternate] = [1..6], [M1..M6], INT, EXT, NONE

SCL example: **node:dacs:set:clock=ext,4;**
 selects external clock to drive the system, with clock recovered from port 4 as the alternate.

CLOCK HIERARCHY.

Internal clock, even if not selected directly on the command line, will be used if none of the selected clock sources are available.

External clock, if present and if enabled by CLOCK parameter, takes precedence over any other sources. This means that regardless of any other sources, the DACS processor will attempt to switch into the external source.



Clock source hierarchy.

If a problem is detected at the current source of clock, DACS will use the alternate source. If the problem clears, DACS will not attempt to switch back unless there is a problem with the alternate.

If clock slippage is detected, the processor will switch between port sources specified in CLOCK parameter.

If the current source is external and it is specified in CLOCK, the above does not apply. DACS will never attempt to switch out of external and will ignore any slips between external and other clocks.

CLOCK SWITCH SEQUENCE.

The clock switching circuit has been carefully designed to provide a smooth transition between the sources. The source cannot be switched at a random instance, since this would result in a distorted clock "tick" and possibly in an extra clock pulse, thus disturbing the data flow throughout the whole network. Such a disturbance could have quite serious consequences.

When a source switch is attempted, the selector circuit waits until the currently used clock "slides" past the new, requested clock until both clocks coincide at the same edge. Then, and only then, the new clock will seamlessly take over.

There are only 2 exceptions to this rule. Clocks are set up asynchronously during the power-up initialization sequence, for obvious reasons. Also, if the external clock fails while it is being used, the system will be forced to the alternate selection or to the internal oscillator at once, since the alternate cannot "slide" smoothly past a non-existent external clock. However, if the external clock is re-established, the system will wait until the external clock precisely aligns with the currently used clock before it switches back to external.

The requirement that sources must coincide in order to switch clocks results in the fact the DACS may not necessarily switch to clock specified in the clock parameter, if that is identical to the one currently used.

For example, consider a situation where a DACS is being set by a user to **clock=4;**, while it is currently using port 1 for its source. If the clocks recovered from ports 4 and 1 are identical to the point where their edges do not move past each other, the DACS will continue using port 1. Only a slip of these clocks past each other will result in the switch of sources.

The actual sequence of switching proceeds as follows:

- One of the clocks specified in the CLOCK parameter is used as the current system clock. The clock from the other source, if specified, is compared against the currently used clock in order to detect any slips.
- If the currently used clock is recovered from a port, and that port fails, the processor attempts to switch to the other source (or internal, if no other is specified). DACS waits for the now free-running recovered clock to slide past the requested clock and at that instance smoothly transitions into it. After the failed port is restored, the processor will use that port's clock for slippage reference, but will not switch back until another problem occurs.

- As mentioned above, if the currently used clock is external and it fails, the DACS abruptly forces its system clock to be sourced from the alternate source (or internal). After the failed external source is restored, the processor will attempt to switch back. That switch will occur only when the currently used clock slips past the external, in order to assure a smooth transition.
- If the currently used and the alternate clocks are recovered from ports (rather than external/internal), and 2 consecutive slips in the same direction between these clocks are detected without a failure of the associated ports, the processor determines that a fault occurred elsewhere in the network and attempts to switch to the other source. DACS waits until the currently used clock slides past the requested alternate clock and smoothly transitions into it. As the network re-arranges the clocks in response to a fault, several back-and-forth clock swaps may occur until everything settles.

ALTERNATE MASTER.

The **M** qualifier is used to compensate for the loss of master timing node in the system by setting up a secondary master.

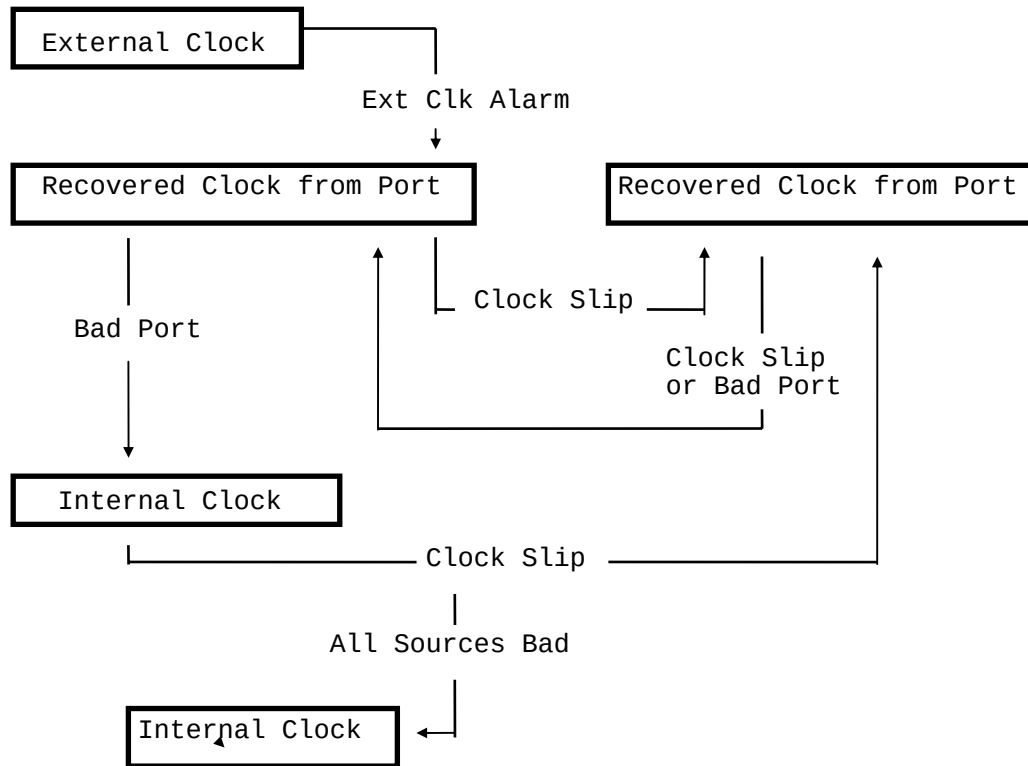
In the next node “downstream” after the master, the port facing the master should be denoted as **M**. For example, if port 1 in next node after master is facing the master, the following command may be issued:

node:dacs:set:clock=M1,4;

Such command results in following sequence of events:

- If a failure is detected at port 1, the clock is first sourced from internal oscillator, regardless of what the other alternate source is. The processor will monitor the alternate source for clock slippage.
- If no slip is present, the processor assumes that its own clock propagated through the system. This indicates that master node is lost. The processor will remain in internal timing, assuming the function of a secondary master, until clock slip occurs.
- If clock slip occurs, then the processor knows that another source of timing is present in the system. DACS will switch to the alternate source specified in **CLOCK** parameter.

Note that only a port and only one port can be selected as **M**.



Clock source hierarchy for secondary master.

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RFL Electronics, Inc.

IMUX Application Note 06.

Rev. 02.27.1997 rdw

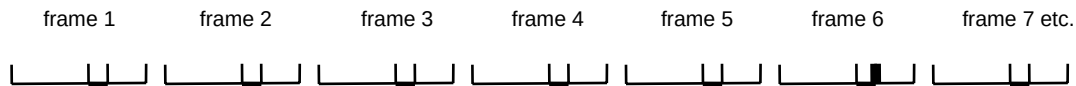
IMUX 2000

Robbed-Bit Signaling and Network Disturbances

RBS Principle.

T1 systems employ Robbed Bit Signaling (RBS) as a method of transmitting signaling information - such as off-hook and ring-down.

The principle of this method lies in substituting the least-significant bit of the timeslot with a bit carrying the signal information. This substitution occurs only every sixth frame, so that 5 out of 6 times the timeslot contains complete, unmodified, 8 bits of data. Correspondingly, 1 out of 6 times, the timeslot has a maximum of 1 bit distortion.



For example, the figure above shows the beginning frames of a superframe. A sample timeslot is highlighted. Frames 1 through 5 carry full 8 bits of data, while frame 6 contains a substituted signaling bit.

The substitution within the timeslot repeats every 6 frames, i.e., every 750us. A different signaling bit can be inserted at each instance. For example, within a 24-frame superframe, 4 different signaling bits denoting 4 different functions can be inserted. This occurs in frames 6, 12, 18 and 24, correspondingly. This process repeats every superframe so that each of the specific signals is transmitted every 3ms if extended superframe format is used.

On the receiving side, the receiver channel card synchronizes itself to the received T1 superframe structure. Once the card is able to determine which is frame 6, 12, etc., it can interpret the least significant bits in the received timeslot of these frames as the signaling bits.

If the multi-frame synchronization is not established, a channel card may erroneously use actual data bits instead of signaling bits.

Frame Sync During Network Disturbances.

In an RFL IMUX 2000 network containing Mini-DACS or ILS nodes, multi-frame synchronization is maintained throughout the system during normal operation. During network disturbance, such as when switching to heal a broken link or to recover a repaired one, loss of multi-frame sync may occur. If that happens, it will take several multiframes for the framer circuits to regain timing. Typically, the superframe structure is recovered from the received T1 stream about 20ms after loss of sync.

RBS During Network Disturbances.

As long as multi-frame synchronization is not re-established, the embedded robbed bits are not properly intercepted by the receiver channel cards. Signaling bits are interpreted as data and data as signaling. The audible symptom of such situation is the chattering of the E&M relays on telephone channel cards.

Only after the framer regains multi-frame sync, will the robbed bits be properly aligned.

Fast Reframe.

RFL Electronics developed a proprietary method of maintaining and regaining synchronization. Called Fast Reframe, this method will take over if the T1 framers lose sync or if there are errors in data. Fast Reframe will force synchronization on a single-frame basis by detecting the position of time slot 24.

Single-frame sync will allow channel data to flow with minimal interruption. Fast Reframe can capture a T1 signal in less than 500us after this signal is regained. Fast Reframe will cede control to the framers once they regain their synchronization.

Because signaling is based on the multi-frame alignment, it will not work properly until the framers are fully in sync, even though channel data may be passing through due to Fast Reframe.

Fast Reframe only speeds up the capture of timeslot data, but has no effect on signaling.

Mapping and Enabling RBS.

A Mini-DACS is passing and mapping RBS by extracting the information from incoming T1 stream, distributing signaling to proper outputs and regenerating the superframes.

If the multi-frame sync is lost, RBS would be inserted into random locations, confusing the whole system. To avoid this, the Mini-DACS turns off Robbed Bit Signaling following a switch or other major disturbances. Only after a safety period (currently 500ms) which allows the whole system to settle, is RBS turned on again.

Configuration guidelines.

To minimize the effect of disturbances on signaling, the following precautions should be taken:

- channels which do not use signaling should have RBS disabled.
- within a Mini-DACS, only those timeslots that actually use signaling should have RBS mapped and enabled. Other timeslots should have RBS disabled.

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IMUX 2000

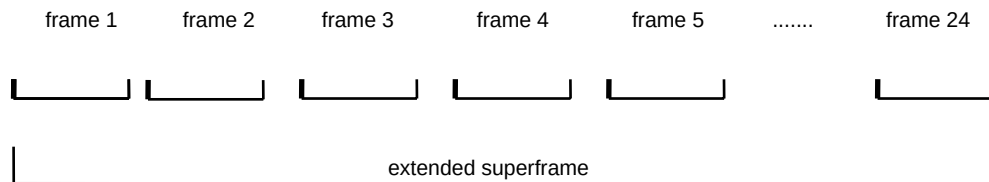
FAST REFRAME PRINCIPLES

T1 / E1 Framing.

A T1 signal consists of frames containing 24 8-bit timeslots. These frames comprise a larger structure, called a superframe (if containing 12 frames) or extended superframe (if containing 24 frames).

In a T1 system, synchronization is maintained via F-bits separating the individual single frames. F-bits occur every 193 bits.

A multi-frame is established by the F-bits following a specific pattern. Framing circuits receiving the T1 stream lock onto this pattern in order to maintain multi-frame synchronization.



The figure above shows the T1 structure. The F-bit location is highlighted. Note that while a single frame is transmitted every 125us, the extended superframe lasts 3ms.

E1 structure is similar. An extended superframe lasts 2ms and contains sixteen 125us frames of 32 8-bit timeslots. There are no additional framing F-bits, like in T1, but instead the synchronization pattern is embedded in part of the first timeslot of every second frame.

Frame Sync Disturbances.

In an RFL IMUX 2000 network, multi-frame synchronization is maintained throughout the system during normal operation. During a network disturbance, for example due to a broken communication link, loss of multi-frame sync may occur. If that happens, it will take several multiframes for the framing circuits to regain timing. Typically, the superframe structure is recovered from the received T1/E1 stream about 20ms after loss of sync.

Fast Reframe.

RFL Electronics developed a proprietary method of maintaining and regaining synchronization. Called Fast Reframe, this method will take over if the T1/E1 framers lose sync or if there are errors in data.

Fast Reframe utilizes alignment data contained in a timeslot. In T1 systems, timeslot 24 (last slot) is used for Reframe. In E1, it is timeslot 30 (one before the last).

The Fast Reframe circuits continuously monitor the data stream and attempt to detect and lock onto the alignment signal.

Fast Reframe and Re-Sync

In normal operation, the system relies on multi-frame sync established by the receiver framers using standard framing methods.

If loss of sync is detected - either by the receiver or by the Fast Reframe circuit - the Reframe circuit takes over and forces synchronization on a single-frame basis by detecting the position of Reframe time slot. The synchronization criterion is the presence of the alignment signal in two consecutive frames. This method aligns only single frames - multi-frame sync is not established.

Single-frame sync will allow channel data to flow with minimal interruption. Fast Reframe can capture a T1/E1 signal in less than 500us after this signal is regained. Fast Reframe will cede control to the framers once they regain their synchronization.

Fast Reframe speeds up the capture of timeslot data, but has no effect on signaling. Because signaling is based on the multi-frame alignment, it will not work properly until the framers are fully in sync, even though channel data will be passing through correctly due to Fast Reframe.

Fast Reframe and DACS/ILS Switching.

RFL DACS and ILS modules allow rerouting of signal in the event of a communication link failure. The route switching occurs in response to such events as detection of All Ones Signal (AIS), loss of sync, etc. These parameters are typically multi-frame-related and may take several milliseconds to initiate a switch.

Due to its robustness, Fast Reframe may be used as a trigger for DACS / ILS switching. A disturbance of the T1/E1 stream will cause loss of sync or errors in the Reframe time slot. Loss of Fast Reframe sync is declared when two consecutive frames do not contain proper alignment signal in the Reframe time slot. As a result, problems can be detected in less than 300us.

After Fast Reframe loses sync, the DELAY/DLY timer starts running. When the timer expires, a switch occurs (see RFL Apnote 03, "DACS and ILS Configuration Parameters" for more details).

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IMUX Application Note 08.

Rev. 04.10.1997 rdw

IMUX 2000

DACS / ILS ACTION ON LOSS OF PORTS 5 AND 6

OVERVIEW.

A DACS / ILS system is designed to protect a communication network in case of a communication link failure.

If a problem is detected on an outward-facing port of a DACS or an ILS (that is, port 1 through 4), the signal is rerouted on a backup path in such a manner that all nodes of a network can still access their traffic.

If a failure is detected at the local node, connected to a particular DACS or ILS, specific steps must be taken to assure the integrity of the network ring.

FAILURE ON INWARD PORTS.

If problems are experienced with the signal arriving from one of the local common modules, connected to the inward-facing ports of a DACS or ILS, special action needs to be taken.

To protect the network, it is desired that the neighboring nodes switch into their backup paths and route their traffic around the malfunctioning node (especially since no signal can pass through half of a drop-and-insert).

If no special action was taken, the signal arriving at port 5 or 6, faulty as it might be, would be reconditioned and transmitted out of one of the appropriate ports 1 through 4. Therefore, the neighboring nodes would be not aware that a problem was occurring because they would see a properly formatted T1 stream (although containing bad DS0-level data).

Without the special action and with fast reframe used, only one neighboring node would see the problem and switch - however, the other neighboring node would remain in normal mode. This would result in a "broken-open" network, still not passing traffic through. Additionally, the switched node would periodically attempt to recover (a process which does not involve fast reframe) and upon recovery would switch back again, effectively bouncing back and forth.

To prevent such occurrence, the DACS/ILS processor monitors signal quality at ports 5 and 6. If a problem is detected at either one of these ports, the processor forces an All-Ones signal (AIS) to be transmitted out of the outward-facing ports. In this manner, the neighbors of the distressed node will be made aware of the failure and will switch into the backup paths facing away from the failed node - routing the traffic around the failure. Although the traffic to and from the failed node will, obviously, be affected, the remaining network will operate properly.

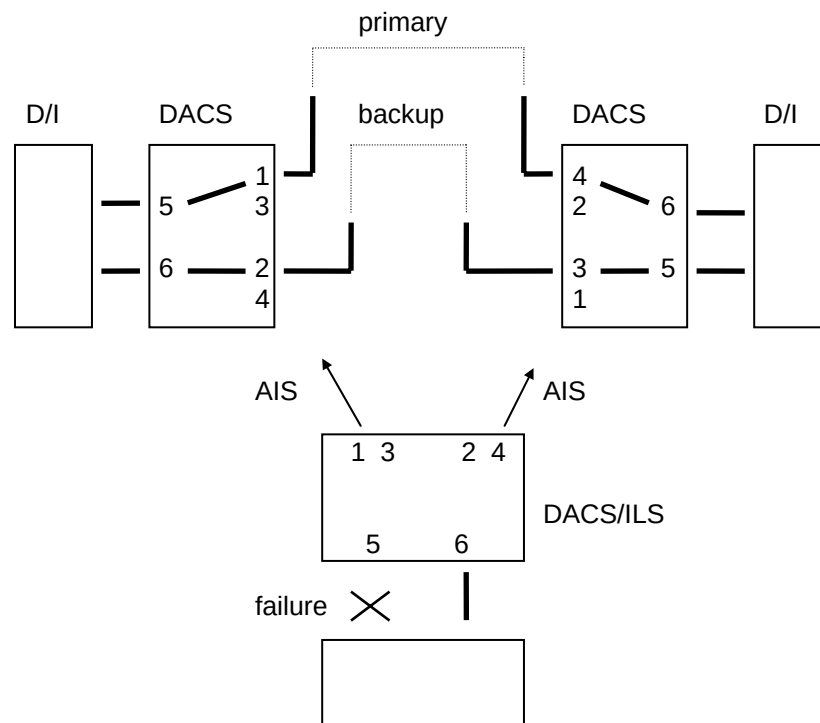


Fig. 1. DACS or ILS system routing around a failed node.

Once the problem is corrected, the distressed node stops emitting AIS. Its neighbors will go through the recovery handshake process and reconnect back to the primary communication path.

Note that even though only one of the inward ports, 5 or 6, may have failed, the whole node needs to be disabled in order to cause the T1 signal to be routed around it.

ILS NETWORK.

Any network containing at least two ILS nodes must contain at least one DACS node.

As described above, any failure on the inward ports of the DACS will result in the whole node shutting down. If that was the only DACS node in the network, a “reversion” process takes place, whereby the two neighboring ILS nodes recognize that the only DACS failed and fall back into normal paths to open up the ring.

As previously, all traffic between the remaining ILS nodes will continue. However, any traffic which was passing through the failed DACS node will not be passed on. Reversion is described in more detail in Application Note 04, Section 8.

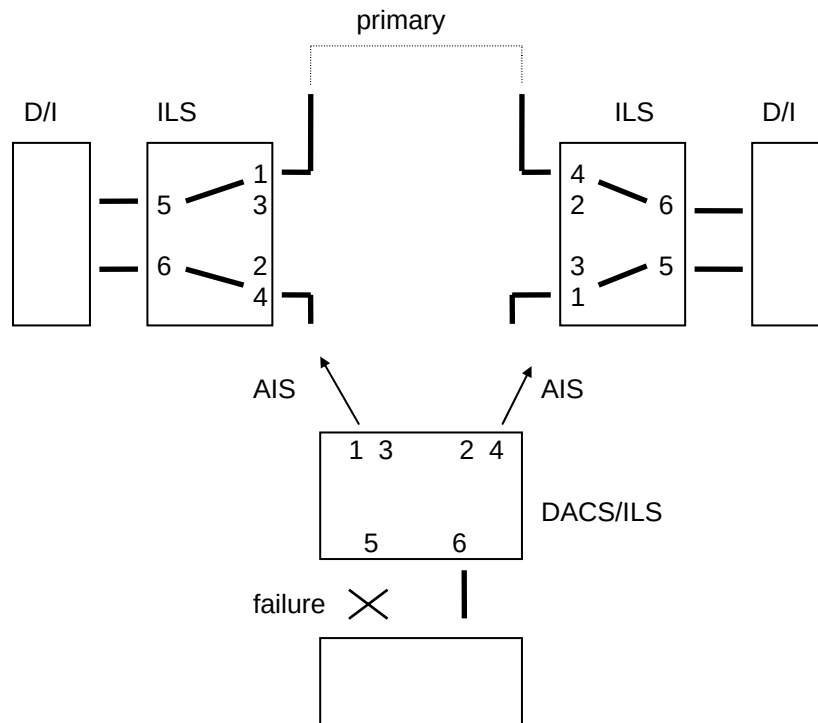


Fig. 2. Reverted ILS system.

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IMUX Application Note 09.

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IMUX 2000

FALLBACK TIMING

OVERVIEW.

Common Modules of an IMUX system continuously monitor the quality of recovered sync of the incoming T1 signal in order to assure that a proper clock is used. If loss of sync is detected by a Common Module, an alternate source of timing may be selected.

This alternate source of timing is referred to as **fallback** and is set as FTIME parameter by the front panel switch from the Diagnostic Group.

During the design of the network, when determining the source of fallback timing, one should consider the network layout and whether DACS or ILS modules are used.

DACS / ILS NETWORK.

a. Terminal.

DACS-Timed.

A DACS/ILS-based network typically derives its timing from a DACS module (by convention, usually at the head/tail node). The DACS unit may utilize either internal or external timing and the terminal will be set for loop timing.

In the event of network failure, the terminal Common Module connected to the DACS will not experience any loss of sync because the DACS reconditions (reframes) the T1 signal. The Common Module will therefore not switch into fallback timing.

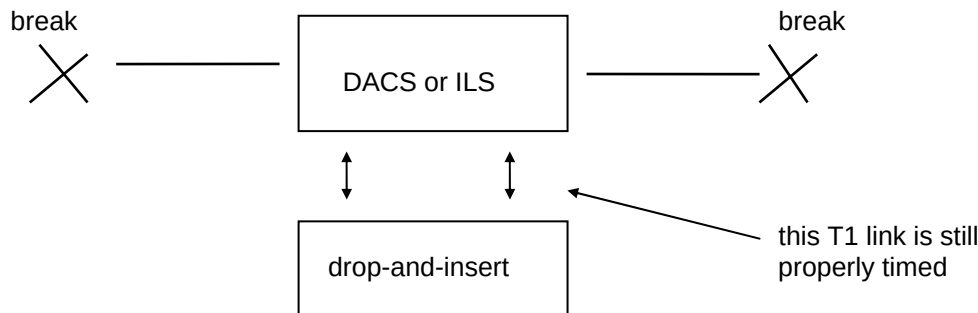
For consistency, fallback timing parameter should be left at a known value. The factory default setting is **INTERNAL**.

Common Module - Timed

In some network configurations, the timing originates in a terminal connected to a DACS or an ILS. This terminal operates in external or internal primary timing mode. For this configuration, the fallback timing should be set for internal to prepare for the possibility of losing the external timing source.

b. Drop-And-Insert.

As it is the case with the loop-timed terminal, the drop-and-insert derives its timing from a DACS or ILS module to which it is connected. In a similar manner, in the event of network failure the DACS or the ILS reframes and reroutes the T1 signal. The drop-and-insert Common Module will not experience any loss of sync and therefore will not switch into fallback timing.

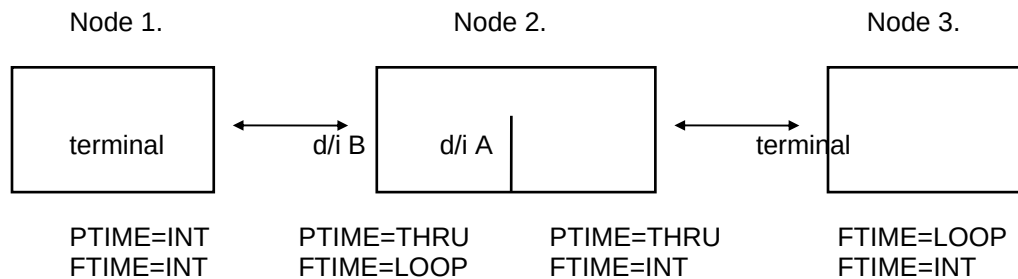


For consistency, fallback timing parameter should be left at a known value. The factory default setting is **INTERNAL**.

Note that the only instance when a terminal or a drop-and-insert Common Module will experience loss of sync is when the connection between it and a DACS or an ILS fails. In such situation the fallback timing setting is irrelevant because the whole node will take itself out of service to allow the network traffic to continue. (See Application Note 08 for more details.)

MUX - ONLY NETWORK.

When a Common Module is connected directly to the T1 pathway, without going through a DACS or ILS module, it will experience loss of sync as a result of T1 path failure. Such failure will break the flow of timing. Provisions must be made to supply the cut-off section of the network with timing, as shown in the example below.



In this example, the primary mode timing flows from the terminal in Node 1 (set up for primary timing = **INT**ernal). It is passed through the drop-and-insert in Node 2 (set up for primary timing = **THRU**), and turned-around by the terminal in Node 3 (set up for primary timing = **LOOP**).

In the event of a break between Node 1 and Node 2, the drop-and-insert facing away from the break (in this case, d/i A) must provide timing for the remainder of the system. Therefore, the fallback timing for this Common Module must be set to **INT**.

If a break occurs between Node 2 and Node 3, timing for the surviving section of the network will originate in Node 1 and thus the drop-and insert facing away from the break (in this case, d/i B) should have its fallback set for loop timing.

Since Node 3 will be isolated in such situation, its fallback timing is irrelevant. For consistency, it should be left at a known value such as factory default setting of **INT**ernal.

NO TIMING SOURCE.

A situation may occur, either due to a failure or by design, that a network will find itself without a designated timing source (i.e., all DACS and Common Modules will use recovered or loop timing). Even then, the network will operate properly. The T1 timing will settle to some average value determined by all phase lock loops in the system. However, the exact value of the clock cannot be guaranteed.

If an ambiguous situation is encountered during the layout of the system, where the proper timing flow cannot be determined, one should err on the side of loop fallback timing as opposed to internal timing. While the network will tolerate operation with all nodes in loop or through timing, it will not tolerate 2 or more independent sources of clock, which will "fight" each other.

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IMUX Application Note 10.

Rev. 02.04.1999 rdw

IMUX 2000 / 2000E

SWITCHING & PATH DELAYS

Note:

T1-based IMUX 2000 system includes DACS (Digital Access and Cross-connect System) and ILS (Intelligent Line Switch) modules, while the E1-based IMUX 2000E system includes only DACS modules. The information presented below applies to both types of systems, with the exception of items specific to the ILS – which apply to T1 systems only.

The designer of a data transmission network must consider various delays occurring in the system. It is important to understand the meaning of various terms and concepts used to describe system performance in that respect. Some of these delays are under the control of the designer, while other may be due to the physics of the process.

RFL IMUX 2000 / 2000E system is designed primarily for private network communications, in particular for teleprotection purposes. DACS and ILS units allow fault tolerance in the system, rerouting signals in the event of link fault. Certain timing characteristics of the network may be specific for these applications.

Of particular interest to the designer are: switch time, path delay and outage time.

Switch time:

time between start of break and change of maps/routes. This value is determined by programmed parameters and operating characteristics of DACS or ILS.

Path Delay:

time required for signal to travel between points of interest. This value is not under control of DACS or ILS programming, but rather is determined by network topology.

Outage Time (Break Time):

time between start of break and arrival of signal over backup path. Combination of the above delays, influenced by event scenario. This is the value of most interest to a protection engineer, since it affects the performance of protective equipment.

Elements of Switch Timing

Switch time (between break and change of maps) consists of the following stages:

Stage 1. Fault detection:

- determined by the failure mechanism and detection principles
- includes time to recognize a problem.
- depends on type of indicator of communication trouble (such as Loss-of-Sync, Alarm Indication Signal, Bit Error Rate, etc.)
- depends on framing mode.

typical values are:

- 300 us with Fast Reframe
- 3-6 ms on AIS (all-ones), without Fast Reframe
- 5-15 ms on loss of sync, without Fast Reframe

Stage 2. Switch delay:

- determined by DACS/ILS settings
- required to prevent false switching.
- depends on type of indicator of communication trouble
- depends on EFAST setting.
- depends on number of nodes.

typical values are:

- 1 ms on 4-node system (typ. 0.5 ms per additional node).
- 250 us on Loss of Data detected with EFAST enabled

Stage 3. Path / routing switch:

- instantaneous.

Elements of Path Timing

1. Delay in Channel Module:

- voice channel - 300 us end-to-end typ.

2. Delay in node:

- drop-and-insert multiplexer - 25 us.
- ILS, each pass or drop - 25 us.
- DACS, each pass or drop - 300us.

3. Delay in media:

- fiber - 8 us / mile
- OC1/OC3 drop - 100 us, typ.
- OC1/OC2 pass - 20 us, typ.
- microwave radio - 20 us each pass, typ.

Elements of Outage Timing

1. Switch Delay

- time required to recognize fault and effect maps/routing switch, as described above.

2. Opposite Node Differential

- difference in other node acting if break is asymmetrical.

In asymmetrical breaks, only one node will initially see the fault. After elapsing of the switch delay, this node will switch its maps/routings and notify the opposite node that a problem exists. This is accomplished by transmitting All-Ones, blue alarm (AIS in T1 or RUA1s in E1) to the opposite node. The opposite node must recognize the blue alarm and must wait through the appropriate delay before it can switch its maps/routings.

3. Path Delay

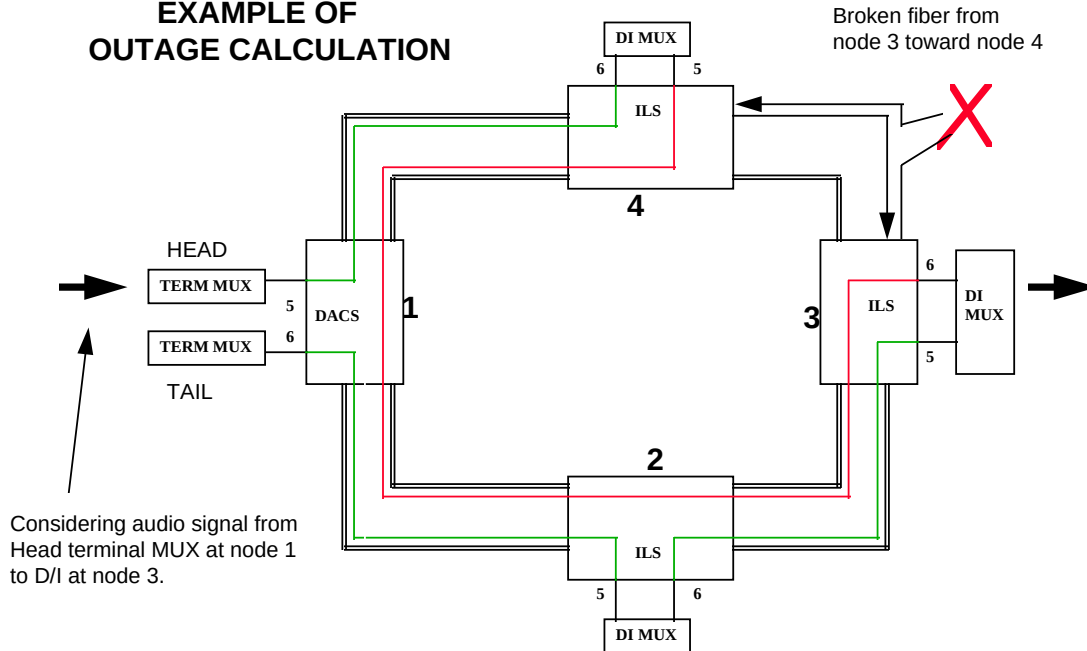
- time required for signal to “turn around” and travel on backup path to reach destination.
- as described above, it includes delays through channel modules, multiplexers and through transmission media.

4. Reframe Time

- time required for the receiving multiplexer to re-synchronize to received signal
- 300 us for DS0-based traffic with Fast Reframe.
- 10-20 ms for multi-frame based signals or for traffic without Fast Reframe.

Note that Fast Reframe is a DS0-only process. It allows very fast re-synchronization of digital signals and tone-carrying audio channels. Multi-frame based signals, such as on/off-hook signaling do not benefit from Fast Reframe.

EXAMPLE OF OUTAGE CALCULATION



EXAMPLE OF DELAY AND OUTAGE CALCULATIONS

Characteristics of the example network:

- DELAY set at 1ms.
- fiber - based
- low number of nodes
- path delay low - switch delays significant

Calculating sample channel: Node 1 to Node 3
Considering break of fiber from Node 3 to Node 4

Note: Critical channels must evaluate each data direction and each break direction. Bi-directional breaks are always faster.

PRIMARY PATH

Steady-state path delay over primary:

- audio channel + 3 MUX's - 300us
- 1 pass through DACS - 300 us
- 3 passes through ILS - 75 us
- fiber delay insignificant
- TOTAL STEADY-STATE DELAY = 700 us

BACKUP PATH

Steady-state path delay over backup:

audio channel + 3 MUX's - 300us

2 passes through DACS - 600 us

4 passes through ILS - 100 us

fiber delay insignificant

TOTAL STEADY-STATE DELAY = 1 ms

BREAK TIMELINE

0	Fiber breaks. Loss of signal at node 4.
0.3 ms	Node 4 detects break.
1.3 ms	Node 4 re-routes and starts sending AIS to Node 3. Signal starts traveling on backup path.
1.6 ms	Node 3 detects break.
1.7 ms	After completing backup loop, signal arrives at Node 3. It is stuck: Node 3 still processes DELAY timer.
2.6 ms	Node 3 re-routes. Signal continues toward MUX. Signal's framing is damaged.
3.0 ms	Fast Reframe aligns signal within MUX.
3.2 ms	Signal exits audio module. Outage is over.
20 ms, 40 ms	1-frame losses of sync as new framing alignment is passed node to node between ILS 's. Does not occur in DACS.



RFL Electronics, Inc.

IMUX Application Note 11.

Rev. 02.08.1999 rdw

IMUX 2000E

E1 DACS CONFIGURATION PARAMETERS

Note:

This Application Note pertains to the E1-based RFL IMUX 2000E system. Refer to Application Note 03 for information on T1-based IMUX 2000.

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EFLOF

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Appendix

DACS switch triggers

A. Introduction

RFL Mini-DACS modules are configured by means of a set of parameters, stored in non-volatile memory of the DACS/ILS Processor. Configuration may be accomplished through the Network Management Software (NMS) or by direct input to the processor module.

The initial configuration can be accomplished only at the local node of a system, since other nodes cannot be accessed until communication paths are functioning.

When using the direct method of parameter entry using SCL (Simple Command Language), rather than NMS, the commands are issued in the following general format:

:*[module]*:set:*[parameter]*=*[value]*;

In this case, *[module]* is *dacs* , *[parameter]* and *[value]* fields are described in further text.

For example, to turn off detection of Unframed All Ones, one would use:

:DACS:SET:EUA1=OFF;

When communicating through a direct connection to the processor module, bypassing the Common Module, the *[module]* field may be omitted and the whole command shortened to:

::set:*[parameter]*=*[value]*;

Unless specifically mentioned, parameter values apply globally to all ports on the module.

As a troubleshooting hint, one should note that the performance of a DACS system depends also on the behavior of CM6B common modules located in the terminals and drop-and-inserts of the network. Parameters controlling the common modules should be carefully reviewed with regard to compatibility with DACS settings.

For example, most common interface problems stem from inappropriate encoding (HDB3 vs. AMI) or framing (CRC-4 on or off) settings on ports on both ends of a T1 link. Even though within a network there may be different configurations used (such as when a DACS is used to translate HDB3 to AMI), on the same link both ports must be set identically.

Sometimes, inexplicable behavior of a system can be corrected by simply resetting the CM6B's to factory settings (from DIAG menu) and then re-entering any settings required for the particular application. This is due to the fact that even one wrong value in a rarely reviewed parameter can cause very subtle changes in performance, as opposed to an outright failure.

B. DACS Modules

1. General DACS Settings.

SRVC values: **ON , OFF** **DACS enable std operation of module**

This parameter allows selection of standard or non-standard initialization of the module.

When SRVC is set to ON, the DACS/ILS processor after initialization will check the status of E1 ports. If a port failure is indicated, the processor will switch the DACS module to a map appropriate for the first bad port detected. If another port indicates failure, no action will be taken until the first port recovers.

When SRVC is set to OFF, upon initialization the processor will set the DACS to map 0. No action will be taken until all monitored ports recover fully. After all ports reach nominal state, normal operation of DACS resumes: the maps will be switched upon port failure.

SRVC ON/OFF does not affect normal operation of the module.

SRVC OFF can be used during powering-up of the network to force all nodes to use the primary pathways until all communication is established.

ACTx values: **ON , OFF** **DACS enable port monitoring**
where **x=[1..6]**

Parameter ACTx allows disabling of status monitoring of individual ports on a DACS module. Ports are always initialized and set according to current configuration.

When ACTx is set to OFF, status of port **x** is not monitored and no actions are taken upon communications failure. Front panel LED corresponding to port **x** is extinguished. Effectively, port **x** is ignored - both with regard to alarms and to switching of maps.

This situation is different from that created by setting LOSDLY,x=1000, in which the status of port **x** is still monitored, although no actions are taken upon failure.

When ACTx is set to ON, status of port **x** is monitored and appropriate actions are taken upon communications failure. LED corresponding to port **x** reflects port status. It is lit when no signal errors are detected and it is extinguished when errors are present - regardless whether map switching occurs (map switching will happen only if errors satisfy certain requirements and constraints).

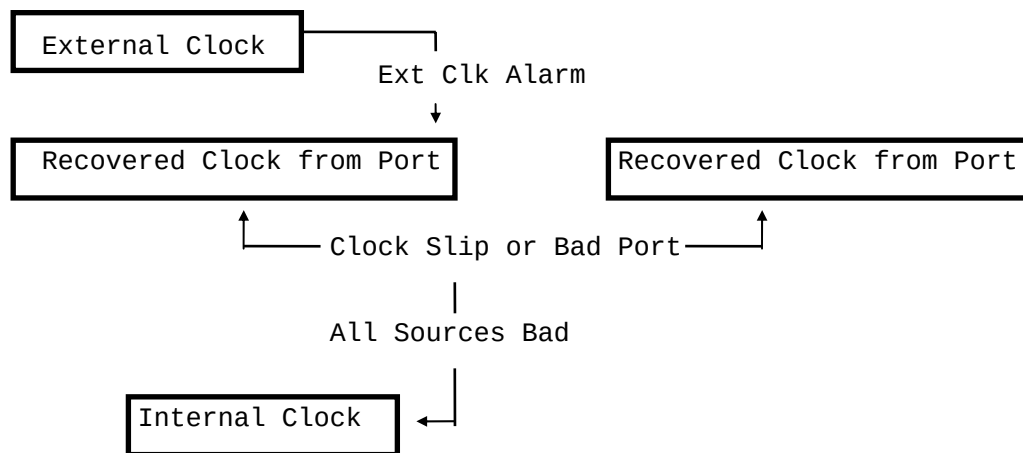
CLOCK values: [primary],[alternate] **DACS primary and alternate clock source**
 where [primary] or [alternate] = [1..6], [M1..M6], INT, EXT, NONE

The DACS module will use clock sources selected by CLOCK parameter to drive the internal DS0 grooming process and to serve as the E1 transmit clock. External clock and/or any of the 6 ports and/or the internal oscillator can serve as a clock source. Only up to 2 sources can be selected by this parameter.

External clock, if present and if enabled by CLOCK parameter, takes precedence over any other sources. Internal clock, even if not selected, will be used if all other clock sources are not available.

If a problem is detected at the current source of clock, DACS will use the alternate source. If the problem clears, DACS will not switch back unless there is a problem with the alternate.

If clock slippage is detected, the processor will switch between port sources specified in CLOCK parameter.



Clock source hierarchy.

The issue of loss of master timing node in the system is addressed by setting up a secondary master using the **M** qualifier.

In the next node “downstream” after the master, the port facing the master should be denoted as **M**. For example, if port 1 in next node after master is facing the master, the following command might be issued:

```
node:dacs:set:clock=M1,4;
```

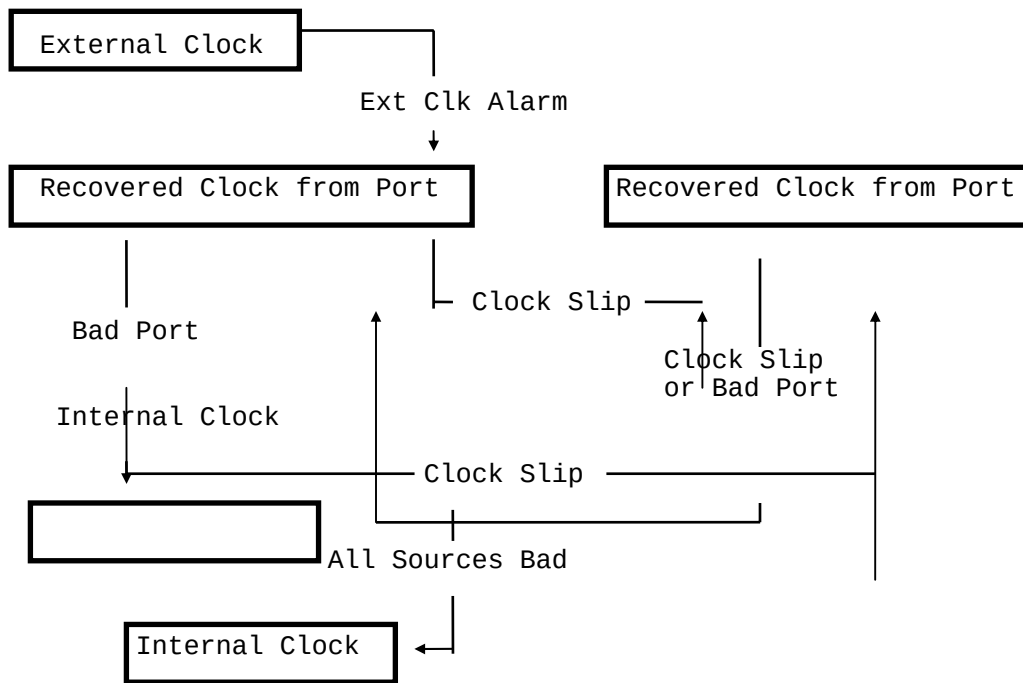
Such command results in following sequence of events:

If a problem is detected at port 1, the clock is first sourced from internal oscillator, regardless of what the other alternate source is. The processor will monitor the alternate source for clock slippage.

If no slip is present, the processor assumes that its own clock propagated through the system. This indicates that master node is lost. The processor will remain in internal timing, assuming the function of a secondary master, until clock slip occurs.

If clock slip occurs, then the processor knows that another source of timing is present in the system. DACS will switch to the alternate source specified in CLOCK parameter.

Note that only a port and only one port can be selected as **M**.



Clock source hierarchy for secondary master.

FTYPE,x values: **CAS, CCS** **DACS signaling type, ports 1 to 4**
where **x=[1..4]**

The FTYPE,x parameter is used to select signaling mode on specified port, 1 through 4. CAS selects Channel Associated Signaling, CCS selects no signaling.

FTYPx values: **CAS, CCS** **DACS signaling type, ports 5 and 6**
where **x=[5,6]**

The FTYPEx parameter is used to select signaling mode on specified port, 5 or 6. CAS selects Channel Associated Signaling, CCS selects no signaling.

CODE,x values: **AMI, HDB3** **DACS coding type, ports 1 through 4**
where **x=[1..4]**

The CODE,x parameter is used to select AMI or HDB3 encoding mode on specified port, 1 through 4.

CODEx values: **AMI, HDB3** **DACS coding type, ports 5 and 6**
where **x=[5,6]**

The CODEx parameter is used to select AMI or HDB3 encoding mode on specified port, 5 or 6.

CRC4,x values: **ON, OFF** **DACS framing mode, ports 1 through 4**
where **x=[1..4]**

The CRC4,x parameter is used to select enable 16-frame CRC-4 multiframe mode on specified port, 1 through 4. Double-frame FAS (Frame Alignment Signal) synchronization is always used.

CRC4x values: **ON, OFF** **DACS framing mode, ports 5 and 6**
where **x=[5,6]**

The CRC4x parameter is used to select enable 16-frame CRC-4 multiframe mode on specified port, 5 or 6. Double-frame FAS (Frame Alignment Signal) synchronization is always used.

EUA1 values: **ON , OFF** **DACS enable UA1 detection**

Problems with communication paths are often indicated by presence of an Unframed All-Ones (UA1) signal at the port.

When EUA1 is set to ON, appearance of UA1 will cause the processor to assume a failure on the E1 port. The processor will take appropriate action.

When EUA1 is set to OFF, the processor will take no action based the state of Unframed All-Ones signal. However, it should be remembered that an UA1 signal would be also detected via ELOS – since it contains no framing.

EBER values: **ON , OFF** **DACS enable BER detection**

Bit-Error-Rate may be used to indicate problems with communication paths. It is a slow alarm, however, since the framer chips update BER only once a second.

When EBER is set to ON, values exceeding those set by **BER** parameter will cause the processor to assume a failure on the E1 port. The processor will take appropriate action.

When EBER is set to OFF, the processor will ignore the bit error rate.

EFLOF values: **ON , OFF** **DACS enable Fast Loss of Frame detect**

CM6B Common Modules independently monitor the quality of E1 communication paths. When a DACS or ILS unit works attached to a chassis containing CM6B's, the common modules can inform the DACS/ILS processor about any perceived problems.

When EFLOF is set to ON, alarm on the FLOF (Fast Loss of Frame) line from the common module will cause the processor to assume a failure on the E1 port. The processor will take appropriate action.

When EFLOF is set to OFF, the processor will ignore the FLOF line.

With Fast Reframe disabled, the FLOF signal from common module(s) represents the LOS (loss of sync) from the CM6B framer chip, and thus it somewhat duplicates the LOS signal generated locally at the DACS or ILS. This signal is less reliable, however, and thus switching on FLOF should be disabled when Fast Reframe is not used.

With Fast Reframe enabled on the common module, FLOF line represents the status of the Fast Reframe circuitry. It is extremely reliable and very fast and is very well suited to controlling DACS/ILS switching. When Fast Reframe is used, switching on FLOF should be enabled (EFLOF=ON) and switching on the less reliable local loss of sync should be disabled (ELOS=OFF).

There are 2 FLOF lines arriving from the Common Module. By default, they represent failure on following DACS ports:

FLOF from Terminal or Drop/Insert A:	assigned to DACS port 1
FLOF from Drop/Insert B:	assigned to DACS port 4

3. DACS Failure Levels.

Parameters listed below determine at which level of disturbance the DACS/ILS processor decides that a fault occurred.

BER values: numeric **DACS Bit Error Rate switch level**

Bit-Error-Rate parameter sets the switch-on-error level. The entry format is nE-m, where n=[0..9] and m=[4..7]. This results in value range of 0 and 1E-7 to 9E-4.

When **EBER** (enable BER switching) is set to ON, error values exceeding those set by BER parameter will cause the processor to assume a failure on the E1 port. The processor will take an appropriate action, such as switching of the maps.

When EBER is set to OFF, the processor will ignore bit error rate.

LEVEL values: numeric, dB **DACS signal strength switch level, dB**

The LEVEL parameter sets the minimum signal strength level, in decibels. If the incoming E1 signal falls below this level and **ELOD** (enable Loss-of-Data) is set to ON, the processor will assume a failure on the E1 port. The processor will take appropriate action.

LEVEL can be set to desired dB value by entering -7.5, -15 or NONE. If NONE is selected, signal strength is ignored.

When ELOD is set to OFF, the processor will ignore both signal strength and Received Carrier Level.

4. DACS Switch-on-Failure Timing.

Parameters listed below determine the delays involved in map switching following a port failure (healing process). Additionally, LOSDLY allows disabling map switching for a given port.

EFAST,x values: **ON , OFF** **DACS enable fast switching**
where x=[1..4]

After the processor determines that port **x** has failed (communication link broken) and if EFAST,x is set to OFF, no actions are taken for a period equal to switch delay **DLYx** or **LOSDLY,x**, depending on failure mode. After the delays pass, the processor will switch the DACS module to a map corresponding to the failed port.

If the EFAST,x parameter is set to ON, DLYx timers are bypassed for Loss of Data (LOD) and the processor switches maps and routings instantly (250us) after detecting port failure. Other failures (Fast Reframe Loss of Sync, Loss of Sync, etc.) are still buffered by their respective time delays.

DLYx values: numeric, msec **DACS error-to-switch delay, msec**
where x=[1..4]

After the processor determines that port **x** has failed, no actions are taken for a period equal to switch delay DLYx, in milliseconds. This pertains to failures detected by means of Carrier Loss and Level (as enabled by **ELOD** parameter), by means of Alarm Indication Signal (as enabled by **EAIS**), by means of BER (as enabled by **EBER**) or by means of Fast Loss of Frame (as enabled by **EFLOF** parameter). After the delay passes, the processor will switch the DACS module to a map corresponding to the failed port.

If the **EFAST** parameter is enabled, timer DLYx is bypassed for LOD errors and the processor switches maps and routings instantly (250us) after detecting port failure.

LOSDLY,x values: numeric, ms **DACS error-to-LOS indication delay, msec**
where x=[1..4] and value = [0..995]
LOSDLY,x values: numeric, ms **DACS map switch disable, port x**
where x=[1..4] and value = 1000

After the processor determines that port **x** has failed by means of Loss of Sync (as enabled by **ELOS** parameter), no actions are taken for a period equal to switch delay LOSDLY,x, in milliseconds. After the delay passes, the processor will switch the DACS module to a map corresponding to the failed port. Any value between 0 and 999 may be entered for the delay, but the processor will round it down to nearest increment of 5.

Setting LOSDLY,x to 1000 disables switching of maps based failure of port **x**. The status of the port will be still monitored and displayed via front panel LED's. Typically, this is used for a port connected to the backup path, to prevent a switch of maps due to bad backup.

This is different from setting ACTx to OFF, which disables both monitoring port and switching of maps.

5. DACS Switch-on-Recovery Timing

Parameters listed below determine the delays involved in map and routing switching following a port recovery.

REC	values: numeric, sec	DACS recovery delay, sec

After the processor determines that a failed port is recovered (communication link restored), no actions are taken for a period equal to the recovery delay, in seconds. After the recovery delay passes, the processor will switch the DACS module back to map 0.

The recovery delay allows the system to settle following the restoration of primary links before attempting to switch to the primaries. The larger and more complex the system, the more delay is required.

REC can be set between 1 and 60s.

6. Typical Settings of DACS parameters.

Table below indicates typical settings of DACS parameters, in order in which they appear as a result of the `::config?:flags_;` statements.

Column **Fast** pertains to a system utilizing Fast Reframe, **No Fast** to a system without this feature. Asterisks highlight differences between both arrangements.

DLY value of 1ms has been determined to be sufficient for systems including up to 4 nodes. Each additional node requires an approximate increase of 0.5ms. Actual measurements should be performed to confirm this setting.

DACS clock settings depend on the topology of the particular system.

	Fast		No Fast	
ELOS	OFF	*	ON	Switch on framer LOS
ELOD	ON		ON	Switch on framer Carrier Loss + Level
EUA1	ON		ON	Switch on All-Ones
EBER	OFF		OF	Switch on BER
EFLOF	ON	*	OFF	Switch on CM6B LOS / FRLOS
ACT1	ON		ON	DACS port enable
ACT2	ON		ON	DACS port enable
ACT3	ON		ON	DACS port enable
ACT4	ON		ON	DACS port enable
ACT5	ON		ON	DACS port enable
ACT6	ON		ON	DACS port enable
REC	10		10	Recover dly, signal-to-switch, sec
BER	1.E-05		1.E-05	BER switch level
DLY1	1		1	DACS error-to-switch delay, port 1, msec
DLY2	100		100	DACS error-to-switch delay, port 2, msec
DLY3	100		100	DACS error-to-switch delay, port 3, msec
DLY4	1		1	DACS error-to-switch delay, port 4, msec
CLOCK	?		?	DACS primary & alternate clock
LEVEL	-7.5dB		-7.5dB	Level switching point (via ELOD)
FTYP5	CAS		CAS	DACS port 5 CAS signaling mode
CODE5	HDB3		HDB3	DACS port 5 coding HDB3
CRC45	ON		ON	DACS port 5 CRC-4 framing enabled
FTYP6	CAS		CAS	DACS port 6 CAS signaling mode
CODE6	HDB3		HDB3	DACS port 6 coding HDB3
CRC46	ON		ON	DACS port 6 CRC-4 framing enabled
FTYPE,1	CAS		CAS	DACS port 1 CAS signaling mode
CODE,1	B8ZS		B8ZS	DACS port 1 coding AMI/B8ZS
CRC4,1	ON		ON	DACS port 1 CRC-4 framing enabled
EFAST,1	ON	*	OFF	DACS fast switch port 1 (bypasses DLY1)
LOSDLY,1	85	*	300	DACS port 1 LOS-to-switch dly, msec

FTYPE,2	CAS		CAS	DACS port 2 CAS signaling mode
CODE,2	HDB3		HDB3	DACS port 2 coding HDB3
CRC4,2	ON		ON	DACS port 2 CRC-4 framing enabled
EFAST,2	OFF		OFF	DACS fast switch port 2 (bypasses DLY2)
LOSDLY,2	85	*	300	DACS port 2 LOS-to-switch dly, msec
FTYPE,3	CAS		CAS	DACS port 3 CAS signaling mode
CODE,3	HDB3		HDB3	DACS port 3 coding HDB3
CRC4,3	ON		ON	DACS port 3 CRC-4 framing enabled
EFAST,3	OFF		OFF	DACS fast switch port 3 (bypasses DLY3)
LOSDLY,3	85	*	300	DACS port 3 LOS-to-switch dly, msec
FTYPE,4	CAS		CAS	DACS port 4 CAS signaling mode
CODE,4	HDB3		HDB3	DACS port 4 coding HDB3
CRC4,4	ON		ON	DACS port 4 CRC-4 framing enabled
EFAST,4	ON	*	OFF	DACS fast switch port 4 (bypasses DLY4)
LOSDLY,4	85	*	300	DACS port 4 LOS-to-switch dly, msec

Figure 1.
DACS parameter setting chart.

Appendix A.

DACS switch triggers

DACS/ILS Processor monitors E1 communication lines connected to ports of DACS modules. If the signal reaching a port is deemed to be deficient, appropriate actions are taken. These actions may result in switching of DACS maps.

The determination of quality of E1 signal is based on the following parameters:

- **LOS** - **Loss of Sync** alert generated by the framer chip.
- **LOD** - **Loss of Data**, a composite alert, consisting of Received Carrier Loss generated by the framer chip or by Receive Level indication, when it is below value set by LEVEL parameter.
- **UA1** - **Unframed All Ones** alert generated by the framer, indicating reception of Blue Alarm (unframed all-ones).
- **BER** - **Bit Error Rate** alert, set when the errors indicated by framer chip exceed level set by BER parameter.
- **FLOF** - **Fast Reframe Loss of Frame** alert, set when the CM6B Common Module attached to DACS detects framing problems. When in fast reframe mode, CM6B indicates loss of fast reframe synchronization. When not in fast reframe, CM6B forwards the Loss of Sync signal from its framer.

All these characteristics are checked independently for each of framers on ports 1 through 4. When a problem is detected, the green front panel LED indicator corresponding to the affected port is extinguished.

The DACS/ILS Processor will take further action only if enabled by the appropriate **E...** parameter (ELOS, ELOD, etc.) and only after certain time delays. LOS (Loss of Sync) is timed by the LOSDLY timer. All other failures are timed by the DLY timer.

If EFAST (Enable FAST switching) is set, LOD (Loss of Data) needs not to be present for the whole DLY/DELAY time period. Instead, switching action will be taken if LOD is present for 2 consecutive polls, typically 125us apart.

In the course of the switching action, the processor will activate a map corresponding to the failed port.

A representation of the switching logic is shown in Figure 2. Switch symbols denote enabling function. Summing nodes require that at least one of involved conditions is present.

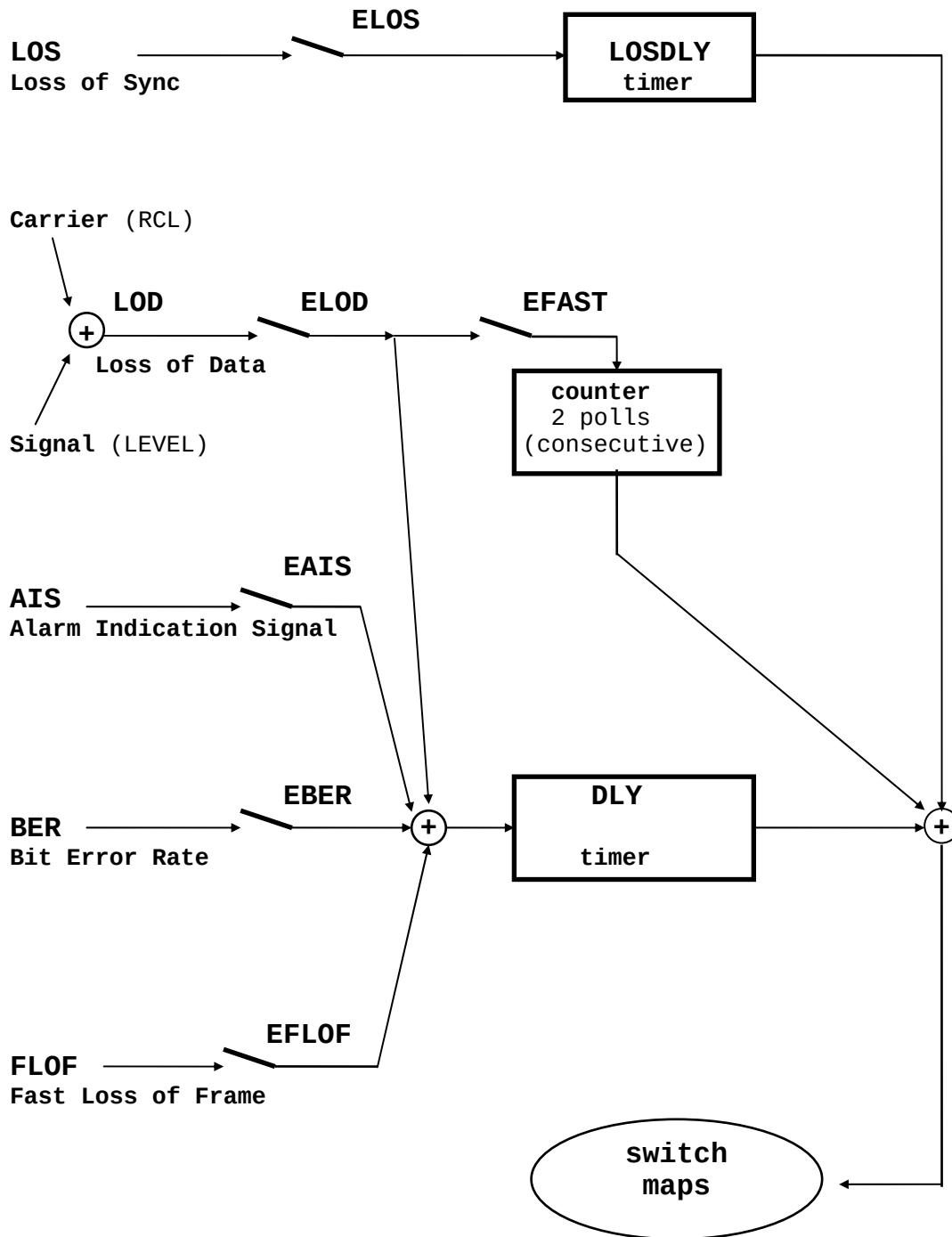


Figure 2.

Triggers of DACS switching..



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IMUX Application Note 12.

Rev. 09.21.2000 rdw

IMUX 2000

CM-3R COMMON MODULE REDUNDANT-MODE DIAGNOSTICS

CM-3R Redundant Common Module provides an indication of current system state in response to status and configuration inquiries. This information is available both locally and remotely through Network Management System.

System state information includes alarms and alerts, as well as T1 performance diagnostics. It also includes some items related to the redundant-mode capabilities, such as which common module is currently active, what is the setting of redundant mode switch, etc. Refer to the IMUX CM-3R instruction manual for more details.

Beyond the system state indicators, an additional level of diagnostics is available in order to assist in troubleshooting and repair of a common module. That information is only accessible locally through the RS-232 port of the common module; it is neither passed between the nodes of an IMUX network, nor between the two sides of a Drop-and-Insert.

Redundant-mode diagnostic information allows the technician to determine the current state of mode switching mechanism and of monitored system parameters which may cause or may have caused a switch.

Retrieving redundant-mode diagnostics.

Redundant-mode diagnostics are contained within ACTEL FPGA registers of a CM-3R Common Module. They can be retrieved by a computer terminal connected to the CM-3R serial port by issuing the following SCL command:

: subadr : DEBUG? : ACTEL ;

where *subadr* is TERM, DI-A or DI-B, respectively.

A reply to the above contains a listing of current values of various ACTEL registers. Those of interest are:

- RDND_CTRL redundant-mode control register
- RDND_STAT redundant-mode status register
- MON_STAT monitored status register
- LATCHED_STAT latched monitored status register
- DETL_MON0 detailed monitoring register 0
- DETL_MON1 detailed monitoring register 1
- DETL_MON2 detailed monitoring register 2
- ALERT_STAT alert status summary register

Origin of redundant-mode diagnostics.

It is imperative to remember that the ACTEL diagnostics are reported by the Main/Standby Common Module pair to which the serial link is connected. In that pair, ACTEL diagnostics originate within the currently active Common Module.

For example, to read the state of Drop-and-Insert B, the link must be connected to serial port of the DI-B module pair, not DI-A. The ACTEL

registers will be read from either the Main or the Standby Module of DI-B, whichever is active at that time.

If the Main Module is active, a reading of internal on-board operational parameters will indicate internal status of the Main Module. If the Standby Module is active, the reading of internal on-board operational parameters will indicate internal status of the Standby Module.

These readings will differ by the content related to on-board parameters (self-check and switching mechanism). Reading of bus (backplane) parameters should be the same whether obtained from Main or from Standby Module, as both use identical monitoring mechanisms.

LATCHED_STAT and DETL_MONx registers will behave differently: in the Main Module, they are continuously providing real-time information, essentially duplicating MON_STAT register. In the Standby Module, they are latched when the module becomes active. This captures the state of the system at the instance of a Main-to-Standby switchover, allowing for subsequent analysis.

Redundant-mode register descriptions.

A. RDND_CTRL

REDUNDANT CONTROL REGISTER

Conveys information about current status of redundant control mechanism.

- **Bit 0:**
ASK_MAIN: set to one to force system to activate Main Common Module (requested over RS-232 or FDL). Effective only if front-panel switch permits.
- **Bit 1:**
ASK_STBY: set to one to force system to activate Standby Common Module (requested over RS-232 or FDL). Effective only if front-panel switch permits.
- **Bits 3-2:**
Unused.
- **Bit 4:**
uP_HAPPY: set to one to confirm correct operation of processor. This bit, if set to zero, counts as one of the triggers of switch-over.
- **Bit 5:**
CONFIGURED: set to 1 when two full cycles of SCB messages from the active DI-A/TERM common module were captured by SPY circuit (at about 8 seconds per cycle).
- **Bits 7-6:**
Unused

B. RDND_STAT

REDUNDANT STATUS REGISTER

Conveys information about current status of redundant control mechanism.

- **Bit 0:**
STBY_MODE. Set to zero if Common Module plugged into Main position, set to 1 in Standby position.
Determined by module adapter. Will be zero if no adapter is present.
Both Main and Standby modules monitor their own internal status.
- **Bit 1:**
MAIN_SW: set to 1 if the front-panel switch is in position to force system to activate Main Common Module. Overrides any requests over RS-232 or FDL (ASK_MAIN/STBY)). Ignored in Main Common Module.
- **Bit 2:**
STBY_SW: set to 1 if the front-panel switch is in position to force system to activate Standby Common Module. Overrides any requests over RS-232 or FDL (ASK_MAIN/STBY)). Ignored in Main Common Module.
- **Bit 3:**
Unused
- **Bit 4:**
ME_ALIVE: set to 1 if the module is on-line (driving the multiplexer backplane). This signal tells the processor to become active, steering I/O signals and framer. This bit is set in both Main and Standby Modules.
- **Bit 5:**
ACTIVATED: set to 1 in the Standby Module if it effected a switch-over and took control of the bus. This bit is set only in Standby Module.
- **Bit 6:**
FORCED: set to 1 if the module received and acted upon a valid command to switch to Main or Standby Module (switch or RS-232/FDL), not due to failure detection. This bit is set only in Standby Module.
- **Bits 7:**
Unused

B. MON_STAT

MONITORED STATUS REGISTER

Conveys real-time information about current state of monitored parameters.

- **Bit 0:**
SWITCH_IN: Set to 1 if SWITCH_IN signal is active (a command to get off-line).
- **Bit 1:**
HIM_SICK: Set to one if line ~SICK_IN does not oscillate, indicating a problem with monitored Main Module.
- **Bit 2:**
RX_TRBL: Set to one if problem with framer reception is detected (RCL, FRLOS).
- **Bit 3:**
BOARD_TRBL: Set to one if problem with any on-board parameters is detected (uP_HAPPY, Watchdog, ALE).
- **Bit 4:**
BUS_A_CHK: Set to one if problem with Bus A is detected (Clock, Overhead, 6F/12F, MSYNC) – if checked in current operating mode.
- **Bit 5:**
BUS_B_CHK: Set to one if problem with Bus B is detected (Clock, Overhead, 6F/12F, MSYNC) – if checked in current operating mode.
- **Bit 6:**
SCB_CHK: Set to one if problem with SCB Bus is detected (SCB Data or Sync) – if checked in current operating mode.
- **Bit 7:**
FAILED_CLK: Set to one if problem with clocks is detected (XTAL, RCLOCK).

C. LATCHED_STAT

LATCHED MONITORED STATUS REGISTER

Latched Register is identical to Monitored Status Register MONIT_STAT, except that in Standby Module, when switch-over to active mode occurs, the register is “frozen”, thus allowing determination of reason for the switch.

In Main Module (in any mode), or in Standby Module in inactive mode, register always shows real-time information, exactly as in MONIT_STAT.

- Bit 0: SWITCH_IN: Set to 1 if SWITCH_IN signal is active (a command to get off-line).
- Bit 1: HIM_SICK: Set to one if line ~SICK_IN does not oscillate, indicating a problem with monitored Main Module,
- Bit 2: RX_TRBL: Set to one if problem with framer reception is detected (RCL, FRLOS).
- Bit 3: BOARD_TRBL: Set to one if problem with any on-board parameters is detected (uP_HAPPY, Watchdog, ALE).
- Bit 4: BUS_A_CHK: Set to one if problem with Bus A is detected (Clock, Overhead, 6F/12F, MSYNC) – if checked in current operating mode.
- Bit 5: BUS_B_CHK: Set to one if problem with Bus B is detected (Clock, Overhead, 6F/12F, MSYNC) – if checked in current operating mode.
- Bit 6: SCB_CHK: Set to one if problem with SCB Bus is detected (SCB Data or Sync) – if checked in current operating mode.
- Bit 7: FAILED_CLK: Set to one if problem with on-board clocks is detected (XTAL, RCLOCK).

D. DETL_MON0

DETAILED LATCHED STATUS REGISTER 0

Shows real-time details of monitored parameters. In Standby Module following switch-over to active mode, this register is “frozen”, thus allowing determination of switch causes.

- Bit 0:
CLK_A_TRBL: Set to 1 if problem with clock A detected.
- Bit 1:
OHD_A_TRBL: Set to 1 if problem with overhead A detected.
- Bit 2:
6F_A_TRBL: Set to 1 if problem with 6F-framing A detected.
- Bit 3:
12F_A_TRBL: Set to 1 if problem with 12F-framing A detected.
- Bit 4:
MSYNC_A_TRBL: Set to one if problem with Multi-Frame Sync A is detected.
- Bit 7-5:
Unused.

E. DETL_MON1

DETAILED LATCHED STATUS REGISTER 1

Shows real-time details of monitored parameters. In Standby Module following switch-over to active mode, this register is “frozen”, thus allowing determination of switch causes.

- Bit 0:
CLK_B_TRBL: Set to 1 if problem with clock B detected.
- Bit 1:
OHD_B_TRBL: Set to 1 if problem with overhead B detected.
- Bit 2:
6F_BTRBL: Set to 1 if problem with 6F-framing B detected.
- Bit 3:
12F_B_TRBL: Set to 1 if problem with 12F-framing B detected.
- Bit 4:
MSYNC_B_TRBL: Set to one if problem with Multi-Frame Sync B is detected.
- Bit 7-5:
Unused.

F. DETL_MON2

DETAILED LATCHED STATUS REGISTER 2

Shows real-time details of monitored parameters. In Standby Module following switch-over to active mode, this register is “frozen”, thus allowing determination of switch causes.

- Bit 0: SCB_SYNC_TRBL: Set to 1 if problem with SCB sync detected.
- Bit 1: SCB_DATA_TRBL: Set to 1 if problem with SCB data detected.
- Bit 2: UP_HAPPY: Set to 1 if uP_HAPPY bit set by CPU.
- Bit 3: ALE_TRBL: Set to 1 if problem with Address Latch Enable detected.
- Bit 4: WDOG_TRBL: Set to one if problem Watchdog Strobe is detected.
- Bit 5: RCL: Set to one if Received Carrier Loss signaled by framer.
- Bit 6: RLOS: Set to one if Received Loss of Sync signaled by framer (not Fast Reframe).
- Bit 7: Unused.

G. ALERT_STAT

ALERT CONDITION STATUS REGISTER

Combines real-time information contained in MONIT_STAT into a shorter format, convenient for generating alarms.

- Bit 0: HIM_SICK: Set to 1 if ~SICK signal from Main module over backplane is not present.
- Bit 1: BUS_TRBL: Set to one if problem with parameters monitored over backplane is detected (SCB_CHK + BUS_A_CHK + BUS_B_CHK).
- Bit 2: LOCAL_TRBL: Set to one if problem with parameters monitored on-board is detected (RX_TRBL + BOARD_TRBL + FAILED_CLK).
- Bit 7-3: Unused.



RFL Electronics, Inc.

IMUX Application Note 13.

Rev. 10.31.2000 rdw

IMUX 2000

CM-3x FDL NODE LOCATION MAPPING

RFL IMUX T1 multiplexers use Facility Data Link (FDL) to provide network management functions. FDL is a low-speed data link embedded within T1 ESF framing structure.

IMUX CM-3x T1 Common Modules (currently, CM-3R, CM-3C and CM-3B) pass configuration and status messages over FDL, allowing an operator using a computer or data terminal located at one node to observe and control the whole network.

In order to speed up FDL access throughout the network, Common Module in the node to which the computer is connected ("local node") will attempt to maintain a map of node locations.

This mapping process is transparent to the user. It is successful in most network configurations and effective under most system conditions.

However, under certain special circumstances the mapping process may fail. This will manifest itself to the user by lack of visibility of some nodes of the network over FDL.

The FDL locations map may be not created or may be lost if:

- New network is created,
- Network topology is changed,
- Computer terminal ("local node") is moved to another location,
- Common Module serving as Drop-and-Insert A (DI-A) in local node is replaced with another one, even the one used as DI-B of the same node,

while at the same time:

- Network topology does not include Terminal nodes at the "head" and "tail" of the system.
- System traffic interruption exists en-route to the "head" or "tail".
- SCB bus problems exist in of the nodes en route to the "head" or "tail".
- DS1 traffic passes through DS0-based equipment, stripping the T1 framing and FDL from the data.

RFL Network Management System (NMS) is usually able to recreate the locations map by auto-configuring its system layout. However, the operator may sometimes have important reasons not to use auto-configuration, for example, to avoid overwriting previously existing node information.

An operator who understands the principles of FDL locations mapping may manually force the Common Module to recreate the locations map by proper use of Simple Command Language (SCL).

PRINCIPLES OF FDL NODE LOCATION MAPPING.

Figure 1 represents a hypothetical 10-node IMUX network. This could be either a linear network or a DACS/ILS ring (which contains a linear structure looped onto itself).

This network consists of Head and Tail terminal nodes 1 and 10 and drop-and-insert nodes in between. 6 is the local node: the computer terminal is located there.

Assume that, for the first time ever, a message is sent from local node to node 3.

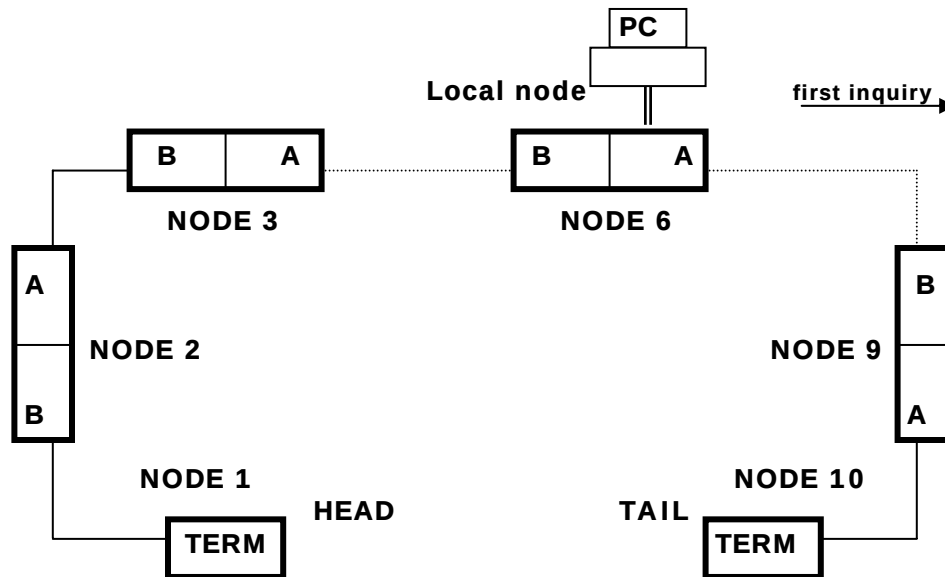


Fig. 1: linear network with terminal multiplexers at Head and Tail.

In each node, the FDL processing controller is contained within the Common Module serving as DI-A or Terminal. All FDL messaging function are handled by that Module. DI-B is only used as an FDL transceiver, it performs no controlling functions.

- When DI-A of the local node does not know where node C is located, it always sends out the message first out of DI-A port. In this particular network, the message is thus sent toward the tail.
- As the message enters other nodes in the network, its address is checked. If it is not addressed to the node where it arrived, it is passed by the drop-and-inserts further down the network. For example, if the message arrived at DI-B of node 9, it will be send further out of DI-A of 9. No action is taken if the node is not a target of a message.
- When the message arrives at a terminal, its address is checked. If it is not addressed to that terminal, a reply will be sent back to the originating node to let it know that the end of the network was reached. In above example, the tail terminal in node 10 will notify the local node that the message reached a dead end.
- Upon receipt of such notification, the local node sends out the message in the other direction, out of DI-B - in this case, toward the head.
- The message reaches its target in node 3 and an appropriate reply is sent back.

- The local node receives the reply. It knows now that node 3 is located in direction of DI-B and stores that information in a map.
- Each subsequent message to node 3 is sent out in direction of DI-B right away; the searching process is avoided.

Note that only the local node builds a locations map. The en-route nodes do not create maps. They do not analyze the traffic passing through them, they just forward the messages that are not addressed to them.

EFFECT OF MISSING TERMINAL END.

Consider the network in Figure 2. It does not contain a Terminal multiplexer, but rather a Drop-and-Insert in its tail end. Occasionally, such topology may be used to interconnect separate ring networks.

Again, follow the path of a message sent from the local node 6 to node 3 for the first time ever.

- The DI-A of the local node sends out the first inquiry out of DI-A, toward the tail.
- As the message enters other nodes in the network, its address is checked. If it is not addressed to the node where it arrived, it is passed by the drop-and-inserts further down the network.
- When the message arrives at tail end drop-and-insert, its address is checked. Since it is not addressed to node 10, the node attempts to continue passing it further away from the originator. No message is sent back, and the originator does not know that the message was lost.
- The originating node will wait for a reply indefinitely and will not turn around to send the message out in the other direction. For the operator at the computer terminal, it will appear that node 3 does not exist in the network.

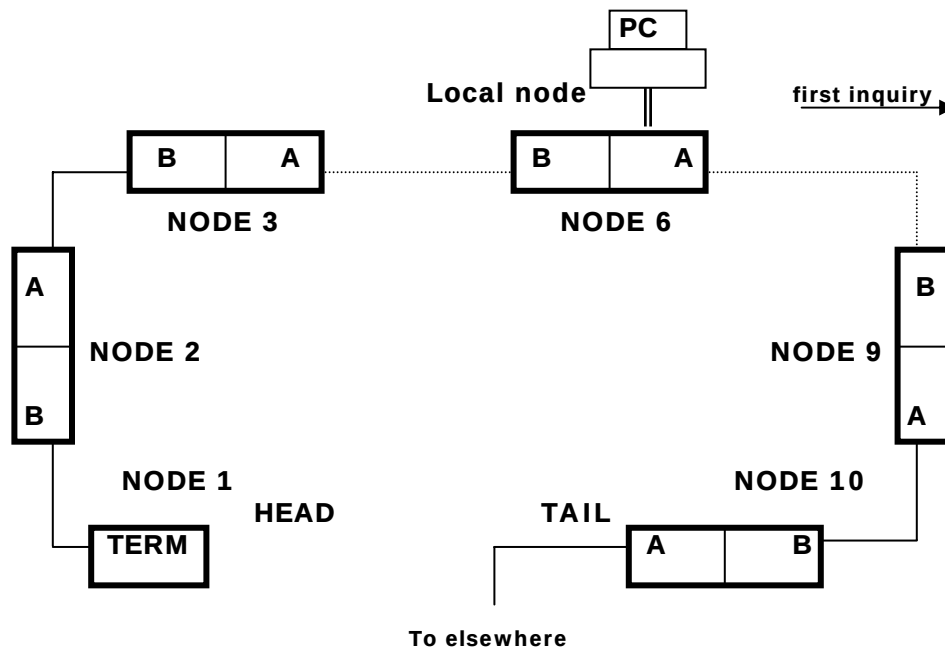


Fig. 2: linear network with terminal multiplexer at Head and drop-and-insert at Tail.

MANUAL BUILDING OF LOCATIONS MAPS.

RFL Simple Command Language (SCL) provides means to force the direction in which an inquiry message is sent out of the multiplexer. This allows an operator to bypass a stalled automatic search process and build a locations map manually.

The manual process relies on the operator eliciting responses from consecutive nodes in the network. When a response message is received from a remote node, the FDL controller in the local node will memorize from which direction it arrived. All subsequent messages to that remote node will be sent in that direction automatically.

The SCL command NEXT facilitates learning the layout of the network. Its function is to order a node to issue an identification request to its neighbor. As the neighboring node is identified, a NEXT command is sent to that location, asking it to identify its neighbor in turn.

This procedure is applied as follows:

◆ The initial neighbor identification inquiry is issued from the local node, where the computer is connected.

◆ If the local node is a **TERMINAL** multiplexer, the initial SCL command will be:

<node>:TERM:NEXT ;

where **<node>** is the node address. This issues an identification request to the next node away from the terminal.

◆ If the local node is a **DROP-AND-INSERT** multiplexer, the initial SCL command will be:

<node>:DI-A:NEXT_A ; or <node>:DI-A:NEXT_B ;

This command requests neighbor identification in direction A (for NEXT_A) or in direction B (for NEXT_B). Unlike a Terminal, a Drop-and-Insert must be told which way to begin.

◆ The subsequent **NEXT** commands are issued to the identified nodes in the network, eliciting responses from their neighbors.

To a DROP-AND-INSERT:

<node>:DI-A:NEXT ;

Drop-and-Insert returns next node number.

To a TERMINAL:

<node>:TERM:NEXT ;

Terminal returns "NO FURTHER NODES PRESENT" code, to signify that end of chain was reached.

Note that these commands are always addressed to DI-A or TERMINAL, even if DI-B is facing the originator. The FDL traffic controller is always located in the TERM/DI-A Common Module.

Once away from local node, only NEXT commands are used (not NEXT_A or NEXT_B). By definition, NEXT requests always propagate away from the originator. Only at the local node it is necessary to initiate the direction of search.

Using system shown in Fig. 2 as an example, the complete search will progress as follows:

- **Initial request in direction A from node 6: 6:DI-A:NEXT_A ;**

The reply will describe type and content of node 7.

- Following inquiry away from node 6: 7:DI-A:NEXT: ;
The reply will describe type and content of node 9.
- And so on - until the last node in this direction: 10:DI-A:NEXT: ;
Node 10 will attempt to find another node downstream. Since there is none, no reply will be received by the originator. Normally, this would be attributed to communications problems, but in this case the operator knows that last node was reached.
- Now the inquiries will be sent in direction B from node 6:
6:DI-A:NEXT_B: ;
The reply will describe type and content of node 5.
- Following inquiry away from node 6: 5:DI-A:NEXT: ;
The reply will describe type and content of node 4.
- And so on - until the last node in this direction: 1:TERM:NEXT: ;
Node 1 will respond with "NO FURTHER NODES PRESENT" code, signifying that the end of chain was reached.

By now, the local node has heard replies from all nodes in the network and has built a locations map for future use. Other nodes have no need for such maps; they always pass the messages away from the originator.

RECOMMENDATIONS.

The search method described above is actually used by RFL Network Management System to auto-configure the system. When collecting network information, a succession of NEXT commands is issued, allowing the local node to build a locations map.

NMS relies on the Terminal ends to issue a "No Further Nodes" message to let it know that the end of chain was reached and that further inquiries must be sent in another direction.

Presence of a Drop-and-Insert at the chain end disrupts this process. "No Further Nodes" message will not be returned, the system will appear to "hang" instead.

In a network with a Drop-and-Insert at the chain end it is therefore recommended that the DI-A's of local nodes face the Terminal end, and the DI-B's of local nodes face the Drop-and-Insert end.

That way, the initial configuration request issued in direction A will encounter a Terminal. "No Further Nodes" message will be returned and the search will move to the other direction (even though it will hang at the very end).

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RFL Electronics, Inc.

IMUX Application Note AN2000-019.

Reference Ass'y 105765-2

IMUX 2000

Alarm Configuration Module Interface for Motherboard to Power Supply I/O.

INTRODUCTION.

There may be a situation where an IMUX Chassis does not have a Power Supply installed, such as where a DACS chassis shares a power supply with a multiplexer; or multiple multiplexers share a common power supply. In this application an Alarm Configuration Module (Part No.105765-2) **MUST** be installed in the empty power supply slot.

OVERVIEW.

The Alarm Configuration Module will provide the interface between the IMUX 2000 Motherboard and the Power Supply I/O. The Alarm Configuration Module will rout the signals from the Motherboard to the Power Supply I/O necessary to drive the Alert/Alarm contacts correctly. See the following page for Jumper Settings.

First release: May 10, 2007

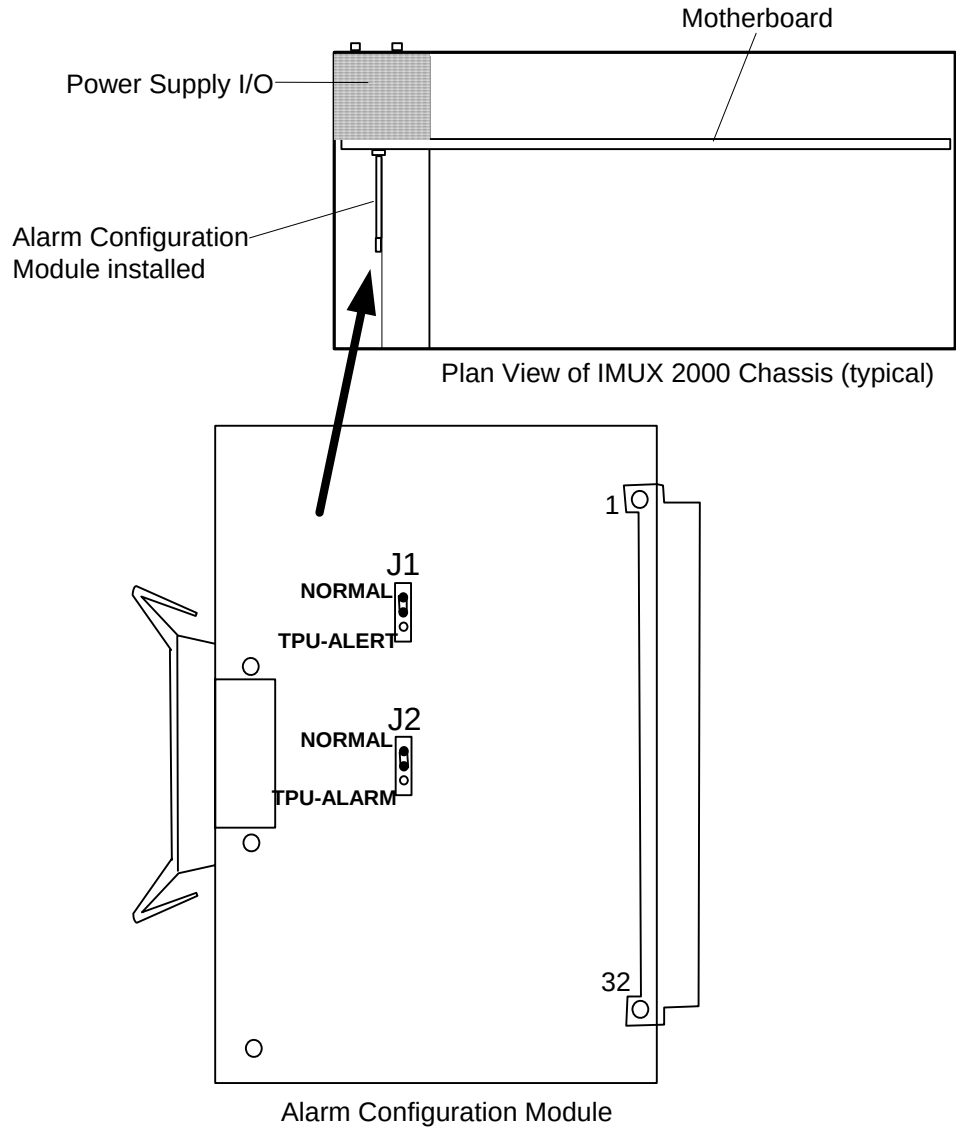


Figure 1. Alarm Configuration Module with Jumper positions

There are two failure situations that can occur:

- A. An internal system failure as detected by the Common Module.
- B. A loss of signal condition (TPU).

Jumpers J1 and J2 configure the module as follows:

Jumper	Position	Result
J1 J2	Normal	Alarm/Alert relays on. (default). I/O is driven by failure conditions internal to the system, as detected by the Common Module.
J1 J2	Normal TPU-Alarm	As above; but additional alarm contacts are driven by the TPU (loss of signal condition).
J1 J2	TPU-Alert Normal	As above; but additional alert contacts are driven by the TPU (loss of signal condition).

SECTION 22. APPENDIX IMUX MODULE ADAPTERS

Last rev.: 10.21.1999 rdw

Note: hot-insertable adapters indicated by: √ HOT-INSERT
 Obsolete items indicated by ~~strikethrough~~.

Table 22-1. T1 MUX and DACS/ILS Adapters

Module Adapter RFL Part Number Description	Associated Channel Module	Ports		Comments
		Type	Connector	
MA-210 9547-1629 <i>Electrical T1 / Timing / Remote</i>	CM3 T1 MUX	T1+Tmg i/o RS-232	DB-15 DB-9	Use to connect MUX to outside line or DACS/ILS. Single-slot module. Refer to sections: 2.3.4, 2.6,6.2. √ HOT-INSERT
MA-215 9547-1820 <i>T1 / Tmg. / SCB / Remote</i>	CM3 T1 MUX	T1+Tmg i/o RS-232 SCB	DB-15 DB-9 DB-9	Use to connect DI-A to DACS/ILS. Two-slot module. Refer to sections: 2.3.4, 2.6,6.2.
MA-220 9547-1830 <i>Dual DB-15 T1 / Timing</i>	DACS/ILS T1 DACS/ILS	T1+Tmg T1+Tmg	DB-15 DB-15	Use to connect 2 local ports of DACS/ILS to T1 MUX. Single-slot module. Refer to section: 3.3.6.
MA-225 9547-1841 <i>SCB / T1 Timing</i>	DACS/ILS T1 DACS/ILS	SCB Timing In	DB-9 DB-9	Use to connect to T1 MUX & timing source. Single-slot module. Refer to section: 3.3.6.
MA-225 9547-1840 <i>SCB / T1 Timing</i>	DACS/ILS T1 DACS/ILS	SCB Timing In	DB-9 DB-9	Use to connect to T1 MUX & timing source. Single-slot module. No jitter buffer, obsoleted by 9547-1841 .
MA-230 9547-1850 <i>Dual Electrical T1</i>	DACS/ILS T1 DACS/ILS	T1 T1	DB-9 DB-9	Use to connect 2 ports of DACS to outside line. Single-slot module. Refer to section: 3.3.6. √ HOT-INSERT
MA-230-1 9547-1850-1 <i>Dual Electrical T1</i>	DACS/ILS T1 DACS/ILS	T1 T1	DB-9 DB-9	Use to connect 2 ports of DACS to outside line. Single-slot module. Special for LG&E, per MD3142. FLOF signal passes through for cascaded DACSes. √ HOT-INSERT
T1 850nm MM OIA 9547-100 <i>Fiberoptic LED T1/ Timing / Remote</i>	DACS/ILS T1 DACS/ILS, CM3 T1 MUX	T1 opto in T1 opto out Timing i/o RS-232	ST ST RJ-11 DB-9	Two-slot module. Refer to sections: 2.3.4, 2.6,6.2 and 12.
T1 1300nm SM OIA 9547-200 <i>Fiberoptic LED T1/ Timing / Remote</i>	DACS/ILS T1 DACS/ILS, CM3 T1 MUX	T1 opto in T1 opto out Timing i/o RS-232	ST ST RJ-11 DB-9	Two-slot module. Refer to sections: 2.3.4, 2.6,6.2 and 12.
T1 1300nm MM OIA 9547-300 <i>Fiberoptic LED T1/ Timing / Remote</i>	DACS/ILS T1 DACS/ILS, CM3 T1 MUX	T1 opto in T1 opto out Timing i/o RS-232	ST ST RJ-11 DB-9	Two-slot module. Refer to sections: 2.3.4, 2.6,6.2 and 12.

Module Adapter RFL Part Number Description	Associated Channel Module	Ports		Comments
		Type	Connector	
T1 1300nm SM OIA 9547-400 <i>Fiberoptic Laser T1/ Timing / Remote</i>	DACS/ILS T1 DACS/ILS, CM3 T1 MUX	T1 opto in T1 opto out Timing i/o RS-232	ST ST RJ-11 DB-9	Two-slot module. Refer to sections: 2.3.4, 2.6,6.2 and 12.
T1 1550nm SM OIA 9547-500 <i>Fiberoptic Laser T1/ Timing / Remote</i>	DACS/ILS T1 DACS/ILS, CM3 T1 MUX	T1 opto in T1 opto out Timing i/o RS-232	ST ST RJ-11 DB-9	Two-slot module. Refer to sections: 2.3.4, 2.6,6.2 and 12.
T1 1550nm SM OIA-10 9547-500-10 <i>Fiberoptic Laser T1/ Timing / Remote</i>	DACS/ILS T1 DACS/ILS, CM3 T1 MUX	T1 opto in T1 opto out Timing i/o RS-232	ST ST RJ-11 DB-9	Two-slot module. Refer to sections: 2.3.4, 2.6,6.2 and 12. Special per MD3115. Higher-power laser, power boosted by 1mW.

Table 22-2. E1 MUX and DACS Adapters

Module Adapter RFL Part Number Description	Associated Channel Module	Ports		Comments
		Type	Connector	
~~MA-211~~ 9547-1797 <i>Electrical E1 / Timing / Remote</i>	CM6 E1 MUX	E1 in E1 out RS-232 Ext Tmg i/o	BNC BNC DB-9 BNC	Use to connect MUX to outside line. Two-slot module. Obsoleted by 9547-17971, MA-211A.
MA-211A 9547-17971 <i>Electrical E1 / Timing / Remote</i>	CM6 E1 MUX	E1 in E1 out RS-232 Ext Tmg i/o	BNC BNC DB-9 BNC	Use to connect MUX to outside line. Two-slot module. ✓ <i>HOT-INSERT</i>
MA-212 9547-1798 <i>E1 / Ext. Tmg. / Remote</i>	CM6 E1 MUX	E1+Tmg i/o RS-232	DB-15 DB-9	Use to connect DI-B to E1 DACS. Single-slot module.
MA-216 9547-1821 <i>E1 / Tmg. / SCB / Remote</i>	CM6 E1 MUX	E1+Tmg i/o RS-232 SCB	DB-15 DB-9 DB-9	Use to connect DI-A to E1 DACS. Two-slot module. Similar to MA-212, with SCB.
MA-221 9547-1831 <i>Dual DB-15 E1 / Timing</i>	DACS-E E1 DACS	E1+Tmg i/o E1+Tmg i/o	DB-15 DB-15	Use to connect to E1 MUX. Single-slot module.
MA-222 9547-1832 <i>Dual BNC Electr. E1 / Tmg.</i>	DACS-E E1 DACS	E1 in A E1 out A E1 in B E1 out B Timing out	BNC BNC BNC BNC BNC	Use to connect DACS to outside line. Two-slot module.
MA-226 9547-1842 <i>SCB / E1 Timing</i>	DACS-E E1 DACS	SCB Timing In	DB-9 BNC	Use to connect to E1 MUX. Single-slot module.
MA-231 9547-1851 <i>Dual Electrical E1</i>	DACS-E E1 DACS	E1 in A E1 out A E1 in B E1 out B	BNC BNC BNC BNC	Use to connect DACS to outside line. Single-slot module. ✓ <i>HOT-INSERT</i>
E1 850nm MM OIA 9547-150 <i>Fiberoptic LED E1/ Timing / Remote</i>	DACS-E E1 DACS, CM6 E1 MUX	E1 opto in E1 opto out Timing i/o RS-232	ST ST RJ-11 DB-9	Two-slot module.
E1 1300nm SM OIA 9547-250 <i>Fiberoptic LED E1/ Timing / Remote</i>	DACS-E E1 DACS, CM6 E1 MUX	E1 opto in E1 opto out Timing i/o RS-232	ST ST RJ-11 DB-9	Two-slot module.
E1 1300nm MM OIA 9547-350 <i>Fiberoptic LED E1/ Timing / Remote</i>	DACS-E E1 DACS, CM6 E1 MUX	E1 opto in E1 opto out Timing i/o RS-232	ST ST RJ-11 DB-9	Two-slot module.
E1 1300nm MM OIA 9547-351 <i>Fiberoptic LED E1/ Timing / Remote</i>	DACS-E E1 DACS, CM6 E1 MUX	E1 opto in E1 opto out Timing i/o RS-232	ST ST RJ-11 DB-9	Two-slot module. Uses T1-style circuit/schematic. Obsoleted by 9547-350.

Module Adapter RFL Part Number <i>Description</i>	Associated Channel Module	Ports		Comments
		Type	Connector	
E1 1300nm SM OIA 9547-450 <i>Fiberoptic Laser E1/ Timing / Remote</i>	DACS-E E1 DACS, CM6 E1 MUX	E1 opto in E1 opto out Timing i/o RS-232	ST ST RJ-11 DB-9	Two-slot module.
E1 1550nm SM OIA 9547-550 <i>Fiberoptic Laser E1/ Timing / Remote</i>	DACS-E E1 DACS, CM6 E1 MUX	E1 opto in E1 opto out Timing i/o RS-232	ST ST RJ-11 DB-9	Two-slot module.

Table 22-3. Power Supply I/O Adapters

Module Adapter RFL Part Number <i>Description</i>	Associated Channel Module	Ports		Comments
		Type	Connector	
2000 PS/ALM I/O DC 9547-18801 <i>DC Pwr Supply / Alarm I/O</i>	2000 PS xxDC DC Pwr Supply	Power Alarm	Term. Block Term. Block	Use for one or two DC power supplies. Refer to IMUX manual, sections 2.3.6, 9.2, 11.3. Use with 9547-820,830,840 (T1).
2000 PS/ALM I/O AC 9547-18802 <i>DC Pwr Supply / Alarm I/O</i>	2000 PS 120AC AC Pwr Supply	Power	Term. Block Term. Block	Use for one or two AC power supplies. Refer to IMUX manual, sections 2.3.6, 9.2, 11.3. Use with 9547-850 (T1).
2000 PS/ALM I/O HYBRID 9547-18803 <i>AC / DC Pwr Supply / Alarm I/O</i>	2000 PS 120AC AC Pwr Supply PS xxDC DC Pwr Supply	Power Alarm	Term. Block Term. Block	Use for one DC and one AC power supply. Refer to IMUX manual, sections 2.3.6, 9.2, 11.3. Use with 9547-820,830,840,850 (T1).
2000 PS/ALM I/O 48/125DC 9547-18804 <i>DC Pwr Supply / Alarm I/O</i>	2000 PS 48/125DC DC Pwr Supply	Power Alarm	Term. Block Term. Block	Use for one or two DC power supplies. Refer to IMUX manual, sections 2.3.6, 9.2, 11.3. Use with 9547-920 (E1).
2000 PS/ALM I/O 88/265AC 9547-18805 <i>DC Pwr Supply / Alarm I/O</i>	2000 PS 220AC AC Pwr Supply	Power Alarm	Term. Block Term. Block	Use for one or two AC power supplies. Refer to IMUX manual, sections 2.3.6, 9.2, 11.3. Use with 9547-930 (E1).
2000 PS/ALM I/O HYBRID 9547-18806 <i>AC / DC Pwr Supply / Alarm I/O</i>	2000 PS 220AC AC Pwr Supply PS 48/125DC DC Pwr Supply	Power Alarm	Term. Block Term. Block	Use for one DC and one AC power supply. Refer to IMUX manual, sections 2.3.6, 9.2, 11.3. Use with 9547-920, -930 (E1).
2000 PS/ALM I/O 24DC 9547-18807 <i>AC / DC Pwr Supply / Alarm I/O</i>	2000 PS	Power Alarm	Term. Block Term. Block	Use with 9547-910.
2000 PS/ALM I/O DC/AC 9547-18808 <i>AC / DC Pwr Supply / Alarm I/O</i>	2000 PS	Power Alarm	Term. Block Term. Block	Use with 9547-950.

Table 22-4. Voice Module Adapters

Module Adapter RFL Part Number <i>Description</i>	Associated Channel Module	Ports		Comments
		Type	Connector	
MA-301 9547-1635 <i>4-Wire 50-Pin Voice Interface</i>	VF5A, VF6I, VF7, VF15, VF17, VF18	Voice	Telco	Uses 50-pin Amphenol connector. Can provide up to 3 channels with optional back cabling. ✓ HOT-INSERT
MA-301A 9547-16353 <i>SWC 4-W Term.Block I/O</i>	VF5A, VF6I	Voice	Term. Block	SWC-rated 2-channel module. Double-slot. ✓ HOT-INSERT
MA-301A-1 9547-163531 <i>SWC 4-W Term.Block I/O</i>	VF5A, VF6I	Voice	Term. Block	SWC-rated 1-channel module. Double-slot module. ✓ HOT-INSERT
MA-301B 9547-16354 <i>Screw Compression I/O</i>	VF5A	Voice	Pluggable Term. Block	
MA-303 9547-1743 <i>2-port Voice I/O</i>	VF5A, VF-8A, VF10, VF11, VF15, VF16, VF17, VF18	Voice	RJ-11	Single-slot module. Requires external ring generator for VF11. Single-slot module. ✓ HOT-INSERT
MA-303B 9547-17433 <i>2W I/O with screw terminal</i>	VF10, VF11	Voice	Removable Terminal Block	Requires external ring generator.
MA-304 9547-17431 <i>2-port Voice I/O w. ring generator</i>	VF5A, VF-8A, VF10, VF11, VF16, VF18	Voice	RJ-11	Single-slot module. Contains on-board ring generator. ✓ HOT-INSERT
MA-304B 9547-17434 <i>2W I/O with screw terminal</i>	VF10, VF11	Voice	Removable Terminal Block	Contains on-board ring generator.
MA-305 9547-1927 <i>4-port Voice Interface</i>	VF-25E	Voice	telco	Uses 50-pin Amphenol connector. Single-slot module.
MA-306 9547-17432 <i>2W with ring generator</i>	VF-8A	Voice	RJ-11	Single-slot module.
MA-322 9547-16352 <i>Two-2-wire Voice Interface</i>	VF-5A, VF6	Voice	telco	Double-slot module. Converts both 4-wire outputs to 2-wire line.
MA-324 9547-16351 <i>2+4 Voice Interface</i>	VF-5A, VF6	Voice	telco	Double-slot module. Converts one of the 4-wire outputs to 2-wire line, the other remains 4-wire.

Table 22-5. Data Module Adapters

Module Adapter RFL Part Number <i>Description</i>	Associated Channel Module	Ports		Comments
		Type	Connector	
MA-402 9547-1692 <i>2-port RS-232 I/O</i>	DA-91	RS-232 RS-232	DB-9 DB-9	Single-slot module.
MA-402I 9547-1691 <i>2-port RS-232 I/O</i>	DA-91I	RS-232 RS-232	DB-9 DB-9	Single-slot module. √ <i>HOT-INSERT</i>
MA-404 9547-1638 <i>5-port RS-232 I/O</i>	DA-191A, DS-961D	5 x RS232, timing	5 x RJ11	Single-slot module.
MA-404A MA-405 9547-16321 <i>7-port RS-232 I/O</i>	DA-191A, DA-191B DA-121	7 x RS232	DB-37	Single-slot module. Requires DB-37 to seven RS-232 ports adapter cable. √ <i>HOT-INSERT</i>
MA-405-1 9547-163211 <i>7-port RS-232 I/O</i>	DA-121	7 x RS232	DB-37	Single-slot module. Requires DB-37 to seven RS-232's adapter cable. Modified per MD3099 for 3ft cable assembly length. √ <i>HOT-INSERT</i>
MA-405I 9547-163212 <i>7-port RS-232 I/O</i>	DA-121I	7 x RS232	DB-37	Single-slot module. Requires DB-37 to seven RS-232 ports adapter cable. √ <i>HOT-INSERT</i>
MA-406 9547-1632 <i>RS-449 DTE/DCE I/O</i>	DS-562B	RS-449	DB-37	Single-slot module. √ <i>HOT-INSERT</i>
MA-406IA 9547-16331 <i>RS-449 DTE/DCE I/O</i>	DS-562I	RS-449	DB-37	Single-slot module. √ <i>HOT-INSERT</i>
MA-407I 9547-1750 <i>G.703 Contr-Dir Adapter</i>	DS-562I	G.703	DB-25	Contra-directional Interface.
MA-408I 9547-1755 <i>G.703 Co-Dir Adapter</i>	DS-562I	G.703	DB-25	Co-directional Interface.
MA-409 9547-1726 <i>V.35 DTE/DCE I/O</i>	DS-562B	V.35	DB-37	Single-slot module.
MA-409IA 9547-1727 <i>V.35 DTE/DCE I/O</i>	DS-562I	V.35	DB-37	Single-slot module.
MA-410I 9547-1760 <i>X.25 I/O</i>	DS-562I	X.25	DB-15	Single-slot module.
MA-412 9547-1731 <i>RS-449 DCE I/O</i>	DS-64NC	RS-449 DCE Timing	DB-37S RJ-11	Single-slot module.
MA-412A MA-413 9547-1734 <i>V.35 DCE I/O</i>	DS-64NC	RS-449 DCE Timing	DB-37S RJ-11	Single-slot module.

Module Adapter RFL Part Number <i>Description</i>	Associated Channel Module	Ports		Comments
		Type	Connector	
MA-414 9547-1737 <i>RS-449 DTE I/O</i>	DS-64NC	RS-449 DTE	DB-37P	Single-slot module.
MA-414A 9547-1737 <i>RS-449 DTE I/O</i>	DS-64NC	RS-449 DTE	DB-37P	Single-slot module.
MA-415 9547-1740 <i>V.35 DTE I/O</i>	DS-64NC	RS-449 DTE	DB-37P	Single-slot module.
MA-415A 9547-1740 <i>V.35 DTE I/O</i>	DS-64NC	RS-449 DTE	DB-37P	Single-slot module.
MA-420 9547-16922 <i>2-port RS-232 I/O</i>	DA-191A	2 x RS232	2 x DB-9	Single-slot module.
MA-420A 9547-16922 <i>2-port RS-232 I/O</i>	DA-191A, DA-191B	2 x RS232	2 x DB-9	Single-slot module.
MA-420X 9547-2140 <i>X.21 DCE Interface</i>	DA-191A	X.21	DB-15	Single-slot module.
MA-421X 9547-21401 <i>X.21 DTE Interface</i>	DA-191A	X.21	DB-15	Single-slot module.
MA-425 9547-16925 <i>2-port RS-422 I/O</i>	DA-191A, DA-191B	2 x RS422	2 x DB-9	Single-slot module. √ <i>HOT-INSERT</i>
MA-427	DS-64NC			
MA-440 9547-16924 <i>4-port RS-232 I/O</i>	DA-191A	4 x RS232	2 x DB-9	Double-slot module.
MA-440A 9547-16924 <i>4-port RS-232 I/O</i>	DA-191A, DA-191B	4 x RS232	2 x DB-9	Double-slot module.
MA-450 106890 <i>HS Async Adapter</i>	DA-200	RS-232	DB-9	Single-slot module. √ <i>HOT-INSERT</i>
MA-455 106965 <i>OCUDP Adapter</i>	OCUDP	DATA	RJ-45	Single-slot module. √ <i>HOT-INSERT</i>
MA-720 106815 <i>1-port MM fiber I/O</i>	DA-191A, DA-191B		ST fiber connector	Single-slot module.
MA-722 106820 <i>2-port MM fiber I/O</i>	DA-191A, DA-191B		ST fiber connector	Single-slot module.
MA-724 106835 <i>1-port SM fiber I/O</i>	DA-191A, DA-191B		ST fiber connector	Single-slot module.
MA-726 106840 <i>2-port SM fiber I/O</i>	DA-191A, DA-191B		ST fiber connector	Single-slot module.

Table 22-6. Specialty Interface Adapters

Module Adapter RFL Part Number <i>Description</i>	Associated Channel Module	Ports		Comments
		Type	Connector	
MA-500 9547-1586 <i>Bus Repeater Adapter</i>	BRM Bus Repeater	Bus	DB-25	Use to connect IMUX expansion shelves. Single-slot module. Requires custom cable & P/STAT I/O. Compatible with older cabling. Obsoleted by MA-501, 9547-15861.
MA-501 9547-15861 <i>Bus Repeater Adapter</i>	BRM Bus Repeater	Bus 1 Bus 2	DB-37 DB-37	Use to connect IMUX expansion shelves. Single-slot module. Requires custom cable. √ <i>HOT-INSERT</i>
MA-503 9547-1641 <i>VF6 Orderwire Adapter</i>	VF6			Use to connect to order-wire chassis. No signaling. Obsoleted.
SHORT HAUL 9547-600 <i>Short-Haul Fiber I/O</i>	DS-562I Sync Data Module	opto in opto out	ST ST	Single-slot module.
MA-700 106810 <i>Telemetry TMX/TMR I/O</i>	TMX,TMR Telemetry Transmitter, Receiver	Analog	Term. Block	Single-slot module. Adapter used for both TMX and TMR. Refer to TMX/TMR instruction. √ <i>HOT-INSERT</i>
MA-800 106875 <i>Variable Video I/O</i>	VS-100 Variable Video	Ext. power in RS-449 Video 2 x future	Term. Block DB-9 BNC 2 x BNC	Single-slot module. √ <i>HOT-INSERT</i>

Table 22-7. Status Module Adapters

Module Adapter RFL Part Number <i>Description</i>	Associated Channel Module	Ports		Comments
		Type	Connector	
MA-601 106140-1 <i>8-IN Status Adapter</i>	STATUS Status Module	I/O Points	Term. Block	8 inputs. Single-slot module. Refer to STATUS instruction. √ <i>HOT-INSERT</i>
MA-602 106140-2 <i>8-OUT Status Adapter</i>	STATUS Status Module	I/O Points	Term. Block	8 outputs. Single-slot module. Refer to STATUS instruction. √ <i>HOT-INSERT</i>
MA-603 106140-3 <i>16-IN Status Adapter</i>	STATUS Status Module	I/O Points	Term. Block	16 inputs. Double-slot module. Refer to STATUS instruction. √ <i>HOT-INSERT</i>
MA-604 106140-4 <i>16-OUT Status Adapter</i>	STATUS Status Module	I/O Points	Term. Block	16 outputs. Double-slot module. Refer to STATUS instruction. √ <i>HOT-INSERT</i>
MA-605 106140-5 <i>8-IN/OUT Status Adapter</i>	STATUS Status Module	I/O Points	Term. Block	8 inputs, 8 outputs. Double-slot module. Refer to STATUS instruction. √ <i>HOT-INSERT</i>
MA-606 106140-6 <i>8-OUT/IN Status Adapter</i>	STATUS Status Module	I/O Points	Term. Block	8 outputs, 8 inputs. Double-slot module. Refer to STATUS instruction. √ <i>HOT-INSERT</i>

Table 22-8. MTS (Transfer-Trip) Module Adapters

Module Adapter RFL Part Number <i>Description</i>	Associated Channel Module	Ports		Comments
		Type	Connector	
2F I/O 48/125 105770-2 <i>2-function solid-state I/O 48/125Vdc</i>	MTS Transfer Trip Module	i/o	Term. Blocks	Two-slot module. Refer to MTS instruction. √ <i>HOT-INSERT</i>
2F I/O 250 105770-3 <i>2-function solid-state I/O 250Vdc</i>	MTS Transfer Trip Module	i/o	Term. Blocks	Two-slot module. Refer to MTS instruction. √ <i>HOT-INSERT</i>
4F I/O 48/125 105770-4 <i>4-function solid-state I/O 48/125Vdc</i>	MTS Transfer Trip Module	i/o	Term. Blocks	Four-slot module. Refer to MTS instruction. √ <i>HOT-INSERT</i>
4F I/O 250 105770-5 <i>4-function solid-state I/O 250Vdc</i>	MTS Transfer Trip Module	i/o	Term. Blocks	Four-slot module. Refer to MTS instruction. √ <i>HOT-INSERT</i>
2F RLY I/O 48/125 105740-2 <i>2-function relay I/O 48/125Vdc</i>	MTS Transfer Trip Module	i/o	Term. Blocks	Two-slot module. Refer to MTS instruction. √ <i>HOT-INSERT</i>
2F RLY I/O 250 105740-3 <i>2-function relay I/O 250Vdc</i>	MTS Transfer Trip Module	i/o	Term. Blocks	Two-slot module. Refer to MTS instruction. √ <i>HOT-INSERT</i>
4F RLY I/O 48/125 105740-4 <i>4-function relay I/O 48/125Vdc</i>	MTS Transfer Trip Module	i/o	Term. Blocks	Four-slot module. Refer to MTS instruction. √ <i>HOT-INSERT</i>
4F RLY I/O 250 105740-5 <i>4-function relay I/O 250Vdc</i>	MTS Transfer Trip Module	i/o	Term. Blocks	Four-slot module. Refer to MTS instruction. √ <i>HOT-INSERT</i>

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SECTION 23. ACCESSORY EQUIPMENT AND SYSTEM DRAWINGS

If any accessory equipment was furnished with your IMUX 2000 terminal at the time of purchase, information on these items will be found immediately following this page. This may include Instruction Data Sheets, Schematics, Wiring Diagrams, or other documents. Drawings that document the specific make-up of your system are also included in this section.

