INSTRUCTION MANUAL

RFL 6785P
Programmable On/Off Carrier System

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RFL Electronics Inc.

WARRANTY

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

RFL Electronics Inc. products are warranted against defects in material and workmanship for one year from the date of shipment. During the warranty period, RFL will repair or, at its option, replace components that prove to be defective at no cost to the customer, except the one-way shipping cost of the failed assembly to the RFL Customer Service facility in Boonton, New Jersey.

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 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.

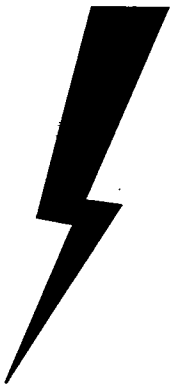
This warranty is in lieu of all other warranties, whether expressed, implied or statutory, including but not limited to implied warranties of merchantability and fitness for a particular purpose. In no event shall RFL be liable, whether in contract, in tort, or on any other basis, for any damages sustained 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 revenue, 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.

RFL Electronics Inc.
Boonton, New Jersey

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

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.

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.

RFL Electronics Inc.

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"Amphenol" is a registered trademark of the Amphenol Products Division of Allied-Signal Inc.
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The trademark information listed above is, to the best of our knowledge, accurate and complete.

LIST OF EFFECTIVE PAGES

When revisions are made to the RFL 6785P Instruction Manual, the entire section where revisions were made is replaced. For the edition of this manual dated November 28, 2001 the sections are dated as follows:

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Section 1	June 26, 1998
Section 2	June 26, 1998
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Section 1. GENERAL INFORMATION

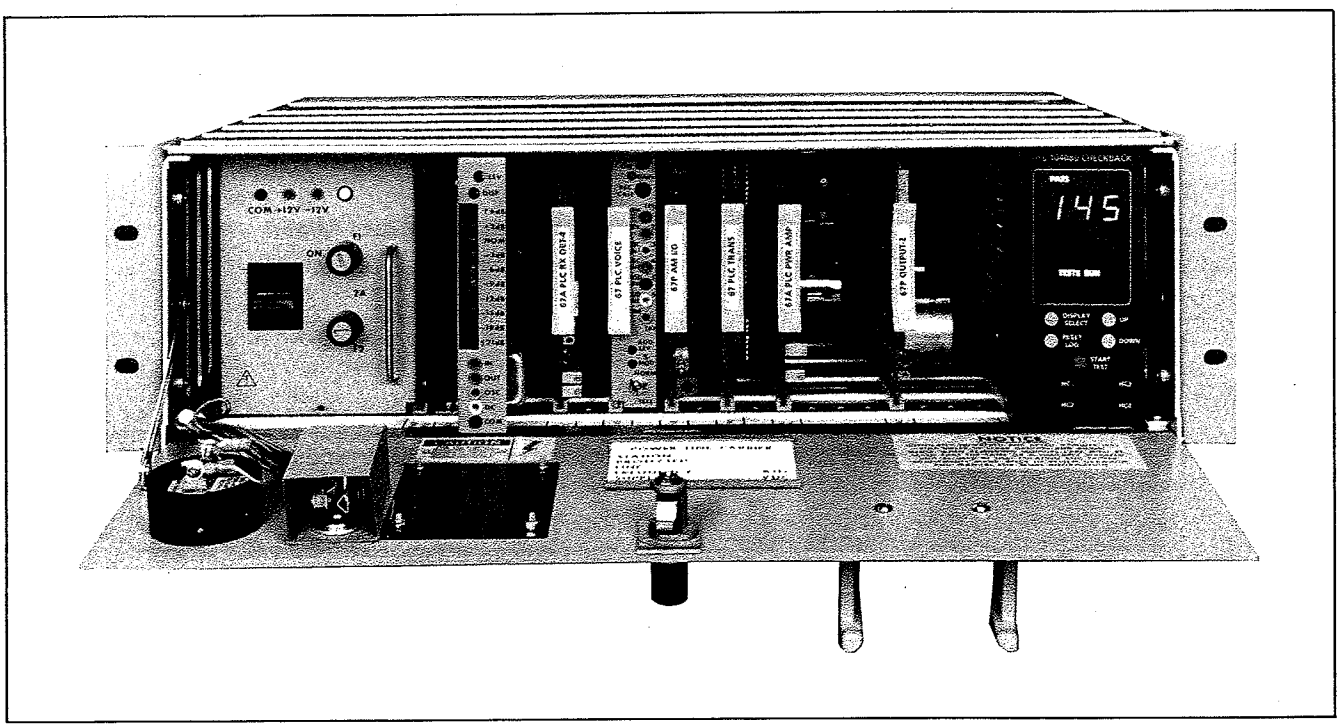


Figure 1-1. RFL 6785P Programmable AM Powerline Carrier System

1.1. PURPOSE OF THIS MANUAL

This manual provides operation and maintenance information for the RFL 6785P Programmable On/Off Carrier System, shown in Figure 1-1. Included are an overall functional description of its purpose, a physical description and specifications, installation instructions, operating procedures, maintenance procedures, theory of operation, and replaceable parts information for all circuit card modules.

1.2. PURPOSE OF EQUIPMENT

The RFL 6785P is a high-speed on/off powerline carrier transmitter/receiver terminal, designed for use in directional comparison blocking applications for high-speed protective relaying communications. A typical system consists of one RFL 6785P terminal at each end of the power line being protected.

Normally, the transmitter is turned off; this allows the line to trip for an internal fault. The carrier is used to prevent tripping during external faults; when one occurs, the directional relay that detects the fault will key the RFL 6785P's CARRIER START input. The transmitter will turn on, sending a carrier to the other end of the protected line. The carrier will be used at the receiving terminal to prevent overtripping.

The blocking carrier is amplitude modulated, and can be set to any frequency from 30 kHz to 535 kHz in 500-Hz steps. If a two-terminal line is being protected, the transmit and receive frequencies will be the same. If a three-terminal line is being protected, the transmitters at each terminal will be 100 Hz apart. The receivers all have wide bandwidths, so each receiver will be able to receive a carrier transmitted by any of the other terminals on the line.

The receiver section contains an LED array, which is visible with the front door closed. The array monitors the incoming signal level, and covers a range of -20 dB to +5 dB. Three green LED's indicate NORMAL operation, followed by two yellow LED's for RESERVE operation and three red LED's for channel WARNING.

The RFL 6785P exhibits a high degree of dependability, and has a response time of 1.5 to 3 ms, depending on the the selected channel bandwidth. Its interface circuits are compatible with almost every existing carrier blocking relay.

1.3. FEATURES

a. Programmable Transmitter Frequency. The transmitter frequency is programmed into the RFL 6785P's transmitter module by setting two DIP switches. Different combinations of switch settings allow the frequency to be set anywhere from 30 kHz to 535 Khz, in 50-Hz increments. The transmitter module can also be used as a two or three-frequency FSK Module (2F or 3F), compatible with existing frequency-shift 6780 powerline carrier systems.

b. Adjustable Output Level. The output power level is continuously adjustable from 0.1 watt to 10 watts, and offers a separately adjustable reduced keying level.

c. Programmable Receiver Frequency. The receiver frequency is set by using two DIP switches on the downshifter module. The frequency can be set anywhere from 30 kHz to 535 kHz, in 500-Hz increments.

d. Compatibility With Existing Equipment. The programmable transmitter and downshifter modules are completely compatible with existing non-programmable RFL 6785 systems. This greatly reduces the number of spares required for both new and existing systems.

In addition, the terminal assignments on the RFL 6785P's rear panel terminal blocks are consistent with those of non-programmable RFL 6785 systems; this allows an RFL 6785P to be installed in a system that was based on the older RFL 6785 product.

e. Compact. A complete 10-watt RFL 6785P transmitter/receiver is contained in a chassis that occupies three vertical rack units (5.25 inches) in a standard 19-inch enclosure.

f. Voice Channel Option. As shown in Figure 1-1, a voice service channel can be added as an option. This allows the terminals at both ends of the protected line to be linked by two-way voice communications. All RFL 6785P chassis are pre-wired for the voice option; it can be easily installed in the field at any time.

g. Checkback Testing Option. All RFL 6785P chassis are pre-wired to accept an RFL 6720P Checkback Module. This can be installed at the factory, or retrofitted in the field at any time. The RFL 6720P allows you to manually or automatically test the RFL 6785P at both ends of the protected line for proper operation. You can also remotely interrogate or re-program the RFL 6720P by accessing it through the RS-232 port on the RFL 6785P's rear panel.

1.4. PHYSICAL DESCRIPTION

Each RFL 6785P terminal is a group of circuit card modules housed in a chassis three rack units high (3U, or 5.25 inches). The chassis accepts circuit card modules in a bookshelf-style arrangement, and is equipped with a drop-down front door.

Interconnections between modules are made by a motherboard at the rear of the chassis. External equipment is connected to the chassis through terminal blocks on the rear panel.

1.5. SYSTEM SPECIFICATIONS

As of the date this manual was published, the following specifications apply to all RFL 6785P terminals, except where indicated. Because all RFL products undergo constant refinement and improvement, these specifications are subject to change without notice.

1.5.1. Transmitter Section

Operating Frequency Range: 30 to 535 kHz, field-programmable by setting switches.

Setting Resolution: 50 Hz.

Power Output: Continuously adjustable from 0.1 watt to 10 watts.

Harmonic Content: -55 dBmo.

Frequency Stability: ±10 Hz.

Output Stability: ±1 dB.

Output Impedance: 50 ohms.

1.5.2. Receiver Section

Operating Range: 30 to 535 kHz, field-programmable by setting switches.

Setting Resolution: 500 Hz.

Operating Bandwidth: 500 Hz, 1000 Hz, or 1500 Hz.

Response Time:
500-Hz Bandwidth: 5 ms.
1000-Hz Bandwidth: 3 ms.
1500-Hz Bandwidth: 1.5 ms.

Sensitivity: 5 mVrms to 70 Vrms.

Input Impedance: 75, 1500, 2000, or 8000 ohms. An optional resistor may be placed directly across the receiver port to tailor its impedance.

1.5.3. Inputs And Outputs

Optically-Isolated Inputs: Two: CARRIER START and CARRIER STOP. Input voltages can range between 42 Vdc and 142 Vdc (either positive or negative), at up to 18 mA. Jumpers on the RFL 67P PLC AM I/O module also allow for activation upon removal of a voltage.

Solid-State Outputs:
BLOCK OUTPUT: 4 Vdc to 156 Vdc @ 0.01 to 1ampere; also 200mA, 180mA, and 20mA @ station battery voltage.
CHECKBACK FAIL: 4 Vdc to 156 Vdc @ 0.01 to 1 ampere.

Relay Outputs:
BLOCK RECEIVED: 2 Form C contacts; each set capable of switching 1 ampere @ 125 Vdc maximum.

> **NOTE**
> The Block Relay adds 15ms to the operate time and should be used for supervision only.

POWER SUPPLY FAIL: 1 Form C contact, capable of switching 1 ampere @ 125Vdc maximum.
TRANSMITTER FAIL: 1 Form C contact, capable of switching 1 ampere @ 125Vdc maximum.

Other Outputs:
STATION BATTERY: Switched and fused; 750 mA maximum @ station battery voltage.
REMOTE LEVEL INDICATOR: 0 to 4 Vdc @ 4 mA maximum (not SWC rated).

1.5.4. RFL 6720P Checkback Module (optional)

Codes: Capable of transmitting and receiving 16 asynchronous codes.

Autotest Time Interval: Programmable from 1 to 24 hours, in 1-hour increments.

Alarm Reporting: Available through RS-232 port on RFL 6785P rear panel.

Test/Fail Output: Solid-state relay, rated for 1 ampere.

1.5.5. General

Channel Spacings And Delay Times: See Table 1-1.

Table 1-1. Minimum permissible channel spacings and delay times, RFL 6785P Programmable On/Off Powerline Carrier System

Nominal Bandwidth	Channel (2) Delay Time	Channel (1) Spacing With Voice	Channel (1) Spacing Without Voice
500 Hz	5 ms	4 kHz	1 kHz
1000 Hz	3 ms	4 kHz	2 kHz
1500 Hz	1.5 ms	4 kHz	3 kHz

NOTE 1. The above channel spacings are based on an approximate line loss of 20 dB.

NOTE 2. Channel delay times are for solid -state outputs only.

Environmental:
Temperature Range: -20°C to +60°C (-4°F to +140°F).
Relative Humidity: Up to 95% at +40°C (+104°F).

Interface Dielectric Strength: All input, output, and tone lines are isolated from ground and from all other circuits. Breakdown is 1500Vrms @50/60Hz, 2500Vdc, and 2500 volts @ 1.5MHz, in accordance with IEEE Surge Withstand Capability Specification 472-1978 (ANSI C.37.90-1978). The RFL 6785P also meets the requirements of ANSI-IEEE Fast Transient Specification C.37.90.1.

Input Power Requirements:
48-Vdc Systems:
Voltage Range: 40 Vdc to 58 Vdc.
Current Draw:
Quiescent: 575 mA.
At 10-Watt Output: 1.15 amperes.
125-Vdc Systems:
Voltage Range: 104 Vdc to 140 Vdc.
Current Draw:
Quiescent: 250 mA.
At 10-Watt Output: 450 mA.

1.6. TERMINAL CONFIGURATION

Each RFL 6785P terminal is housed in a rack-mounted chassis containing interconnected circuit card modules. The space and power requirements for all RFL 6785P modules are listed in Table1-2.

Table 1-2. Space and power requirements, RFL 6785P subassemblies

Description	Model No.	Assy. No.	Current Draw (1) +12V	-12V	+15V	-15V	Module Spaces Required	Additional Information
Input/Output Module	67P AM I/O	104025	50	50	. . .	. . .	2	Section 5
Transmitter Module	67P PLC TRANS	104040	75	240	. . .	. . .	2	Section 6
10-Watt Amplifier	67P PLC AMP	104015	. . .	. . .	600	600	4	Section 7
Output Filters:								
30 kHz to 67.5 kHz	67P OUTPUT	104070-1	(2)	(2)	(2)	(2)	3	Section 8
64 kHz to 157.5 kHz	67P OUTPUT	104070-2						
154 kHz to 393.5 kHz	67P OUTPUT	104070-3						
392 kHz to 535 kHz	67P OUTPUT	104075						
Downshifter Module	67P RX DNSH	104005	220	50	. . .	. . .	3	Section 9
Receiver Detectors:								
Standard Module	67A PLC RX DET	99015-2	110	85	. . .	. . .	2	Section 10
With Voice Filter	67A PLC RX DET-1	99015-3	150	150	. . .	. . .		
Voice Module (3)	67PLC VOICE	95555	95	60	. . .	. . .	2	Section 11
Checkback Module (3)	RFL 6720P	104080	400	. . .	. . .	. . .	5	Section 12
Power Supplies:								
48-Volt Input	67P 48DC	104020-2	1000 (4)	1000 (4)	3300 (4)	3300 (4)	8	Section 13
125-Volt Input	67P 125DC	104020-3						
Chassis	67P CHASSIS	104060-1	. . .	. . .	. . .	. . .	. . .	Section 14
Motherboard	67P INTERCONNECT	104030-1	. . .	. . .	. . .	. . .	(5)	
Isolation Board	67P ISOL	104035-1	30	. . .	. . .	. . .	(6)	

1. Currents are shown in milliamperes. Values shown for power supply modules are output capacity.
2. Passive; no active components.
3. Optional.
4. The +12-volt supply is derived from the output of the +15-volt supply, and the -12-volt supply is derived from the output of the -15-volt supply. Because of this, the total current draw from both positive outputs and both negative outputs cannot exceed 3.33 amperes. (For example a current draw of 2.75 amperes from the +15-volt supply and 1 ampere from the +12-volt supply would equal 3.75 amperes, which would exceed the current limit.
5. Mounts at rear of chassis; contains mating connectors for all other modules.
6. Mounts at rear of chassis; contains rear panel terminal blocks and isolation relays and circuits.

1.7. RFL 6785P SUBASSEMBLIES

Each RFL 6785P terminal contains several circuit card modules and other subassemblies. Paragraphs 1.7.1 through 1.7.11 describe the different parts of the RFL 6785P terminal. A block diagram for a typical RFL 6785P terminal appears in Figure 1-2.

1.7.1. Input/Output Module

The RFL 67P AM I/O input/output module monitors the CARRIER START, CARRIER STOP, and RESERVE SIGNAL KEY input lines, as well as several signals generated inside the RFL 6785P; it uses the information it receives from these signals to generate command signals for the transmitter and receiver detector modules. Jumpers on the RFL 67P AM I/O allow the logic to be set according to the requirements of the specific application. Additional information on the RFL 67P AM/I/O can be found in Section 5 of this manual.

1.7.2. Transmitter Module

The RFL 67P PLC TRANS is a programmable powerline carrier transmitter, utilizing Direct Digital Synthesis (DDS). DDS is used to generate a stepped sine wave from a digital-to-analog (D/A) converter by reading a sine look-up table stored in ROM; the desired output frequency is selected by programming a set of DIP switches.

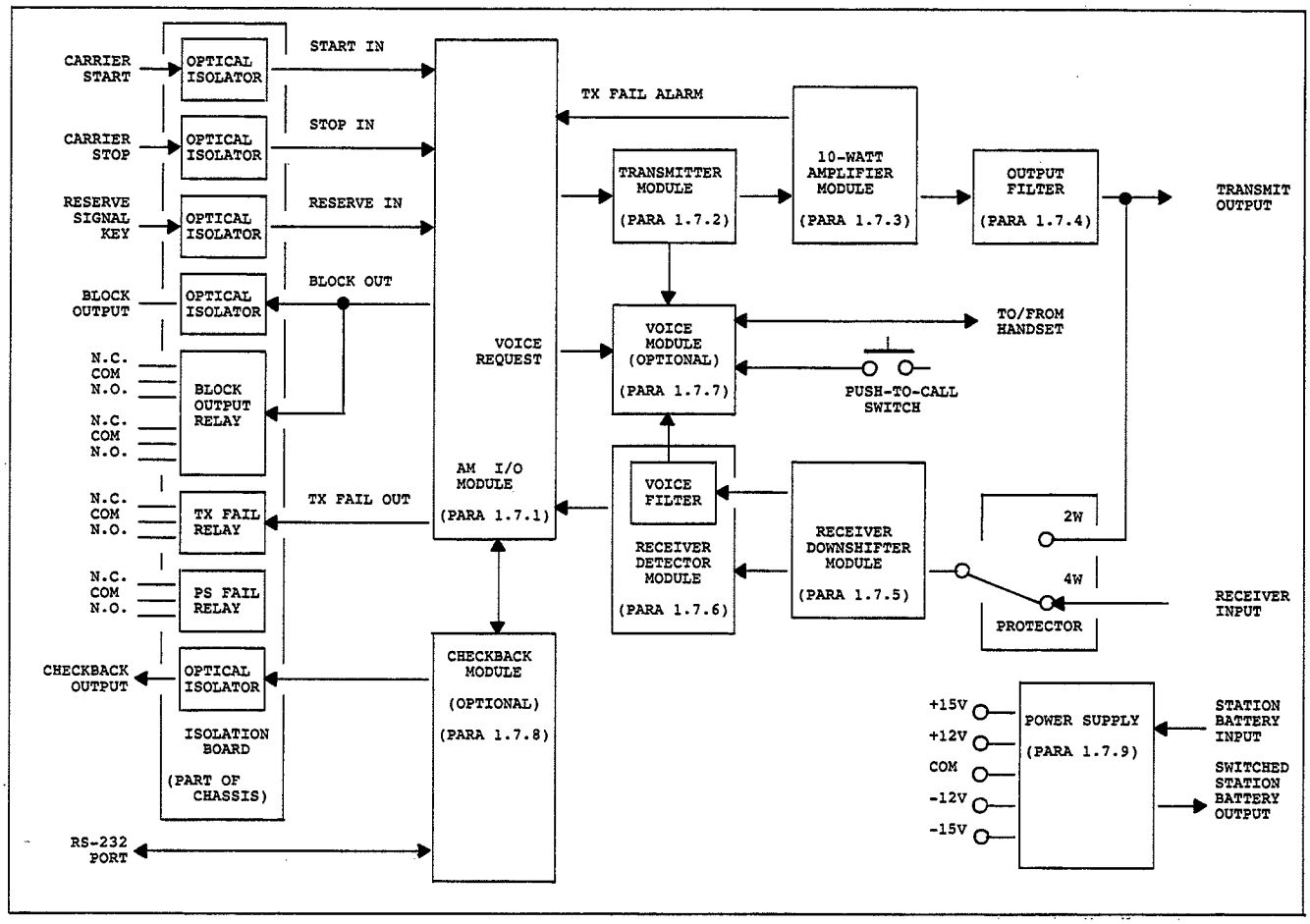


Figure 1-2. Block diagram, RFL 6785P Programmable On/Off Powerline Carrier System

The waveform produced by the D/A converter is smoothed by an anti-aliasing filter before it is fed to an amplitude modulating circuit. The modulation circuit can also be modulated by voice if the RFL 6785P is equipped with the voice option (para 1.7.7). The output of the modulating circuit is amplified before it is fed to the 10-watt amplifier.

The RFL 67P PLC TRANS is pin-for-pin compatible with the non-programmable RFL 67 PLC TRANS transmitter module. This means that the RFL 67P PLC TRANS can be used as a replacement module in existing RFL 6780 and RFL 6785 systems, as well as in new RFL 6780P and RFL 6785P systems. For more information on the RFL 67P PLC TRANS, see Section 6 of this manual.

1.7.3. 10-Watt Amplifier Module

The RFL 67P 10W AMP is driven by the transmitter module, and raises the power of the transmitter to the level chosen for the application. It also includes a level monitoring circuit that will send a TX FAIL alarm to the AM I/O module if the transmitter fails. The amplifier has a transformer-isolated output, and a 50Ω impedance. Section 7 of this manual contains additional information on the RFL 67P 10W AMP.

1.7.4. Filter Modules

RFL 67P OUTPUT filter modules reduce the harmonic content of the RFL 67P 10W AMP's output signal to a level that is at least 55 dB below the carrier level. In order to cover the RFL 6785P's entire operating range (30 kHz to 535 kHz), there are four different RFL 67P OUTPUT filters; three filters are equipped with jumpers for selecting the desired frequency range and the fourth has a fixed range which covers the top of the RFL 6785P's frequency band. All four filters are entirely passive, and require no input power for proper operation. For additional information on the RFL 67P OUTPUT filter modules, refer to Section 8 of this manual.

1.7.5. Downshifter Module

The RFL 67P RX DNSH downshifter module shifts the desired set of incoming frequencies down to a lower range to be further processed by the receiver detector module (para 1.7.6). It also contains a set of DIP switches for programming the desired frequency shift, and a level indicator circuit that drives an LED array on the front of the module; this provides a visual indication of the incoming signal level. For more information on the RFL 67P RX DNSH, see Section 9.

1.7.6. Receiver Detector Modules

The RFL 67P RX DET accepts the signal from the receiver downshifter module, and amplifies it. It then decides whether or not a block is being requested, based on the incoming signal strength. A timer/shutdown circuit enables the local receiver to energize whenever the local transmitter is keyed. RFL 67P RX DET-1 modules are equipped with a voice bandpass filter and voice muting circuit, and are used in terminals equipped with the optional voice module (para 1.7.7). Section 10 contains additional information on the receiver detector modules.

1.7.7. Voice Module

The optional RFL 67PLC VOICE Voice Module contains a voice transmitter, a signaling tone oscillator for sending signaling tones, a signaling tone detector for receiving tones, and a voice receiver. When the RFL 6785P terminals at both ends of a protected line are equipped with voice modules (and the other components that comprise the Voice Option), two-way voice communications can occur between stations without the need for a telephone hook-up; the voice signals will be injected onto the powerline carrier. Additional information on the RFL 6785P Voice Option can be found in Section 11.

1.7.8. Checkback Module (optional)

The RFL 6720P Checkback Module is a microprocessor-based, single-module checkback system. Control and logic signals are interfaced between the RFL 6720P and the RFL 6785P system through the card-edge fingers along the rear of the module. In addition, the RFL 6720P interfaces directly with the RS-232 port on the RFL 6785P's rear panel; this port can be used to program the RFL 6720P's operating parameters, or to operate it from a remote location.

The front panel of the RFL 6720P serves as the local operator interface. A 3-digit LED display shows operating parameters, and LED annunciators display pertinent system data. Its pushbutton switches can be used to manually initiate tests. They can also allow various values to appear on the display, such as code transmitted, code received, last code received, and hours to next test. Additional information on the RFL 6720P can be found in Section 12.

1.7.9. Power Supplies

RFL 6785P power supplies accept the incoming station battery voltage and produces four regulated dc output voltages: +12, -12, +15, and -15. Two different versions are available: one for 48-volt station batteries, and one for 125-volt batteries. Additional information on these power supplies can be found in Section 13.

1.7.10. Chassis

The RFL 67P CHASSIS houses all RFL 6785P modules, and contains a motherboard which provides all electrical interconnections between the modules. Coaxial connectors on the rear panel are used to connect the RFL 6785P to the line tuning equipment; if desired, a jumper inside the chassis can be set to combine the rf input and rf output onto a single coaxial connector.

The RFL 67P ISOL Isolation Board is mounted to the rear panel of the RFL 67P CHASSIS. It contains three optically-isolated input circuits (CARRIER START, CARRIER STOP, and RESERVE SIGNAL KEY), two isolated output drivers (BLOCK OUTPUT and CHECKBACK OUTPUT), three output relays (BLOCK RECEIVED, TX FAIL ALARM, and PS FAIL ALARM), and high-voltage and transient suppression circuits. Terminal blocks on the RFL 67P ISOL extend out of the rear panel, and are used to connect external equipment to the RFL 6785P. Section 14 of this manual provides additional information on the chassis, the motherboard, and the isolation board.

1.7.11. Accessory Equipment

Other circuit card modules and assemblies are available to enhance the operation of the RFL 6785P system, or to adapt it to special applications. If any accessory equipment was furnished with your system, Instruction Data Sheet for each item will appear in Section 15 of this manual.

Section 2. INSTALLATION

WARNING

ALL RFL 6785P TERMINALS ARE EQUIPPED WITH A PROTECTIVE COVER THAT EXTENDS ACROSS THE REAR OF THE CHASSIS. THIS COVER IS INTENDED TO PROTECT THE OPERATOR FROM POTENTIALLY HAZARDOUS VOLTAGES, WHICH MAY BE PRESENT ON THE REAR PANEL TERMINAL BLOCKS. THIS COVER MUST ONLY BE REMOVED BY QUALIFIED SERVICE PERSONNEL WHEN ACCESS TO THE REAR PANEL IS REQUIRED. IT MUST BE REPLACED BEFORE PLACING THE TERMINAL IN SERVICE.

CAUTION

During normal system operation, the switching of relay contacts can produce voltage spikes. These spikes can travel down the relay output leads and induce currents in other leads. These induced currents can affect system operation. To reduce this possibility, use a shielded twisted pair for each input lead, and ground the shield at the RFL 6785P's chassis only. As an added precaution, do not bundle input, output, and power leads into the same harness - keep them as far apart as possible.

2.1. INTRODUCTION

This section contains installation instructions for the RFL 6785P, including unpacking, mounting, and interconnection wiring.

2.2. UNPACKING

RFL 6785P equipment may be supplied as individual chassis or interconnected with other chassis or assemblies as part of a system. Paragraph 2.2.1 provides unpacking instructions for individual chassis, and paragraph 2.2.2 provides instructions for interconnected chassis.

2.2.1. Individual Chassis

RFL 6785P terminals supplied as individual chassis are packed in their own shipping cartons:

1. Open each carton carefully to make sure the equipment is not damaged.
2. After the chassis 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 chassis to hold the circuit card modules in place during transit.
4. Make sure all modules are fully seated in the chassis.

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 equipment.

2.2.2. Interconnected Chassis

RFL 6785P terminals ordered as part of a larger system may be interconnected with other chassis and mounted in a relay rack or cabinet, or on 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 individual chassis to hold the circuit card modules in place during transit.

4. Make sure all modules are fully seated in the chassis.

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 equipment.

2.3. MOUNTING

After unpacking, RFL 6785P equipment must be securely mounted, following the instructions in paragraphs 2.3.1 through 2.3.3.

2.3.1. Individual Chassis

RFL 6785P terminals housed in individual chassis have two mounting ears (one on each side) that may be positioned so that the front panel is either flush or forward-mounted with respect to the vertical supporting channels of the rack or cabinet. Two sets of mounting holes are provided on the chassis; by reversing the mounting ears in either set of holes, four different front panel positions are available.

The RFL 6785P can be installed in any EIA-standard 19-inch rack or enclosure, or it can be mounted to a flat panel. Dimensions are given in Figure 2-1 for both mounting methods.

CAUTION

Any installation using an enclosed cabinet with a swing-out rack must be securely fastened to the floor. This will prevent the cabinet from falling forward when the rack is moved outward.

2.3.2. Interconnected Chassis Installed In Rack Or Cabinet

Systems mounted in racks or cabinets at the factory are to be placed in position and then bolted to the floor or wall, as appropriate, to secure the equipment in place.

The type of hardware used will depend upon the particular surface to which the rack or cabinet is being mounted. Because of this, mounting hardware is not supplied with the rack or cabinet.

2.3.3. Interconnected Chassis Mounted On Shipping Rails

Equipment to be installed in a rack or cabinet at the customer's site is mounted on shipping rails at the factory. To remove the shipping rails and mount the equipment, proceed as follows:

1. Place the equipment as close to the front of the rack or cabinet as possible, with the rear panels of the equipment facing the front of the rack or cabinet.

2. Remove all the screws securing the shipping rails to the equipment.

3. Slide the equipment into the rack or cabinet.

4. Install and tighten screws to all panels to secure the equipment in place.

2.4. VENTILATION

The specified operating temperature range for RFL 6785P equipment is -20°C to +60°C (-4°F to +140°F). Operation at higher temperatures may affect system reliability and performance. Systems installed in enclosed cabinets should be ventilated to keep the temperature inside the cabinet within limits.

NOTE

Specific terminals on the rear panel terminal blocks are noted by the terminal block number followed by a dash and the terminal number (TB1-1, TB1-2, TB1-3).

2.5. CONNECTIONS

Electrical connections are made to each RFL 6785P chassis through the terminal blocks and connectors on the chassis rear panel. The rear panel of a typical RFL 6785P terminal is shown in Figure 2-2.

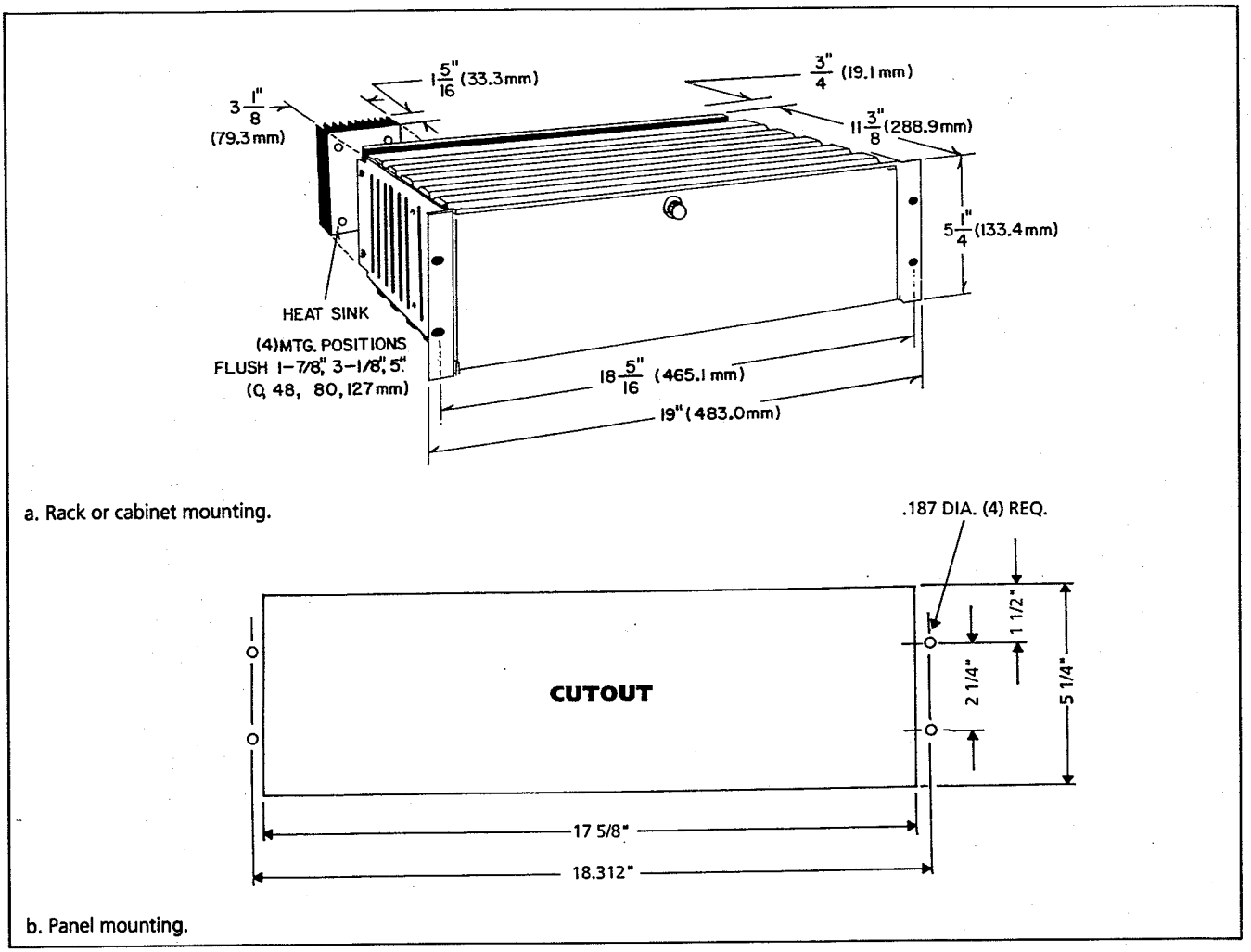


Figure 2-1. Mounting dimensions, RFL 6785P Programmable On/Off Carrier System

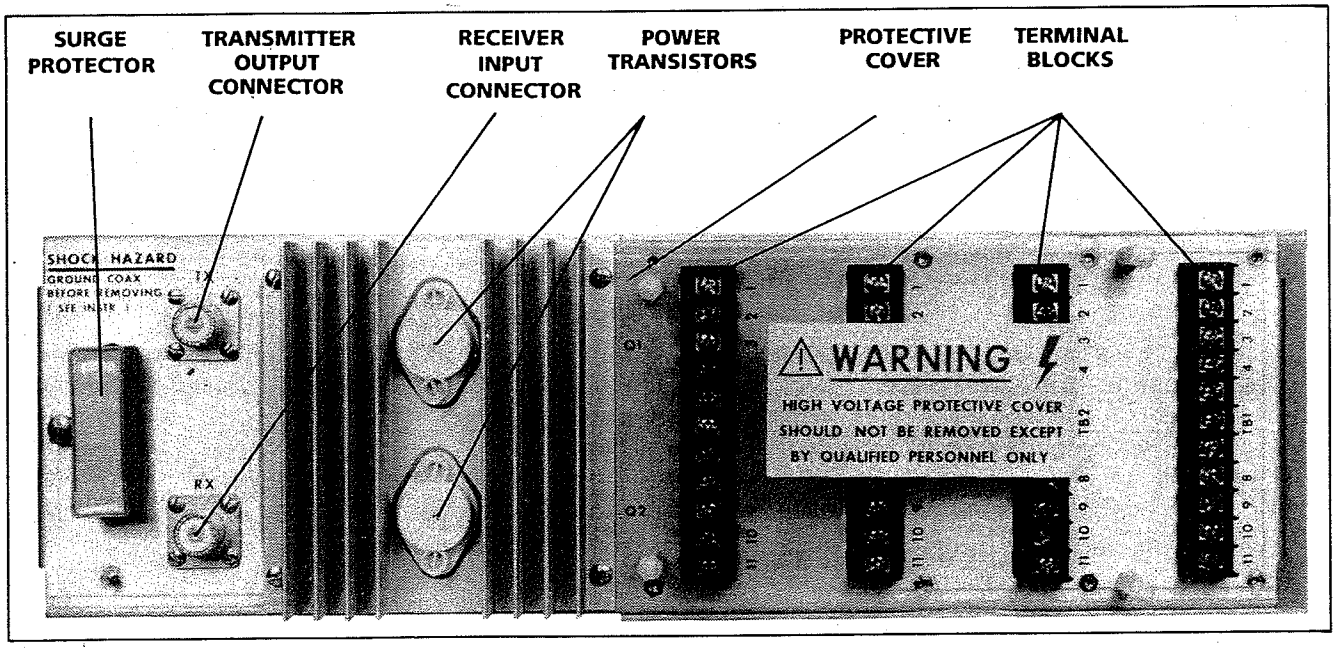


Figure 2-2. Rear view, RFL 6785P Programmable On/Off Carrier System

Paragraphs 2.5.1 through 2.5.8 provide basic descriptions of all the connections that must be made. Refer to the "as supplied" drawings furnished with your RFL 6785P for more detailed descriptions of the connections that must be made to your system.

2.5.1. Making Connections To Terminal Blocks

The terminal blocks on the rear of the RFL 6785P are conventional screw-type barrier blocks. Wires can either be stripped or terminated in spade lugs, depending on local practice. To connect wires to the terminal blocks, proceed as follows:

1. Remove the protective cover from the rear of the chassis by pulling it out of the standoffs holding it in place.

2. Using strippers, remove about 1/4 inch (10 cm) of insulation from the end of the wire to be connected.

3. If local practice calls for lugged wires, crimp a spade lug onto the stripped end of the wire.

4. Locate the terminal to which the wire is to be connected.

   All terminals blocks are numbered. Terminal numbers appear on the rear panel, directly below the terminal block. Terminal block numbers are directly below the terminal numbers.

5. Using a screwdriver, turn the screw at that position counterclockwise until the wire or lug can be slipped underneath the screw head.

6. If the wire is lugged, slip the lug under the screw head. If lugs are not being used, use a pair of needle-nose pliers to bend the stripped end of the wire into a hook, and slip this hook under the screw head so that the hook surrounds the screw.

7. Using a screwdriver, turn the screw clockwise until tight to secure the wire in place.

8. Repeat steps 2 through 8 for all other wires to be connected.

9. Line up the mounting holes in the rear panel protective cover with the standoffs on the rear of the chassis, and push down on the protective cover until it is secured in place.

2.5.2. Input Connections

Input connections are made to terminal blocks TB2 and TB4 on the rear panel. Terminal assignments are as follows; be sure to observe proper polarity when making these connections:

Signal Name	Positive	Negative
CARRIER START	TB2-1	TB2-2
CARRIER STOP	TB2-3	TB2-4
RESERVE SIGNAL KEY	TB4-1	TB4-2

2.5.3. Relay Output Connections

Relay output connections are made to terminal blocks TB3 and TB4 on the rear panel. Terminal assignments are as follows:

Alarm Output Name	Type	Terminal Assignments
BLOCK RCVD:		
Contact Set #1	N.C.	TB4-8
	COM	TB4-7
	N.O.	TB4-6
Contact Set #2	N.C.	TB3-8
	COM	TB3-7
	N.O.	TB3-6
TX FAIL	N.C.	TB3-11
	COM	TB3-10
	N.O.	TB3-9
PS FAIL	N.C.	TB4-5
	COM	TB4-4
	N.O.	TB4-3

2.5.4. Block Output Connections

Block output connections are made to terminal block TB3. The exact terminals you will use depends on the amount of output current required by the blocking relay being used:

Output Current	Current Input	Current Output
1.0 A	TB3-1	TB3-2
200 mA	TB3-1	TB3-3
180 mA	TB3-1	TB3-4
20 mA	TB3-1	TB3-5

For all block output currents, TB3-1 is tied to station battery positive to provide the current input. The selected current output terminal is connected to one side of the blocking relay's coil. The other side of the coil is connected to station battery negative.

2.5.5. Checkback Output Connections

If your RFL 6785P terminal is equipped with the optional RFL 6720P Checkback Module, a CHECKBACK FAIL signal is available at the rear panel (positive at TB2-7, negative at TB2-8). This output can be used to drive external equipment in the event that a checkback test is not successfully completed. It is rated for 156 volts at up to 1 ampere.

2.5.6. RS-232 Connections

You can use the RFL 6785P's rear-panel RS-232 port to access the optional RFL 6720P Checkback Module from a dumb terminal or a personal computer equipped with a terminal emulator. Once connected, you can use APRIL (**A**synchronous **P**rogramming and **R**emote **I**nterrogation **L**anguage) to view a list of parameter settings, change parameter settings as required, monitor RFL 6720P operation, or initiate checkback tests. Because APRIL is menu-based, you do not have to memorize the commands. Help screens can always be displayed by pressing the **[H]** key.

The terminal you use to access the RFL 6720P can be a dumb RS-232 terminal, or a PC or laptop computer with an RS-232 port running a terminal emulation program. You could also connect the RS-232 port to one of the ports on an RFL 9660 Digital Switch or a stand-alone modem, and access the RFL 6720P with APRIL from a remote site.

The serial port on your terminal or computer must be configured the same as the RS-232 serial port. Settings are as follows:

Data Bits	8
Stop Bits	1
Parity	None
Baud Rate	1200 baud
Flow Control:	XON/XOFF or RTS/CTS

"Baud rate" determines how fast data is sent through the RS-232 port. "Flow control" is a protocol used by RS-232 devices to establish connections. Two different methods are possible with the RFL 6720P: "XON/XOFF" and "RTS/CTS." XON/XOFF flow control is also called "software flow control." It uses commands sent through the port to control data flow, and required no additional cable connections. (See Figure 2-3.)

RTS/CTS flow control is also called "hardware flow control," and requires two additional cable connections. (See Figure 2-4.) When RTS/CTS flow control is used and the RFL 6720P is ready to receive characters, it raises the RTS line. The RFL 6720P will not transmit its characters until it sees the CTS line go high. To communicate with most devices, XON/XOFF flow control is recommended.

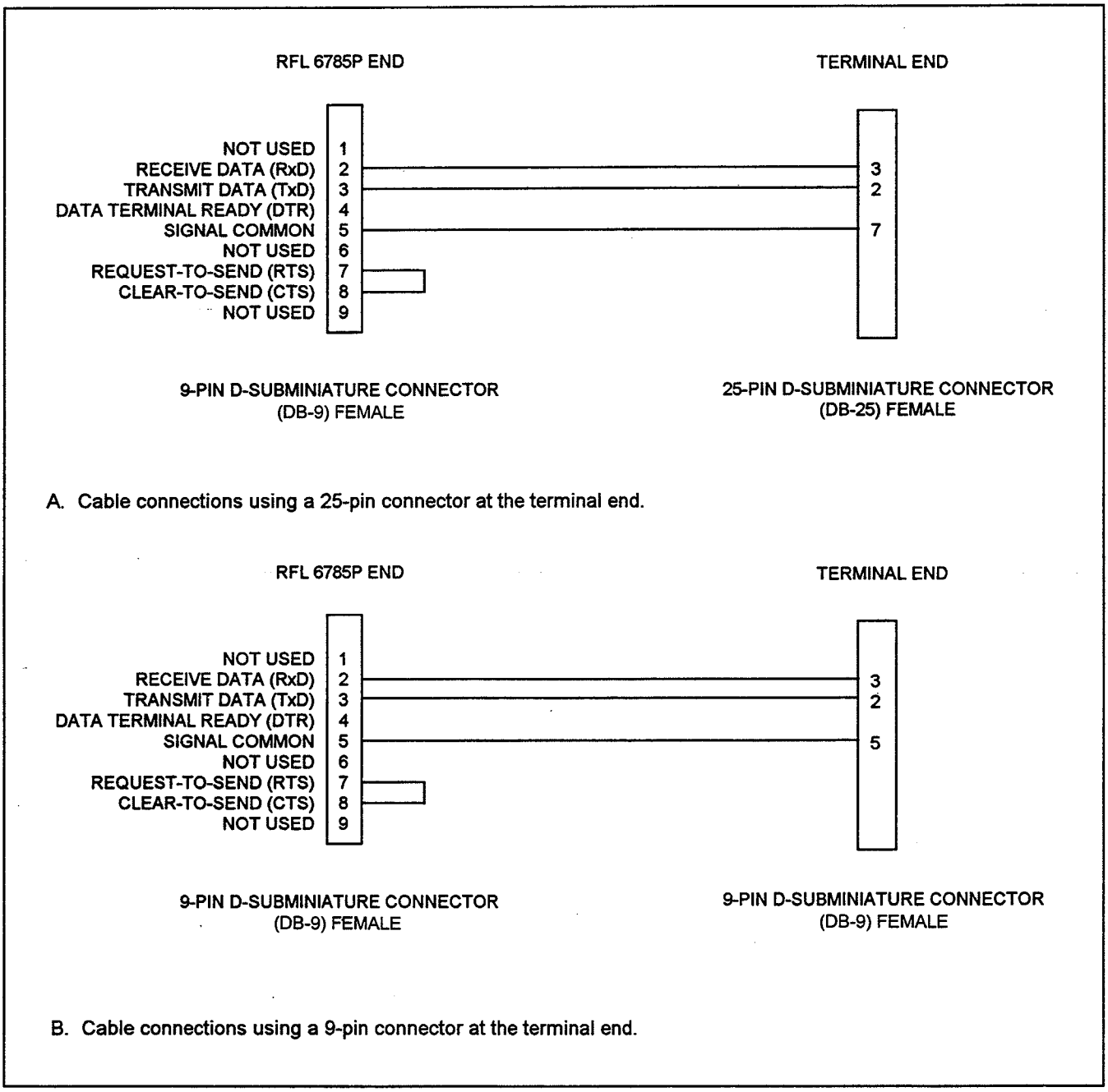


Figure 2-3. Cable connections between RFL 6785P and PC or terminal using XON/XOFF flow control

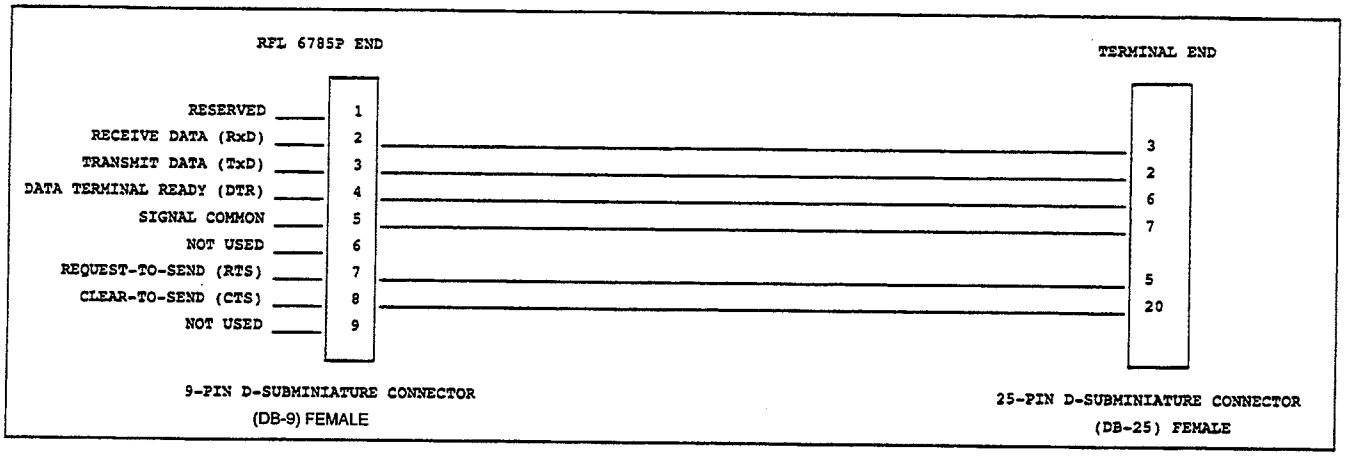


Figure 2-4. RS-232 cable connections between RFL 6785P and PC or terminal using RTS/CTS flow control

2.5.7. Rf Input/Output Connections

There are two rf connectors on the rear of the RFL 6785P: one marked "TX", and one marked "RX." Unless otherwise specified at the time of order, all RFL 6785P terminals are internally connected at the factory for two-wire (2W) operation, where the transmitter output and receiver input are both connected to the rear-panel TX connector.

If the line tuning equipment you are using has a single rf connector for input and output, simply connect a cable from the connector on the line tuning equipment to the TX connector.

If your application requires separate rf connectors for input and output, two jumpers on the interconnect motherboard inside the RFL 6785P will have to be reset. Once this is done, separate transmit and receive cables can be run between the external equipment and the RFL 6785P. To do this, proceed as follows:

1. There are four screws securing the rear panel to the chassis: two on each side. Using a flat-blade screwdriver, remove the top screws, loosen the bottom screws, and pull down on the rear panel to gain access to the inside of the panel.

2. Find 2W/4W jumpers J9 and J10 on the motherboard; they are on either side of the mating connector for the RFL 67P OUTPUT module. Place J9 and J10 in the "4W" position.

3. Raise the rear panel back into position, and reinstall the two screws removed during step 1. Using a flat-blade screwdriver, tighten all screws to secure the rear panel in place.

The output of the RFL 6785P's transmitter section is now connected to the TX connector, and the input of the receiver section is connected to the RX connector. Separate input and output cables can now be run between the line tuning equipment and the RFL 6785P. Connect one cable between the RFL 6785P's TX connector and the input connector on the line tuning equipment; a second cable is then connected between the output connector on the line tuning equipment and the RFL 6785P's RX connector.

WARNING

THE RFL 6785P MUST BE PROPERLY GROUNDED AS DESCRIBED IN PARAGRAPH 2.5.7 BEFORE ATTEMPTING TO CONNECT INPUT POWER. IMPROPER GROUND CONNECTIONS MAY RESULT IN SYSTEM MALFUNCTIONS, EQUIPMENT DAMAGE, OR ELECTRICAL SHOCK.

2.5.8. Chassis Ground Connections

TB1-1 is the main ground for the RFL 6785P terminal. Grounding is accomplished by connecting a wire 16AWG or larger between TB1-1 and a solid earth

ground. The grounding wire should be kept as short and straight as possible, to keep its resistance and inductance to a minimum.

CAUTION

Before attempting to make power connections, make sure the RFL 6785P terminal is equipped with a power supply designed to operate at the available station battery voltage. This can be determined by checking the model designator on the module handle. "67P 48DC" denotes a 48-volt supply, and "67P 125DC" is a 125-volt supply. If the wrong voltage is connected to the power supply module, component damage will result.

2.5.9. Power Connections

After all other connections have been made to the RFL 6785P, dc power connections can be made.

The station battery voltage is connected to terminal block TB1; positive to TB1-10, and negative to TB1-11. Depending on the dc-dc converter power supply installed in the RFL 6785P terminal, either 48-volt or 125-volt station batteries can be accommodated.

A switched station battery output is also available on terminal block TB1; positive at TB1-7, and negative to TB1-8. This output can be used to shut down external equipment in the event that the RFL 6785P is shut down for any reason.

Section 3. OPERATING INSTRUCTIONS

WARNING

ALL RFL 6785P TERMINALS ARE EQUIPPED WITH A PROTECTIVE COVER THAT EXTENDS ACROSS THE REAR OF THE CHASSIS. THIS COVER IS INTENDED TO PROTECT THE OPERATOR FROM POTENTIALLY HAZARDOUS VOLTAGES THAT MAY BE PRESENT ON THE REAR-PANEL TERMINAL BLOCKS. THIS COVER MUST ONLY BE REMOVED BY QUALIFIED SERVICE PERSONNEL WHEN ACCESS TO THE REAR PANEL IS REQUIRED. IT MUST BE REPLACED BEFORE PLACING THE TERMINAL IN SERVICE.

3.1. INTRODUCTION

This section contains the instructions necessary for operating the RFL 6785P. All controls and indicators are shown and described. The jumper and switch settings are also described, and a procedure is included for verifying operation before placing the RFL 6785P into continuous service.

NOTE

Throughout the procedures in this section, the terminal that initiates a function is called the "local" terminal; the other terminal is the "remote" terminal.

3.2. CONTROLS AND INDICATORS

The circuit card modules in each RFL 6785P terminal contain controls and indicators which are used to prepare it for use and monitor system functions during normal operation. Figure 3-1 shows the module locations in a typical RFL 6785P chassis; Table 3-1 lists the figures and tables in this section that describe the controls and indicators on each module.

If your RFL 6785P was equipped with any accessory equipment containing controls and indicators, refer to the Instruction Data Sheets in Section 15 of this manual for further information.

3.3. JUMPER AND SWITCH SETTINGS

Some RFL 6785P circuit board modules and assemblies are equipped with programmable jumpers and DIP switches. Circuit board modules and assemblies supplied as part of a system have their jumpers and DIP switches set at the factory, according to the overall system configuration and the requirements of the specific application. Under normal circumstances, jumpers and DIP switches should only have to be reset in the field if a replacement module is being installed or a change in system configuration is desired. Paragraphs 3.3.1 through 3.3.6 describe the jumper and DIP switch settings that must be made.

NOTE

The different sections of the programmable DIP switches on RFL 6785P modules are noted by the switch number followed by a dash and the section number. (Examples: SW1-1, SW1-2).

3.3.1. Receiver Downshifter Module

There are two DIP switches on the RFL 67P RX DNSH downshifter module, as shown in Figure 3-3 on page 3-4 of this manual: SW1 and SW2. These switches are used to select the downshifter frequency, which must be set 2 kHz below the desired center frequency.

Each switch section equals a specific frequency. By placing switch sections in the OFF position and adding up the frequencies they represent, any frequency from 30 to 535 kHz can be selected:

SW1-1	0.5 kHz
SW1-2	1.0 kHz
SW1-3	2.0 kHz
SW1-4	4.0 kHz
SW1-5	8.0 kHz
SW1-6	16.0 kHz
SW1-7	32.0 kHz
SW1-8	64.0 kHz
SW2-1	128.0 kHz
SW2-2	256.0 kHz
SW2-3	512.0 kHz

SW2-4 is not used in the RFL 6785P system; leave it in the OFF position.

>>> Continued on page 3-17 <<<

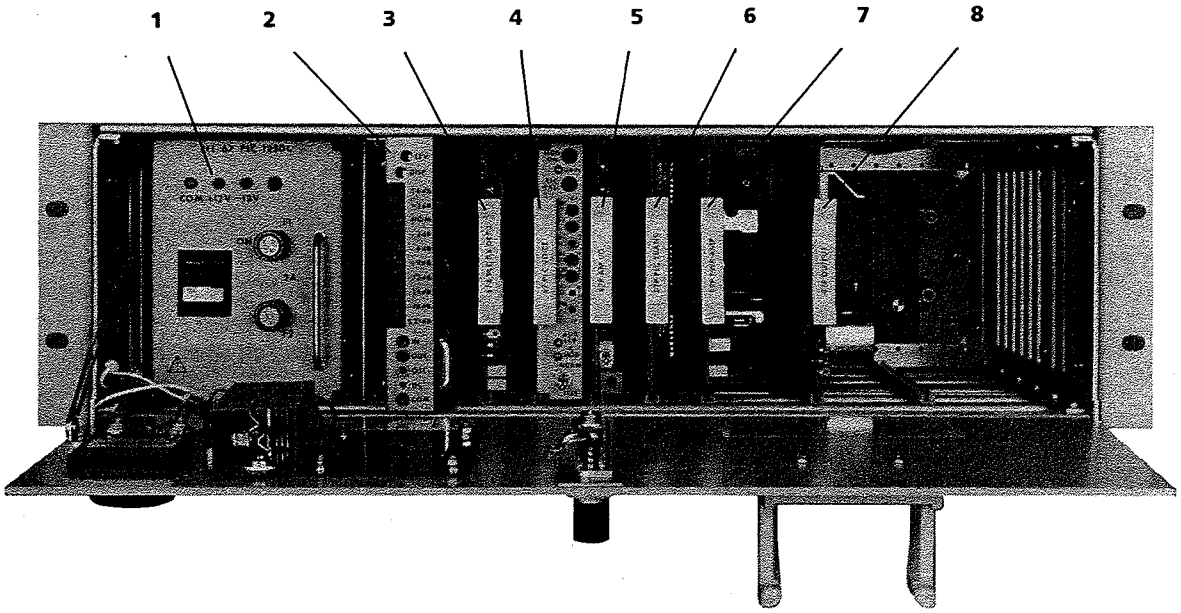


Figure 3-1. Location of circuit board modules in typical RFL 6785P terminal

Table 3-1. Circuit board modules in typical RFL 6785P terminal

Item	Description	Control And Indicator Information	Page
1	RFL 67P **DC power supply module	Figure 3-2/Table 3-2	3-3
2	RFL 67P RX DNSH Receiver Downshifter Module	Figure 3-3/Table 3-3	3-4
3	RFL 67A PLC RX DET and RFL 67A PLC RX DET-1 receiver detector modules	Figure 3-4/Table 3-4	3-6
4	RFL 67PLC VOICE Voice Module (optional)	Figure 3-5/Table 3-5	3-8
5	RFL 67P AM I/O Input/Output Module	Figure 3-6/Table 3-6	3-10
6	RFL 67P PLC TRANS Programmable Transmitter Module	Figure 3-7/Table 3-7	3-11
7	RFL 67P PLC AMP 10-Watt Power Amplifier	Figure 3-8/Table 3-8	3-12
8	RFL 67P OUTPUT Output Filter	Figure 3-9/Table 3-9	3-13
9	RFL 6720P Checkback Module (optional)	Figure 3-10/Table 3-10	3-14
. . .	RFL 67P INTERCONNECT Interconnect Motherboard	Figure 3-11/Table 3-11	3-16

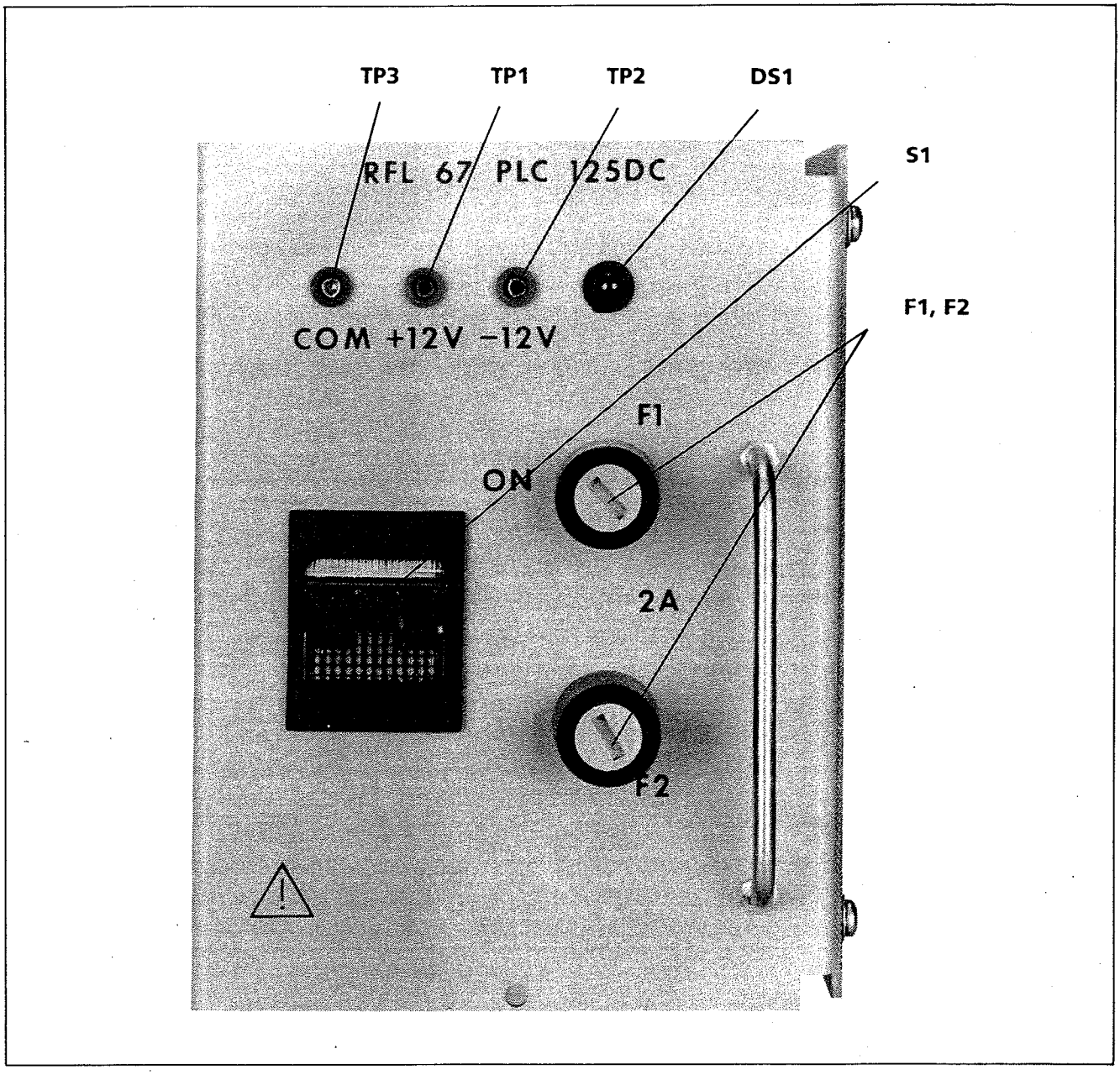


Figure 3-2. Controls and indicators, RFL 67P **DC power supply modules

Table 3-2. Controls and indicators, RFL 67P **DC power supply modules

Circuit Symbol	Description, Marking (if any)	Functional Description
DS1	Indicator LED	Lights when power supply is turned on and producing regulated output voltages.
F1, F2	Fuses	Input overcurrent protection.
S1	Power switch	Serves as main power switch for entire RFL 6785P terminal.
TP1	Test point, +12V (red)	Monitoring point for +12-volt output.
TP2	Test point, -12V (red)	Monitoring point for -12-volt output.
TP3	Test point, COM (black)	Ground point.

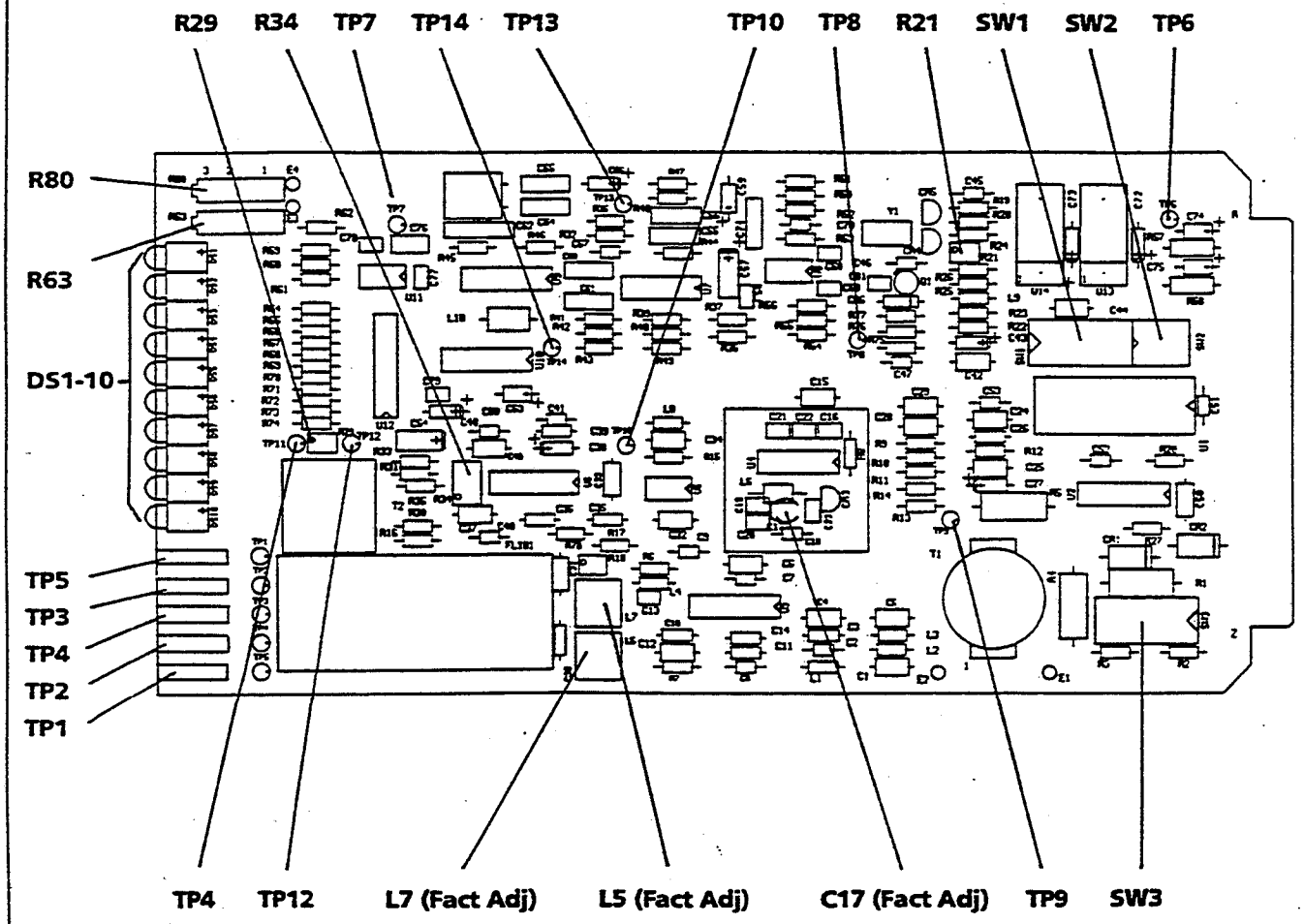


Figure 3-3. Controls and indicators, RFL 67P RX DNSH Receiver Downshifter Module

Table 3-3. Controls and Indicators, RFL 67P RX DNSH Receiver Downshifter Module

CAUTION

The controls in Figure 3-3 labeled "FACT ADJ" are set at the factory, and cannot be readjusted in the field. Any attempt to adjust these controls in the field may result in system malfunctions.

Circuit Symbol	Description, Marking (if any)	Functional Description
DS1-10	LED array	Provides visual indication of receiver input signal level.
R18	Potentiometer, GAIN ADJ	Used to adjust the overall gain of the i.f. amplifier.
R21	Potentiometer, FREQ ADJ	Used to adjust local oscillator frequency.
R29	Potentiometer	Used to adjust the signal level being applied to the third mixer.
R34	Potentiometer, NULL LO	Used to null the third mixer output.
R63	Potentiometer, MTR NULL	Used to adjust LED array.
SW1, SW2	DIP switches	Program downshifter module for desired receive frequency. (See para 3.3.1.)
SW3	DIP switch	Sets input attenuation factor. (See para 3.3.1.)
TP1	Test point, COM (black)	Ground reference.
TP2	Test point, DC (yellow)	Monitoring point for the signal being applied to the LED array.
TP3	Test point, OUT (green)	Monitoring point for the downshifter module output signal.
TP4	Test point, OSC (gray)	Monitoring point for the local oscillator output frequency.
TP5	Test point, IN (red)	Monitoring point for the input signal (after attenuation).
TP6	Test turret	Ground reference.
TP7	Test turret	Monitoring point for the amplified signal being applied to the LED array.
TP8	Test turret	Monitoring point for the reference voltage for the LED driver.
TP9	Test turret	Monitoring point for the input to the voltage-controlled oscillator (VCO).
TP10	Test turret	Monitoring point for the output to the i.f. amplifier.
TP11	Test turret	Monitoring point for the output of the second mixer.
TP12	Test turret	Monitoring point for the input to the third mixer.
TP13	Test turret	Monitoring point for the output of the third mixer.
TP14	Test turret	Monitoring point for the 26-kHz local oscillator signal.

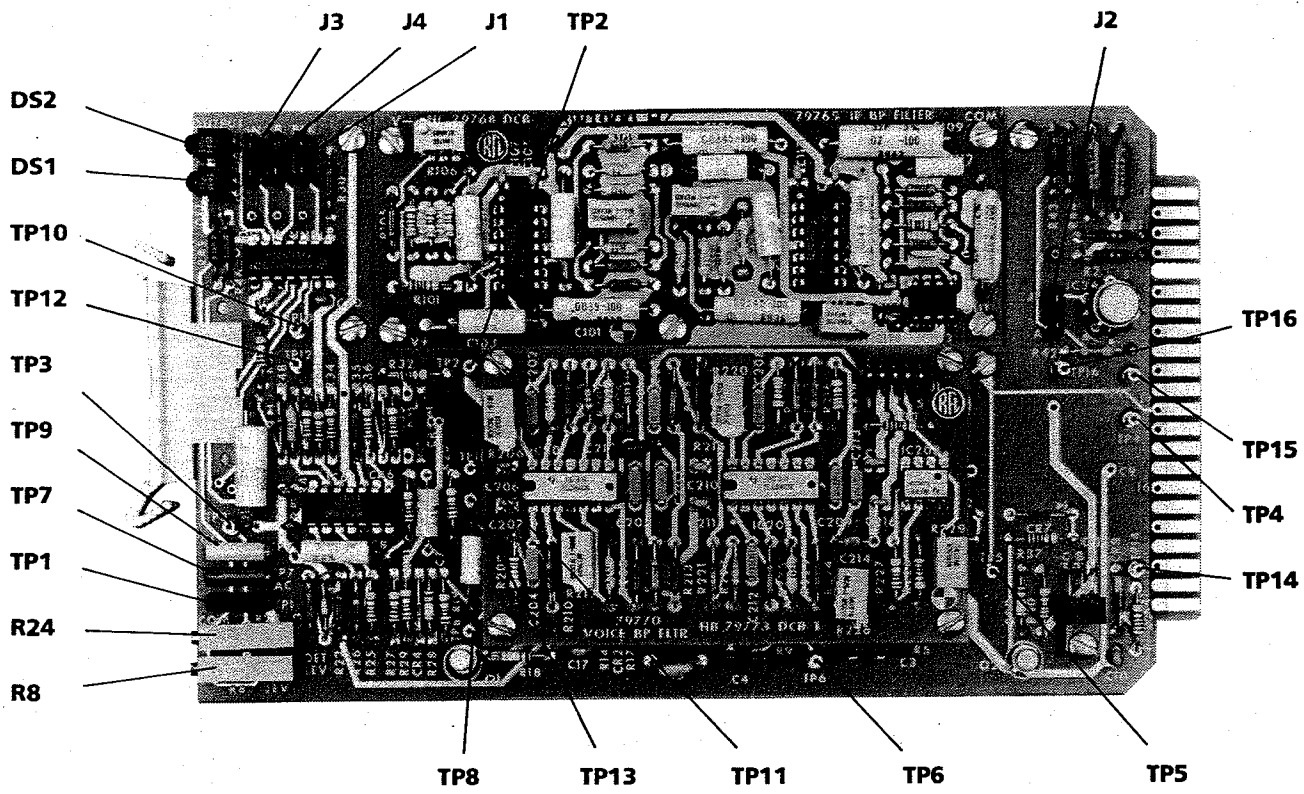


Figure 3-4. Controls and indicators, RFL 6785P receiver detector modules

Table 3-4. Controls and indicators, RFL 6785P receiver detector modules

Circuit Symbol	Description, Marking (if any)	Functional Description
DS1	Indicator, DET	Lights when an incoming signal is detected.
DS2	Indicator, OUTPUT	Lights when a block condition is detected.
J1	Jumper, BLK/UNBLK	Determines the polarity of the receiver detector module's output signal. For proper system operation, J1 must be placed in the BLK position.
J2	Jumper, A/B	Sets the gain for the receiver detector module's AGC circuit. (See para 3.3.2)
J3	Jumper, IN/OUT	Controls the receiver detector module's Receiver Kill function. (See para 3.3.2)
J4	Jumper, A/B	Controls the receiver detector module's Voice Kill function. (See para 3.3.2)
R8	Potentiometer, AC LEV	Adjusts the gain of operational amplifier IC2 to compensate for i.f. bandpass filter gain variations.
R24	Potentiometer, DET LEV	Adjusts detector reference voltage.
TP1	Test point, COM (black)	Ground reference.
TP2	Test turret	Ground reference.
TP3	Test turret	Monitoring point for the reference voltage set by potentiometer R24.
TP4	Test turret	Monitoring point for the signal received from the downshifter module.
TP5	Test turret	Monitoring point for the output of the co-planar i.f. bandpass filter.
TP6	Test turret	Monitoring point for the output of the first i.f. amplifier.
TP7	Test point, AC (green)	Monitoring point for the AC LEV output.
TP8	Test turret	Monitoring point for the rectified output signal.
TP9	Test point, DC (yellow)	Monitoring point for the filter output voltage.
TP10	Test turret	Monitoring point for the direct block output.
TP11	Test turret	Monitoring point for the input to the block output circuit (after delay)
TP12	Test turret	Monitoring point for the input to the force block timer.
TP13	Test turret	Monitoring point for the output from the force block timer.
TP14	Test turret	Monitoring point for the BLOCK OUTPUT signal passed on to the AM I/O module.
TP15	Test turret	Monitoring point for the downshifter module signal output.
TP16	Test turret	Monitoring point for the output of the voice bandpass filter (when present).

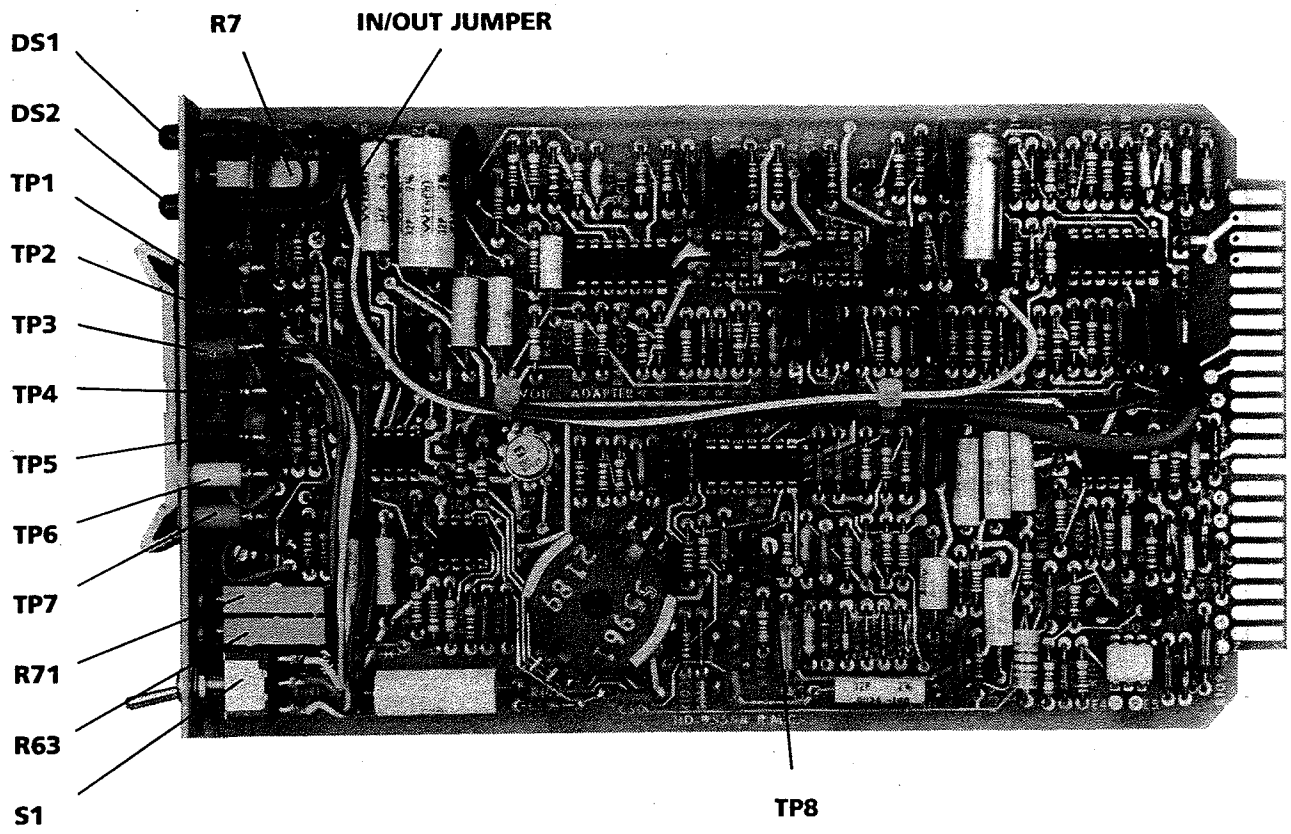


Figure 3-5. Controls and indicators, RFL 67PLC VOICE Voice Adapter module (optional)

Table 3-5. Controls and indicators, RFL 67PLC VOICE Voice Adapter module (optional)

Circuit Symbol	Description, Marking (if any)	Functional Description
. . .	Jumper, IN/OUT	Enables/disabled sidetone audio output.
DS1	Indicator, MOD ON	Lights when the voice-enable signal has been sent to the AM I/O module.
DS2	Indicator, REC CALL	Lights when a call is received from the station at the other end of the protected line.
R7	Potentiometer, GAIN	Adjusts gain of first amplifier stage.
R63	Potentiometer, % MOD	Adjusts signal level sent to transmitter module for modulation of the carrier.
R71	Potentiometer, AUD LEV	Adjusts audio output level.
S1	Switch, NORM/TEST	Controls AGC circuit: **NORM:** AGC circuit enabled **TEST:** AGC circuit disabled; used during module alignment only. For proper module operation, S1 must be in the NORM position.
TP1	Test point, COM (black)	Ground reference.
TP2	Test point, LEV (green)	Monitoring point for input signal level.
TP3	Test point, AGC IN (orange)	Monitoring point for input of AGC circuit.
TP4	Test point, AGC OUT (red)	Monitoring point for output of AGC circuit.
TP5	Test point, MOD LEV (brown)	Monitoring point for output of voice detector.
TP6	Test point, AUD OUT (yellow)	Monitoring point for audio output signal.
TP7	Test point, TONE (blue)	Monitoring point for call tone.
TP8	Test turret	Monitoring point for input of voice detector.

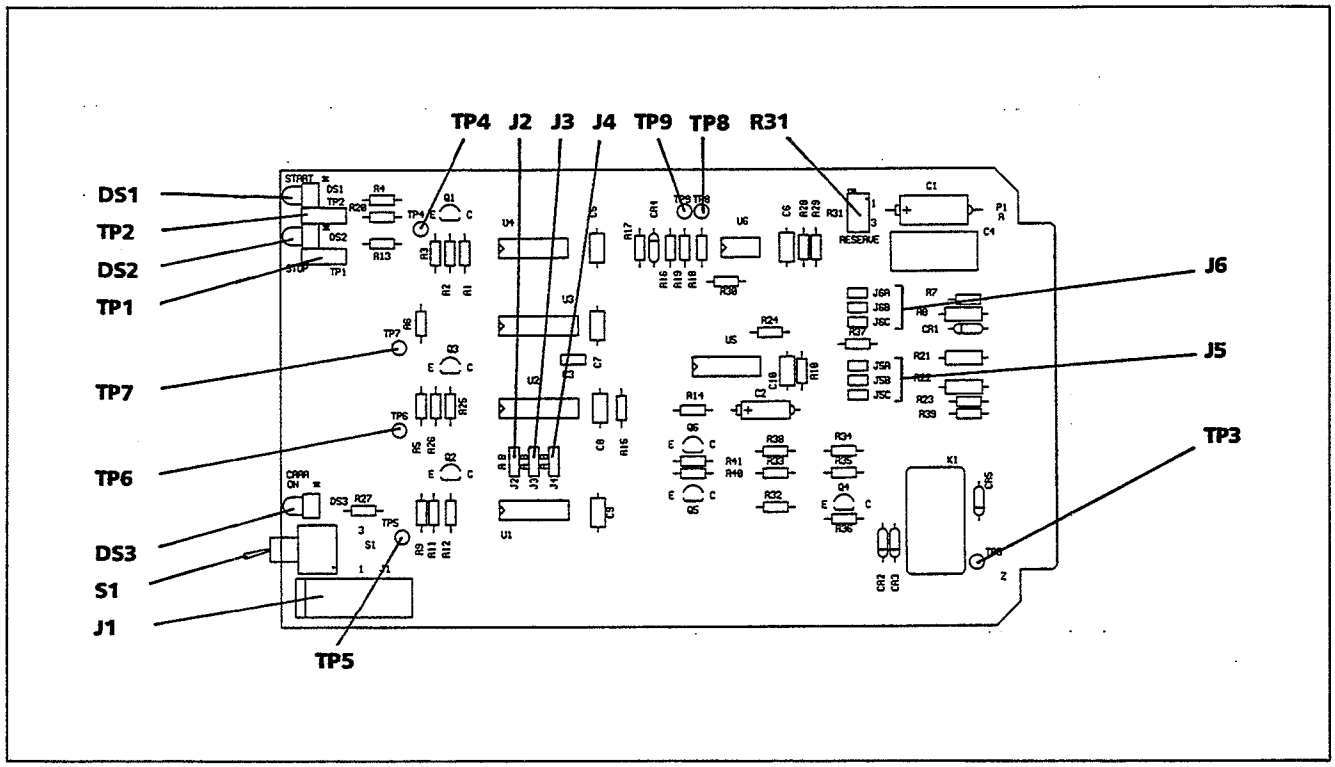


Figure 3-6. Controls and indicators, RFL 67P AM I/O Input/Output Module

Table 3-6. Controls and indicators, RFL 67P AM I/O Input/Output Module

Circuit Symbol	Description, Marking (if any)	Functional Description
DS1	START indicator	Lights when CARRIER START input is active.
DS2	STOP indicator	Lights when CARRIER STOP input is active.
DS3	CARRIER ON indicator	Lights when CARRIER START input is active.
J1	Phone jack	Allows the trip output current to be monitored.
J2	Jumper, CARRIER START control	Determines how module will respond to its CARRIER START input. (See para 3.3.4.)
J3	Jumper, CARRIER STOP control	Determines how module will respond to its CARRIER STOP input. (See para 3.3.4.)
J4	Jumper, BLOCK INPUT control	Determines how the module will respond to its BLKINPUT input. (See para 3.3.4.)
J5	Jumper, POWER LEVEL control	Controls the power output level of the transmitter section. (See para 3.3.4.)
J6	Jumper, RECEIVER KILL control	Controls the receiver kill function. (See para 3.3.4.)
R31	Potentiometer	Adjusts RESERVE2 signal level.
S1	Manual key switch	Used to manually key the transmitter module during setup and alignment tests.
TP1	Test point (black)	Ground point.
TP2	Test point (orange)	Monitoring point for the CARRIER CONTROL signal.
TP3	Test turret	Ground point.
TP4	Test turret	Monitoring point for the CARRIER START input.
TP5	Test turret	Monitoring point for the CARRIER STOP input.
TP6	Test turret	Monitoring point for the VOICE REQ input.
TP7	Test turret	Monitoring point for the UTILITY output.
TP8	Test turret	Monitoring point for the TX FAIL signal.
TP9	Test turret	Monitoring point for the CARR DET signal.

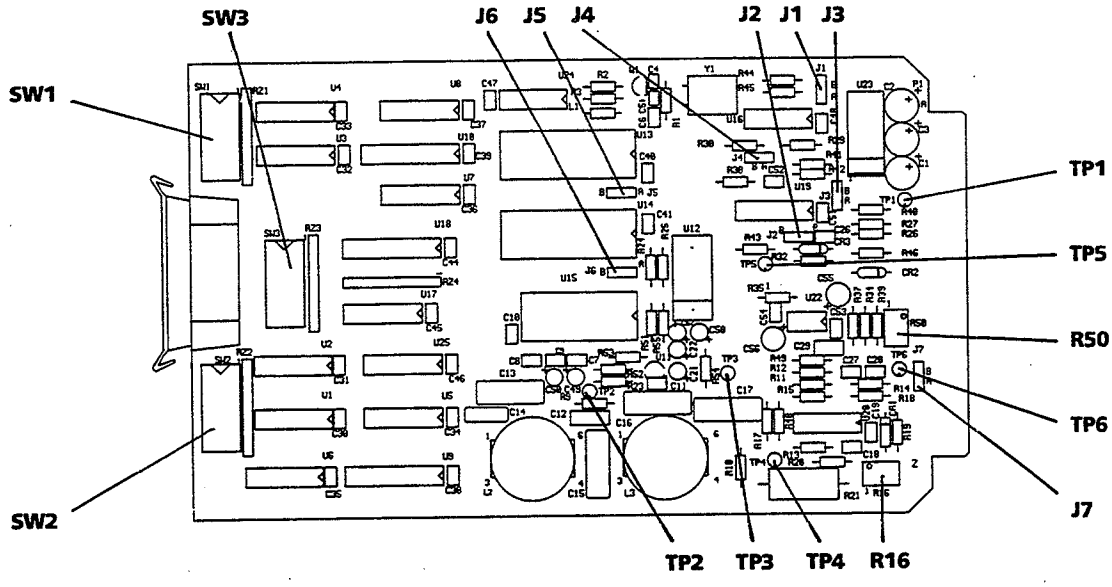


Figure 3-7. Controls and indicators, RFL 67P PLC TRANS Programmable PLC Transmitter Module

Table 3-7. Controls and indicators, RFL 67P PLC TRANS Programmable PLC Transmitter Module

Circuit Symbol	Description, Marking (if any)	Functional Description
J1	Jumper, carrier shift control	Not used in RFL 6785P system. (See para 3.3.5.)
J2	Jumper, carrier enable control	Determines how module will respond to CARRIER ENABLE inputs. (See para 3.3.5.)
J3	Jumper, power level control	Determines how module will respond to PWR A inputs. (See para 3.3.5.)
J4	Jumper, voice enable control	Determines how module will respond to VOICE ENABLE inputs. (See para 3.3.5.)
J5, J6	Jumper, EPROM device type selection	Set at the factory according to the EPROM type used. (See para 3.3.5.)
J7	Jumper, modulation control	Determines the edge connector terminal that will be used to pass the output signal to the power amplifier module: **Position A:** When module is being used in RFL 6785 or RFL 6785P terminals. **Position B:** When module is being used in RFL 6780 or RFL 6780P terminals. For more information, see paragraph 3.3.5.
R16	Potentiometer	Adjusts OUTPUT signal level; adjusted for 6 Vp-p reading from TP6 to ground.
R50	Potentiometer	Sets the signal level applied to the input of the amplitude modulator.
SW1,SW2	DIP switches	Used to program transmit frequency. (See para 3.3.5.)
SW3	DIP switch	Used to program amount of frequency shift in FSK systems; not used in RFL 6785P terminals. All sections must be kept in the OFF position.
TP1	Test turret, COM	Ground point.
TP2	Test turret, D/A	Monitoring point for the output of D/A converter U15.
TP3	Test turret, FILTER OUT	Monitoring point for the filtered D/A converter output signal.
TP4	Test turret, MOD IN	Monitoring point for the signal applied to modulator input.
TP5	Test turret, VOICE IN	Monitoring point for the voice signal input.
TP6	Test turret, TX OUT	Monitoring point for the transmitter output signal.

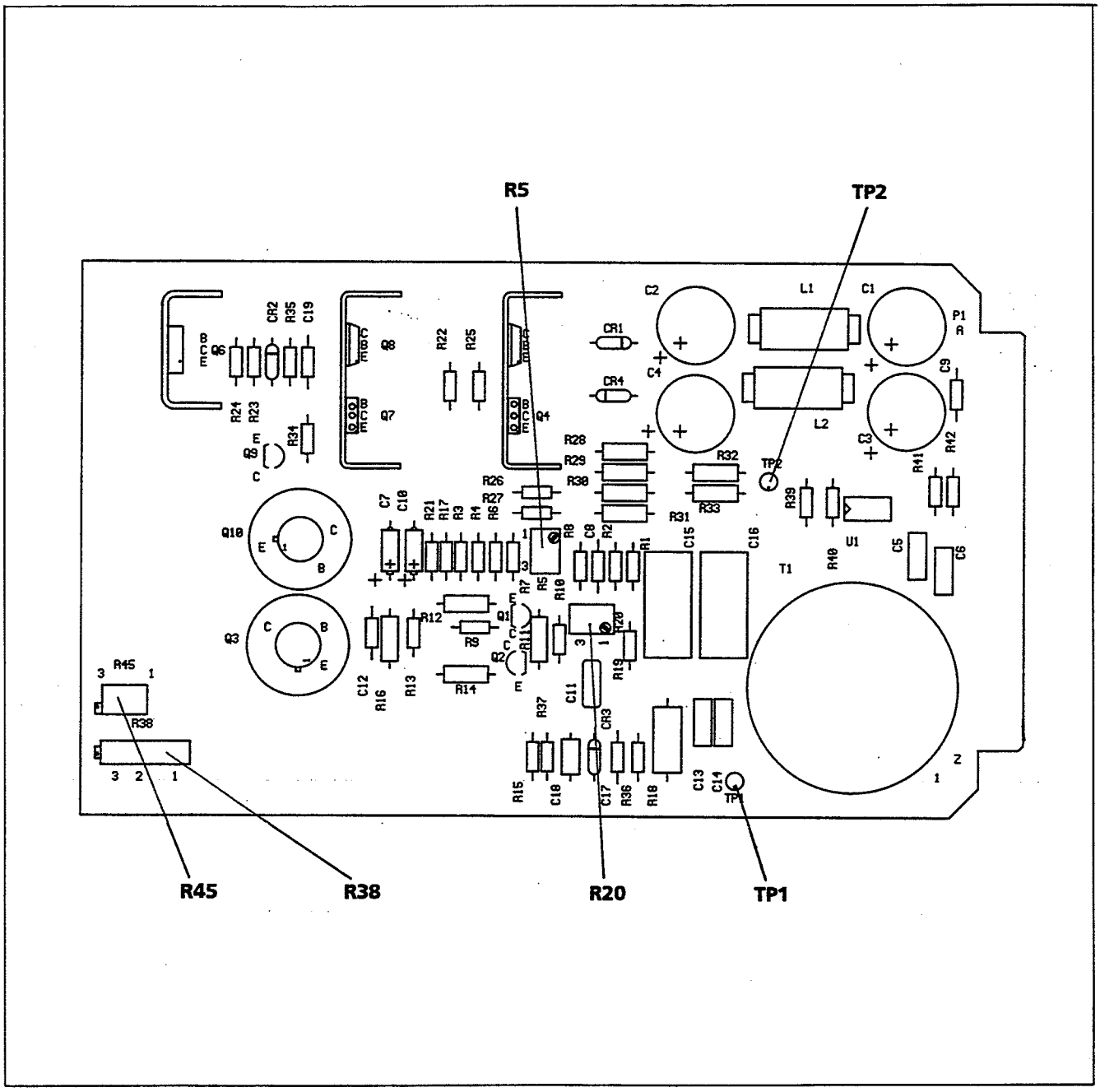


Figure 3-8. Controls and indicators, RFL 67P PLC AMP 10-Watt Power Amplifier

Table 3-8. Controls and indicators, RFL 67P PLC AMP 10-Watt Power Amplifier

Circuit Symbol	Description, Marking (if any)	Functional Description
R5	Potentiometer	Null adjustment; used to obtain a zero-volt reading at test point TP2.
R20	Potentiometer	Adjusts the amplifier output impedance.
R38	Potentiometer	Adjusts alarm circuit sensitivity.
R45	Potentiometer	Adjusts the amplifier output level.
TP1	Test turret	Ground reference.
TP2	Test turret	Monitoring point for the null adjustment.

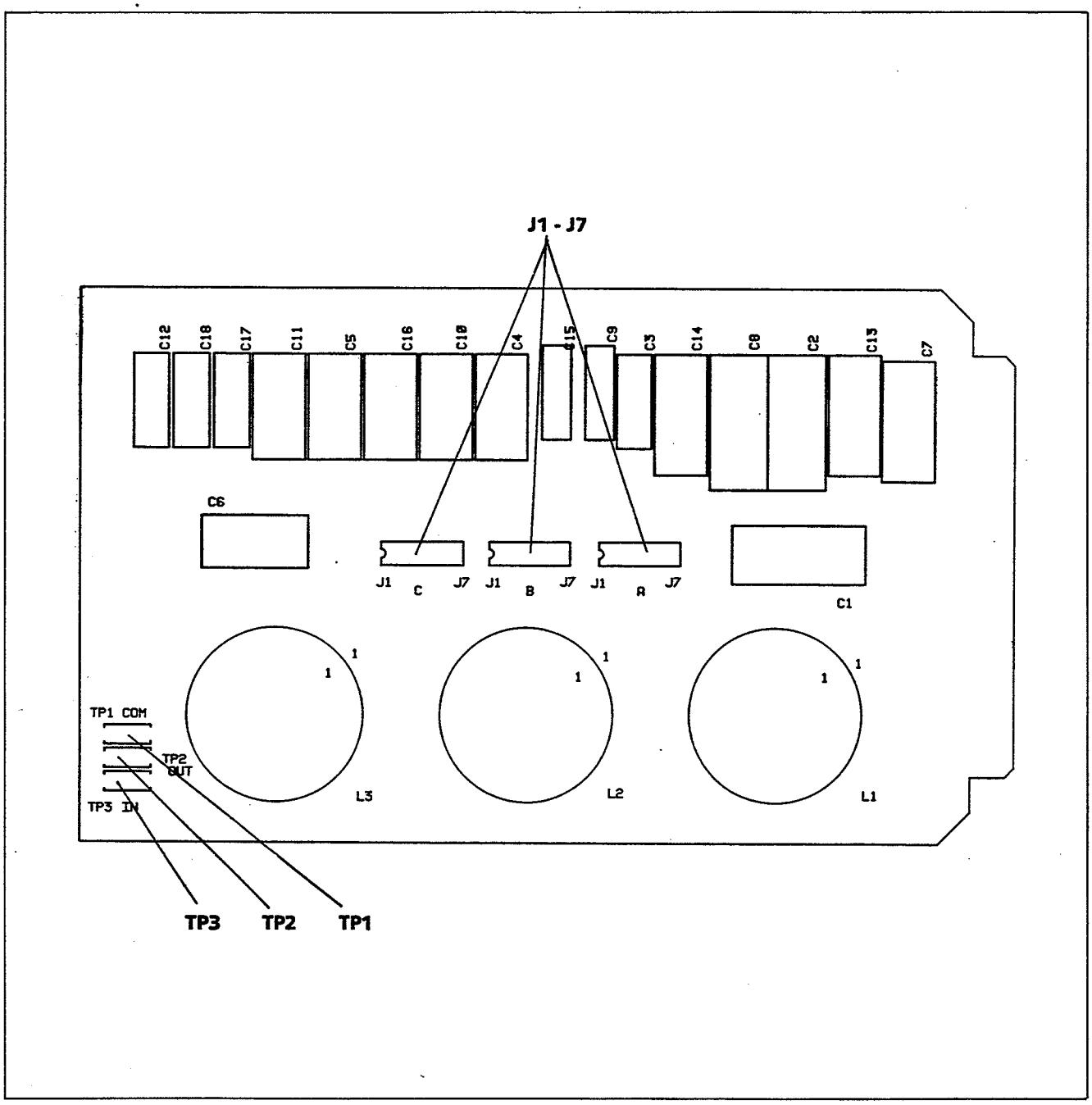


Figure 3-9. Controls and indicators, RFL 67P OUTPUT Output Filters

Table 3-9. Controls and indicators, RFL 67P OUTPUT Output Filters

Circuit Symbol	Description, Marking (if any)	Functional Description
J1-J7	Jumpers, range selection (104070-X filters only)	Used to set the filter to one of its three operating ranges; all jumpers must be placed in the same position. (See para 3.3.6.)
TP1	Test point, COM (black)	Ground reference.
TP2	Test point, OUTPUT (red)	Monitoring point for output signal.
TP3	Test point, INPUT (orange)	Monitoring point for input signal.

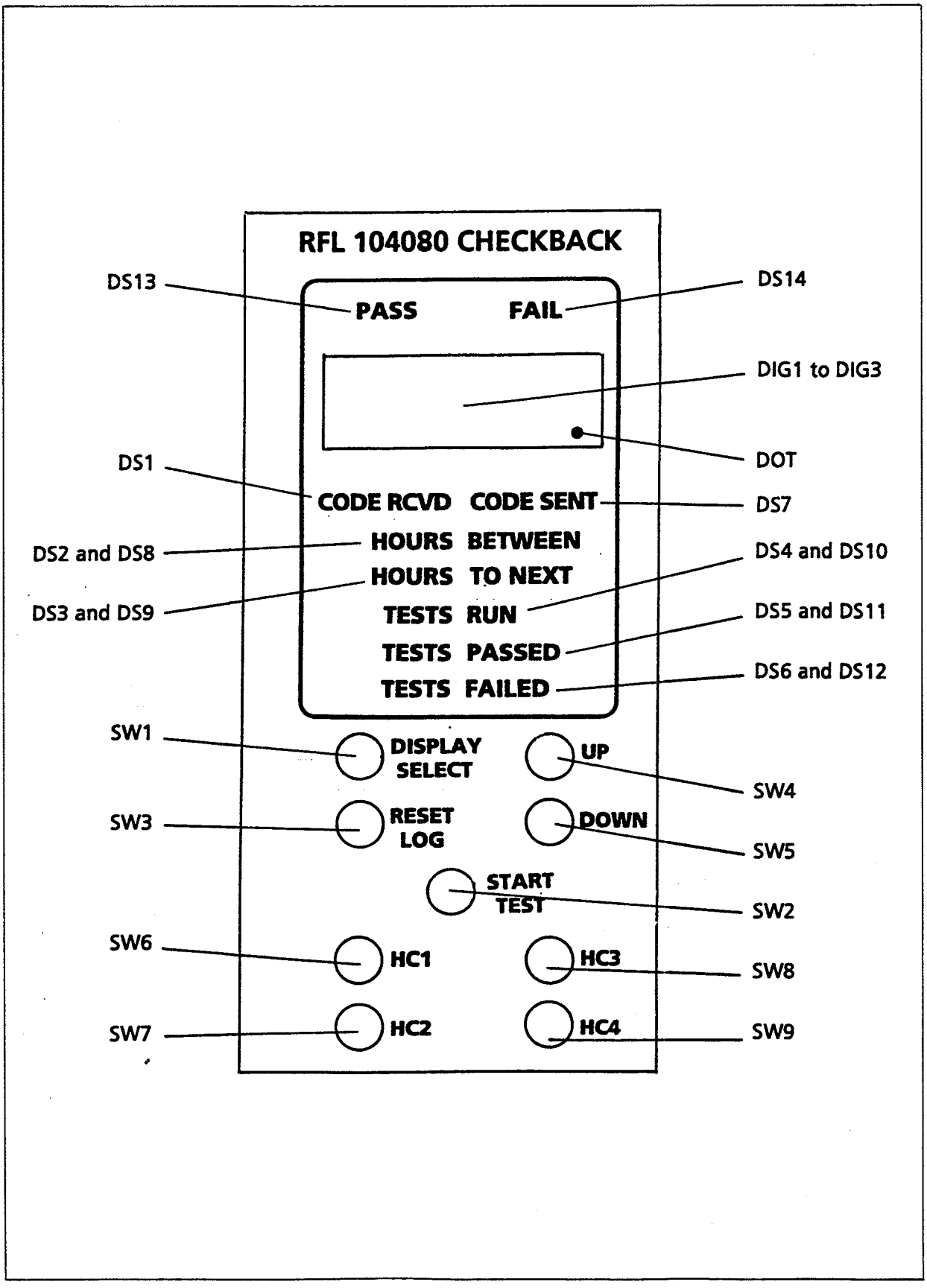


Figure 3-10. Controls and indicators, RFL 6720P Checkback Module

Table 3-10. Controls and indicators, RFL 6720P Checkback Module

Symbol	Description, Marking	Functional Description
DIG1 to DIG3	Seven-segment displays	Display codes, numeric values, and "Err" error indications. "HC" will appear when one of the Hard Carrier Request switches is pressed and a hard carrier is being sent. "HCr" will appear when a hard carrier is being received. The information displayed is controlled by DISPLAY SELECT switch SW1. (See page 3-29 for more information.) All display segments will light momentarily in turn when power is applied to the module. This serves as a lamp test.
DS1	CODE RCVD indicator	Lights when the seven-segment display is showing the code number being received. Will flash when a valid code is received.
DS2 and DS8	HOURS BETWEEN indicators	Light when the seven-segment display is showing the amount of time between automatic checkback tests. Can only be displayed on Master checkback modules.
DS3 and DS9	HOURS TO NEXT indicators	Light when the seven-segment display is showing the amount of time until the next automatic checkback test. Can only be displayed on Master checkback modules.
DS4 and DS10	TESTS RUN indicators	Light when the seven-segment display is showing the number of tests run since the last time the test log was reset. Can only be displayed on Master checkback modules.
DS5 and DS11	TESTS PASSED indicators	Light when the seven-segment display is showing the number of successful tests run since the last time the test log was reset. Can only be displayed on Master checkback modules.
DS6 and DS12	TESTS FAILED indicators	Light when the seven-segment display is showing the number of test failures that have occurred since the last time the test log was reset. Can only be displayed on Master checkback modules.
DS7	CODE SENT indicator	Lights when the seven-segment display is showing the code being sent.
DS13	PASS indicator	Lights if the system passed the last checkback test.
DS14	FAIL indicator	Lights if the system failed the last checkback test.
SW1	DISPLAY SELECT switch	Selects display mode. (See page 3-29 for more information.)
SW2	START TEST switch	Manually starts checkback test. (Tests can only be initiated at the Master.)
SW3	RESET LOG switch	Manually resets the test log. This sets the TESTS RUN, TESTS PASSED, and TESTS FAILED totals to zero.
SW4	UP switch	Increases value on display one number each time it is pressed. *
SW5	DOWN switch	Decreases value on display one number each time it is pressed. *
SW6	HC1 switch	Manually activates Hard Carrier 1 when pressed and held for five seconds.
SW7	HC2 switch	Manually activates Hard Carrier 2 when pressed and held for five seconds.
SW8	HC3 switch	Manually activates Hard Carrier 3 when pressed and held for five seconds.
SW9	HC4 switch	Manually activates Hard Carrier 4 when pressed and held for five seconds.
. . .	Dot	Lights when a carrier is received.

* - Has no effect on values that cannot be altered from the front panel.

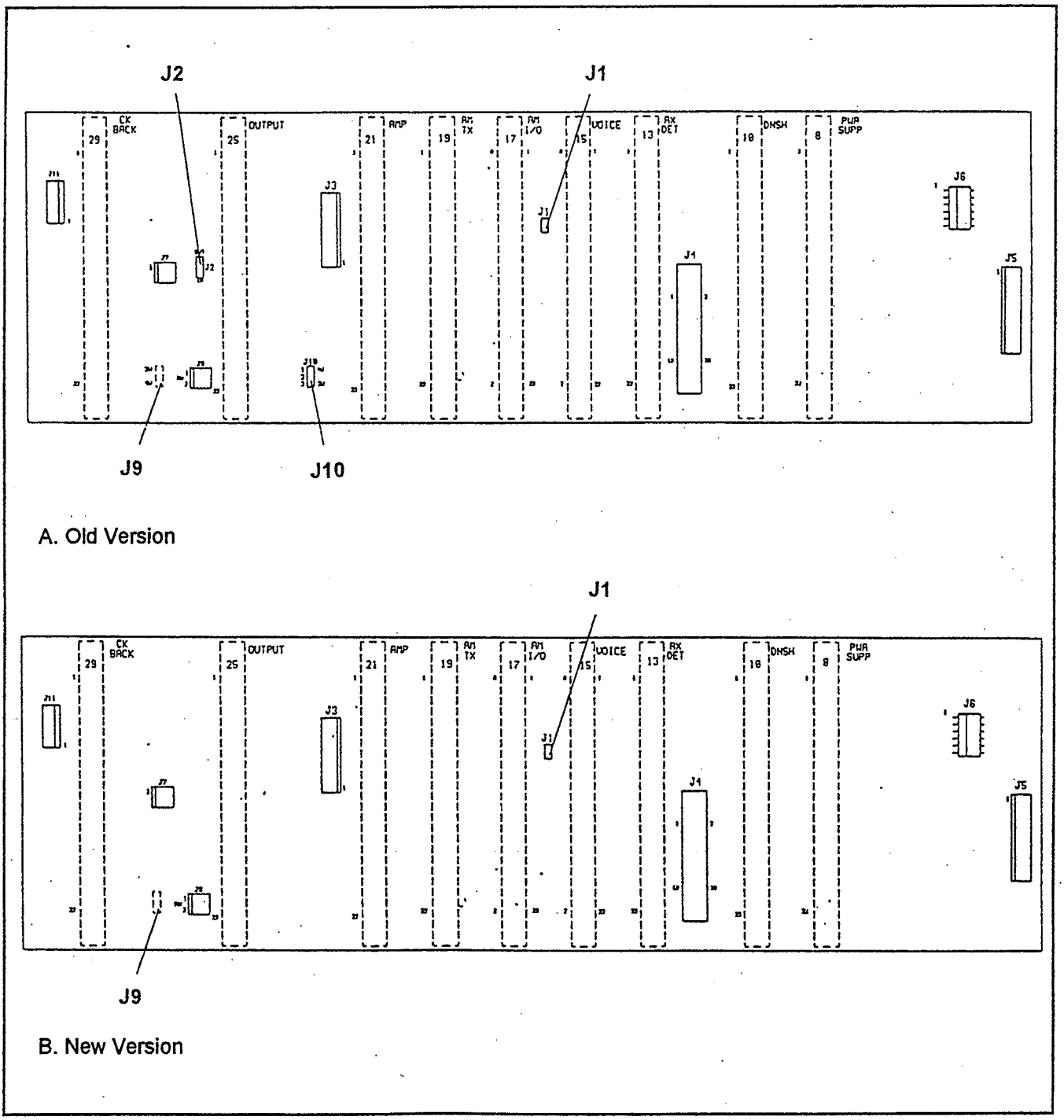


Figure 3-11. Controls and indicators, RFL 67P INTERCONNECT Motherboard

Table 3-11. Controls and Indicators, RFL 67P INTERCONNECT Motherboard

Circuit Symbol	Version of Motherboard	Description, Marking (if any)	Functional Description
J1	Old and New	Jumper, programmable	Connects output of optional voice module to the input of its AGC circuit. This Jumper must be in place if the RFL 6785P is equipped with a voice module. (See para. 3.3.7.a)
J2	Old	Jumper, OUT/IN	Determines whether amplifier output is filtered before it is fed to the line tuning equipment. Must be placed in the OFF position if the RFL 6785P will be used with the filter removed from the chassis.
J9	Old	Jumper, 2W/4W	Always in 4W position
	New	Jumper, A, B, C	Sets the RFL 6785P to two-wire/Receiver unfiltered operation, four-wire operation, or to two-wire/Receiver filtered operation. (See para. 3.3.7.b)
J10	Old	Jumper, 2W/4W	Sets the RFL 6785P to two-wire or four-wire operation.

>>> Continued from page 3-1 <<<

For example, you would set the following switches to the OFF position to set the receiver for a channel frequency of 190 kHz:

SW2-1	128 kHz
SW1-7	32 kHz
SW1-6	16 kHz
SW1-5	8 kHz
SW1-4	4 kHz
Total:	188 kHz (190 kHz - 2 kHz)

A third DIP switch on the RFL 67P RX DNSH module (SW3) controls the input attenuator. It should be set according to the expected input signal level, as shown **in Table 3-12.**

CAUTION

The lowest input range (5 to 120 mVrms) cannot be used when jumpers J9 and J10 on the interconnect motherboard are set for two-wire operation (a single coaxial cable between the RFL 6785P and the line tuning equipment). Damage to the downshifter module will result.

An additional resistor can be placed across the receiver port to tailor its impedance or attenuate a signal that is larger than 25 Vrms. If an additional resistor is used, make sure its power rating is high enough to handle the voltage dropped across it without overheating.

3.3.2. Receiver Detector Modules

There are four jumpers on the RFL 6785P receiver detector modules: J1 through J4. These jumpers must be set according to the specific requirements of your application before the RFL 6785P terminal can be placed in continuous service. Figure 3-4 on page 3-6 of this manual shows the location of these jumpers; their functions are detailed below.

a. Detector Output Polarity. Jumper J1 determines the polarity of the receiver detector module's output (edge connector terminals X and 20). J1 has two positions: BLK and UNBLK. In order for the RFL 6785P terminal to function properly, J1 must be placed in the BLK position.

b. AGC Range Control. Jumper J2 sets the range for the receiver detector module's AGC circuit. When J2 is placed in Position A, the high gain range is selected; the low gain range will be selected when J2 is placed in Position B. Position A is used in most applications.

c. Receiver Kill Control. Jumper J3 controls the receiver detector module's Receiver Kill function. This determines whether or not the receiver detector module's block output will be killed when the transmitter module is keyed. When J3 is placed in the IN position, Receiver Kill is enabled; Receiver Kill is disabled if J3 is placed in the OUT position. The IN position is used in most applications.

d. Voice Kill Control. Jumper J4 controls the receiver detector module's Voice Kill function. This determines the conditions that will disable the optional voice adapter module.

When J4 is placed in Position A, voice reception is disabled whenever carrier is not being received. This position is usually used in installations where the transmitter and receiver operate on different frequencies.

When J4 is placed in Position B, voice reception is disabled whenever carrier is not being received, or when the local carrier is keyed. This position is usually used in installations where the transmitter and receiver operate at the same frequency.

Table 3-12. Input attenuator settings, RFL 67P RX DNSH downshifter module

Input Level Range	SW3-1	SW3-2	SW3-3	SW3-4	SW3-5	SW3-6	SW3-7
3.0 V to 23.0 V	OFF	OFF	OFF	ON	OFF	OFF	ON
800 mV to 3.0 V	OFF	OFF	ON	OFF	OFF	OFF	ON
120 mV to 800 mV	OFF	ON	OFF	OFF	OFF	ON	OFF
5 mV to 120 mV *	ON	OFF	OFF	OFF	ON	OFF	OFF

NOTE: This range cannot be used when jumpers J9 and J10 on the interconnect motherboard are set for two-wire operation (a single coaxial cable between the RFL 6785P and the line tuning equipment). Damage to the downshifter module will result.

3.3.3. Voice Adapter Module

If your RFL 6785P terminal is equipped with the Voice Option, it will contain an RFL 67 PLC VOICE Voice Adapter Module. There is a single jumper on this module, labeled "A-B"; Figure 3-5 shows the location of this jumper. Place this jumper in the Position A if sidetones are to be transmitted along with the voice signals. If no sidetones are to be transmitted, place this jumper in Position B. Position A is towards the front of the board and Position B is towards the rear of the board.

3.3.4. Input/Output Module

There are five jumpers on the RFL 67P AM I/O module: J2 through J6. These jumpers must be set according to the specific requirements of your application before the RFL 6785P terminal can be placed in continuous service. Figure 3-6 shows the location of these jumpers; their functions are detailed below.

a. CARRIER START Control. The user has the option to start the carrier when the voltage is either applied or removed from the carrier start input (TB2 pins 1 and 2).

When J2 is in position A, applying a voltage to TB2 pins 1 and 2 will turn the carrier ON.

When J2 is in position B, removing a voltage from TB2 pins 1 and 2 will turn the carrier ON.

b. CARRIER STOP Control. The user has the option to stop the carrier when the voltage is either applied or removed from the carrier stop input (TB2 pins 3 and 4).

When J3 is in position B, applying a voltage to TB2 pins 3 and 4 will turn the carrier OFF.

When J3 is in position A, removing a voltage from TB2 pins 3 and 4 will turn the carrier OFF.

> **NOTE**
> **Carrier Stop Input has priority over Carrier Start Input**

c. BLOCK OUTPUT Control. Jumper J4 controls how the RFL 67P AM I/O will respond to voltages applied to its BLKINPUT input (edge connector terminal N) by the receiver detector module. When J4 is placed in position A, the BLOCK OUTPUT line will be active when BLKINPUT is high. When J4 is placed in position B, the BLOCK OUTPUT line will be active when BLKINPUT is low.

d. Power Level Control. Three-position jumper J5 controls the power output level:

Position A Output level is fixed at 10 watts.

Position B Output level goes high when voice or block signals are sent; otherwise, the output level will be 3 watts.

Position C Output level is fixed at 3 watts

e. Receiver Kill Control. Three-position jumper J6 controls the receiver kill function:

Position A The REC KILL line will go low when the CARR EN line goes low.

Position B The REC KILL line will go high when the CARR EN line goes low.

Position C The REC KILL line will go high when the STOP line goes high

3.3.5. Transmitter Module

The RFL 67P PLC TRANS transmitter module contains jumpers and DIP switches that must be set before the RFL6785P terminal is placed in continuous service. Figure 3-7 shows the location of these jumpers; their functions are detailed below.

a. Jumper Settings. There are seven jumpers on the RFL 67P PLC TRANS transmitter module: J1 through J7. The following paragraphs describe how these jumpers must be set.

(1) Carrier Shift Control. Jumper J1 determines how the RFL 67P PLC TRANS will respond to commands applied to the OSC2/1 input (edge connector terminal11). Since the RFL 6785P does not use the RFL 67P PLC TRANS's FSK capabilities, this jumper can be placed in either position; it will have no effect on RFL 6785P operation.

(2) Carrier Enable Control. Jumper J2 determines how the RFL 67P PLCT RANS will respond to commands applied to the CARRIER ENABLE input (edge connector terminal 9). If J2 is placed in Position A, carrier will be enabled when zero volts is applied to the CARRIER ENABLE input; with J2 in Position B, carrier will be enabled when +12 volts is applied to the CARRIER ENABLE input.

(3) Power Level Control. Jumper J3 determines how the RFL 67P PLC TRANS will respond to commands applied to the PWRA input (edge connector terminal 6). If J3 is placed in Position A, a 3-watt power level will be selected when zero volts is applied to the PWRA input; with J3 in Position B, the 3-watt power level will be selected when +12 volts is applied to the PWRA input.

(4) Voice Enable Control. Jumper J4 determines how the RFL 67P PLC TRANS will respond to commands applied to the VOICE ENABLE input (edge connector terminal 10). If J4 is placed in Position A, voice transmissions will be enabled when zero volts is applied to the VOICE ENABLE input; with J4 in Position B, voice transmissions will be enabled when +12 volts is applied to the VOICE ENABLE input.

(5) EPROM Device Type Selection. Jumpers J5 and J6 are set according to the type of EPROM devices being used for U13 and U14. Both J5 and J6 must be placed in Position A if 27C64 devices are being used; if 27C128 or 27C256 devices are being used, both jumpers must be placed in Position B.

(6) Output Routing. Jumper J7 determines the edge connector terminal that will be used to pass the output signal on to the power amplifier module. J7 must be placed in Position A when the RFL 67P PLC TRANS is being used in RFL6785 or RFL6785P terminals; if the RFL 67P PLC TRANS is being used in RFL6780 or RFL 6780P terminals, J7 must be placed in Position B.

b. DIP Switch Settings. There are two DIP switches on the 67P TRANS transmitter module: SW1 and SW2. These switches are used to select the transmit frequency. The frequency you program in must be within the passband of the RFL 67P OUTPUT power output filter being used. (See paragraph 3.3.6.)

Each switch section equals a specific frequency (in kHz). By placing switch sections in the ON position and adding up the frequencies they represent, any frequency from 30 to 535 kHz can be selected:

SW1-1	0.05 kHz (50 Hz)
SW1-2	0.1 kHz (100 Hz)
SW1-3	0.2 kHz (200 Hz)
SW1-4	0.4 kHz (400 Hz)
SW1-5	0.8 kHz (800 Hz)
SW1-6	1.6 kHz
SW1-7	3.2 kHz
SW1-8	6.4 kHz
SW2-1	12.8 kHz
SW2-2	25.6 kHz
SW2-3	51.2 kHz
SW2-4	102.4 kHz
SW2-5	204.8 kHz
SW2-6	409.6 kHz
SW2-7	Not used (leave OFF).
SW2-8	Not used (leave OFF).

For example, you would set SW1 and SW2 as follows for a transmit frequency of 190 kHz:

SW2-4	102.4 kHz
SW2-3	51.2 kHz
SW2-2	25.6 kHz
SW1-8	6.4 kHz
SW1-7	3.2 kHz
SW1-5	0.8 kHz
SW1-4	0.4 kHz
Total	190.0 kHz

3.3.6. Output Filter Modules

In order to cover the RFL 6785P's entire operating range (30 to 535 kHz), there are four different RFL 67P OUTPUT filter modules. Three filter modules are equipped with jumpers for selecting the frequency range; the fourth has a fixed range that covers the top of the RFL 6785P's frequency band. Refer to Figure 3-9 on page 3-13 of this manual for jumper locations.

Table 3-13 summarizes the output filter/jumper setting selections that can be made. If the wrong output filter is being used or all of its jumpers are not properly set, the RFL 6785P terminal will not work properly.

Table 3-13. Frequency ranges, RFL 6785P output filter modules

Passband Frequency Range	Filter Part No.	Jumper Position
30 to 41.5 kHz	104070-1	A
38 to 52.5 kHz	104070-1	B
49 to 67.5 kHz	104070-1	C
64 to 88.5 kHz	104070-2	A
85 to 117.5 kHz	104070-2	B
114 to 157.5 kHz	104070-2	C
154 to 212.5 kHz	104070-3	A
209 to 288.5 kHz	104070-3	B
285 to 393.5 kHz	104070-3	C
390 to 537.5 kHz	104075	. . .

3.3.7. Interconnect Motherboard

The RFL 67P INTERCONNECT Interconnect Motherboard contains four jumpers that must be set before the RFL 6785P terminal is placed in continuous service. Figure 3-11 on page 3-16 of this manual shows the location of these jumpers; their functions are detailed below.

a. Voice Module AGC Input. Jumper J1 connects the output of the optional RFL 67 PLC VOICE module to the input of its own AGC circuit. This jumper must be in place if the RFL 6785P is equipped with a voice module.

c. Output Configuration. Jumper J9 is a three position jumper which sets the output configuration. The function of each position is described below.

Position A (Two wire/Receiver unfiltered): In position A the transmitter output and receiver input are available from one UHF connector identified as TX on the rear of the chassis.

Position B (Four wire): In position B the transmitter output is routed to the UHF connector identified as TX on the rear of the chassis, and the received signal is applied

sometimes required when multiple power line carrier signals are combined with hybrids.

Position C (Two wire/Receiver filtered): In position C both the transmitter and receiver signals are available from one UHF connector identified as TX on the rear of the chassis. The received signal however, is routed through the transmitter power filter. The power filter provides the ability to attenuate unwanted signals that may interfere with receiver operation. The frequency of the unwanted signals must fall outside the passband of the power filter range to be of any benefit.

3.3.8. Isolation Board

The RFL 67P ISOL Isolation Board has one jumper, J3, that must be set before the RFL 6785P terminal is placed in continuous service. The function of this jumper is to cause relay K10 to provide either a Test In Progress or a Block Received, form C contact output. Figure 14-2 on page 14-4 shows the location of this jumper.

When the 6785P is equipped with the 6720P Automatic Checkback module, jumper J3 will be placed in position B. Relay K10 will be energized when the automatic checkback test is in progress. The form C contact output is intended to provide system operators an indication that a checkback test is in progress.

When the 6785P is not equipped with the checkback module, jumper J3 will be located in position A. This will provide a second set of form C Block Received output contacts. These contacts are located on terminal block four, positions 6,7, and 8.

3.4 INITIAL STARTUP PROCEDURES

All RFL 6785P terminals are checked and adjusted at the factory. Once all electrical connections and jumper settings have been made, the terminals at each end of each communication line should be checked for proper operation. To do this, an operator must be at each station, and the operators must be in contact with each other, either by telephone, PLC voice channel, or similar means.

The following procedures can be used to check the RFL 6785P terminals at each end of a communications line for proper operation, either at time of installation or any time system operation needs to be verified. Perform all steps in each procedure in the order presented. Expected results or comments are indented and appear in **boldface** type.

3.4.1. Equipment Requirements

The following equipment will be required to perform the initial startup procedures:

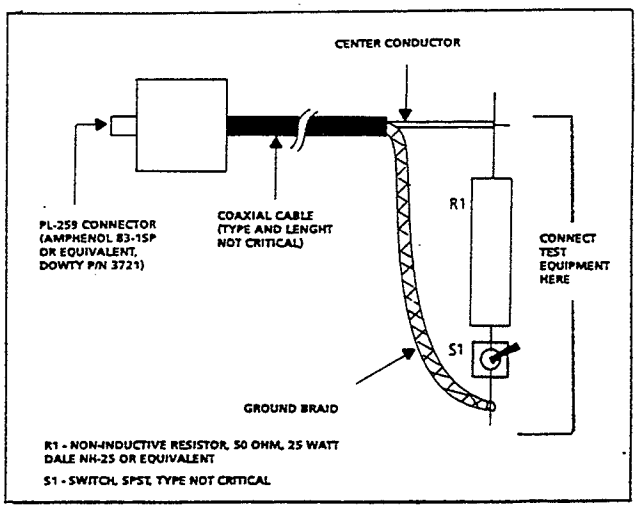


Figure 3-12. Construction details, 50-ohm dummy load for initial startup procedures

1. Digital multimeter, 3 1/2-digit with true-rms response, Fluke Model 8010A or equivalent.

2. Frequency-selective voltmeter (FSVM), Rycom Model 6021A or equivalent.

3. Small flat-blade screwdriver or potentiometer adjustment tool.

4. 50-ohm dummy load, constructed as shown in Figure 3-12.

3.4.2. Equipment Setup Procedure

1. Make sure all modules within the RFL 6785P terminal are properly strapped for desired circuit operation, and that the DIP switches on the transmitter and downshifter modules have been set for the desired operating frequencies. (Refer to paragraphs 3.3.1 through 3.3.6, and the "as supplied" drawings furnished with the equipment.)

2. Disconnect the cable from the TX connector on the rear panel, and connect the dummy load in its place.

3. Connect the FSVM across the dummy load. Tune the FSVM the the transmitter carrier frequency, and select a range that will accept a 30-volt signal without overranging.

4. Turn on the RFL 6785P by placing the power switch on the power supply module in the ON (up) position.

POWER indicator DS1 on the front of the power supply module will light.

5. Place manual key switch S1 on the front of the input/output module (67P AM I/O) in the "active" position.

The transmitter module will start generating a carrier. When the carrier detect circuit on the input/output module senses that a carrier is being generated, CARRIER ON indicator DS3 on the input/output module will light.

6. Note the carrier output level, as indicated on the FSVM connected across the dummy load. If necessary, adjust potentiometer R45 on the power amplifier module (67P PLC AMP) until the FSVM indicates the desired output level.

   The FSVM will indicate 7.07 volts for a 1-watt output, 12.24 volts for a 3-watt output, and 22.3 volts for a 10-watt output.

7. Turn off the RFL 6785P by placing the power switch on the power supply module in the OFF (down) position.

   POWER indicator DS1 on the front of the power supply module will go out.

8. Disconnect the dummy load from the TX connector on the rear panel, and re-connect the transmitter output cable in its place.

9. Have the operator at the remote station key his transmitter for a full-power output.

10. Tune the FSVM to the incoming carrier frequency.

11. Using the FSVM, measure and record the amplitude of the carrier signal at the end of the receiver input cable.

    If the RFL 6785P is set up for two-wire operation, there will be a single cable coming from the line tuning equipment that carries both the transmitter output and the receiver input signals. If it is set up for four-wire operation there will be two separate cables.

12. Connect the receiver input cable to the proper connector on the rear panel of the chassis.

    If the RFL 6785P is set up for two-wire operation, connect the cable to the rear-panel TX connector, since it will also be carrying transmitter output signals. If the RFL 6785P is set up for four-wire operation, connect it to the RX connector.

13. Remove the receiver downshifter module (67P RX DNSH) from the chassis and set DIP switch SW3 for the proper attenuation factor for the signal level recorded during step 9. (See Table **3-12 on page 3-17** of this manual for proper switch settings.) Once SW3 has been properly set, reinsert the receiver downshifter module into the chassis.

14. Turn on the RFL 6785P by placing the power switch on the power supply module in the ON (up) position.

    POWER indicator DS1 on the front of the power supply module will light.

15. Adjust the receiver downshifter module as follows:

    a. With a carrier signal applied to the receiver input, adjust potentiometer R80 until NOM indicator DS3 (green) lights.

    b. Connect the positive multimeter lead to test point TP2 (yellow), and connect the negative multimeter lead to test point TP1 (black). Set the multimeter for dc voltage measurements, and select a range that will display a 4-volt reading without overranging.

    c. Note the multimeter indication. If necessary, fine-tune potentiometer R80 until the multimeter indicates -4.0 volts.

    d. Disconnect the multimeter from the receiver downshifter module.

The setup procedure is now completed for a standard RFL 6785P terminal (with or without the voice or checkback options), and the terminal is now ready for continuous operation. If additional equipment that requires adjustment has been supplied with your terminal, supplemental instructions will be supplied.

NOTE

Throughout the following alignment procedures, test points that are accessible from the front of the chassis are identified by panel marking and/or color and are called "test points". Those that are not identified by color are turrets or wire loops on the circuit board itself, and are called "test turrets". A card extender may be required to gain access to the test turrets.

3.5. TERMINAL ALIGNMENT PROCEDURES

Each RFL 6785P terminal is aligned at the factory. Alignment should only be performed in the field after one or modules have been repaired or replaced, or if a malfunction is suspected. Perform all steps in the order presented. Expected results and/or comments are indented and appear in **boldface** type.

3.5.1. Equipment Requirements

In addition to the equipment required for the initial startup procedures (para 3.4.1), the following equipment will be required to perform the RFL 6785P alignment procedures:

1. Oscilloscope, 100 MHz bandwidth; Tektronix Model 2335 or equivalent.

2. Signal generator, Wavetek Model 132 or equivalent.

3. Audio oscillator, 600-ohm output impedance, Hewlett-Packard 200CD or equivalent.

4. Digital frequency counter, Hewlett-Packard Model 5315A or equivalent.

5. Patch cord with 0.080-inch pin tips at each end, 24 inches long, Pomona 1990-24 or equivalent (two required: one red and one black).

6. Patch cord with plunger-type test clips at each end, 12 inches long, Pomona 3781-12 or equivalent.

7. Card extender, RFL 68 EXT (P/N 39585).

8. Resistor, carbon composition, 300 ohm, 1/2 watt, Allen-Bradley EB Series or equivalent.

3.5.2. Power Supply Output Verification

RFL 6785P terminals require four regulated voltages for proper operation: +12 volts, -12 volts, +15 volts, and -15 volts. These voltages are obtained from an RFL 67P **DC power supply module mounted inside the RFL 6785P chassis. Because the outputs cannot be adjusted, this procedure will only verify whether or not the power supply is working.

CAUTION

To prevent damage to the multimeter, the input voltage being fed to the power supply must be known before attempting to perform the following procedure.

1. Set the multimeter for dc voltage measurements. Set the multimeter range control as required to produce a reading that does not force the multimeter to overrange.

2. At terminal block TB1 on the rear panel, measure the incoming station battery voltage by connecting the positive multimeter lead to terminal TB1-10, and the negative lead to terminal TB1-11. Note the multimeter indication.

   The multimeter indication must be within the following limits:

   48-Vdc Terminals - 42 to 56 volts
   125-Vdc Terminals - 104 to 140 volts

   The power supply may not be able to produce enough power to operate the terminal with input voltages below these limits; voltages above these limits may result in damage to the power supply.

3. Disconnect the multimeter from terminal block TB1.

4. Set the multimeter for dc voltage measurements, on a range that will produce 15-volt readings without over-ranging.

5. Turn on the power supply by placing the POWER switch in the on (up) position.

6. Connect the negative multimeter lead to the COM test point on the front of the power supply; connect the positive multimeter lead to the +12V test point. Note the multimeter indication.

   The multimeter indication should be between +10.8 and +13.2 volts.

7. Move the positive meter lead to the -12V test point on the front of the power supply. Note the multimeter indication.

   The multimeter indication should be between -10.8 and -13.2 volts.

8. Turn off the power supply by placing the POWER switch in the on (down) position.

If the above procedure can be successfully completed at both terminals, the power supplies are functioning properly. If not, refer to the fuse replacement procedures in Section 4 before proceeding with paragraph 3.5.3. If fuse replacement does not correct the problem, either replace or troubleshoot the power supply before proceeding to paragraph 3.5.3.

3.5.3 Transmitter Alignment

1. If at all possible, test two chassis back-to-back in 2-wire mode. Two chassis are required for the voice option.

2. If 2-W mode is being used, connect an attenuator to the UHF connectors marked TX on both chassis as shown in the figure below and set the attenuator to 20 dB. If 4-W mode is being used, connect an attenuator to the UHF connectors marked TX and RX as shown in the figure below and set the attenuator to 20 dB.

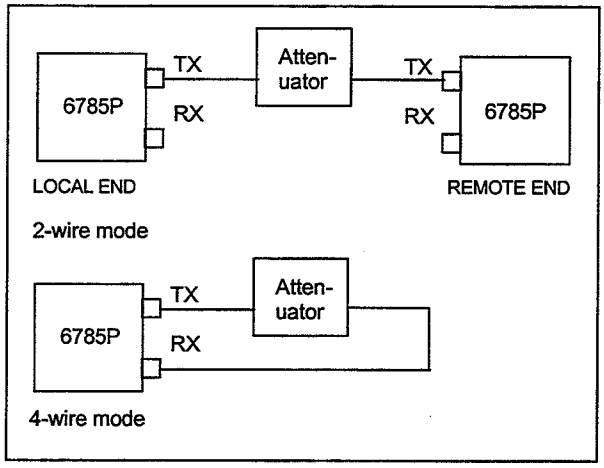


Figure 3-13. Attenuator Connections

3. Check the J9 strap on the motherboard(s), located behind the output filter of the chassis. It should be in the 2-W position for both chassis under test, or in the 4-W position if only one chassis is being used.

4. Connect the appropriate station battery voltage to the power terminals. Verify that the external resistors on the terminal block are the proper values in accordance with the control drawings which are usually located at the end of this manual.

5. Check all modules for proper strapping per the charts on the control drawings and/or the sales order. Use the frequency settings shown in tables 3-1 and 3-2 to select the desired operating frequency for the Transmitter module and the Downshifter module. Turn on the power supply and check for the presence of ± 12 Vdc. Adjust R45 of the 67P Power Amp module to the CCW position.

6. Place the 67P Transmitter module on a card extender. Place a scope probe on TP4 (+) and TP1 (-). Key the TX on with the start input (noise will be visible). Adjust R50 for 35 to 40 mVp-p.

7. Move the scope probe to TP6 (+) and TP1 (-). With the TX still on, adjust R16 for 6 Vp-p. Also check TP6 with a frequency counter and measure the carrier frequency ± 10 Hz.

8. Unkey the TX start input and remove the 67P Transmitter module and the card extender from the chassis.

3.5.4 Amplifier Alignment

1. Put the 67P Power Amp module on a card extender and short pin 15 to pin 17. Measure the voltage at TP2 (+) and TP1 (-) with a DC voltmeter. Using R5 adjust the DC OFFSET for a null. The jumper from pin 15 to pin 17 can now be removed. This adjustment must be performed every time a new power amplifier is installed in the chassis.

2. Reinstall the 67P Transmitter module and key the start input.

3. Remove the Filter module (67P OUTPUT) from the chassis. Measure the 67P Power Amp output on pins 22 (+) and 20 (-) and adjust R45 for a level of 35 dB. Reinstall the Filter module (67P OUTPUT) while observing the PWR AMP output level. The power level should drop by about 6 dB. Adjust R20 on the PWR AMP to get a 6 dB drop in level. NOTE: If the power level dropped by about 2 dB when the Filter module was installed, check the Downshifter module input attenuator straps. SW3-1 and SW3-5 should be in the OFF position.

4. Reinstall the 67P Power Amp module into chassis and adjust R45 for the proper TX level at filter output TP2 (+) and TP1 (-), as determined from the sales order.

   10 Watt = 22.35 Vrms
   3 Watt = 12-25 Vrms
   1 Watt = 7.07 Vrms

   Un-key the start input.

5. Place the 67P I/O module on a card extender and key the reserve signal input. Then adjust R31 for 1/10th of the full power output that was adjusted in Step 4. Unkey the reserve signal input and reinstall the 67P I/O module back into the chassis.

   1 Watt = 7.07 Vrms
   0.3 Watt = 3.87 Vrms
   0.1 Watt = 2.23 Vrms

6. Key the start input and verify that the TX signal is on line. Verify that the START LED is lit on the 67P AM I/O module. Key the stop input and verify that the TX signal is gone, and that the STOP LED is lit on the 67P AM I/O module. Key the input and verify that the TX signal is on line at reduced power. Unkey the reserve input.

7. Key the reserve signal on and adjust R38 on the PWR AMP so that the CARR ON LED is lit on the I/O board.

3.5.5 Receiver Alignment

1. Remove the 67P TX module from the local end if 2-W operation is being used. Never use the attenuator settings SW3-1 and SW3-5 for 2-W operation.

2. Place the 67P Downshifter on a card extender and turn R80 to full clockwise position. Adjust R18 to obtain a maximum output level.

3. Key the 67P TX on, and monitor TP5 (+) RED and TP1 (-) BLK. Adjust the load attenuator switches and attenuator switches on the 67P RX DNSH to obtain 10 mVrms ± 1 mV. Use a Rycom Selective Voltmeter to obtain the reading.

4. Using a 10X scope probe adjust R21 for 5.120000 MHz at the junction of C47 and C48 (left side of C47).

5. Adjust R80 for 1.5 Vp-p at TP11.

6. Adjust R29 at TP12 (+), TP1 (-) with a scope probe for 400 mVp-p.

7. Connect a Rycom to TP3 (+) GRN and TP1 (-) BLK. Using R34, adjust the 26 kHz signal for a null.

8. Monitor a frequency of 26kHz at TP14 (+) and TP1 (-). Then observe a level of approximately 1.0 Vp-p at TP3 (+) GRN and TP1(-) BLK with a scope.

9. Connect a Digital Voltmeter to TP2 (+) YEL and TP1 (-) and adjust the DC level to -4.5 Vdc by adjusting R8 on the 67P DET.

10. Adjust R63 on the downshifter module (DNSH) for +4.5 Vdc at TP7 (+) and TP1 (-).

11. Re-strap SW3 for the desired setting. The normal setting is SW3-3 and SW3-7 in the ON position. Reinstall the DNSH into the chassis. Readjust the attenuator switches back to 20 dB of attenuation. If the TX level was adjusted, return it to the level that was set up in Step 4 at this time.

12. With the far end TX transmitting at a normal level of 10 watts, adjust R80 on the DNSH for -4 Vdc at TP2 (+) YEL and TP1 (-) BLK.

13. Unkey the TX and adjust R24 on the 67P DET for a -1.0 Vdc level at TP3 (+) and TP1 (-).

14. Reinstall the 67P TX module at the local end.

15. Check all signal levels and contact closures for proper operation on the rear panel by referring to Figure 13-6. The operation of TX fail can be checked by first keying the stop input and then keying the reserve signal input.

3.5.6 Voice Option Alignment

1. The voice option will include a voice accessory front panel, a voice adapter and a DET-1 module, which is the regular DET module, but equipped with a voice plug-on filter.

2. On the transmit end adjust the percent modulation as one does for the existing 6780 PLC equipment. In this system, trip always has priority over voice. If the system is a blocked type and the system is tripped, the output will not be modulated. To get voice with this scheme, trip must be off and the handset plug inserted with the push to talk switch squeezed.

3. The AGC switch should be in the TEST position.

4. Connect a 300 ohm resistor between pins 16 and ground of the 67 Voice Card. The power output is 12.5 Vrms ± 1.5 dB (3 watts). Adjust the scope amplitude as shown in Figure 3-14.

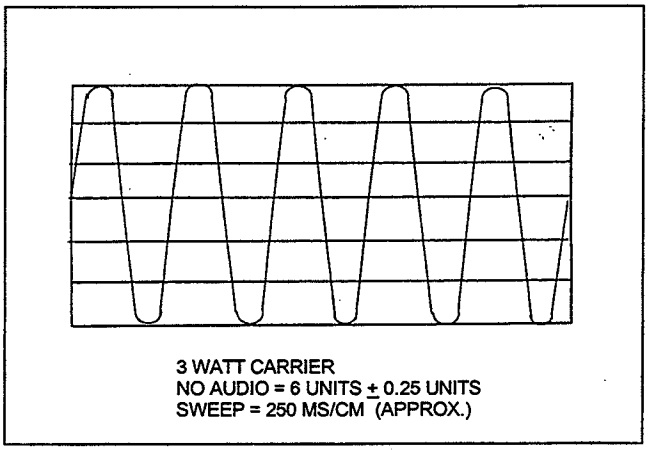


Figure 3-14. Typical carrier output with no audio.

5. Adjust 600 ohm oscillator with 300 ohm resistor across input terminals for for 0.3 Vrms at 1 Khz. Apply this to pins 16 and ground of the 67 Voice Card. This should produce a sine wave that is just clipping at TP8. Verify that the power output is 12.5 Vrms ± 1.5 dB (3 watts).

6. With the audio signal applied, adjust R63 on the 67 Voice card for the approximate waveform as shown in Figure 3-15.

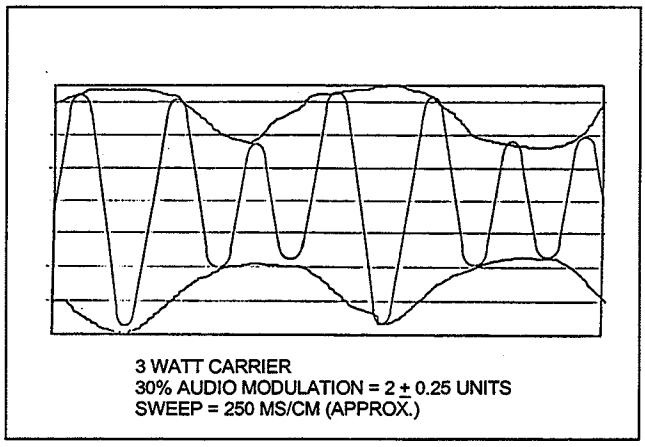


Figure 3-15. Typical carrier output with 30-percent modulation.

7. Remove the 300 ohm resistor and audio tone. Apply 12 Vdc to the call button input terminals to activate the call tone. Observe the amplifier output for a similar waveform, however, the modulating frequency will be 1800 Hz ± 5 Hz. Measure the frequency at TP7 (Blue).

8. On the receiver end put the RX DET module on the card extender. While receiving the nominal system level, adjust R229 on voice BP filter for 75 mVrms at TP16.

9. Activate the remote call signal and observe TP6 (Yellow) on the Voice card. Adjust R71 for 0.2 Vrms. While sending a remote call, observe TP7 (Blue) for 4 Vrms ± 2 dB.

10. Activate remote call signal. Observe TP2 (Green) and adjust R7 for 1 Vrms. Set switch to NORM and note, after several seconds, that TP2 returns to 1 Vrms ± 2 dB.

SW-1 POSITION		SW-2 POSITION	
1	500 Hz	1	128 Khz
2	1 kHz	2	256 kHz
3	2 kHz	3	512 kHz
4	4 kHz	4	not used
5	8 kHz		
6	16 kHz		
7	32 kHz		
8	64 kHz		

Table 3-14. Frequency settings, RFL 6785P Programmable Downshifter (Assembly No. 104005)

NOTE: You must set the frequency 2 kHz below the desired center frequency.

EXAMPLE: To set the receiver for a channel frequency of 190 kHz, you should select the following switch settings:

SW-2-1	128 kHz
SW-1-7	32 kHz
SW-1-6	16 kHz
SW-1-5	8 kHz
SW-1-4	4 kHz
	188 kHz

(188 kHz = 190 kHz - 2 kHz)

SW-1 POSITION		SW-2	
1	50 Hz	1	12.8 Khz
2	100 Hz	2	25.6 kHz
3	200 Hz	3	51.2 kHz
4	400 Hz	4	102.4 kHz
5	800 Hz	5	204.8 kHz
6	1600 Hz	6	409.6 kHz
7	3200 Hz	7	FSK use
8	6400 Hz	8	FSK use

Table 3-15. Frequency settings, RFL 6785P Programmable Transmitter (Assembly No. 104040)

NOTE: The programmed transmitter frequency must be within the passband of the power output filter. See Table 3-13 for available filter modules.

EXAMPLE: To set a transmit frequency of 190 kHz, you should select the following switch settings:

SW-2-4	102.4 kHz
SW-2-3	51.2 kHz
SW-2-2	25.6 kHz
SW-1-8	6.4 kHz
SW-1-7	3.2 kHz
SW-1-5	0.8 kHz
SW-1-4	0.4 kHz
	190 kHz Total

3.6. CHECKBACK TESTING

The following paragraphs contain the instructions necessary for using the RFL6720P Checkback Module to test the RFL6785P. Instructions are also provided on programming the RFL6720P using APRIL (Asynchronous Programming and Remote Interrogation Language).

The RFL6720P's front panel contains controls and indicators that are used to initiate tests, monitor system functions during normal operation, initiate checkback tests, and reset alarms. These controls and indicators are shown in Figure 3-10 and are described in Table 3-10.

3.6.1 Operating The RFL 6720 By Using The Front-Panel Switches

The pushbutton switches on the front of the RFL6720P checkback module can be used to change display modes, set automatic checkback test times, run checkback tests manually, make hard carrier requests, and view checkback test results. All other RFL6720P functions must be done using a terminal or PC connected to the RS-232 connector on the RFL6785P's rear panel. (See paragraph 3.6.2 for more information.) The functions described below can also be performed through the rear-panel RS-232 connector.

3.6.1.1 Changing Display Modes

The 4-digit seven-segment display on the front of the checkback module has many display modes. The DISPLAY SELECT switch is used to switch from one mode to another. Each time you press the DISPLAY SELECT switch, the mode will change in the following order:

CODE SENT
The last checkback code that the checkback module sent.

CODE RCVD
The last checkback code that the checkback module received.

HOURS BETWEEN
The programmed amount of time (in hours) between automatic checkback tests.

HOURS TO NEXT
The amount of time (in hours) until the next automatic checkback test.

TESTS RUN
The total number of checkback tests (manual and automatic) run since the last time the totals were reset.

TESTS PASSED
The number of successful checkback tests (manual and automatic) run since the last time the totals were reset.

TESTS FAILED
The number of unsuccessful checkback tests (manual and automatic) run since the last time the totals were reset

CODE SENT and CODE RCVD can be displayed at all checkback modules; the other modes can only be displayed at Master checkback modules. Most of these values are read-only, and cannot be changed by pressing front panel switches. The HOURS BETWEEN and HOURS TO NEXT values can be changed by using the procedure in paragraph 3.6.1.2.

3.6.1.2. Setting Automatic Test Times

Automatic test times can be set at the Master checkback module in one-hour increments from zero to twenty-four. To set, proceed as follows:

1. Press and release the DISPLAY SELECT switch on the Master checkback module until the HOURS BETWEEN legend beneath the seven-segment display is lit.

   The display will indicate the amount of time (in hours) between automatic checkback tests.

2. Press the UP and DOWN switches until the desired value is displayed.

   Holding down the UP switch will cause the displayed number to increase until it reaches "24." Once it does, it will stop; there is no "wrap-around" feature to bring it back to zero.

   Holding down the DOWN switch will cause the displayed number to decrease until it reaches zero. Once it does, it will stop; there is no "wrap-around" feature to bring it back to 24.

3. Press and release the DISPLAY SELECT switch once.

   The HOURS TO NEXT legend beneath the seven-segment display will light. The display will indicate the amount of time (in hours) until the next automatic checkback test.

4. Press the UP and DOWN switches until the desired value is displayed.

The automatic test times are now set.

3.6.1.3. Running Checkback Tests Manually

To run a checkback test manually, press the red START TEST switch on the Master checkback module. The checkback will send out the code it is programmed to send, and monitor the line for the code it is programmed to receive. The TESTS RUN, TESTS PASSED, and TESTS FAILED totals will be changed to reflect the outcome of the test; the PASS or FAIL indicator will also light to indicate the outcome of the test.

3.6.1.4. Making Hard Carrier Requests

The HC1, HC2, HC3, and HC4 switches are used to make manual hard carrier requests. Each checkback can be programmed to send up to four hard carrier requests. (This programming must be done through the rear-panel RS-232 connector; see page 3-31 for details.) If you press a switch for a hard carrier that has not been programmed, an "Err" error message will appear on the seven-segment display.

NOTE

The hard carrier request switches must be pressed and held for five seconds before a hard carrier request is sent. This is done to prevent accidental hard carrier requests.

3.6.1.5. Viewing Checkback Test Results

The seven-segment display has three modes that allow you to view checkback test results:

TESTS RUN
The total number of checkback tests (manual and automatic) run since the last time the totals were reset.

TESTS PASSED
The number of successful checkback tests (manual and automatic) run since the last time the totals were reset.

TESTS FAILED
The number of unsuccessful checkback tests (manual and automatic) run since the last time the totals were reset.

To move between these modes, press and release the DISPLAY SELECT switch.

3.6.1.6. Resetting The Test Log

To reset the test log, press and release the RESET LOG switch twice. This will clear all three test logs, setting them to zero. They will change at the next checkback test to reflect the results of that test.

NOTE

The RESET LOG switch must be pressed and released twice before the test logs will be reset. This is done to prevent accidental resets.

3.6.2. Accessing the RFL 6720P From A PC Or Terminal

You can use the RFL 6785P's RS-232 port to access the RFL 6720P from a dumb terminal or a personal computer equipped with a terminal emulator. Once connected, you can use APRIL (**A**synchronous **P**rogramming and **R**emote **I**nterrogation **L**anguage) to view a list of parameter settings, change parameter settings as required, monitor operation, or initiate checkback tests. Because APRIL is menu-based, you do not have to memorize the commands. Help screens can always be displayed by pressing the **[H]** and **[ENTER]** keys.

To use APRIL, you will have to connect a terminal to the RS-232 connector on the rear of the chassis housing the RFL 6720P. The terminal you use can be a dumb RS-232 terminal, or a PC or laptop computer with an RS-232 port running a terminal emulation program. You could also connect the RS-232 port to one of the ports on an RFL 9660 Digital Switch or a stand-alone modem, and access the RFL 6720P with APRIL from a remote site.

For more information on connecting a PC or terminal to the RS-232 port, refer to Section 2 of this manual.

3.6.2.1. Viewing APRIL Commands

Once you have connected a terminal to the RFL 6785P's RS-232 port (either directly or through an RFL 9660), press the **[ENTER]** key a few times. The RFL 6720P will send the following prompt to your terminal:

6720P>

This means that you have accessed the RFL 6720P, and can now use APRIL commands to view lists of parameter settings, alarm conditions, and other information. To view a list of the APRIL commands, press the **[H]** and **[ENTER]** keys:

6720P>H [ENTER]

This tells the RFL 6720P to send a list of APRIL commands to your terminal. A typical APRIL command list appears in Figure 3-16.

For more information on each APRIL command, refer to the page number listed below next to the command.

Command	Meaning	Page
H	Display the main menu	3-28
A	Go to the alarms display	3-28
V	Go to the values display	3-28
P	Go to the programming menu	3-31
D	Go to the read settings menu	3-29
F	Go to the configure and software version display	3-30
T	Go to the test menu	3-35
U	Enter the update mode	3-30
X	Exit the update mode	3-31

3.6.2.2. Viewing The Alarms Display

To view the current status of all RFL 6720P alarms, enter the "A" command.

Format: 6720P>A [ENTER]

The "A" command tells the RFL 6720P to send a copy of the alarms display to your terminal. A typical alarm display is shown in Figure 3-17.

The alarm display shows the code number for each alarm, a brief description of its meaning, and its status ("I" for "inactive," or "A" for "active"). Full descriptions for each alarm are as follows:

010 - Tx Fail
The RFL 6785P system being tested by the RFL 6720P has failed to transmit a block.

011 - Test Fail
The last checkback test failed.

3.6.2.3. Viewing The Values Display

To view a list of all parameter values, enter the "V" command.

Format: 6720P>V [ENTER]

```
RFL Electronics APRIL(t) Remote Communications, Version 1.0 (c) 1993

H - Display the main menu
A - Go to the alarms display
V - Go to the values display
P - Go to the programming menu (password required)
D - Go to the read settings menu
F - Go to the configuration and software version display
T - Go to the test menu
U - Enter the update mode
X - Exit the update mode
6720P> _
```

Figure 3-16. APRIL commands for use with RFL 6720P

```
 #   ALARM            STATUS (I/A)      #   ALARM            STATUS (I/A)
-----------------------------------    -----------------------------------
010  Tx Fail             I             011  Test Fail           I

6720P> _
```

Figure 3-17. Typical alarm display

The "V" command tells the RFL 6720P to send a current copy of the to your terminal. A typical values display is shown in Figure 3-18.

The values display shows the code number for each measured value, a brief description of its meaning, and its value. Full descriptions for each measured value are as follows:

004 - Block Received
The current status of the BLOCK output.

005 - ChkBk Output
The current status of the CHECKBACK output.

006 - Tests Since Rst
The number of checkback tests run since the last time the test log was reset. This total includes automatic and manually-initiated tests.

007 - Tests Passed
The number of successful checkback tests since the last time the test log was reset. This total includes automatic and manually-initiated tests.

008 - Tests Failed
The number of unsuccessful checkback tests since the last time the test log was reset. This total includes automatic and manually-initiated tests.

009 - Last Failed
The number of the last code that should have been received, but failed.

010 - Last Rx Code
The number of the last valid code received.

011 - Hours To Next
The number of hours until the next automatic checkback tests is initiated.

3.6.2.4. Viewing The Parameter Settings Display

The "D" command tells the RFL 6720P to send a list of all parameter settings to your terminal. This list of settings is called the "read settings" menu.

Format: 6720P>D [ENTER]

A typical read settings menu appears in Figure 3-19. All the currently-active parameter settings but you can't change the displayed values. To change these values, you will have to enter the programming mode. **(See paragraph 3.6.3 for more information.)** The programming mode is password-protected, so only authorized persons can change the RFL 6720P's parameter settings.

```
#   DESCRIPTION        VALUE
-----------------------------------------
004  Block Received    Inactive
005  ChkBk Output      Inactive
006  Tests Since Rst   1
007  Tests Passed      1
008  Tests Failed      0
009  Last Failed       00
010  Last Rx Code      00
011  Hours To Next     3

6720P> _
```

Figure 3-18. Typical values display

```
 #   PARAMETER          SETTING             #   PARAMETER          SETTING
999  System Label
020  Mode               Master              021  Slave Number       N/A
022  Hard Tx 1          14                  023  Hard Tx 2          13
024  Hard Tx 3          15                  025  Hard Tx 4          14
026  Low Rx HC          00                  027  High Rx HC         16
028  HC Duration        30 sec              029  Hours Between      03
030  Response Time      20 sec              031  Hours To Next      03
032  Reset Log          No                  033  Chassis Type       6785P

                     Code  Power  Response
034  Test One        01      H      02
035  Test Two        03      L      04
036  Test Three      05      H      06
037  Test Four       07      L      08
038  Test Five       09      H      10
039  Test Six        11      L      12
040  Test Seven      13      H      14
041  Test Eight      15      L      16

     Printer Triggers
050  Receive Block   Inactive            051  Lose Block         Inactive
052  Test Fail       Active              053  Transmit Fail      Inactive
6720P> _
```

Figure 3-19. Typical read settings menu

3.6.2.5. Viewing Configuration And Software Information

The "F" command tells the RFL 6720P to send a configuration and software version display to your terminal. This display tells you how the RFL 6720P is configured, and what software version is being used.

Format: 6720P>F [ENTER]

A typical configuration and software version display is shown in Figure 3-20.

3.6.2.6. The Update Mode

The update mode places a display on your terminal that is constantly revised to show up-to-the-minute information about RFL 6720P operation. This mode is entered by using the "U" command.

Format: 6720P>U [ENTER]

When the "U" command is entered, the screen on your terminal will be cleared, and replaced by the UPDATE screen shown in Figure 3-21. This display is updated about once every two seconds. This screen can be used to monitor RFL 6720P operation.

```
6720P Checkback Configuration:
060  Version          1.0

6720P> _
```

Figure 3-20. Typical configuration and software version display

```
Value Update - Type 'X<CR>' to Stop
004  Block Received    Inactive
005  ChkBk Output      Inactive
006  Tests Since Rst   1
007  Tests Passed      1
008  Tests Failed      0
009  Last Failed       00
010  Last Rx Code      00
011  Hours To Next     3
```

Figure 3-21. Typical UPDATE screen

To exit the update mode, press the **[X]** key, followed by the **[ENTER]** key. The screen on your terminal will be cleared, and the "6720P>" prompt will re-appear.

3.6.3. Programming the RFL 6720P With A PC Or Terminal

You can use APRIL and your terminal to program the RFL 6720P by using the "P" command.

Format: 6720P>P [ENTER]

The "P" command tells the RFL 6720P to send a list of all programming commands to your terminal. Since using the programming commands will affect how the RFL 6720P operates, the "P" command is password-protected. When you enter the "P" command, the following prompt appears:

6720P> enter password:

Either enter the super-user password ("BCCE") or the programming password that has been stored in the RFL 6720P's memory. The RFL 6720P gives you three chances to enter the correct password. After the third incorrect password is entered, the RFL 6720P 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.

If the proper password is entered, a programming menu similar to the one shown in Figure 3-22 will appear.

You are now in the programming mode, as indicated by the "6720P-P>" prompt on your screen. You may now use the programming commands to re-program the RFL 6720P. For more information on each programming command, refer to the page number listed below next to the command.

Command	Meaning	Page
H	Display programming help	...
Q	Leave programming menu	3-35
SV	Save new settings	3-35
C	Change password	3-31
D	Display current settings and parameter numbers	3-32

3.6.3.1. Changing The Programming Password

You can use the "C" command to change the password that can be used to enter the programming mode.

Format: 6720P-P>C [ENTER]

When you enter the "C" command, the RFL 6720P sends the following prompt to your terminal:

enter super-user:

Enter the super-user password ("BCCE"), and then press **[ENTER]**. The following prompt will appear:

Current password is (current password)
enter new password:

```
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
6720P-P> _
```

Figure 3-22. Typical programming menu

Enter the new password, and then press **[ENTER]**. The following prompt will appear:

repeat new password:

Enter the new password again, and then press **[ENTER]**. The following prompt will appear:

password modified

The new password is now stored in the RFL 6720P's non-volatile RAM memory.

3.6.3.2. Displaying Parameter Settings

To view a list of all current parameter settings, use the "D" command.

Format: 6720P-P>D [ENTER]

When you enter the "D" command, the RFL 6720P sends a list of all current parameter settings to your terminal. Typical parameter setting lists for the two RFL 6720P configuration modes available when installed in an RFL 6785P (Master and Remote) are shown in Figures 3-23 and 3-24.

The following parameters appear on each parameter setting list:

999 - System Label
This is a user-defined identifier that appears on the second line of the APRIL command list. It can be any combination of letters or numbers up to 25 characters long. It is normally used to indicate a substation name, a line number, or some other identifier.

020 - Mode
This parameter sets the configuration mode for the checkback module being programmed. Two settings are possible when the RFL 6720P is installed in an RFL 6785P: M (Master) and R (Remote). The RFL 6720P's other two configuration modes (Head Slave and Slave) cannot be used when it is installed in an RFL 6785P.

021 - Slave Number
This parameter is only used at Slave checkback modules. Since Parameter #20 (Mode) can only be set to "M" or "R" at RFL 6720P modules installed in an RFL 6783P, this parameter is automatically set to "N/A."

022 - Hard Tx 1
This parameter selects the code that will be transmitted if the HC1 switch on the front panel is pressed and held for five seconds (Hard Carrier 1).

023 - Hard Tx 2
This parameter selects the code that will be transmitted if the HC2 switch on the front panel is pressed and held for five seconds (Hard Carrier 2).

024 - Hard Tx 3
This parameter selects the code that will be transmitted if the HC3 switch on the front panel is pressed and held for five seconds (Hard Carrier 3).

025 - Hard Tx 4
This parameter selects the code that will be transmitted if the HC4 switch on the front panel is pressed and held for five seconds (Hard Carrier 4).

026 - Low Rx HC
This parameter selects the received code that will cause the local terminal to respond with a low-level hard carrier.

027 - High Rx HC
This parameter selects the received code that will cause the local terminal to respond with a high-level hard carrier.

028 - HC Duration
This parameter sets the amount of time a hard carrier will be sent when the appropriate HARD CARRIER REQUEST code is received. This can be set to either 30 or 60 seconds.

```
 #   PARAMETER          SETTING              #   PARAMETER          SETTING
999  System Label
020  Mode               Master               021  Slave Number       N/A
022  Hard Tx 1          00                   023  Hard Tx 2          00
024  Hard Tx 3          00                   025  Hard Tx 4          00
026  Low Rx HC          00                   027  High Rx HC         00
028  HC Duration        30 sec               029  Hours Between      00
030  Response Time      20 sec               031  Hours To Next      00
032  Reset Log          No                   033  Chassis Type       6785P

                     Code  Power  Response
034  Test One        00      H      00
035  Test Two        00      H      00
036  Test Three      00      H      00
037  Test Four       00      H      00
038  Test Five       00      H      00
039  Test Six        00      H      00
040  Test Seven      00      H      00
041  Test Eight      00      H      00

     Printer Triggers
050  Receive Block   Inactive             051  Lose Block         Inactive
052  Test Fail       Inactive             053  Transmit Fail      Inactive
6720P> _
```

Figure 3-23. Typical parameter settings list - Master Mode

```
 #   PARAMETER          SETTING              #   PARAMETER          SETTING
999  System Label
020  Mode               Remote               021  Slave Number       N/A
022  Hard Tx 1          00                   023  Hard Tx 2          00
024  Hard Tx 3          00                   025  Hard Tx 4          00
026  Low Rx HC          00                   027  High Rx HC         00
028  HC Duration        30 sec               029  Hours Between      N/A
030  Response Time      N/A                  031  Hours To Next      N/A
032  Reset Log          No                   033  Chassis Type       6785P

                     Incoming  Response  Power
034  Test One        00        00        H
035  Test Two        00        00        H
036  Test Three      00        00        H
037  Test Four       00        00        H
038  Test Five       00        00        H
039  Test Six        00        00        H
040  Test Seven      00        00        H
041  Test Eight      00        00        H

     Printer Triggers
050  Receive Block   Inactive             051  Lose Block         Inactive
052  Test Fail       Inactive             053  Transmit Fail      Inactive
6720P> _
```

Figure 3-24. Typical parameter settings list - Remote Mode

029 - Hours Between

This parameter sets the amount of time between automatic checkback tests. This can be set from one to 24 hours, in one-hour increments, and can only be set at the Master checkback module.

Whenever a new value is entered for this parameter, the time base is reset. This time base will also be reset every time the Master checkback module is turned on.

030 - Response Time

This parameter sets the amount of time the Master checkback module will wait for a response from a remote terminal before declaring a test failure. This can be set from 1 second to 255 seconds in one-second increments, and can only be set at the Master checkback module.

031 - Hours To Next

This parameter indicates the amount of time until the next automatic checkback test. Once it is initially set, this parameter's value is calculated, based on the setting of Parameter #29 (Hours Between).

032 - Reset Log

Whenever this parameter is invoked, the three test logs (TESTS RUN, TESTS PASSED, and TESTS FAILED) are reset in non-volatile RAM. This parameter can only be invoked at the Master checkback module.

033 - Chassis Type

This parameter must be set according to the type of chassis housing the checkback module being programmed. When housed in an RFL 6785P chassis, this parameter must be set to "85P."

034 - Test One
035 - Test Two
036 - Test Three
037 - Test Four
038 - Test Five
039 - Test Six
040 - Test Seven
041 - Test Eight,

These parameters control what happens during each of the eight checkback tests that can occur during a test sequence. For each test, different values are stored; these values determine what codes the checkback module will respond to, what code will be transmitted in response, and the power level to be used during transmission. The values displayed will vary according to the setting of Parameter #20 (Mode).

050 - Receive Block

This is a "print trigger" parameter; it can send a printout message to your terminal when a block is received. To activate, set this parameter to "Y" for yes; to de-activate, set it to "N" for no.

051 - Lose Block

This is a "print trigger" parameter; it can send a printout message to your terminal when a block ceases to be received. To activate, set this parameter to "Y" for yes; to de-activate, set it to "N" for no.

052 - Test Fail

This is a "print trigger" parameter; it can send a printout message to your terminal whenever a checkback test fails. To activate, set this parameter to "Y" for yes; to de-activate, set it to "N" for no.

This parameter can only be set at the Master checkback module.

053 - Transmit Fail

This is a "print trigger" parameter; it can send a printout message to your terminal whenever a TRANSMIT FAIL alarm occurs. To activate, set this parameter to "Y" for yes; to de-activate, set it to "N" for no.

This parameter can only be set at checkback modules housed in RFL 6785P chassis.

To re-program any of the values shown on the parameter settings list, 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:

To change the checkback module's configuration, type in the following:

6720P-P> 20 [ENTER]

The "Mode" parameter will be displayed, with information about its setting below it.

020 Mode Master
[M,R,H,S]> _

The values allowed for this parameter appear between brackets; in this case, "M" for Master, "R" for Remote, "H" for Head Slave, and "S" for Slave. To set the configuration to Head Slave, type in "H"

and then press **[ENTER]**. The "Mode" parameter will be re-displayed, set to the new value.

020 Mode Head Slave

The "printer triggers" can be disabled or enabled. When enabled, the last measured values will be transmitted to the terminal when a new event is started or stopped.

EXAMPLE:

The "Test Fail" trigger is usually set to "Active." To de-activate it, type in the following:

6720P-P> 52 [ENTER]

The "Test Fail" trigger will be displayed, with information about its setting below it.

052 Test Fail Active
[Y:N]> _

Type in "N," and then press **[ENTER]**. The parameter will be re-displayed, set to its new value.

052 Test Fail Inactive

The "System Label" is an identifier that appears on the second line of the APRIL command list. This list appears each time you issue an "H" command when you are not in the Programming Mode.

EXAMPLE:

To change the System Label, type in the following:

6720P-P> 999 [ENTER]

The System Label parameter will be displayed, with information about its setting below it.

999 System Label
[any string]> _

Type in whatever you want the new System Label to be. It can be any combination of letters or numbers up to 25 characters long. When you are finished, press the **[ENTER]** key. The System Label parameter will be re-displayed, set to the new value.

999 System Label SUBSTATION 12

3.6.3.3. Saving New Settings

The "SV" command saves any new settings you made while in the programming mode:

Format: 6720P-P>SV [ENTER]

The "SV" command tells the RFL 6720P to store all the changes in its non-volatile RAM memory. Once the changes are stored, the "6720P-P>" prompt will reappear.

Before you enter the "SV" command, the RFL 6720P 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 reissuing the "D" command to display the parameter settings list. (For more information on the "D" command, go to page 3-35 of this section.)

3.6.3.4. Leaving The Programming Mode

Whenever you are finished programming the RFL 6720P, use the "Q" command:

Format: 6720P-P>Q [ENTER]

The "Q" command tells the RFL 6720P to leave the programming mode. The list of APRIL commands in Figure 3-16 on page **3-29** will reappear, with the normal "6720P>" prompt beneath it. If you changed any setting while in the programming mode, be sure to use the "SV" command described on page **3-35** to save the changes before invoking the "Q" command; otherwise, your changes will be lost.

3.6.4. Initiating Tests With A PC Or Terminal

You can use APRIL and your terminal to initiate RFL 6720P checkback tests. All test functions that are normally done using the pushbutton switches on the RFL 6720P's front panel can be done using a terminal. To use your PC or terminal to initiate tests, use the "T" command.

Format: 6720P>T [ENTER]

The "T" command tells the RFL 6720P to send a list of all test commands to your terminal. Since using the test commands will affect how the protection system operates, the "T" command is password-protected.

When you enter the "T" command, the following prompt appears:

6720P> enter password:

Either enter the super-user password ("BCCE") or the testing password that has been stored in the RFL 6720P's memory. The RFL 6720P gives you three chances to enter the correct password. After the third incorrect password is entered, the RFL 6720P enters a lock-out mode. This mode will last for about five minutes, during which you will not be able to enter the testing mode.

If the proper password is entered, a testing menu similar to the one shown in Figure 3-25 will appear.

You are now in the test mode, as indicated by the "6720P-T>" prompt on your screen. You may now use the test commands to initiate RFL 6720P checkback tests. For more information on each testing command, refer to the page number listed below next to the command.

Command	Meaning	Page
H	Display test menu help	...
Q	Leave test menu	3-37
C	Change password *	3-36
T	Re-display tests (and select for running)	3-36

* - Superuser authorization required.

3.6.4.1. Changing The Test Password

You can use the "C" command to change the password that can be used to enter the test mode.

Format: 6720P-T>C [ENTER]

When you enter the "C" command, the RFL 6720P sends the following prompt to your terminal:

enter super-user:

Enter the super-user password ("BCCE"), and then press **[ENTER]**. The following prompt will appear:

Current password is (current password)
enter new password:

Enter the new password, and then press **[ENTER]**. The following prompt will appear:

repeat new password:

Enter the new password again, and then press **[ENTER]**. The following prompt will appear:

password modified

The new password is now stored in the RFL 6720P's non-volatile RAM memory.

3.6.4.2. Running Tests

To run one or more RFL 6720P tests, use the "T" command.

Format: 6720P-T>T [ENTER]

When you enter the "T" command, the RFL 6720P sends a list of all possible test routines to your terminal. A typical test routine list is shown in Figure 3-26.

The values display shows the code number for each test routine, and a brief description of its meaning. Full descriptions for each test routine are as follows:

060 - Key Carrier Low Power
This routine energizes the reduced-power output.

061 - Key Carrier High Power
This routine energizes the full-power output.

062 - Run Test Sequence
This routine initiates the checkback test sequence.

063 - Send Code #
This routine causes a specific code to be sent.

064 - Key Hard Carrier #1
This routine initiates Hard Carrier 1.

065 - Key Hard Carrier #2
This routine initiates Hard Carrier 2.

```
H - Display test menu help
Q - Leave test menu
C - Change password (superuser authorization required)
T - Redisplay tests
## - Run this test
6720P-T> _
```

Figure 3-25. Typical test menu

```
 #   DESCRIPTION
------------------------------
060  Key Carrier Low Power
061  Key Carrier High Power
062  Run Test Sequence
063  Send Code #
064  Key Hard Carrier #1
065  Key Hard Carrier #2
066  Key Hard Carrier #3
067  Key Hard Carrier #4

6720P> _
```

Figure 3-26. Typical test routine list

066 - Key Hard Carrier #3
This routine initiates Hard Carrier 3.

067 - Key Hard Carrier #4
This routine initiates Hard Carrier 4.

3.6.4.3. Leaving The Test Mode

Whenever you are finished running checkback tests, use the "Q" command:

Format: 6720P-T>Q [ENTER]

The "Q" command tells the RFL 6720P to leave the test mode. The list of APRIL commands in Figure 3-16 on page **3-29** will reappear, with the normal "6720P>" prompt beneath it.

3.6.4.4. Returning To Normal RFL 6720P Operation

Once you are finished accessing the RFL 6720P using APRIL, make sure you have returned to the "6720P>" prompt:

1. If you were in the Test Mode, press the **[Q]** and **[ENTER]** keys to return to the "6720P>" prompt.

2. If you were in the Update Mode, press the **[X]** and **[ENTER]** keys to return to the "6720P>" prompt.

When the "6720P>" prompt is displayed, simply disconnect your PC or terminal from the RFL 6720P's RS-232 connector. If you accessed the RFL 6720P through an RFL 9660 Digital Switch, type in the deselect code (normally "BYE") to deselect the port, and then enter the "Q" command to terminate the session. (Refer to the RFL 9660 Instruction Manual for more information.)

Section 4. MAINTENANCE

WARNING

HAZARDOUS VOLTAGES CAN BE PRESENT INSIDE RFL 6785P TERMINALS. BEFORE ATTEMPTING MAINTENANCE, BE SURE TO READ AND COMPLY WITH THE HIGH VOLTAGE WARNING AND SAFETY SUMMARY INFORMATION ON PAGES iii AND iv OF THIS MANUAL.

ALL RFL 6785P TERMINALS ARE EQUIPPED WITH A PROTECTIVE COVER THAT EXTENDS ACROSS THE REAR OF THE CHASSIS. THIS COVER IS INTENDED TO PROTECT THE OPERATOR FROM POTENTIALLY HAZARDOUS VOLTAGES, WHICH MAY BE PRESENT ON THE REAR PANEL TERMINAL BLOCKS. THIS COVER MUST ONLY BE REMOVED BY QUALIFIED SERVICE PERSONNEL WHEN ACCESS TO THE REAR PANEL IS REQUIRED. IT MUST BE REPLACED BEFORE PLACING THE TERMINAL IN SERVICE.

4.1. INTRODUCTION

This section provides maintenance instructions for the RFL 6785P. Topics discussed include removal and replacement procedures, corrective maintenance information, and a list of typical measurements that can serve as an aid to troubleshooting. Information is also provided on how to arrange for service by RFL personnel.

CAUTION

Each module position in the RFL 6785P chassis is dedicated to a specific module type, as indicated by a label along the front of the chassis. Modules can suffer component damage if they are installed in the wrong chassis slot. When removing and replacing modules, use the label in the chassis as a guide to make sure each module is in the proper slot.

4.2. MODULE REMOVAL AND REPLACEMENT

All RFL 6785P plug-in modules are held in place by card guides at the top and bottom of the chassis, and fit into mating connectors in the chassis motherboard. To remove any of these modules, proceed as follows:

1. Open the door on the front of the chassis by turning the knob counterclockwise as far as it will go, and then lowering the door to its horizontal position.
2. Place the POWER switch on the power supply module in the OFF position.
   Indicator DS1 on the front of the power supply module will go out, indicating that the terminal is turned off.
3. Grab the handle on the front of the module to be removed, and rock up and down until the module slips out of its mating connector in the chassis motherboard.
4. Pull on the handle until the module is out of the chassis.

To replace the module, proceed as follows:

1. Using the label along the front of the chassis as a guide, determine the slot in the chassis where the module is to be installed.
2. Line up the edges of the module circuit board with the card guides in the chassis.
3. Slide the module into the chassis, and then push until it is firmly seated in its mating connector.
4. Place the POWER switch on the power supply module in the ON position.
   Indicator DS1 on the front of the power supply module will light, indicating that the terminal is turned on.
5. Raise the door on the front of the chassis to its vertical position, and turn the knob clockwise as far as it will go to close the door.

CAUTION

Never attempt to remove or replace a fuse with the power supply module energized; component damage may result.

4.3. FUSE REPLACEMENT

The input fuses for RFL 6785P power supply modules are located on the front of the module. Fuses can be changed without removing the power supply module from the chassis. To check and/or replace the fuses, proceed as follows:

1. Place the POWER switch on the power supply module in the OFF position.

2. Remove one of the input fuses from its fuseholder by pushing in on the fuseholder cap and turning it counter clockwise about 1/4 turn.
   Some fuseholders require a screwdriver to remove the fuse, while others can be turned with the fingers.

3. Remove the fuse from the fuseholder cap and inspect it for damage.
   If the fuse is bad, it must be replaced. If the fuse is good, check for presence of input voltage at TB1-10 and TB1-11 on the rear panel. If voltage is present and the power supply does not function, troubleshoot the supply to determine the cause of failure.

CAUTION

For continued safe operation, always replace a fuse with one having the same voltage and current ratings. (See Section 12 for proper replacements.)

4. Insert a fuse with the proper voltage and current ratings into the fuseholder cap and push it in until it is firmly seated.

5. Insert the fuse and fuseholder cap into the fuseholder. Using a flat-blade screwdriver, push in on the cap and turn clockwise about one quarter-turn.
   This will secure the fuse in place.

6. Repeat steps 2 through 5 for the other fuse.

7. Once both fuses have been checked and/or replaced, place the power switch in the ON position.
   If indicator DS1 of the front of the power supply lights, the power supply module is working properly. If DS1 does not light or if one or both fuses blow again, troubleshoot the power supply module.

4.4. CORRECTIVE MAINTENANCE

The RFL 6785P Programmable AM Powerline Carrier System has been designed for years of trouble-free service. Should a malfunction occur involving the RFL 6785P, use standard troubleshooting techniques to determine if the problem is in the RFL 6785P, or in some other connected equipment.

If the problem lies within the RFL 6785P, use the schematics in Sections 5 through 13 and the list of typical measurements in Table 4-1 to try and determine which module is defective. Once this is done, replace the module; this should solve the problem.

Defective modules can be repaired locally, or they can be returned to RFL for repair (para 4.6).

4.5. HOW TO ARRANGE FOR SERVICING

If necessary, RFL 6785P modules and subassemblies may be returned to RFL for repair. Contact our Customer Service Department using the telephone number listed on the back cover of this manual. You will be given a Returned Material Authorization (RMA) and shipping instructions.

Table 4-1. Typical measurements, RFL 6785P Programmable AM Powerline Carrier System

Module	Test Point	Reference	Signal	Condition	Expected Measurement
67 PLC **DC	+12V	COM	+12-volt output	. . .	+10.8 to +13.2 volts
	-12V	COM	-12-volt output	. . .	-10.8 to -13.2 volts.
67P PLC TRANS	TP2	TP1	D/A converter output	. . .	Stair-stepped sinewave, 1.2-Vp-p (approx. 420 mVrms).
	TP3	TP1	Filtered D/A output	. . .	Smoothed sinewave, 500-mVp-p (approx. 115 mVrms).
	TP4	TP1	MOD IN	. . .	35 to 40 mVp-p, depending upon the setting of potentiometer R50.
	TP5	TP1	VOICE IN	. . .	-200 mV.
	TP6	TP1	TX OUT	. . .	Approx. 6 Vp-p (629 mVrms), depending upon the setting of potentiometer R16.
67P AM I/O	TP2	TP1 or TP3	CARRIER CONTROL	Carrier OFF	+12 volts.
				Carrier ON	0 volts.
	TP4	TP1 or TP3	CARRIER START	Carrier OFF	+12 volts with Jumper J2 in Position A; zero volts with J2 in Position B.
				Carrier ON	Zero volts with Jumper J2 in Position A; +12 with J2 in Position B.
	TP5	TP1 or TP3	CARRIER STOP	STOP input OFF	+12 volts with Jumper J3 in Position A; zero volts with J3 in Position B.
				STOP input ON	Zero volts with Jumper J3 in Position A; +12 with J3 in Position B.
	TP6	TP1 or TP3	VOICE REQ	MIK KEY input ON	+12 volts.
				MIK KEY input OFF	Zero volts.
	TP7	TP1 or TP3	UTILITY	Normal	+12 volts.
				Carrier ON	Zero volts.
	TP8	TP1 or TP3	TX FAIL	Normal	Zero volts.
				START input ON	Approx. 150 ms after START input is applied, TP8 will rise to +12 volts.
	TP9	TP1 or TP3	CARRIER DETECT	Normal	+12 volts; falls to zero volts when START input is applied.
				67P PLC AMP removed.	+12 volts, regardless of START input status.
67P RX DNSH	TP2 (yellow)	TP1 or TP6	DC signal being applied to LED array.	No input	Approx. -115 mV.
				Nominal input	Approx. -4 volts.
	TP3 (green)	TP1 or TP6	OUT (downshifter output)	No input	Approx. 90 mVp-p (30 mVrms).
				Nominal input	Approx. 2 Vp-p (500 mVrms).
	TP4 (gray)	TP1 or TP6	OSC (local oscillator output)	. . .	Approx. 600 mVp-p (150 mVrms).
	TP5 (red)	TP1 or TP6	Attenuated input signal	No input	Approx. 1.5 mVrms.
				Nominal input	Approx. 3 mVrms.
	TP7	TP1 or TP6	Amplified LED signal	No input	Approx. +100 mV.
				Nominal input	Approx. +4 V.
	TP8	TP1 or TP6	LED driver reference	. . .	Approx. +6.5 V.

Table 4-1. Typical measurements, RFL 6785P Programmable AM Powerline Carrier System - continued.

Module	Test Point	Reference	Signal	Condition	Expected Measurement
67P RX DNSH (cont.)	TP9	TP1 or TP6	Voltage-controlled oscillator output	No input	500-Hz signal, no dc offset.
				Nominal input	500-Hz signal with 3-volt dc offset.
	TP10	TP1 or TP6	Output to if. amp.	No input	Approx. 180 mVp-p, modulated.
				Nominal input	Approx. 350 mVp-p, modulated.
	TP11	TP1 or TP6	Output to 2nd mixer	No input	Approx. zero volts.
				Nominal input	Approx. 650 mVp-p.
	TP12	TP1 or TP6	Output to 3rd mixer	No input	Approx. 90 mVp-p (composite).
				Nominal input	Approx. 840 mVp-p (composite).
	TP13	TP1 or TP6	Output from 3rd mixer	No input	Approx. 150 mVp-p (composite).
				Nominal input	Approx. 625 mVp-p (composite).
	TP14	TP1 or TP6	Local oscillator	. . .	12-volt, 26-kHz square wave.
	TP15	TP1 or TP6	Downshifter signal output	No input	Approx. 100 mVp-p, modulated.
				Nominal input	Approx. 2.0 Vp-p, modulated.
	TP16	TP1 or TP6	Voice bandpass filter output	No input	Approx. zero volts.
				Nominal input	500-mVp-p, 24-kHz sine wave.
67A RX DET, 67A RX DET-1	TP3	TP1 or TP2	Reference voltage	. . .	-1.0 volts; if not, adjust R24.
	TP4	TP1 or TP2	Signal from downshifter	No input	Approx. 50 mVp-p.
				Nominal input	Approx. 300 mVp-p.
	TP5	TP1 or TP2	If. bandpass filter output	No input	Approx. 25 mVp-p, modulated.
				Nominal input	Approx. 324 mVp-p, modulated.
	TP6	TP1 or TP2	Output of first if. amplifier	No input	Approx. 300 mVp-p.
				Nominal input	Approx. 2.5 Vp-p @ 24 kHz.
	TP7 (green)	TP1 or TP2	AC LEV amplifier	No input	Approx. 1.0 Vp-p.
				Nominal input	Approx. 12 Vp-p @ 24 kHz.
	TP8	TP1 or TP2	Rectified output signal	No input	Approx. 200 mVp-p (composite).
				Nominal input	Approx. 1.3 Vp-p (composite).
	TP9 (yellow)	TP1 or TP2	Filter output voltage	No input	Approx. -1.0 volts.
				Nominal input	Approx. -4.0 volts.
	TP10	TP1 or TP2	DIRECT BLOCK output	No input	Approx. zero volts when jumper J1 is in BLK position; +12 volts when J1 is in UNBLK position.
				Nominal input	Approx. +12 volts when jumper J1 is in BLK position; zero volts when J1 is in UNBLK position.
	TP11	TP1 or TP2	Input to block output circuit	No input	Approx. +12 volts when jumper J1 is in BLK position; zero volts when J1 is in UNBLK position.
				START or RESERVE keyed	Approx. zero volts when jumper J1 is in BLK position; +12 volts when J1 is in UNBLK position.
	TP12	TP1 or TP2	FORCE BLOCK timer input	No input	Approx. -11 volts.
				Nominal input	Approx. +10 volts.

Table 4-1. Typical measurements, RFL 6785P Programmable AM Powerline Carrier System - continued.

Module	Test Point	Reference	Signal	Condition	Expected Measurement
67A RX DET, 67A RX DET-1 (cont.)	TP13	TP1 or TP2	FORCE BLOCK timer output	No input	Approx. -11 volts.
				START or RESERVE keyed	Approx. +10 volts.
	TP14	TP1 or TP2	BLOCK OUTPUT input	No input	Approx. zero volts.
				Nominal input	Approx. +12 volts.
67P PLC AMP	TP2	TP1	Dc null adjustment	Full power	Approx. 15.5 Vp-p (6 Vrms).
				Reduced power	Approx. 9 Vp-p (3.4 Vrms).
67P OUTPUT	TP2	TP1	OUTPUT	Full power	Approx. 56 Vp-p (23 Vrms).
				Reduced power	Approx. 35 Vp-p (12 Vrms).
	TP3	TP1	INPUT	Full power	Approx. 56 Vp-p (23 Vrms).
				Reduced power	Approx. 35 Vp-p (12 Vrms).

1. A frequency counter connected across these test points should read within ±10 Hz of the carrier frequency.
2. Trip and guard voltages must be at least 15 volts apart.
3. Composite signal.
4. Approximate sine offset +3 volts (700 mVp-p).

Section 5. INPUT/OUTPUT MODULE

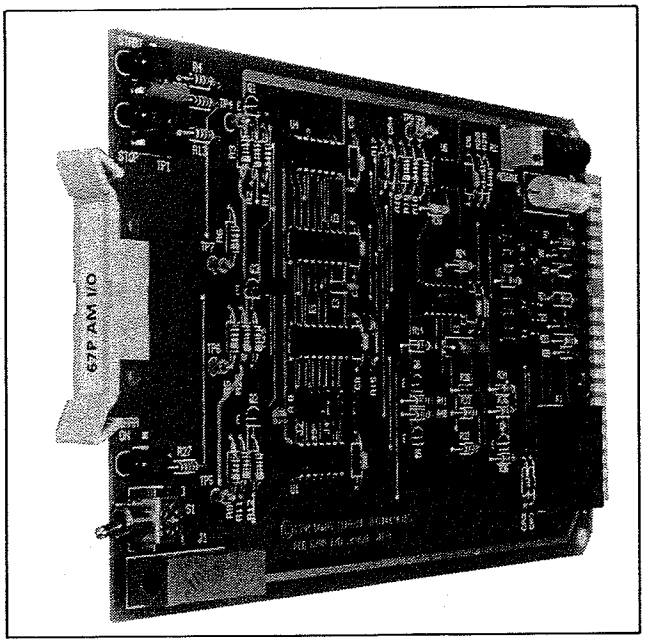


Figure 5-1. RFL 67P AM I/O Input/Output Module

5.1. DESCRIPTION

The RFL 67P AM I/O Input/Output Module (Fig. 5-1) monitors the CARRIER START, CARRIER STOP, and RESERVE SIGNAL KEY input lines, as well as several signals generated inside the RFL 6785P; it uses the information it receives from these signals to generate command signals for the transmitter and receiver detector modules. Jumpers on the RFL 67P AM I/O allow the logic to be set according to the requirements of the specific application.

5.2. SPECIFICATIONS

As of the date this manual was published, the following specifications apply to the RFL 67P AM I/O Input/Output Module. Because all RFL products undergo constant refinement and improvement, these specifications are subject to change without notice.

Environmental:

Temperature Range:
Operating: -20°C to +60°C (-4°F to +140°F).
Storage: -30°C to +70°C (-22°F to +158°F).
Relative Humidity: Up to 95% at +40°C (+104°F).

Input Power Requirements:
+12-Volt Supply: 50 mA.
-12-Volt Supply: 50 mA.

Dimensions: 4.713 inches high x 8.0 inches deep x 0.5 inches wide (12 cm x 20.3 cm x 1.3 cm); requires two module spaces in chassis.

NOTE

Throughout the following theory of operation discussion, signal names appear in CAPITAL letters. Inverted or active-low signals appear in CAPITAL letters followed by an asterisk (RESERVE*). IC pin numbers are indicated by the device circuit symbol followed by a dash and the pin number (U1-1, U1-2, etc).

5.3. THEORY OF OPERATION

The RFL 67P AM I/O Input/Output Module receives inputs from the rear panel and other boards in the RFL 6785P terminal. It determines the correct response based on its logic and the jumper settings and enables the correct output.

The START signal present at edge connector terminal 14 is buffered and sent to jumper J2. J2 is used to set the polarity of the START input. The active high output is combined with an active low signal signal from the STOP input in one of U4's AND gates (U4-1 and U4-2 in, U4-3 out). Jumper J3 determines the polarity of that stop input. The resulting active high signal is combined with the other possible sources of carrier start in eight-input NOR gate U5; these include DIRECT KEY, MANUAL SWITCH, RESERVE KEY, and CHECKBACK KEY. A high on one or more of these lines will cause the SEND output to go active (low).

START indicator DS1 and STOP indicator DS2 are driven by the START and STOP indicators, and provide a visual indication of when these inputs are active.

The SEND signal is inverted and available on edge connector terminal 6 as an active-high UTILITY output. The VOICE REQUEST input on edge connector terminal P is inverted to make an active-low signal that is combined

with the SEND signal in one of U4's AND gates (U4-5 and U4-6 in, U4-4 out). If either signal goes low, U4-4 goes low. Depending on the jumper settings, this signal can be used to control the CARRIER ENABLE output, and the AM ENABLE output.

The CARRIER ENABLE signal can be applied to the RCVR KILL output directly or inverted, depending on how jumper J9 is set. The STOP signal is tied directly to the CARRSW output (edge connector terminal K) in order to override any start signal. The stop signal can also be tied directly to the RCVR KILL output (edge connector terminal M) by placing jumper J6 in position C.

The SEND signal is also used to key the transmitter failure timer. When it goes low, the carrier should be transmitted within a fixed time. The charge on capacitor C4 is bled through resistor R17 when the SEND signal goes low. Once the level on capacitor C5 is less than the level set by resistors R28 and R29, the output of operational amplifier U6 goes high. If this occurs before a CARRDET signal comes in on edge connector terminal 9, the TX FAIL output (edge connector terminal 18) is triggered.

The BLKINPUT signal comes in through edge connector terminal N; it is polarized by jumper J4 before it is fed out through edge connector terminal 15.

The RESERVE* signal (edge connector terminal W) starts the carrier as noted above and also energizes relay K1. K1's normally-closed contacts short out R31, the potentiometer that sets the reserve signal level. The checkback level can control this relay to change the level as well.

Front panel jack J1 is provided to allow the monitoring of the trip output current.

Table 5-1. Replaceable parts, RFL 67P AM I/O Input/Output Module Assembly No. 104025

Circuit Symbol (Figs. 5-2 & 5-3)	Description	Part Number
	CAPACITORS	
C1	Capacitor,electrolytic,47µF,20%,100V,Nichicon TLB2A470M or equiv.	1007 1484
C2	Capacitor,tantalum,5.6µF,10%,60V,Kemet T140B565K060AS or equiv.	1007 1083
C3	Capacitor,dipped ceramic,0.0039µF,5%,50V,AVX SR205A392JAA or equiv.	1007 1657
C4	Capacitor,metallized polycarbonate,0.75µF,2%,100V,Wesco 32MPC or equiv.	1007 1018
C5-10	Capacitor,X7R ceramic,0.1µF,10%,50V,AVX SA305C104KAA or equiv.	0130 51041
	RESISTORS	
R1,4,5-7,9,13,18-20, 27,32,33,35,36, 40,41	Resistor,metal film,1KΩ,1%,1/4W, Type RN1/4	0410 1288
R2,3,11,12,16,21,25,26	Resistor,metal film,5.11KΩ,1%,1/4W, Type RN1/4	0410 1356
R8,22	Resistor,metal film,100Ω,1%,1/2W, Type RN1/2	0410 2192
R10,15,38,39	Resistor,metal film,51.1KΩ,1%,1/4W, Type RN1/4	0410 1452
R14,28,29,34,37	Resistor,metal film,10KΩ,1%,1/4W, Type RN1/4	0410 1384
R17	Resistor,metal film,287KΩ,1%,1/4W, Type RN1/4	0410 1524
R23	Resistor,metal film,475Ω,1%,1/4W, Type RN1/4	0410 1257
R24	Resistor,metal film,33.2KΩ,1%,1/4W, Type RN1/4	0410 1434
R30	Resistor,metal film,154KΩ,1%,1/4W, Type RN1/4	0410 1498
R31	Resistor,variable,18-turn cermet,5KΩ,10%,1/2W,Beckman Helipot 68WR5K or equiv.	94271

Table 5-1. Replaceable parts, RFL 67P AM I/O Input/Output Module - continued.

Circuit Symbol (Figs. 5-2 & 5-3)	Description	Part Number
	SEMICONDUCTORS	
CR1-5	Diode,silicon,1N914B or 1N4448	26482
DS1-3	Light-emitting diode,red,Dialight 550-0102 or equiv.	39568
Q1,3	Transistor,NPN,plastic package,2N2222A	37445
Q2,4-6	Transistor,PNP,plastic package,2N2907A	37439
U1	MOS hex Schmitt trigger,14-pin DIP,Motorola MC14584CP or equiv.	0615 60
U2,3	MOS hex inverter/buffer,16-pin DIP,RCA CD4049AE or equiv.	0615 7
U4	MOS quad 2-input AND gate,14-pin DIP,RCA CD4081BE or equiv.	0615 31
U5	MOS 8-input NOR gate,14-pin DIP,Motorola MC14078BCP or equiv.	0615 49
U6	Linear operational amplifier,dual monolithic,8-pin DIP,Raytheon RC4558P or equiv.	0620 129
	MISCELLANEOUS COMPONENTS	
K1	Relay,SPDT,1-amp contacts,12-volt/390Ω coil,pc mount, American Zettler AZ2530-08-1 or equiv.	49421
S1	Switch,toggle,SPDT,ON-NONE-ON,C & K Components 7101AG or equiv.	39562
. . .	Shorting bar,single,Molex 90059-0009 or equiv.	98306

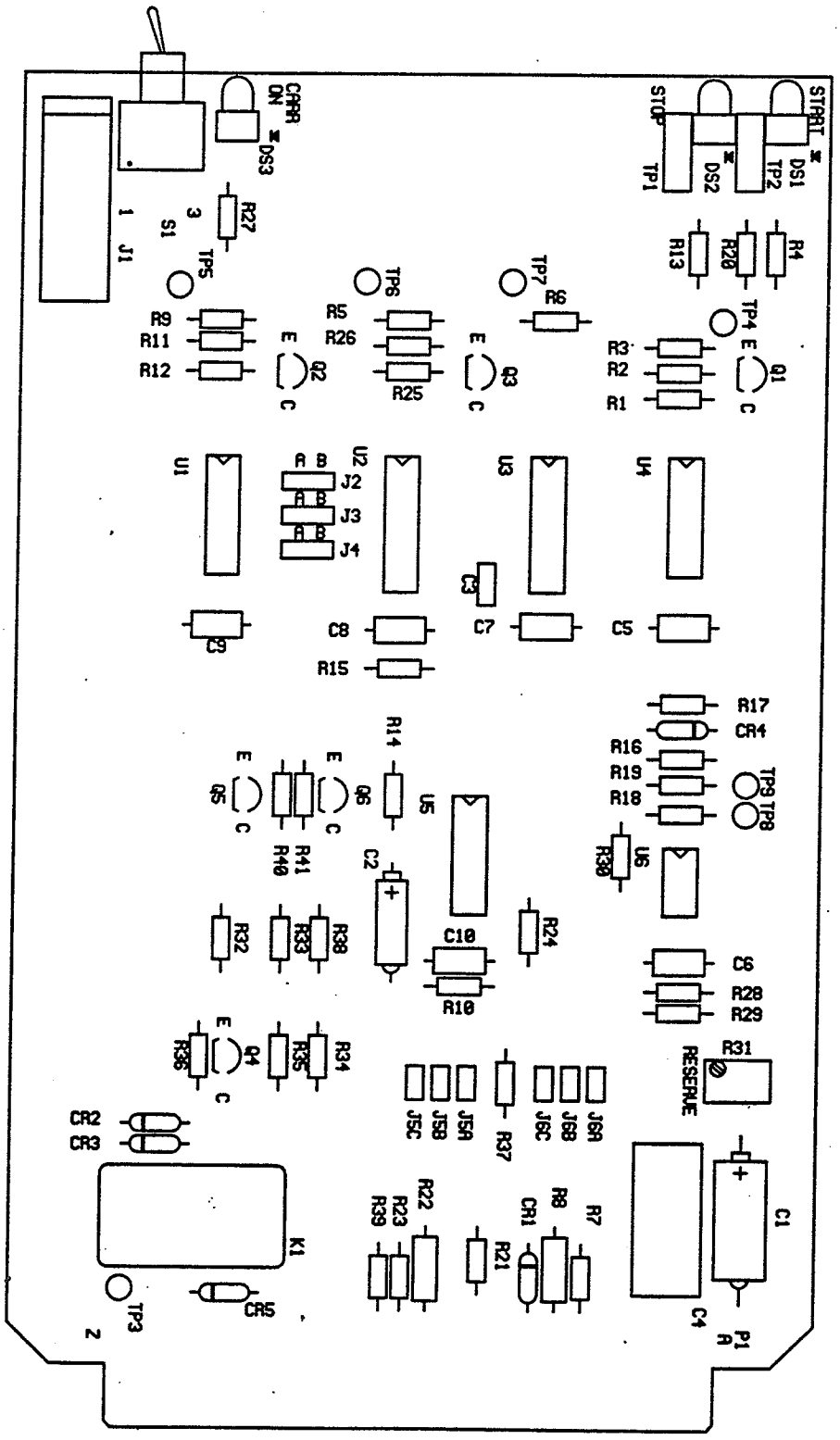
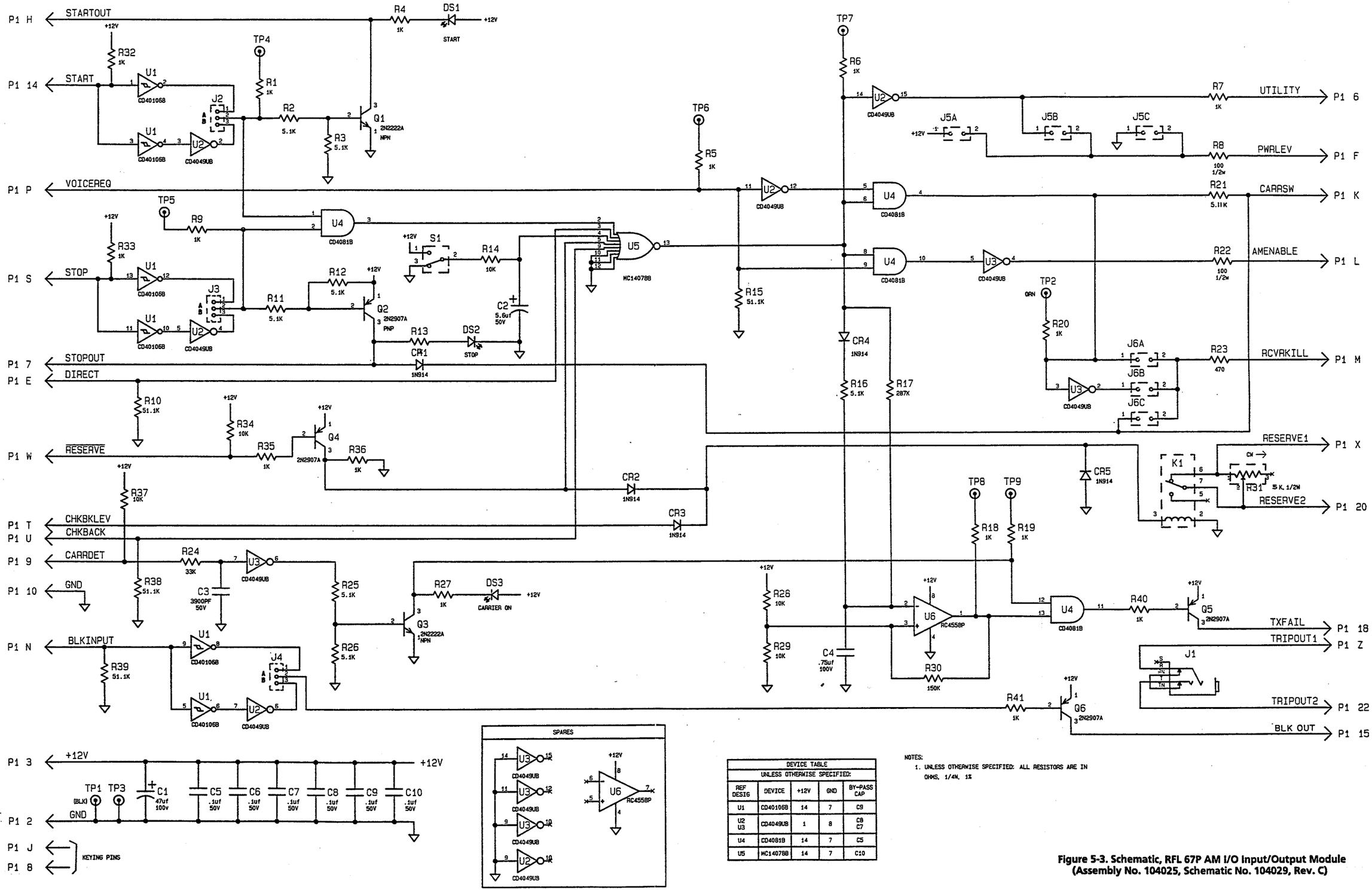


Figure 5-2. Component locator drawing, RFL 67P AM I/O Input/Output Module (Assembly No. 104025, Circuit Board No. 104028, Rev. C)



DEVICE TABLE				
UNLESS OTHERWISE SPECIFIED:				
REF DESIG	DEVICE	+12V	GND	BY-PASS CAP
U1	CD40106B	14	7	C9
U2 U3	CD4049UB	1	8	C8 C7
U4	CD4081B	14	7	C5
U5	MC14078B	14	7	C10

NOTES:
1. UNLESS OTHERWISE SPECIFIED: ALL RESISTORS ARE IN OHMS, 1/4W, 1%

Figure 5-3. Schematic, RFL 67P AM I/O Input/Output Module (Assembly No. 104025, Schematic No. 104029, Rev. C)

Section 6. TRANSMITTER MODULE

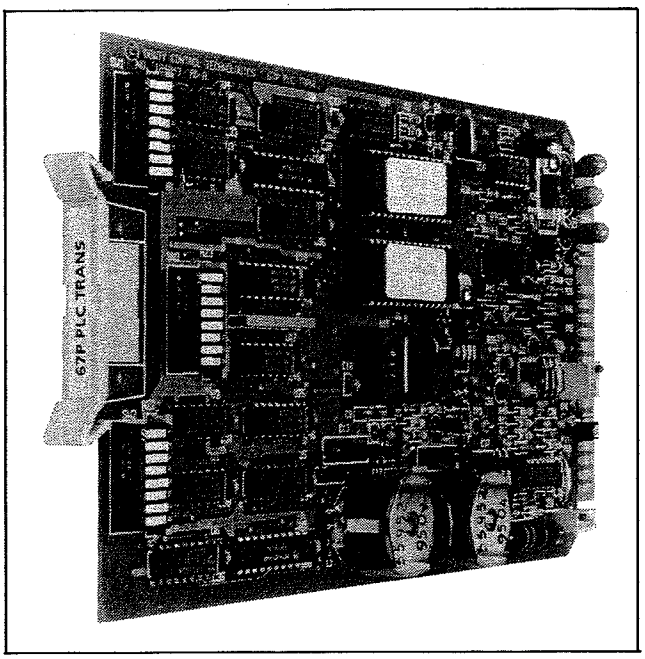


Figure 6-1. RFL 67P PLC TRANS Programmable Transmitter Module

6.1. DESCRIPTION

The RFL 67P PLC TRANS (Fig. 6-1) is a programmable powerline carrier transmitter, utilizing Direct Digital Synthesis (DDS). DDS is used to generate a stepped sine wave from a D/A converter by reading a sine look-up table stored in ROM; the desired output frequency is selected by programming a set of DIP switches. The waveform produced by the D/A converter is smoothed by an anti-aliasing filter before it is fed to an amplitude modulating circuit that can also be modulated by voice if the RFL 6785P is equipped with the voice option (Section 11). The output of the modulating circuit is amplified before it is fed to the 10-watt power amplifier (Section 7).

6.2. SPECIFICATIONS

As of the date this manual was published, the following specifications apply to the RFL 67P PLC TRANS. Because all RFL products undergo constant refinement and improvement, these specifications are subject to change without notice.

Output Frequency: 30 kHz to 535 kHz, adjustable in 50-Hz increments.

Frequency Stability: ±10 Hz

Harmonic Content: Less than -55 dB, typically -60dB.

Output Range (when used with RFL 67P PLC AMP Power Amplifier Module):
10-Watt Output: 6.0 Vp-p
3-Watt Output: 3.4 Vp-p
1-Watt Output: 2.0 Vp-p

Maximum Output Current: ±80 mArms.

Voice Input: 1.6 Vp-p nominal; a 1000-Hz test tone at this level will produce 20 to 30 percent modulation. Voice input level is adjusted on the optional RFL 67PLC VOICE Voice Adapter Module (Section 11).

Environmental:
Temperature Range: -20°C to +60°C (-4°F to +140°F).
Relative Humidity: Up to 95% at +40°C (+104°F).

Input Power Requirements:
+12-Volt Supply: 75 mA typical.
-12-Volt Supply: 240 mA typical.

Dimensions: 4.713 inches high x 8.0 inches deep x 0.675 inches wide (12 cm x 20.3 cm x 1.7 cm); requires two module spaces in chassis.

6.3. THEORY OF OPERATION

The RFL 67P PLC TRANS is a programmable powerline carrier transmitter utilizing Direct Digital Synthesis (DDS). The basic principle of DDS is to generate a stepped sine wave from a high-speed digital-to-analog (D/A) converter by reading a sine lookup table stored in ROM. The output of the D/A converter is then smoothed by an anti-aliasing filter; the output of the filter drives an amplitude modulating circuit that can be modulated by voice. The modulated signal is then amplified to the level required to drive the power amplifier (Section 7). A block diagram of the RFL 67P PLC TRANS appears in Figure 6-2.

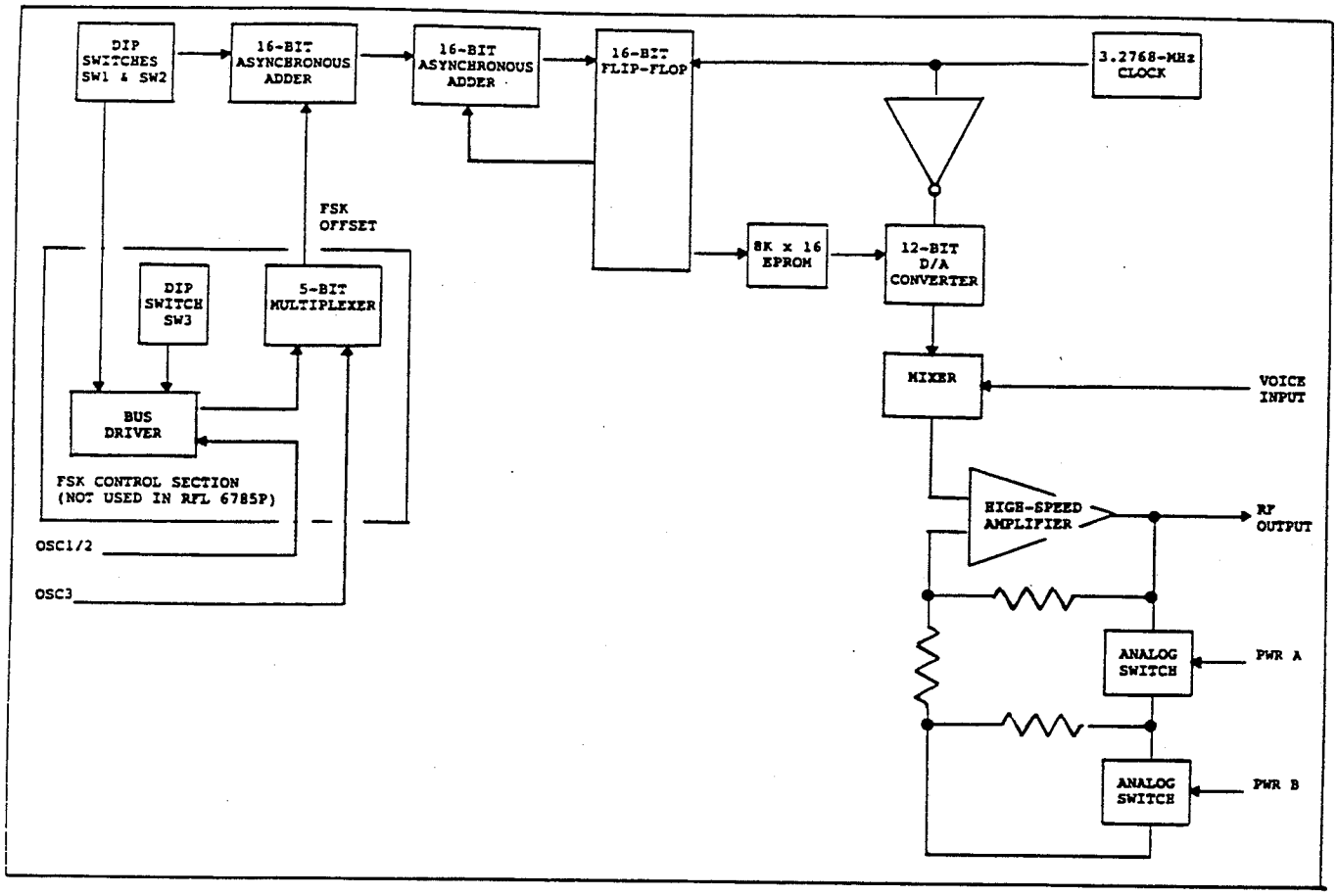


Figure 6-2. Block diagram, RFL 67P PLC TRANS Programmable Transmitter Module

Binary adders U1 through U4 accept programming information from the DIP switches. Binary adders U5 through U8 are incremented by the output of the look-up table so that the addresses are cycled through continuously. Latches U9 and U10 clock the address information to EPROMs U13 and U14, which contain the sine lookup table. Binary-coded analog data is clocked out of the EPROMs, and into the D/A converter (out of phase), where it is latched into the D/A converter's internal registers.

There are 8,096 address locations that make up a sine wave. With all DIP switches off, the binary adders do not jump any locations in the lookup table. If an LSB is added, every other address location is jumped, which doubles the output frequency, and so on.

The clocks are generated by an oscillator consisting of crystal Y1, field-effect transistor Q1, inverter U24, and their associated components.

b. Filter. The output of the D/A converter is a stepped sine wave which must be fed to an anti-aliasing filter. The filter is a five-pole passive low-pass LC filter, with a 3-db roll-off point at 610 kHz. The result is a smooth sine wave. This output is attenuated and coupled to the amplitude modulating circuit.

Carrier output can only occur when the CARRIER ENABLE input at edge connector terminal 9 is at the voltage selected by jumper J2. When the proper voltage is present, analog switch U19 will close, applying the output of the filter to potentiometer R50, which sets the signal level applied to the input of the amplitude modulator.

c. Amplitude Modulator. U20 is a balanced modulator configured for amplitude modulation. R50 is the attenuator for the filter's output; it is adjusted so that the carrier signal into the modulator is no larger than 40 mVp-p @ 535 kHz. This guarantees that the modulator operates in its linear region.

If the RFL 6785P terminal is equipped with the voice option, voice and signaling tones will be produced by the voice adapter module (Section 11). These will be used by U20 to modulate the carrier; the % MOD control on the RFL 67 PLC VOICE is adjusted so that

the amount of modulation is held between 20 and 30 percent. The output of the modulator is fed to the amplifier stage.

d. Amplifier. U22 is a high-speed amplifier, capable of delivering ±80mA of output current. Three output levels are achieved by switched combinations of feedback resistors. The switching is controlled by combinations of the PWR A input (edge connector terminal 6), the PWR B input (edge connector terminal 13), and jumper J3.

In order to obtain a ten-watt output from the RFL 67P PLC AMP power amplifier module (Section 7), potentiometer R16 is adjusted for a reading of 6 Vp-p at TX OUT test point TP6. Once R16 is properly set, the voltage at TP6 will be reduced to 3.4 Vp-p when the RFL 67P PLC TRANS is keyed for a 3-watt output, and 2.0 Vp-p when it is keyed for a 1-watt output. The output of the amplifier is passed on to the power amplifier module through edge connector terminal 19.

e. Regulators and References. U23 is a fixed +5-volt regulator which provides power to all devices on the RFL 67P PLC TRANS that require +5-volt power. U11 is an adjustable negative voltage regulator; it is set at for the -1.2-volt reference required by U15. U12 is a fixed -5.2-volt regulator which provides a negative supply for U15. Zener diode CR1 and resistor R21 serve as a -8.2-volt reference for U20.

Table 6-1. Replaceable parts, RFL 67P PLC TRANS Programmable Transmitter Module Assembly No. 104040

Circuit Symbol (Figs. 6-3 & 6-4)	Description	Part Number
	CAPACITORS	
C1,2	Capacitor,tantalum,47µF,10%,20V,radial leads,Kemet T353K476K020AS or equiv.	1007 1715
C3	Capacitor,tantalum,15µF,20%,35V,Sprague 196D156X0035PEX or equiv.	1007 539
C4	Capacitor,ceramic,33pF,5%,100V,AVX SR151A330JAA or equiv.	1007 1639
C5	Capacitor,ultra-stable NPO ceramic,150pF,10%,100V,Kemet C315C151K1G5EA or equiv.	1007 1396
C6-8	Capacitor,X7R ceramic,0.01µF,10%,100V,Kemet C320C103K1R5EA or equiv.	1007 1390
C9-11,18-20,26,27, 30-41,44-48,51-54	Capacitor,ceramic,0.1µF,GMV,50V,Centralab CY20C104P or equiv.	1007 1366
C12	Capacitor,X7R ceramic,0.33µF,10%,100V,Kemet C340C334K1R5CA or equiv.	1007 1498
C13	Capacitor,dipped mica,950pF,2%,500V, Type DM19	16207
C14	Capacitor,dipped mica,53.5pF,5%,500V, Type DM15	1080 374
C15	Capacitor,dipped mica,0.00155µF,2%,500V, Type DM19	16217
C16	Capacitor,dipped mica,160pF,2%,500V, Type DM15	16610
C17	Capacitor,dipped mica,865pF,2%,500V, Type DM19	16205
C21,22,49,50,57,58	Capacitor,tantalum,1µF,10%,35V,Kemet T368A105K035AS or equiv.	1007 1692
C23	Capacitor,ceramic,5pF,10%,100V,Murata RPA10COG050K100V or equiv.	0125 10501
C29	Capacitor,X7R ceramic,0.47µF,20%,50V,Kemet C330C474M5R5CA or equiv.	1007 1560
C55,56	Capacitor,tantalum,10µF,10%,20V,Kemet T362B106K020AS or equiv.	1007 1465
	RESISTORS	
R1	Resistor,metal film,100KΩ,1%,1/4W, Type RN1/4	0410 1480
R2	Resistor,metal film,100Ω,1%,1/4W, Type RN1/4	0410 1192
R3,30,35,40,41,44	Resistor,metal film,10KΩ,1%,1/4W, Type RN1/4	0410 1384
R9,10	Resistor,metal film,332Ω,1%,1/4W, Type RN1/4	0410 1242
R11,12,18	Resistor,metal film,1KΩ,1%,1/4W, Type RN1/4	0410 1288
R13	Resistor,metal film,51.1Ω,1%,1/4W, Type RN1/4	0410 1164
R14,15	Resistor,metal film,301Ω,1%,1/4W, Type RN1/4	0410 1238

Table 6-1. Replaceable parts, RFL 67P PLC TRANS Programmable Transmitter Module - continued.

Circuit Symbol (Figs. 6-3 & 6-4)	Description	Part Number
	RESISTORS - continued.	
R16	Resistor,variable,18-turn cermet,50KΩ,10%,1/2W,Beckman Helipot 68WR50K or equiv.	93667
R17	Resistor,metal film,6.81KΩ,1%,1/4W, Type RN1/4	0410 1368
R19,20	Resistor,metal film,750Ω,1%,1/4W, Type RN1/4	0410 1276
R21	Resistor,composition,100Ω,5%,1W,Allen-Bradley GB Series or equiv.	1009 182
R23	Resistor,metal film,2.21KΩ,1%,1/4W, Type RN1/4	0410 1321
R24,25	Resistor,metal film,27.4Ω,1%,1/8W,Type RN55D	1510 1425
R26	Resistor,metal film,590Ω,1%,1/4W, Type RN1/4	0410 1266
R27	Resistor,metal film,20KΩ,1%,1/4W, Type RN1/4	0410 1413
R29,42,43,45	Resistor,metal film,14KΩ,1%,1/4W, Type RN1/4	0410 1398
R32,46	Resistor,metal film,200KΩ,1%,1/4W, Type RN1/4	0410 1509
R34	Resistor,metal film,499Ω,1%,1/4W, Type RN1/4	0410 1259
R37	Resistor,metal film,16.5KΩ,1%,1/4W, Type RN1/4	0410 1405
R38	Resistor,metal film,12.1KΩ,1%,1/4W, Type RN1/4	0410 1392
R39	Resistor,metal film,6.98KΩ,1%,1/4W, Type RN1/4	0410 1369
R48,49	Resistor,metal film,3.92KΩ,1%,1/4W, Type RN1/4	0410 1345
R50	Resistor,variable,18-turn cermet,10KΩ,10%,1/2W,Beckman Helipot 68WR10K or equiv.	48548
R51	Resistor,metal film,1.87KΩ,1%,1/4W, Type RN1/4	0410 1314
R52,53	Resistor,metal film,1.62KΩ,1%,1/4W, Type RN1/4	0410 1308
R54	Resistor,metal film,113Ω,1%,1/4W, Type RN1/4	0410 1197
R55	Resistor,metal film,243Ω,1%,1/4W, Type RN1/4	0410 1229
R56	Resistor,wirewound,15Ω,5%,3.25W,Ohmite 4365 Style 995-3A or equiv.	1100 673
RZ1-4	Resistor network,nine 10KΩ 2% resistors,1.25 W total,10-pin SIP,Bourns 4310R-101-103 or equiv.	32622
	SEMICONDUCTORS	
CR1	Diode,Zener,8.2V,5%,1W,1N4738A	29754
CR2,3	Diode,germanium,1N100A	28507
Q1	Transistor,N-channel JFET,VHF/UHF,TO-92 case,Siliconix J309 or equiv.	32531
U1-8	MOS 4-bit binary full adder,16-pin plastic DIP,RCA CD74HC283E or equiv.	0615 367
U9,10	MOS octal tri-state D-type flip-flop,20-pin DIP,Motorola MC74HC574N or equiv.	0615 298
U11	Linear voltage regulator,negative,adjustable,TO-92 case,National Semiconductor LM337LZ or equiv.	0620 247
U12	Linear voltage regulator,-5.2 volts,3-terminal plastic package,Motorola MC7905.2CT or equiv.	0620 334
U13,14	EPROM,8K x 8, programmed at factory	Contact factory
U15	Digital-to-analog converter,10-bit,high-speed (85 ns),18-pin ceramic DIP, Precision Monolithics DAC10FX or equiv.	0625 31
U16	MOS hex inverter,14-pin DIP,National Semiconductor MM74HC04N or equiv.	0615 185
U17,25	MOS quad 2-input multiplexer,16-pin DIP,National Semiconductor MM74HC157N or equiv.	0615 171
U18	MOS tri-state octal buffer,20-pin DIP,National Semiconductor MM74HC244N or equiv.	0615 176
U19	MOS quad analog switch,SPST,14-pin DIP,Harris Semiconductor HI-3-0201-5 or equiv.	0605 10

Table 6-1. Replaceable parts, RFL 67P PLC TRANS Programmable Transmitter Module - continued.

Circuit Symbol (Figs. 6-3 & 6-4)	Description	Part Number
	SEMICONDUCTORS - continued.	
U20	Linear balanced modulator/demodulator,14-pin ceramic DIP,Motorola MC1596L or equiv.	0620 331
U22	Linear operational amplifier,high-speed,wide bandwidth,8-pin DIP, Precision Monolithics OP64FZ or equiv.	0620 335
U23	Linear voltage regulator,+5-volt,3-terminal TO-220 case,Motorola MC78M05CT or equiv.	0620 222
U24	MOS hex inverter,unbuffered,high-speed,14-pin DIP,RCA CD74HCU04E or equiv.	0615 304
	MISCELLANEOUS COMPONENTS	
L1	Inductor,rf,molded,100µH,10%,Gowanda 10/103 or equiv.	32505 1
L2	Coil,cup-core,0.1230µH	55952 9509
L3	Coil,cup-core,0.1096µH	55952 9504
S1-3	Switch array,eight SPST switches,16-pin DIP,Grayhill 90B08S or equiv.	98493
Y1	Crystal,quartz,3.2768 MHz	99091
. . .	Shorting bar,single,Molex 90059-0009 or equiv.	98306

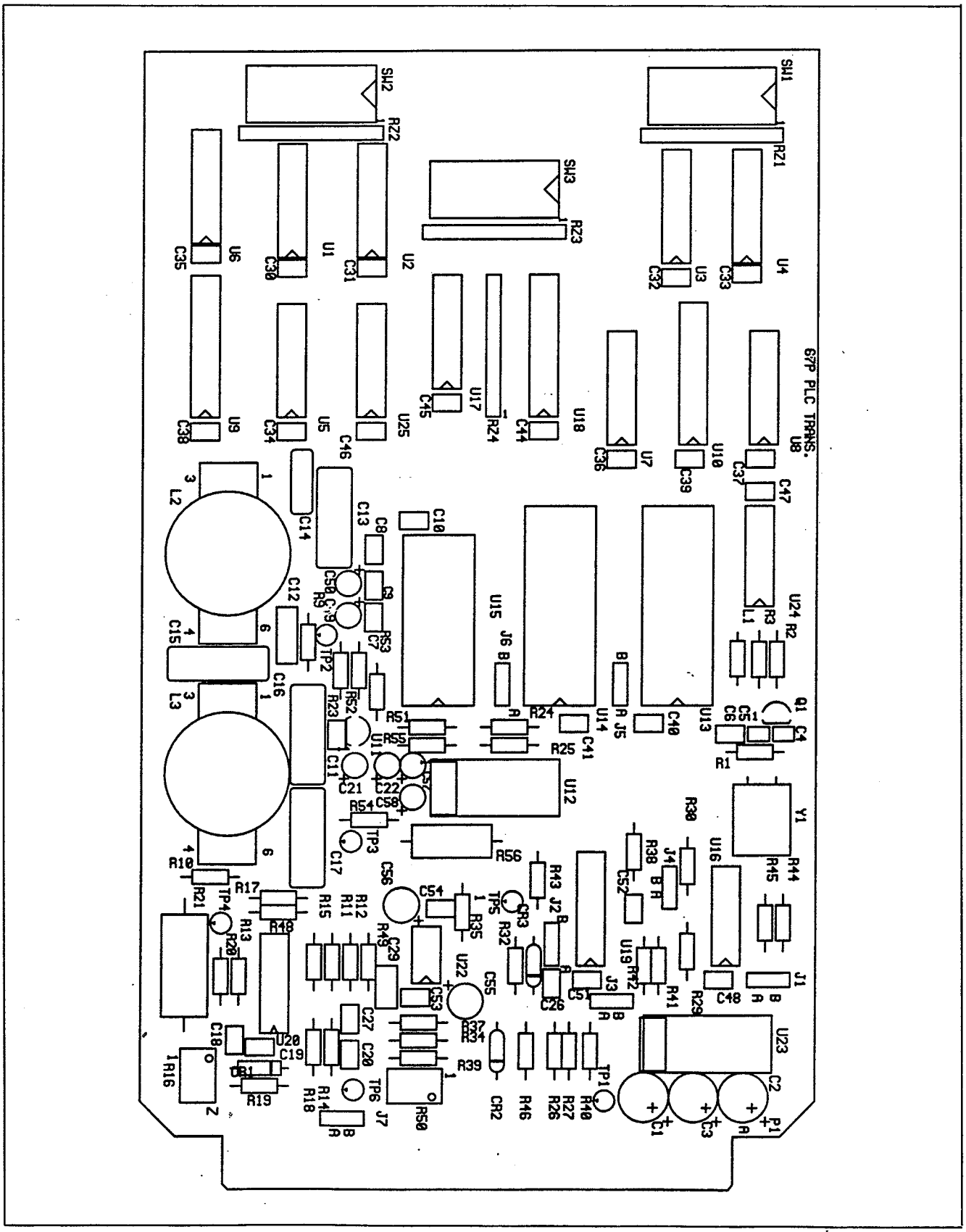
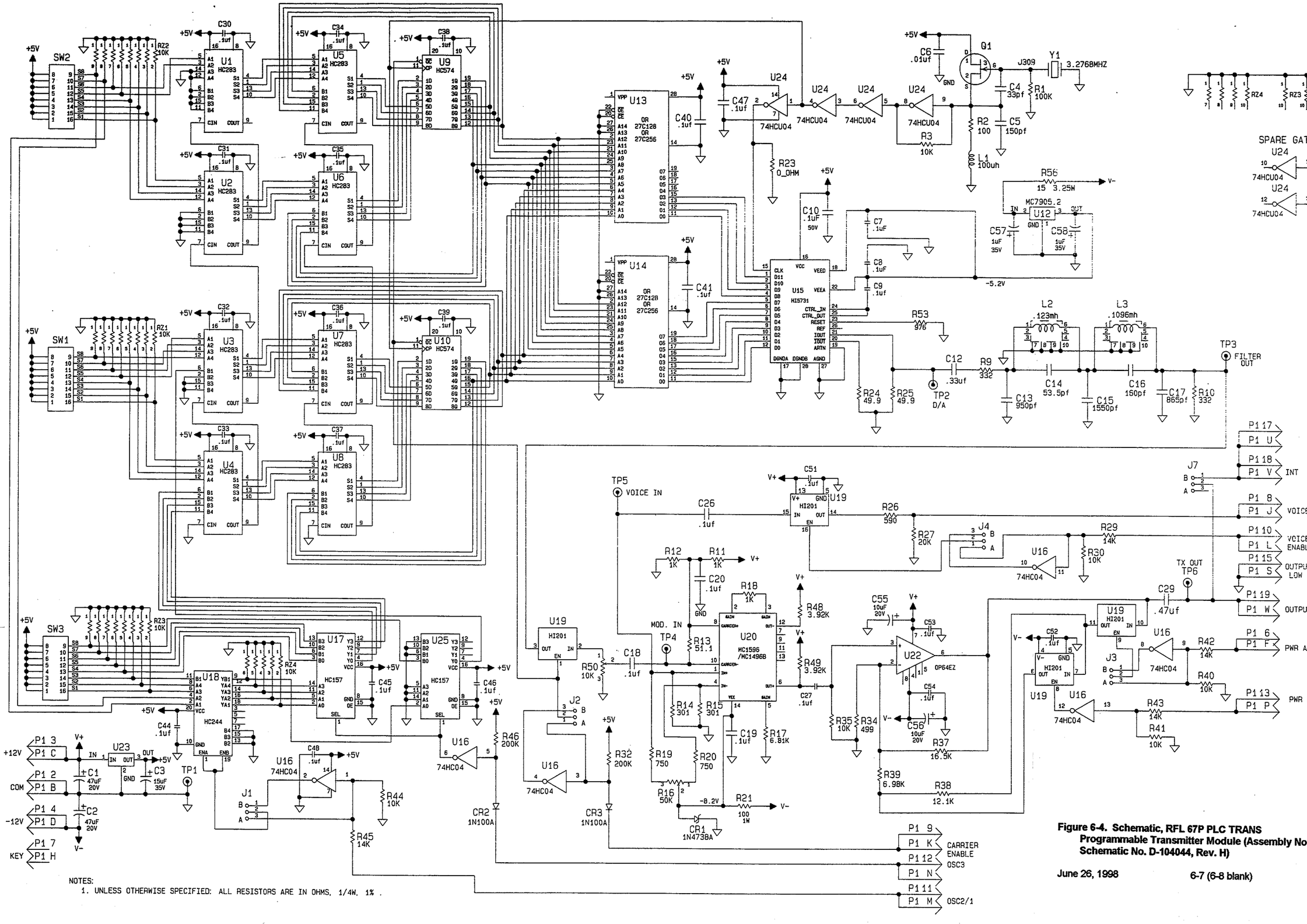


Figure 6-3. Component locator drawing, RFL 67P PLC TRANS Programmable Transmitter Module (Assembly No. 104040, Circuit Board No. D-104043, Rev. F)



NOTES:
1. UNLESS OTHERWISE SPECIFIED: ALL RESISTORS ARE IN OHMS, 1/4W, 1% .

Figure 6-4. Schematic, RFL 67P PLC TRANS Programmable Transmitter Module (Assembly No. 104040, Schematic No. D-104044, Rev. H)

Section 7. POWER AMPLIFIER

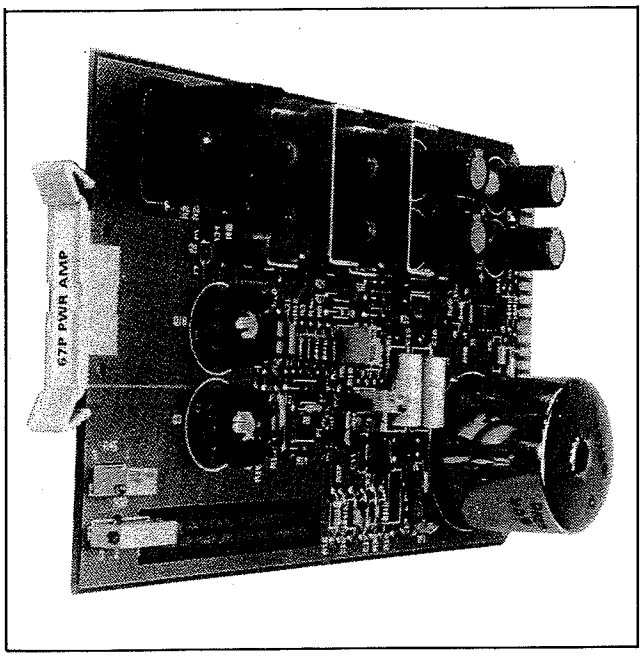


Figure 7-1. RFL 67P PLC AMP Power Amplifier Module

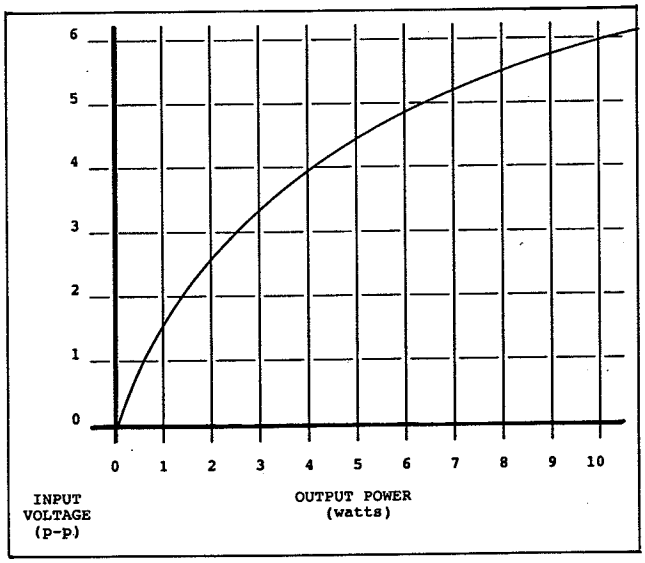


Figure 7-2. Input voltage vs output power, RFL 67P PLC AMP Power Amplifier Module

7.1. DESCRIPTION

The RFL 67P PLC AMP Power Amplifier Module (Fig. 7-1) is driven by the transmitter module (Section 6), and raises the power of the transmitter to the level chosen for the application. It also includes a level monitoring circuit that will send a TX FAIL alarm to the AM I/O module if the transmitter fails. The amplifier has a transformer-isolated output, and a 50Ω impedance.

7.2. SPECIFICATIONS

As of the date this manual was published, the following specifications apply to the RFL 67P PLC AMP Power Amplifier Module. Because all RFL products undergo constant refinement and improvement, these specifications are subject to change without notice.

Input/Output Levels: See Figure 7-2.

Input Impedance: 1500 ohms minimum.

Output Impedance: 50 ohms.

Harmonic Content: -35 dB maximum, typically -42 dB.

Output Variation: ±1 dB over the specified temperature and operating voltage ranges.

Amplifier Gain: 22.5 dB (+17.5 dBm amplified to +40 dBm).

Environmental:
Temperature Range: -20°C to +60°C (-4°F to +140°F).
Relative Humidity: Up to 95% at +40°C (+104°F).

Input Power Requirements:
+15-Volt Supply: 600 mA typical.
-15-Volt Supply: 600 mA typical.

Dimensions: 4.713 inches high x 8.0 inches deep x 1.5 inches wide (12 cm x 20.3 cm x 3.8 cm); requires four module spaces in chassis.

7.3. THEORY OF OPERATION

The RFL 67P PLC AMP is a ten-watt power amplifier module which is capable of amplifying signals from 30 kHz to 535 Khz to an output level of +40 dBM.

The output signal from the transmitter module enters the RFL 67P PLC AMP through edge connector terminals U (high) and S (low). It passes through potentiometer R45, which serves as the final signal

level adjustment. The signal is then fed through coupling capacitors C5 and C6 to a differential amplifier formed from transistors Q1 and Q2, and their associated components. Resistors R3 through R7 provide a dc offset null adjustment for the differential amplifier; potentiometer R5 is adjusted for a dc null at test point TP2 when the amplifier's input is grounded.

The collector of Q2 drives the base of transistor Q3, which is configured as a common-emitter amplifier. A fixed-bias current of about 27 mA is provided by transistors Q9 and Q10, diode CR2, and resistors R34 and R35. A fixed-bias voltage of about 3.2 volts is created by transistors Q4, Q6, and Q7, and resistors R23 and R24. (This voltage varies slightly with temperature.) The voltage across Q4, Q6, and Q7 remains stable, but these devices "float" above and below zero volts when an input signal is applied to the amplifier.

The collector of Q4 and the emitter of Q7 drive the bases of transistors Q5 and Q8, which function as emitter-follower drivers. At this point, the signal leaves the RFL 67P PLC AMP through edge connector terminals F and K; the The signal is routed to the final amplifier transistors, which are mounted on the rear panel of the RFL 6785P chassis. These devices are also configured as emitter-followers. After final amplification, the signal re-enters the RFL 67P PLC AMP through edge connector terminals H and J.

The emitters of each final amplifier transistor are connected on the amplifier board through resistors R32 and R33, and the signal is coupled to transformer T1 by capacitors C15 and C16. T1 has a turns ratio of 4:1, with a 50-ohm secondary; it yields an output of +40 dBm into a 50-ohm load. R20, which appears in the feedback path, is adjusted so that 6 dB of attenuation occurs when a 50-ohm load is placed across the secondary of T1. This ensures that the amplifier's output impedance is matched to the load impedance.

Operational amplifier U1 and its associated components provide an alarm when the RFL 67P PLC AMP's output drops below a preset level. The output signal is rectified by diode CR3, and then filtered by R37 and C18. Potentiometer R38 sets the level at which U1 pulls to +15 volts, indicating an alarm.

Table 7-1. Replaceable parts, RFL 67P PLC AMP Power Amplifier Module Assembly No. 104015

Circuit Symbol (Figs. 7-3 & 7-4)	Description	Part Number
	CAPACITORS	
C1-4	Capacitor,electrolytic,1000µF,+50/-10%,25V,Siemens 85209/1000/25 or equiv.	1007 1633
C5,6,13,14	Capacitor,X7R ceramic,0.27µF,10%,50V,Murata RPA40X7R274K50V or equiv.	0130 52741
C7,10	Capacitor,tantalum,3.3µF,20%,35V,Kemet T322C335M035AS or equiv.	1007 1260
C8	Capacitor,ceramic,5pF,10%,100V,Murata RPA10COG050K100V or equiv.	0125 10501
C9,19	Capacitor,Z5U ceramic,0.33µF,+80/-20%,50V,Murata RPA3025U334Z50V or equiv.	0135 53348
C11	Capacitor,dipped mica,140pF,2%,500V, Type DM19	16607
C12	Capacitor,ceramic,47pF,5%,100V,AVX SA101A470JAA or equiv.	0125 14705
C15,16	Capacitor,metallized polycarbonate,3µF,5%,50V,Wesco 32MPC or equiv.	1007 1287
C17	Capacitor,X7R ceramic,0.01µF,10%,50V,AVX SA105C103KAA or equiv.	0130 51031
C18	Capacitor,X7R ceramic,0.1µF,10%,50V,AVX SA305C104KAA or equiv.	0130 51041
	RESISTORS	
R1	Resistor,metal film,1.5KΩ,1%,1/4W, Type RN1/4	0410 1305
R2	Resistor,metal film,10KΩ,1%,1/4W, Type RN1/4	0410 1384
R3,7	Resistor,metal film,7.5KΩ,1%,1/4W, Type RN1/4	0410 1372
R4,6,10,36,37,41,42	Resistor,metal film,1KΩ,1%,1/4W, Type RN1/4	0410 1288
R5,20	Resistor,variable,18-turn cermet,1KΩ,10%,1/2W,Beckman Helipot 68WR1K or equiv.	49995
R8	Resistor,metal film,6.49KΩ,1%,1/4W, Type RN1/4	0410 1366
R9,13	Resistor,metal film,182Ω,1%,1/4W, Type RN1/4	0410 1217

Table 7-1. Replaceable parts, RFL 67P PLC AMP Power Amplifier Module - continued

Circuit Symbol (Figs. 7-3 & 7-4)	Description	Part Number
	RESISTORS - continued.	
R11,12,14,16	Resistor,metal film,10Ω,1%,1/4W,Type RN60D	1510 1015
R15	Resistor,metal film,4.22Ω,1%,1/4W, Type RN1/4	0410 1348
R17,22	Resistor,composition,2.7Ω,5%,1/4W, Allen-Bradley CB Series or equiv.	1009 900
R18	Resistor,non-inductive wirewound,0.25Ω,5%,7W,C.T.Gamble CGN-9 AXIAL or equiv.	1100 816
R19	Resistor,metal film,402Ω,1%,1/4W, Type RN1/4	0410 1250
R21	Resistor,metal film,1KΩ,1%,0.5W, Type RN1/2	0410 2288
R23	Resistor,metal film,750Ω,1%,1/4W, Type RN1/4	0410 1276
R24	Resistor,metal film,1.21KΩ,1%,1/4W, Type RN1/4	0410 1296
R25,27,34	Resistor,metal film,2.21KΩ,1%,1/4W, Type RN1/4	0410 1321
R26	Resistor,metal film,33.7Ω,1%,1/4W, Type RN1/4	0410 1146
R28-31	Resistor,metal film,15Ω,1%,1/4W,Type RN60D	1510 1023
R32,33	Resistor,wirewound,0.10Ω,1%,1W,Mills Resistor MRP-1 or equiv.	1100 801
R35	Resistor,metal film,23.7Ω,1%,1/4W, Type RN1/4	0410 1132
R38	Resistor,variable,15-turn cermet,100KΩ,10%,3/4W,Beckman Helipot 89PHR100K or equiv.	47540
R39	Resistor,metal film,47.5KΩ,1%,1/4W, Type RN1/4	0410 1449
R40	Resistor,metal film,715Ω,1%,1/4W, Type RN1/4	0410 1274
R45	Resistor,variable,18-turn cermet,1KΩ,10%,1/2W,Beckman Helipot 68XR1K or equiv.	91952
	SEMICONDUCTORS	
CR1,4	Diode,silicon,200 PIV,1N4003	30769
CR2	Diode,silicon,1N914B or 1N4448	26482
CR3	Diode,germanium,1N100A	28507
Q1,2	Transistor,NPN,TO-92 case,2N3903	21562
Q3	Transistor,PNP,TO-5 case,2N2905A	39567
Q4,6,7	Transistor,NPN,60V,4A,15W,Type 77-03 case,Motorola MJE-223 or equiv.	34756
Q5	Transistor,NPN,Type 152-02 case,Motorola MPS-U07 or equiv.	92671
Q8	Transistor,PNP,Type 152-02 case,Motorola MPS-U57 or equiv.	92672
Q9	Transistor,NPN,plastic package,2N2222A	37445
Q10	Transistor,NPN,TO-5 case,2N2219A	39569
U1	Linear voltage comparator/buffer,8-pin DIP,National Semiconductor LM311N or equiv.	0620 188
	MISCELLANEOUS COMPONENTS	
L1,2	Inductor,molded,10mH,5%,4A,resonant frequency greater than 10 Mhz, Stanwyck ER-3114 or equiv.	92620
T1	Transformer,output	102726

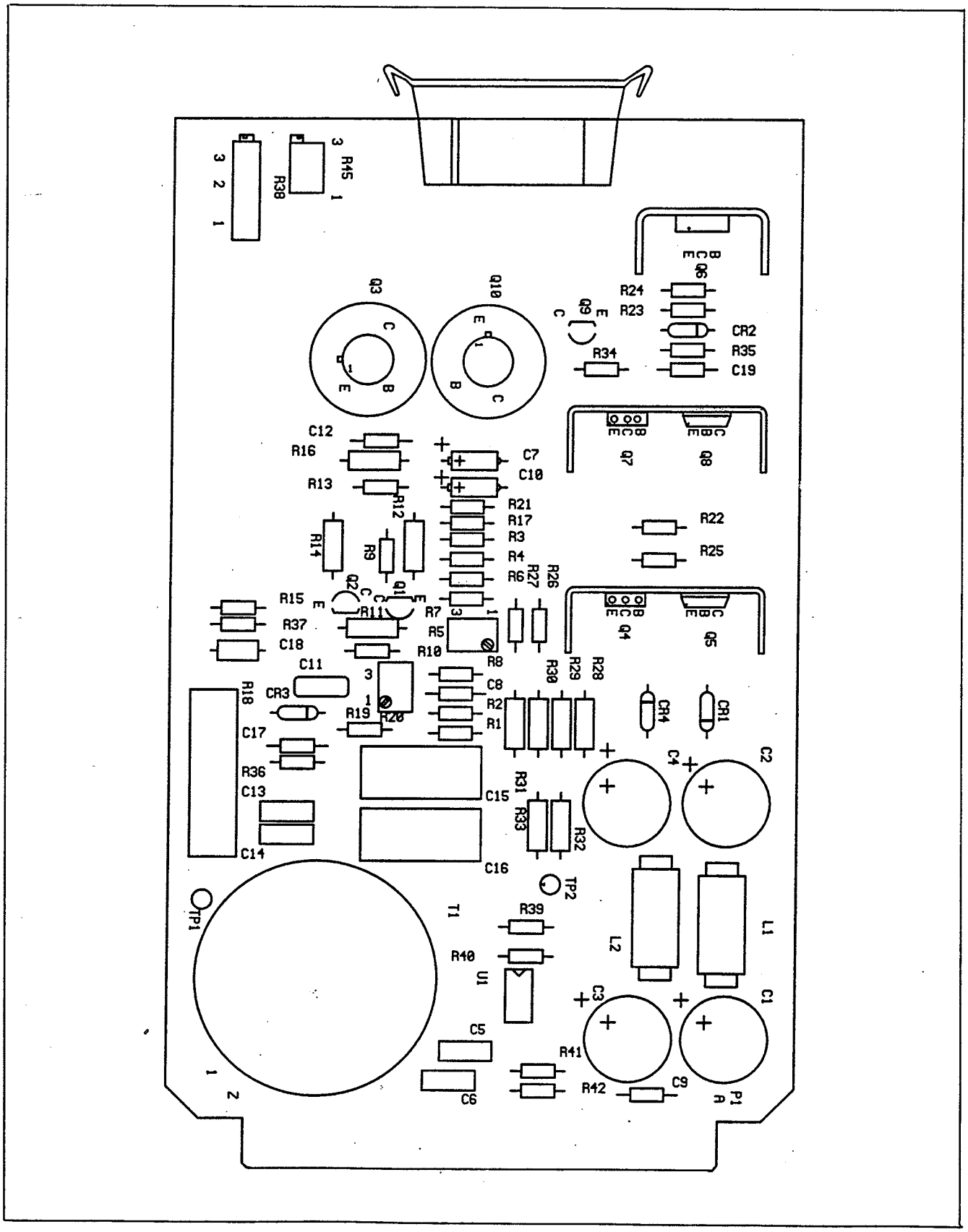
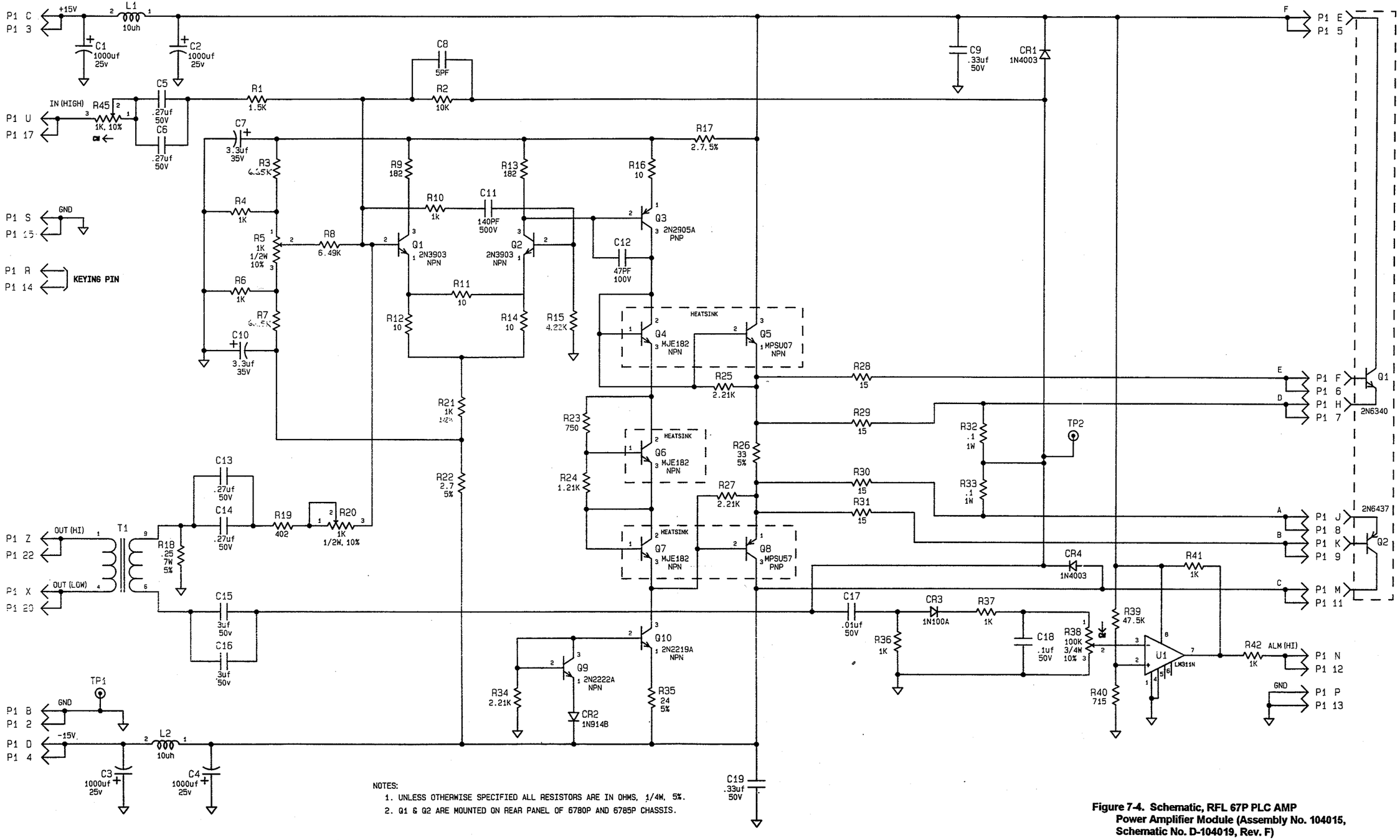


Figure 7-3. Component locator drawing, RFL 67P PLC AMP Power Amplifier Module (Assembly No. 104015; Circuit Board No. D-104019, Rev. C)



NOTES:

1. UNLESS OTHERWISE SPECIFIED ALL RESISTORS ARE IN OHMS, 1/4W, 5%.
2. Q1 & Q2 ARE MOUNTED ON REAR PANEL OF 6780P AND 6785P CHASSIS.

Figure 7-4. Schematic, RFL 67P PLC AMP Power Amplifier Module (Assembly No. 104015, Schematic No. D-104019, Rev. F)

Section 8. FILTER MODULES

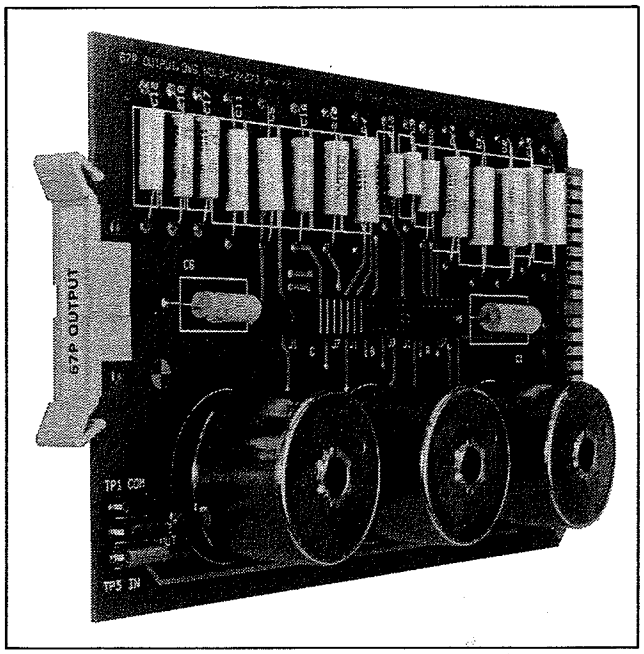


Figure 8-1. Typical RFL 67P OUTPUT filter module

8.1. DESCRIPTION

RFL 67P OUTPUT Filters Modules are used to reduce the harmonic content of the RFL 6785P's output signal to a level that is at least 55 dB below the carrier level. A typical RFL 67P OUTPUT filter module appears in Figure 8-1.

In order to cover the RFL 6785P's entire operating range (30 to 537 kHz), there are four different RFL 67P OUTPUT filter modules, as listed in Table 8-1. Three filter modules are equipped with jumpers for selecting the frequency range; the fourth module has a fixed range which covers the top of the RFL 6785P's frequency band.

All four filters are entirely passive, and require no input power for proper operation. Each filter occupies three module slots in the RFL 6785P chassis.

RFL 67P OUTPUT filters are elliptical six-pole filters, that present less than 0.075 dB of attenuation to frequencies within their passband. They are designed to have greatest attenuation at about the third harmonic of the lowest frequency in the passband; these are the frequencies listed in Table 8-1 as the "frequency of greatest attenuation," which will be attenuated by at least 55 dB. Signals between this frequency and 1 MHz will be at least 45 dB below the passband level.

Table 8-1. RFL 6785P output filter frequency ranges

Filter Part No.	Jumper Position	Passband Frequency Range	Frequency Of Greatest Attenuation
104070-1	A	30 to 41.5 kHz	90 kHz
	B	38 to 52.5 kHz	114 kHz
	C	49 to 67.5 kHz	147 kHz
104070-2	A	64 to 88.5 kHz	192 kHz
	B	85 to 117.5 kHz	255 kHz
	C	114 to 157.5 kHz	342 kHz
104070-3	A	154 to 212.5 kHz	462 kHz
	B	209 to 288.5 kHz	627 kHz
	C	285 to 393.5 kHz	855 kHz
104075	. . .	390 to 537.5 kHz	1170 kHz

NOTE: For proper filter operation, all jumpers must be placed in the same position (A, B, or C).

8.2. SPECIFICATIONS

As of the date this manual was published, the following specifications apply to all RFL 67P OUTPUT filter modules, except as indicated. Because all RFL products undergo constant refinement and improvement, these specifications are subject to change without notice.

Frequency Range: See Table 8-1.

Attenuation Notch:

Magnitude: Greater than 55 dB below passband level.

Approximate Frequency:

104070-1: 90 kHz.
104070-2: 192 kHz.
104070-3: 462 kHz.
104075: 1.17 MHz.

Stopband:

Attenuation: Greater than 45 dB below passband level.

Approximate Frequency Range:

104070-1: 90 kHz to 1 MHz.
104070-2: 192 kHz to 1 MHz.
104070-3: 462 kHz to 1 MHz.
104075: 1.17 MHz to 1 MHz.

Passband: 0.75 dB deviation.

Signal Power: 10 watts maximum.

Impedance: 50 ohms.

Environmental:

Temperature Range: -20°C to +60°C (-4°F to +140°F).

Relative Humidity: Up to 95% at +40°C (+104°F).

Input Power Requirements: None; no active components.

Dimensions: 4.713 inches high x 8.0 inches deep x 1.25 inches wide (12 cm x 20.3 cm x 3.2 cm); requires three module spaces in chassis.

Table 8-2. Replaceable parts, RFL 67P OUTPUT multiple-range output filters
30 to 65 kHz - Assembly No. 104070-1
65 to 156 kHz - Assembly No. 104070-2
156 to 392 kHz - Assembly No. 104070-3

Circuit Symbol (Figs. 8-2 & 8-3)	Description	Part Number
C1	Capacitor,polyester,2%,400V,value dependent upon assembly:	
	104070-1: 0.0715µF;Wesco 32P or equiv.	5115 176
	104070-2: 0.033µF;Wesco 32P or equiv.	5115 159
	104070-3: 0.014µF;Wesco 32P or equiv.	5115 142
C2	Capacitor,polyester,2%,400V,value dependent upon assembly:	
	104070-1: 0.091µF;Wesco 32P or equiv.	5115 181
	104070-2: 0.041µF;Wesco 32P or equiv.	5115 164
	104070-3: 0.018µF;Wesco 32P or equiv.	5115 147
C3	Capacitor,polyester,2%,400V,value dependent upon assembly:	
	104070-1: 0.00715µF;Wesco 32P or equiv.	5115 128
	104070-2: 0.00315µF;Wesco 32P or equiv.	5115 110
	104070-3: 0.0014µF;F-Dyne PST-11-.0014-400-2 or equiv.	5115 281
C4	Capacitor,polyester,2%,400V,value dependent upon assembly:	
	104070-1: 0.036µF;Wesco 32P or equiv.	5115 161
	104070-2: 0.017µF;Wesco 32P or equiv.	5115 146
	104070-3: 0.00715µF;Wesco 32P or equiv.	5115 128
C5	Capacitor,polyester,2%,400V,value dependent upon assembly:	
	104070-1: 0.0285µF;Wesco 32P or equiv.	5115 156
	104070-2: 0.013µF;Wesco 32P or equiv.	5115 141
	104070-3: 0.0056µF;Wesco 32P or equiv.	5115 123
C6	Capacitor,polyester,2%,400V,value dependent upon assembly:	
	104070-1: 0.024µF;Wesco 32P or equiv.	5115 153
	104070-2: 0.011µF;Wesco 32P or equiv.	5115 137
	104070-3: 0.0047µF;Wesco 32P or equiv.	5115 119
C7	Capacitor,polyester,2%,400V,value dependent upon assembly:	
	104070-1: 0.0535µF;Wesco 32P or equiv.	5115 170
	104070-2: 0.024µF;Wesco 32P or equiv.	5115 153
	104070-3: 0.01µF;Wesco 32P or equiv.	5115 135
C8	Capacitor,polyester,2%,400V,value dependent upon assembly:	
	104070-1: 0.068µF;Wesco 32P or equiv.	5115 175
	104070-2: 0.315µF;Wesco 32P or equiv.	5115 158
	104070-3: 0.013µF;Wesco 32P or equiv.	5115 141
C9	Capacitor,polyester,2%,400V,value dependent upon assembly:	
	104070-1: 0.00535µF;Wesco 32P or equiv.	5115 122
	104070-2: 0.0024µF;Wesco 32P or equiv.	5115 105
	104070-3: 0.001µF;F-Dyne PST-11-.001-400-2 or equiv.	5115 274

Table 8-2. Replaceable parts, RFL 67P OUTPUT multiple-range output filters - continued.

Circuit Symbol (Figs. 8-2 & 8-3)	Description	Part Number
C10	Capacitor,polyester,2%,400V,value dependent upon assembly:	
	104070-1: 0.027µF;Wesco 32P or equiv.	5115 155
	104070-2: 0.0125µF;Wesco 32P or equiv.	5115 140
	104070-3: 0.0051µF;Wesco 32P or equiv.	5115 121
C11	Capacitor,polyester,2%,400V,value dependent upon assembly:	
	104070-1: 0.021µF;Wesco 32P or equiv.	5115 150
	104070-2: 0.01µF;Wesco 32P or equiv.	5115 135
	104070-3: 0.0041µF;Wesco 32P or equiv.	5115 116
C12	Capacitor,polyester,2%,400V,value dependent upon assembly:	
	104070-1: 0.018µF;Wesco 32P or equiv.	5115 147
	104070-2: 0.0082µF;Wesco 32P or equiv.	5115 131
	104070-3: 0.00345µF;Wesco 32P or equiv.	5115 112
C13	Capacitor,polyester,2%,400V,value dependent upon assembly:	
	104070-1: 0.043µF;Wesco 32P or equiv.	5115 165
	104070-2: 0.018µF;Wesco 32P or equiv.	5115 147
	104070-3: 0.0075µF;Wesco 32P or equiv.	5115 129
C14	Capacitor,polyester,2%,400V,value dependent upon assembly:	
	104070-1 and 104070-2: Same as C7.	
	104070-3: 0.0095µF;Wesco 32P or equiv.	5115 134
C15	Capacitor,polyester,2%,400V,value dependent upon assembly:	
	104070-1: 0.0041µF;Wesco 32P or equiv.	5115 116
	104070-2: 0.0018µF;F-Dyne PST-11-.0018-400-2 or equiv.	5115 285
	104070-3: 0.00075µF;F-Dyne PST-11-.00075-400-2 or equiv.	5115 268
C16	Capacitor,polyester,2%,400V,value dependent upon assembly:	
	104070-1: Same as C11.	5115 150
	104070-2: 0.0095µF;Wesco 32P or equiv.	5115 134
	104070-3: 0.00375µF;Wesco 32P or equiv.	5115 114
C17	Capacitor,polyester,2%,400V,value dependent upon assembly:	
	104070-1: 0.017µF;Wesco 32P or equiv.	5115 146
	104070-2: 0.0075µF;Wesco 32P or equiv.	5115 129
	104070-3: 0.003µF;Wesco 32P or equiv.	5115 109
C18	Capacitor,polyester,2%,400V,value dependent upon assembly:	
	104070-1: 0.014µF;Wesco 32P or equiv.	5115 142
	104070-2: 0.0062µF;Wesco 32P or equiv.	5115 125
	104070-3: 0.00255µF;Wesco 32P or equiv.	5115 106
L1-3	Coil,cup-core,number of turns dependent upon assembly:	
	104070-1: 77.5 turns	99403 1
	104070-2: 52.5 turns	99403 2
	104070-3: 33.5 turns	99403 3

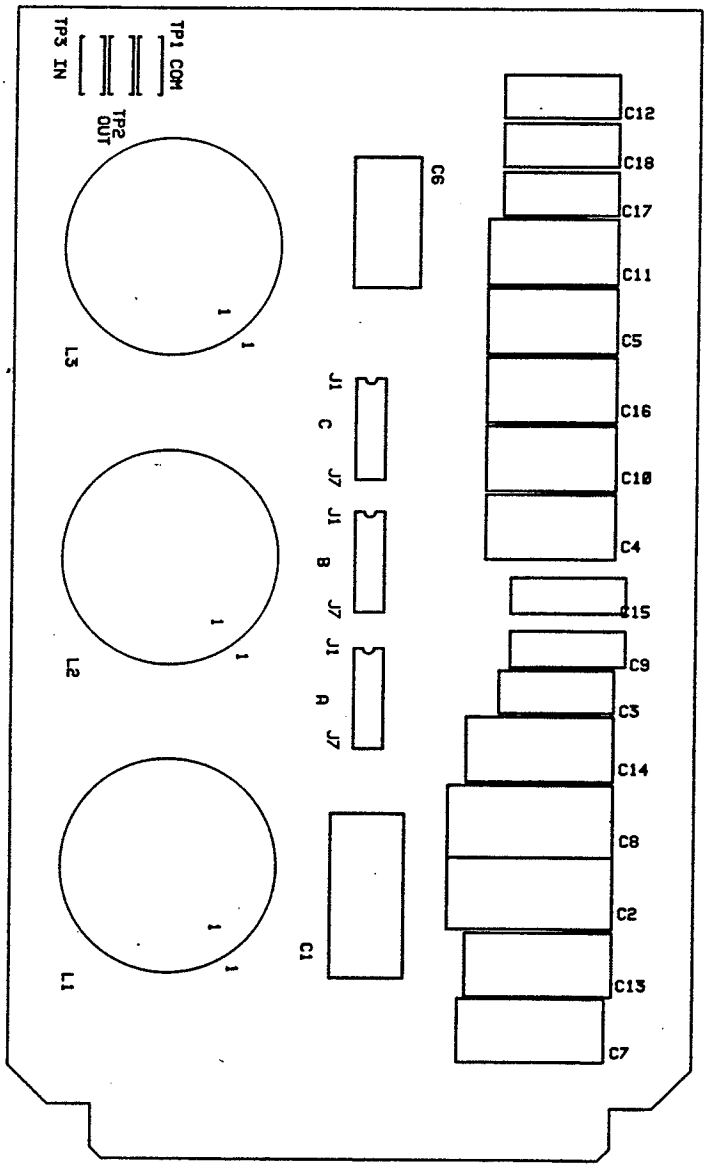


Figure 8-2. Component locator drawing, RFL 67P OUTPUT multiple-range output filters (Assembly No. 104070-X; Circuit Board No. D-104073, Rev. A)

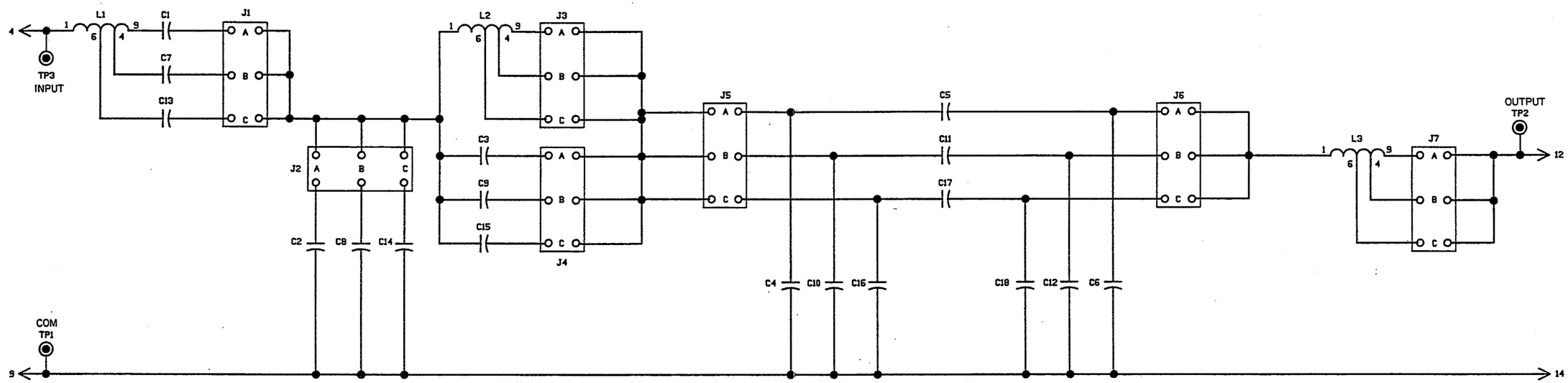


Figure 8-3. Schematic, RFL 67P OUTPUT multiple-range output filters (Assembly No. 104070-X; Schematic No. D-104074, Rev. A)

Table 8-3. Replaceable parts, RFL 67P OUTPUT single-range output filter (392 to 535 kHz) Assembly No. 104075

Circuit Symbol (Figs. 8-4 & 8-5)	Description	Part Number
C1	Capacitor,polyester,0.0056µF,2%,400V,Wesco 32P or equiv.	5115 123
C2	Capacitor,polyester,0.00715µF,2%,400V,Wesco 32P or equiv.	5115 128
C3	Capacitor,polyester,0.000535µF,2%,400V,F-Dyne PST-11-.000535-400-2 or equiv.	5115 261
C4	Capacitor,polyester,0.00285µF,2%,400V,Wesco 32P or equiv.	5115 108
C5	Capacitor,polyester,0.0022µF,2%,400V,Wesco 32P or equiv.	5115 103
C6	Capacitor,polyester,0.0018µF,2%,400V,F-Dyne PST-11-.0018-400-2 or equiv.	5115 285
L1-3	Coil,cup-core,21.5 turns	99404

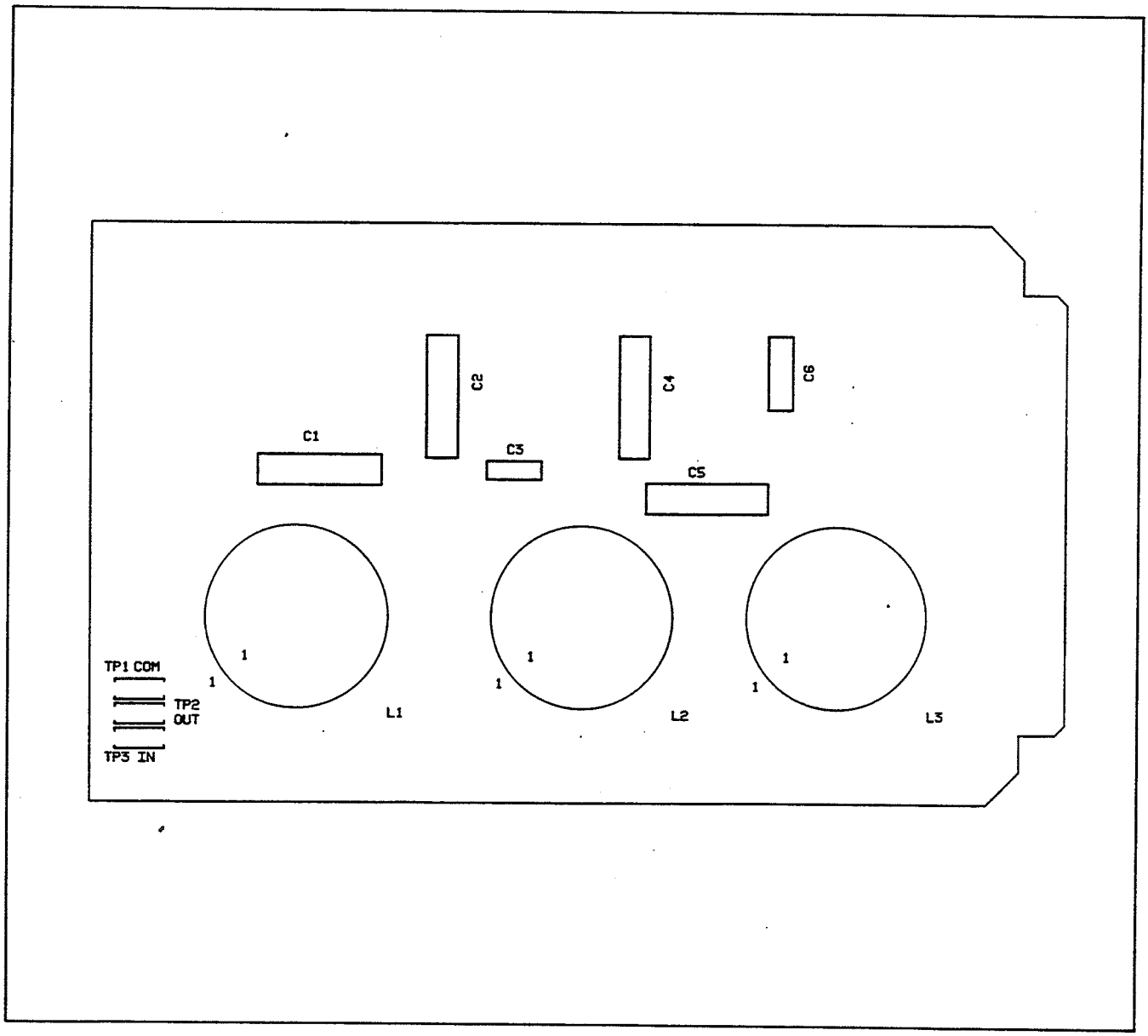


Figure 8-4. Component locator drawing, RFL 67P OUTPUT single-range output filter (392 to 535 kHz) (Assembly No. 104075; Circuit Board No. D-104078, Rev. A)

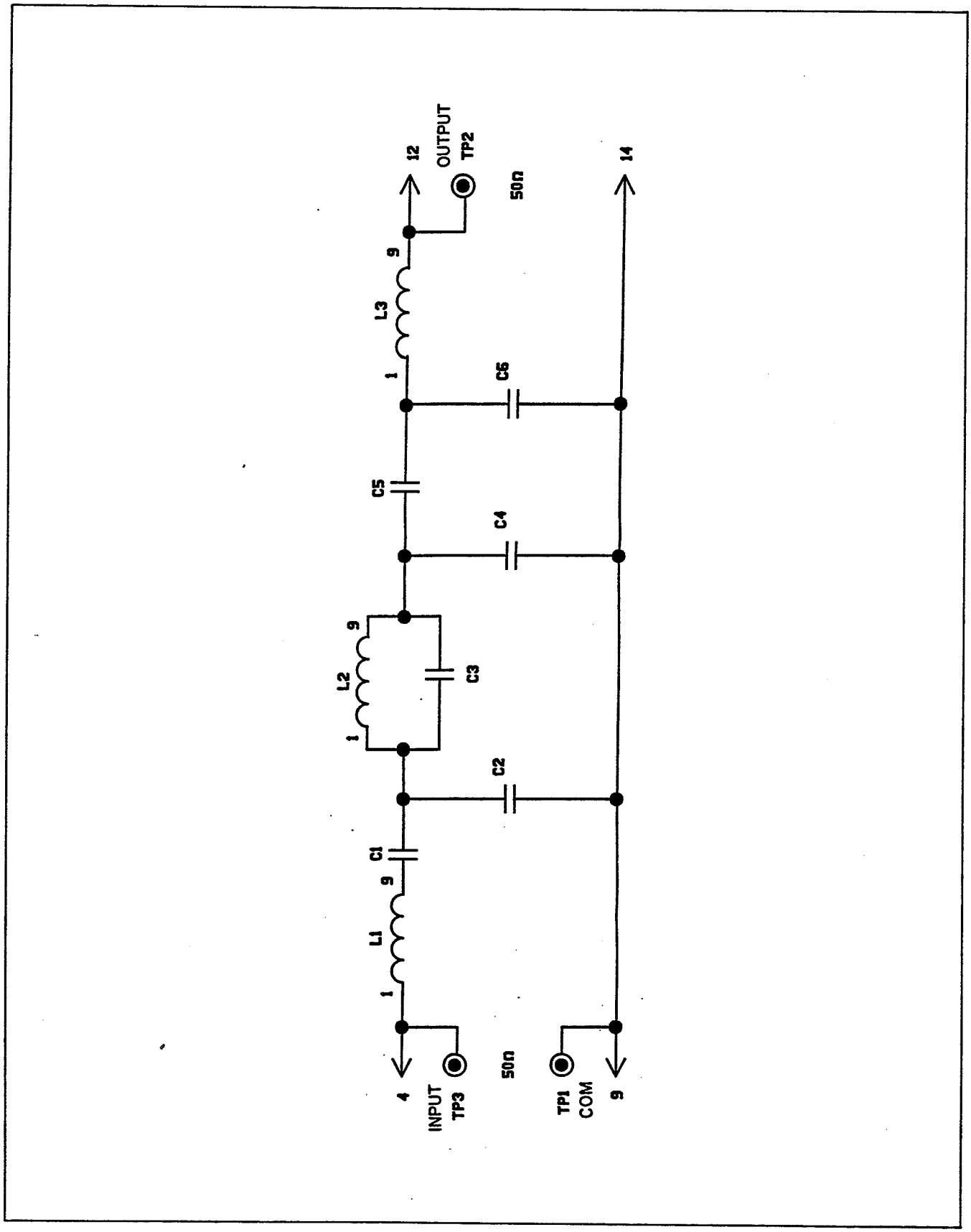
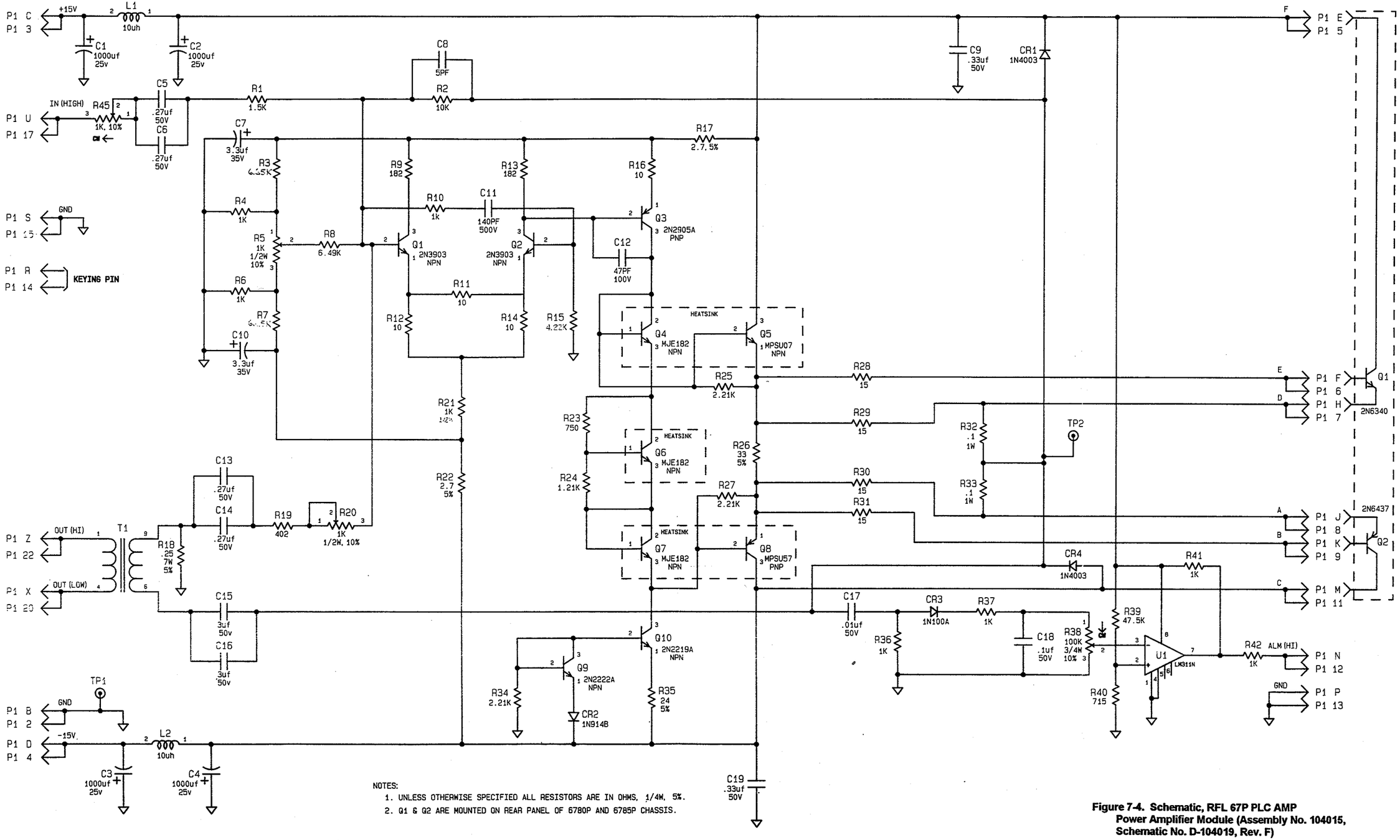


Figure 8-5. Schematic, RFL 67P OUTPUT single-range output filter (392 to 535 kHz) (Assembly No. 104075; Schematic No. B-104079, Rev. A)



NOTES:

1. UNLESS OTHERWISE SPECIFIED ALL RESISTORS ARE IN OHMS, 1/4W, 5%.
2. Q1 & Q2 ARE MOUNTED ON REAR PANEL OF 6780P AND 6785P CHASSIS.

Figure 7-4. Schematic, RFL 67P PLC AMP Power Amplifier Module (Assembly No. 104015, Schematic No. D-104019, Rev. F)

Section 9. RECEIVER DOWNSHIFTER

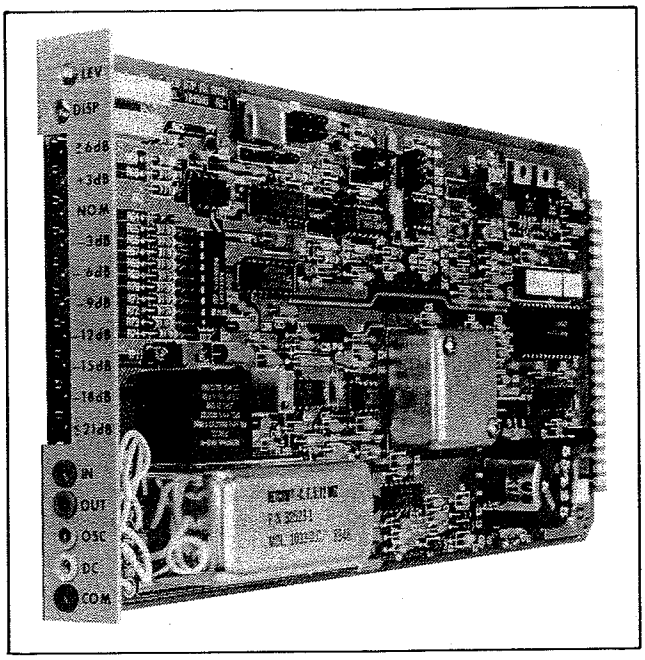


Figure 9-1. RFL 67P RX DNSH Receiver Downshifter Module

9.1. DESCRIPTION

The RFL 67P RX DNSH Receiver Downshifter Module (Fig. 9-1) is used to shift the desired set of incoming frequencies down to a lower range to be further processed by the receiver detector module (para 1.7.6). It also contains a set of DIP switches for programming the desired frequency shift, a level indicator circuit that drives an LED array on the front of the module; this provides a visual indication of the incoming signal level.

9.2. SPECIFICATIONS

As of the date this manual was published, the following specifications apply to the RFL 67P RX DNSH Receiver Downshifter Module. Because all RFL products undergo constant refinement and improvement, these specifications are subject to change without notice.

Frequency Range: 30 kHz to 535 kHz in 500-Hz steps.

Modulation: AM.

Bandwidth: 3700 Hz.

Input Impedance: 75, 1500, 2000, or 8000 ohms. An optional resistor can be placed directly across the receiver port to tailor its impedance.

Nominal Input Level: 10 mVrms.

Minimum Input Level: 5 mVrms.

Output Impedance: 600 ohms.

Output Signal: 24-kHz carrier.

Display Range: 6 dB to -21 dB.

Display Resolution: 3 dB.

Environmental:
Temperature Range: -20°C to +60°C (-4°F to 140°F).
Relative Humidity: Up to 95% at +40°C (+104°F).

Input Power Requirements:
+12-Volt Supply: 220 mA.
-12-Volt Supply: 50 mA.

Dimensions: 4.713 inches high x 10.0 inches deep x 0.875 inches wide (12 cm x 25.4 cm x 2.2 cm); requires three module spaces in chassis.

NOTE

Throughout the following theory of operation discussion, signal names appear in CAPITAL letters. Inverted or active-low signals appear in CAPITAL letters followed by an asterisk (RESERVE*). IC pin numbers are indicated by the device circuit symbol followed by a dash and the pin number (U1-1, U1-2, etc).

9.3. THEORY OF OPERATION

The RFL 67P RX DNSH Receiver Downshifter Module converts the incoming rf signals from their present center frequency to a center frequency of 24 kHz. Its channel filter has a 3700-Hz bandwidth, which will pass the voice sidebands that will be present if the system is equipped with the voice option (Section 11). The RFL 67P RX DNSH contains an attenuator, an input low-pass filter, a crystal oscillator, a synthesizer, an input mixer, a crystal i.f. filter, a product detector, an output modulator, an output amplifier, a display driver

and an LED array. A block diagram of the RFL 67P RX DNSH appears in Figure 9-2.

a. General Description. The RFL 67P RX DNSH accomplishes the frequency shift by first up-converting the incoming signal to an intermediate frequency (if.) of 5.12 MHz. A programmable synthesized local oscillator is used to perform the up-conversion. The signal is then passed through a crystal filter which passes the lower sideband of the 5.12 MHz (3700-Hz wide). Next, the signal is down-converted to a 2-kHz carrier and finally converted to a 24-kHz base frequency (bf.).

An LED array on the front of the RFL 67P RX DNSH module serves as a panel meter, used in the AM system to logarithmically display carrier level. The receiver detector module (Section 10) supplies a dc level proportional to the RFL 67P RX DNSH's 24 kHz output.

b. Crystal Oscillator. Transistor Q1, crystal Y1, varactors CR4 and CR5, and their associated components form a crystal oscillator. This oscillator serves as the beat frequency oscillator (BFO) for the product detector, and the reference frequency for the frequency synthesizer. FREQ ADJ potentiometer R21 adjusts the voltage applied to the junction of CR4 and CR5; this voltage determines the output frequency of the oscillator. For proper module operation, this oscillator is set to 5.12 MHz.

c. Synthesizer. Synthesizer U1 sets the frequency at which the demodulator section will receive inputs. For proper module operation, the frequency programmed into the synthesizer by DIP switches SW1 and SW2 must be 2 kHz below the desired carrier frequency.

The 5.12-MHz output of the crystal oscillator is fed to pin 15 of decade counter U2, which produces a 512-kHz signal at U2-4 and U2-8. This is fed to U1-27, which is the input of the phase-locked loop (PLL). U1 divides the 512-kHz signal by 1024, creating a 500-Hz reference frequency. (This equals the 500-Hz channel spacing which the RFL 67P RX DNSH can provide.) Voltage-controlled oscillator U4, varactor CR3, and their associated components form a tunable voltage controlled oscillator controlled by the PLL. That is, the signal at U1-4 causes the output frequency of U4 (when inputted to U1-1 and divided by a number determined by the pins grounded by the DIP switches SW1 and SW2) to match the 500-Hz reference frequency. Under these conditions, the loop is stable. Capacitors C24 through C29 and resistors R10 through R12 form a 500-Hz notch filter. This filter works to reduce the reference sidebands. Capacitor C51 attenuates very high frequency noise, as well as harmonics of the reference frequency.

d. Input Attenuator. The incoming carrier enters the RFL 67P RX DNSH through edge connector terminals 22/Z (high) and 20/X (low). It passes through a discreet step-adjustable attenuator controls by the settings of DIP switch SW3 before reaching level adjust potentiometer R80. The input attenuator can handle signals as large as 25 volts rms; an optional resistor (with a suitable power rating) may be placed directly across the receiver port for impedance matching or to accommodate a larger input signal.

CR1 and CR2 at the end of the attenuator are surge arresters for moderate voltage spikes that may pass by the higher-powered unit mounted on the rear plate of the chassis. The attenuator factors obtainable by setting SW3 are listed in Table 9-1.

An external resistor can be placed across the receiver port to tailor its impedance or attenuate a signal that is larger than 25 Vrms. If an external resistor is used, make sure its power rating is high enough to handle the voltage dropped across it without overheating.

e. Input Low-Pass Filter. The attenuated input signal is applied to a low-pass filter formed from capacitors C2 through C5 and inductors L1 through L3. This filter removes the image frequency from the receiver mixer. It has a cutoff frequency of 600 kHz.

f. Input Mixer. Mixer U3 takes the input signal and converts it to the 5.12-MHz if. by combining it with the output of the voltage controlled oscillator (VCO) formed from U4 and its associated components. The VCO output is also fed to synthesizer U1. The VCO output frequency is controlled by varactor CR3, which serves as a tuner. Capacitor C27 and resistors R13 and R14 form a filter, which sets the dynamics of this loop.

g. If. Filter. FL101 is a ten-pole crystal filter, which allows the lower 3.7-kHz sideband of the 5.12 MHz if. to pass. It cleans up the output of the if. mixer before it is fed to the if. amplifier.

h. If. Amplifier. Operational amplifier U5 is a high-gain if. amplifier, which boosts the output of the if. filter. U5 supplies most of the gain in the RFL 6785P's receiver section. U5's gain is controlled by GAIN ADJ potentiometer R18. The higher the voltage the lower the gain, to a limit of about 7 volts.

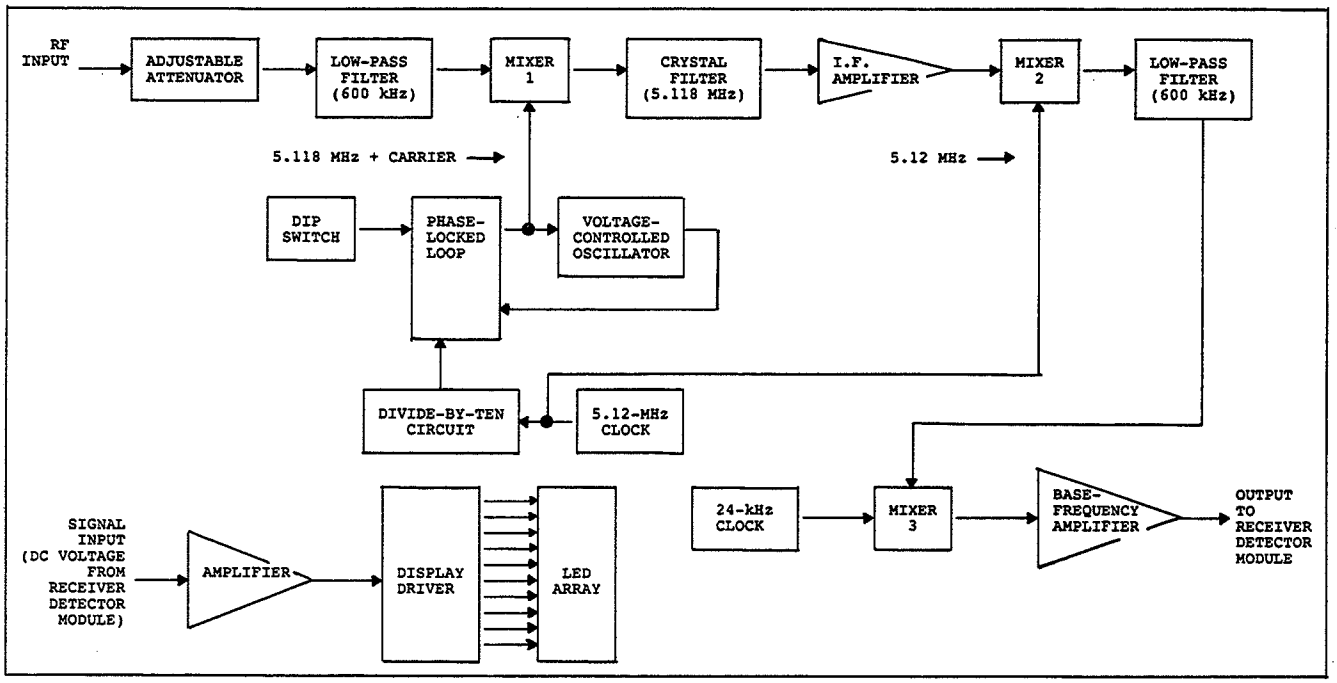


Figure 9-2. Block diagram, RFL 67P RX DNSH Receiver Downshifter Module

Table 9-1. Input attenuator settings, RFL 67P RX DNSH downshifter module

Input Level Range	SW3-1	SW3-2	SW3-3	SW3-4	SW3-5	SW3-6	SW3-7
3.0 V to 23.0 V	OFF	OFF	OFF	ON	OFF	OFF	ON
800 mV to 3.0 V	OFF	OFF	ON	OFF	OFF	OFF	ON
120 mV to 800 mV	OFF	ON	OFF	OFF	OFF	ON	OFF
5 mV to 120 mV *	ON	OFF	OFF	OFF	ON	OFF	OFF

NOTE: This range cannot be used when jumper J2 on the interconnect motherboard is set for two-wire operation (a single coaxial cable between the RFL 6785P and the line tuning equipment). Damage to the downshifter module will result.

i. Product Detector. The output of the if. amplifier (U5-8) is fed to pin 13 of U6, which serves as a product detector. U6 combines the if. signal with the 5.12-MHz crystal oscillator output to produce an audio output signal, consisting of a 2-kHz carrier with upper and lower sidebands if the voice option is present. The output of the product detector is fed to audio transformer T2.

j. Output Modulator. The 2-kHz carrier from the product detector is fed through potentiometer R29 and into the modulator. This modulator converts the 2-kHz signal to a 24-kHz if. signal. The frequency of the local oscillator for U7 (26 kHz) is set 2 kHz above the if. frequency; this is determined by the frequency of crystal Y2 (3.328 MHz), which is divided by 128 by U10. This supplies U7 with a 26-kHz source. The output of the modulator is buffered by U8.

R34 is used to balance the modulator. To adjust R34, the signal normally fed to it through transformer T2 is eliminated by shorting pin U6-13 to ground. Once this is done, R34 is adjusted for a null of less than 10 mVrms at test point TP3 (gray).

k. Display Circuit. The display circuit is built around interface dot/bar display driver U12. U12 drives the LED array, consisting of light-emitting diodes DS1 through DS10. R64, connected to U12-7 and U12-8, sets the LED drive current. Zener diode CR6 and its associated components provides a stable voltage reference for U12, which also serves as the the switch point for DS1, which lights when the incoming signal is +6 dB or greater.

The potential applied to U12-5 must be -4 volts in order to light NOM indicator DS3. Normally, the system

is set up to have the voltage at both TP2 and TP7 the same; that is, to have operational amplifier U11 have unity gain. If necessary, the display may be offset by adjusting MTR NULL potentiometer R63, which adjusts U11's gain.

I. Onboard Regulators. Most of the circuits on the RFL 67 RX DNSH module operate from the +12-volt and -12-volt inputs provided by the RFL 6785P's power supply module (Section 12). Voltage regulator U13 provides a regulated +8-volt source for those circuits that require it, and U14 provides a regulated +5 volts.

Table 9-2. Replaceable parts, RFL 67P RX DNSH Receiver Downshifter Module Assembly No. 104005-1

Circuit Symbol (Fig. 9-3 & 9-4)	Description	Part Number
	CAPACITORS	
C1,6,12,14,15,24, 25,28,29,32-34,37, 42,44,50	Capacitor,X7R ceramic,0.1µF,10%,50V,AVX SA305C104KAA or equiv.	0130 51041
C2	Capacitor,ceramic,470pF,5%,100V,AVX SA101A471JAA or equiv.	0125 14715
C3,4,30	Capacitor,ceramic,0.0012µF,5%,50V,AVX SA205A122JAA or equiv.	0125 51225
C5	Capacitor,ceramic,820pF,5%,50V,AVX SA305A821JAA or equiv.	0125 58215
C7,9,52	Capacitor,X7R ceramic,0.001µF,10%,100V,AVX SA101C102KAA or equiv.	0130 11021
C8,40,41,45	Capacitor,X7R ceramic,0.01µF,10%,50V,AVX SA105C103KAA or equiv.	0130 51031
C10,11,35,36,39	Capacitor,ceramic,0.001µF,5%,100V,AVX SA201A102JAA or equiv.	0125 11025
C13	Capacitor,X7R ceramic,0.01µF,10%,100V,Kemet C320C103K1R5EA or equiv.	1007 1390
C16,20,22,23	Capacitor,dipped ceramic,0.001µF,10%,50V,AVX SR205A102KAA or equiv.	1007 1666
C17	Capacitor,variable,ceramic,5-25pF,Johansen 9374 or equiv.	30129
C18	Capacitor,ceramic,33pF,5%,100V,AVX SA101A330JAA or equiv.	0125 13305
C19,21	Capacitor,dipped ceramic,0.1µF,10%,50V,AVX SR205C104KAA or equiv.	1007 1667
C26	Capacitor,ceramic,0.0015µF,5%,100V,AVX SA301A152JAA or equiv.	0125 11525
C27,38,43,59,63,72-75	Capacitor,tantalum,1µF,20%,35V,Kemet T322B105M035AS or equiv.	1007 496
C31	Capacitor,ceramic,0.0039µF,5%,100V,AVX SA301A392JAA or equiv.	0125 13925
C46,53	Capacitor,ceramic,100pF,5%,100V,AVX SA101A101JAA or equiv.	0125 11015
C47,48	Capacitor,ceramic,150pF,5%,100V,AVX SA101A151JAA or equiv.	0125 11515
C49	Capacitor,ceramic,0.0022µF,5%,100V,AVX SA301A222JAA or equiv.	0125 12225
C51	Capacitor,X7R ceramic,220pF,10%,100V,AVX SA101C221KAA or equiv.	0130 12211
C54,57	Capacitor,tantalum,15µF,20%,20V,Kemet T322D156M020AS or equiv.	1007 716
C55,56,60,61	Capacitor,dipped mica,5pF ±0.5pF,500V, Type DM15	16503
C58	Capacitor,dipped ceramic,0.033µF,20%,50V,radial leads,Kemet C320C333M5U5EA or equiv.	1007 1370
C62	Capacitor,dipped mica,100pF,2%,500V, Type DM15	16600
C64,65	Capacitor,dipped mica,39pF,5%,500V, Type DM15	16513
C66,80	Capacitor,tantalum,2.2µF,20%,25V,Kemet T322B225M025AS or equiv.	1007 645
C67	Capacitor,ceramic,560pF,5%,100V,AVX SA101A561JAA or equiv.	0125 15615
C68,69,77-79,81-83	Capacitor,ceramic,0.1µF,GMV,50V,Centralab CY20C104P or equiv.	1007 1366
C70	Capacitor,X7R ceramic,330pF,10%,100V,AVX SA101C331KAA or equiv.	0130 13311
C71	Capacitor,dipped mica,10pF,5%,500V, Type DM15	16504
C76	Capacitor,ceramic,0.47µF,+80/-20%,50V,Murata RE50-474M or equiv.	1007 939

Table 9-2. Replaceable parts, RFL 67P RX DNSH Receiver Downshifter Module - continued.

Circuit Symbol (Fig. 9-3 & 9-4)	Description	Part Number
	RESISTORS	
R1 (optional)	Resistor,composition,51Ω,5%,1W, Allen-Bradley GB Series or equiv.	1009 317
R2	Resistor,metal film,8.06KΩ,1%,1/4W, Type RN1/4	0410 1375
R3	Resistor,metal film,75.0Ω,1%,1/4W, Type RN1/4	0410 1180
R4	Resistor,composition,2KΩ,5%,1W, Allen-Bradley GB Series or equiv.	1009 8
R5	Resistor,composition,1KΩ,5%,1W, Allen-Bradley GB Series or equiv.	1009 6
R6	Resistor,metal film,383Ω,1%,1/4W, Type RN1/4	0410 1248
R7,78	Resistor,metal film,536Ω,1%,1/4W, Type RN1/4	0410 1262
R8	Resistor,metal film,47.5Ω,1%,1/8W,Type RN55D	1510 707
R9,23	Resistor,metal film,47.5KΩ,1%,1/4W, Type RN1/4	0410 1449
R10,11	Resistor,metal film,3.16KΩ,1%,1/4W, Type RN1/4	0410 1336
R12	Resistor,metal film,1.58KΩ,1%,1/4W, Type RN1/4	0410 1307
R13	Resistor,metal film,7.15KΩ,1%,1/4W, Type RN1/4	0410 1370
R14	Resistor,metal film,4.12KΩ,1%,1/4W, Type RN1/4	0410 1347
R15	Resistor,metal film,226Ω,1%,1/4W, Type RN1/4	0410 1226
R16,42,55,56	Resistor,metal film,604Ω,1%,1/4W, Type RN1/4	0410 1267
R17,48,49	Resistor,metal film,2KΩ,1%,1/4W, Type RN1/4	0410 1317
R18,21	Resistor,variable,12-turn cermet,10KΩ,10%,1/4W,top adjust,Bourns 3266W-1-103 or equiv.	32996
R19	Resistor,metal film,221KΩ,1%,1/4W, Type RN1/4	0410 1513
R20,27,28,60	Resistor,metal film,100KΩ,1%,1/4W, Type RN1/4	0410 1480
R22	Resistor,metal film,3.01KΩ,1%,1/4W, Type RN1/4	0410 1334
R24	Resistor,metal film,200KΩ,1%,1/4W, Type RN1/4	0410 1509
R25	Resistor,metal film,27.4KΩ,1%,1/4W, Type RN1/4	0410 1426
R26	Resistor,metal film,221Ω,1%,1/4W, Type RN1/4	0410 1225
R29	Resistor,variable,12-turn cermet,5KΩ,10%,1/4W,top adjust,Bourns 3266W-1-502 or equiv.	32995
R30	Resistor,metal film,909Ω,1%,1/4W, Type RN1/4	0410 1284
R31,33	Resistor,metal film,10Ω,1%,1/8W,Type RN55D	1510 1092
R32,37,47,54	Resistor,metal film,100Ω,1%,1/4W, Type RN1/4	0410 1192
R34	Resistor,variable,18-turn cermet,200Ω,10%,1/2W,Beckman Helipot 68WR200 or equiv.	96318
R35	Resistor,metal film,301Ω,1%,1/4W, Type RN1/4	0410 1238
R36	Resistor,metal film,6.19KΩ,1%,1/4W, Type RN1/4	0410 1364
R38	Resistor,metal film,1.5KΩ,1%,1/4W, Type RN1/4	0410 1305
R39,41	Resistor,metal film,402Ω,1%,1/4W, Type RN1/4	0410 1250
R40	Resistor,metal film,15Ω,1%,1/8W,Type RN55D	1510 1317
R43	Resistor,metal film,11KΩ,1%,1/4W, Type RN1/4	0410 1388
R44	Resistor,metal film,750Ω,1%,1/4W, Type RN1/4	0410 1276
R45	Resistor,metal film,10.0MΩ,1%,1/4W, Type RN1/4	0410 1672
R46	Resistor,metal film,2.21KΩ,1%,1/4W, Type RN1/4	0410 1321

Table 9-2. Replaceable parts, RFL 67P RX DNSH Receiver Downshifter Module - continued.

Circuit Symbol (Fig. 9-3 & 9-4)	Description	Part Number
	RESISTORS - continued.	
R50,61	Resistor,metal film,10KΩ,1%,1/4W, Type RN1/4	0410 1384
R51,62,65-74	Resistor,metal film,1KΩ,1%,1/4W, Type RN1/4	0410 1288
R52	Resistor,metal film,18.7KΩ,1%,1/4W, Type RN1/4	0410 1410
R53	Resistor,metal film,5.11KΩ,1%,1/4W, Type RN1/4	0410 1356
R57,58	Resistor,composition,2.2Ω,5%,1/2W, Allen-Bradley EB Series or equiv.	1009 1059
R59	Resistor,metal film,4.99KΩ,1%,1/4W, Type RN1/4	0410 1355
R63	Resistor,variable,15-turn cermet,25KΩ,10%,3/4W,Beckman Helipot 89PR25K or equiv.	96717
R64	Resistor,metal film,806Ω,1%,1/4W, Type RN1/4	0410 1279
R75	Resistor,metal film,17.8KΩ,1%,1/4W, Type RN1/4	0410 1408
R76	Resistor,metal film,4.87KΩ,1%,1/4W, Type RN1/4	0410 1354
R77	Resistor,metal film,499Ω,1%,1/4W, Type RN1/4	0410 1259
R80	Resistor,variable,15-turn cermet,100Ω,10%,3/4W,Beckman Helipot 89PHR100 or equiv.	46901
	SEMICONDUCTORS	
CR1,2	Transient suppressor,7.22 to 7.98 V_{BR},General Semiconductor LCD 6.5A or equiv.	99697
CR3	Diode,varactor,26-32pF,Motorola MV209 or equiv.	32509
CR4,5	Diode,varactor,400-520pF,Motorola MVAM109 or equiv.	32598
CR6	Diode,Zener,10V,5%,400mW,1N961B	34874
DS1,7-10	Light-emitting diode,red,right-angle PC mount,Hewlett-Packard HLMP-5030 or equiv.	98534
DS2-4	Light-emitting diode,green,right-angle PC mount,Hewlett-Packard HLMP-5050 or equiv.	99799
DS5,6	Light-emitting diode,amber,right-angle PC mount,Hewlett-Packard HLMP-5040 or equiv.	99798
Q1	Transistor,NPN Darlington,TO-92 case,2N918	46541
U1	MOS frequency synthesizer,28-pin DIP,Motorola MC145151P or equiv.	0615 198
U2	MOS dual 4-bit decade counter,16-pin DIP,National Semiconductor MM74HC390N or equiv.	0615 252
U3,6	Linear mixer,16-pin DIP,Plessey SL 6440C/DP or equiv.	0620 250
U4	Voltage-controlled oscillator,14-pin DIP,Motorola M1648P or equiv.	0690 3
U5	Linear i.f. amplifier,8-pin DIP,Motorola MC1350P or equiv.	0620 251
U7	Linear balanced modulator/demodulator,14-pin ceramic DIP,Motorola MC1596L or equiv.	0620 331
U8	Linear operational amplifier,8-pin DIP,National Semiconductor LM318N or equiv.	0620 126
U9	MOS hex inverter,high-speed,16-pin DIP,Signetics HEF4049BP or equiv.	0615 248
U10	MOS 12-stage binary counter,16-pin DIP,Signetics HEF4040BP or equiv.	0615 258
U11	Linear operational amplifier,JFET input,8-pin DIP,Texas Instruments TL082IP or equiv.	0620 227
U12	Dot/bar display driver,18-pin DIP,National Semiconductor LM3915N or equiv.	0680 7
U13	Linear voltage regulator,+8-volt,3-terminal TO-220 package,Motorola MC7808CT or equiv.	0620 141
U14	Linear voltage regulator,+5-volt,3-terminal plastic package,Motorola MC7805CP or equiv.	0620 77

Table 9-2. Replaceable parts, RFL 67P RX DNSH Receiver Downshifter Module - continued.

Circuit Symbol (Fig. 9-3 & 9-4)	Description	Part Number
	MISCELLANEOUS COMPONENTS	
FL101	Filter,crystal,5.12 MHz	32523 2
L1-3	Inductor,rf,molded,180µH,10%,Gowanda 10/183 or equiv.	32505 2
L4,8	Inductor,molded,33µH,10%,130mA,ferrite core, Jeffers Electronics Type 09 1326-1K or equiv.	32868
L5,7	Inductor,variable,1.4µH nominal,Coilcraft SLOT TEN-5-01 or equiv.	32977
L6	Shielded inductor assembly	96955
L9	Inductor,rf,molded,100µH,10%,Gowanda 10/103 or equiv.	32505 1
L10	Inductor,molded,220µH,5%,Dale Electronics IM-4 or equiv.	46598
SW1,3	Switch array,eight SPST switches,16-pin DIP,Grayhill 90B08S or equiv.	98493
SW2	Switch array,four SPST switches,8-pin DIP,Grayhill 90B04S or equiv.	98492
T1	Transformer,bridging	55725
T2	Transformer,audio,4000Ω primary,600Ω center-tapped secondary, 200-15,000-Hz frequency response,PC mount,Microtran MMT11-M or equiv.	30134
Y1	Crystal,quartz,5.12 Mhz,0.002%,-30°C to +60°C,International Crystal 433575 or equiv.	93637
Y2	Crystal,quartz,3.3280 MHz	99215 6

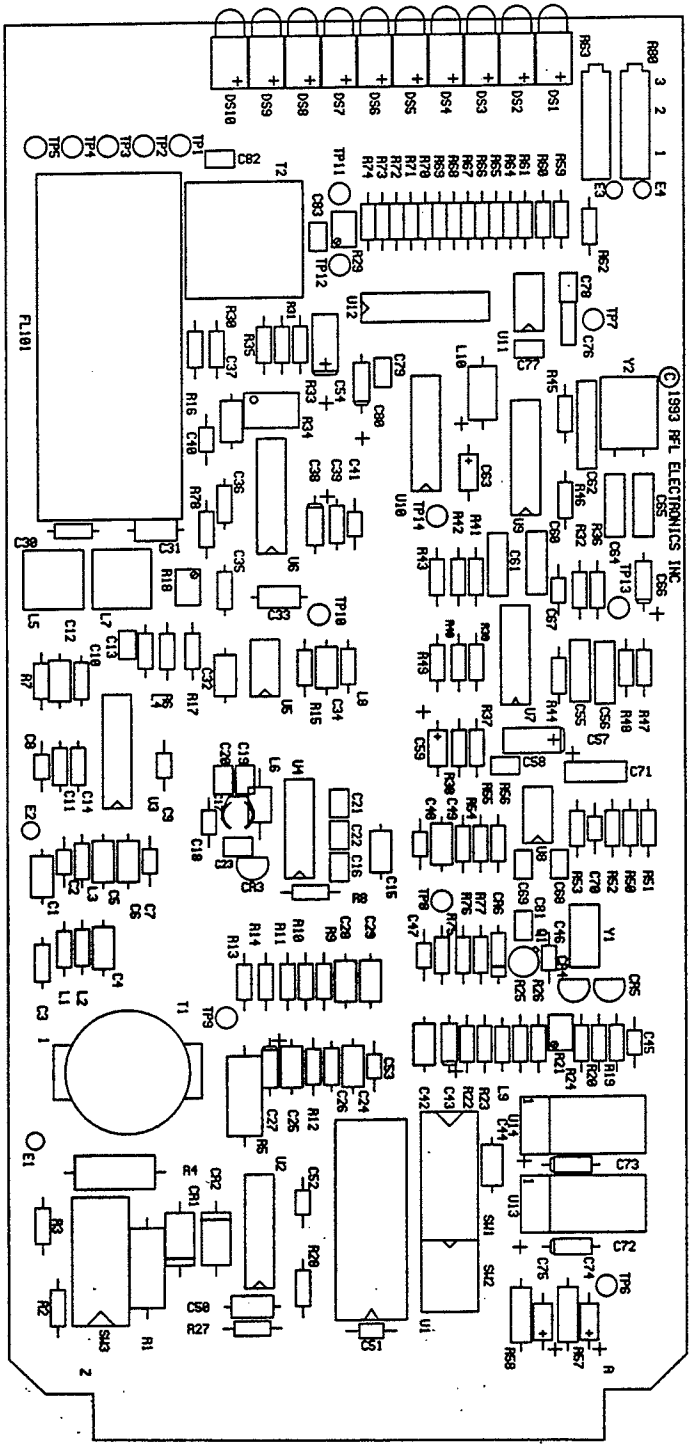


Figure 9-3. Component locator drawing, RFL 67P RX DNSH Receiver Downshifter Module (Assembly No. 104005; Circuit Board No. D-104008, Rev. E)

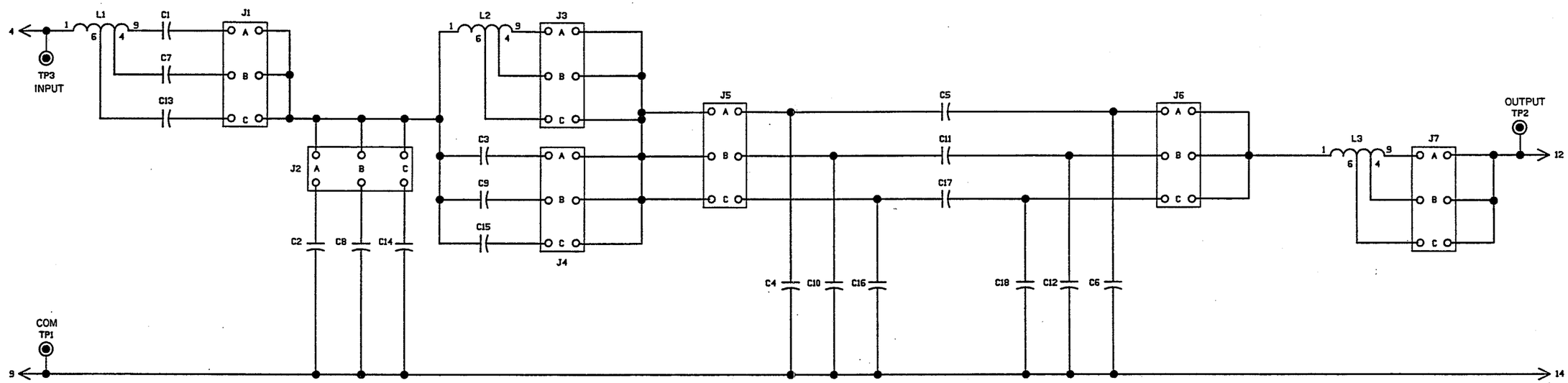


Figure 8-3. Schematic, RFL 67P OUTPUT multiple-range output filters (Assembly No. 104070-X; Schematic No. D-104074, Rev. A)

INPUT LEVEL SWITCH POSITIONS (SW3) CLOSED

INPUT LEVEL		SW3
23.0V	TO 3.0V	4 | 7
3.0V	TO 800MV	3 | 7
800MV	TO 120MV	2 | 6
120MV	TO 5MV	1 | 5

SW1 - DIP SPST 8 POS
SW2 - DIP SPST 4 POS

NOTES:

1. UNLESS OTHERWISE SPECIFIED ALL RESISTORS ARE IN OHMS, 1/8W, 1% .
2. P.M. DENOTES PANNEL MOUNT .
3. * C46 MAY REQUIRE FACTORY SELECT VALUE.

Figure 9-4. Schematic, RFL 67P RX DNSH Receiver Downshifter Module (Assembly No. 104005, Schematic No. D-104009, Rev. J)

Section 10. RECEIVER DETECTOR

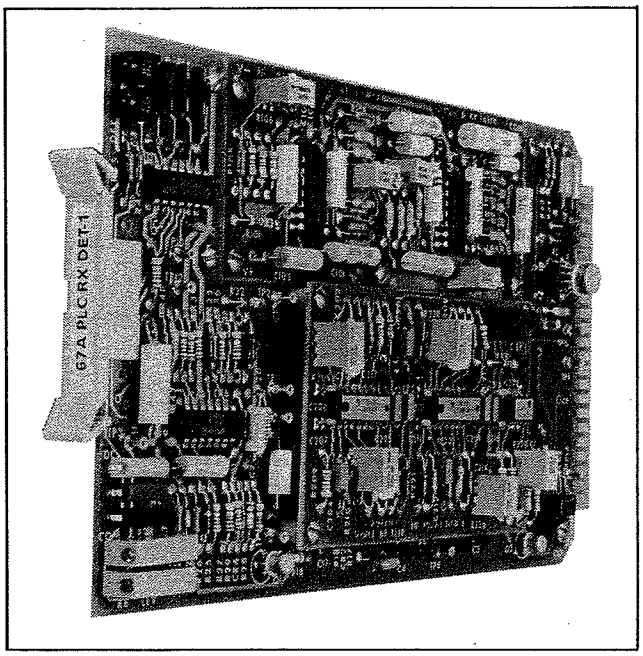


Figure 10-1. Typical RFL 6785P receiver detector module

NOTE

Throughout this section, signal names appear in CAPITAL letters. Inverted or active-low signals appear in CAPITAL letters followed by an asterisk (RESERVE*). IC pin numbers are indicated by the device circuit symbol followed by a dash and the pin number (U1-1, U1-2, etc).

10.1. DESCRIPTION

RFL 6785P receiver detector modules accept the signal produced by the receiver downshifter module (Section 9), and amplifies it. It then decides whether or not a block is being requested, based on the incoming signal strength. A timer/shutdown circuit enables the local receiver to energize whenever the local transmitter is keyed. A typical receiver detector module is shown in Figure 10-1.

There are two different RFL 6785P receiver detector modules. RFL 67A PLC RX DET modules are used in terminals that are not equipped for voice transmission. RFL 67A PLC RX DET-1 modules are equipped with a voice bandpass filter and voice muting circuit, and are used in terminals equipped with the optional voice module (Section 11).

10.2. THEORY OF OPERATION

RFL 6785P receiver detector modules are used to determine whether or not the RFL 6785P system is in a block state. This determination is based on the amount of energy within the proper frequency band coming from the receiver downshifter module (Section 9). The following circuit description applies to all RFL 6785P receiver detector modules. The portion covering the voice circuits only applies to RFL 67A PLC RX DET-1 modules. A block diagram of the RFL 6785P receiver detector modules appears in Figure 10-2, with a schematic appearing in Figure 10-7 at the end of the section.

Figure 10-8 is a schematic for the co-planar if. bandpass filter used on all RFL 6785P receiver downshifter modules, and Figure 10-9 is a schematic for the plug-on voice bandpass filter used on RFL 67A PLC RX DET-1 modules.

NOTE

The plug-on voice bandpass filter is only used on RFL 67A PLC RX DET-1 modules. This filter contains five potentiometers; only one of these potentiometers (R229) can be adjusted in the field, using the instructions given in Section 3 of this manual. Any attempts to adjust the other potentiometers on the voice bandpass filter may result in voice degradation.

a. Voice Bandpass Filter. The voice bandpass filter accepts the signal output from the receiver downshifter module and passes the portion of the band containing voice on to the voice adapter module (Section 11).

CAUTION

The if. bandpass filter contains many frequency-dependent components, and none of its parts are field-replaceable. If any attempts are made to repair this assembly, its operating characteristics will be altered, and system malfunctions may occur.

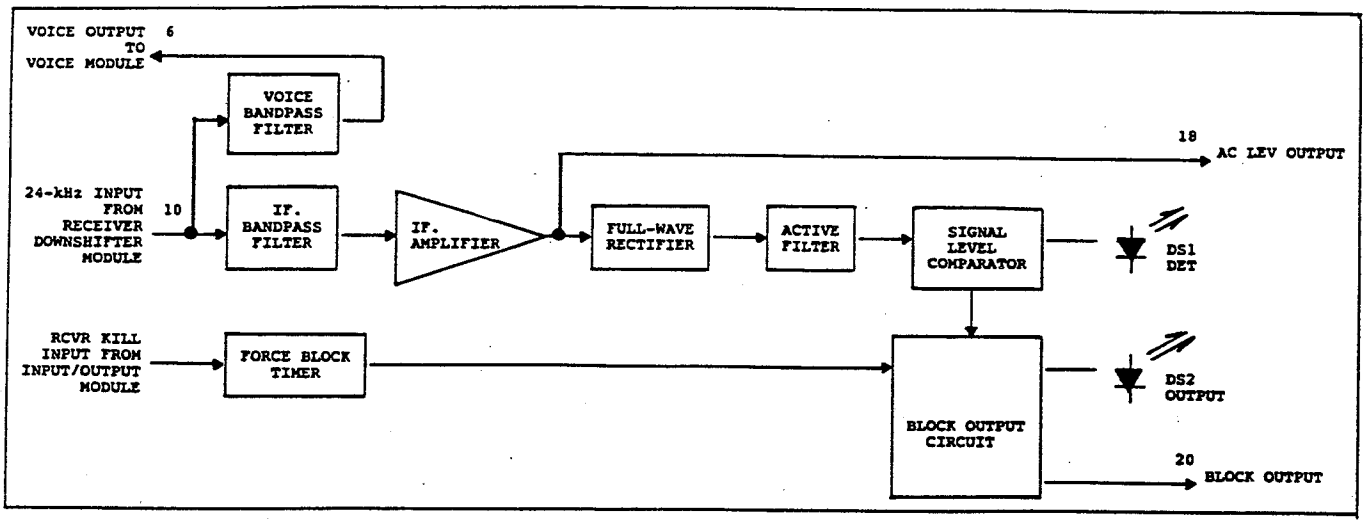


Figure 10-2. Block diagram, RFL 6785P receiver detector modules

The signal produced by the receiver downshifter module is present on edge connector terminal 8, and can be measured at test point TP15. This is passed through connector P1-1 to the input of the voice bandpass filter The output of the voice bandpass filter is passed back through P1-4 to the the main circuit board, and can be measured at test point TP16. Figure 10-3 shows the frequency response curve for the voice bandpass filter.

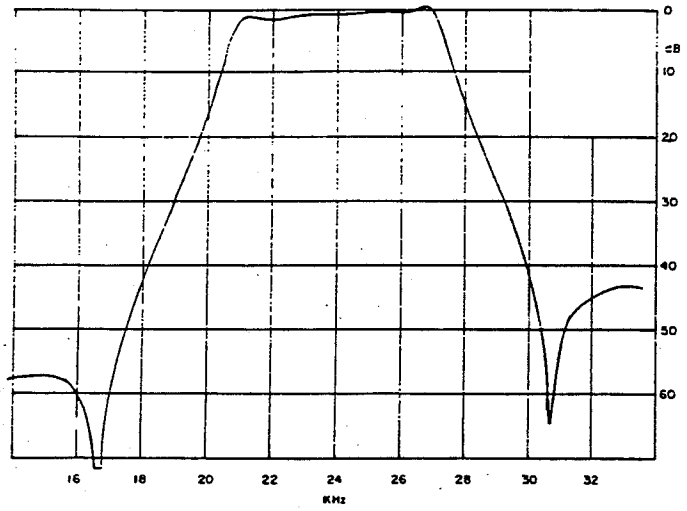


Figure 10-3. Frequency response curve for voice bandpass filter used on RFL 67A PLC RX DET-1 receiver detector module

Resistors R42 through R44 form a voltage divider for the output of the voice bandpass filter. Jumper J2 sets the gain for the AGC control circuit on the voice module by connecting IC3-8 to different places on the voltage divider; this determines how much signal is passed on to the voice module through edge connector terminal 6 when IC3 is closed.

b. If. Bandpass Filter. The signal applied to the receiver detector module through edge connector terminal 10 is identical to the signal applied to the voice circuits on RFL 67A PLC RX DET-1 modules. This signal contains noise and unwanted signals created by the difference between the incoming carrier frequency and the harmonics generated by the receiver downshifter module's local oscillator. These must be removed before the signal can be processed further.

The if. bandpass filter is an active filter that removes all unwanted frequencies near 24 kHz. The filter assembly is contained on a circuit board that is installed on the receiver detector module in the same plane as the main circuit board. Three different filters (with bandwidths of 500, 1000, and 1500 Hz) are used with the receiver detector module, depending on the system bandwidth; frequency response curves for these filters are shown in Figures 10-4 through 10-6. Each filter produces an output that is a clean 24-kHz sine wave.

c. If. Signal Amplification, Rectification, And Filtering. The output of the if. bandpass filter is amplified by operational amplifiers IC1 and IC2. AC LEV potentiometer R8 controls the gain of IC2; this compensates for gain variations in the if. bandpass filter. The output of IC2 (IC2-6) becomes the AC LEV output, available at test point TP7 and edge connector terminal 18. This signal is also fed to an active full-wave rectifier and two-pole Butterworth filter, formed from dual operational amplifier IC5 and its associated components. The filter cutoff frequency is 10 kHz, and

its output (IC5-7) is a smooth dc voltage that is passed on to the signal level comparator.

d. Signal Level Comparator. Two amplifiers in quad operational amplifier IC6 serve as a signal level comparator. The first amplifier (IC6-5 and IC6-6 in, IC6-7 out) provides additional filtering for the output of the active Butterworth filter. The other amplifier (IC6-2 and IC6-3 in, IC6-1 out) compares the filter output to a reference voltage set by Zener diode CR3 and DET LEV potentiometer R24. The filter output voltage can be measured at test point TP9 (yellow), and the DET LEV reference voltage can be measured at test point TP3.

Because IC6 is a bipolar device, the signal at IC6-1 will vary between +12 and -12 volts. The -12-volt level is too low for the circuits that follow, so it is used to drive the base of transistor Q1, which is connected as an emitter-follower. The result is a signal that is a +12 volts when a signal is present, and zero volts when no signal is present. This signal is applied to pin 1 of Exclusive-OR gate IC4. When jumper J1 is in the BLK position, IC4 acts as a buffer; when it is in the UNBLK position, IC4 inverts the signal before it is passed on. In order for the RFL 6785P system to function properly, jumper J4 must be placed in the BLK position.

The output of IC4 is applied to pin 9 of operational amplifier IC6. When an incoming signal is detected and the signal at IC4-3 falls to zero, IC6-8 goes high and DET indicator DS1 lights. When the incoming signal is no longer detected and IC4-3 goes high, IC6-8 changes state and DS1 goes out. The signal at IC6-8, which is passed on to the block output circuit, can be monitored at test turret TP11.

e. Force Block Timer. Capacitor C11, resistors R47 through R51 and R53, diode CR9, and the fourth amplifier in IC6 (IC6-12 and IC6-13 in, IC6-14 out) serve as the force block timer. It is driven by an Exclusive-OR gate in IC4 (IC4-8 and IC4-9 in, IC4-10 out), which receives its input from edge connector terminal 13. This is the RCVR KILL output from the input/output module (Section 5). When a kill command is received, IC4-10 goes low, discharging C11 through R47.

As soon as C1 charges, IC6-14 will change state, sending a logic high to the block output circuit. When the RCVR KILL signal goes inactive, IC4-10 goes high, charging C11. When C11 charges, IC6-14 will change state again. The entire process takes about 3 ms, and can be monitored at test turret TP13.

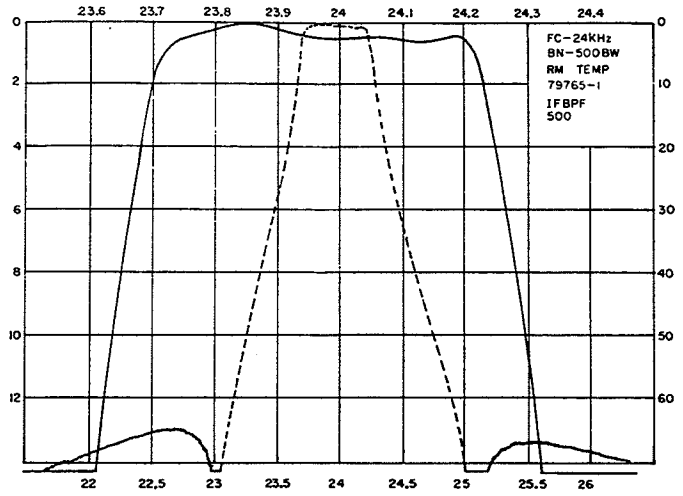


Figure 10-4. Frequency response curve for if. bandpass filter with 500-Hz bandwidth

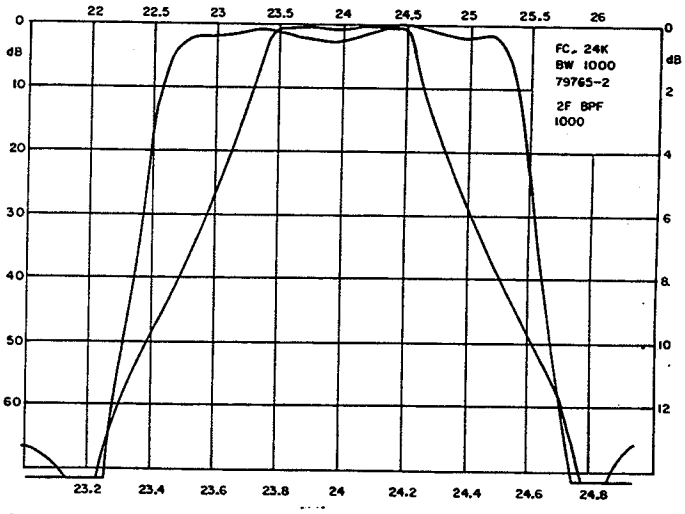


Figure 10-5. Frequency response curve for if. bandpass filter with 1000-Hz bandwidth

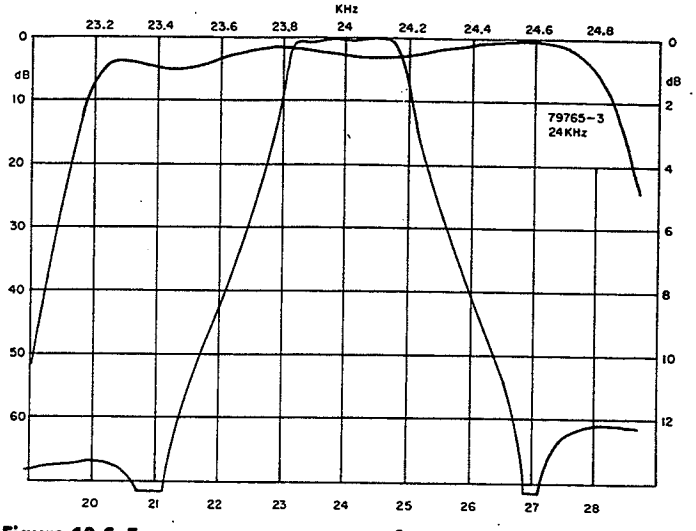


Figure 10-6. Frequency response curve for if. bandpass filter with 1500-Hz bandwidth

f. Block Output Circuit. The outputs of the signal level comparator and the force block timer are applied to an OR gate formed from diodes CR7 and CR10, and resistors R37, R38, and R52. The output of this gate drives the base of transistor Q2. The collector of Q2 drives Darlington transistor Q3, which produces a block output at edge connector terminal 20.

Table 10-1. Replaceable parts, RFL 6785P receiver detector modules
RFL 67A PLC RX DET (standard module) - Assembly No. 99015-2
RFL 67A PLC RX DET-1 (standard module plus Voice Bandpass Filter) - Assembly No. 99015-3

Circuit Symbol (Fig. 10-7)	Description	Part Number
C1,2	Capacitor,tantalum,6.8µF,20%,35V,Kemet T322D685M035AS or equiv.	1007 655
C3,4	Capacitor,dipped mica,150pF,2%,500V, Type DM15	16608
C5	Capacitor,ceramic,0.47µF,+80/-20%,50V,Murata RE50-474M or equiv.	1007 939
C6	Capacitor,polyester,0.001580µF,1%,100V,F-Dyne PST-11-.001580-100-1 or equiv.	5115 311
C7	Capacitor,polypropylene,0.0022µF,2%,100V,F-Dyne PPA-11-.0022-100-2 or equiv.	0105 62
C8	Capacitor,polyester,0.00115µF,2%,400V,F-Dyne PST-11-.00115-400-2 or equiv.	5115 277
C10,12-20	Capacitor,ceramic,0.1µF,GMV,50V,Centralab CY20C104P or equiv.	1007 1366
C11	Capacitor,polyester,0.0285µF,2%,100V,Wesco 32P or equiv.	5115 56
CR1,2,4,6-10	Diode,silicon,1N914B or 1N4448	26482
CR3	Diode,Zener,8.2V,5%,400mW,1N756A	37441
CR5	Resistor,zero-ohm,1/4-watt size,Corning OMA07 or equiv.	1510 2217
DS1,2	Light-emitting diode,red,Dialight 550-0102 or equiv.	39568
IC1,2	Linear operational amplifier,8-pin DIP,National Semiconductor LM318N or equiv.	0620 126
IC3	MOS dual analog switch,SPST,10-pin TO-100 case,Siliconix DG200BA or equiv.	0605 3
IC4	MOS quad Exclusive-OR gate,14-pin DIP,Motorola MC14070BCP or equiv.	0615 69
IC5	Linear operational amplifier,JFET input,8-pin DIP,Texas Instruments TL082CP or equiv.	0620 155
IC6	Linear quad operational amplifier,JFET input,14-pin DIP,Texas Instruments TL084CN or equiv.	0620 151
Q1,2	Transistor,NPN,TO-18 case,2N2222A	44178
Q3	Transistor,PNP Darlington,Motorola MPS-U95 (case 152-02) or equiv.	47509
R1,2	Resistor,composition,2.7Ω,5%,1/4W, Allen-Bradley CB Series or equiv.	1009 900
R3	Resistor,metal film,604Ω,1%,1/4W, Type RN1/4	0410 1267
R4,7,25,36,41	Resistor,metal film,2KΩ,1%,1/4W, Type RN1/4	0410 1317
R5	Resistor,metal film,8.06KΩ,1%,1/4W, Type RN1/4	0410 1375
R6,9,12-15,19-21,27, 29,33,34,37,50-52	Resistor,metal film,10KΩ,1%,1/4W, Type RN1/4	0410 1384
R8	Resistor,variable,15-turn cermet,10KΩ,10%,3/4W,Beckman Helipot 89PHR10K or equiv.	39539
R10,30	Resistor,metal film,20KΩ,1%,1/4W, Type RN1/4	0410 1413
R11,17,18,28,38,39	Resistor,metal film,4.99KΩ,1%,1/4W, Type RN1/4	0410 1355
R16	Resistor,metal film,100Ω,1%,1/4W, Type RN1/4	0410 1192
R22	Resistor,metal film,698Ω,1%,1/4W, Type RN1/4	0410 1273
R23	Resistor,metal film,15.4KΩ,1%,1/4W, Type RN1/4	0410 1402
R24	Resistor,variable,15-turn cermet,5KΩ,10%,3/4W,Beckman Helipot 89PHR5K or equiv.	39538
R26	Resistor,metal film,1.0MΩ,1%,1/4W, Type RN1/4	0410 1576

Table 10-1. Replaceable parts, RFL 6785P receiver detector modules - continued.

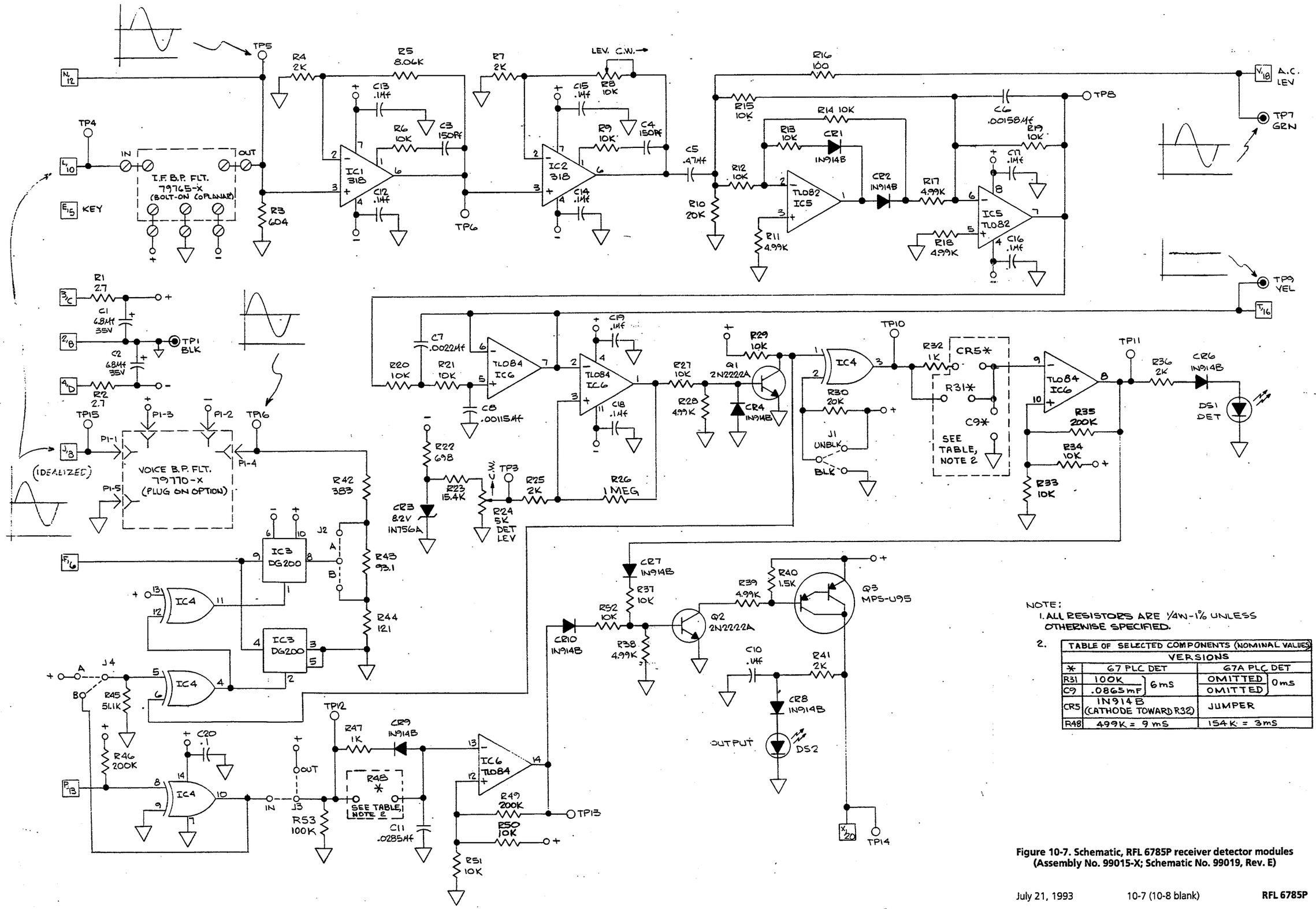
Circuit Symbol (Fig. 10-7)	Description	Part Number
R32,47	Resistor,metal film,1KΩ,1%,1/4W, Type RN1/4	0410 1288
R35,46,49	Resistor,metal film,200KΩ,1%,1/4W, Type RN1/4	0410 1509
R40	Resistor,metal film,1.5KΩ,1%,1/4W, Type RN1/4	0410 1305
R42	Resistor,metal film,383Ω,1%,1/4W, Type RN1/4	0410 1248
R43	Resistor,metal film,93.1Ω,1%,1/4W, Type RN1/4	0410 1189
R44	Resistor,metal film,121Ω,1%,1/4W, Type RN1/4	0410 1200
R45	Resistor,metal film,51.1KΩ,1%,1/4W, Type RN1/4	0410 1452
R48	Resistor,metal film,154KΩ,1%,1/4W, Type RN1/4	0410 1498
R53	Resistor,metal film,100KΩ,1%,1/4W, Type RN1/4	0410 1480
. . .	Shorting bar,single,Aries LP300 or equiv.	42904

NOTE

The co-planar if. bandpass filter (Assembly No. 79765-X) contains no field-replaceable components. If the filter is defective, contact the factory for replacement information. A schematic for the if. bandpass filter is shown in Figure 10-8 for reference only.

Table 10-2. Replaceable parts, voice bandpass filter (RFL 67A PLC RX DET-1 only)
Assembly No. 79770-1

Circuit Symbol (Fig. 10-9)	Description	Part Number
C201,204,205	Capacitor,ceramic DIP,2700pF,5%,50V,AVX MD015A272JAA or equiv.	0120 30
C202,203	Capacitor,ceramic DIP,1500pF,2%,50V,AVX MD015A152GAA or equiv.	0120 27
C206,207,210,211, 215,216	Capacitor,ceramic,0.1μF,GMV,50V,Centralab CY20C104P or equiv.	1007 1366
C208,209,212,213	Capacitor,ceramic DIP,1800pF,5%,50V,AVX MD015A182JAA or equiv.	0120 28
C214	Capacitor,ceramic DIP,270pF,2%,50V,AVX MD015A271JAA or equiv.	0120 18
C217	Capacitor,dipped mica,28.5pF,5%,500V, Type DM15	1080 326
IC201,202	Linear operational amplifier,JFET input,14-pin DIP,Texas Instruments TL084CN or equiv.	0620 151
IC203	Linear operational amplifier,JFET input,8-pin DIP,Texas Instruments TL082CP or equiv.	0620 155
R201	Resistor,metal film,487Ω,1%,1/4W, Type RN1/4	0410 1258
R202	Resistor,metal film,2.55KΩ,1%,1/4W, Type RN1/4	0410 1327
R203,204	Resistor,metal film,4.75KΩ,1%,1/4W, Type RN1/4	0410 1353
R205,217,218	Resistor,metal film,4.32KΩ,1%,1/4W, Type RN1/4	0410 1349
R206,220,226	Resistor,variable,18-turn cermet,1KΩ,10%,1/2W,Beckman Helipot 68XR1K or equiv.	91952
R207	Resistor,metal film,2.37KΩ,1%,1/4W, Type RN1/4	0410 1324
R208	Resistor,metal film,5.49KΩ,1%,1/4W, Type RN1/4	0410 1359
R209	Resistor,metal film,2.74KΩ,1%,1/4W, Type RN1/4	0410 1330
R210,216	Resistor,metal film,2.8KΩ,1%,1/4W, Type RN1/4	0410 1331
R211	Resistor,metal film,2.49KΩ,1%,1/4W, Type RN1/4	0410 1326
R212	Resistor,variable,18-turn cermet,500Ω,10%,1/2W,Beckman Helipot 68XR500 or equiv.	91951
R213	Resistor,metal film,2.87KΩ,1%,1/4W, Type RN1/4	0410 1332
R214	Resistor,metal film,11.5KΩ,1%,1/4W, Type RN1/4	0410 1390
R215,225	Resistor,metal film,3.83KΩ,1%,1/4W, Type RN1/4	0410 1344
R219	Resistor,metal film,3.74KΩ,1%,1/4W, Type RN1/4	0410 1343
R221	Resistor,metal film,14.7KΩ,1%,1/4W, Type RN1/4	0410 1400
R222	Resistor,metal film,8.25KΩ,1%,1/4W, Type RN1/4	0410 1376
R223,224	Resistor,metal film,4.22KΩ,1%,1/4W, Type RN1/4	0410 1348
R227,230	Resistor,metal film,10KΩ,1%,1/4W, Type RN1/4	0410 1384
R228	Resistor,metal film,1KΩ,1%,1/4W, Type RN1/4	0410 1288
R229	Resistor,variable,18-turn cermet,50KΩ,10%,1/2W,Beckman Helipot 68PR50K or equiv.	91956



NOTE:

1. ALL RESISTORS ARE ¼W-1% UNLESS OTHERWISE SPECIFIED.
2.

TABLE OF SELECTED COMPONENTS (NOMINAL VALUES)		
	VERSIONS	
*	67 PLC DET	67A PLC DET
R31	100K (6 ms)	OMITTED (0 ms)
C9	.0865 mF (6 ms)	OMITTED (0 ms)
CR5	IN914B (CATHODE TOWARD R32)	JUMPER
R48	499K = 9 ms	154K = 3 ms

Figure 10-7. Schematic, RFL 6785P receiver detector modules (Assembly No. 99015-X; Schematic No. 99019, Rev. E)

NOTES:

1. ALL RESISTORS ARE 1/4W 1% UNLESS OTHERWISE SPECIFIED.
2. ALL CAPACITORS ARE IN uf UNLESS OTHERWISE SPECIFIED.

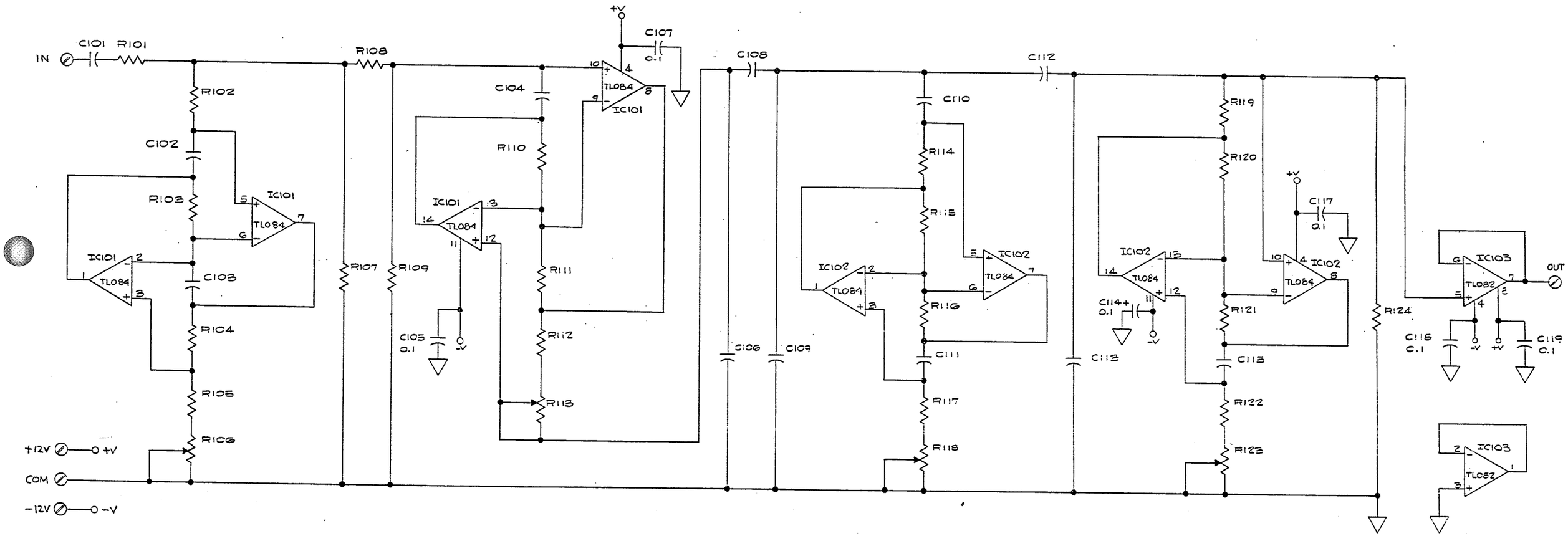
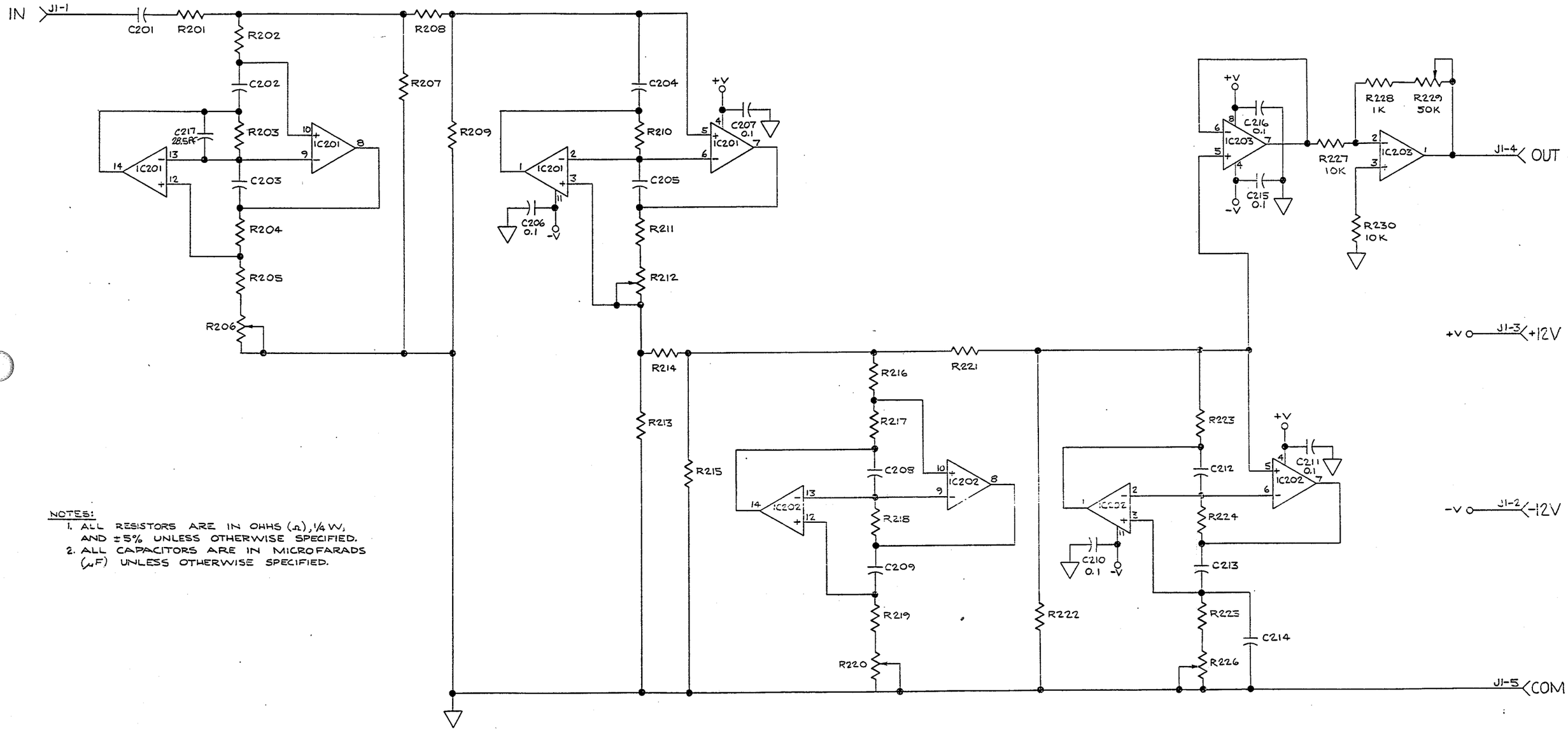


Figure 10-8. Schematic, if. bandpass filters for RFL 6785P receiver detector modules (Assembly No. 79765-X; Schematic No. 79769, Rev. A)



NOTES:
1. ALL RESISTORS ARE IN OHMS (Ω), 1/4 W, AND ±5% UNLESS OTHERWISE SPECIFIED.
2. ALL CAPACITORS ARE IN MICROFARADS (μF) UNLESS OTHERWISE SPECIFIED.

Figure 10-9. Schematic, voice bandpass filter for RFL 67A PLC RX DET-1 Receiver Detector Modules (Assembly No. 79770-1; Schematic No. 79774, Rev. B)

Section 11. VOICE MODULE

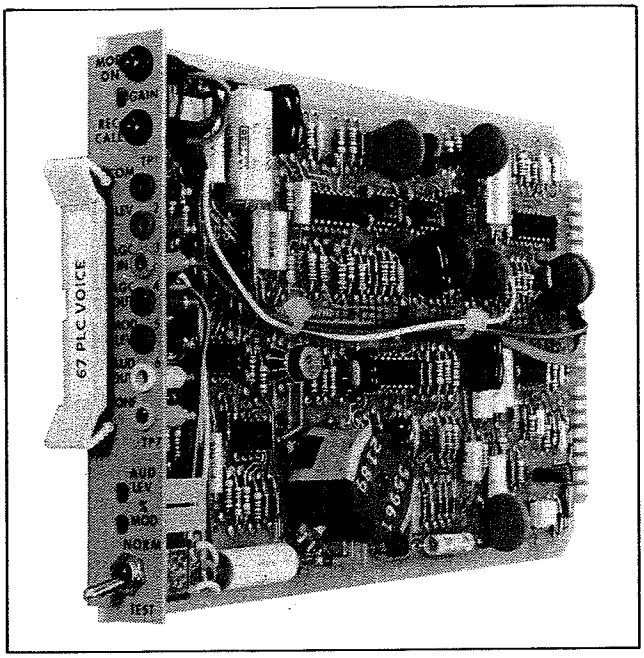


Figure 11-1. RFL 67 PLC VOICE Voice Adapter Module

NOTE

Throughout this section, signal names appear in CAPITAL letters. Inverted or active-low signals appear in CAPITAL letters followed by an asterisk (RESERVE*). IC pin numbers are indicated by the device circuit symbol followed by a dash and the pin number (IC1-1, IC1-2, etc).

11.1. DESCRIPTION

The optional RFL 67PLC VOICE Voice Adapter Module (Fig. 11-1) contains a voice transmitter, a signaling tone oscillator for sending signaling tones, a signaling tone detector for receiving tones, and a voice receiver. When the RFL 6785P terminals at both ends of a protected line are equipped with voice adapter modules (and the other components that comprise the Voice Option), two-way voice communications can occur between the stations without the need for a telephone hook-up; the voice signals will be injected onto the powerline carrier.

11.2. SPECIFICATIONS

As of the date this manual was published, the following specifications apply to the RFL 67 PLC VOICE Voice Adapter Module. Because all RFL products undergo constant refinement and improvement, these specifications are subject to change without notice.

Dynamic Range: 30 dB.

Input Signal: See Figure 11-2.

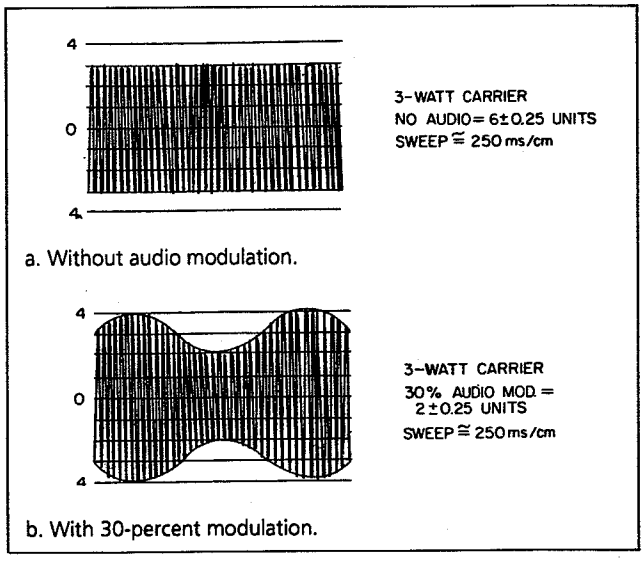


Figure 11-2. Input signal from transmitter module, RFL 67 PLC VOICE Voice Adapter Module

Frequency Response: See Figures 11-3 through 11-5.

Environmental:

Temperature Range: -20°C to +60°C (-4°F to +140°F).

Relative Humidity: Up to 95% at +40°C (+104°F).

Input Power Requirements:

+12-Volt Supply: 95 mA.

-12-Volt Supply: 60 mA.

Dimensions: 4.713 inches high x 8.0 inches deep x 0.875 inches wide (12 cm x 20.3 cm x 2.2 cm); requires two module spaces in chassis.

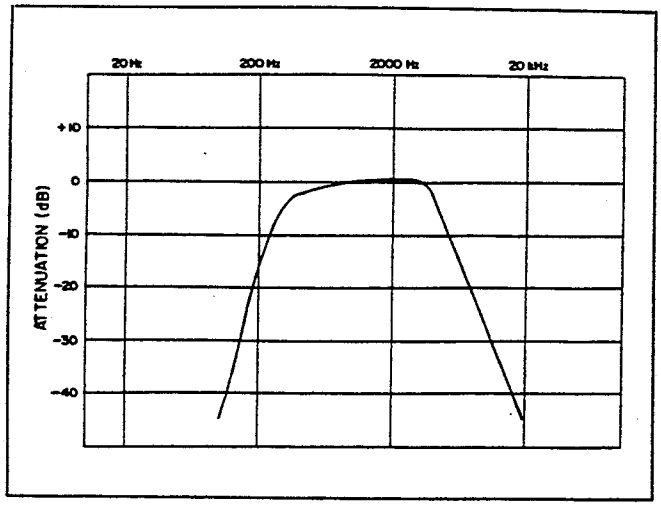


Figure 11-3. Transmitter section frequency response, RFL 67 PLC VOICE Voice Adapter Module

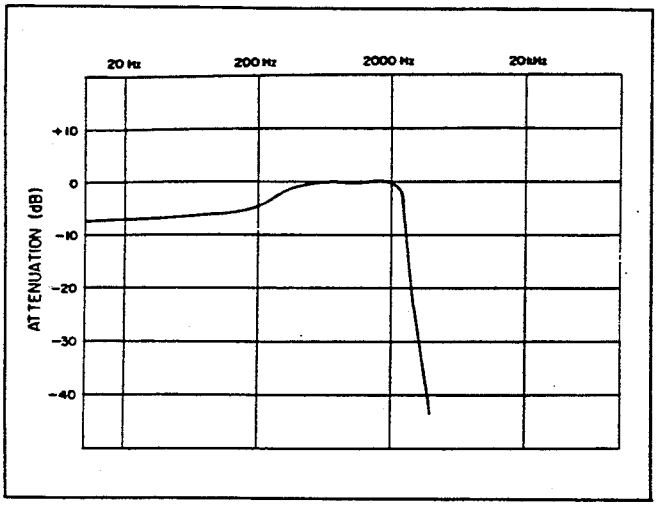


Figure 11-4. Receiver section frequency response, RFL 67 PLC VOICE Voice Adapter Module

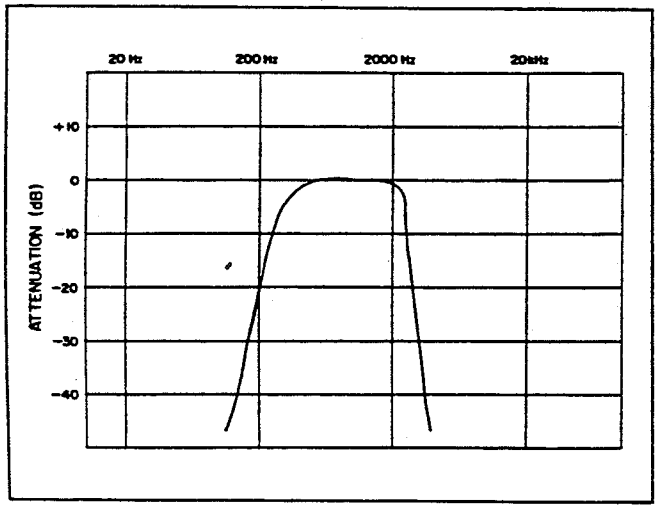


Figure 11-5. Typical RFL 6785P system frequency response to voice communications

11.3. THEORY OF OPERATION

The RFL 67 PLC VOICE Voice Adapter Module contains a transmitter section, a receiver section, and a call tone circuit. A block diagram of the RFL 67 PLC VOICE appears in Figure 11-6.

11.3.1. Transmitter Section

The transmitter section accepts voice signals generated by the carbon microphone in a telephone-type handset and prepares them for use in modulating the RFL 6785P's output carrier. The handset is connected to a mating jack on the front of the chassis; it is connected across edge connector terminals 15 (ground) and 16. Transistor Q2 provides the current necessary to operate the carbon microphone, which will vary between 15 and 20 mA. The signal generated by the microphone is fed to operational amplifier IC5A, which serves as a high-pass filter with a 250-Hz cutoff frequency. The signal then passes to IC5C, an operational amplifier with a diode bridge (CR7 through CR10) and Zener diode CR11 in its feedback circuit. IC5C acts as a limiter, holding the peak signal amplitude to about 2.4 volts. This prevents overmodulation of the RFL 6785P's carrier signal, which could be interpreted by the receiving station as a failure.

After limiting, the speech signal passed through operational amplifier IC5D, which is connected as a low-pass filter with a 4-kHz cutoff frequency. Potentiometer R63 controls the amount of voice signal that will be sent on to the transmitter module (Section 6); this determines the percent modulation to be applied to the carrier.

Call tones from the call tone generator/detector section (para 11.3.3) enter the speech signal path at the input of IC5C, and from there on follow the same path as voice signals.

Comparator IC8A serves as a microphone presence detector, and controls the entire transmission process. When a carbon microphone is connected to the jack on the front of the RFL 6785P and its low impedance is detected by IC8A, its output shifts from logic low to logic high. This logic high is passed to edge connector terminal 13 as the VOICE ENABLE signal. The input/output module (Section 5) uses this signal to produce an enable signal for the transmitter module when voice signals can be transmitted.

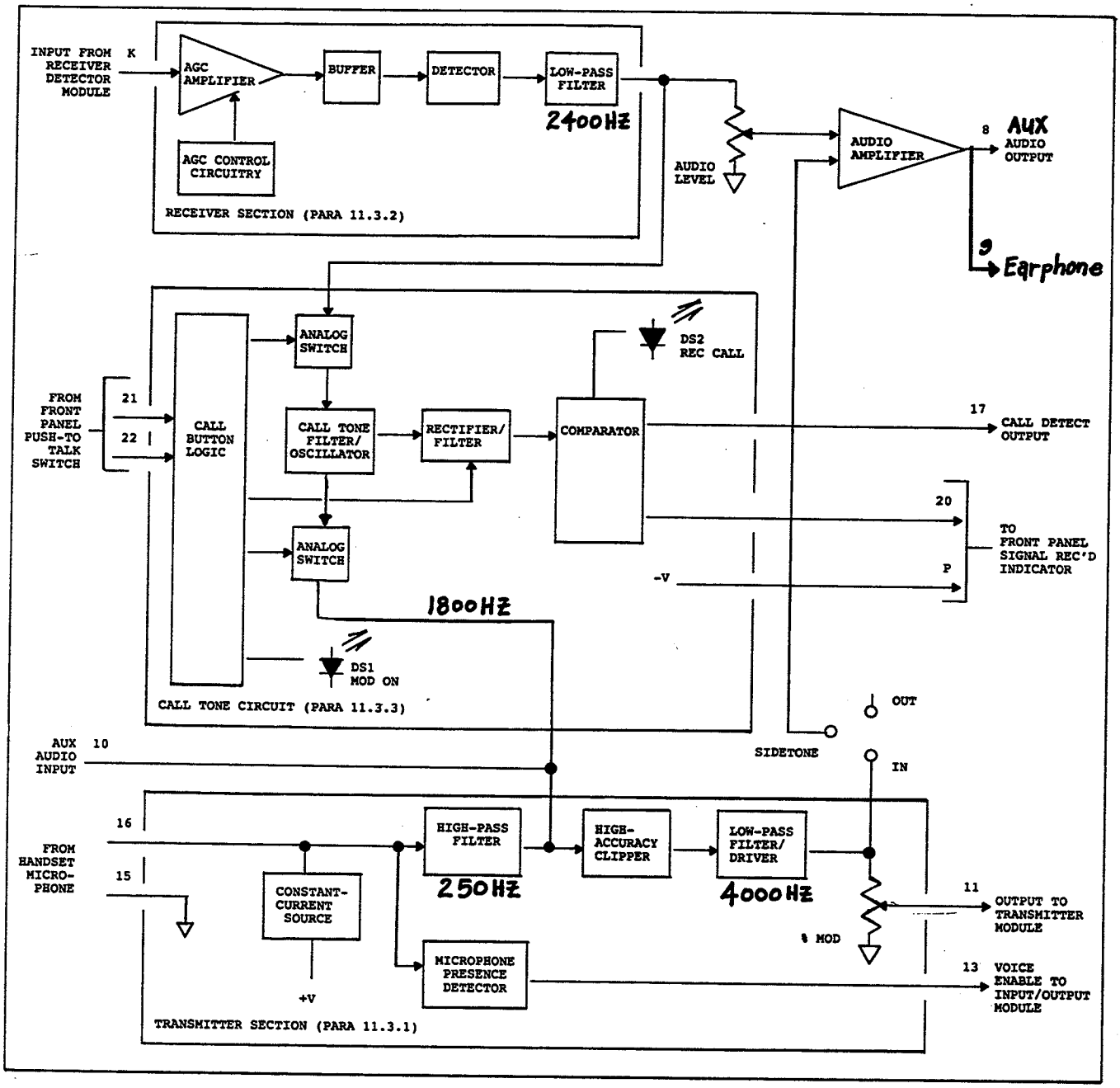


Figure 11-6. Block diagram, RFL 67 PLC VOICE Voice Adapter Module

MOD ON indicator DS1 will light when IC8A-7 is high, providing a visual indication that that the VOICE ENABLE signal has been sent to the input/output module. IC8A can be bypassed by connecting the voice signal input to edge connector terminal 10, which is an auxiliary audio input.

Signals applied to the auxiliary audio input terminal are fed directly to the input of IC5C, and from there out to the transmitter module; they will modulate the carrier without being controlled by the enable signal from the input/output module.

11.3.2. Receiver Section

Voice signals are received by the RFL 67 PLC VOICE as modulation on a 24-kHz carrier at edge connector terminal K, and are fed to the input of buffer/amplifier IC3. The output of IC3 becomes the input for IC2, an operational amplifier with the detector portion of photoisolator LCR1 in its feedback circuit. The action of LCR1 makes IC2 act as an AGC amplifier.

The output of the AGC amplifier is sent off the module through edge connector terminal J. In most RFL 6785P systems, the AGC output is directly fed back to edge connector terminal 6 as the reference signal for the AGC circuit; in some applications, additional control circuits may be added in series with the AGC amplifier output.

The AGC circuit reference signal is buffered by operational amplifier IB1C, and then fed to operational amplifier IC1A, where it is compared with the reference voltage established by Zener diode CR3. IC1A generates an error voltage that drives transistor Q1. The emitter portion of photoisolator LCR1 is in series with the emitter of Q1, so when Q1 conducts, LCR1 varies the feedback resistance in IC2, changing its gain and providing AGC action.

The gain-regulated output of IC2 becomes the input for operational amplifier IC1B, the first stage of the voice detector circuit. Operational amplifiers IC4D and IC4B, along with diodes CR5 and CR6, rectify and demodulate the signal. Operational amplifiers IC4A, IC4C, and IC7A form a low-pass filter with a 2000-Hz cutoff frequency. This removes the 24-kHz portion of the demodulated signal, leaving only the audio portion.

The audio signal separated by the low-pass filter is fed to operational amplifier IC7B, which serves as the audio amplifier. AUDIO LEVEL potentiometer R71 controls the audio level by setting the gain for IC7B. The output of the audio amplifier (IC7B-7) is fed to edge connector terminal 9. From there, the received voice signal is fed to the receiver portion of the telephone handset connected to the mating connector on the front panel.

11.3.3. Call Tone Circuit

The call tone circuit is used to generate call tones to send to a remote station, and detect incoming call tones. Operational amplifiers IC5B and IC6B form the call tone circuit, which is controlled by analog switch IC9, photo-coupled isolator IC10, transistors Q4 and Q5, and their associated components.

a. Call Tone Generation. When the PUSH TO CALL switch on the front panel is pressed, a 12-Vdc potential is placed across edge connector terminals 21 and 22. This will cause an LED inside IC10 to light, making its output go high. This turns on Q5, which pulls IC9-2 low. With IC9-2 held low, the B switch in IC9 closes, completing a positive feedback path from IC6B to IC5B, causing the circuit to oscillate. Inductor L2 and capacitor C46 hold the oscillation at their resonant frequency, 1800 Hz. This call tone signal is fed to the input of operational amplifier IC5B in the transmitter section (para 11.3.1), where it enters the speech transmission path.

When Q5 is turned on, the logic high at IC9-1 opens the A switch in IC9. With the A switch open, speech signals from the receiver section (para 11.3.2) are kept out of the call tone circuit.

b. Call Tone Detection. When the call tone circuit is not generating tones, it is ready to detect incoming tones. In this state, Q5 is turned off and IC9A is turned on. As a result, the feedback path between IC6B and IC5B is kept open, and no oscillations occur. Incoming signals are fed to the input of IC5B by way of the receiver section (para 11.3.2), analog switch IC9B, and resistor R90. L2 and C46 are connected in parallel across the output of IC5B, and will resonate when an 1800-Hz tone is present in the incoming signal.

If an 1800-Hz tone is present, it will be amplified by IC6B and rectified by diodes CR15 and CR17. The rectified signal is filtered by resistor R102 and capacitor C50, and then fed to IC6A-2. Operational amplifier IC6A acts as a comparator, which will turn on transistor Q3. Q3 can be used to drive a signaling device connected to edge connector terminal 17, or a relay coil connected across edge connector terminals P and 20. REC CALL indicator DS1 is in series with the base of Q3, and lights to indicate that a call tone has been detected.

When the PUSH TO CALL switch on the front panel is pressed, Q5 is turned on and diode CR19 conducts. This will hold IC6A-2 high, disabling the call tone detection function.

Table 11-1. Replaceable parts, RFL 67 PLC VOICE Voice Adapter Module Assembly No. 95555

Circuit Symbol (Fig. 11-7)	Description	Part Number
	CAPACITORS	
C1,2,34,41	Capacitor,tantalum,1µF,10%,35V,Kemet T110A105K035AS or equiv.	1007 1156
C3,27,33,35,54	Capacitor,Z5U ceramic,0.47µF,20%,50V,AVX SA405E474MAA or equiv.	0135 54742
C4,5,8,9,13,14,18,20, 26,29,36,44,47, 51-53	Capacitor,ceramic,0.1µF,GMV,50V,Centralab CY20C104P or equiv.	1007 1366
C6	Capacitor,electrolytic,100µF,+75/-10%,25V,Sprague 30D107G025DD2 or equiv.	1007 882
C7	Capacitor,ceramic disc,0.0068µF,20%,1000V,Erie CK62AW682M or equiv.	1007 91
C10,15	Capacitor,dipped mica,150pF,2%,500V, Type DM15	16608
C11	Capacitor,dipped mica,0.0015µF,2%,500V, Type DM19	1080 285
C12,38,56,57	Capacitor,X7R ceramic,0.047µF,10%,50V,AVX SA205C473KAA or equiv.	0130 54731
C16,17	Capacitor,ceramic disc,0.0047µF,10%,500V,Erie 811-000X5R0472K or equiv.	1007 92
C19	Capacitor,polyester,0.001µF,2%,400V,F-Dyne PST-11-.001-400-2 or equiv.	5115 274
C21	Capacitor,polyester,0.315µF,2%,400V,Wesco 32P or equiv.	5115 158
C22	Capacitor,polyester,0.016µF,2%,100V,Wesco 32P or equiv.	5115 45
C23	Capacitor,dipped mica,0.00125µF,2%,500V, Type DM19	16213
C24	Capacitor,metallized polycarbonate,0.043µF,2%,200V,Wesco 32MPC or equiv.	1007 1195
C25	Capacitor,dipped mica,255pF,2%,500V, Type DM19	16619
C28	Capacitor,dipped mica,100pF,5%,500V, Type DM15	1080 338
C30	Capacitor,polyester,0.0036µF,2%,100V,Wesco 32P or equiv.	5115 13
C31	Capacitor,metallized polycarbonate,0.013µF,2%,200V,Wesco 32MPC or equiv.	1007 1121
C32	Capacitor,dipped mica,270pF,2%,500V, Type DM15	16620
C37	Capacitor,tantalum,15µF,20%,20V,Kemet T322D156M020AS or equiv.	1007 716
C39	Capacitor,polyester,0.0082µF,2%,100V,Wesco 32P or equiv.	5115 31
C40,42,43	Capacitor,polyester,0.013µF,2%,100V,Wesco 32P or equiv.	5115 41
C45	Capacitor,dipped mica,15pF,5%,500V, Type DM15	16506
C46	Capacitor,polyester,0.1µF,2%,100V,Wesco 32P or equiv.	5115 83
C48,49	Capacitor,metallized polycarbonate,0.22µF,2%,50V,Wesco 32MPC or equiv.	1007 1329
C50	Capacitor,tantalum,2.2µF,10%,25V,Kemet T322B225K025AS or equiv.	1007 752
C55	Capacitor,polyester,0.011807µF,1%,100V,F-Dyne PST-11-.011807-100-1 or equiv.	5115 355
	RESISTORS	
R1,2	Resistor,composition,2.7Ω,5%,1/4W, Allen-Bradley CB Series or equiv.	1009 900
R3,6,57,62,65,81, 83,92,98	Resistor,metal film,1KΩ,1%,1/4W, Type RN1/4	0410 1288
R4,9-11,13,18,27,28, 33,35,37-40,42, 45,88,99	Resistor,metal film,10KΩ,1%,1/4W, Type RN1/4	0410 1384
R5	Resistor,metal film,3.01KΩ,1%,1/4W, Type RN1/4	0410 1334
R7,71	Resistor,variable,15-turn cermet,25KΩ,10%,3/4W,Beckman Helipot 89PHR25K or equiv.	45829
R8,22,29,61,74,96	Resistor,metal film,100Ω,1%,1/4W, Type RN1/4	0410 1192

Table 11-1. Replaceable parts, RFL 67 PLC VOICE Voice Adapter Module - continued.

Circuit Symbol (Fig. 11-7)	Description	Part Number
	RESISTORS - continued.	
R12,115	Resistor,metal film,4.75KΩ,1%,1/4W, Type RN1/4	0410 1353
R14,43,66	Resistor,metal film,4.99KΩ,1%,1/4W, Type RN1/4	0410 1355
R15,78	Resistor,metal film,3.32KΩ,1%,1/4W, Type RN1/4	0410 1338
R16	Resistor,metal film,30.1KΩ,1%,1/4W, Type RN1/4	0410 1430
R17	Resistor,metal film,475KΩ,1%,1/4W, Type RN1/4	0410 1545
R19,41	Resistor,metal film,2.21KΩ,1%,1/4W, Type RN1/4	0410 1321
R20	Resistor,metal film,221Ω,1%,1/4W, Type RN1/4	0410 1225
R21,93	Resistor,metal film,68.1KΩ,1%,1/4W, Type RN1/4	0410 1464
R23	Resistor,metal film,6.65KΩ,1%,1/4W, Type RN1/4	0410 1367
R24,64,70,89,94,106	Resistor,metal film,100KΩ,1%,1/4W, Type RN1/4	0410 1480
R25	Resistor,metal film,750Ω,1%,1/4W, Type RN1/4	0410 1276
R26	Resistor,metal film,7.5KΩ,1%,1/4W, Type RN1/4	0410 1372
R30,114	Resistor,metal film,31.6KΩ,1%,1/4W, Type RN1/4	0410 1432
R31	Resistor,metal film,909Ω,1%,1/4W, Type RN1/4	0410 1284
R32	Resistor,metal film,18.2KΩ,1%,1/4W, Type RN1/4	0410 1409
R34	Resistor,metal film,47.5Ω,1%,1/4W, Type RN1/4	0410 1161
R36,101	Resistor,metal film,24.9KΩ,1%,1/4W, Type RN1/4	0410 1422
R44,46-50,58-60	Resistor,metal film,20KΩ,1%,1/4W, Type RN1/4	0410 1413
R51,76	Resistor,metal film,604Ω,1%,1/4W, Type RN1/4	0410 1267
R52	Resistor,metal film,38.3KΩ,1%,1/4W, Type RN1/4	0410 1440
R53	Resistor,metal film,6.98KΩ,1%,1/4W, Type RN1/4	0410 1369
R54,55,68	Resistor,metal film,15KΩ,1%,1/4W, Type RN1/4	0410 1401
R56	Resistor,metal film,40.2KΩ,1%,1/4W, Type RN1/4	0410 1442
R63	Resistor,variable,15-turn cermet,1KΩ,10%,3/4W,Beckman Helipot 89PHR1K or equiv.	39574
R67	Resistor,metal film,392KΩ,1%,1/4W, Type RN1/4	0410 1537
R69	Resistor,metal film,4.32KΩ,1%,1/4W, Type RN1/4	0410 1349
R72,87	Resistor,metal film,33.2KΩ,1%,1/4W, Type RN1/4	0410 1434
R73	Resistor,metal film,3.16KΩ,1%,1/4W, Type RN1/4	0410 1336
R75,90	Resistor,metal film,1.5KΩ,1%,1/4W, Type RN1/4	0410 1305
R77,97,110	Resistor,metal film,332Ω,1%,1/4W, Type RN1/4	0410 1242
R79	Resistor,metal film,562Ω,1%,1/4W, Type RN1/4	0410 1264
R80	Resistor,metal film,43.2Ω,1%,1/4W, Type RN1/4	0410 1157
R82	Resistor,metal film,26.7KΩ,1%,1/4W, Type RN1/4	0410 1425
R84	Resistor,metal film,7.32KΩ,1%,1/4W, Type RN1/4	0410 1371
R85	Resistor,metal film,365KΩ,1%,1/4W, Type RN1/4	0410 1534
R86	Resistor,metal film,140KΩ,1%,1/4W, Type RN1/4	0410 1494
R91	Resistor,metal film,34.8KΩ,1%,1/4W, Type RN1/4	0410 1436
R95	Resistor,composition,10Ω,5%,1/4W, Allen-Bradley CB Series or equiv.	1009 823
R100	Not used.	

Table 11-1. Replaceable parts, RFL 67 PLC VOICE Voice Adapter Module - continued.

Circuit Symbol (Fig. 11-7)	Description	Part Number
	RESISTORS - continued.	
R102	Resistor,metal film,562KΩ,1%,1/8W,Type RN55D	1510 2013
R103	Resistor,metal film,47.5KΩ,1%,1/4W, Type RN1/4	0410 1449
R104,107,113	Resistor,metal film,3.92KΩ,1%,1/4W, Type RN1/4	0410 1345
R105	Resistor,metal film,10.5KΩ,1%,1/4W, Type RN1/4	0410 1386
R108	Resistor,metal film,1.21KΩ,1%,1/4W, Type RN1/4	0410 1296
R109	Resistor,metal film,681Ω,1%,1/2W, Type RN1/2	0410 2272
R111	Resistor,metal film,2KΩ,1%,1/4W, Type RN1/4	0410 1317
R112	Resistor,metal film,825Ω,1%,1/4W, Type RN1/4	0410 1280
	SEMICONDUCTORS	
CR1,2,4-10,12,15, 16-20,22	Diode,silicon,1N914B or 1N4448	26482
CR3	Diode,Zener,3.3V,5%,400mW,1N746A	18760
CR11	Diode,Zener,2.4V,5%,500mW,DO-7 case,1N5221B	40476
CR13,14,21	Diode,silicon,200 PIV,1N4003	30769
DS1,2	Light-emitting diode,red,panel mount,Dialight 559-0101-003 or equiv.	91115
IC1,4,5	Linear operational amplifier,JFET input,14-pin DIP,Texas Instruments TL084CN or equiv.	0620 151
IC2,3	Linear operational amplifier,8-pin DIP,National Semiconductor LM318N or equiv.	0620 126
IC6-8	Linear operational amplifier,JFET input,8-pin DIP,Texas Instruments TL082CP or equiv.	0620 155
IC9	MOS dual analog switch,SPST,10-pin TO-100 case,Siliconix DG200BA or equiv.	0605 3
IC10	Optically-isolated coupler,6-pin DIP,Motorola MOC8021 or equiv.	90271
LCR1	Photo-coupled resistor,Clairex Electronics CLM-6500 or equiv.	46546
Q1,5	Transistor,NPN,plastic package,2N2222A	37445
Q2,3	Transistor,PNP,plastic package,2N2907A	37439
Q4	Not used.	
	MISCELLANEOUS COMPONENTS	
L1	Inductor,molded,1000µH,5%,Stanwyck 410000M or equiv.	26529
L2	Coil,cup-core,77.62µH	55961 2189
S1	Switch,toggle,SPDT ON-NONE-ON,C&K Components 7101 or equiv.	26564
. . .	Shorting bar,single,Molex 90059-0009 or equiv.	98306

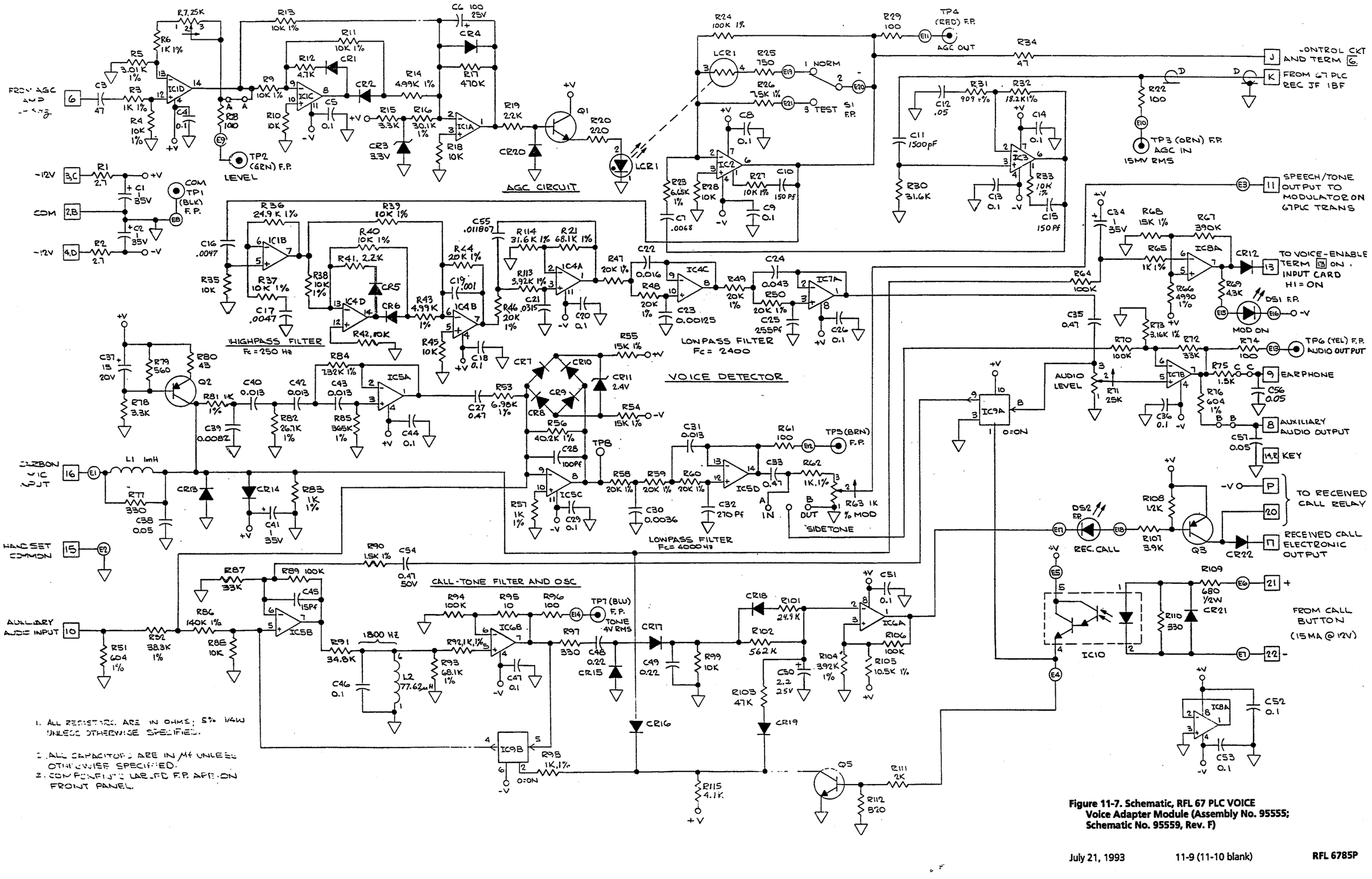


Figure 11-7. Schematic, RFL 67 PLC VOICE Voice Adapter Module (Assembly No. 95555; Schematic No. 95559, Rev. F)

Section 12. CHECKBACK MODULE

Figure 12-1. RFL 6720P Checkback Module

12.1. INTRODUCTION

The RFL 6720P Checkback Module (Fig. 12-1) is a microprocessor-based, single-module checkback system. Control and logic signals are interfaced between the RFL 6720P and the RFL 6785P system through the card-edge fingers along the rear of the module. In addition, the RFL 6720P interfaces directly with the RS-232 port on the RFL 6785P's rear panel; this port can be used to program the RFL 6720P, or to operate it from a remote location.

The front panel of the RFL 6720P serves as the local operator interface. Its pushbutton switches allow entry of operating parameters and control functions. A 3-digit LED display shows operating parameters, and LED annunciators display pertinent system data.

The RFL 6720P can perform powerline carrier functionality testing on multi-terminal lines and tandem line sections. Figures 12-2 through 12-6 are examples of multi-terminal configurations that can be tested by the RFL 6720P.

12.2. SPECIFICATIONS

As of the date this manual was published, the following specifications apply to the RFL 6720P Checkback Module. Because all RFL products undergo constant refinement and improvement, these specifications are subject to change without notice.

Codes: Capable of transmitting and receiving 16 asynchronous codes.

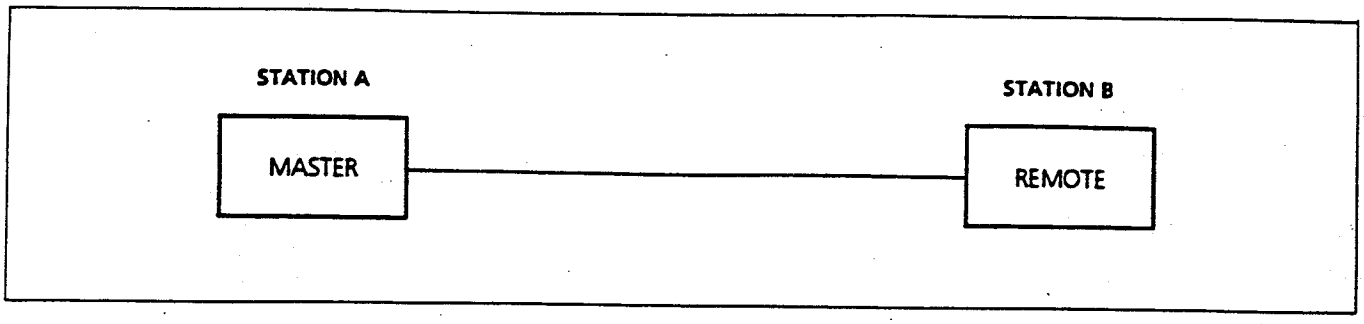


Figure 12-2. Two-terminal line testing

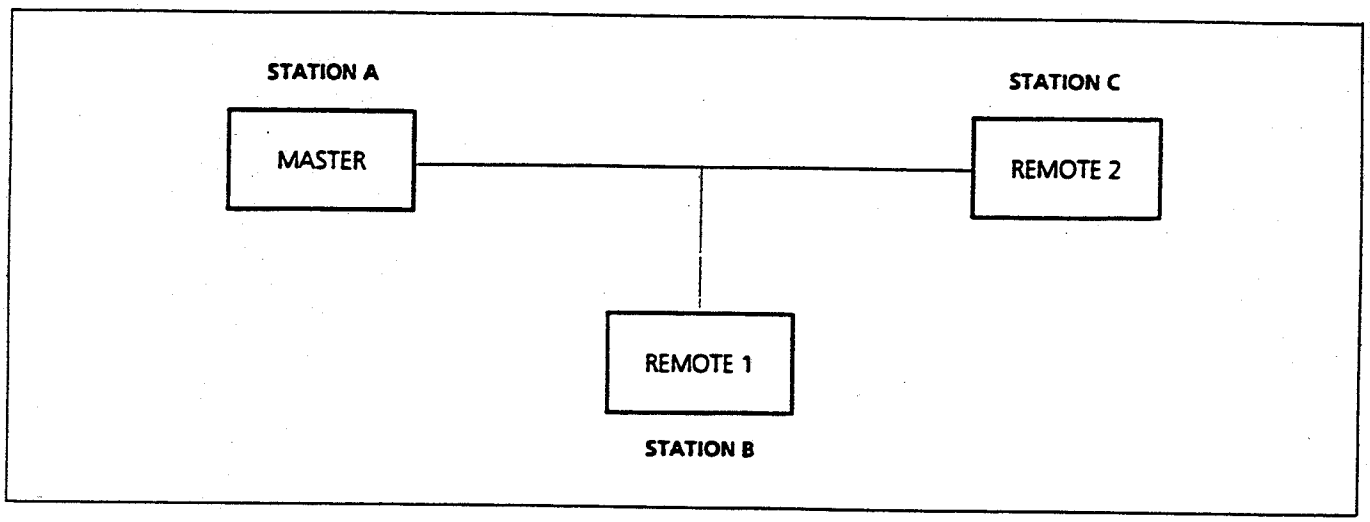


Figure 12-3. Three-terminal line testing

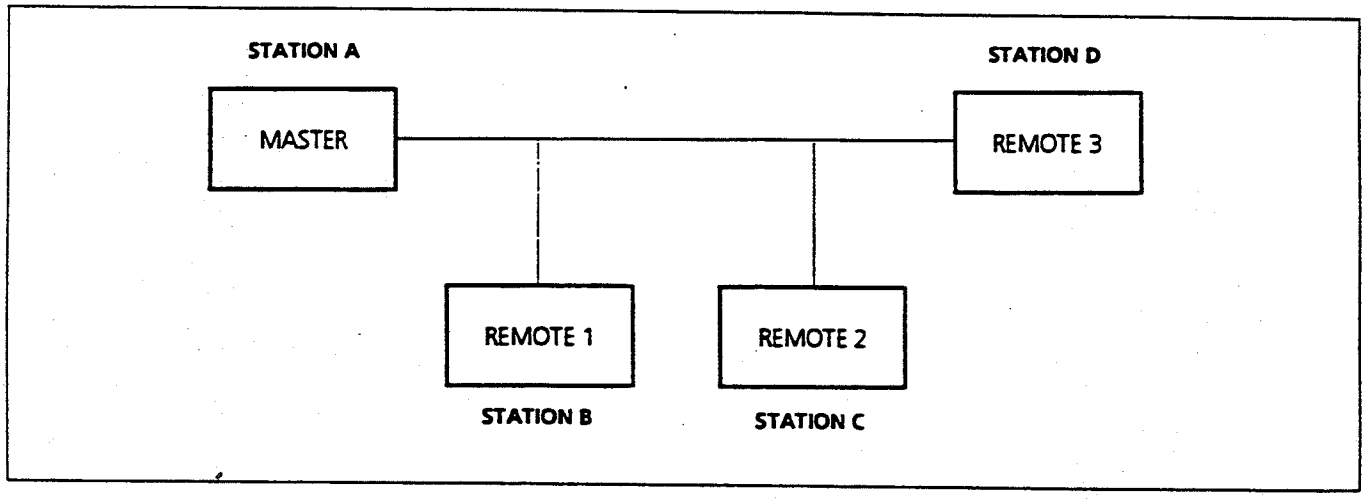


Figure 12-4. Four-terminal line testing

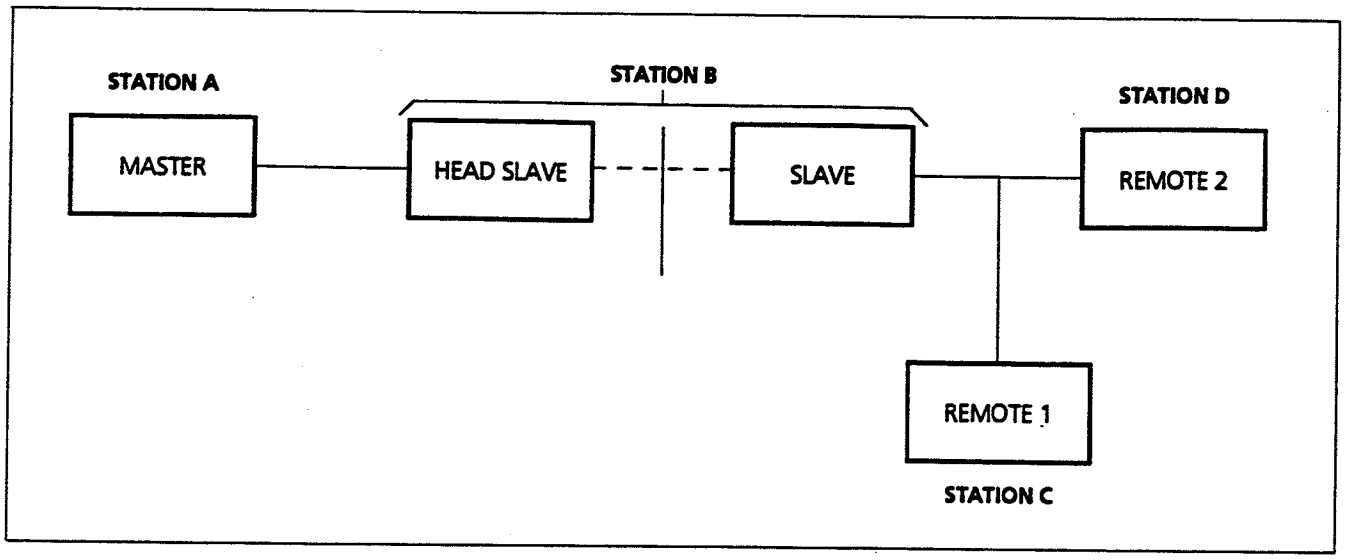


Figure 12-5. Two-terminal/three-terminal tandem line testing

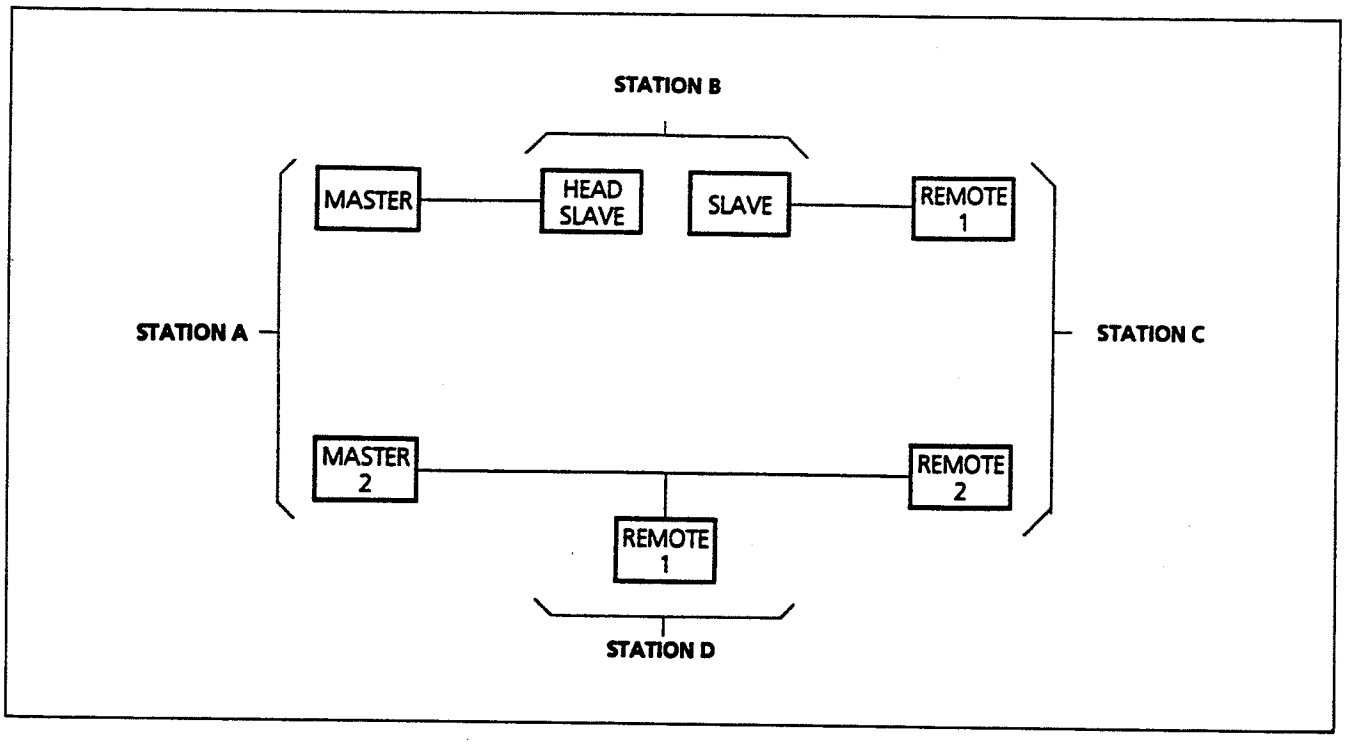


Figure 12-6. Multi-line testing

Alarm Reporting: Available through RS-232 port.

Test/Fail Output: Solid-state relay, rated for 1 ampere.

Temperature:
Storage: -30°C to +70°C (-22°F to +158°F).
Operating: -20°C to +60°C (-4°F to +140°F).

Relative Humidity: 95 percent @ +40°C, non-condensing.

Input Power Requirements:
+12-Volt Supply: 400 mA.
-12-Volt Supply: None.

Dimensions: 4.713 inches high x 8.0 inches deep x 2.0 inches wide (12.0 cm x 20.3 cm x 5.0 cm); requires two module spaces in chassis.

12.3. THEORY OF OPERATION

A block diagram of the RFL 6720P appears in Figure 12-7. Figure 12-8 on page 12-10 is a component locator drawing for the RFL 6720P; its schematic appears in Figure 12-9.

12.3.1. CPU AND MEMORY

U5 is the central processing unit (CPU) for the RFL 6720P. Its clock source is a 12-MHz oscillator formed from crystal Y2 and capacitors C40 and C41. 32K EPROMs U11 and U12 store all program memory used by the CPU. 8K static RAM U13 stores all user-entered operating parameters and system variables. A lithium battery inside U13 guards against data loss during power outages.

12.3.2. CPU I/O PORTS

CPU U5 has four I/O ports: Port Ø through Port 3.

Port Ø serves as a multiplexed, low-order address/data bus interface. During program memory fetches and data or I/O read/write operations, Port Ø first outputs the low-order address byte. It then reads or outputs the data byte to the bus (ADØ through AD7).

Port 1 is a general-purpose I/O interface. It is configured to input and output data and control signals to the RFL 6720P. Port lines P1.Ø through P1.3 are outputs, and P1.4 through P1.7 are inputs. Line P1.Ø toggles at the end of each program pass to reset watchdog timer U3. Lines P1.1, P1.2, and P1.3 are the row enable outputs for the front-panel pushbutton switch matrix; they pull low sequentially to enable each row of switches. Line P1.4, P1.5, and P1.6 are the column inputs for the 3 x 3 pushbutton switch matrix. These inputs are read when each row is enabled to determine which pushbutton (if any) has been pressed. Line P1.7 is a spare input; its state is determined by the position of strap J2.

Port 2 serves as the high-order address bus interface. During program memory fetches and data or I/O read/write operations, Port 2 outputs the high-order address byte to the bus (A8 through A15).

Port 3 serves as an interface for several of the special features incorporated into CPU U5. Line P3.Ø is the Receive Data (RXD) input for U5's serial port, used for Head Slave/Slave communications. Line P3.1 is the Transmit Data (TXD) output for U5's serial port. (This port utilizes Mode 3 operation for Head Slave/Slave communications; one start bit, eight data bits, one parity bit, and one stop bit, at 12ØØ bps.) Line P3.2 is the Communications Interrupt (/COMINT) input, generated when DUART U1 requires servicing. Line P3.6 is the Write (/WR) output. Line P3.7 is the Read (/RD) output. Lines P3.3, P3.4, and P3.5 are not used in this application.

12.3.3. PROGRAM MEMORY READ OPERATION

When program memory is to be read into the CPU, the Address Latch Enable (ALE) line pulls high. The low-order address byte is output through Port Ø onto address lines ADØ through AD7. The byte is buffered by buffer U9, and appears at the input of address latch U10. When the bus has stabilized, ALE pulls low, and the low-order address byte is latched into U10. The output of U10 now presents the low-order address byte to EPROMs U11 and U12.

During this entire sequence, U5 outputs the high-order address byte to A8 through A15 through Port 2. A8 through A14 are connected directly to the address inputs of both EPROMs. A15 is connected directly to the Chip Enable input of EPROM U11, which selects it for locations ØØØØH through 7FFFH. A15 is inverted by U2 and then connected to the chip enable input of EPROM U12, which selects it for locations 8ØØØH through FFFFH.

When the address bus has stabilized, the ROM Select (/ROMS) line pulls low; this enables the selected EPROM's output. The EPROM then outputs the instruction code on ADØ through AD7. When the bus has stabilized, the CPU reads the instruction code in, and the sequence is completed.

12.3.4. DATA MEMORY READ/WRITE OPERATIONS

Static RAM U13 occupies locations 8ØØØH through 9FFFH on the memory map. When data memory is to be accessed, A15 in the high-order address byte pulls high. This signal is inverted by U2, and U2's output enables U13. In addition, lines A8 through A12 are presented to the RAM. The low-order address byte is then latched (as described in paragraph 12.3.3), and presented to the RAM.

If data is to be read from the RAM to CPU U5, the Read (/RD) line is pulled low, and U13 outputs its data on lines ADØ through AD7. When the bus has stabilized, the CPU reads the data in, and the sequence is completed.

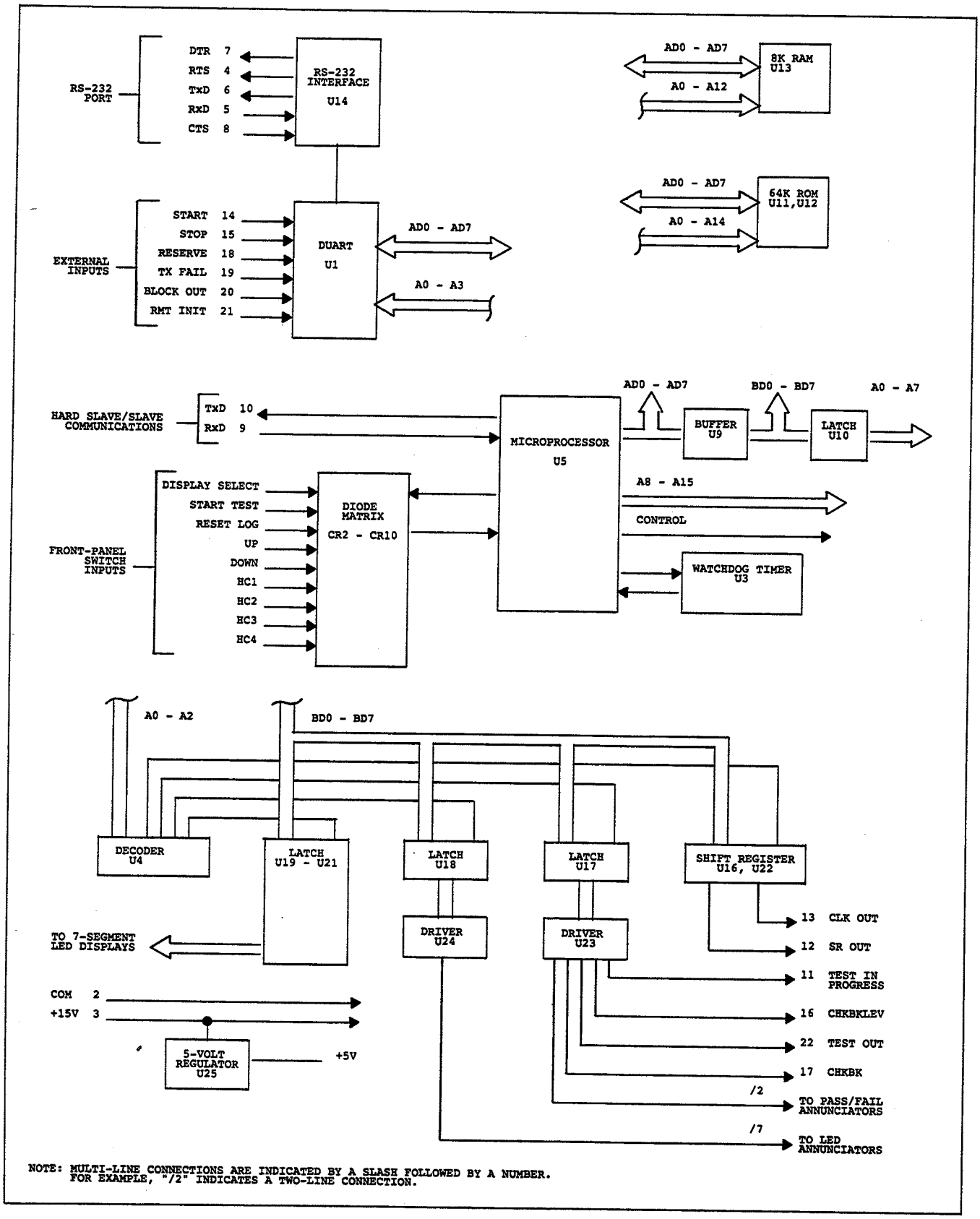


Figure 12-7. Block diagram, RFL 6720P Checkback Module

If data is to be written from CPU U5 to the RAM, the CPU outputs its data on lines AD0 through AD7. When the bus has stabilized, the Write (/WR) line is pulled low, the RAM reads the data in, and the sequence is completed.

12.3.5. RS-232 PORT OPERATION

The RFL 6720P has an RS-232 port for serial communications. This port is wired to the edge connector fingers along the rear of the module, and to a plug-in connector on the circuit board. Through this port, connection can be made to a local terminal for programming, or to a modem for remote operation of the RFL 6720P.

DUART U1 and its associated components control all RS-232 communications. U1 handles baud-rate generation, data formatting, handshaking, and Tx and Rx buffering so that a considerable burden is removed from the CPU. In addition, it provides a 9600-Hz clock on output line OP3, which is used for the shift register clock (SRCLK).

U1 occupies locations 4000H through 400FH on the memory-map. As such, the CPU handles read/write operations as though it were simply a RAM. When the CPU services a communications interrupt, A14 of the high-order address byte pulls high. A14 is then inverted by U2; this pulls the Communications Select (/COMS) line low to enable U1. The low-order address byte is then latched (as described in the PROGRAM MEMORY READ OPERATION section), and A0 through A3 are presented to the inputs of U1. Lines A0 through A3 are used to address registers within the DUART.

If data is to be read from the DUART to the CPU, the Read (/RD) line is pulled low, and the DUART outputs its data on AD0 through AD7. When the bus has stabilized, the CPU reads the data in, and the sequence is completed.

If data is to be written from the CPU to the DUART, the CPU outputs its data on AD0 through AD7. When the bus has stabilized, the Write (/WR) line is pulled low, the DUART reads the data in, and the sequence is completed.

At this point, operations involving the CPU are complete. The DUART continues monitoring the RXD line for new incoming data, and prepares outgoing data for transmission.

EIA interface U14 converts the CMOS-level signals from the DUART to RS-232 signals. U14 contains an on-chip oscillator and charge pump, utilizing capacitors C30, C31, C32, C33, and C42. This allows ±10-volt EIA signals to be generated using only the +5-volt supply. DTR, RTS, CTS, TXD, and RXD signals are accommodated by the port.

Port handshaking operates in the following fashion. When the RFL 6720P is initialized, the RTS line pulls high and remains high. This signals that the port is ready to accept incoming data. When the port wishes to send outgoing data, it pulls the DTR line high. Transmission of data is inhibited until the device connected to the port (modem or terminal) pulls the CTS line high. After transmission of data is completed, the port pulls the DTR line low once again. This protocol conforms with standard computer industry DTE/DCE interfacing.

12.3.6. EXTERNAL INPUT OPERATION

External inputs are interfaced to the RFL 6720P through DUART U1. All external inputs are provided with pull-up/down resistors, and RC noise filtering. After filtering, the inputs are connected to U1's input lines (IP1 through IP6).

When the CPU wishes to read input status, it enables U1 using address 400DH. The Read (/RD) line is pulled low, and U1 places the status information on lines AD0 through AD7. When the bus has stabilized, the CPU reads the status in, and the sequence is completed.

12.3.7. OUTPUT WRITE OPERATION

Latches U19 through U21 are output latches for the numeric LED display. They occupy the following locations on the memory map:

2000H (digit 1)
2002H (digit 2)
2001H (digit 3)

The CPU writes inverted 7-segment display format plus decimal point to each latch. The latches in turn drive displays DS1 through DS3.

U18 and U17 are also output latches, and occupy locations 2003H and 2004H respectively on the memory-map. The outputs of both devices are connected to drivers U23 and U24. These drivers provide high-current relay and front-panel LED drive capability.

When the CPU wishes to write data to an output(s), A13 of the high-order address byte pulls high, which will later enable Chip Select decoder U4. The low-order address byte is then latched, and AØ through A2 are presented to the inputs of U4 for decoding. The CPU then outputs its data on ADØ through AD7. When the bus has stabilized, U4's outputs are enabled by the Write (/WR) line being pulled low. U4 pulls the appropriate I/O Chip Select line high, and the output data is latched. This completes the sequence.

12.3.8. SHIFT REGISTER OPERATION

The shift register serially transfers test result status to another shift register located on the chassis motherboard. Once shifted, relays located on the I/O board will be energized corresponding to failed tests.

Shift registers U16 and U22 occupy location 2ØØ5H on the memory-map. For security, a header pattern of "ØØØØ" is hard-wired into U16, and a trailer pattern of "1ØØØ" into U22. This means data is written to the low nibble of U16 and the high nibble of U22 simultaneously. For security, flip-flop U15 is reset during power-up and power-down. This disables the shift register clock (SRCLK) through AND gate U8 until the shift registers contain valid data.

After each test sequence, U16 and U22 are loaded in the same fashion as described in paragraph 12.3.7. IOCS5 is inverted by U2; U2's output is connected to the load inputs of U16 and U22, and U15's clock input. When IOCS5 pulls low, its inverse pulls high; this latches the test result status into U16 and U22. Simultaneously, a high is clocked into U15. Its Q output pulls high, which enables AND gate U8. The SRCLK signal, generated by DUART U1, is now able to clock U16 and U22, and the motherboard shift register simultaneously. (The clock signal to the motherboard shift register is inverted by U2 to ensure that data is clocked in at the theoretical center of each bit.) Data shifts out to the motherboard in the following sequence:

1. Header
2. Status Bit 7
3. Status Bit 6
4. Status Bit 5
5. Status Bit 4
6. Status Bit 3
7. Status Bit 2
8. Status Bit 1
9. Status Bit Ø
10. Trailer

The data is also looped back through the shift registers. In this way, the same data pattern is shifted continually, until the CPU loads the shift registers with new test results.

12.3.9. WATCHDOG TIMER

U3 and its associated components form the RFL 6720P's watchdog timer. P1.Ø on the CPU is connected to the watchdog input (WDI) of U3. At the end of each program pass, P1.Ø changes state, and the watchdog is reset. If the watchdog is not reset after the time set by capacitor C39 (about 1 second), the RST and /RST lines will pull to their active states. This will reset CPU U5, DUART U1, and the output latches. For diagnostic purposes, the watchdog can be disabled by placing strap J1 in the TEST position.

U3 also serves as a power supply monitor. On power-up, the RST and /RST lines will pull to their active states until the power supply rises above 4.75 volts. RST and /RST also will activate if the power supply falls below 4.5 volts.

12.3.10. POWER SUPPLY

The RFL 6720P may be powered by a +12-volt or a +15-volt supply. U25 and its associated components form a highly efficient switching regulator, which provides a +5-volt regulated source. All devices on the RFL 6720P are powered by +5 volts, except the annunciator LEDs and the CHKBKLEV, TEST OUT, and CHKBK outputs; they are powered directly by the +12-volt or +15-volt supply.

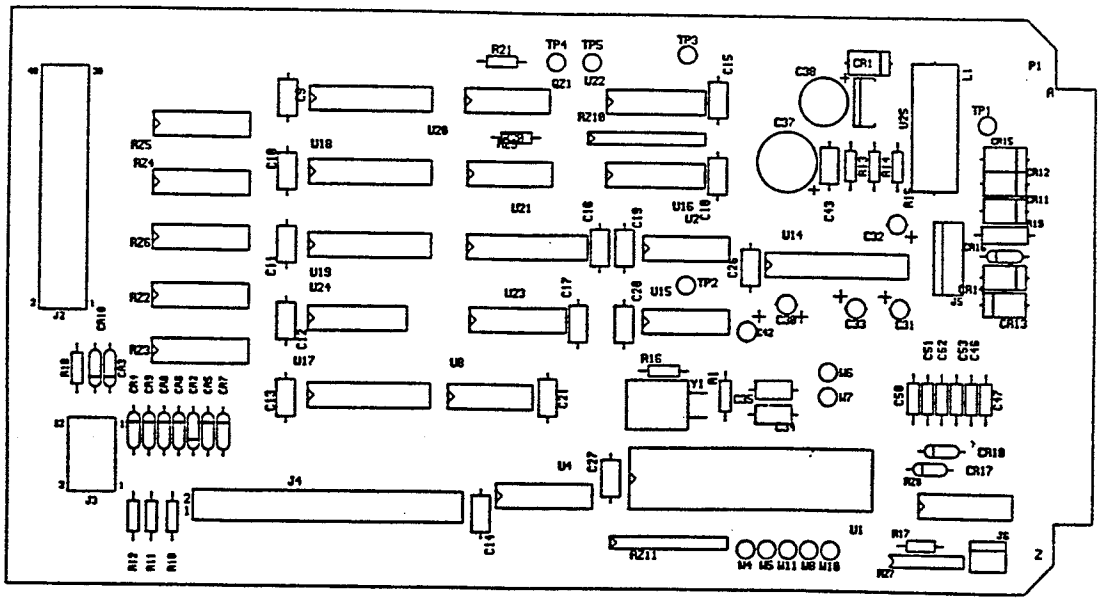
Decoupling capacitors C1 through C22, C26, and C27 are connected between the +5-volt rail and ground. These capacitors help remove rf noise from the power bus.

Table 12-1. Replaceable parts, RFL 6720P Checkback Module
Assembly No. 104080

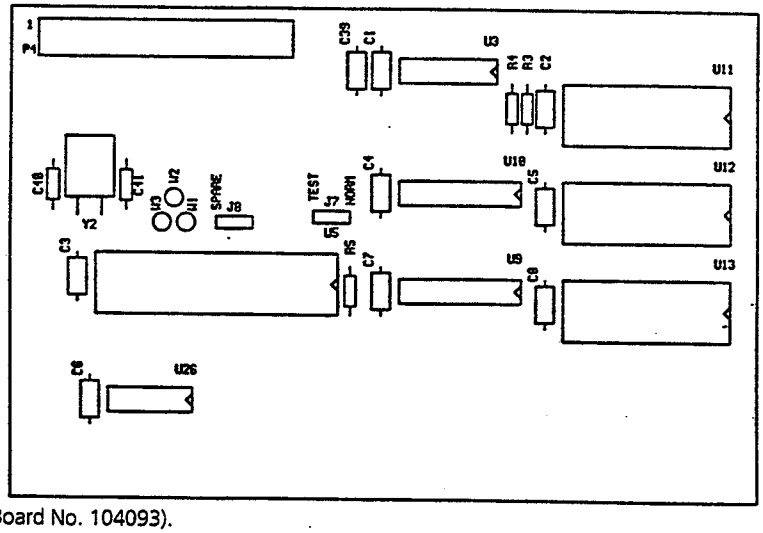
Circuit Symbol (Figs. 12-8 & 12-9)	Description	Part Number
	CAPACITORS	
C1-21,26,27,43	Capacitor,X7R ceramic,0.01µF,10%,50V,AVX SA105C103KAA or equiv.	0130 51031
C22-25,28,29,36, 44,45,48,49	Not used	
C30-33,42	Capacitor,tantalum,1µF,10%,20V,Kemet T362A105K020AS or equiv.	1007 1461
C34,35	Capacitor,ceramic,10pF,10%,100V,AVX SA101A100KAA or equiv.	0125 11001
C37	Capacitor,electrolytic,470µF,20%,16V,Illinois Capacitor 477RZS016M or equiv.	1007 1755
C38	Capacitor,electrolytic,220µF,+50/-10%,35V,Panasonic ECEA1VV2215 or equiv.	1007 1480
C39	Capacitor,ceramic,120pF,5%,100V,AVX SA101A121JAA or equiv.	0125 11215
C40,41	Capacitor,ceramic,33pF,5%,100V,AVX SA101A330JAA or equiv.	0125 13305
C46,47,50-53	Capacitor,ceramic,0.0056µF,5%,100V,AVX SA401A562JAA or equiv.	0125 15625
	RESISTORS	
R1	Resistor,metal film,499KΩ,1%,1/4W, Type RN1/4	0410 1547
R2,6-9	Not used.	
R3,4	Resistor,metal film,3.09KΩ,1%,1/4W, Type RN1/4	0410 1355
R5,10-12,16	Resistor,metal film,47.5KΩ,1%,1/4W, Type RN1/4	0410 1449
R13	Resistor,metal film,2.74KΩ,1%,1/4W, Type RN1/4	0410 1330
R14	Resistor,metal film,2.8KΩ,1%,1/4W, Type RN1/4	0410 1331
R15	Resistor,metal film,2.21KΩ,1%,1/4W, Type RN1/4	0410 1321
R17	Resistor,metal film,75.0Ω,1%,1/4W, Type RN1/4	0410 1180
R18	Resistor,metal film,243Ω,1%,1/4W, Type RN1/4	0410 1229
R19	Resistor,metal film,3.01KΩ,1%,1/4W, Type RN1/4	0410 1334
R20	Resistor,metal film,6.81KΩ,1%,1/4W, Type RN1/4	0410 1368
R21	Resistor,metal film,17.8KΩ,1%,1/4W, Type RN1/4	0410 1408
RZ2,3	Resistor network,eight 330Ω 2% resistors,1.75W total,16-pin DIP, CTS of Berne 761-3-R330 or equiv.	44532
RZ4-6	Resistor network,eight 680Ω 2% resistors,1.75W total,16-pin DIP, CTS of Berne 761-3-R680 or equiv.	101651
RZ7	Resistor network,five 10KΩ 2% resistors,0.75W total,6-pin SIP, Bourns 4306R-101-103 or equiv.	32664
RZ8	Resistor network,eight 10KΩ 2% resistors,1.75W total,16-pin DIP, CTS of Berne 761-3-R10K or equiv.	27371
RZ9	Resistor network,seven 6.8KΩ 2% resistors,1.5W total,14-pin DIP, CTS Of Berne 760-3-6.8K or equiv.	38835
	SEMICONDUCTORS	
CR1	Diode,Schottky,3A,30V,1N5821	30074
CR2-10,16-18	Diode,silicon,1N914B or 1N4448	26482
CR11-15	Transient voltage suppressor,bi-directional,15.2 to 16.8-volt breakdown, General Semiconductor P6KE16CA or equiv.	100572
CR19	Diode,Schottky,1A,20V,1N5817	30150

Table 12-1. Replaceable parts, RFL 6720P Checkback Module - continued.

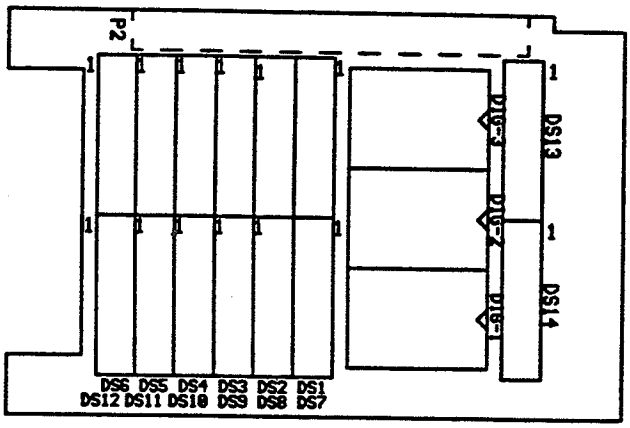
Circuit Symbol (Figs. 12-8 & 12-9)	Description	Part Number
	SEMICONDUCTORS - continued.	
DIG1-3	7-segment display,high-efficiency red,single-digit,0.43-inch,right-hand decimal, common anode,Hewlett-Packard 5082-7651 or equiv.	102412
DS1-12,14	Light-emitting diode array,four 0.75 x 0.15-inch bars,red, Hewlett-Packard HLMP-2350 or equiv.	101643
DS13	Light-emitting diode array,four 0.75 x 0.15-inch bars,green, Hewlett-Packard HLMP-2550 or equiv.	101644
QZ1	Transistor array,14-pin DIP,Sprague TPQ2907 or equiv.	49479
U1	MOS DUART,40-pin DIP,Signetics SCN2681AE1N40 or equiv.	0615 392
U2,26	MOS hex inverter,14-pin DIP,National Semiconductor MM74HC04N or equiv.	0615 185
U3	Microprocessor supervisor,16-pin DIP,Maxim MAX691EPE or equiv.	0635 31
U4	MOS 3-to-8-line decoder/demultiplexer,16-pin DIP,Texas Instruments SN74HC238N or equiv.	0615 361
U5	MOS microcontroller,40-pin DIP,Intel TP80C32 or equiv.	0615 357
U8	MOS quad 2-input AND gate,14-pin DIP,National Semiconductor MM74HC08N or equiv.	0615 161
U9	MOS octal buffer/line driver,20-pin DIP,RCA CD74HC241E or equiv.	0615 319
U10	MOS octal tri-state D-type latch,20-pin DIP,Texas Instruments SN74HC573N or equiv.	0615 308
U11,12	EPROM,32K x 8,120-ns access time,programmed at the factory	Contact factory
U13	Static RAM,non-volatile,8K x 8,150-ns access time,28-pin DIP, Dallas Semiconductor DS1225Y-150-IND or equiv.	0630 67
U14	RS-232 line driver,4 drivers/3 receivers,24-pin narrow DIP,Maxim MAX236ENG or equiv.	0680 17
U15	MOS dual D-type flip-flop w/preset and clear,14-pin DIP, National Semiconductor MM74HC74N or equiv.	0615 166
U16,22	MOS shift register,8-bit,parallel in/serial out,14-pin DIP, National Semiconductor MM74HC165N or equiv.	0615 174
U17-21	MOS octal D-type flip-flops w/clear,20-pin DIP, National Semiconductor MM74HC273N or equiv.	0615 255
U23,24	Transistor array,Darlington,high-voltage,high-current,16-pin DIP, Texas Instruments ULN2004AN or equiv.	0720 1
U25	Linear switching regulator,5-pin TO-220 package,Linear Technology LT1074CT or equiv.	0620 328
	MISCELLANEOUS COMPONENTS	
L1	Choke,ferrite,100µH,10%,2A,0.103Ω,Caddell-Burns 6310-8 or equiv.	41074
SW1-9	Switch,SPST pushbutton,long actuator,ITT Schadow KSL1M411 or equiv.	101655
Y1	Crystal,quartz,3.6864 MHz	99215 12
Y2	Crystal,quartz,12.00 MHz	99215 3
. . .	Shorting bar,single,Molex 90059-0009 or equiv.	98306
. . .	Switch button,round,red,ITT Schadow K0903 RED or equiv.	101663 1
. . .	Switch button,round,gray,ITT Schadow K0904 GRAY or equiv.	101663 2
. . .	Switch button,round,black,ITT Schadow K0901 BLACK or equiv.	101663 3



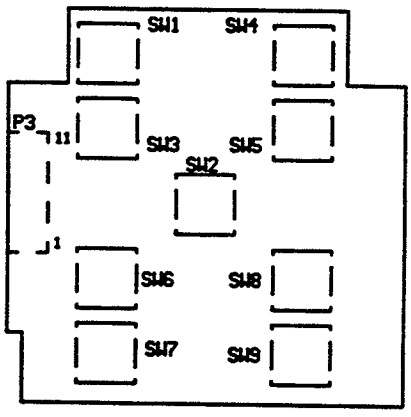
a. Main board (Circuit Board No. 104083).



b. Plug-on board (Circuit Board No. 104093).



c. Display board (Circuit Board No. 104088).



d. Switch board (Circuit Board No. 104098).

Figure 12-8. Component locator drawing, RFL 6720P Checkback Module (Assembly No. 104080; Drawing No. D-104080, Rev. A)

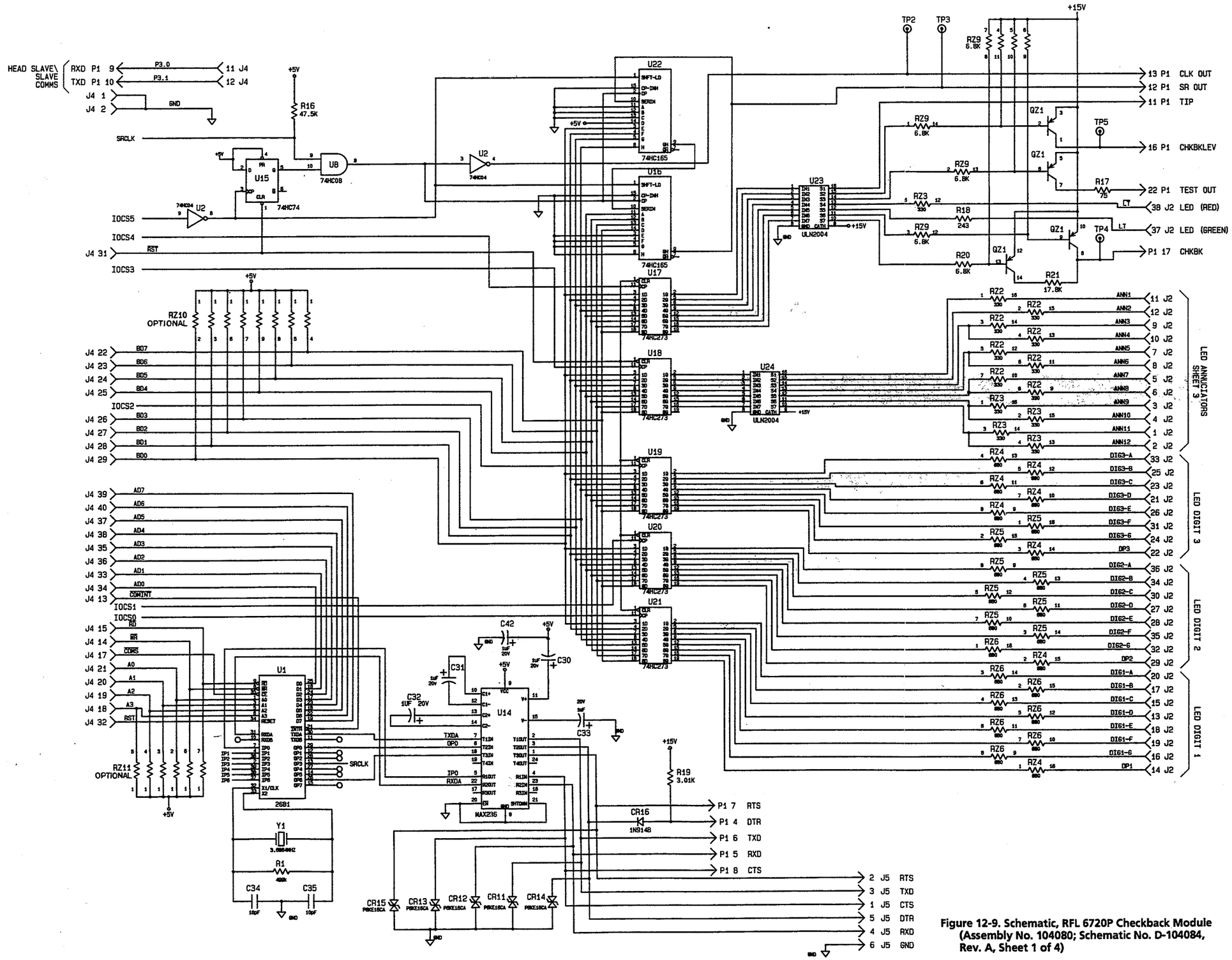


Figure 12-9. Schematic, RFL 6720P Checkback Module (Assembly No. 104080; Schematic No. D-104084, Rev. A, Sheet 1 of 4)

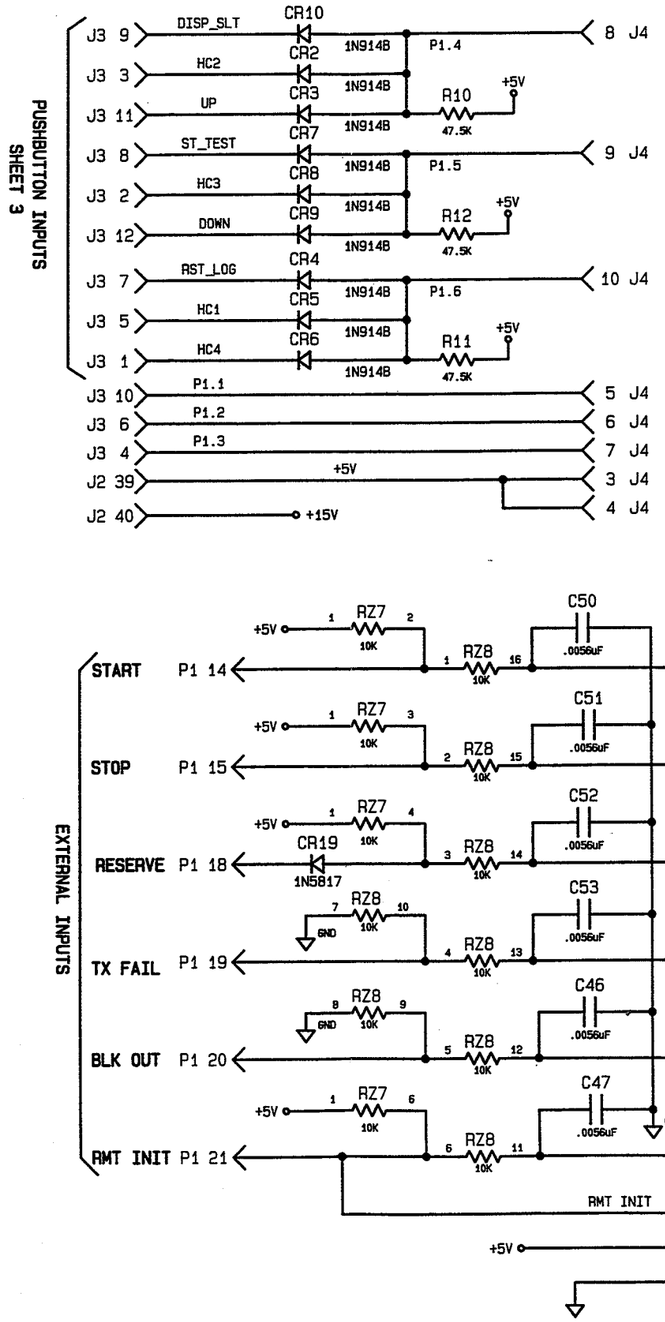


Figure 12-9. Schematic, RFL 6720P Checkback Module (Assembly No. 104080; Schematic No. D-104084, Rev. A, Sheet 2 of 4)

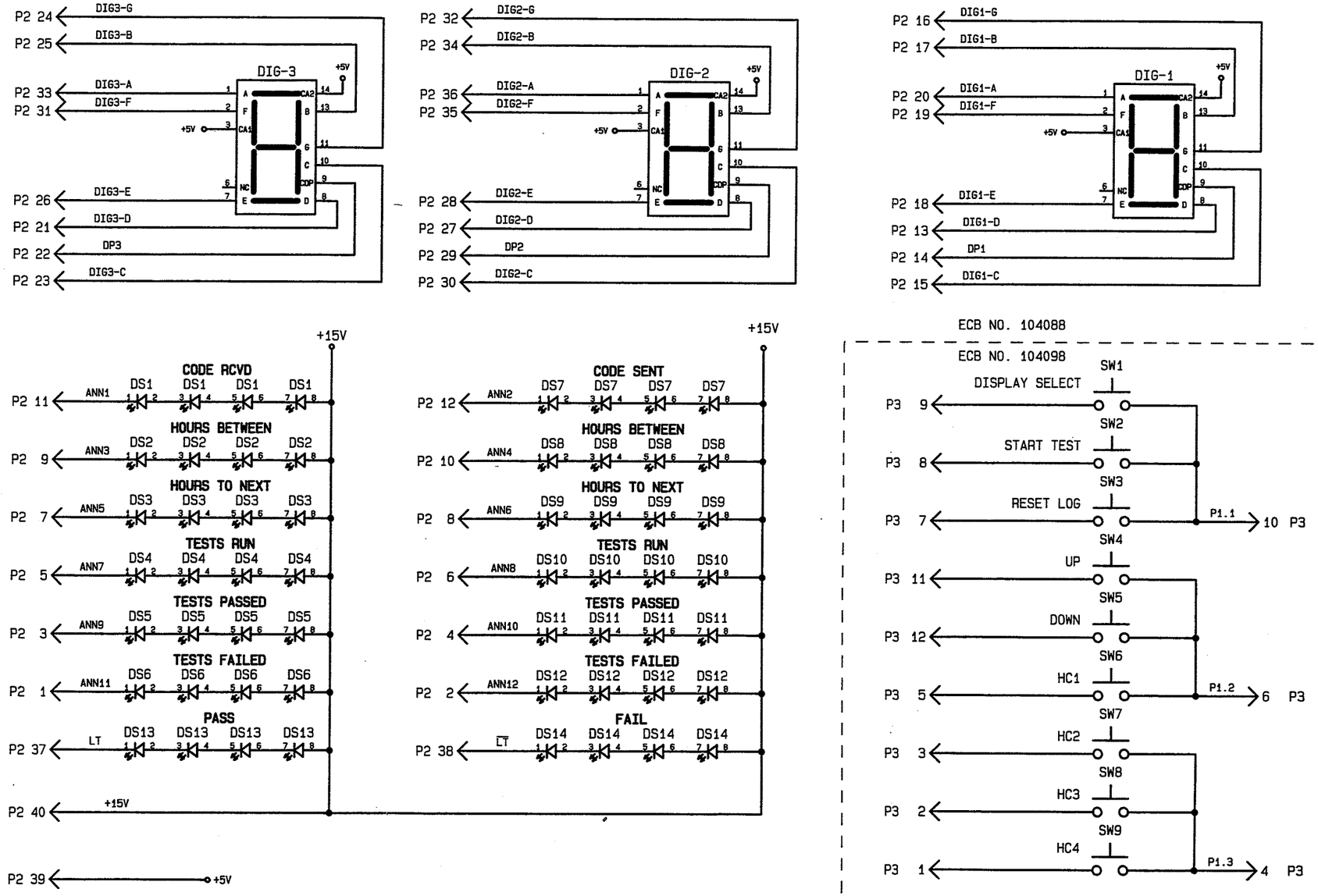


Figure 12-9. Schematic, RFL 6720P Checkback Module (Assembly No. 104080; Schematic No. D-104084, Rev. A, Sheet 3 of 4)

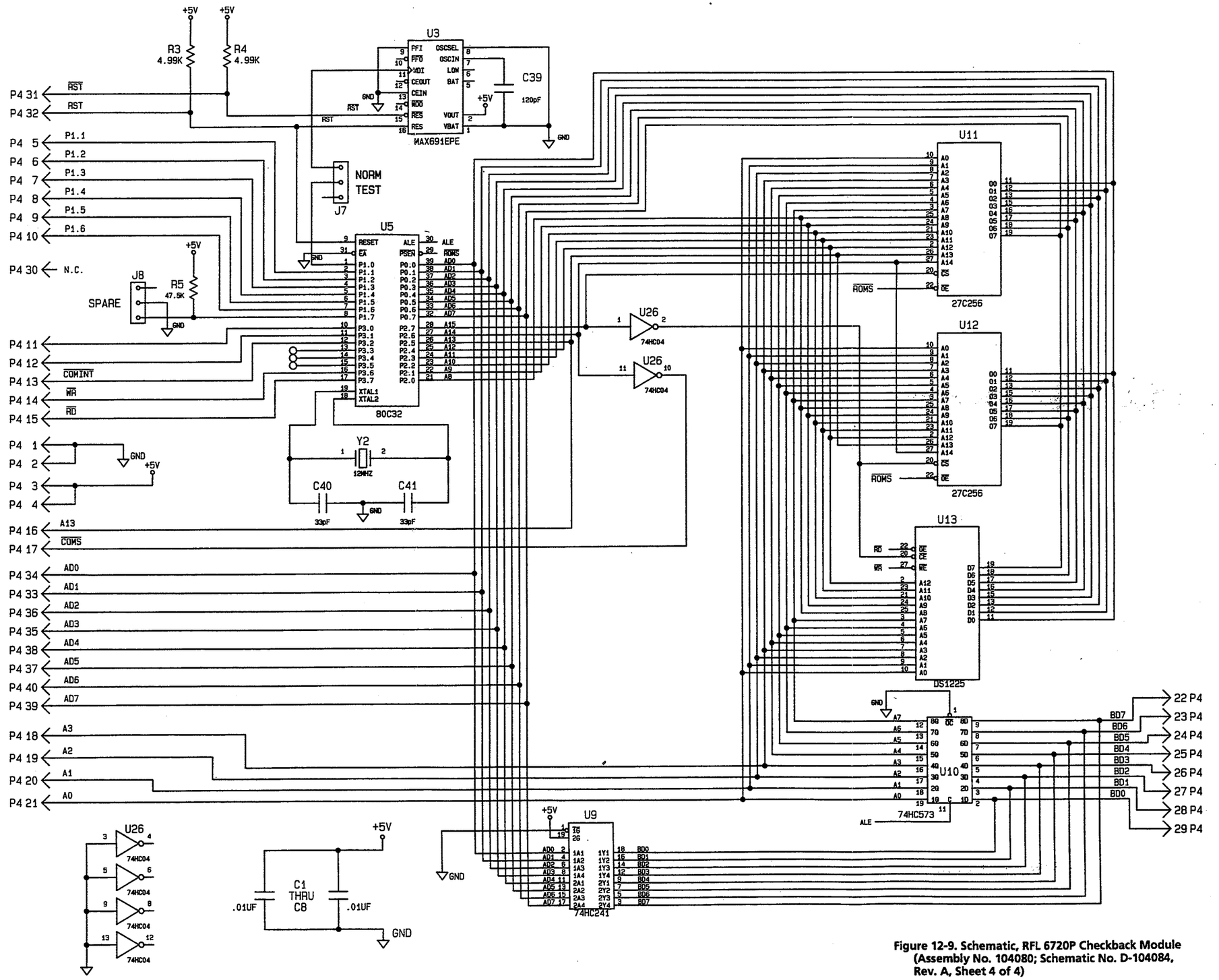


Figure 12-9. Schematic, RFL 6720P Checkback Module (Assembly No. 104080; Schematic No. D-104084, Rev. A, Sheet 4 of 4)

Section 13. POWER SUPPLIES

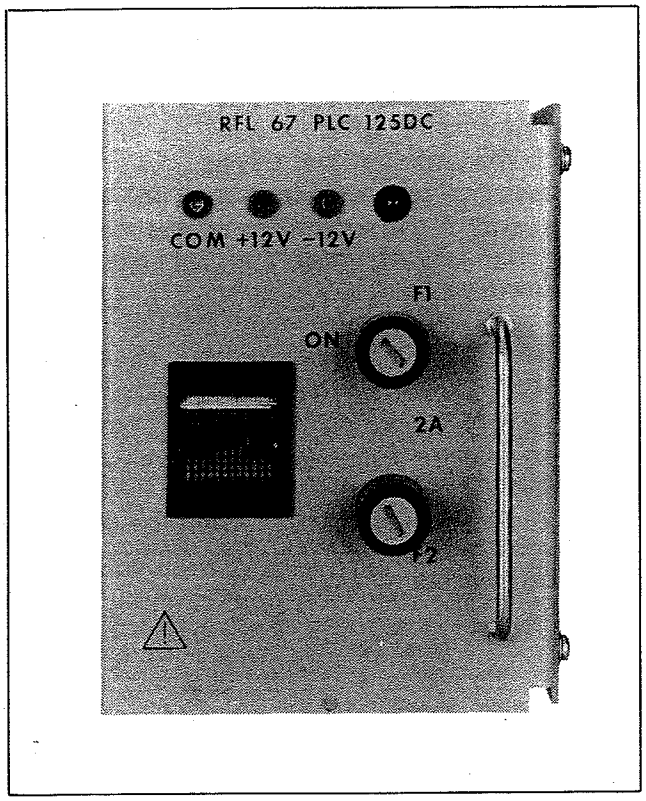


Figure 13-1. Typical RFL 6785P power supply module

13.1. DESCRIPTION

RFL 6785P power supplies accept the incoming station battery voltage and produces four regulated dc output voltages: +12, -12, +15, and -15. Two different versions are available: one for 48-volt station batteries, and one for 125-volt batteries. A typical RFL 6785P power supply module is shown in Figure 13-1.

13.2. SPECIFICATIONS

As of the date this manual was published, the following specifications apply to all RFL 6785P power supply modules, except where indicated. Because all RFL products undergo constant refinement and improvement, these specifications are subject to change without notice.

Input Voltage Range:
RFL 67P PLC 48DC: 42 to 56 Vdc.
RFL 67P PLC 125DC: 104 to 140 Vdc.

Maximum Input Current:
RFL 67P PLC 48DC: 3.3 amperes.
RFL 67P PLC 125DC: 1.3 amperes.

Maximum input current is achieved at full load with minimum voltage input.

Input-To-Output Isolation: 2500 Vdc; heat sink is coupled to chassis ground.

Regulated Outputs:
Voltage Range:
+15-Volt Supply: +14.8 to +17.6 volts.
-15-Volt Supply: -14.8 to -17.6 volts.
+12-Volt Supply: +10.8 to +13.2 volts.
-12-Volt Supply: -10.8 to -13.2 volts.
Maximum Current:
15-Volt Supplies: 3.33 amperes.
12-Volt Supplies: 1.0 ampere.

The +12-volt supply is derived from the output of the +15-volt supply, and the -12-volt supply is derived from the output of the -15-volt supply. Because of this, the total current draw from both positive outputs and both negative outputs cannot exceed 3.33 amperes. (For example a current draw of 2.75 amperes from the +15-volt supply and 1 ampere from the +12-volt supply would equal 3.75 amperes; this would exceed the current limit.

Line Regulation: ±1 percent.

Load Regulation: ±5 percent.

Output Ripple: 50 mVp-p.

Environmental:
Temperature Range: -20°C to +60°C (-4°F to +140°F).
Relative Humidity: Up to 95% at +40°C (+104°F).

Dimensions: 4.713 inches high x 8.0 inches deep x 3.75 inches wide (12 cm x 20.3 cm x 35.7 cm); requires eight module spaces in chassis.

13.3. THEORY OF OPERATION

RFL 6785P power supply modules produce four regulated dc output voltages from the single station battery voltage applied to their input terminals. They also provide a switched station battery voltage that can be

used to control external equipment. A block diagram for these power supplies appears in Figure 13-2.

13.3.1. Front Panel Fuses And Power Switch

The incoming station battery voltage applied to edge connector terminals 18 (positive) and 14 (negative) is passed through fuses F1 and F2, and power switch S1. The output of this switch is fed out of edge connector terminals 22 (positive) and 20 (negative) as the switched station battery output; it is also passed on to the dc-dc converter (para 13.3.2).

13.3.2. Dc-dc Converter

The dc-dc converter converts the incoming station battery voltage into bipolar regulated 15-volt outputs. There are two different dc-dc converters used in the RFL 6785P: one for 48-volt station batteries, and one for 125-volt batteries. Both dc-dc converters function in a similar manner; component values are changed to accommodate the different input voltages.

The following circuit theory discussion applies to both dc-dc converters; a block diagram appears in Figure 13-3.

The dc-dc converters use FET switching transistors and a pulse-width modulation controller. The pulse width controller contains drive transistors which provide gate potential for FET switches Q3 and Q4. As each FET alternately turns on, current flows from the positive supply connected to the center tap of transformer T2's primary, through the winding, and the FET. The induced secondary winding current is rectified and filtered, producing the new dc level. The output dc voltage level is sampled and used as the sense input for the pulse-width modulation control circuit. Voltage regulation is achieved by varying the pulse width; as output voltage increases, pulse width decreases.

Zener diode CR15 clamps the dc-dc converter input voltage, protecting against excessive input voltage. If the input voltage is reversed, it will be short-circuited by forward-biased diode CR15, protecting the converter. Capacitor C1 and common-mode choke L2 work together to filter ripple on the input lines, while capacitors C2 and C3 provide a source for the peak current demands and help stabilize the power supply.

To start operation, voltage is supplied to PWM controller U1 through resistor R1. This supplies enough current to make U1 operational. U1's internal 5-volt reference and a sampling of the input voltage obtained from a voltage divider formed from resistors R1, R2, and R3 are compared by one of the internal error amplifiers. When the divided voltage reaches 5 volts, the PWM begins to operate.

The PWM controller consists of a single active device (U1), and its associated components. U1 contains an oscillator, a 5-volt reference, two error amplifiers, and a dead-time control. U1 is powered by diode bridge CR14 and capacitors C4 and C5. Resistor R4 and C7 set the sawtooth oscillator frequency at 100 kHz. Output pulse widths are determined by the PWM comparator, which receives signals from the error amplifier and the sawtooth oscillator.

Outputs are enabled whenever the sawtooth voltage is greater than the error amp output. The dead-time control disables the output during the beginning of the sawtooth waveform. Its input has an offset to create a minimum 3-percent dead time, during which there is no voltage at the control input. The dead time is the period between one transistor turning off and the other turning on.

Additional dead time can be imposed by applying a voltage to the input; a 3.3-volt level will result in 100-percent dead time. This input is used two ways by the supply: to provide a "soft start", and to serve as a current limit circuit.

The PWM controller contains two drive transistors which provide gate potential for FET switchers Q3 and Q4. As each FET turns on alternately, resistor R13 or R14 limit the current through the drive transistors. This current is created by the gate-to-source capacitance of the FET, which must be charged to turn on the FET. To turn the FET off quickly, the residual gate charge must be drained. When the drive transistor opens, resistor R11 or R12 provide a return path to the base of transistor Q1 or Q2. Since Schottky diodes CR9 or CR10 are reverse biased, positive potential remaining on the gates turns on Q1 or Q2; this provides a path for gate discharge. Protection from excessive gate voltage is provided by CR1.

Voltage regulation is accomplished by directly sampling the output and providing a voltage adjustment to the input of the error amplifier on the PWM. The PWM adjusts the duty cycle of the gate drive pulses. This results in a proportional change to the average voltage at the secondary of T2. The gate-drive pulse width will vary according to the voltage at the PWM input from 97 percent of the period for a 0.5-volt input to zero percent for a 3.5-volt input. Optical isolator U2 connects the loop from the output to the PWM.

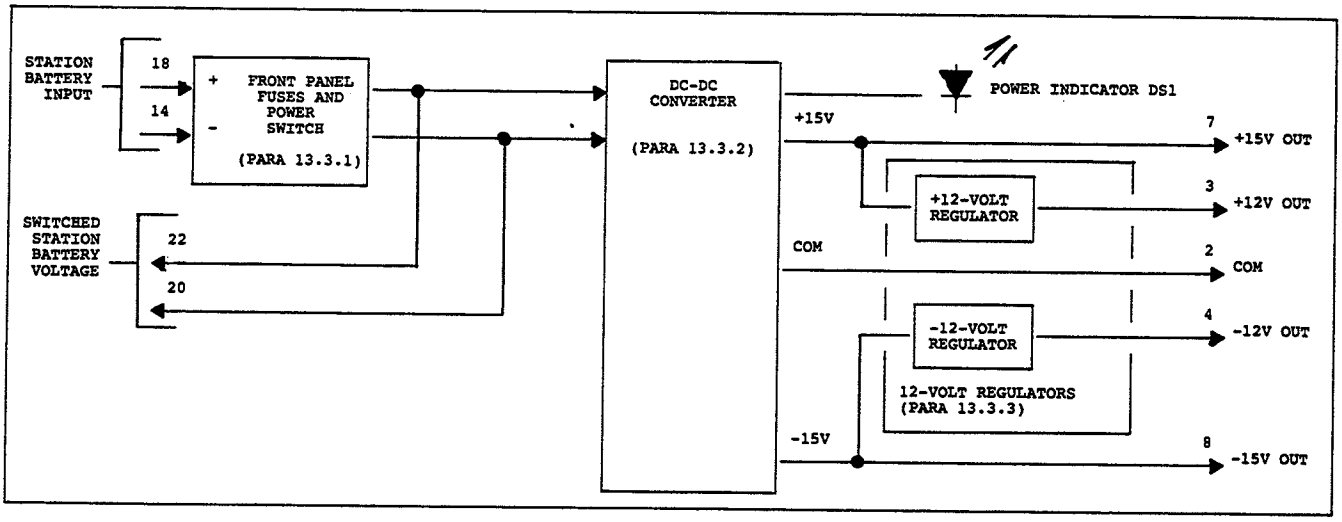


Figure 13-2. Block diagram, RFL 6785P power supply modules

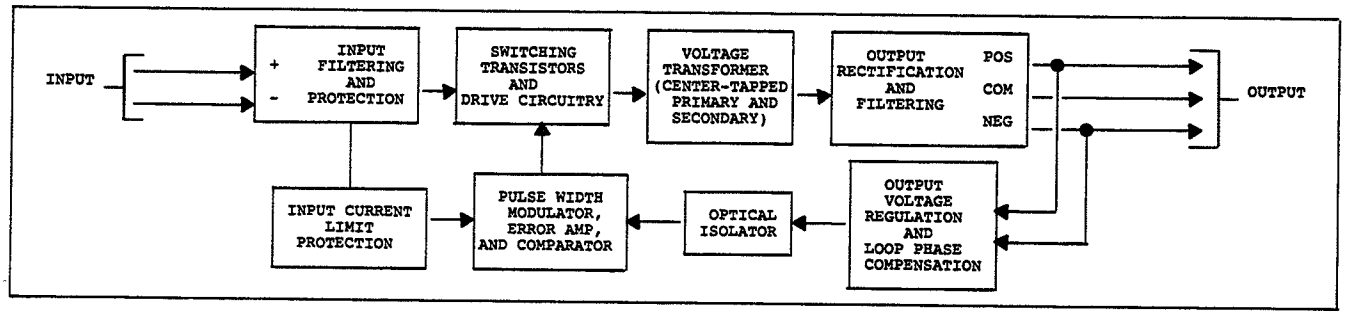


Figure 13-3. Block diagram, dc-dc converters for RFL 6785P power supply modules

A signal ranging from zero to 4.5 volts is provided across resistor R10 at the PWM input. The current through the LED input of U2 is controlled by adjustable shunt regulator CR16. The current flow through CR16 is controlled by the voltage at its reference, which is nominally 2.5 volts. Within a very small window, voltages greater than 2.5 volts turn on the shunt, allowing current to flow; lower voltages decrease the current flow. The sensitivity of compensation is determined by resistor R24. Current through the LED is limited by resistor R26. Transistor Q5 is used to maintain loop stability under all load conditions; it provides a low impedance to the compensation network consisting of resistors R27 and R28, and capacitor C19. The reference voltage to CR16 is also derived from resistors R27 and R28.

The secondary winding current is rectified by a bridge formed from diodes CR12 and CR13. The rectified outputs are averaged by a filter formed from inductor L4 and capacitors C15 and C16. This provides effective filtering of the 100-kHz ripple but has little effect on the high-frequency components, which are filtered out at destination assemblies. A snubber consisting of R21 and C14 controls transient spike voltages across the rectifier. Transformer T2 utilizes a feedback winding; its current is rectified by diode bridge CR14 and averaged to supply voltage to the PWM.

The dc-dc converter is protected against excessive input current flow. Input current limit protection has been incorporated to protect the switching FET's. The input current is monitored; if excessive levels are detected, a control voltage is applied to the dead-time input. Current transformer T1 monitors the current flowing to the center tap of T2. The secondary of T1 generates a current equal to 1/30th of the input current. The secondary current is then rectified by diodes CR6 through CR8, and a voltage is developed across scaling resistor R17. Additional voltage is dropped across diode CR5 before reaching potentiometer R16 and capacitor C12. R16 provides a means to adjust the threshold of protection while C12 serves as an integrator. The result is a fast protection circuit which is set to start limiting at a specified input current. Once the set level is exceeded, the dead time increases; this effectively limits FET current.

When dc power is first applied to the dc-dc converter's input terminals, the output gradually climbs from zero to full voltage. After initial power is applied, an initializing pulse is generated by an RC network formed from capacitor C8 and resistors R7 and R8. This pulse is applied to the pulse width modulation controller dead-time input. Switching pulse widths start out narrow and then gradually widen, bringing converter output up to full voltage.

DS1 is an LED indicator, which lights when the dc-dc converter is producing an output. It serves as a power indicator for the entire RFL 6785P station.

13.3.3. 12-Volt Regulators

The dc-dc converter (para 13.3.2) produces two regulated outputs: +15 volts and -15 volts. These outputs are applied to the motherboard through edge connector terminals 7 (+15) and 8 (-15). They are also fed to linear regulators U1 and U2. These regulators generate the ±12 volts which is supplied to the motherboard as well as to test points TP1 and TP2 on the front panel.

Table 13-1. Replaceable parts, RFL 6785P power supply modules
RFL 67P PLC 48DC (48-Vdc Input) - Assembly No. 104020-2
RFL 67P PLC 125DC (125-Vdc Input) - Assembly No. 104020-3

Circuit Symbol (Figs. 13-4 & 13-5)	Description	Part Number
C1,2	Capacitor,ceramic disc,0.005µF,20%,3kV,Centralab DD30-502 or equiv.	1007 1264
C3,4	Capacitor,metallized polycarbonate,1µF,10%,50V,Wesco 32MPC or equiv.	1007 1414
C5,6	Capacitor,tantalum,47µF,10%,20V,radial leads,Kemet T353K476K020AS or equiv.	1007 1715
DS1	Light-emitting diode,red,panel mount,Dialight 559-0101-003 or equiv.	91115
F1,2	Fuse,3AG voltage and current ratings dependent upon model: RFL 67P PLC 48DC: Slow-blow,4A,250V;Littelfuse 313 004 or equiv. RFL 67P PLC 125DC: Slow-blow,2A,250V,Littelfuse 313 002 or equiv.	 91935 7549
L1,2	Inductor,molded,10µH,5%,4A,resonant frequency grgeater than 10 MHz, Stanwyck ER-3114 or equiv.	92620
PS1	Dc-dc converter assembly (Table 13-2).	
R1,2	Resistor,metal film,1KΩ,1%,1/4W, Type RN1/4	0410 1288
R3	Resistor,metal film,634Ω,1%,1/2W, Type RN1/2	0410 2269
S1	Switch,rocker,DPST,16A,rated for high inrush current, amber rocker/matte black bezel,Oslo Controls RTP11H3M9-HIGH INRUSH or equiv.	99089
U1	Linear voltage regulator,+12-volt,3-terminal TO-220 case,Motorola MC7812CT or equiv.	0620 78
U2	Linear voltage regulator,-12-volt,3-terminal plastic package, National Semiconductor LM320T-12 or equiv.	0620 315
. . .	Fuseholder carrier,3AG fuses,Schurter FEK 031.1666 or equiv.	90277

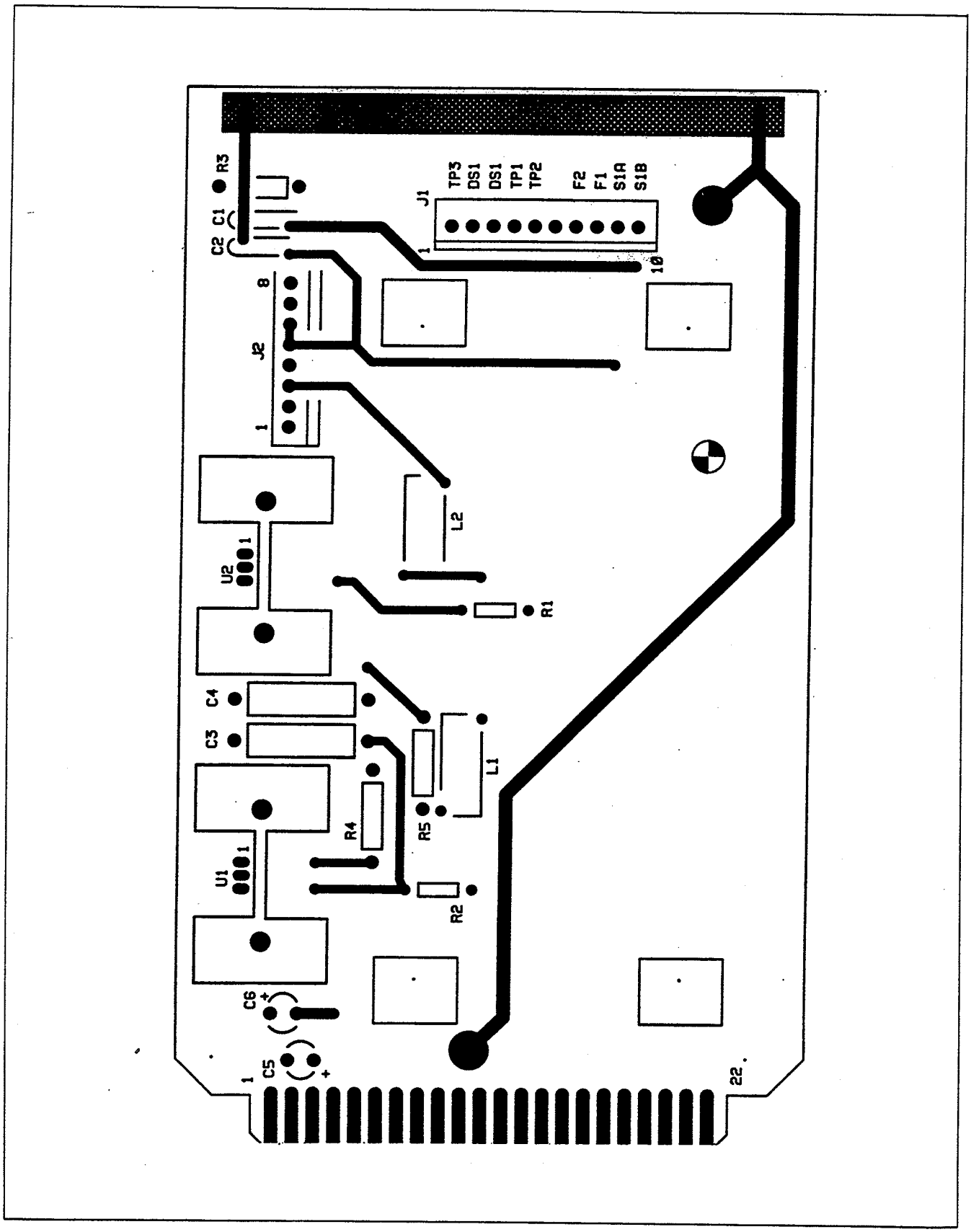


Figure 13-4. Component locator drawing, RFL 6785P power supply modules (Assembly No. 104020-X; Circuit Board No. D-104023, Rev. E)

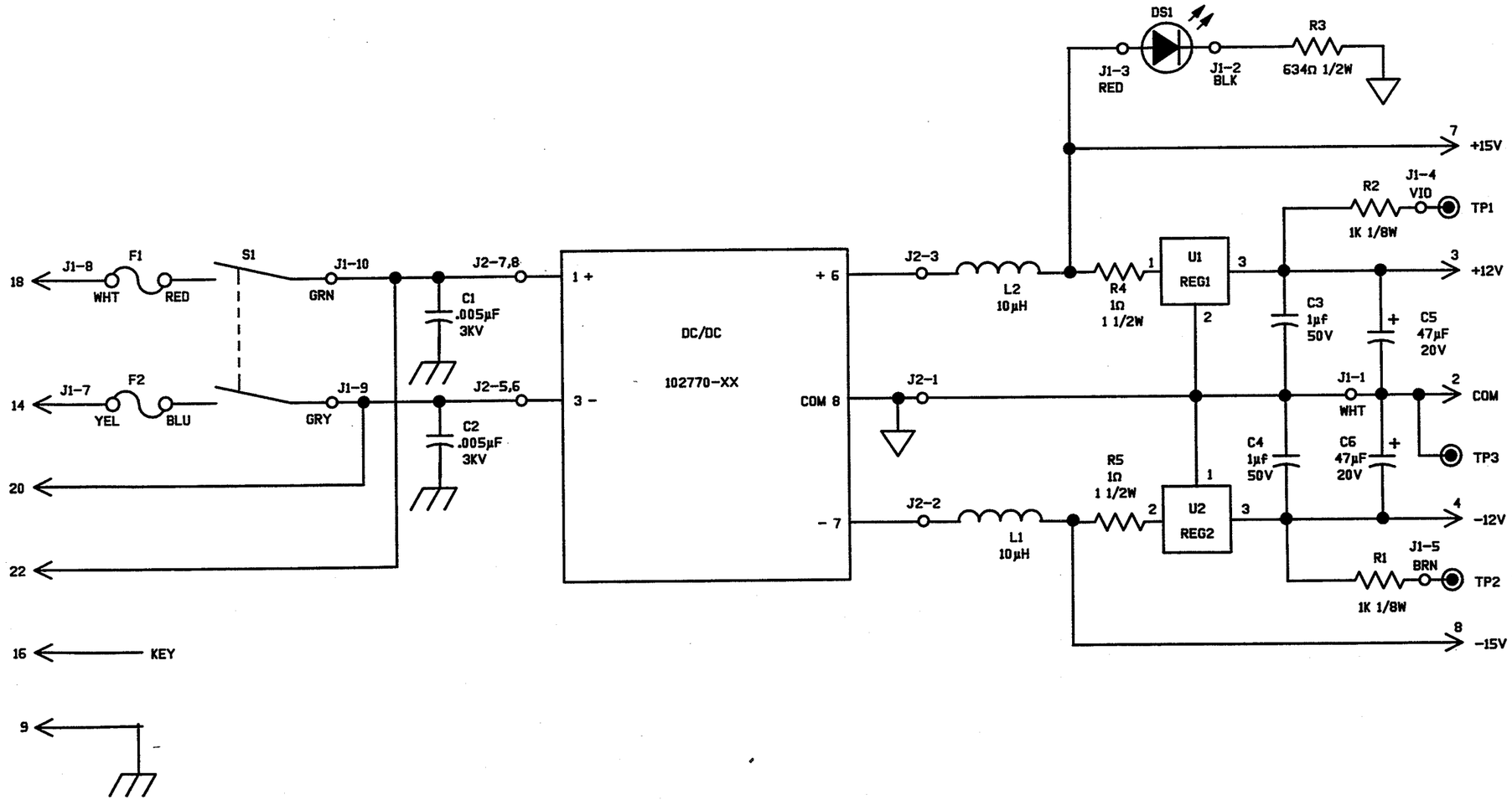


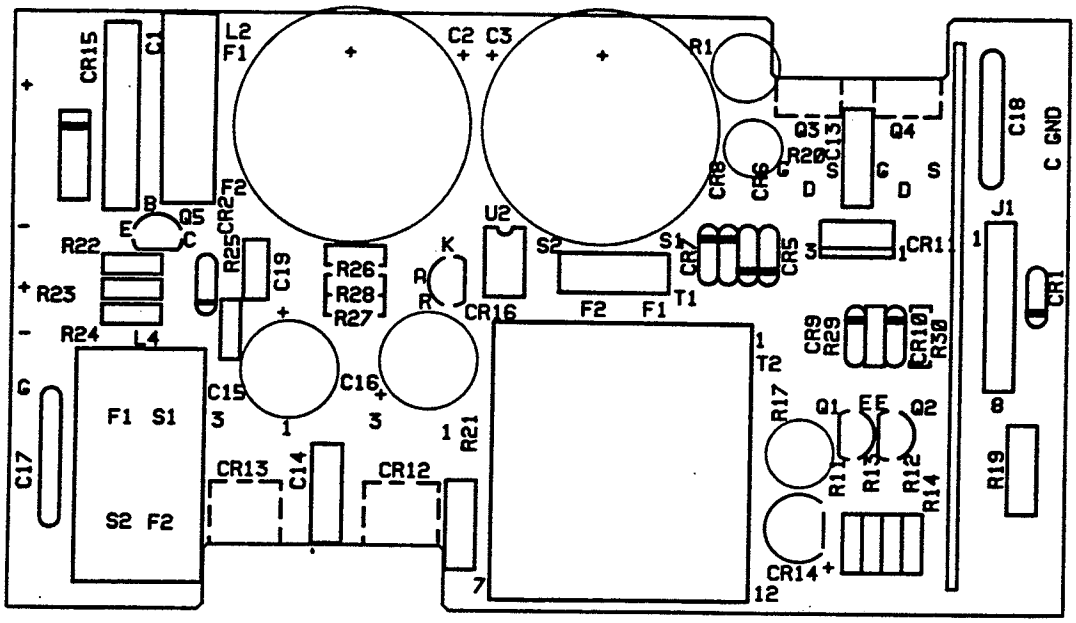
Figure 13-5. Schematic, RFL 6785P power supply modules (Assembly No. 104020-X; Schematic No. C-104024, Rev. C)

Table 13-2. Replaceable parts, dc-dc converter assemblies for RFL 67P PLC **DC power supplies
For RFL 67P PLC 48 DC (48 Vdc in, ±15 Vdc out) - Assembly No. 102765-2
For RFL 67P PLC 125 DC (125 Vdc in, ±15 Vdc out) - Assembly No. 102765-3

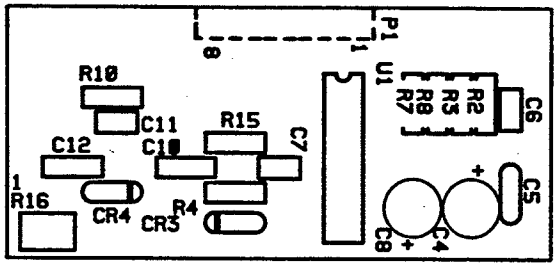
Circuit Symbol (Figs. 13-6 & 13-7)	Description	Part Number
	CAPACITORS	
C1	Capacitor,metallized polypropylene,0.47µF,10%,250V,radial leads, Illinois Capacitor 474MPR250K or equiv.	1007 1693
C2,3	Capacitor,electrolytic,radial leads, value, tolerance, and voltage rating dependent upon assembly:	
	Assy. No. 102765-2: 330µF,20%,200V,Illinois Capacitor 337LPR200M or equiv.	1007 1698
	Assy. No. 102765-3: 100µF,20%,250V,Illinois Capacitor 107LPR250M or equiv.	1007 1697
C4,8	Capacitor,electrolytic,100µF,20%,25V,Nichicon ULB1E101M or equiv.	1007 1630
C5	Capacitor,ceramic,0.47µF,+80/-20%,50V,Murata RE50-474M or equiv.	1007 939
C6	Capacitor,dipped ceramic,0.1µF,10%,50V,AVX SR205C104KAA or equiv.	1007 1667
C7,11	Capacitor,dipped ceramic,0.001µF,10%,50V,AVX SR205A102KAA or equiv.	1007 1666
C10,12	Capacitor,X7R ceramic,0.01µF,10%,50V,AVX SA105C103KAA or equiv.	0130 51031
C13	Capacitor,metallized polypropylene,0.033µF,10%,400V,radial leads, Illinois Capacitor 333MPR400K or equiv.	1007 1694
C14	Capacitor,dipped mica,510pF,2%,500V, Type DM19	16634
C15,16	Capacitor,electrolytic,470µF,20%,35V,radial leads,Sprague 513D477M035DK4 or equiv.	1007 1705
C17,18	Capacitor,ceramic disc,0.005µF,20%,3kV,Centralab DD30-502 or equiv.	1007 1264
C19	Capacitor,X7R ceramic,0.033µF,10%,50V,AVX SA205C333KAA or equiv.	0130 53331
	RESISTORS	
R1	Resistor, wirewound, value, tolerance, and power rating dependent upon assembly:	
	Assy. No. 102765-2: 4.3KΩ,1%,1/4W,Type 5013	1780 817
	Assy. No. 102765-3: 330Ω,0.1%,1/4W,Type 5013	1780 818
R2,11,12,15	Resistor,metal film,10KΩ,1%,1/4W, Type RN1/4	0410 1384
R3	Resistor,metal film,30.1KΩ,1%,1/4W, Type RN1/4	0410 1430
R4	Resistor,metal film,11KΩ,1%,1/4W, Type RN1/4	0410 1388
R7	Resistor,metal film,100Ω,1%,1/4W, Type RN1/4	0410 1192
R8,10	Resistor,metal film,1KΩ,1%,1/4W, Type RN1/4	0410 1288
R13,14,24	Resistor,metal film,15Ω,1%,1/8W,Type RN55D	1510 1317
R16	Resistor,variable,12-turn cermet,2KΩ,10%,1/4W,side adjust,Bourns 3266X-1-202 or equiv.	32732
R17	Resistor,wirewound,5%,value and power rating dependent upon assembly:	
	Assy. No. 102765-2: 100Ω,5W;Ohmite 4592 Style 995-5B or equiv.	1100 293
	Assy. No. 102765-3: 150Ω,3.25W,Ohmite 4396 Style 995-3A or equiv.	1100 566
R19	Resistor,metal film,1KΩ,1%,1/2W, Type RN1/2	0410 2288
R20	Resistor, wirewound, value, tolerance, and power rating dependent upon assembly:	
	Assy. No. 102765-2: 5KΩ,5%,3.25W,Ohmite 4442 Style 995-3A or equiv.	1100 460
	Assy. No. 102765-3: 25KΩ,5%,5W,Ohmite 4664 Style 995-5B or equiv.	1100 480
R21	Resistor,wirewound,75Ω,5%,1.5W,Ohmite 4087 Style 995-1A or equiv.	1100 688
R22	Resistor,metal film,2.49KΩ,1%,1/4W, Type RN1/4	0410 1326
R23	Resistor,metal film,1.54KΩ,1%,1/4W, Type RN1/4	0410 1306
R26	Resistor,metal film,1.05KΩ,1%,1/4W, Type RN1/4	0410 1290
R27	Resistor,metal film,499Ω,1%,1/4W, Type RN1/4	0410 1259

Table 13-2. Replaceable parts, dc-dc converter assemblies for RFL 67P PLC **DC power supplies - continued.

Circuit Symbol (Figs. 13-6 & 13-7)	Description	Part Number
	RESISTORS - continued.	
R28	Resistor,metal film,1.78KΩ,1%,1/4W, Type RN1/4	0410 1312
R29,30	Resistor,metal film,20Ω,1%,1/8W,Type RN55D	1510 1412
	SEMICONDUCTORS	
CR1	Diode,Zener,18V,5%,1W,1N4746A	29757
CR2	Resistor,zero-ohm,1/4-watt size,Corning OMA07 or equiv.	1510 2217
CR3,4	Diode,silicon,1N914B or 1N4448	26482
CR5	Diode,Zener,8.2V,5%,1W,1N4738A	29751
CR6,7	Diode,silicon,200 PIV,1N4003	30769
CR8	Diode,Zener,43V,5%,1W,1N4755A	34877
CR9,10	Diode,Schottky,60V,1A,DO-41 case,International Rectifier 11DQ06 or equiv.	96365
CR11	Rectifier, type dependent upon assembly: Assy. No. 102765-2: Same as CR12. Assy. No. 102765-3: Common-cathode,2-diode,500V,16A,50-ns TRR, 3-terminal TO-220 case,General Instrument FEP16HT or equiv.	30460
CR12	Rectifier,common-cathode,2-diode,200V,16A,35-ns TRR,3-terminal TO-220 case, General Instrument FEP16DT or equiv.	30490
CR13	Rectifier,common-anode,2-diode,200V,16A,35-ns TRR,3-terminal TO-220 case, General Instrument FEN16DT or equiv.	30489
CR14	Bridge rectifier,100V,1.5A,General Instrument RW01M or equiv.	30497
CR15	Transient suppressor, type dependent upon assembly: Assy. No. 102765-2: 71.3- to 78.8-volt breakdown,1N6262A Assy. No. 102765-3: 180-220V breakdown,General Instrument 1.5KE180A or equiv.	101952 32727
CR16	Linear adjustable precision shunt regulator,3-terminal TO-92 case,Motorola TL431ILP or equiv.	0620 320
Q1,2	Transistor,PNP,high-speed switching,40-volt VCEO,TO-92 case,2N4402	29099
Q3,4	Transistor,N-channel FET,TO-220AB plastic case; voltage rating, current rating, and type dependent upon model: Assy. No. 102765-2: 200V,18A,International Rectifier IRF640 or equiv. Assy. No. 102765-3: 400V,10A,International Rectifier IRF740 or equiv.	0715 27 0715 28
Q5	Transistor,NPN,TO-92 case,2N4124	18862
U1	Linear power control circuit,16-pin DIP,Motorola TL494IN or equiv.	0620 313
U2	Optical isolator,transistor output,6-pin DIP,Motorola MOC8101 or equiv.	99392
	MISCELLANEOUS COMPONENTS	
L1,3	Not used.	
L2	Choke,input,11μH,6A,common mode	32722
L4	Choke,output,155mH,3.3A	32725
T1	Transformer,current	32726
T2	Transformer,15-volt secondary,primary voltage dependent upon assembly: Assy. No. 102765-2: 48-volt primary Assy. No. 102765-3: 129-volt primary	32720 32721



a. Power converter board (Circuit Board No. D-102773, Rev. F).



b. PWM controller board (Circuit Board No. C-102768, Rev. D).

Figure 13-6. Component locator drawing, dc-dc converter for RFL 6785P power supply modules (Assembly No. 102765-X)

Section 14. CHASSIS

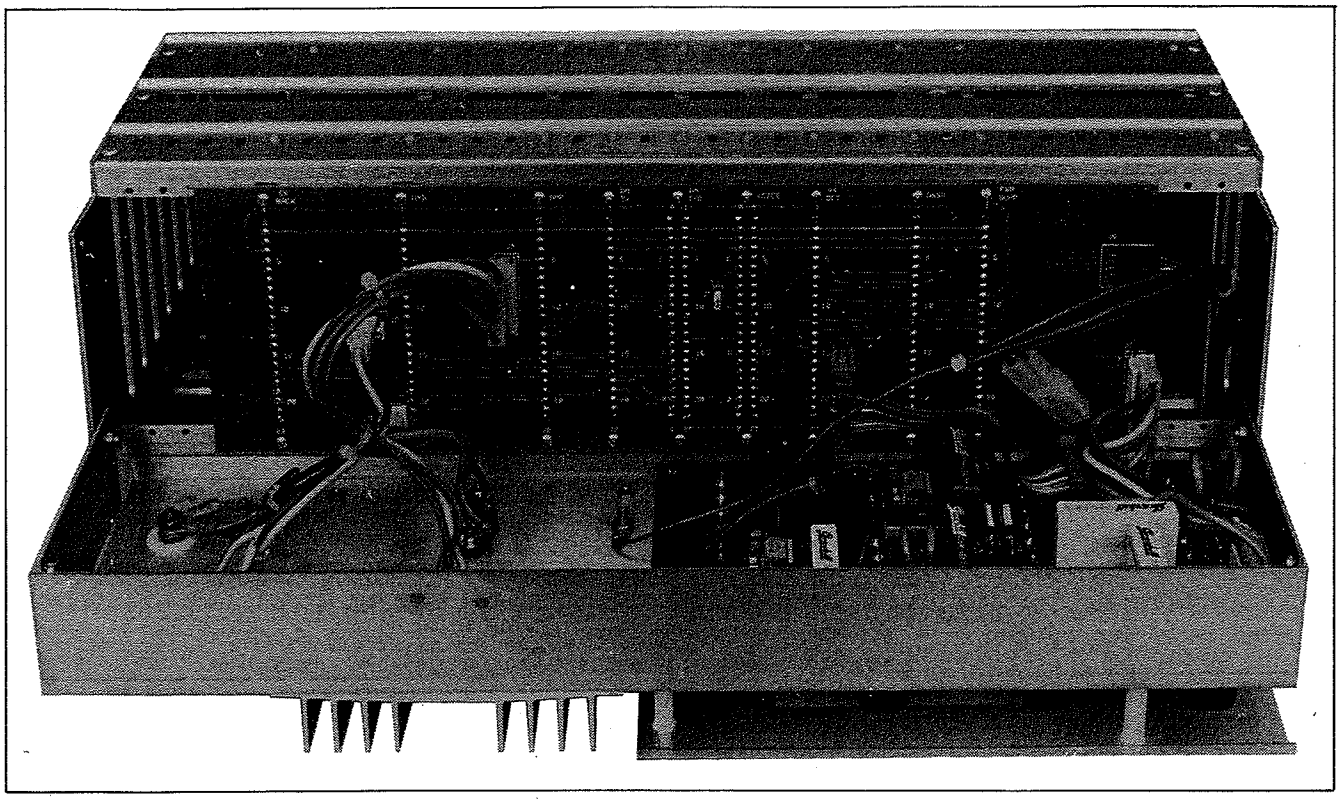


Figure 14-1. Typical RFL 6785P chassis with rear panel lowered to show RFL 67P INTERCONNECT motherboard and RFL 67P ISOL isolation board

14.1. INTRODUCTION

This section provides information on the three major assemblies that make up the RFL 6785P chassis: the chassis itself (para 14.2), the motherboard (para 14.3), and the isolation board (para 14.4).

14.2. CHASSIS

The RFL 67P CHASSIS serves as a common enclosure for all RFL 6785P modules. Coaxial connectors on the rear panel are used to connect the RFL 6785P to the line tuning equipment; if desired, a jumper inside the chassis can be set to combine the rf input and rf output onto a single coaxial connector. The RFL 67P CHASSIS contains no field-replaceable components; because of this, there is no replaceable parts list in this section for the RFL 67P CHASSIS.

14.3. MOTHERBOARD

The RFL 67P INTERCONNECT motherboard is mounted toward the rear of the RFL 67P CHASSIS. It provides all electrical interconnections between the modules. Mating connectors on the motherboard accept cables from the isolation board (para 14.4); these cables bring input signals onto the motherboard, and pass output signals over to the isolation board, where they can be fed to external equipment.

The motherboard contains no field-replaceable components; because of this, there is no replaceable parts list in this section for the motherboard. Figure 14-4 at the end of this section is a component locator drawing that shows the loaction on all jumpers and cable connectors on the motherboard. A schematic for the motherboard appears in Figure 14-5 at the end of this section.

14.4. ISOLATION BOARD

14.4.1. Description

The RFL 67P ISOL Isolation Board is mounted to the rear panel of the RFL 67P CHASSIS. It contains three optically-isolated input circuits (CARRIER START, CARRIER STOP, and RESERVE SIGNAL KEY), two isolated output drivers (BLOCK OUTPUT and CHECKBACK OUTPUT), three output relays (BLOCK RECEIVED, TX FAIL ALARM, and PS FAIL ALARM), and high-voltage and transient suppression circuits. Terminal blocks on the RFL 67P ISOL extend out of the rear panel, and are used to connect external equipment to the RFL 6785P.

The RFL 67P ISOL protects the RFL 6785P terminal from surges and transients that may be riding on the input and output lines. It also changes the logic-level signals used inside the RFL 6785P terminal into higher-level signals used by external equipment.

14.4.2. Specifications

As of the date this manual was published, the following specifications apply to the RFL 67P ISOL Isolation Board. Because all RFL products undergo constant refinement and improvement, these specifications are subject to change without notice.

Input Voltage: 42 to 141.9 Vdc @ 18 mA maximum.

Output Current:
- Solid-State Outputs:
  - +25°C Ambient Temperature: 1.0 ampere.
  - +65°C Ambient Temperature: 0.675 ampere @ 125 Vdc maximum.
- Relay Outputs:
  - Switching Current: 1.0 ampere @ +65°C.
  - Minimum Load Current: 0.05 ampere.
  - Maximum Off Voltage: 1000 Vdc.

Input-To-Output Isolation: 3750 Vac rms.

Surge Withstand Capabilities (SWC): All input and output lines withstand the common mode and transverse mode transients called out in IEEE 474-1974 without false operation or damage.

Environmental:
- Temperature Range: -20°C to +60°C (-4°F to +140°F).
- Relative Humidity: Up to 95% at +40°C (+104°F).

Input Power Requirements: +12 Vdc, 30 mA maximum.

Dimensions: 4.94 inches wide x 8.75 inches long x 1.625 inches behind panel (12.5 cm x 22.2 cm x 4.1 cm); mounts to rear panel with terminal blocks portruding through slots.

14.4.3. Theory Of Operation

The RFL 67P ISOL Isolation Board changes the logic-level signals used inside the RFL 6785P terminal into higher-level signals used by external equipment. It contains input modules for accepting inputs from external equipment and converting them to signal levels that can be accepted by the input/output module, output modules for converting signals produced by the input/output module into drive signals for external equipment, and output relays that provide higher-current block outputs and alarm outputs.

14.4.3.1. Input Modules

K6, K7, and K8 are optically-isolated solid-state input modules. The current input signal to these modules is derived from the station battery through fault relay contacts and 5000-ohm limiting resistors. The modules contain internal circuits for protection against high-voltage transients.

An input signal applied to the input terminals of these modules will cause the output transistors to pull down a 1000-ohm resistor on the AM I/O board (Section 5).

14.4.3.2. Output Modules

K4 and K5 are optically-isolated, 1-amp, solid-state output modules. Signals applied to their inputs cause their output transistors to conduct, effectively shorting the output terminals together. Capacitors and inductors connected to their output terminals protect the output transistors from high-voltage transients. The output lines from trip output module K5 are also fed through the AM I/O card; this allows the trip current to be monitored from the front of the terminal. K4 is used by the checkback card to signal a completed test.

Resistors R8 and R9 are mounted on the terminal blocks and limit the output current to different levels; resistor R7 performs the same function, but is mounted to the rear panel.

14.4.3.3. Output Relays

K1, K2, K3 and K10 are used as low speed mechanical outputs. K1 is a SPDT (Form C) relay used to signal a TX FAIL condition. K2 is a SPDT (Form C) relay used to signal a POWER FAIL condition. K3 is a SPDT (Form C) relay used to signal a TRIP condition. K10 is a SPDT (Form C) relay used as a backup TRIP output when program jumper J3 is in position A. When program jumper J3 is in position B, K3 is used as test in process, for use with checkback systems.

Table 14-1. Replaceable parts, RFL 67P ISOL Isolation Board Assembly No. 104035-1

Circuit Symbol (Figs. 14-2 & 14-3)	Description	Part Number
C1-6	Capacitor, ceramic disc, 0.005μF, 20%, 3kV, Centralab DD30-502 or equiv.	1007 1264
C7	Capacitor, X7R ceramic, 0.1μF, 10%, 50V, AVX SA305C104KAA or equiv.	0130 51041
CR1-3, 6	Diode, silicon, 200 PIV, 1N4003	30769
CR4	Transient suppressor, bi-directional, 380- to 420-volt breakdown, General Semiconductor 1.5KE400CA or equiv.	30442
CR5	Diode, Zener, 5.1V, 5%, 1W, 1N4733A	29759
J3	Program jumper connector	98306
K1, 2, 3, 10	Relay, SPDT, 5-amp contacts, 12-volt coil, American Zettler AZ8-1CH-12DE or equiv.	101178
K4,5	Optical output module, 5-volt input, 4- to 200-volt output @ 1 amp load current, Grayhill 70M-ODC-5A or equiv.	30267
K6-9	Optical input module,3- to 32-Vdc input A 18 mA, 5-volt logic output @ 50 mA, Grayhill 70M-IDC5 or equiv.	98098
L1-6	Inductor, rf, 10μH, 5%, J.W. Miller 4622 or equiv.	30285
Q1	Transistor, silicon, PNP, National 2N3905 or equiv.	21564
R1-6, 12, 13	Resistor, wirewound, 5KΩ, 5%, 3.25W, Ohmite 4442 style 995-3A or equiv.	1100 460
R7 (1)	Resistor, wirewound, 1%, value and power rating dependent upon station battery voltage:	
	48-Volt Terminals: 210Ω, 25W, Dale RH-25 or equiv.	1100 771
	129-Volt Terminals: 600Ω, 50W, Dale RH-50 or equiv.	1100 767
R8 (2)	Resistor, wirewound, 5%, value and power rating dependent upon station battery voltage:	
	48-Volt Terminals: 27Ω, 2.25W, Ohmite 3902 Style 995-2A or equiv.	1100 770
	129-Volt Terminals: 62Ω, 5W, Ohmite 4584 Style 995-5B or equiv.	1100 766
R9 (2)	Resistor, wirewound, 5%, 5W, value dependent upon station battery voltage:	
	48-Volt Terminals: 390Ω, Ohmite 4607 Style 995-5B or equiv.	1100 573
	129-Volt Terminals: 4.5KΩ, Ohmite 4640A Style 995-5B or equiv.	1100 690
R10	Resistor, metal film, 182Ω, 1%, 1/2W, Type RN1/2	0410 2217
R11	Resistor, metal film, 511Ω, 1%, 1/4W, Type RN1/4	0410 1260
R14	Resistor, metal film, 1KΩ, 1%, 1/4W, Type RN1/4	0410 1288

1.Mounted on rear panel of chassis.

2.Mounted on rear-panel terminal blocks.

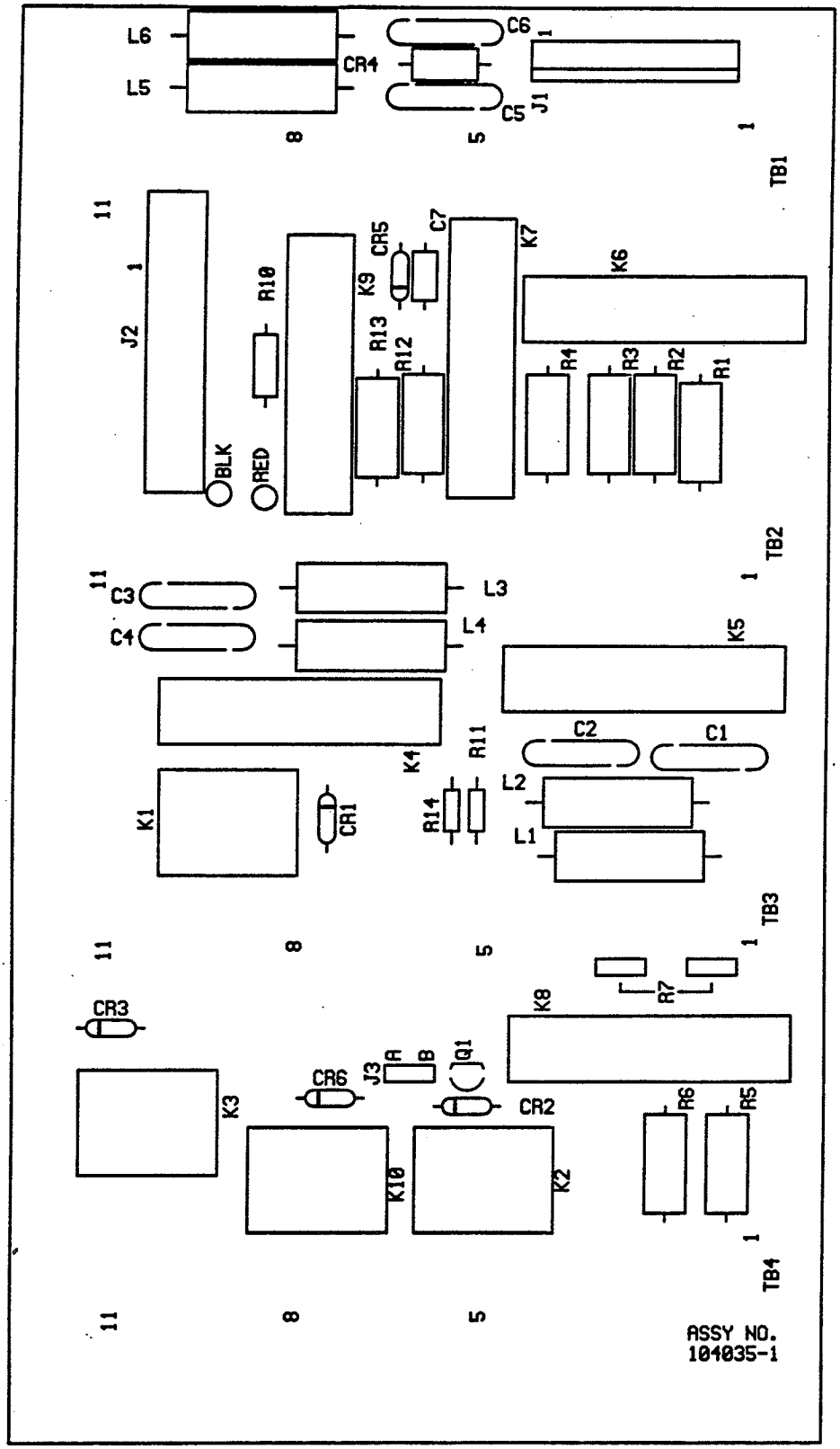
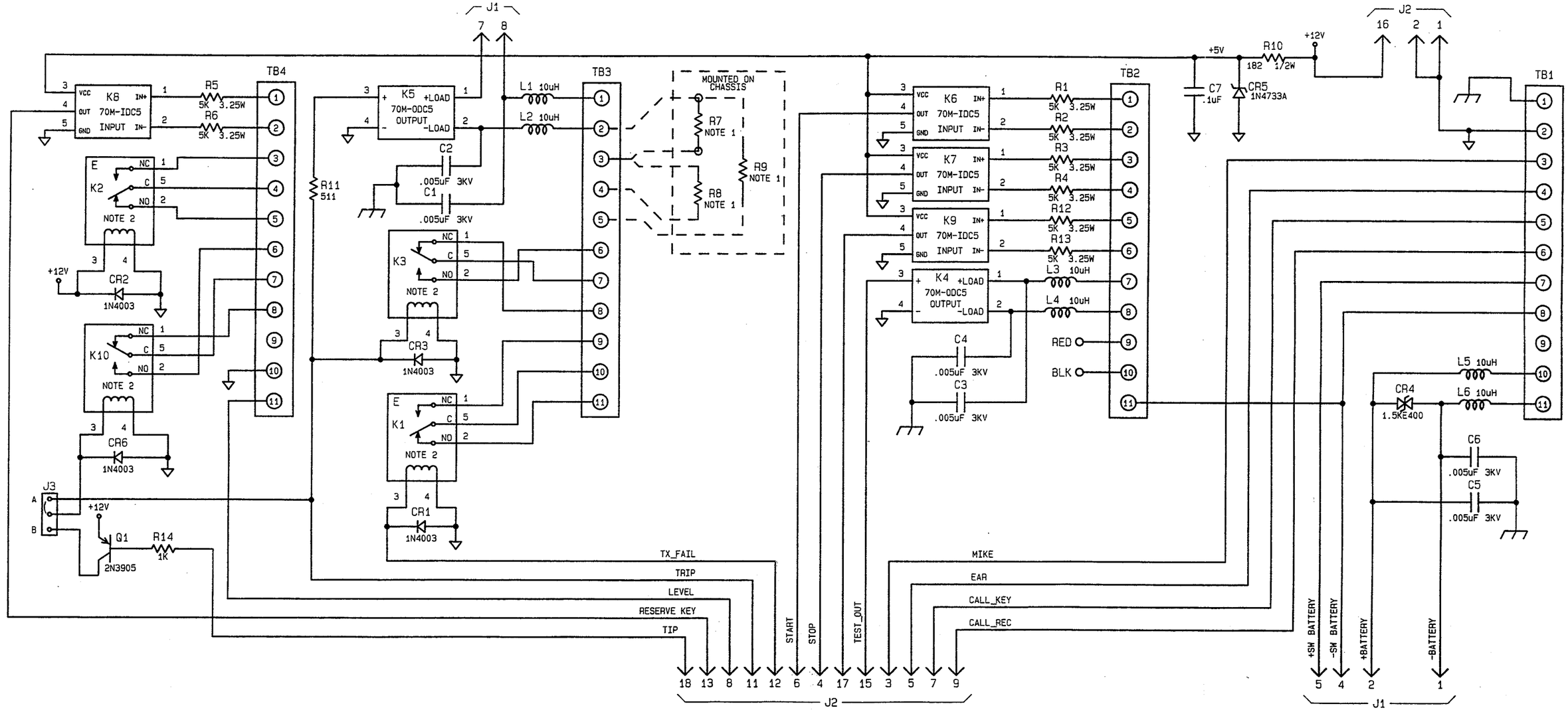


Figure 14-2. Component locator drawing, RFL 67P ISOL Isolation Board (Assembly No. 104035-1; Circuit Board No. 104038-1, Rev. C)



NOTES:

1. R7 IS MOUNTED INSIDE OF REAR PANEL AND R8 & R9 ARE MOUNTED ON TERMINAL BLOCK.
2. K1, K2, K3 AND K10 ARE AZ8-1CH-12DE RELAYS (101178). K1 AND K2 ARE SHOWN IN THEIR NORMAL (ENERGIZED) STATE. K3 AND K10 ARE SHOWN IN THEIR NORMAL (DE-ENERGIZED) STATE.

Figure 14-3. Schematic, RFL 67P ISOL Isolation Board (Assembly No. 104035-1; Schematic No. 104039-1, Rev. B)

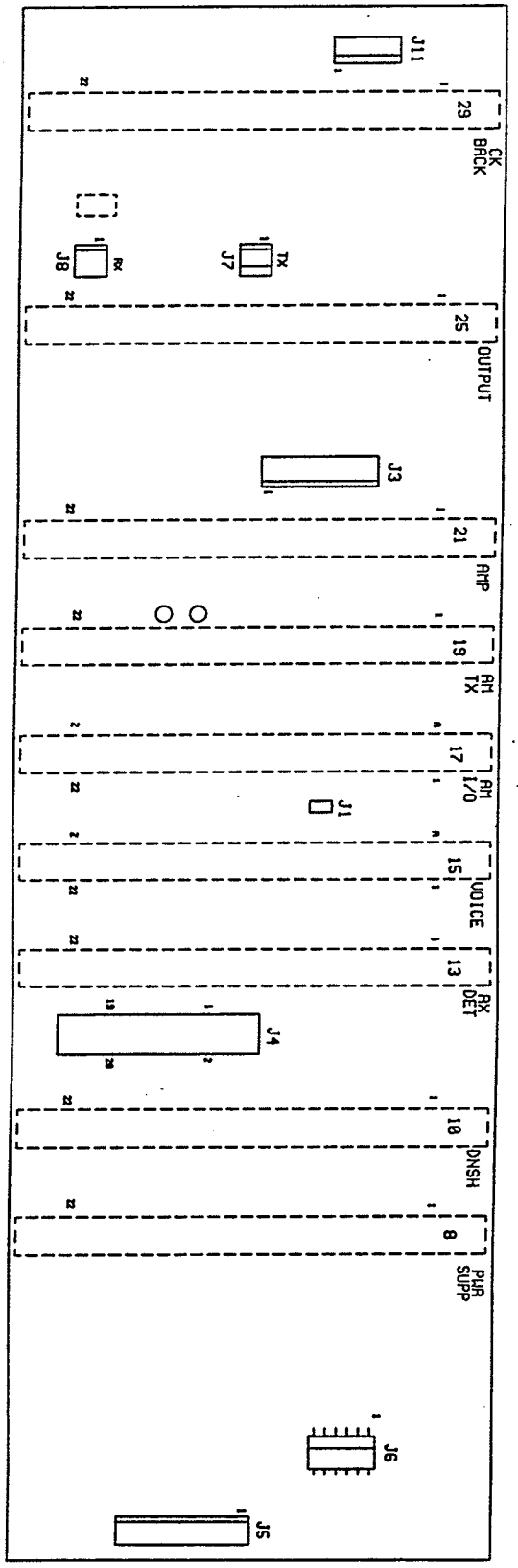


Figure 14-4. Component locator drawing, RFL 67P INTERCONNECT Chassis Motherboard (Assembly No. 1040305-1; Circuit Board No. 104033-1, Rev. B)

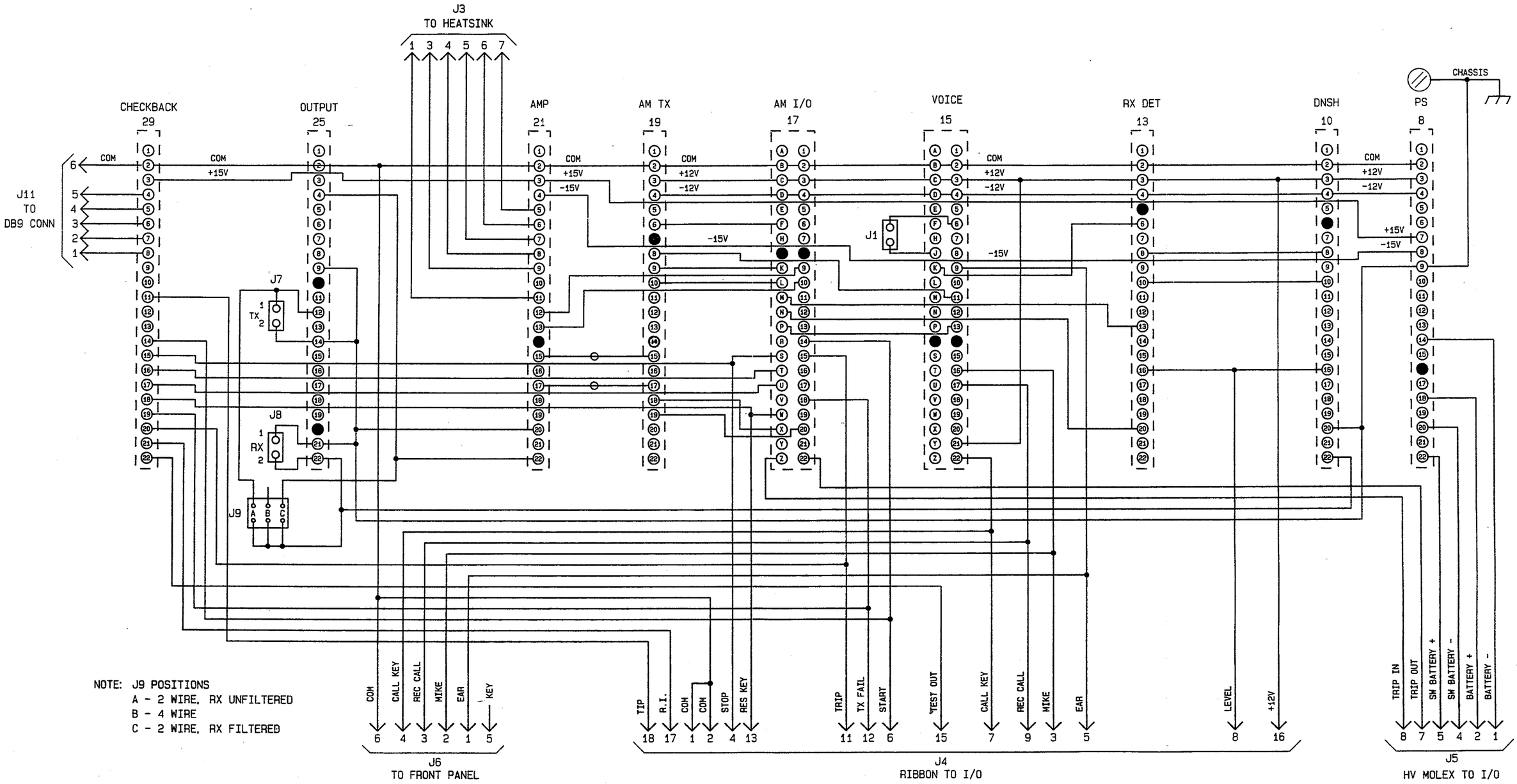
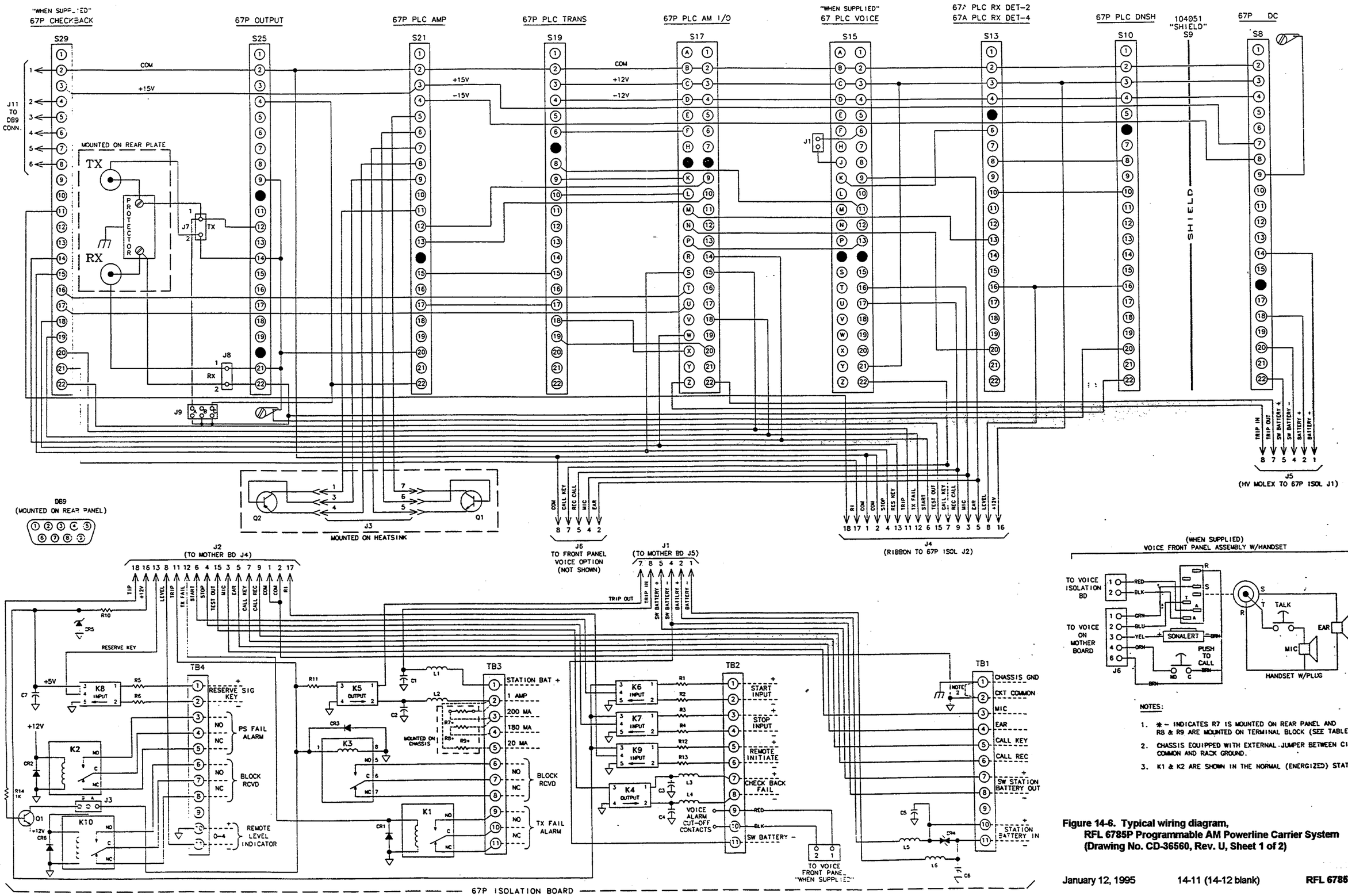


Figure 14-5. Schematic, RFL 67P INTERCONNECT Chassis Motherboard (Assembly No. 104030; Schematic No. 104034-1, Rev. B)



NOTES:

1. * – INDICATES R7 IS MOUNTED ON REAR PANEL AND R8 & R9 ARE MOUNTED ON TERMINAL BLOCK (SEE TABLE 1).
2. CHASSIS EQUIPPED WITH EXTERNAL JUMPER BETWEEN CIRCUIT COMMON AND RACK GROUND.
3. K1 & K2 ARE SHOWN IN THE NORMAL (ENERGIZED) STATE.

Figure 14-6. Typical wiring diagram, RFL 6785P Programmable AM Powerline Carrier System (Drawing No. CD-36560, Rev. U, Sheet 1 of 2)

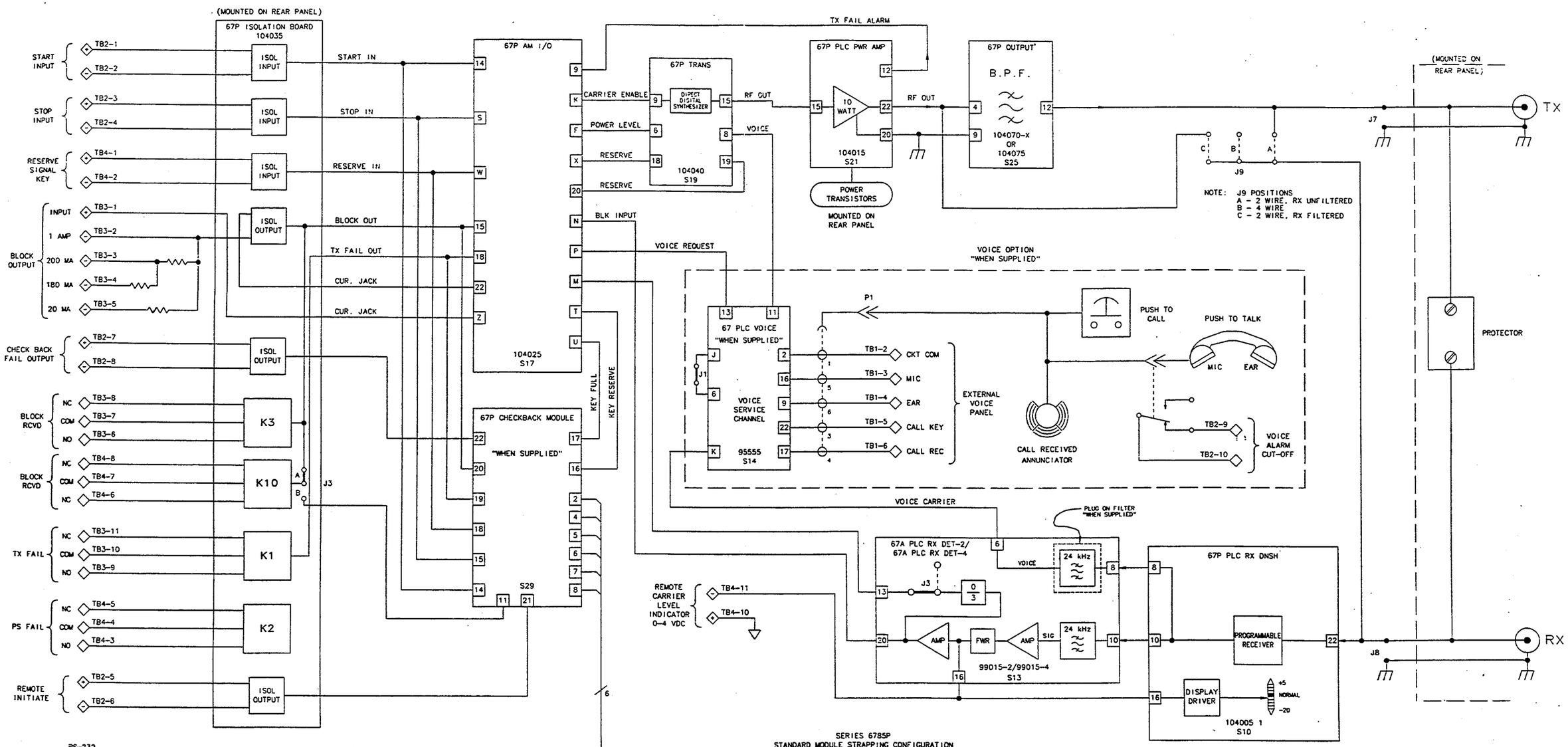


TABLE 2

RS-232	
PIN #	DESC.
1	CTS
2	RTS
3	TXD
4	RXD
5	DTR
6	GND

SERIES 6785P
STANDARD MODULE STRAPPING CONFIGURATION

	STRAPS/DIP SWITCHES	BLOCKING
67P RX DNSH	SW1-1 THRU SW1-8 SW2-1 THRU SW2-3	DETERMINED BY CARRIER FREQ. PER SALES ORDER. SEE SEC. 3.3.1 OF MANUAL
	SW2-4	OFF
	SW3-1 THRU SW3-8	SEE TABLE 3-12 OF MANUAL
67A PLC RX DET	J1	BLK
	J2	A
	J3	IN
	J4	B
67 PLC VOICE "WHEN SUPPLIED"	IN/OUT	B
67P PLC AM I/O	J2,J3	SEE SEC. 3.3.4(a),(b) OF MANUAL
	J4	A
	J5	A (NO VOICE), B (VOICE)
	J6	C
67P PLC TRANS	J1 THRU J7	A
	SW1-1 THRU SW1-8 SW2-1 THRU SW2-6	DETERMINED BY CARRIER FREQ. PER SALES ORDER. SEE SEC. 3.3.5(b) OF MANUAL
	SW2-7,SW2-8,SW3	OFF
67P OUTPUT	J1 THRU J7	DETERMINED BY CARRIER FREQ PER SALES ORDER SEE TABLE 3-13 OF MANUAL

TABLE 1

STATION BATTERY	POWER SUPPLY	R7 200mA OUT	R8 180mA OUT	R9 20mA OUT
48V	104020-2	210Ω 30385-2	27Ω 1100-770	390Ω 1100-573
129V	104020-3	600Ω 30385-3	60Ω 1100-766	4.5kΩ 1100-690

Figure 14-7. Typical wiring diagram, RFL 6785P Programmable AM Powerline Carrier System (Drawing No. CD-36560, Rev. U, Sheet 2 of 2)

Section 15. ACCESSORY EQUIPMENT

If any accessory equipment was furnished with your RFL 6785P terminal at the time of purchase, information on these accessory items will be found immediately following this page. This may include Instruction Data Sheets, schematics, wiring diagrams, or other documents.