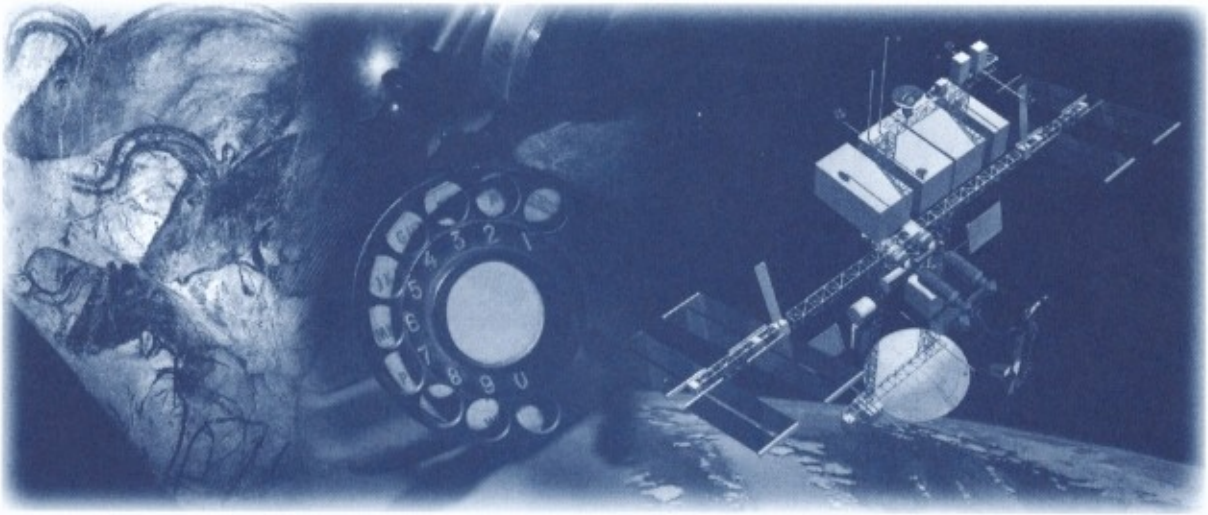

RFL 6745

FREQUENCY-SHIFT AUDIO-TONE PROTECTIVE RELAYING SYSTEM

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INSTRUCTION MANUAL

RFL 6745
Frequency-Shift Audio-Tone
Protective Relaying System

NOTICE

Publication Number MC 6745
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Revised February 26, 1993

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 date of shipment. This warranty does not apply if the equipment has been damaged by accident, neglect, misuse, or causes other than performed or authorized by RFL Electronics Inc. This warranty specifically excludes damage incurred "in shipment" to or from RFL. In the event that an item is received in damaged condition, the carrier should be notified immediately. All claims for such damage should be filed with the carrier.

NOTE

If you do not intend to use the product immediately, it is recommended that it be opened immediately after receiving and inspected for proper operation and signs of impact damage.

This warranty is in lieu of all other warranties, whether expressed, implied or statutory, including but not limited to implied warranties of merchantability and fitness for a particular purpose. In no event shall RFL be liable, whether in contract, in tort, or on any other basis, for any damages sustained by the customer or any other person arising from or related to loss of use, failure or interruption in the operation of any products, or delay in maintenance or for incidental, consequential, indirect or special damages or liabilities, or for loss of business or other financial loss arising out of or in connection with the sale, lease, maintenance, use, performance, failure or interruption of the products.

RFL Electronics Inc.
Boonton, New Jersey USA

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 electrical 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 protective 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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* - U.S. Patent No. 4,015,220.

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BIBLIOGRAPHY

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TRADEMARKS

Section 1. GENERAL INFORMATION

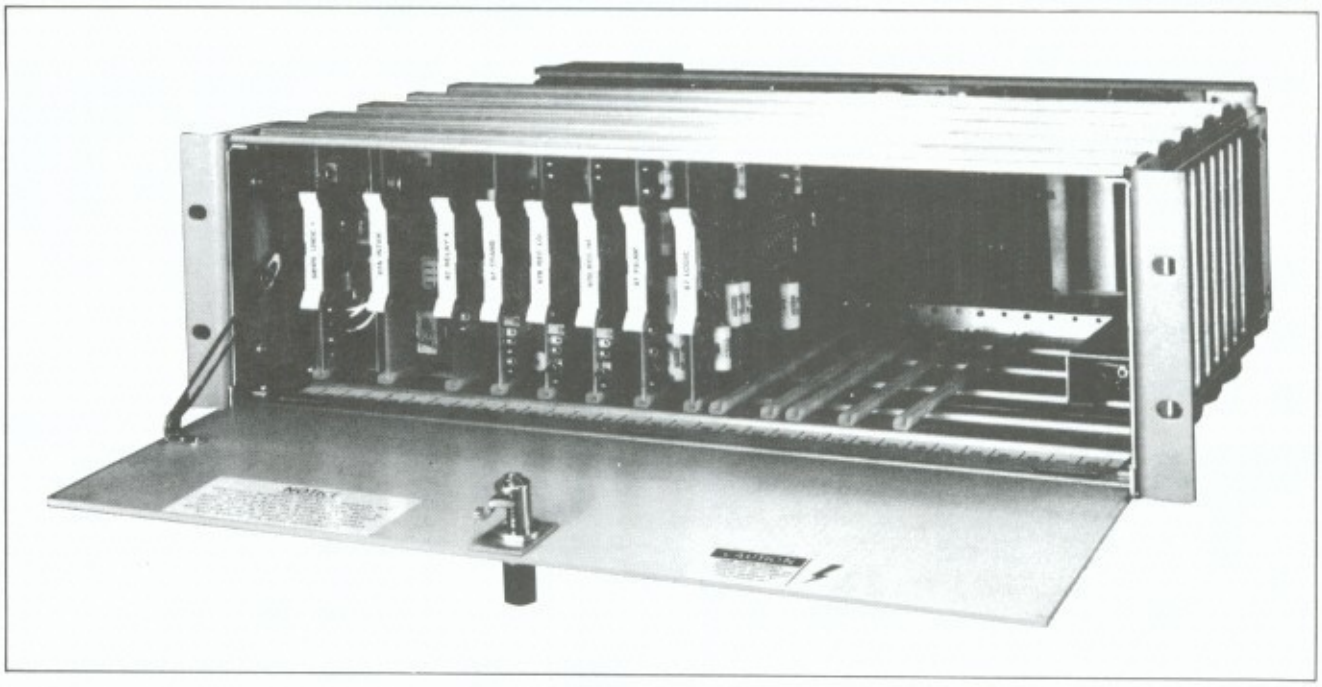


Figure 1-1. RFL 6745 Frequency-Shift Audio-Tone Protective Relaying System

1.1. PURPOSE OF THIS MANUAL

This manual provides operation and maintenance information for the RFL 6745 Frequency-Shift Audio Tone Protective Relaying 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 board modules.

1.2. PURPOSE OF EQUIPMENT

The RFL 6745 is a voice-frequency carrier communication system, specifically designed for the transmission of protective relaying commands from one point to another. RFL 6745 equipment exhibits a high degree of security against false commands or failure to deliver valid commands. Redundancy, supervisory monitoring, and logical testing for validity are used freely throughout the RFL 6745 for enhanced reliability.

The RFL 6745 is a completely self-contained, solid-state, dual-subchannel system. Its voice-frequency signals can be used directly over communication circuits, or they may be frequency-translated to powerline carrier frequencies, including single-sideband formats.

1.3. FEATURES

- **Dual Subchannels.** Provides optimum performance and dependability at reduced cost.
- **Crystal-Controlled Oscillators And Tracking Active Bandpass Filters.** Maintain stable outputs with virtually zero time delay and harmonic-free sine waves.
- **Built-In 600-Hz High-Pass Filters.** These filters protect the integrity of undistorted, unsuppressed signals - even at levels as low as -30 dBm with 40-Vac signals induced across the line.
- **Redundant Circuitry.** Assures fail-safe security against false trips caused by the failure of any single component.
- **Wide Dynamic Range.** Two-wire transmitter output levels are adjustable from -40 dBm to +20 dBm. Four-wire transmitter output levels are adjustable from -40 dBm to +30 dBm.

- **Automatic Gain Control (AGC).** Will hold signal level constant during dynamic range variations as high as 20 dB.

- **In-Band Noise Detection.**

- **Trip-Up/Trip-Down Frequency-Shift Coding.**

- **Guard-Before-Trip Logic.**

- **Trip Hold/Hold Off Timer.**

- **Optically-Isolated Trip Inputs And Outputs.**

- **High-Speed Quadrature AM Detectors.**

- **Low-Threshold Linear FS Detectors.**

- **Meets IEEE High-Potential And Surge Withstand Capability (SWC) Specifications.** In standard units, the trip input, trip output, and tone lines are isolated from ground and from all other circuits. Breakdown is 1500 Vrms @ 60 Hz, 2200 Vdc, and 2500 volts @ 1.5 MHz, in accordance with IEEE 472-1974 (ANSI C.37.90a-1974).

  In units equipped with the Fast-Transient Option, the Power input, trip input, trip output, redundant trip output, BLOCK contact sets, and ALARM contact sets are isolated from chassis ground and each other by 2121 Vdc, in accordance with ANSI C.37.90-1989. The tone lines have the same ratings without the surge suppression components installed.

- **Fast-Transient Option.** A Fast Transient Option is available for the RFL 6745. With this option, special motherboards and rear-panel interface boards are fitted to assure compliance with the SWC requirements of ANSI C.37.90 and the Fast Transient requirements of ANSI C.37.90.1.

- **Only Three Controls To Adjust.**

1.4. PHYSICAL DESCRIPTION

Each RFL 6745 terminal comprises a group of circuit board modules housed in a compact chassis three rack units high (5.25 inches, or 133.4 mm). The chassis accepts the circuit boards in a bookshelf style arrangement. Interconnections between the circuit boards are made by discrete wiring between the mating connectors for the circuit boards. External equipment is connected to the chassis through barrier-type terminal blocks on the rear panel.

1.5. SPECIFICATIONS

As of the date this manual was published, the following specifications apply to all RFL 6745 protective relaying systems. Specifications for individual circuit boards within the system can be found in Sections 5 through 12 of this manual. Because all RFL products undergo constant refinement and improvement, these specifications are subject to change without notice.

1.5.1. Transmitter Section

Tone Frequency Tolerance: ±0.02%, crystal-controlled.

Trip Boost:
Level: Set by plug-in networks to 0 dB (no boost), 3 dB, 6 dB, 9 dB, or 12 dB.
Duration: Adjustable from zero to 200 ms.

Output Level:
Two-Wire Operation: -40 dBm to +20 dBm.
Four-Wire Operation: -40 dBm to +30 dBm (1 watt).

Harmonic Output: All harmonics in output signal are more than 40 dB below the level of the fundamental frequency.

Amplitude Stability: Output amplitude will not vary more than ±1 dB over the specified input voltage and operating temperature ranges.

Relative Output Amplitudes: The guard outputs of each subchannel will be within 1.5 dB of each other; each subchannel's guard and trip outputs will be within 0.5 dB of each other.

1.5.2. Receiver Section

Sensitivity: Adjustable from -40 dBm to 0 dBm.

AGC Dynamic Range: 20 dB.

Bandwidth: See Figure 1-2.

Discriminator Response: See Figure 1-3.

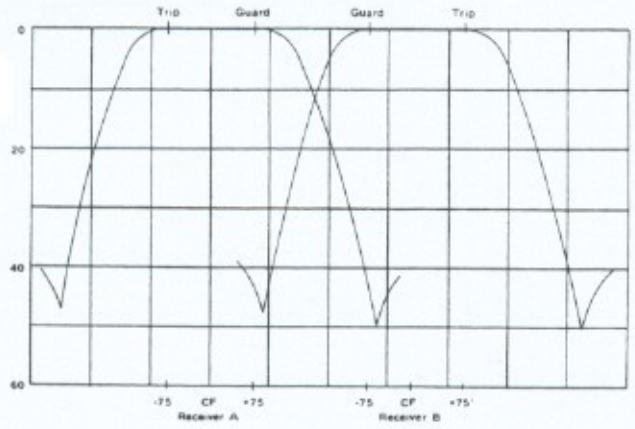


Figure 1-2. Receiver input bandwidth with 340-Hz subchannel spacing

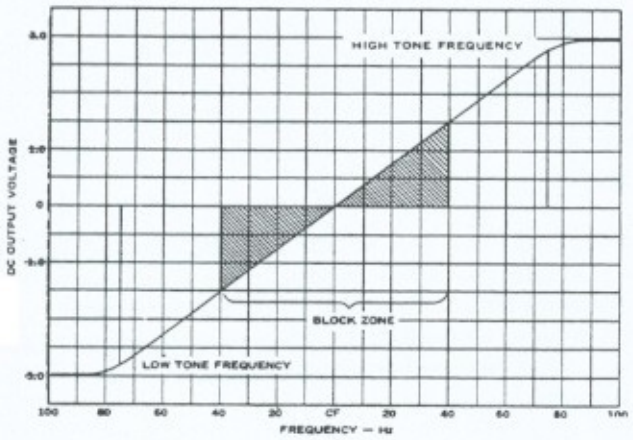


Figure 1-3. Typical discriminator response with 340-Hz subchannel spacing

1.5.3. General

Recommended Tone Frequencies: See Table 1-1.

Tone Input And Output: 600-ohm impedance, balanced, jumper-selectable for either two-wire or four-wire circuits.

On units equipped with the Fast Transient Option, the voltage between conductor and chassis ground is device-limited to 68 Vpeak. The voltage between conductors ("metallic" voltage) is device-limited to 136 Vpeak.

Input And Output Filters: High-pass, with more than 30 dB of rejection @ 50/60 Hz. A received signal at -30 dBm will not be affected by an extraneous 50/60-Hz input signal as great as 40 Vrms.

Table 1-1. Recommended tone frequencies, RFL 6745 Protective Relaying System

Group [1]	Subchannel	Center Frequency	Mode	Frequency
1	A	935	Trip Guard	860 1010
	B	1275	Guard Trip	1200 1350
2	A	1275	Trip Guard	1200 1350
	B	1615	Guard Trip	1540 1690
3 [2]	A	1615	Trip Guard	1540 1690
	B	1955	Guard Trip	1880 2030
4 [2]	A	1955	Trip Guard	1880 2030
	B	2295	Guard Trip	2220 2370
5 [2]	A	2295	Trip Guard	2220 2370
	B	2635	Guard Trip	2560 2710
6	A	2635	Trip Guard	2560 2710
	B	2975	Guard Trip	2900 3050
7	A	2975	Trip Guard	2560 2710
	B	3315	Guard Trip	2900 3050
8	A	935	Trip Guard	785 1085
	B	1615	Guard Trip	1465 1765
9	A	1615	Trip Guard	1465 1765
	B	2295	Guard Trip	2145 2445
10	A	2295	Trip Guard	2145 2445
	B	2975	Guard Trip	2825 3125

1. Groups 1 through 7 have 340-Hz subchannel spacings, and a nominal bandwidth of 170-Hz. Groups 8 through 10 have 680-Hz subchannel spacings, and a nominal bandwidth of 340-Hz.
2. Preferred for minimum noise and to avoid roll-off at lower or upper end of communications channel. CCITT frequencies and spacings are also available on request.

Trip Time Delay (typical):

340-Hz Subchannel Spacing: 12 ms.
680-Hz Subchannel Spacing: 8 ms.

Trip delay is measured with transmitter and receiver connected back-to-back. Shorter times are available for permissive trip applications, with reduced security.

Security: See Figure 1-4.

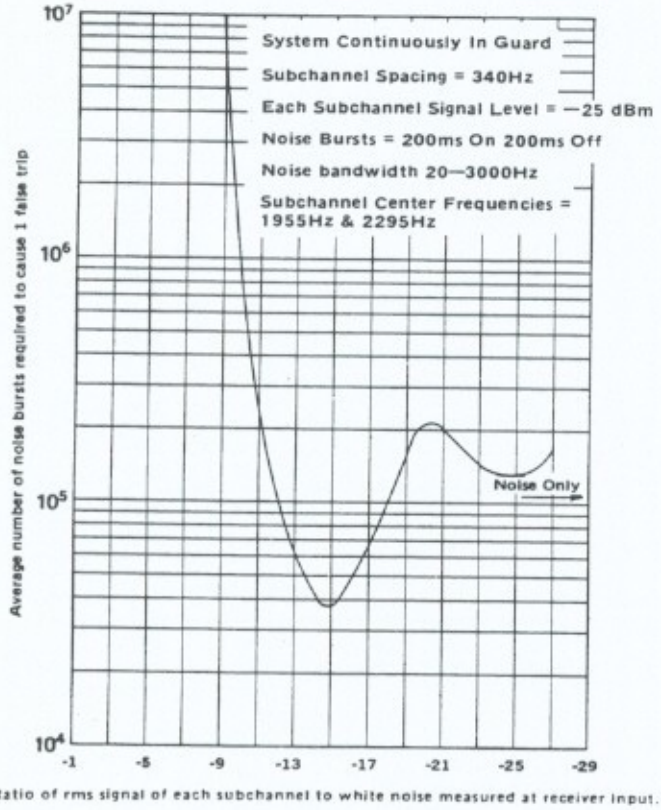


Figure 1-4. Security with 340-Hz subchannel spacing

Dependability: See Figure 1-5.

Trip Input: Station battery voltage (24, 48, or 129 Vdc) fed into floating optical isolators. Input current is 20 to 30 mA.

Trip Output: Base drive to a floating NPN transistor rated for collector currents of 1 ampere and open-circuit voltages of 150 volts. Open-circuit leakage current is less than 2 mA.

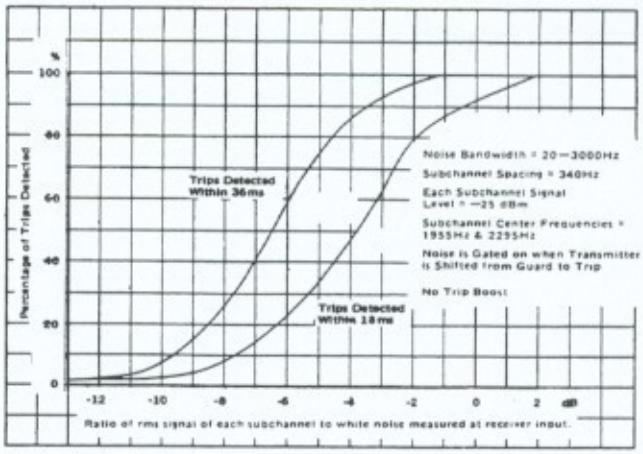


Figure 1-5. Dependability with 340-Hz subchannel spacing

Block Output: Two sets of Form C relay contacts; each set rated 50 Vdc @ 2A (resistive load). Current must be derated if relays are to be used at higher voltage. The block output relay will de-energize after 100 ms if power failure or an abnormal signal is sensed.

Alarm Output: Two sets of Form C relay contacts; each set rated 50 Vdc @ 2A (resistive load). Current must be derated if relays are to be used at higher voltage. The block output relay will de-energize after 2 seconds if power failure or an abnormal signal is sensed.

System Reset Time:

340-Hz Subchannel Spacing: 12 ms.
680-Hz Subchannel Spacing: 8 ms.

Interface Dielectric Strength:

Standard Units: Trip input, trip output, and tone lines are isolated from ground and from all other circuits. Breakdown is 1500 Vrms @ 60 Hz, 2200 Vdc, and 2500 volts @ 1.5 MHz, in accordance with IEEE 472-1974 (ANSI C.37.90a-1974).

Units Equipped With Fast Transient Option: Power input, trip input, trip output, redundant trip output, BLOCK contact sets, and ALARM contact sets are isolated from chassis ground and each other by 2121 Vdc, in accordance with ANSI C.37.90-1989. The tone lines have the same ratings without the surge suppression components installed.

Surge Withstand Capability (SWC): In units equipped with the Fast Transient Option, the power input, trip input, trip output, redundant trip output, BLOCK contact sets, and ALARM contact sets are protected in accordance with ANSI C.37.90.1-1989.

CAUTION

Only the the power input, trip input, trip output, redundant trip output, BLOCK contact sets, and ALARM contact sets are protected on units equipped with the Fast Transient option. The TX MULT and RX MULT connections (TB2-5 through TB2-8 on the rear panel) are not protected. Any attempt to test an unprotected customer wiring point in accordance with ANSI C.37.90.1-1989 may result in component damage.

Operating Temperature: -30°C to +60°C (-22°F to +140°F).

Power Requirements:
24-Volt Systems: 21 to 28 Vdc, 50 watts max.
48-Volt Systems: 42 to 56 Vdc, 50 watts max.
129-Volt Systems: 104 to 140 Vdc, 50 watts max.

Chassis Dimensions: All chassis dimensions (including mounting hole centers) conform to EIA specifications:
Height: 5.25 inches (13.4 cm).
Panel Width: 19 inches (48.3 cm).
Depth: 12.5 inches (31.8 cm).

Maximum Weight: 15 lbs (6.8 kg).

1.6. SYSTEM CONFIGURATION

Each RFL 6745 terminal is housed in a rack-mounted chassis containing interconnected circuit board modules. The space and power requirements for all RFL 6745 modules are listed in Table 1-2, along with the section number in this manual where additional information on each module can be found.

1.7. FUNCTIONAL BLOCK DIAGRAM

The block diagram of a typical RFL 6745 system is shown in Figure 1-6. Paragraphs 1.7.1 through 1.7.12 describe the different parts of the RFL 6745 system.

1.7.1. Basic System Layout

As shown in Figure 1-6, each RFL 6745 terminal contains a transmitter (para 1.7.3) with two tone generators, one for each subchannel. Each subchannel is processed by a separate wideband receiver module (para 1.7.4). The outputs of both wideband receivers are fed to a FS/AM detector module (para 1.7.5), which feeds the logic module (para 1.7.6). A second logic module may be connected in parallel with the first for increased system security.

An interface module (para 1.7.2) carries trip input circuits for the transmitter, coupling circuits to connect the transmitter output and the receiver inputs to the communications medium, and a trip output circuit. A second trip output circuit is added to the interface module in systems containing two logic modules. A relay module (para 1.7.7) contains the block and alarm relays, and has provisions for optional guard-output and transmit-flasher circuits.

1.7.2. Interface Module

The interface module accepts trip inputs for the transmitter, interfaces the RFL 6745 to the communications medium, and produces an optically-isolated trip output.

a. Trip Voltage Input Processing. Trip voltages (either 24, 48, or 129 Vdc) are applied through a current limiting resistor to two optical isolators. Each isolator drives a separate Schmitt trigger on the transmitter module. Each keying circuit is wired out separately for test purposes; under normal operation conditions, both circuits are connected in parallel for keying by the relay system.

b. Line Interfacing. The interface module contains linear toroidal line coupling transformers for both transmit and receive signals. These transformers are combined with tuning capacitors to form high-pass filters with 600-Hz cutoff frequencies. They will suppress any 50/60-Hz signal that may be induced in the communication circuit. Received signals as low as -30 dBm are not distorted by 50/60-Hz signals as high as 40 Vrms.

c. Trip Output Processing. An optical isolator accepts the trip output from the logic module and delivers base drive current to an NPN transistor switch. This switch can supply up to one ampere of current, which is used to drive an auxiliary trip relay. For solid-state relay systems, the trip-buffer output is driven directly by the logic module.

Table 1-2. Space and power requirements, RFL 6745 circuit board modules

Description	Model Number	Assembly Number	+12V Current Draw (1)	-12V Current Draw (1)	Module Spaces Req'd.	Additional Information
Interface Modules:						
Single Trip Output	67C INTER	104695	. . .	50 (3)	2	Section 5
Dual Trip Output	67C INTER-1	104695-1	. . .	50 (3)		
Transmitter Module	67 TRANS	41010	110	20	2	Section 6
Wideband Receiver Module (2)	67B REC	101110	30	30	2	Section 7
FS/AM Detector Module	67 FS/AM	41015	55	55	2	Section 8
Logic Modules:						
Standard Range	67 LOGIC	41020	60 (4)	50 (5)	2	Section 9
Wide Dynamic Range	67A LOGIC	47000	180	70	3	
Wide Dynamic Range (redundant)	67A LOGIC-1	. . .	135	25	3	
Relay Modules:						
Block/Alarm	67A RELAY	104690	. . .	45	2	Section 10
Block/Alarm w/Guard And Flasher	67A RELAY-4	104690-4	40	90		
Dc-dc Converter Power Supplies:						
24-volt input	68 HPS 24DC-1	41935-1				
48-volt input	68 HPS 48DC-1	41515-1	1000	1000	3 (6)	Section 11
129-volt input	68 HPS 129DC-1	41505-1				
Chassis, 3RU	68 CHAS		. . .	. . .	. . .	Section 12
Motherboards:						
Standard Product Single Logic	. . .	47040	. . .	. . .	(7)	
Standard Product Dual Logic	. . .	47030	. . .	. . .	(7)	
Fast-Transient Single Logic	. . .	104605	. . .	. . .	(7)	
Fast-Transient Dual Logic	. . .	104610	. . .	. . .	(7)	
SWC Interface Boards: (8)						
Basic Connections	67 SWC INTFC-1	104615	. . .	. . .	(9)	
Custom Connections	67 SWC INTFC-2	104630	. . .	. . .	(10)	
Custom Connections w/ Transverse Protection	67 SWC INTFC-3	104635	. . .	. . .	(10)	
Accessory Equipment:						
Buffer Module	67 BUFFER	41110	100 (11)	25	2	Section 13
Narrowband Receiver (12)	67 NB REC	41085	60	25	2	
Signal Level Indicator And Monitor	67A LEV IND	101105	30	30	2	
Manual Test Panel	67 TEST	45760	75	25	2	
Manual Diagnostic Panel	67 MAN DIAG	45185	. . .	. . .	8	
Auxiliary Relay Module	67 AR (XXX)	46666-X	. . .	. . .	7	
Interface Assemblies:						
Universal	67 UNIV	90100	(13)	(13)	(13)	
w/One Trip Output Circuit	HB-90100-1	90100-1	(13)	(13)	(13)	
w/Two Trip Output Circuits	HB-90100-2	90100-2	(13)	(13)	(13)	
Card Extender	68 EXT	39585	. . .	. . .	. . .	

1. For dc-dc converter power supplies, values in these columns are output current capacity.
2. Two wideband receiver modules are required (one for each subchannel).
3. Also requires 35 mA from 10-kHz output of dc-dc converter power supply.
4. Current draw for first logic module; add 40 mA for each additional module.
5. Current draw for first logic module; add 10 mA for each additional module.
6. RFL 68 HPS **DC-1 supplies also require an RFL 68 REG External Regulator mounted on rear of chassis. (See Section 2.)
7. Mounted at rear of chassis; contains mating connectors for all other modules.
8. Used in fast-transient versions only.
9. Mounts to rear panel; occupies four terminal block slots. Used as required to make connections to accessory equipment.
10. Mounts to rear panel; occupies one terminal block slot. Used as required to make connections to accessory equipment.
11. If 18-volt output is required, this module will also required 35 mA from 10-kHz output of dc-dc converter power supply.
12. Used along with wideband receiver modules (not a replacement).
13. Dependent upon auxiliary circuits installed on interface module. (Refer to RFL 67 UNIV Instruction Data Sheet for further information.)

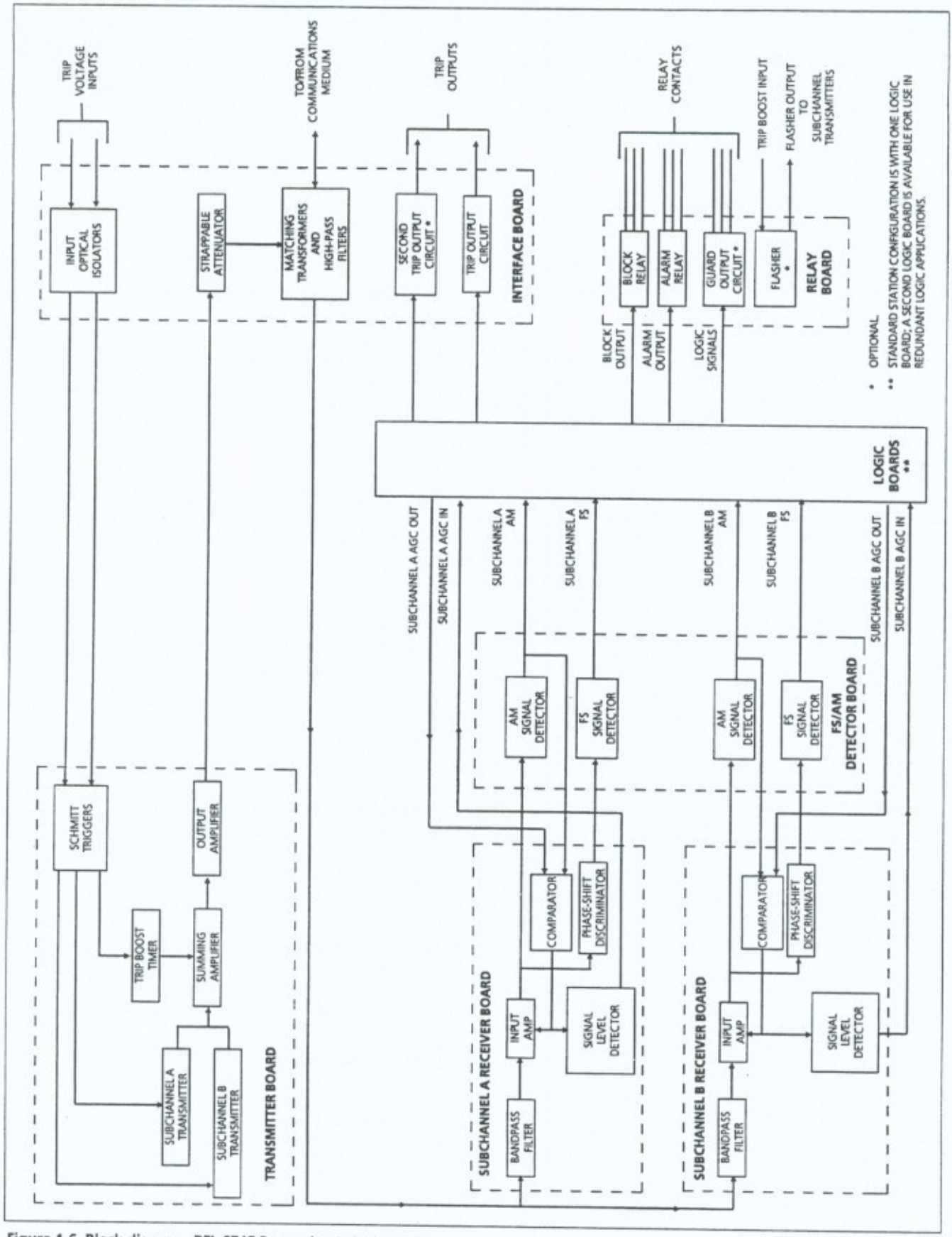


Figure 1-6. Block diagram, RFL 6745 Protective Relaying System

There are two different interface modules available for the RFL 6745. The RFL 67C INTER contains one isolated trip output circuit, and the RFL 67C INTER-1 contains two isolated trip output circuits. Section 5 of this manual provides additional information on both interface modules.

1.7.3. Dual-Subchannel Transmitter Module

The RFL 67 TRANS Dual Subchannel Transmitter Module contains two Schmitt triggers, one tone generator for each subchannel, a summing amplifier, and an output amplifier.

a. Schmitt Triggers. The Schmitt triggers in the transmitter accept the trip inputs from the interface module and produce the trip commands for the tone generators. The high-frequency filtering and hysteresis characteristics of the Schmitt triggers suppress any transients that may be fed to the trip input terminals.

b. Tone Generators. Each tone generator contains two crystal-controlled oscillators. One oscillator generates the guard frequency and the other generates the trip frequency. Either oscillator can be gated to feed a digital frequency divider, depending on the status of the Schmitt triggers. The divider output is passed through an active bandpass filter to suppress harmonics. The result is a pure sine wave, which is at the guard frequency under normal conditions.

A trip command from one of the Schmitt triggers will cause its tone generator to shift to the trip frequency. At the same time, feedback resistors in the active filter are switched; this will re-program the filter so that it will pass the trip frequency. This method produces a constant-level, continuous-phase, low-harmonic sine wave signal with the stability of a crystal oscillator. Crystals and all frequency-determining components in the filters are plug-in units, so channel frequencies can be changed in the field if necessary.

c. Summing Amplifier. The outputs of both tone generators are fed to a summing amplifier. Normally the output of the summing amplifier is at a fixed level, but the output can be increased if a trip boost command is applied to both Schmitt triggers. When this happens, the trip boost timer is energized, sending a boost signal to the summing amplifier. When the summing amplifier receives this signal, its gain is increased until the trip boost timer times out and the boost commands are removed. A plug-in network on the transmitter module determines the amount of boost and its duration.

d. Output Amplifier. The summing amplifier drives the output amplifier, which is capable of outputs as high as +30 dBm (1 watt). A strappable attenuator on the interface module provides coarse level adjustment to any convenient range from -40 dBm to +30 dBm; fine level adjustment is made through a gain control potentiometer on the transmitter module.

Additional information on the RFL 67 TRANS can be found in Section 6 of this manual.

1.7.4. Wideband Receiver Modules

Each RFL 6745 terminal uses two RFL 67B REC Wideband Receiver Modules, one for each subchannel. Each wideband receiver contains an input bandpass filter, an input amplifier, an AGC comparator, a quadrature signal generator, a signal level detector, and a phase shift discriminator.

a. Input Bandpass Filter. A bandpass filter at the input of each wideband receiver only passes frequencies within the selected subchannel. The passed frequencies are then applied to the input amplifier.

b. Input Amplifier. The input amplifier accepts and amplifies the signals it receives from the input bandpass filter. It is equipped with a slow-acting automatic gain control (AGC). The dynamic range of the AGC function is usually set for 20 dB. The input amplifier produces the receiver tone output, which is fed to one of the AM detectors on the FS/AM detector module.

c. Comparator. The comparator circuit is used to check the tone output level against a logic reference level generated on the logic module. Its output is applied to the input amplifier as the AGC voltage, and also drives the signal level detector.

d. Signal Level Detector. The output of the comparator is fed to a pair of signal level detectors. The outputs of these detectors are combined into one signal, which is passed on to the logic module.

e. Phase Shift Discriminator. The AGC-leveled tone output is also fed to a special linear phase shift discriminator, which has high noise rejection. This avoids generating false trip signals caused by high-level interference or noise. The discriminator features high speed, short response time, good linearity, and low output ripple.

Additional information on the RFL 67B REC can be found in Section 7 of this manual.

1.7.5. FS/AM Detectors

In the wideband receiver modules, the incoming signal for each subchannel is split into a quadrature signal. The two components are then full-wave rectified on the RFL 67 FS/AM Detector Module, applied to a summing amplifier, and then passed through a three-pole active low-pass filter. The AM signal detectors are very fast, and will effectively recognize both noise and weak signals. This recognition capability allows them to block before a false trip can be generated. The quadrature rectified signals are interleaved so that the ripple frequency is doubled and ripple amplitude is reduced by 70 percent. This technique permits good ripple rejection while using a filter with fast response obtained from a higher cutoff frequency.

Four outputs are obtained from the RFL 67 FS/AM module, and passed on to the logic module: Subchannel A AM, Subchannel B AM, Subchannel A FS, and Subchannel B FS. Section 8 of this manual provides more information on the RFL 67 FS/AM.

1.7.6. Logic Module

The logic module controls the operation of the receivers by processing the outputs from the FS/AM detector module and passing outputs to the interface module and the relay module. A second logic module may be connected in parallel with the first; this redundancy will prevent false trip outputs that may be caused by component failures.

a. AM Signal Processing. The signals passed by the AM detectors are applied to dual-threshold window detectors on the logic module. In-band noise or interfering tones will modulate the level of the received signal away from its normal value. If the level goes beyond the limits set for the window comparator, the logic module will inhibit trip and deliver a block output signal to the relay module.

b. FS Signal Processing. The outputs from the FS discriminators are dc voltages that are negative when the tone is at guard frequency, and positive when the tone is at trip frequency. Threshold detectors on the logic module sense which frequency is received.
If one subchannel is neither at trip nor guard, the output from its FS discriminators will be near zero volts. This is referred to as the discriminator's "dead zone". When this condition occurs, trip inhibit and block output signals will be sent to the relay module.

c. AGC Level Control. Signal level detectors on the wideband receiver modules monitor the AGC voltages being applied to their input amplifiers. If the AGC voltage goes beyond predetermined limits, an out-of-limits signal will be sent to the logic module, and a block output signal will be sent to the relay module.

A plug-in network on the logic module sets threshold levels for the AGC circuits, the threshold detectors, and the window detectors. The network is chosen to complement the plug-in network on the transmitter module that determines the trip boost level (para 1.7.2c).

d. Logic Circuits. Digital logic circuits on the logic module monitor the outputs of all the comparators on the logic module as well as the signal level detectors on the wideband receiver modules.

On Subchannel A, the guard frequency is higher than the center frequency, and on Subchannel B, the guard frequency is lower than the center frequency. Under normal conditions, these frequencies are present, and the system is in the "guard" mode. If both subchannels shift to their trip frequencies (Subchannel A below center frequency, Subchannel B above center frequency), the system will enter its "trip" mode.

Noise, interference, or frequency translation can prevent the system from entering the trip mode. This is referred to as a "trip inhibition". Trip inhibition can also occur if the amount of time between the end of guard mode and the start of trip mode is more than 100 ms. If this happens and a jumper on the logic module is set to the G/T (guard-before-trip") position, the trip inhibition will only be removed after guard has been received for at least 100 ms.

When trip is inhibited for 100 ms or more, or if signal is lost or wrong disposition of guard and trip frequencies occurs, the system will enter its "block" mode. A block can only be removed by a return to guard state for at least 100 ms.

For permissive trip applications, the receive logic circuits can be connected to conditionally defeat the guard-before-trip requirement. High security is maintained because a guard signal must still proceed the first trip, although guard does not have to proceed subsequent trips.

There are two different logic modules available for the RFL 6745. The RFL 67 LOGIC Standard-Range Logic Module is used in most applications. The RFL 67A LOGIC Wide-Dynamic-Range Logic Module is used in applications where signals of varying level will be received, or where large amounts of noise may be

present. Section 9 of this manual provides additional information on both logic modules.

1.7.7. Relay Modules

Relay modules provide higher output current capacities for the RFL 6745. The RFL 67A RELAY Relay Module carries block and alarm relays that are normally held in while the system is in a guard or a trip mode. When a block occurs, the block relay drops out and its contacts change position. If the block condition persists for more than two seconds, the alarm relay will also drop out and its contacts will change position.

The RFL 67A RELAY-4 Relay Module is similar to the RFL 67A RELAY, except that is also contains guard output and flasher circuits that may be needed for specific applications. Additional information on both relay modules can be found in Section 10 of this manual.

1.7.8. Dc-Dc Converter Power Supplies

RFL 6745 terminals use dc-dc converter power supplies to produce bipolar regulated voltages from an unregulated dc source. They produce two outputs: +12 volts and -12 volts. Three different versions are available to accommodate station batteries from 24 to 129 volts. Additional information on these power supplies can be found in Section 11 of this manual.

1.7.9. Chassis

The RFL 68 CHAS chassis serves as the main enclosure for the RFL 6745, providing a means of housing and interconnecting all the RFL 6745 modules. It can be mounted in any standard EIA 19-inch rack or cabinet, or it can be used as a standalone desk-mount cabinet. When rack-mounted, the RFL 68 CHAS occupies three vertical rack mounting spaces, or 5.25 inches of vertical panel space (13.34 cm). Adjustable mounting ears allow the chassis to be mounted so that its front panel is either flush with the rack or protruding out the front of the rack. Additional information on the RFL 68 CHAS can be found in Section 12 of this manual.

1.7.10. Motherboards

Motherboards provide power and signal interconnections between all RFL 6745 circuit board modules. Each circuit board connector on the motherboard is keyed to only accept the module for which it is wired. Four different motherboards are available for use in the RFL 6745. The motherboard used in your unit will depend upon its basic configuration:

Single Logic Board:	
Standard Product	47040
Fast-Transient Version	104605
Dual Logic Boards:	
Standard Product	47030
Fast-Transient Version	104610

Additional information on all RFL 6745 motherboards can be found in Section 17 of this manual.

1.7.11. SWC Interface Boards

SWC interface boards are only used in RFL 6745 terminals equipped with the Fast-Transient option. They help the RFL 6745 achieve compliance with the SWC requirements of ANSI C.37.90-1989, and the Fast-Transient requirements of ANSI C.37.90.1-1989. These boards reduce transient amplitudes to levels that do not exceed the dielectric capabilities of the isolating components. The transient rise time is also decreased; this reduces the amount of radiated energy that could be induced into the RFL 6745's circuitry, causing system misoperation.

Three different SWC interface boards are available for use in the RFL 6745:

RFL 67 SWC INTFC-1 (Assy. No. 104615)
Provides protection for the RFL 6745's basic connections (trip input, trip output, power input, tone lines, and ALARM and BLOCK relay contacts).

RFL 67 SWC INTFC-2 (Assy. No. 104630)
Provides eleven protected I/O circuits. These circuits can be used as required to make connections to any accessory equipment installed in the RFL 6745 chassis.

RFL 67 SWC INTFC-3 (Assy. No. 104635)

Similar to the RFL 67 SWC INTFC-2, except the circuits are grouped as three independent circuits and four circuit pairs. Each circuit pair is bridged with a varistor to provide transverse voltage clamping.

Section 12 of this manual provides additional information on all RFL 6745 SWC interface boards.

1.7.12. Accessory Equipment

Other circuit module modules and assemblies are available to enhance the operation of the RFL 6745, or to adapt it to special applications. Additional information on accessory equipment can be found in Section 13 of this manual.

Section 2. INSTALLATION

2.1. INTRODUCTION

This section contains installation instructions for the RFL 6745, including unpacking, mounting, and interconnect wiring.

2.2. UNPACKING

RFL 6745 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 6745 equipment 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 board modules in place during transit.

4. Make sure all front-panel 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 unit.

2.2.2. Interconnected Chassis

RFL 6745 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 board modules in place during transit.

4. Make sure all front-panel 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 unit.

2.3. MOUNTING

After unpacking, RFL 6745 equipment must be securely mounted. Paragraphs 2.3.1 through 2.3.3 provide mounting instructions.

2.3.1. Rack Mounting Individual Chassis

RFL 6745 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 6745 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.

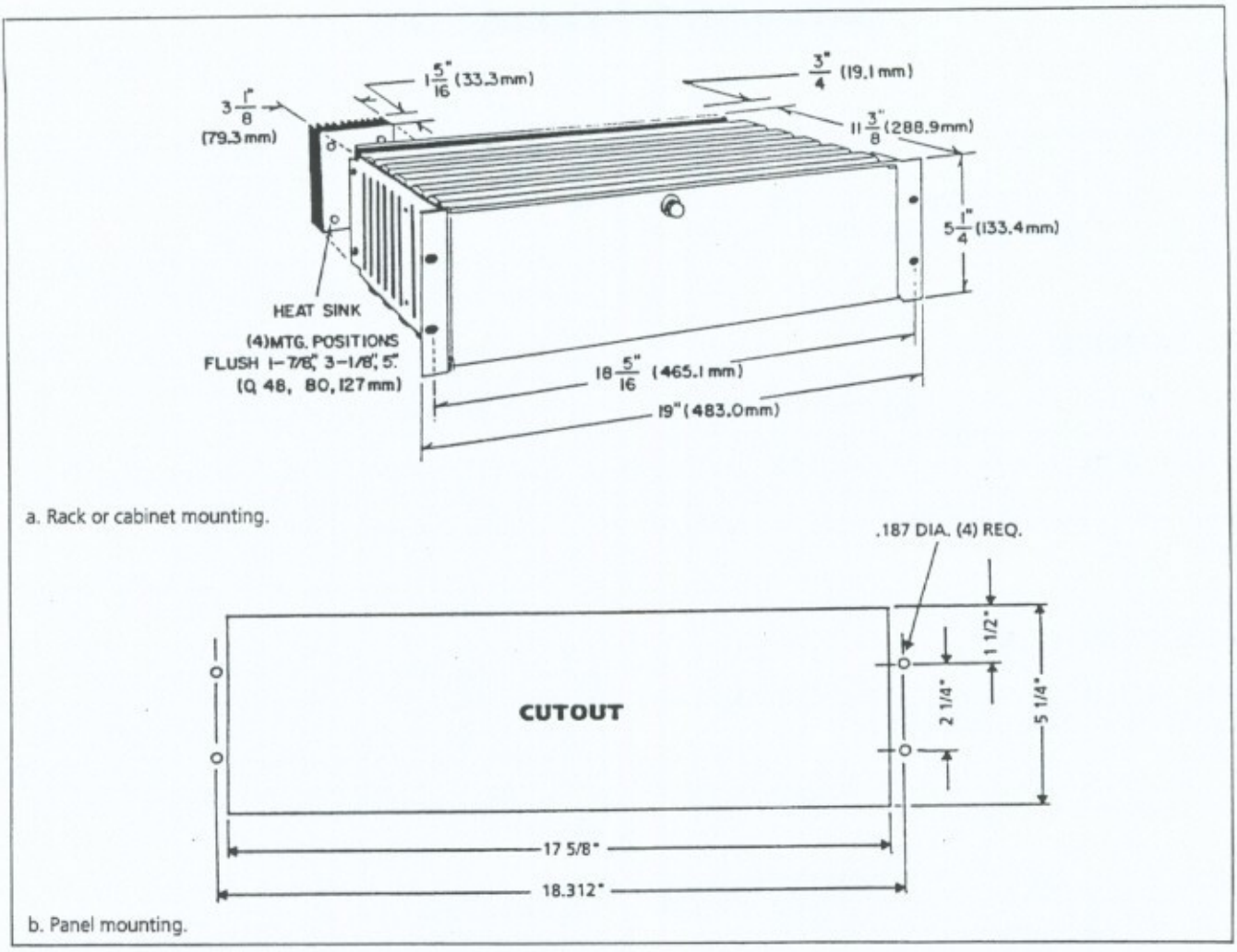


Figure 2-1. Mounting dimensions, RFL 6745 Frequency-Shift Audio-Tone Protective Relaying System

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 6745 equipment is -30°C to +60°C (-22°F to +140°F). Operation at higher temperatures may affect system reliability. Systems installed in enclosed cabinets should be ventilated to keep the temperature inside the cabinet within limits.

2.5. CONNECTIONS

Electrical connections are made to the RFL 6745 through the barrier-type terminal blocks on the rear panel of the chassis. These terminal blocks are shown in Figure 2-2. Paragraphs 2.5.1 through 2.5.4 describe the connections that must be made.

For an overall wiring diagram of the RFL 6745 system, refer to the typical wiring diagram in Section 12 of this manual or the "as supplied" drawings furnished with the equipment.

CAUTION

***Induced currents in the trip leads may* result in false trips. To reduce induced currents, use a shielded twisted lead for each trip lead, and only ground the shield at the RFL 6745 chassis. Keep trip leads away from any wires carrying *high voltage and/or* high current.**

2.5.1. Trip Keying Input Connections

Trip keying input connections are made to terminal block TB1 on the rear panel. Figure 2-3a shows the connections to be made for single keying, using the station battery as the voltage source. If another voltage source is to be used for single keying, the connections are made as shown in Figure 2-3b. The connections for dual keying are shown in Figure 2-3c; this is the recommended method. When dual keying is used, the optical isolators are in parallel. If one isolator fails, only one subchannel is keyed.

If your are making trip input connections to an RFL 6745 terminal equipped with the Fast-Transient Option, refer to the "as supplied" drawings furnished with the equipment.

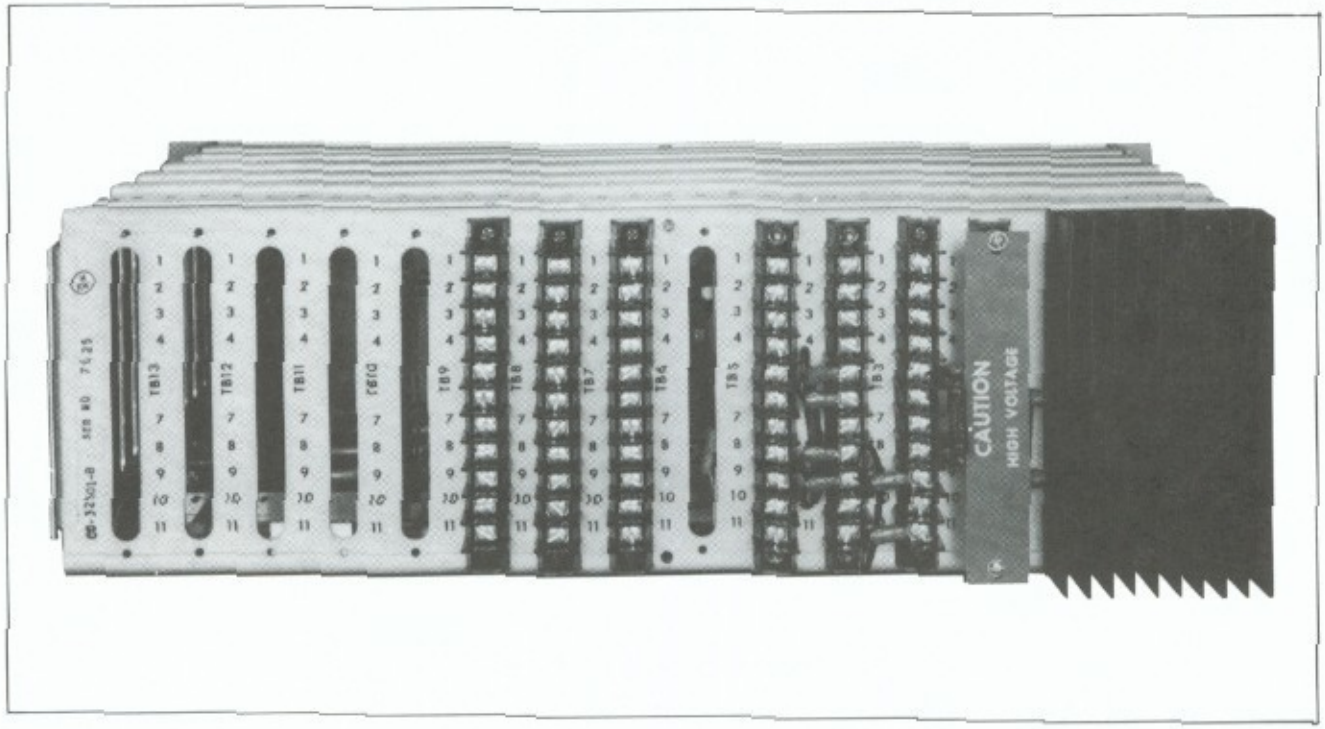
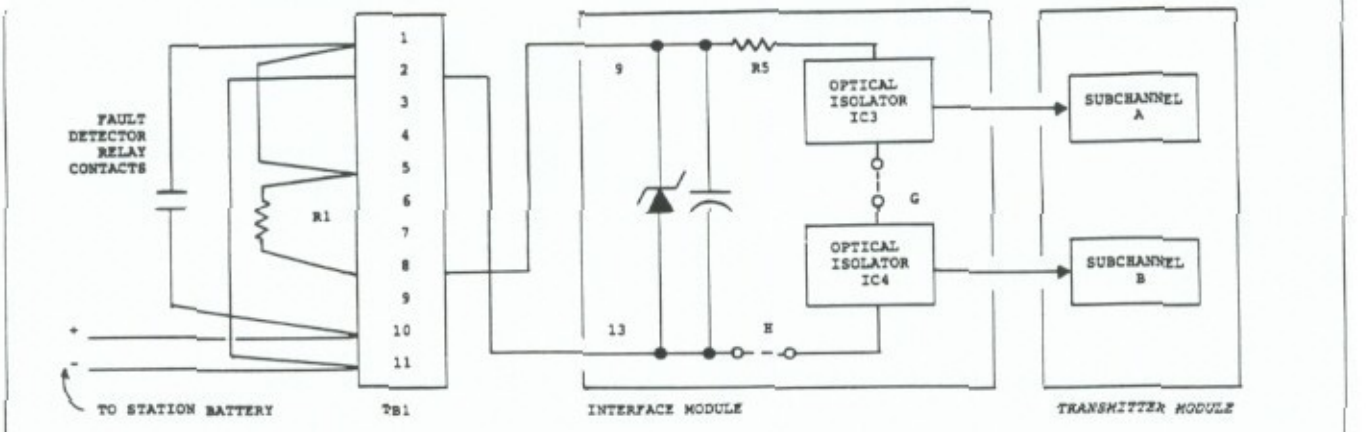
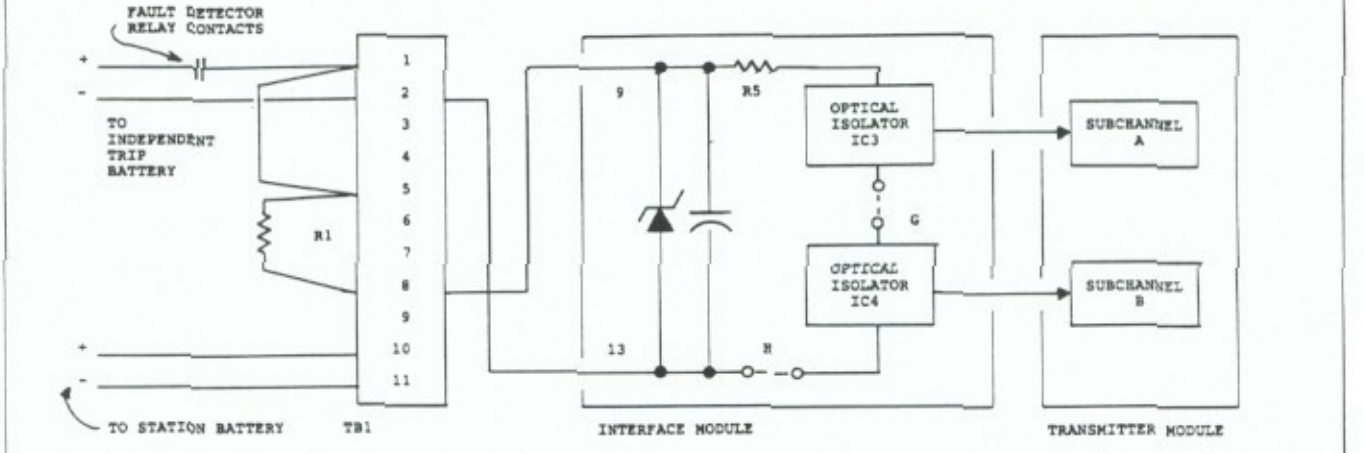


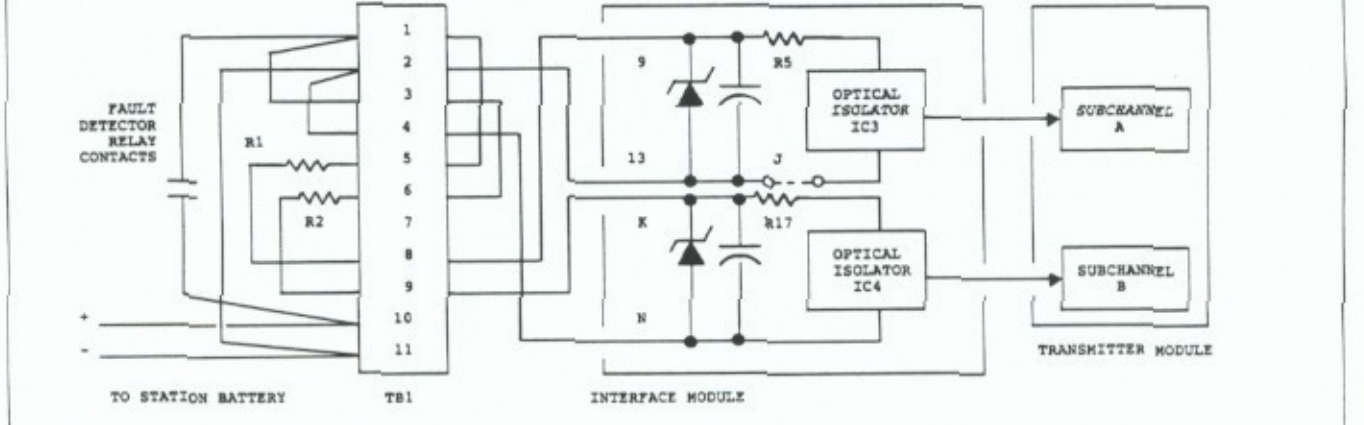
Figure 2-2. Rear view, RFL 6745 Frequency-Shift Audio-Tone Protective Relaying System



a. Single keying input from station battery.



b. Single keying input from independent battery.



c. Dual keying input (recommended method).

NOTE: RESISTORS R1 AND R2 ARE SELECTED TO LIMIT CURRENT TO BETWEEN 30 AND 50 mA. (SEE TABLE 2-1.)

Figure 2-3. Typical trip keying input connections

Keying current must be held between 20 and 30 mA. The recommended values for the dropping resistors shown in Figure 2-3 are given below. The power ratings shown are minimum; higher wattage resistors may be used if desired.

Station Battery Voltage	Resistor Value And Type	RFL P/N
24 Vdc	500Ω,3.25W;Ohmite 4411 or equiv.	1100 308
48 Vdc	1500Ω,3.25W;Ohmite 4427 or equiv.	1220 35
110 Vdc	3500Ω,6.5W;Clarostat VCE PFD or equiv.	1100 701
129 Vdc	4500Ω,5W;Ohmite 4640 or equiv.	1100 690

2.5.2. Trip Output Connections

Trip output connections are made to terminal block TB2 on the rear panel. Figure 2-4 shows three basic methods which can be used for making these connections. Figure 2-4a shows the connections to be made to the single trip output of a RFL 6745 system with a single logic module and one trip output circuit. Figure 2-4b shows how the two trip outputs of a system with two logic modules (and redundant trip output circuits) can be wired independently, and Figure 2-4c shows how they can be wired in series.

If your are making trip output connections to an RFL 6745 terminal equipped with the Fast-Transient Option, refer to the "as supplied" drawings furnished with the equipment.

2.5.3. Communication Circuit Connections

Connections to the communication circuit are made at terminal block TB2 on the rear panel. TB2-1 and TB2-2 are used for transmit/receive connections to two-wire lines and receive connections to four-wire lines. TB2-3 and TB2-4 are used for transmit connections to four-wire lines. Be sure the jumpers on the interface module are set for the desired operating mode; these jumpers are described in Section 5.

Up to four RFL 6745 transmitters or four pairs of wideband receivers may be multiplexed onto the same voice-grade communication circuit. Figure 2-5 shows the transmit connections and Figure 2-6 shows the receive connections.

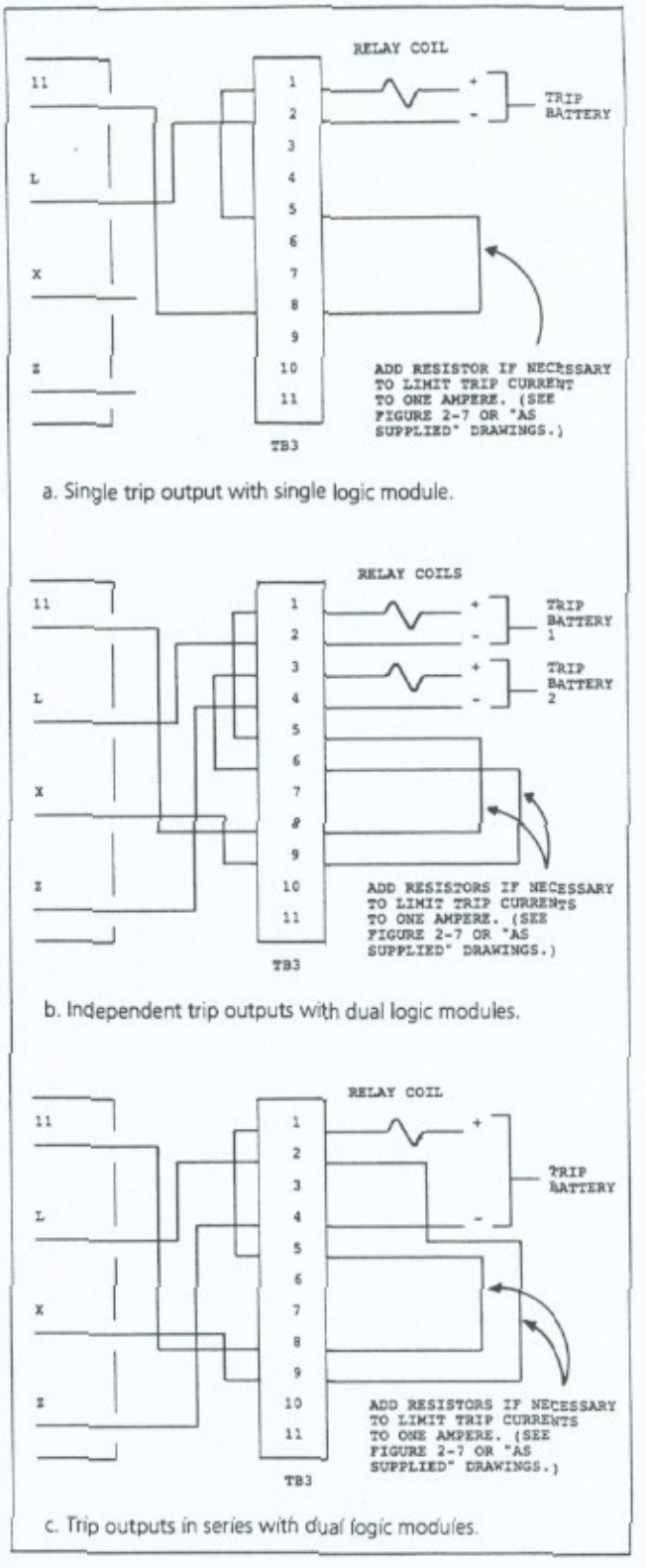


Figure 2-4. Typical trip output connections

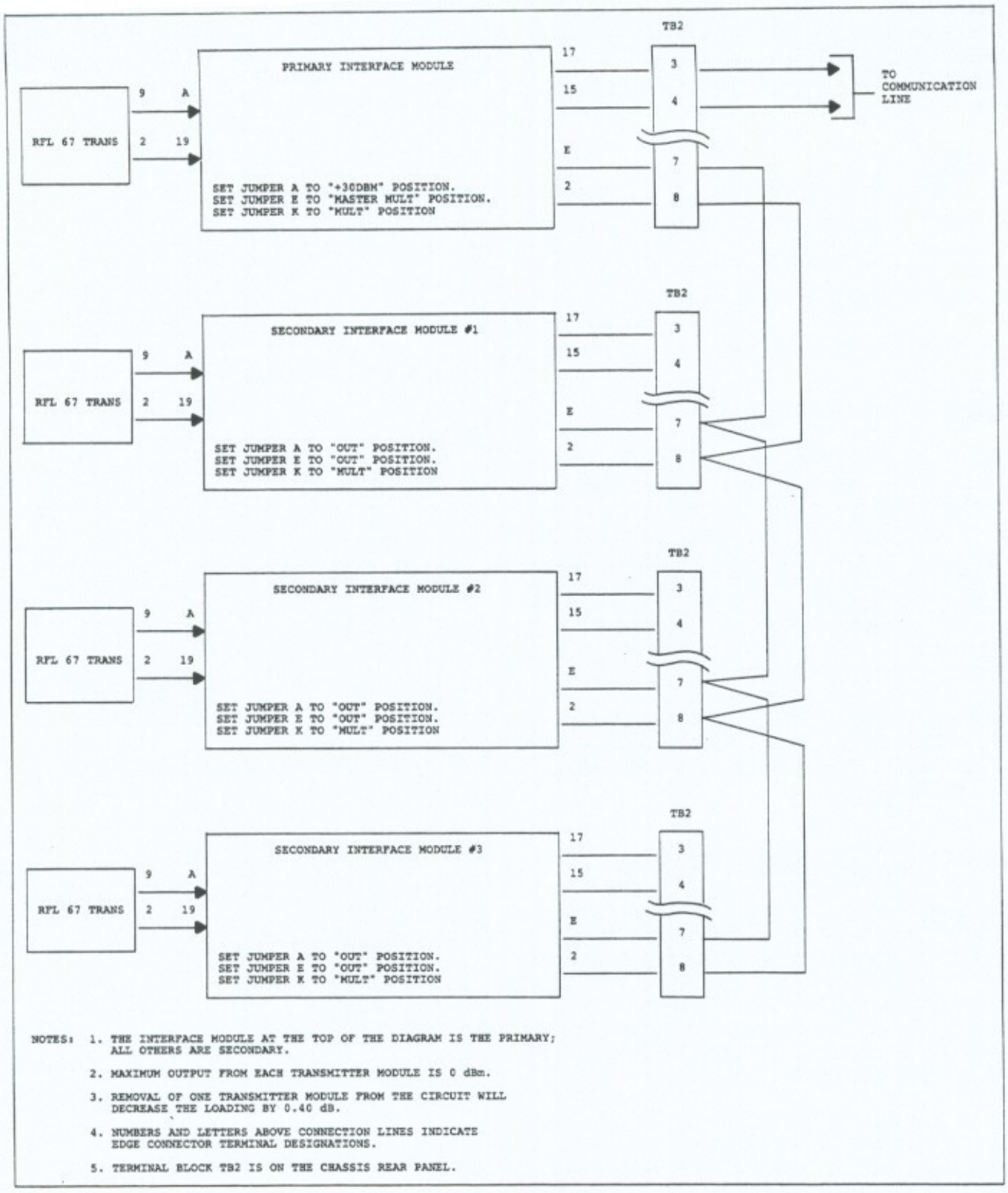


Figure 2-5. Wiring diagram for multiplexing up to four RFL 6745 transmitter modules onto one communication circuit

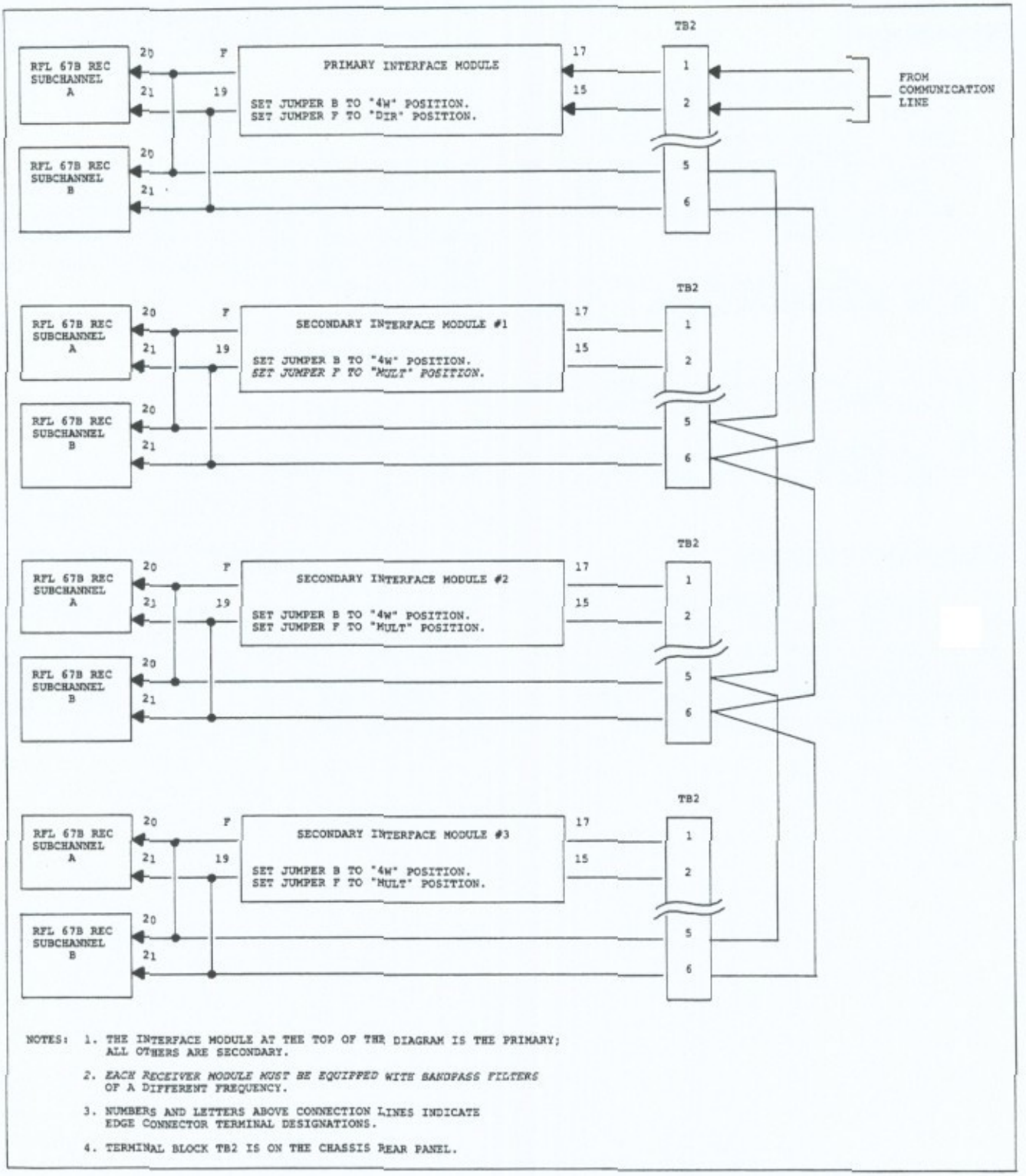


Figure 2-6. Wiring diagram for multiplexing up to four pairs of RFL 6745 wideband receiver modules onto one communication circuit

When multiplexing transmitters or receivers, the following rules apply:

1. One RFL 6745 transmitter and one pair of wideband receivers must be designated the "primary." It is connected directly to the communications circuit through its interface module. The other transmitters and receivers are the "secondaries". The secondaries are connected to the primary in parallel.

2. Each transmitter must be adjusted independently for the desired composite output level. (See Section 3.)

3. Removal of one transmitter from the communication circuit will decrease the loading by 0.40 dB.

4. All wideband receivers must be equipped with bandpass filters of different frequency ranges.

2.5.4. All Other Connections

After the trip input and output connections have been made and the connections have been made to the communication circuit, use the wiring diagram in Section 12 of this manual or the "as supplied" drawings furnished with the equipment to make all other connections. Station battery voltage should be connected last, after double-checking all the other connections to be sure they were properly made.

2.6. RELAY CONTACT PROTECTION

Guard output relay K201 on the RFL 67 RELAY or RFL 67 RELAY-4 Relay Module must be protected by the addition of a capacitor and resistor, connected in series across each set of relay contacts. The values of resistance and capacitance may be calculated from the following equations:

$$C = \frac{I^2}{10}$$

$$R = \frac{E}{10 \times I^{(1 + 50/E)}}$$

where C = capacitance in μF
R = resistance in Ω
I = current immediately prior to opening of contacts
E = source voltage immediately prior to closing of contacts

The minimum permissible values for C and R are *0.001μF and 0.5Ω. Contact protection on the relay* module itself is considered the minimum level of protection; additional protection should be added at the terminal block on the rear of the chassis to meet the requirements of the load used.

Section 3. OPERATING INSTRUCTIONS

3.1. INTRODUCTION

Instructions necessary for operating the RFL 6745 terminal are given in this section. The controls and indicators used during operation are shown and described. Also included are procedures for initial setup and operating the terminal after it is placed into continuous operation.

3.2. CONTROLS AND INDICATORS

The circuit board modules in the RFL 6745 chassis contain controls and indicators which are used to prepare the terminal for use and to monitor module functions during normal system operation. Figure 3-1 shows the module locations in a typical RFL 6745 terminal. Table 3-1 lists the figures and tables in this section that describe the controls and indicators on each module.

(Text continued on page 3-10.)

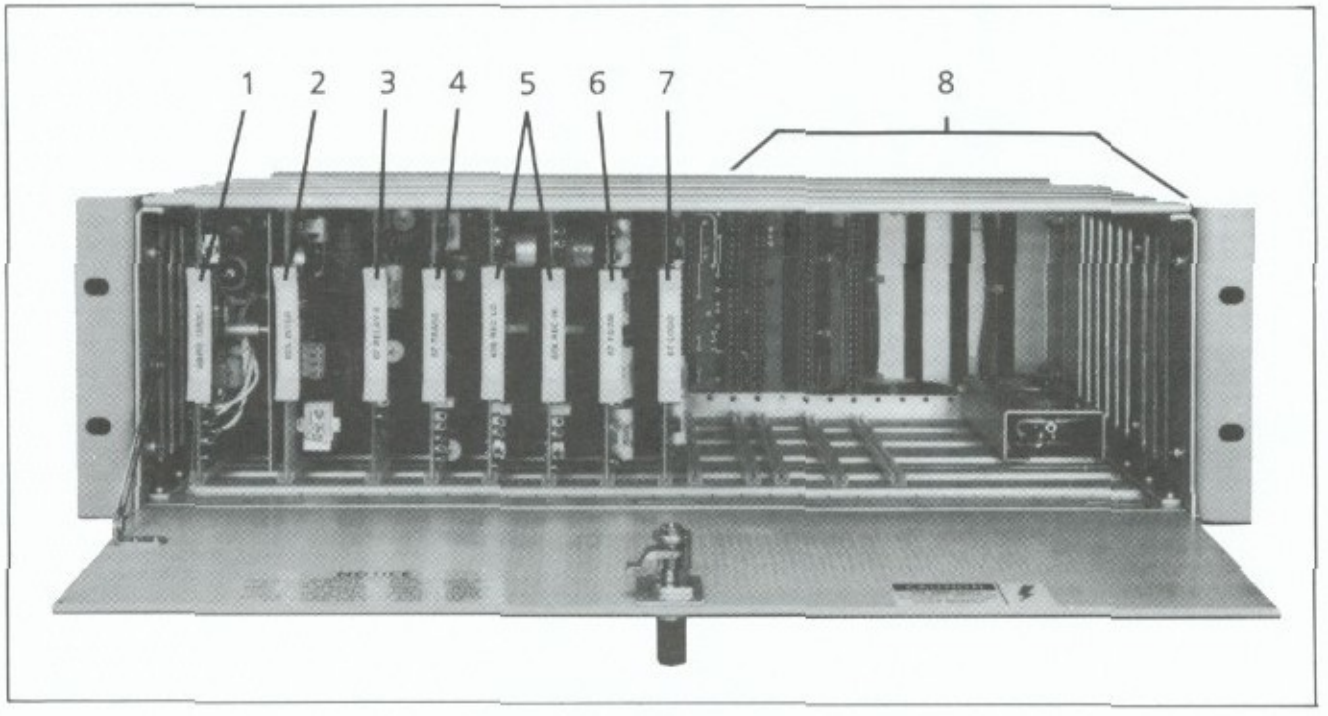


Figure 3-1. Circuit board module locations in typical RFL 6745 chassis

Table 3-1. Circuit board modules in typical RFL 6745 chassis

Item	*Description*	Control And Indicator *Information*	*Page*
1	RFL 68 HPS **DC-1 Dc-dc Converter Power Supply	Figure 3-2/Table 3-2	3-2
2	RFL 67C INTER or 67C INTER-1 Interface Module	Figure 3-3/Table 3-3	3-3
3	RFL 67A RELAY or 67A RELAY-4 Relay Module	Figure 3-4/Table 3-4	3-4
4	RFL 67 TRANS Dual Subchannel Transmitter Module	Figure 3-5/Table 3-5	3-5
5	RFL 67B REC Wideband Receiver Module	Figure 3-6/Table 3-6	3-6
6	RFL 67 FS/AM Detector Module	Figure 3-7/Table 3-7	3-7
7	RFL 67 LOGIC Standard-Range Logic Module	Figure 3-8/Table 3-8	3-8
	RFL 67A LOGIC Wide Dynamic Range Logic Module/ RFL 67A LOGIC-1 Wide Dynamic Range Redundant Logic Module	*Figure 3-9/Tables 3-9 & 3-10*	3-9
8	Optional Accessory Equipment	Section 13	. . .

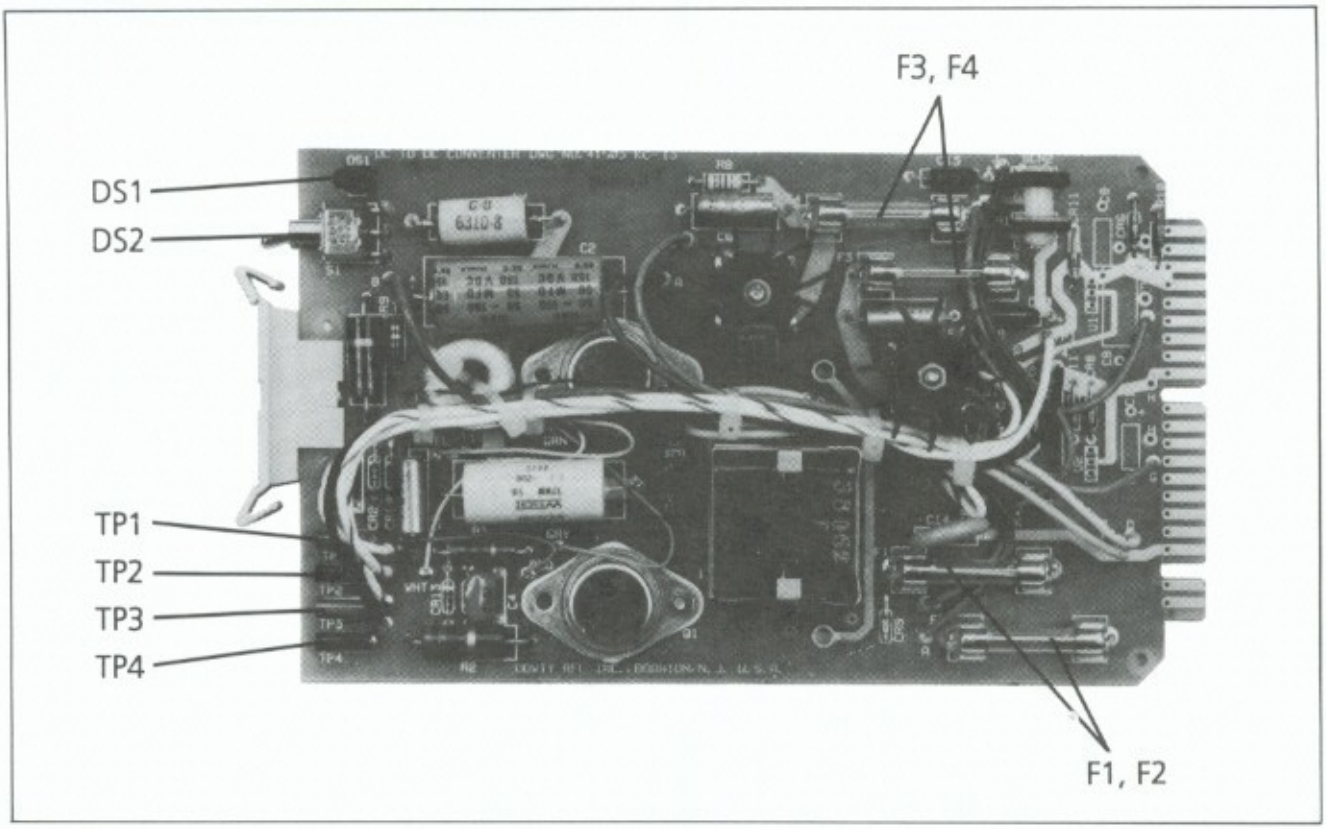


Figure 3-2. Controls and indicators, RFL 68 HPS **DC-1 Dc-dc Converter Power Supply

Table 3-2. Controls and indicators, RFL 68 HPS **DC-1 Dc-dc Converter Power Supply

Symbol	Name/Description	Function
DS1	POWER indicator	Lights when dc-dc converter is operating.
F1,F2	Input fuses	Provide current protection for input section of dc-dc converter.
F3,F4	Crowbar fuses	Open when crowbars fire to shut down supply outputs if voltages exceed a preset limit.
S1	Power switch	Applies station battery voltage to input section of dc-dc converter.
TP1	Test point (red)	Positive output of regulator IC1.
TP2	Test point (black)	Negative output of regulator IC1.
TP3	Test point (red)	Positive output of regulator IC2.
TP4	Test point (black)	Negative output of regulator IC2.

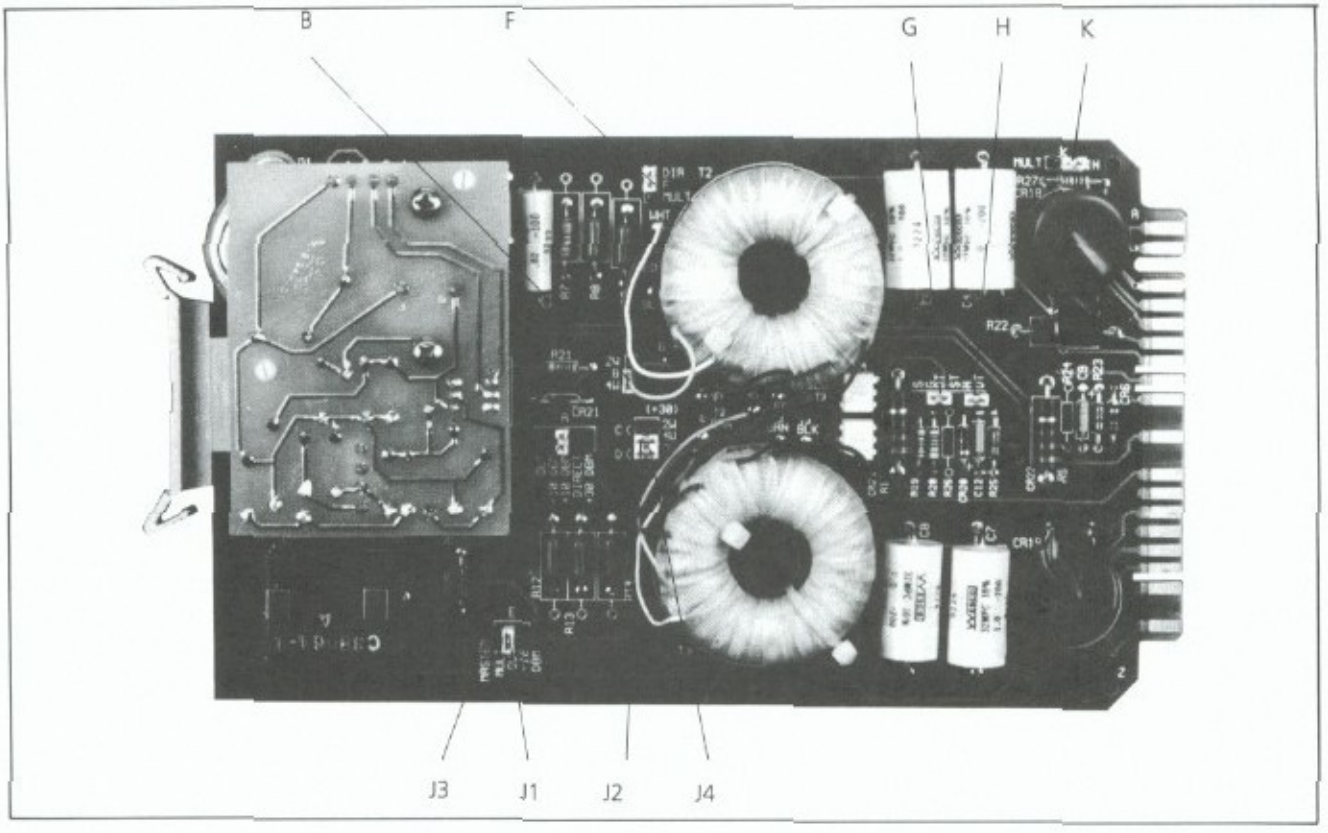


Figure 3-3. Controls and indicators, RFL 67C INTER or 67C INTER-1 interface modules

Table 3-3. Controls and indicators, RFL 67C INTER or 67C INTER-1 interface modules

Symbol	Name/Description	Function
. . .	Jumpers A through E	Select maximum transmit output level and configuration. (See Table 3-11.)
. . .	Jumper F	Determines whether multiplexed connections are being made to the receive circuit: Position DIR: Used when a single RFL 6745 terminal is being connected to the receive circuit (non-multiplexed connections). Position MULT: Used when up to four RFL 6745 terminals are being connected to the receive circuit (multiplexed connections).
. . .	Jumpers G and H	Determines whether the RFL 6745 is set for single-trip or dual-trip operation: Position ST: Sets the RFL 6745 for single-trip operation. Position DT: Sets the RFL 6745 for dual-trip operation. For proper operation, both jumpers must be set to the same position (either ST or DT).
. . .	Jumper K	Determines whether multiplexed connections are being made to the transmit circuit. Position IN: Used when a single RFL 6745 terminal is being connected to the transmit circuit (non-multiplexed connections). Position MULT: Used when up to four RFL 6745 terminals are being connected to the transmit circuit (multiplexed connections).

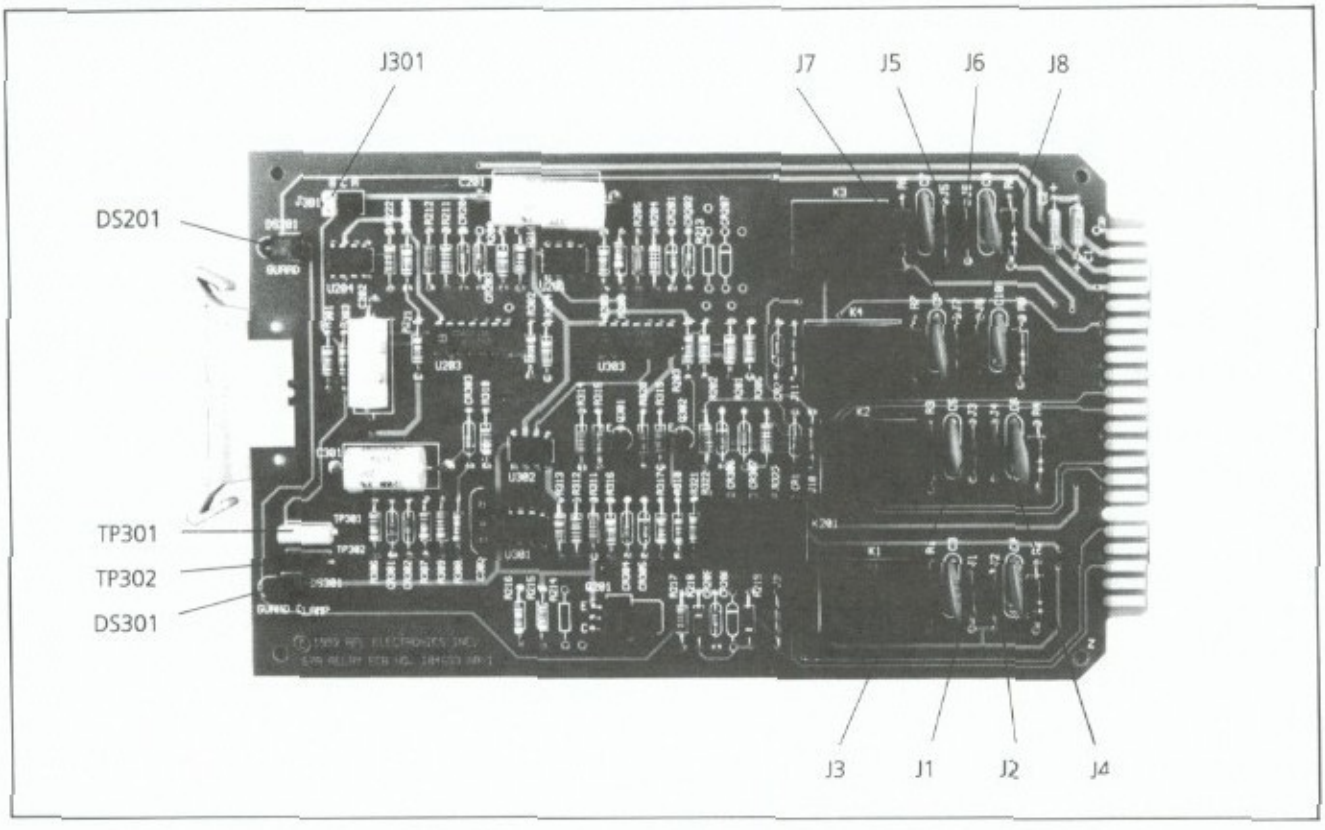


Figure 3-4. Controls and indicators, RFL 67A RELAY or RFL 67A RELAY-4 Relay Module

Table 3-4. Controls and indicators, RFL 67A RELAY or RFL 67A RELAY-4 Relay Module

Symbol	Name/Description	Usage	Function
DS201	GUARD indicator	67C RELAY-4 only	Lights when guard signal is received.
DS301	GUARD CLAMP indicator	67C RELAY-4 only	Lights when the transmitter is clamped to guard.
J1-8	Contact protection jumpers	All	Installed when protection is required for interrupting 125-Vdc circuits. Must be removed for ac switching applications.
J301	Flasher control jumper	67C RELAY-4 only	Controls flasher circuit: Position A: Flasher is enabled. Position B: Flasher will be inhibited during trip-boost. Position C: Flasher is disabled.
J302	Flasher bypass jumper	67C RELAY only	Bypasses flasher portion of circuit board.
TP301	FLASHER DISABLE test point	67C RELAY-4 only	Disables flasher circuit when a jumper is placed between this test point and TP302.
TP302	COMMON test point	67C RELAY-4 only	Ground point.

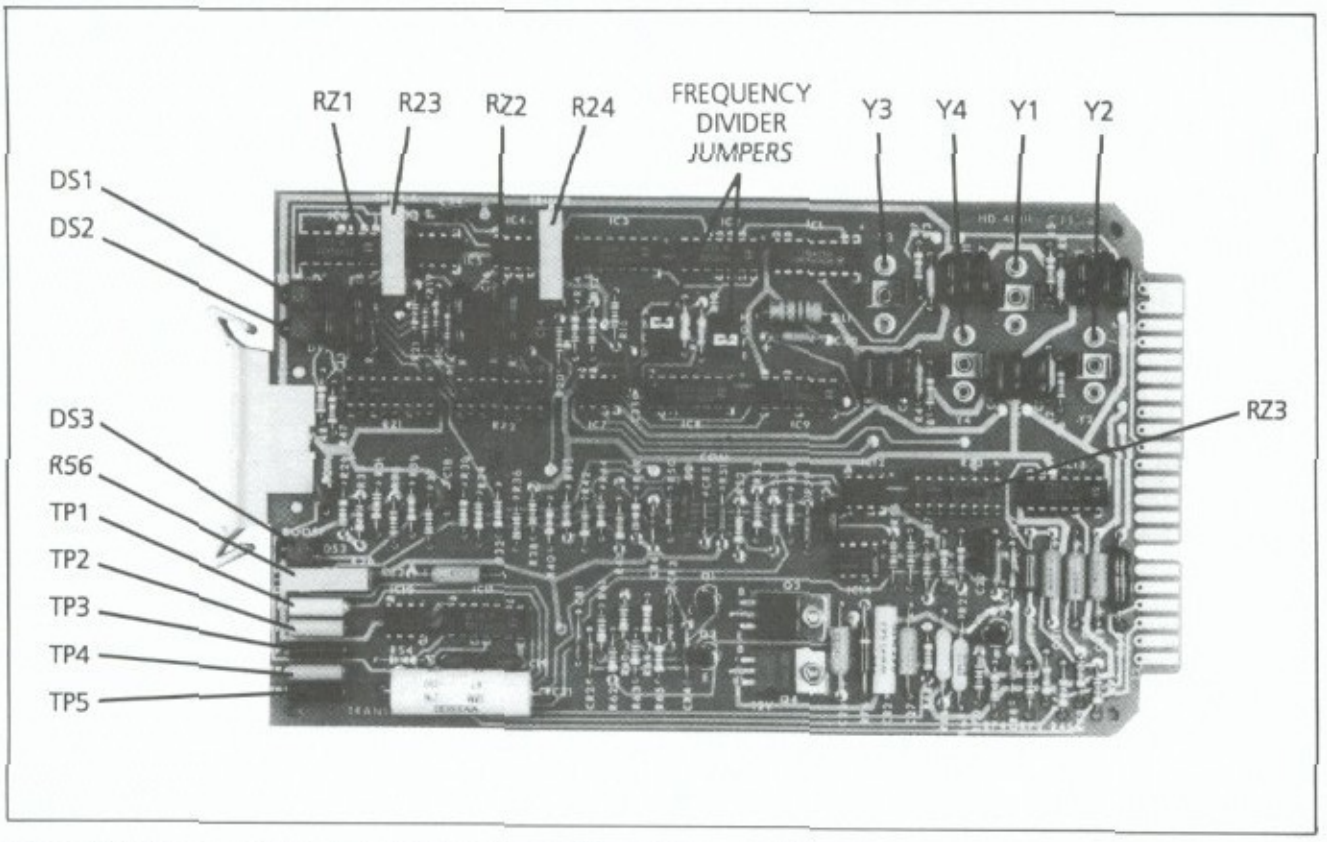


Figure 3-5. Controls and indicators, RFL 67 TRANS Dual Subchannel Transmitter Module

Table 3-5. Controls and indicators, RFL 67 TRANS Dual Subchannel Transmitter Module

Symbol	Name/Description	Function
DS1	TRIP A indicator	Lights when Subchannel A is sending a trip signal.
DS2	TRIP B indicator	Lights when Subchannel B is sending a trip signal.
DS3	TRIP BOOST indicator	Lights when transmitter is in trip boost mode.
R23	Level control potentiometer	Fine adjustment of Subchannel B output level.
R24	Level control potentiometer	Fine adjustment of Subchannel A output level.
R56	TRANS LEVEL potentiometer	Controls TONE OUT amplitude.
RZ1	Resistor network	Used to determine the Subchannel A operating frequency. (See para 3.4.)
RZ2	Resistor network	Used to determine the Subchannel B operating frequency. (See para 3.4.)
RZ3	Resistor network	Used to determine output level (including trip boost). (See para 3.5.1.)
TP1	TONE LEVEL test point (yellow)	TONE OUT signal applied to communication medium.
TP2	BOOST test point (gray)	Output of trip boost timer.
TP3	KILL B test point (brown)	Disables Subchannel B when tied to TP5.
TP4	KILL A test point (orange)	Disables Subchannel A when tied to TP5.
TP5	COMMON test point (black)	Ground point.
Y1	Crystal	Used to determine the Subchannel A trip frequency. (See para 3.4.)
Y2	Crystal	Used to determine the Subchannel B trip frequency. (See para 3.4.)
Y3	Crystal	Used to determine the Subchannel A guard frequency. (See para 3.4.)
Y4	Crystal	Used to determine the Subchannel B guard frequency. (See para 3.4.)
. . .	Frequency divider jumpers	Set according to the desired operating frequency. (See para 3.4.)

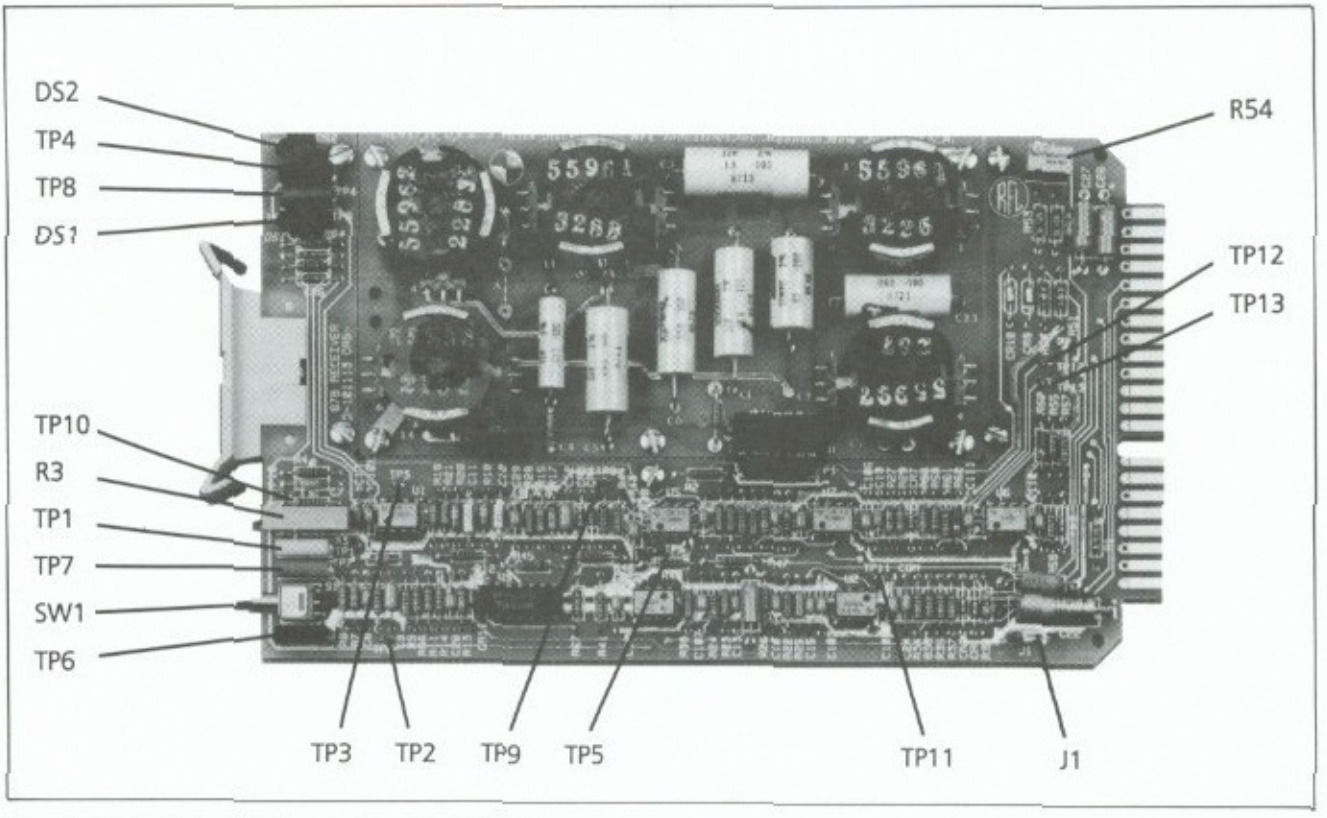


Figure 3-6. Controls and indicators, RFL 67B REC Wideband Receiver Module

Table 3-6. Controls and indicators, RFL 67B REC Wideband Receiver Module

Symbol	Name/Description	Function
DS1	LO SIG indicator	Lights when tone signal falls below preset limit.
DS2	HI SIG indicator	Lights when tone signal exceeds preset limit.
J1	F/S jumper	Sets AGC system for fast (F) or slow (S) response. (See para 3.3.3.)
R3	LEV potentiometer	Controls the signal level applied to the receiver input.
R54	Potentiometer	Sets offset voltage applied to summing/inverting stage of AGC system.
SW1	Pushbutton switch	Reduces signal gain by 12 dB when pressed.
TP1	Test point (yellow)	Output of input bandpass filter.
TP2	Turret-type test point	Output of preamplifier stage.
TP3	Turret-type test point	Output of first stage of voltage-controlled amplifier.
TP4	Test point (brown)	Tone output sent to detector module.
TP5	Turret-type test point	Output of AGC system.
TP6	Test point (black)	Ground point.
TP7	Test point (gray)	Disables AGC circuit when a jumper is placed between this point and TP6.
TP8	Test point (red)	Positive output of reference voltage generator.
TP9	Turret-type test point	AGC signal sent to detector module.
TP10	Turret-type test point	Input to preamplifier stage.
TP11	Turret-type test point	Ground point (same as TP6).
TP12	Turret-type test point	Output of quadrature signal network.
TP13	Turret-type test point	Output of frequency-shift discriminator.

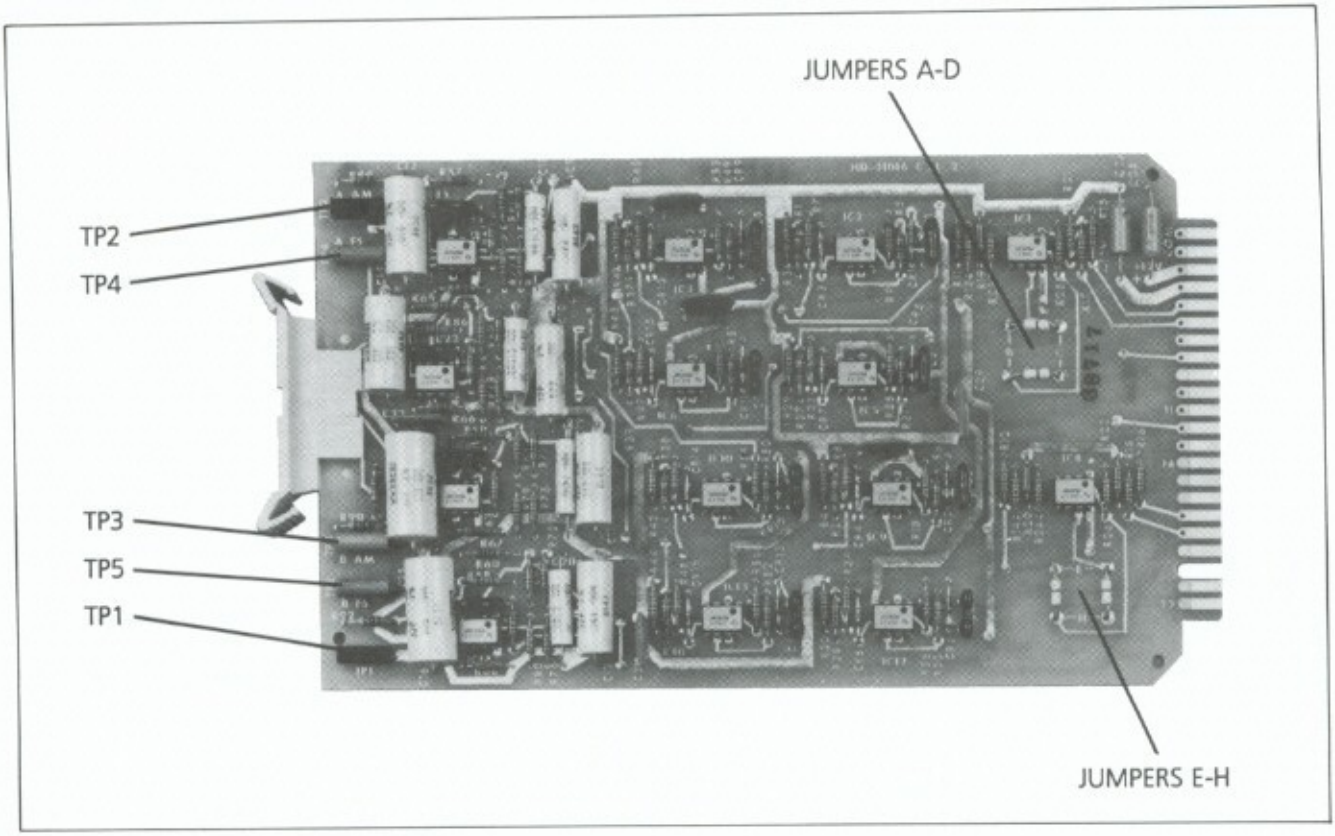


Figure 3-7. Controls and indicators, RFL 67 FS/AM Detector Module

Table 3-7. Controls and indicators, RFL 67 FS/AM Detector Module

Symbol	Name/Description	Function
TP1	COMMON test point (black)	Ground point.
TP2	CHAN A AM test point (brown)	Rectified AM output of Subchannel A.
TP3	CHAN B AM test point (orange)	Rectified AM output of Subchannel A.
TP4	CHAN A AM test point (blue)	FS output of Subchannel A.
TP5	CHAN B AM test point (gray)	FS output of Subchannel A.
. . .	Jumpers A through H	Route input signals to the four detector circuits. (See para 3.3.4.)

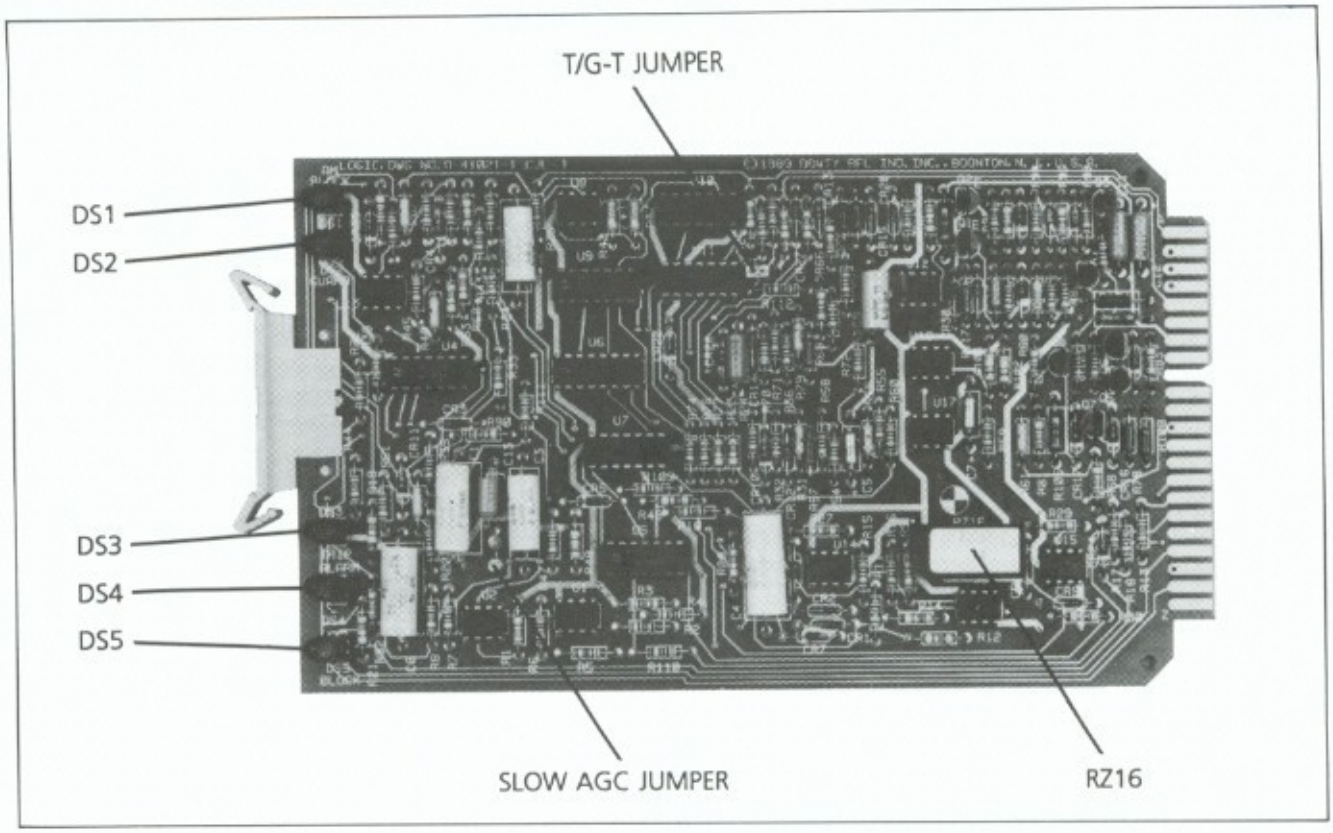


Figure 3-8. Controls and indicators, RFL 67 LOGIC Standard-Range Logic Module

Table 3-8. Controls and indicators, RFL 67 LOGIC Standard-Range Logic Module

Symbol	Name/Description	Function
DS1	AM BLOCK indicator	Lights when RFL 6745 is in block mode.
DS2	GUARD indicator	Lights when guard signal is received and detected.
DS3	TRIP indicator	Lights when trip signal is received and detected.
DS4	ALARM indicator	Lights when an alarm condition is present.
DS5	BLOCK indicator	Lights when RFL 6745 is in block mode.
RZ16	Resistor network	Sets input signal level for wideband receiver modules. (See para 3.3.5.)
. . .	Jumper, slow AGC	Slows AGC response in terminals using trip boost. (See para 3.3.5.)
. . .	Jumper, T/G-T	Enables/disables guard-before-trip feature. (See para 3.3.5.)

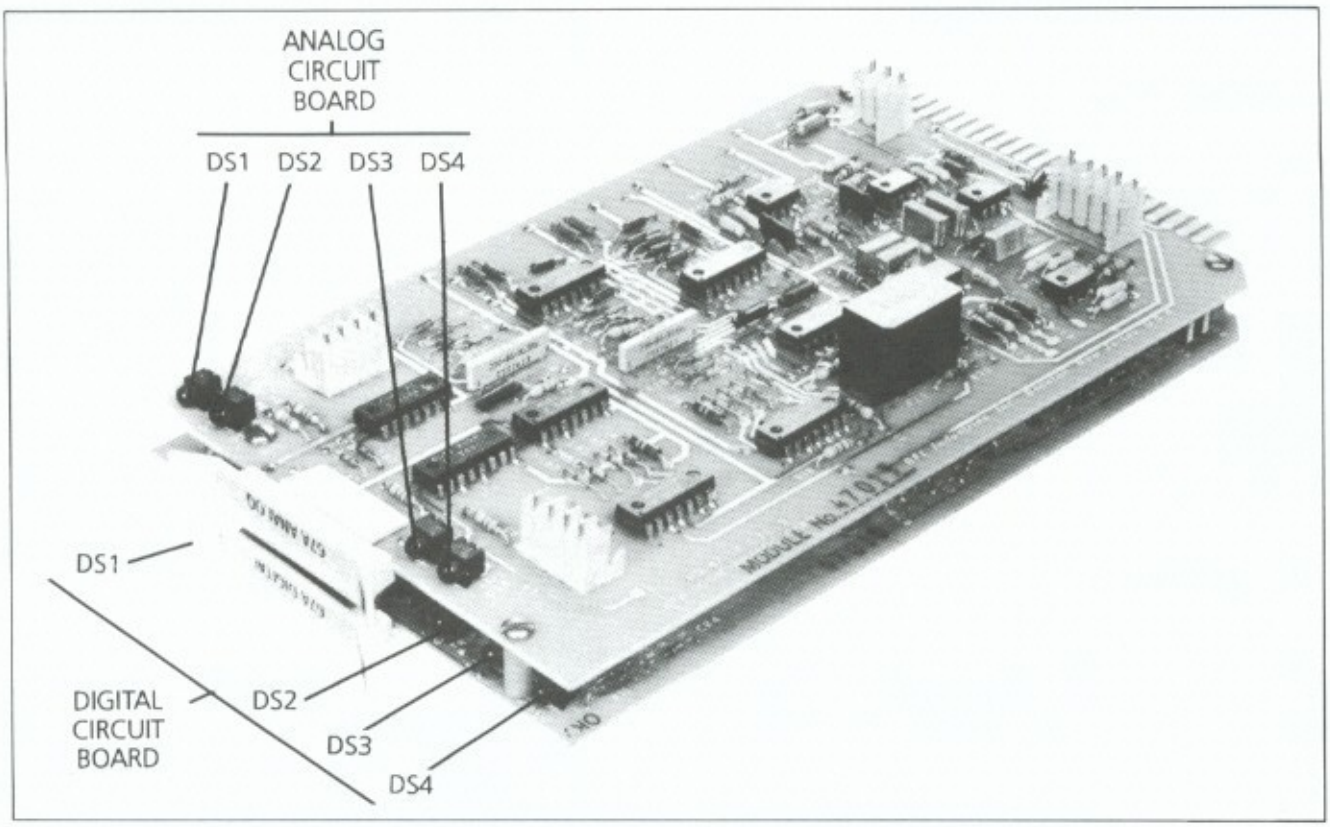


Figure 3-9. Controls and indicators, RFL 67A LOGIC and RFL 67A LOGIC-1 Wide-Dynamic-Range Logic Modules

Table 3-9. Controls and indicators, digital circuit board for RFL 67A LOGIC and RFL 67A LOGIC-1 Wide-Dynamic-Range Logic Modules

Symbol	Name/Description	Function
DS1	GUARD indicator	Lights when guard signal is received and detected.
DS2	TRIP indicator	Lights when trip signal is received and detected.
DS3	ALARM indicator	Lights when an alarm condition is present.
DS4	BLOCK indicator	Lights when RFL 6745 is in block mode.

Table 3-10. Controls and indicators, analog circuit board for RFL 67A LOGIC Wide-Dynamic-Range Logic Modules

Symbol	Name/Description	Function
DS1	AM NOISE indicator	Lights when the amount of AM noise exceeds a preset limit.
DS2	FS NOISE indicator	Lights when the amount of FS noise exceeds a preset limit.
DS3	HI SIGNAL indicator	Lights when the overall signal level exceeds a preset limit.
DS4	LO SIGNAL indicator	Lights when the overall signal level falls below a preset limit.

NOTE

For information on jumper locations and settings, see paragraph 3:3.6 in this section.

(Continued from page 3-1.)

3.3. JUMPER SETTINGS

Some RFL 6745 circuit board modules and assemblies are equipped with programmable jumpers. Circuit board modules supplied as part of a system have their jumpers set at the factory, according to the overall system configuration and the requirements of the specific application. Under normal circumstances, jumpers 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 3.3.4 describe the jumper settings that must be made.

3.3.1. Interface Module

Each RFL 67C INTER or RFL 67C INTER-1 Interface Module has nine jumpers, labeled A through K; the letters "I" and "J" are not used. Figure 3-3 on page 3-3 shows the location of these jumpers.

A thru E

Jumpers A through E select the maximum transmit output level, and determine whether two-wire or four-wire connections are to be made to the communication circuit. (See Table 3-11.)

F and K

Jumpers F and K determine whether multiplexed connections are being made to the communications line. Jumper F controls the receive circuit, and Jumper K the transmit circuit.

When jumper F is in the MULT position, up to four RFL 6745 transmitter modules can be connected to the same line; if only one transmitter module is to be connected to the line, jumper F must be placed in the DIR position.

Up to four pairs of RFL 6745 wideband receiver modules can be connected to the same line when jumper K is placed in the MULT position; if only one pair of receiver modules is to be connected to the line, jumper K must be placed in the IN position.

Refer to paragraph 2.5.3 in Section 2 for further information on multiplex connections.

G and H

Jumpers G and H set the interface module for single trip (Position ST) or dual trip (Position DT). These jumpers must be set to whatever is required for the particular application.

3.3.2. Relay Module

Two different relay modules are used in the RFL 6745: the RFL 67A RELAY and the RFL 67A RELAY-4. . Both relay modules have ten jumpers: eight labeled "J1" through "J8," one labeled "J301," and one labeled "J302." Figure 3-4 on page 3-4 shows the location of the relay module jumpers.

J1 thru J8

Jumpers J1 through J8 add contact protection to the relay output circuits. They should be in place when protection is required for 125-Vdc circuits. Remove these jumpers when the relay module is being used in ac switching applications.

J301

Jumper J301 has three positions: "A," "B," and "C." When J301 is placed in Position A, the flasher circuit is enabled. Position B will inhibit the flasher circuit during trip-boost intervals. The flasher circuit is totally disabled when J301 is placed in Position C.

J302

Jumper J302 is a single-position jumper that is only installed on relay modules that do not contain flasher circuits.

3.3.3. Wideband Receiver Modules

RFL 67B REC Wideband Receiver Modules have a single jumper, labeled "F/S." (See Figure 3-6 on page 3-6 of this section for location.) This jumper controls the AGC circuit's response time. It must be placed in Position S (slow) when trip boost is used, and in Position F (fast) when trip boost is not being used.

Trip boost is controlled by the transmitter module; additional information can be found in paragraph 3.5.1 on page 3-14 of this section.

CAUTION

There is a single-position jumper on the discriminator/filter assembly labeled "A." This jumper may or may not be installed at the factory, depending on the operating subchannel. Do not change the setting of this jumper; system malfunctions may occur.

Table 3-11. Transmit level and configuration settings, RFL 6745 interface modules

Configuration	Maximum Output	Jumper A	Jumper B	Jumper C	Jumper D	Jumper E
Two-Wire	-10 dBm	-10DBM	2W	2W	. . .	-10DBM
Two-Wire	+10 dBm	+10DBM	2W	2W	. . .	. . .
Two-Wire	+20 dBm	+30DBM	2W	. . .	+30DBM	. . .
Four-Wire	-10 dBm	-10DBM	4W	4W	. . .	-10DBM
Four-Wire	+10 dBm	+10DBM	4W	4W	. . .	. . .
Four-Wire	+30 dBm	+30DBM	4W	4W	. . .	. . .

3.3.4. FS/AM Detector Module

The RFL 67 FS/AM Detector Module has eight jumper positions, labeled "A" through "H". (See Figure 3-7 on page 3-7 of this section for location.) Jumpers are installed in these positions to route input signals to the four detector circuits on this module. For most applications, jumpers will be installed in Positions A, D, F, and G; other arrangements may be required for special applications.

3.3.5. RFL 67 LOGIC Standard-Range Logic Module

The RFL 67 LOGIC Standard-Range Logic Module has a single jumper, labeled "T" and "G/T". (See Figure 3-8 on page 3-8 for location.) When this jumper is placed in Position G/T, the guard-before-trip feature is enabled; this feature is disabled when the jumper is placed in Position T.

In addition, there is an unlabeled jumper that adds capacitor C13 to the guard-before-trip timing circuit. This jumper must be in place whenever slow AGC response is being used. (See paragraph 3.3.3 above.)

3.3.6. RFL 67A LOGIC And RFL 67A LOGIC-1 Wide-Dynamic-Range Logic Modules

The RFL 67A LOGIC Wide-Dynamic-Range Logic Module has two circuit boards: one analog and one digital. Jumpers must be set on both boards for proper terminal operation. The RFL 67A LOGIC-1 has an interconnect circuit board instead of an analog circuit board; this interconnect board has no jumpers. Paragraphs 3.3.6.1 and 3.3.6.2 describe the jumper settings that must be made on boards equipped with jumpers.

3.3.6.1. Analog Circuit Board Jumper Settings

The analog board has five jumpers, as shown in Figure 3-10a. Jumpers 1 through 4 have three positions ("A", "B", and "C"), and Jumper 5 has two positions ("A" or "B"). One position must be selected for each jumper, as described below:

Jumper 1:

Position A: Provides for AM noise detection without incurring blocking caused by a steady-state difference in subchannel levels.

Position B: Provides for blocking to occur because of a difference in subchannel AM levels.

Position C: Disables the AM noise detectors.

Jumper 2:

Position A: Provides for FS noise detection without incurring blocking caused by a steady-state difference in subchannel levels.

Position B: Provides for blocking to occur because of a difference in subchannel FS levels.

Position C: Disables the FS noise detectors.

Jumper 3:

Position A: Provides a level-too-high indication when either subchannel exceeds a predetermined limit.

Position B: Provides a level-too-high indication when Subchannel B exceeds a predetermined limit.

Position C: Provides a level-too-high indication when Subchannel A exceeds a predetermined limit.

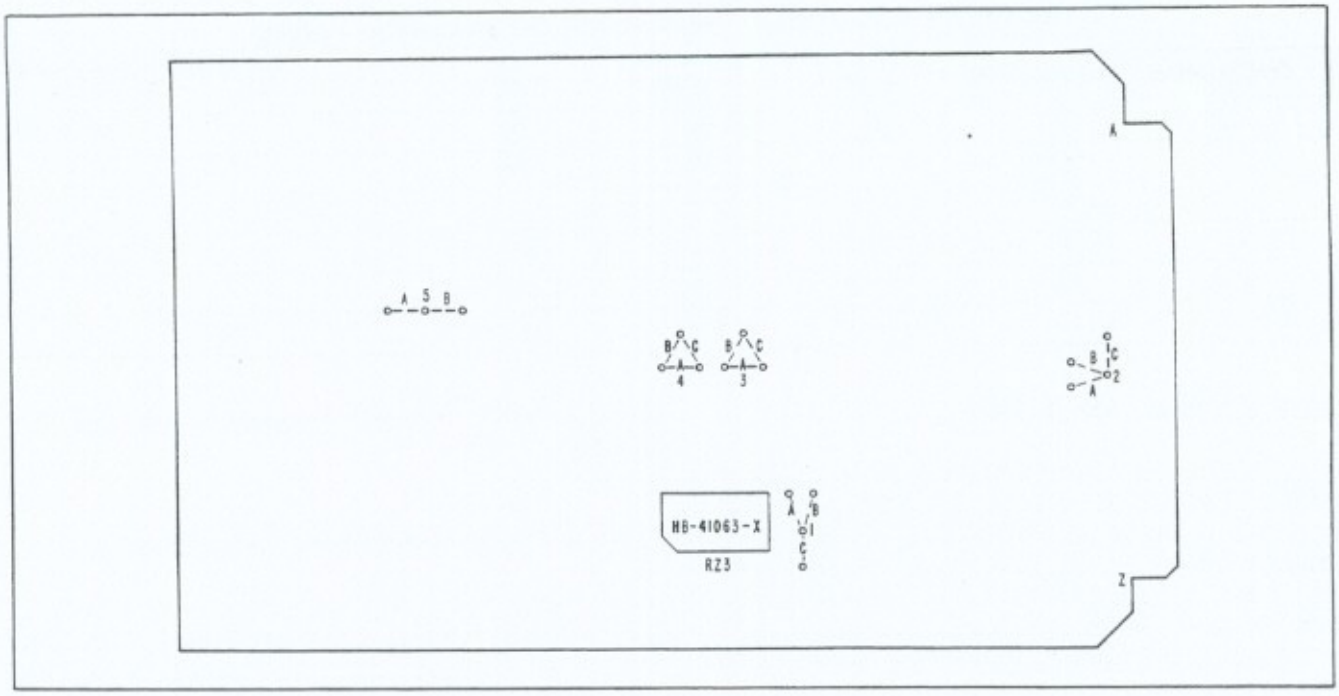


Figure 3-10. Jumper locations, analog circuit board for RFL 67A LOGIC Wide-Dynamic-Range Logic Module

Jumper 4:

Position A: Provides a level-too-low indication when either subchannel exceeds a predetermined limit.

Position B: Provides a level-too-low indication when Subchannel B exceeds a predetermined limit.

Position C: Provides a level-too-low indication when Subchannel A exceeds a predetermined limit.

Jumper 5:

Position A: Allows the detection and visual indication of a guard signal during low-level conditions.

Position B: Prevents the detection of a guard signal during low-level conditions.

3.3.6.2. Digital Circuit Board Jumper Settings

The digital circuit board has thirteen jumpers, as shown in Figure 3-11. Each jumper has two positions: "A" or "B." One position must be selected for each jumper, as described below:

Jumper 1:

Position A: Requires that a trip signal appear on Subchannel A.

Position B: Does not require that a trip signal appear on Subchannel A.

Jumper 2:

Position A: Requires that a trip signal appear on Subchannel B.

Position B: Does not require that a trip signal appear on Subchannel B.

Jumper 3:

Position A: Requires that a guard signal appear on Subchannel A.

Position B: Does not require that a guard signal appear on Subchannel A.

Jumper 4:

Position A: Requires that a guard signal appear on Subchannel B.

Position B: Does not require that a guard signal appear on Subchannel B.

If Jumper 1 or Jumper 2 is placed in Position B, only one subchannel is required for a trip, and if Jumper 3 or Jumper 4 is placed in Position B, only one subchannel is required for guard. Using only one subchannel for trip or guard will improve dependability, but at a reduced security level.

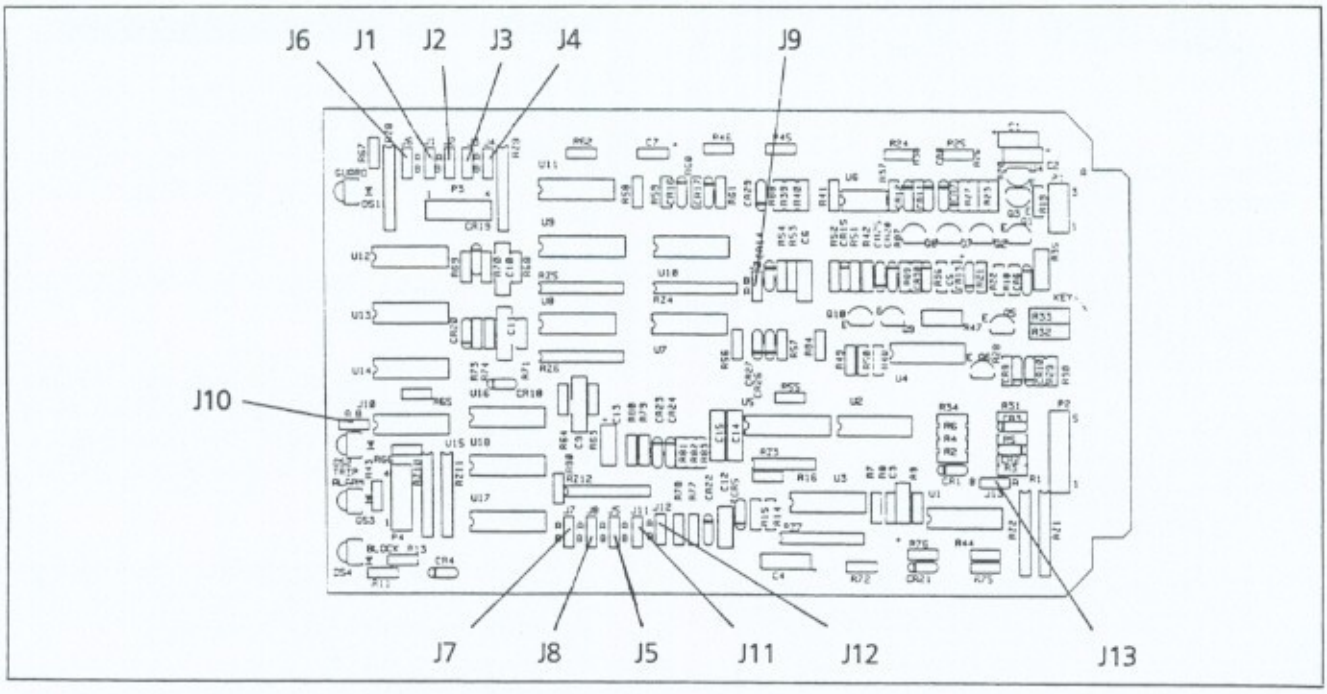


Figure 3-11. Jumper locations, digital circuit board for RFL 67A LOGIC and RFL 67A LOGIC-1 Wide-Dynamic-Range Logic Modules

Jumper 5:

Position A: Requires that guard be present for a predetermined amount of time before a trip can be detected, and that a trip must be detected within a predetermined amount of time after loss of guard.

Position B: Disables the guard-before-trip (G/T) and trip-after-guard (T/G) timers.

If Jumper 5 is set to Position B, guard-before-trip is still required to unblock the logic module through Jumper 8 Position A (described below).

Jumper 6:

Position A: Requires that a guard signal be present on both subchannels, unless Jumper 3 and/or Jumper 4 are set to Position B.

Position B: Requires that a guard signal be present on only one subchannel. This will result in a reduction in security and an improvement in dependability.

Jumper 7:

Position A: Requires that a guard signal only precede the first trip. This position incorporates the action of the G/T restore and G/T disable timers, and has trip memory for POTT applications.

Position B: Requires that each trip be preceded by a valid guard signal.

Jumper 8:

Position A: Guard enables noise detection for the block timer; trip will override. Noise or low signal will block the trip output, but a valid trip signal will override the noise detector.

Position B: Guard signal is not required for noise detection. This gives added security.

Jumper 9:

Position A: Provides for guard signal override of the trip-hold timer. When a return from trip to guard is recognized, the trip-hold timer will cease to hold the trip output.

Position B: Permits the trip-hold timer to time out before the return of a guard signal can be acknowledged. This position must be selected in terminals using a flasher.

Jumper 10:

Position A: Used in most applications.

Position B: Used in permissive trip applications on the direct-transfer-trip logic module when Subchannel B is used to indicate a permissive trip condition.

Placing Jumper 10 in Position B has no measurable effect on either the security or the dependability of the direct-transfer-trip portion of a direct- and permissive-transfer-trip system, prior to the receipt of a permissive-trip signal. Once this signal is received, the security of the

direct-transfer-trip system is partially reduced, because one of the subchannels is already in trip.

Jumper 11:

Position A: Enables the bipolar noise detector.
Position B: Disables the bipolar noise detector.

Position A is not recommended in terminals applied to powerline carrier circuits, or on the permissive-transfer-trip logic module of permissive-transfer-trip systems.

Jumper 12:

Position A: Used in most applications.
Position B: Used in unblocking applications; a loss of guard signal will provide a trip.

If Position B is selected for Jumper 12, Jumpers 5 and 11 must also be set to Position B.

Jumper 13:

Position A: Direct-transfer trip negates the permissive-transfer trip output.
Position B: In a direct-transfer trip condition, both the direct-trip output and the permissive-trip output will trip. This position is required when two DTT logic modules are being used.

When Position A is selected for Jumper 13, the dual-function feature is being used, and the direct-transfer-trip is required to negate the permissive-transfer trip output, it is possible to get a momentary permissive-transfer trip output during a direct-transfer trip condition.

3.4. FREQUENCY-DETERMINING COMPONENTS

RFL 6745 transmitter and wideband receiver modules contain some components that will have to be changed if the terminal is to operate on a different channel. Table 3-12 lists the frequency-determining components for the RFL 67 TRANS Dual Subchannel Transmitter Module; the frequency-determining components for the RFL 67B REC Wideband Receiver Module are listed in Table 3-13. If the terminal has been equipped with optional RFL 67 NB REC narrowband receivers, information on frequency-determining components for these modules can be found in Section 13. Tables 3-12 and 3-13 list the frequency-determining components for all standard Bell and CCITT channels. For operation on other channels, contact the factory.

3.5. LEVEL-DETERMINING PLUG-IN NETWORKS

RFL 6745 transmitter modules use plug-in networks to set their guard, trip, and trip boost output levels. Additional networks are used on RFL 6745 logic modules to set signal levels for input to the wideband receiver modules.

The following rules apply when selecting level-determining plug-in networks:

1. The network(s) selected for the logic module(s) should complement the network selected for the transmitter module; that is, the transmitter output boost level and the receiver logic level change should be the same.

2. There is no relationship between the networks used on RFL 67 LOGIC modules and those specified for RFL 67A LOGIC modules.

3. Whenever possible in powerline carrier applications using trip boost, the boost amplitude of the RFL 67 TRANS transmitter module should be set to 10 dB and a duration of at least 200 ms.

Paragraphs 3.5.1 through 3.5.3 describe the standard plug-in networks that are available for each module. Special networks can also be supplied for special level requirements. Contact the factory for further information.

3.5.1. RFL 67 TRANS Dual Subchannel Transmitter Module

Resistor network RZ3 on the RFL 67 TRANS Dual Subchannel Transmitter Module determines the transmission signal level (including boost). The RFL part numbers for networks that will produce various boost levels are as follows:

No Boost	41066-1
3-dB Boost, 70-ms Duration	41066-2
6-dB Boost, 70-ms Duration	41066-4
9-dB Boost, 70-ms Duration	41066-5
12-dB Boost, 70-ms Duration	41066-3
Adjustable Boost, 70-ms Duration	41062

Table 3-12. Frequency-determining components, RFL 67 TRANS Dual Subchannel Transmitter Module

	Channel Spacing (Hz)	Freq. Shift (Hz)	Sub-ch.	Center Freq. (Hz)	Trip Freq. (Hz)	Guard Freq. (Hz)	RFL P/N For Resistor Network RZ1	RFL P/N For Resistor Network RZ2	Frequency Divider Jumper Position	Trip Crystals			Guard Crystals		
										Circuit Symbol	RFL Part No.	Frequency (MHz)	Circuit Symbol	RFL Part No.	Frequency (MHz)
1	340	±75	A	935	860	1010	41065-1	. . .	A	Y1	41034-7	3.522560	Y3	41034-8	4.136960
			B	1275	1350	1200	. . .	41065-2	F	Y2	41034-6	2.764800	Y4	41034-5	2.457600
2	340	±75	A	1275	1200	1350	41065-2	. . .	B	Y1	41034-5	2.457600	Y3	41034-6	2.764800
			B	1615	1690	1540	. . .	41065-3	F	Y2	41034-10	3.461120	Y4	41034-9	3.153920
3	340	±75	A	1615	1540	1690	41065-3	. . .	B	Y1	41034-9	3.153920	Y3	41034-10	3.461120
			B	1955	2030	1880	. . .	41065-4	F	Y2	41034-12	4.157440	Y4	41034-11	3.850240
4	340	±75	A	1955	1880	2030	41065-4	. . .	B	Y1	41034-11	3.850240	Y3	41034-12	4.157440
			B	2295	2370	2220	. . .	41065-5	F	Y2	41034-14	4.853760	Y4	41034-13	4.546560
5	340	±75	A	2295	2220	2370	41065-5	. . .	B	Y1	41034-13	4.546560	Y3	41034-14	4.853760
			B	2635	2710	2560	. . .	41065-6	G	Y2	41034-4	2.775040	Y4	41034-3	2.621440
6	340	±75	A	2635	2560	2710	41065-6	. . .	C	Y1	41034-3	2.621440	Y3	41034-4	2.775040
			B	2975	3050	2900	. . .	41065-7	G	Y2	41034-2	3.123200	Y4	41034-1	2.969600
7	340	±75	A	2975	2900	3050	41065-7	. . .	C	Y1	41034-1	2.969600	Y3	41034-2	3.123200
			B	3315	3390	3240	. . .	41065-8	G	Y2	41034-16	3.471360	Y4	41034-15	3.317760
8	680	±150	A	935	785	1085	41065-9	. . .	A	Y1	41034-17	3.215360	Y3	41034-18	4.444160
			B	1615	1765	1465	. . .	41065-10	F	Y2	41034-20	3.614720	Y4	41034-19	3.000320
9	680	±150	A	1615	1465	1765	41065-10	. . .	B	Y1	41034-19	3.000320	Y3	41034-20	3.614720
			B	2295	2445	2145	. . .	41065-11	F	Y2	41034-22	5.007360	Y4	41034-21	4.392960
10	680	±150	A	2295	2145	2445	41065-11	. . .	B	Y1	41034-21	4.392960	Y3	41034-22	5.007360
			B	2975	3125	2825	. . .	41065-12	G	Y2	41034-24	3.200000	Y4	41034-23	2.892800
19	240	±60	A	480	420	540	41065-19	. . .	A	Y1	41034-65	1.720320	Y3	41034-66	2.211840
			B	720	780	660	. . .	41065-20	E	Y2	41034-62	3.194880	Y4	41034-61	2.703360
21	240	±60	A	960	900	1020	41065-21	. . .	A	Y1	41034-26	3.686400	Y3	41034-27	4.177920
			B	1200	1260	1140	. . .	41065-22	F	Y2	41034-29	2.580480	Y4	41034-28	2.334720
23	240	±60	A	1440	1380	1500	41065-23	. . .	B	Y1	41034-30	2.826240	Y3	41034-31	3.072000
			B	1680	1740	1620	. . .	41065-24	F	Y2	41034-33	3.563520	Y4	41034-15	3.317760
25	240	±60	A	1920	1860	1980	41065-25	. . .	B	Y1	41034-34	3.809280	Y3	41034-35	4.055040
			B	2160	2220	2100	. . .	41065-26	F	Y2	41034-13	4.546560	Y4	41034-36	4.300800
27	240	±60	A	2400	2340	2460	41065-27	. . .	C	Y1	41034-38	2.396160	Y3	41034-39	2.519040
			B	2640	2700	2580	. . .	41065-28	G	Y2	41034-41	2.764800	Y4	41034-40	2.641920
29	240	±60	A	2880	2820	2940	41065-29	. . .	C	Y1	41034-42	2.887680	Y3	41034-43	3.010560
			B	3120	3180	3060	. . .	41065-30	G	Y2	41034-45	3.256320	Y4	41034-44	3.133440
31	240	±60	A	3360	3300	3420	41065-31	. . .	C	Y1	41034-46	3.379200	Y3	41034-47	3.502080
			B	3600	3660	3540	. . .	41065-32	G	Y2	41034-49	3.747840	Y4	41034-48	3.624960
33	240	±60	A	3480	3420	3540	41065-33	. . .	C	Y1	41034-47	3.502080	Y3	41034-48	3.624960
			B	3720	3780	3660	. . .	41065-34	G	Y2	41034-54	3.870720	Y4	41034-49	3.747840

Table 3-13. Discriminator/filter assemblies for RFL 67B REC Wideband Receiver Modules

Group	Channel Spacing (Hz)	Frequency Shift (±Hz)	Subchannel A Center Frequency (Hz)	Required Subchannel A Discriminator Filter Assembly	Subchannel B Center Frequency (Hz)	Required Subchannel B Discriminator Filter Assembly
1	340	75	935	79720-1	1275	79720-2
2	340	75	1275	79720-2	1615	79720-3
3	340	75	1615	79720-3	1955	79720-4
4	340	75	1955	79720-4	2295	79720-5
5	340	75	2295	79720-5	2635	79720-6
6	340	75	2635	79720-6	2975	79720-7
7	340	75	2975	79720-7	3315	79720-8
8	680	150	935	79720-9	1615	79720-10
9	680	150	1615	79720-10	2295	79720-11
10	680	150	2295	79720-11	2975	79720-12
19	240	60	480	79720-19	720	79720-20
21	240	60	960	79720-21	1200	79720-22
23	240	60	1440	79720-23	1680	79720-24
25	240	60	1920	79720-25	2160	79720-26
27	240	60	2400	79720-27	2640	79720-28
29	240	60	2880	79720-29	3120	79720-30
31	240	60	3360	79720-31	3600	79720-32
33	240	60	3480	79720-33	3720	79720-34

NOTE: Discriminator/filter assemblies cannot be repaired in the field; they must be returned to the factory for repair or replacement.

3.5.2. RFL 67 LOGIC Standard-Range Logic Module

The input signal level for the wideband receiver modules is set by resistor network RZ16 on the RFL 67 LOGIC. RFL part numbers for the standard choices are as follows:

No Boost	41067-1
3-dB Boost, 70-ms Duration	41067-2
6-dB Boost, 70-ms Duration	41067-4
9-dB Boost, 70-ms Duration	41067-5
12-dB Boost, 70-ms Duration	41067-3

3.5.3. RFL 67A LOGIC Wide-Dynamic-Range Logic Module

The RFL 67A LOGIC Wide-Dynamic-Range Logic Module can be used in protective relaying systems employing one of many different communication mediums. Because each medium has its own special characteristics, resistor network RZ3 is used to match the wide dynamic range of the RFL 67A LOGIC's analog circuit board to the specific requirements of the medium being used.

Table 3-14 lists all the standard plug-in networks that were available as of the date this manual was published. Contact the factory for information on ordering non-standard networks for special applications.

Table 3-14. Level-determining plug-in networks, RFL 67A LOGIC Wide-Dynamic-Range Logic Module

RFL Part Number	Voltage Range (1)		Input Level Dynamic Range		AGC Reference Level (volts) (2)
	Minimum	Maximum	Below Nominal	Above Nominal	
41063-1	0.15	7.0	-28 dB	+5 dB	4.0
41063-2	0.475	6.0	-11 dB	+11 dB	1.69
41063-3	0.437	7.0	-8 dB	+16 dB	1.1
41063-4	0.15	7.0	-13 dB	+20 dB	0.7
41063-5	0.22	7.0	-25 dB	+5 dB	4.0
41063-6	0.22	7.0	-15 dB	+15 dB	1.24
41063-7	0.15	7.0	-25 dB	+8 dB	2.8
41063-8	0.15	7.0	-19 dB	+14 dB	1.4
41063-9	0.22	7.0	-19 dB	+11 dB	1.97
41063-10	0.475	7.0	-18.5 dB	+5 dB	4.0
41063-11	0.22	7.0	-22 dB	+8 dB	2.8
41063-12	0.22	7.0	-10 dB	+20 dB	0.7
41063-13	0.475	6.0	-8 dB	+14 dB	1.2
41063-14	2.0	6.3	-6 dB	+4 dB	4.0

1. As measured at the following test points on the RFL 67 FS/AM Detector Module:
   Subchannel A: TP4 (blue) to TP1 (black).
   Subchannel B: TP5 (gray) to TP1 (black).

2. As measured at the following test points on the RFL 67 FS/AM Detector Module:
   Subchannel A: TP2 (brown) to TP1 (black).
   Subchannel B: TP3 (orange) to TP1 (black).

3.6. INITIAL STARTUP

All RFL 6745 terminals are checked and adjusted at the factory. Once all electrical connections and jumper settings have been made and the proper plug-in networks have been installed, the terminals at each end of the communication circuit should be checked for proper operation. Perform all steps in the order presented. Expected results or comments appear in **boldface** type.

a. Equipment Required. To perform the initial startup procedure, a digital multimeter with true-rms response (Fluke Model 8010A or equivalent) will be required for making signal measurements. In addition, a small screwdriver or potentiometer adjustment wand will be required to set signal levels.

b. Initial Startup Procedure. The following procedure must be performed at each RFL 6745 terminal to adjust the output of the transmitter module and the input sensitivity of the two wideband receiver modules.

Before attempting this procedure on terminals using trip boost, the amount of boost and boost duration must be known. (See paragraph 3.5 for further information.)

1. At both terminals, place the power switches on the dc-dc converters (RFL 68 HPS **DC-1) in the ON (up) position.

   If the following indicators are lit in each chassis, the terminals are functioning properly:

   1. **GUARD indicator DS1 on the RFL 67A RELAY-4 module (if present).**
   2. **GUARD indicator DS2 on the RFL 67 LOGIC module (if present).**
   3. **Power indicator DS1 on the dc-dc converter power supply.**

2. Adjust the output level of one of the terminals as follows:

   a. Set the multimeter for ac voltage measurements and connect meter leads across the transmit output terminals of terminal block TB2 on the rear of the chassis (TB2-1 and TB2-2 for two-wire systems, and TB2-3 and TB2-4 for four-wire systems).

   b. Note the guard signal level, as indicated on the multimeter. If necessary, adjust TRANS LEVEL potentiometer R56 for the desired value.

      The guard signal level is a composite of two tones and must not exceed the limits established for the communication channel used with the RFL 6745.

      If trip boost is used, the guard level must be set below the allowed maximum. Table 3-15 lists the maximum guard levels permissible for various combinations of trip boost time and level. These values represent the maximum guard signal levels that may be reliably sent over a 600-ohm telephone line.

Table 3-15. Maximum guard tone output levels for various trip boost time/level combinations

Trip Boost Level	Unit Of Measure	70-ms Trip Boost	100-ms Trip Boost	150-ms Trip Boost	200-ms Trip Boost
3 dB	dBm	-0.112	-0.158	-0.227	-0.280
	mW	0.977	0.967	0.952	0.938
	V	0.765	0.761	0.755	0.750
6 dB	dBm	-0.308	-0.424	-0.615	-0.792
	mW	0.934	0.909	0.869	0.833
	V	0.748	0.738	0.722	0.707
9 dB	dBm	-0.663	-0.921	-1.316	-1.660
	mW	0.859	0.810	0.740	0.681
	V	0.718	0.697	0.666	0.640
12 dB	dBm	-1.316	-1.771	-2.443	-3.000
	mW	0.740	0.666	0.571	0.500
	V	0.666	0.632	0.585	0.548

   c. Disconnect the multimeter from the transmit output terminals on the rear of the chassis.

3. Repeat step 2 at the other terminal to set its guard signal level.

4. Adjust the input sensitivity of the wideband receiver modules in one of the terminals as follows:

   a. Press and hold PUSH TO ATTENUATE switch SW1 on one of the RFL 67B REC wideband receiver modules.

   b. While holding SW1 in, slowly turn LEV potentiometer R3 until LO SIG indicator DS1 lights.

      If the terminal is set up for trip boost, the AGC response of the receiver is very slow. It will take about eight seconds for the LO SIG light to respond.

      When adjusting R3, it is best to turn it slightly and wait to see if DS1 lights; if DS1 doesn't light, turn R3 a little more.

   c. Once the LO SIG indicator lights, release SW1.

   d. Repeat steps 4a through 4c for the other wideband receiver module.

5. Repeat step 4 at the other terminal to adjust the input sensitivity of its wideband receiver modules.

6. If either terminal contains accessory equipment, refer to Section 12 of this manual for any additional setup procedures.

If the above test sequence can be successfully completed, both terminals are working properly. If the sequence cannot be completed at one or both terminals, check all connections to both terminals, as described in Section 2. If all connections were correctly made, perform the terminal alignment procedure in paragraph 3.7 below.

3.7. TERMINAL ALIGNMENT

All RFL 6745 terminals are aligned at the factory. Alignment should only be performed in the field after one or more circuit modules have been repaired or replaced, or if a malfunction is suspected. Alignment procedures appear in paragraphs 3.7.1 through 3.7.8. Perform these procedures in the order presented. Expected results or comments appear in **boldface** type.

3.7.1. Test Equipment Required

The following test equipment will be required to align the RFL 6745:

1. Oscilloscope, 5-Mhz minimum bandwidth; Tektronix Model 2200 or equivalent.

2. Digital multimeter with true-rms ac response and dB reading capability; Fluke 8050A or equivalent.

3. Frequency counter, Fluke 1900A or equivalent.

4. Variable attenuator, 600-ohm impedance, Hewlett-Packard Model 350D or equivalent. Two attenuators will be required for back-to-back four-wire connections. (See para 3.7.2.)

5. Switch, SPST, any style (pushbutton momentary contact preferred). Two switches will be required for back-to-back four-wire connections. (See para 3.7.2.)

6. Clip lead, 8 inches long with pin tips on each end, Pomona P-8-0 or equivalent (2 required).

3.7.2. Preparation for Alignment

Two different methods can be used when testing RFL 6745 terminals: "loopback" or "back-to-back," as shown in Figure 3-12. In the loopback method, the transmitter output of one terminal is connected to its own receiver inputs; in effect, the terminal will communicate with itself. In the back-to-back method, the transmitter output of one terminal is connected to the receiver inputs of another; this allows signals to be sent from one terminal to another, and more closely simulates the normal operation of RFL 6745 equipment. Because of this, the back-to-back method of testing is recommended whenever practical, and must be used when a RFL 6745 terminal transmits and receives on different frequencies.

If the back-to-back connection method is used, adjustments are made at one terminal and then repeated at the other. This will ensure that both terminals are functioning properly and that one terminal will not cause false readings at the other.

The alignment procedures in this manual are suitable for either connection method, although they were written for the back-to-back method. When using the loopback method, ignore all references to different terminals; the single terminal is performing all functions.

WARNING

DURING ALIGNMENT, STATION BATTERY VOLTAGE WILL BE PRESENT ON THE TERMINALS OF THE "PUSH TO TRIP" SWITCHES. TO PREVENT ELECTRICAL SHOCK, THESE TERMINALS MUST BE INSULATED.

Before proceeding, all trip and guard frequencies must be known. If trip boost is being used, the amount of boost and boost duration must also be known. (See paragraph 3.5 for further information.) To prepare the terminal(s) for alignment, proceed as follows:

1. Place the power switch on each dc-dc converter (RFL 68 HPS **DC-1) in the off (down) position.
   All indicators on all modules will go out.

2. Pull the following modules out of the chassis, set the jumpers listed below to the positions indicated, and reinsert into the chassis. Leave all other jumpers set the way they are.
   Note which way all the jumpers are set, so they can be reset once the terminal is aligned. (Refer to the section of this manual covering each module for additional information on jumper settings.)

   a. On each wideband receiver module (RFL 67B REC), set the FAST/SLOW jumper to FAST for non-boost applications; set it to SLOW for applications using trip boost.

   b. On the detector module (RFL 67 FS/AM), install jumpers in Positions A, D, F, and G; leave all other positions unoccupied.

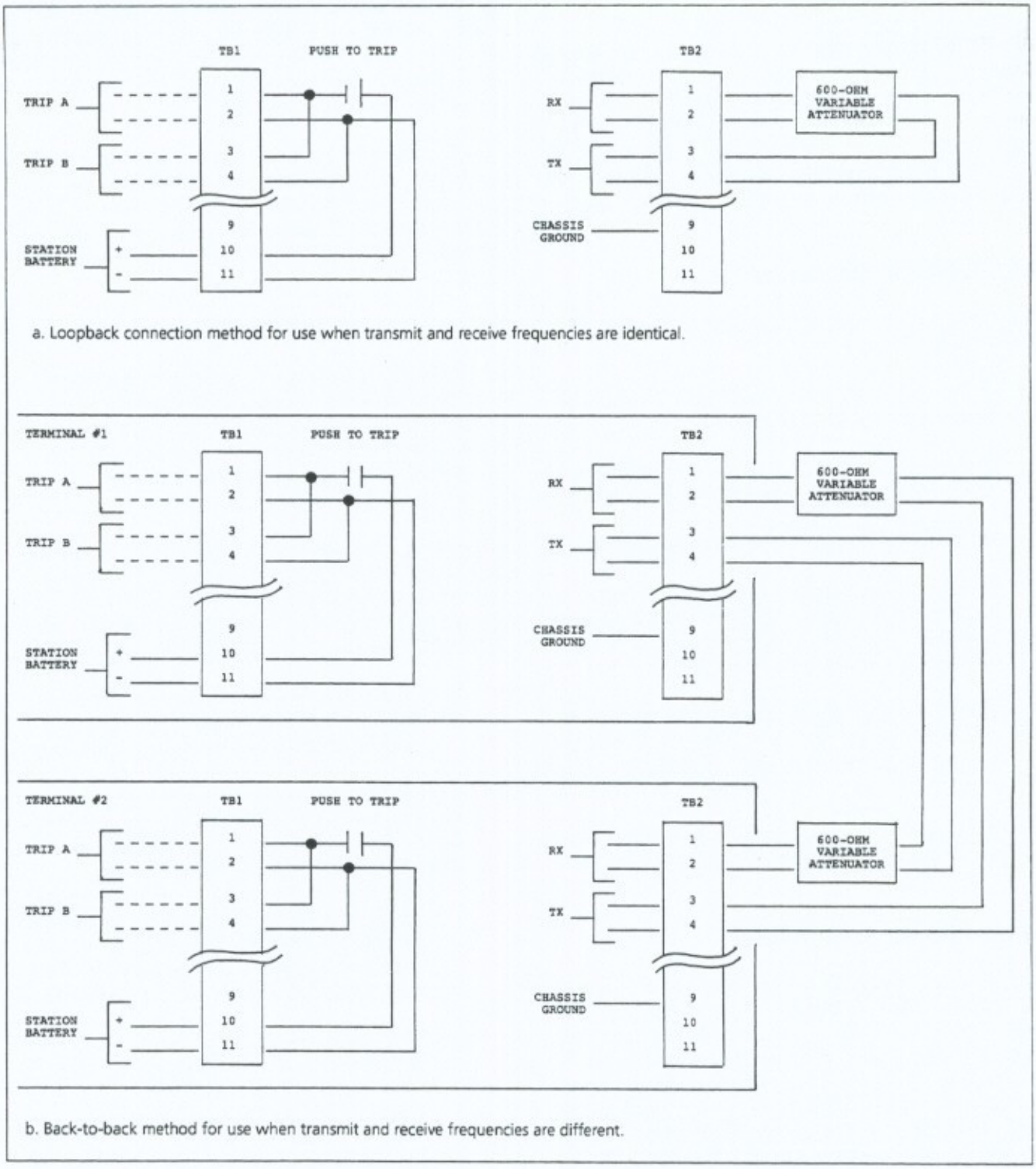


Figure 3-12. Equipment connections for alignment procedure

c. On the interface module (RFL 67C INTER or RFL 67C INTER-1), set jumpers G and H to Position ST (single trip). Set jumpers A through E for four-wire operation at the desired signal level, as described in paragraph 3.3.1.

d. If alignment is being performed using the back-to-back connection method, repeat steps 2a through 2c for the other terminal.

3. Connect the RFL 6745 equipment as shown in Figure 3-12. The loopback method shown in Figure 3-12a can be used if transmit and receive frequencies are identical; if not, the back-to-back method shown in Figure 3-12b must be used.

4. Set both variable attenuators for 20-dB attenuation.

5. At both terminals, place power switch S1 on the dc-dc converters (68 HPS **DC-1) in the ON (up) position.

   The following indicators should light in each chassis:

   1. **GUARD indicator DS1 on the RFL 67A RELAY-4 module (if present).**

   2. **GUARD indicator DS2 on the RFL 67 LOGIC module (if present).**

   3. **Power indicator DS1 on the dc-dc converter power supply.**

If the above indicators are lit in both terminals, they are ready for alignment, If any of these indicators are not lit in one terminal or the other, that terminal is not working properly. Determine the cause of failure and correct before proceeding to paragraph 3.7.3. (See Section 4 and the sections on each circuit module that does not seem to be working properly.)

3.7.3. Dc-dc Converter Output Check

Each RFL 6745 terminal contains a RFL 68 HPS **DC-1 dc-dc converter power supply with two fixed 12-volt outputs. Because the outputs cannot be adjusted, this procedure only verifies whether or not the power supply is working. Proceed as follows:

1. Set the multimeter for dc voltage measurements. Set the range control as required for the available station battery voltage.

2. At one terminal, measure the available station battery voltage by connecting the positive multimeter lead to TB1-10, and the negative lead to TB1-11.

   The multimeter indication should be between 21 and 28 volts for 24-volt batteries, between 42 and 56 volts for 48-volt batteries, and between 105 and 145 volts for 129-volt batteries. If voltage is below these limits, the dc-dc converter may not produce enough power to operate the terminal properly. If the voltage is above these limits, the dc-dc converter may be damaged.

3. Connect the positive multimeter lead to test point TP1 on the front of the dc-dc converter; connect the negative lead to test point TP2. Note the multimeter indication.

   The multimeter indication should be between 11.4 and 12.6 volts.

4. Connect the positive multimeter lead to test point TP3 on the front of the dc-dc converter; connect the negative lead to test point TP4. Note the multimeter indication.

   Meter indication should be between 11.4 and 12.6 volts.

5. If the back-to-back connection method is being used, repeat steps 2 through 4 at the other terminal.

If the above procedure could be completed successfully, the dc-dc converters are functioning properly. If not, refer to the fuse replacement procedures in Section 4 before proceeding with paragraph 3.7.4. If fuse replacement does not correct the problem, refer to Section 11 for further information.

3.7.4. Transmitter Module Adjustments

Once the dc-dc converter output check has been made, the RFL 67 TRANS transmitter module(s) must be adjusted. Proceed as follows:

1. Set the multimeter for ac voltage measurements, and select a range that will display a 4-volt reading with good resolution.

2. On the transmitter module at one terminal, connect the positive multimeter lead to test point TP1 (TONE LEVEL - yellow); connect the negative lead to test point TP5 (COM - black).

3. Turn ten-turn TRANS LEVEL potentiometer R56 fully counterclockwise. Note the multimeter indication.

   The multimeter indication should be about 400 mV.

4. Turn R56 fully clockwise; note the multimeter indication.

   The multimeter indication should be about 4 volts.

5. Disconnect the multimeter from the transmitter module, and connect the oscilloscope in its place.

6. Adjust the oscilloscope controls as needed to produce a stable display of the transmitter module's output waveform.

   The waveform should be an unclipped sine wave. If clipping occurs, turn R56 counterclockwise until the clipping just disappears.

7. Set the multimeter for dB measurements, with a 600-ohm reference.

8. Connect the multimeter across the tone output terminals on the rear of the chassis (TB2-3 and TB2-4). Note the multimeter indication.

   The multimeter indication should be the maximum output level set by the jumpers on the interface module (Section 6).

   If trip boost is being used, the multimeter indication will be the level set by the jumpers minus the amount of trip boost.

9. Connect the frequency counter across the same rear panel terminals as the multimeter.

10. Connect one clip lead between test points TP5 (COM - black) and TP4 (KILL A - orange) on the transmitter module. Note the counter indication.

    The counter should indicate the Subchannel B guard frequency.

11. Close the trip keying switch connected to the trip keying input terminals on terminal block TB1. Note the counter indication.

    The counter should indicate the Subchannel B trip frequency. In addition, TRIP B indicator DS2 on the transmitter module will light.

12. Re-open the trip keying switch.

    TRIP B indicator DS2 will go out and the counter indication will return to the Subchannel B guard frequency.

13. Connect a second clip lead between TP5 and test point TP2 (BOOST - gray).

    If trip boost is being used, the multimeter should indicate the boost level set by the jumpers on the interface module (Section 6). The counter should indicate the Subchannel B guard frequency. In addition, TRIP BOOST indicator DS3 on the transmitter module will light; if the terminal contains an RFL 67 LOGIC module, its AM BLOCK indicator (DS1) will go out.

14. Disconnect the clip lead installed during the previous step, and move the other clip lead from TP4 to test point TP3 (KILL B - brown). Note the counter indication.

    The counter should indicate the Subchannel A guard frequency.

15. Close the trip keying switch again. Note the counter indication.

    The counter should indicate the Subchannel A trip frequency and TRIP A indicator DS1 will light.

16. Re-open the trip keying switch.

    TRIP A indicator will go out, and the counter indication will return to the Subchannel A guard frequency.

17. Reconnect the second clip lead between TP5 and test point TP2. Note the indications on the multimeter and the counter.

    If trip boost is being used, the multimeter should indicate the boost level set by the jumpers on the interface module (Section 6). The counter should indicate the Subchannel A guard frequency. In addition, TRIP BOOST indicator DS3 on the transmitter module will light; if the terminal contains an RFL 67 LOGIC module, its AM BLOCK indicator (DS1) will go out.

18. Disconnect the multimeter, the counter, and all clip leads from the terminal.

19. If back-to-back connection method is being used, repeat steps 2 through 18 to adjust the other transmitter module.

If the above procedure can be successfully completed, the transmitter module(s) is (are) working properly. If not, refer to Section 6 and determine the cause of failure before proceeding with paragraph 3.7.5.

3.7.5. Receiver Module Adjustment

The RFL 67B REC wideband receiver modules are to be adjusted after the transmitter module producing the signals they will be receiving is adjusted. This makes sure that they are receiving the proper signals. Make sure the trip keying switch at the terminal producing the signal is open before starting. Proceed as follows:

1. Set the multimeter for dB measurements and connect its leads to the receiver input terminals on the rear panel (TB2-1 and TB2-2).

2. Adjust the variable attenuator at the receiver input until the multimeter indicates -29 dB.
   For the rest of this procedure, this will be referred to as the "nominal value".

3. Adjust the receiver input sensitivity as follows:

   a. Place power switch S1 on the dc-dc converter (RFL 68 HPS **DC-1) in the off (down) position.

   b. Pull both RFL 67B REC modules out of the chassis, and check the setting of the F/S jumpers. (See Figure 3-6 on page 3-6 for the location of these jumpers.)
      The F/S jumpers set the AGC circuits for fast or slow response. If either jumper is in Position S, move it to Position F.

   c. Re-insert the RFL 67B REC modules into the chassis.

   d. Place power switch S1 on the dc-dc converter back in the ON (up) position.
      The following indicators should light:

      1. **GUARD indicator DS1 on the RFL 67A RELAY-4 module (if present)**
      2. **GUARD indicator DS2 on the RFL 67 LOGIC module (if present)**
      3. **Power indicator DS1 on the dc-dc converter power supply.**

   e. Press and hold pushbutton switch SW1 on one of the RFL 67B REC wideband receiver modules.

   f. While holding SW1 in, slowly turn LEV potentiometer R3 until LO SIG indicator DS1 lights.

   g. Once LO SIG indicator DS1 lights, release SW1.

   h. Repeat steps 3e through 3g for the other receiver module.

   i. If the F/S jumpers on the RFL 67B REC modules were reset during step 3b above, place the power switch on the dc-dc converter (RFL 68 HPS **DC-1) in the off (down) position, pull both RFL 67B REC modules out of the chassis, return both F/S jumpers to Position S, reinsert them into the chassis, and place power switch S1 on the dc-dc converter back in the ON (up) position.

4. Set the multimeter for ac voltage measurements.

5. On the receiver module that is receiving Subchannel A, connect the positive multimeter lead to test point TP4 (brown); connect the negative lead to test point TP6 (black). Note the multimeter indication.
   If the multimeter has a dB function, the multimeter indication should be between 4.5 and 7.5 dBm; otherwise, it will be between 1.2 and 1.8 Vrms.

6. Disable the AGC circuit on the Subchannel A receiver module by connecting a clip lead between test points TP7 (gray) and TP6 (black).
   LO SIG indicator DS1 should light.

7. Disconnect the clip lead from TP6 and connect it to test point TP8 (red).
   HI SIG indicator DS2 should light.

8. Disconnect clip lead from the receiver module.
   HI SIG indicator DS2 will go out.

9. Adjust the variable attenuator until the input signal is increased above nominal by 12 dB ±1 dB (-16 to -18 dB).
   HI SIG indicator DS2 should light.

10. Return the variable attenuator to its nominal value setting (-29 dB).
    HI SIG indicator DS2 will go out.

11. Adjust the variable attenuator until the input signal is decreased below nominal by 12 dB ±1 dB (-40 to -42 dB).
    LO SIG indicator DS1 should light.

12. Return variable attenuator to its nominal value setting (-29 dB).
    LO SIG indicator DS1 will go out.

13. Repeat steps 5 through 12 for the receiver module that is receiving Subchannel B.

14. If the back-to-back connection method is being used, repeat steps 3 through 13 to adjust the receiver modules in the other terminal.

The wideband receiver modules are now adjusted. If the above procedure could not be successfully completed, refer to Section 7 for further information and determine the cause of failure before proceeding to paragraph 3.7.6.

3.7.6. Detector Module Measurements

There are no adjustments to be made on the RFL 67 FS/AM detector module. If the receiver module adjustments in paragraph 3.7.5 were properly made, the dc voltages listed below should be present at test points TP2 through TP5 on the detector module, with respect to test point TP1 (ground). If these voltages are not present, refer to Section 8 for further information and determine the cause of failure before proceeding to paragraph 3.7.7.

TP2 (brown)

Guard	+4.0
Trip (no boost)	+4.0
Trip (3-dB boost)	+2.8
Trip (6-dB boost)	+2.0
Trip (9-dB boost)	+1.4
Trip (12-dB boost)	+1.0

TP3 (yellow)

Guard	+4.0
Trip (no boost)	+4.0
Trip (3-dB boost)	+2.8
Trip (6-dB boost)	+2.0
Trip (9-dB boost)	+1.4
Trip (12-dB boost)	+1.0

TP4 (blue)

Guard	-2.6
Trip (no boost)	+2.6
Trip (3-dB boost)	+1.8
Trip (6-dB boost)	+1.4
Trip (9-dB boost)	+0.9
Trip (12-dB boost)	+0.7

TP5 (gray)

Guard	-2.6
Trip (no boost)	+2.6
Trip (3-dB boost)	+1.8
Trip (6-dB boost)	+1.4
Trip (9-dB boost)	+0.9
Trip (12-dB boost)	+0.7

3.7.7. Logic Module Verification

There are two different logic modules used in RFL 6745 equipment: the RFL 67 LOGIC (standard range) and the RFL 67A LOGIC (wide dynamic range). Neither module has any adjustable components, but their operation should be verified as part of the terminal alignment.

Before verifying logic module operation, make sure the receive level network installed on it complements the transmit level network installed on the transmitter module (Refer to paragraph 3.5 for further information.) To verify logic module operation, proceed as follows:

1. Make sure the trip keying switch at the transmitter is open.
   The terminal will be in the guard mode, and the GUARD indicator on the logic module will be lit.

2. Close the trip keying switch.
   The GUARD indicator will go out and the TRIP indicator will light.

3. Adjust the variable attenuator to either increase or decrease the signal level by more than 14 dB.

   The BLOCK indicators on the logic module will light, and the ALARM indicator will light a few seconds later.

4. Return variable attenuator to its nominal value setting.

If the above procedure cannot be successfully completed, refer to Section 9 for further information and determine the cause of logic module failure before proceeding to paragraph 3.7.8.

3.7.8. Other Tests

The following tests may or may not be performed on your terminal, depending on the modules installed in your terminals and the operation modes required by your specific application.
If any of these tests cannot be successfully completed, refer to the Instruction Data sheets in Section 13 for further information and determine the cause of failure before proceeding to the next test.

3.7.8.1. Buffer Module Tests

This procedure is to be performed on terminals containing RFL 67 BUFFER buffer modules. Proceed as follows:

1. Set the multimeter for dc voltage measurements.

2. Connect the positive multimeter lead to the TRIP OUT + terminal on rear panel of chassis; connect the negative lead to the COM terminal. (Refer to the "as supplied" drawings furnished with the equipment.)

3. Make sure the trip keying switch at the transmitter is open (transmitter in guard mode). Note the multimeter indication.

   The multimeter should indicate about zero volts.

4. Close the trip keying switch; note the multimeter indication.

   The multimeter should indicate about +10 volts.

5. Re-open the trip keying switch.

   The terminal will return to guard mode, and all GUARD indicators will light.

6. Connect the positive multimeter lead to the CHANNEL A OUT OF LIMIT terminal on rear panel of chassis; connect the negative lead to the COM terminal. (Refer to Figure 12-4 in Section 12 or the "as supplied" drawings furnished with the equipment.)

7. With the variable attenuator set for the -29-dB nominal value, note the multimeter indication.

   The multimeter should indicate about +10 volts.

8. Adjust the variable attenuator to increase or decrease the signal level by more than 12 dB; note multimeter indication.

   The multimeter should indicate about zero volts.

9. Return the variable attenuator to the nominal value setting (-29 dB).

10. Repeat steps 6 through 9 for Subchannel B.

3.7.8.2. Auxiliary Relay Test

This test is only performed on RFL 6745 terminals containing RFL 67AR (XXX) relay modules. Before proceeding with this test, make sure the AR relays are connected as shown in the "as supplied" drawings furnished with the equipment.

1. Disconnect the multimeter from the terminal and set it for resistance measurements.

2. With the terminal in guard, use the multimeter to check the status of the AR relay contacts. (Refer to the "as supplied" drawings furnished with the equipment.)

3. Close the trip keying switch to place the terminal in the trip mode. Use the multimeter to check the status of the AR relay contacts.

4. Adjust the variable attenuator to increase or decrease the signal level by more than 12 dB; this will place the terminal in the block mode. Use the multimeter to check the status of the block relay contacts.

5. Wait about two seconds for the terminal to enter the alarm mode. When it does, use the multimeter to check the status of the alarm relay contacts.

3.7.8.3. Channel Delay Time

"Channel delay time" is defined as the amount of time that passes between the application of a trip voltage at the transmitter keying input and the generation of a trip output voltage at the receiver (excluding line delay). To measure channel delay time, proceed as follows:

1. Set the oscilloscope controls for external triggering, with negative polarity.

2. Connect the oscilloscope trigger input to BOOST test point TP2 on the transmitter module that will be generating the trip signal.

3. Connect the oscilloscope vertical input to the TRIP OUTPUT terminals on the rear panel of the chassis containing the receiver.

4. Open and close the trip keying switch at the transmitter several times. Adjust the vertical deflection, time base, and triggering controls on the oscilloscope until a waveform appears on the CRT.
   The amount of time the waveform is low before it goes high is the channel delay time. When 340-Hz subchannel spacing is used, the delay time must be 12 ms or less; for 680-Hz spacing, it must be 8 ms or less.

3.7.8.4. Guard-Before-Trip Verification

The following test is performed to check the guard-before-trip logic. Proceed as follows:

1. Make sure the terminal is in the guard mode (all GUARD indicators lit).

2. Cause an out-of-limits condition by adjusting the variable attenuator to increase or decrease the signal level by at least 12 dB.

3. Close the trip keying switch at the transmitter, and then return the variable attenuator to its nominal value setting.
   No trip output should occur.

4. Open the trip keying switch to return the terminal to its guard mode.
   All GUARD indicators should light.

5. Close the trip keying switch at the transmitter, and then cause an out-of-limits condition by adjusting the variable attenuator to increase or decrease the signal level by at least 12 dB.

6. Return the variable attenuator to its nominal value setting.
   Trip output should occur.

NOTE

The logic module can be set to only require a guard signal before the initial trip. For RFL 67 LOGIC modules, the T/GT jumper is placed in Position T; on RFL 67A LOGIC modules, jumper J7 on the digital circuit board is placed in Position A. If the jumpers have been set this way, verification is complete at this point.

If the logic module has been set to require a valid guard signal before each trip (the T/GT jumper on RFL 67 LOGIC modules in Position GT, or jumper J7 on the digital circuit board of RFL 67A LOGIC modules in Position B), perform steps 7 through 12.

7. Make sure terminal is in the guard mode.
   All GUARD indicators should be lit.

8. Cause an out-of-limits condition by adjusting the variable attenuator to increase or decrease the signal level by at least 12 dB.

9. Close the trip keying switch at the transmitter, and then return the variable attenuator to its nominal value setting.
   No trip output should occur.

10. Open the trip keying switch to return the terminal to its guard mode.
    All GUARD indicators should light.

11. Close the trip keying switch at the transmitter, and then cause an out-of-limits condition by adjusting the variable attenuator to increase or decrease the signal level by at least 12 dB.

12. Return the variable attenuator to its nominal value setting.
    No trip output should occur.

3.8. PROCEDURES FOR CHANGING OPERATING CHANNELS

Paragraphs 3.8.1 through 3.8.4 provide information and procedures to be used when RFL 6745 equipment must be modified to operate on different channels.

3.8.1. Equipment Required

The following equipment will be required to change RFL 6745 operating channels.

1. Digital multimeter with true-rms response, Fluke Model 8010A or equivalent.
2. Card extender, RFL 68 EXT.
3. Small screwdriver or potentiometer adjustment wand.
4. Clip lead with pin tips on each end, Pomona P-8-0 or equivalent.
5. New frequency-determining components for transmitter module (resistor networks RZ1 and RZ2, crystals Y1 through Y4). (For proper part numbers, refer to Table 3-12 on page 3-15 of this section.)
6. New discriminator/filter assemblies for each wideband receiver module. (Refer to Table 3-13 on page 3-16 for the proper part numbers.)

3.8.2. Transmitter Channel-Changing Procedure

Two resistor networks and four crystals will have to be replaced on the transmitter module to change its operating channel. Part numbers for the required parts can be found in Section 6 of this manual. Perform all steps in the order presented. Expected results or comments appear in **boldface** type.

1. Make sure power switch S1 on the chassis dc-dc converter power supply (68 HPS **DC-1) is in the off (down) position.
2. Pull the RFL 67 TRANS transmitter module out of the chassis.
3. Remove resistor networks RZ1 and RZ2 and crystals Y1 through Y4 from the transmitter module and replace then with parts suitable for the new operating channel. (For proper part numbers, refer to Table 3-12 on page 3-15 of this section.)
4. Once the proper parts are installed, the digital frequency dividers must be set for the new channel's division factor. (The correct jumper settings can also be found in Table 3-12.)
5. Re-insert the transmitter module into the chassis.
6. Set the multimeter for ac voltage measurements and connect the meter leads across the transmit terminals of terminal block TB2 on the rear panel of the chassis (terminals 1 and 2 for two-wire systems, or 3 and 4 for four-wire systems).
7. Place power switch S1 on chassis power supply in the on (up) position.
   Both subchannels will be transmitting at their new guard frequencies.
8. Connect a clip lead between KILL B test point TP3 and COMMON test point TP5.
   Subchannel B will be killed (turned off), and Subchannel A will still be transmitting at its guard frequency.
9. Measure the amplitude of Subchannel A's guard signal by noting and recording the multimeter reading while Subchannel A is not keyed to trip.
10. Key Subchannel A to trip while noting the multimeter indication.
    Guard and trip signals should be almost equal in amplitude. If not, adjust TRIM FREQ potentiometer R23 and repeat steps 9 and 10 until guard and trip signals are almost equal.
11. Disconnect the clip lead from test point TP3 and connect it to KILL A test point TP4.
    Subchannel A will now be killed, and Subchannel B will be re-activated.
12. Measure the amplitude of Subchannel B's guard signal by noting and recording the multimeter reading while Subchannel B is not keyed to trip.
13. Key Subchannel B to trip while noting the multimeter indication.
    Guard and trip signals should be almost equal in amplitude. If not, adjust TRIM FREQ potentiometer R24 and repeat steps 12 and 13 until guard and trip signals are almost equal.

14. Disconnect the multimeter from the transmit terminals, and remove the clip lead from the transmitter module.

The transmitter module is now set to operate on its new channel.

3.8.3. Wideband Receiver Channel-Changing Procedure

Once a transmitter module is set to operate in a different channel, complementary changes must be made on every RFL 6745 wideband receiver module that will be receiving its signals. All frequency-determining components for each wideband receiver module are mounted on its discriminator/filter assembly. This assembly must be replaced to change the operating channel. Part numbers for the required assembly can be found in Table 3-13 on page 3-16 of this section. Perform all steps in the order presented. Expected results or comments appear in **boldface** type.

1. Place power switch S1 on the chassis dc-dc converter power supply (68 HPS **DC-1) in the off (down) position.

2. Determine which RFL 67B REC Wideband Receiver Module is receiving Subchannel A. Pull this module out of the chassis, insert a card extender in its place, and plug the wideband receiver module into the card extender.

3. Remove the discriminator/filter assembly from the wideband receiver module and replace it with one suitable for the new operating channel. (Refer to Table 3-13 on page 3-16 for the proper part number.)

4. Set the multimeter for dc voltage measurements.

5. Connect the positive meter lead to CHAN A FS test point TP4 (blue) on the RFL 67 FS/AM detector module.

6. Connect the negative meter lead to COMMON test point TP1 (black) on the detector module.

7. Place power switch S1 on the chassis power supply in the on (up) position.
   All GUARD indicators should light.

8. With a guard signal being received on Subchannel A, note and record the multimeter indication.
   Depending upon the amount of trip boost the terminal is set for, multimeter indication should be as follows:

Non-Boost	**2.6 volts**
3-dB boost	**1.8 volts**
6-dB boost	**1.4 volts**
9-dB boost	**0.92 volts**
12-dB boost	**0.7 volts**

9. At the transmitter, key Subchannel A to trip. Note multimeter indication.
   Multimeter indication should be equal in amplitude to the reading recorded in step 8, but opposite polarity.

10. Place power switch S1 on the chassis power supply in the off (down) position.

11. Pull the Subchannel A wideband receiver module and the card extender out of the chassis, disconnect the wideband receiver module from the card extender, and reinsert the wideband receiver module into the chassis.

12. Pull the Subchannel B wideband receiver module out of the chassis, insert the card extender in its place, and plug the wideband receiver module into the card extender.

13. Remove the discriminator/filter assembly from the wideband receiver module and replace it with one suitable for the new operating channel.

14. Move the positive meter lead to CHAN B FS test point TP5 (gray) on the RFL 67 FS/AM detector module.

15. Place power switch S1 on the chassis power supply in the on (up) position.
   All GUARD indicators should light.

16. With a guard signal being received on Subchannel B, note and record the multimeter indication.
   Depending upon the amount of trip boost the terminal is set for, multimeter indication should be as follows:

Non-Boost	**2.6 volts**
3-dB boost	**1.8 volts**
6-dB boost	**1.4 volts**
9-dB boost	**0.92 volts**
12-dB boost	**0.7 volts**

17. At the transmitter, key Subchannel B to trip. Note the multimeter indication.

    The multimeter indication should be equal in amplitude to the reading recorded in step 16, but of opposite polarity.

18. Place power switch S1 on the chassis power supply in the off (down) position.

19. Pull the Subchannel B wideband receiver module and the card extender out of the chassis, disconnect the wideband receiver module from the card extender, and reinsert the wideband receiver module into the chassis.

20. Repeat steps 1 through 19 at any other RFL 6745 terminals that will be receiving the new frequencies being generated by the transmitter module that was changed in paragraph 3.8.2.

3.8.4. Narrowband Receiver Channel-Changing Procedure

If the RFL 6745 terminal has been equipped with RFL 67 NB REC Narrowband Receiver Modules, information on changing operating channels will be found in Section 13 of this manual.

Section 4. MAINTENANCE

WARNING

HAZARDOUS VOLTAGES CAN BE PRESENT INSIDE THE RFL 6745 CHASSIS. 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.

NEVER ATTEMPT TO REMOVE OR REPLACE ANY FUSES WITH THE DC-DC CONVERTER POWER SUPPLY ENERGIZED; COMPONENT DAMAGE OR ELECTRICAL SHOCK MAY RESULT.

4.1. INTRODUCTION

This section provides maintenance instructions for RFL 6745 equipment. Topics discussed include fuse removal and replacement procedures, and corrective maintenance information. Information is also provided on how to arrange for service by RFL personnel.

4.2. FUSE REPLACEMENT

Paragraphs 4.2.1 and 4.2.2 provide replacement procedures for input fuses F1 and F2 or crowbar fuses F3 and F4 on the RFL 68 HPS **DC-1 dc-dc converter power supply module in each RFL 6745 terminal. Figure 4-1 shows the location of these fuses.

4.2.1. Input Fuse Replacement

Input fuses F1 and F2 provide current protection to the input section of the dc-dc converter power supply. To replace these fuses, proceed as follows:

1. Make sure power switch S1 on the dc-dc converter power supply is in the OFF (down) position.

2. Remove the dc-dc converter power supply from the chassis.

3. Using a screwdriver or fuse puller, remove the suspect fuse from its fuse clips and inspect for damage.

   If the fuse is good, check for presence of station battery voltage on the chassis input terminals. If voltage is present and dc-dc converter power supply does not function, troubleshoot the dc-dc converter power supply to determine the cause of failure. (See Section 11.)

CAUTION

For continued safe operation, always replace fuse with one having the same voltage and current ratings. (See parts list in Section 11.)

4. Insert a fuse of the proper voltage and current ratings into the fuse clips and push in until both ends are firmly seated.

5. Reinsert the dc-dc converter power supply into the chassis.

6. Place power switch S1 on the dc-dc converter power supply in the ON (up) position.

   If the power indicator lights, the dc-dc converter power supply is working properly. If the indicator does not light or if the fuse blows again, troubleshoot the dc-dc converter power supply and the external regulator. (See Section 11.)

4.2.2. Crowbar Fuse Replacement

Crowbar fuses F3 and F4 provide overvoltage protection to the other modules in the RFL 6745 by blowing when the crowbar circuit senses that the output of the dc-dc converter power supply has exceeded an established limit. Replacing these fuses resets the crowbar circuit and returns the dc-dc converter power supply to normal operation. To replace these fuses, proceed as follows:

1. Make sure the power switch on the dc-dc converter power supply is in the off (down) position.

2. Remove the dc-dc converter power supply from chassis.

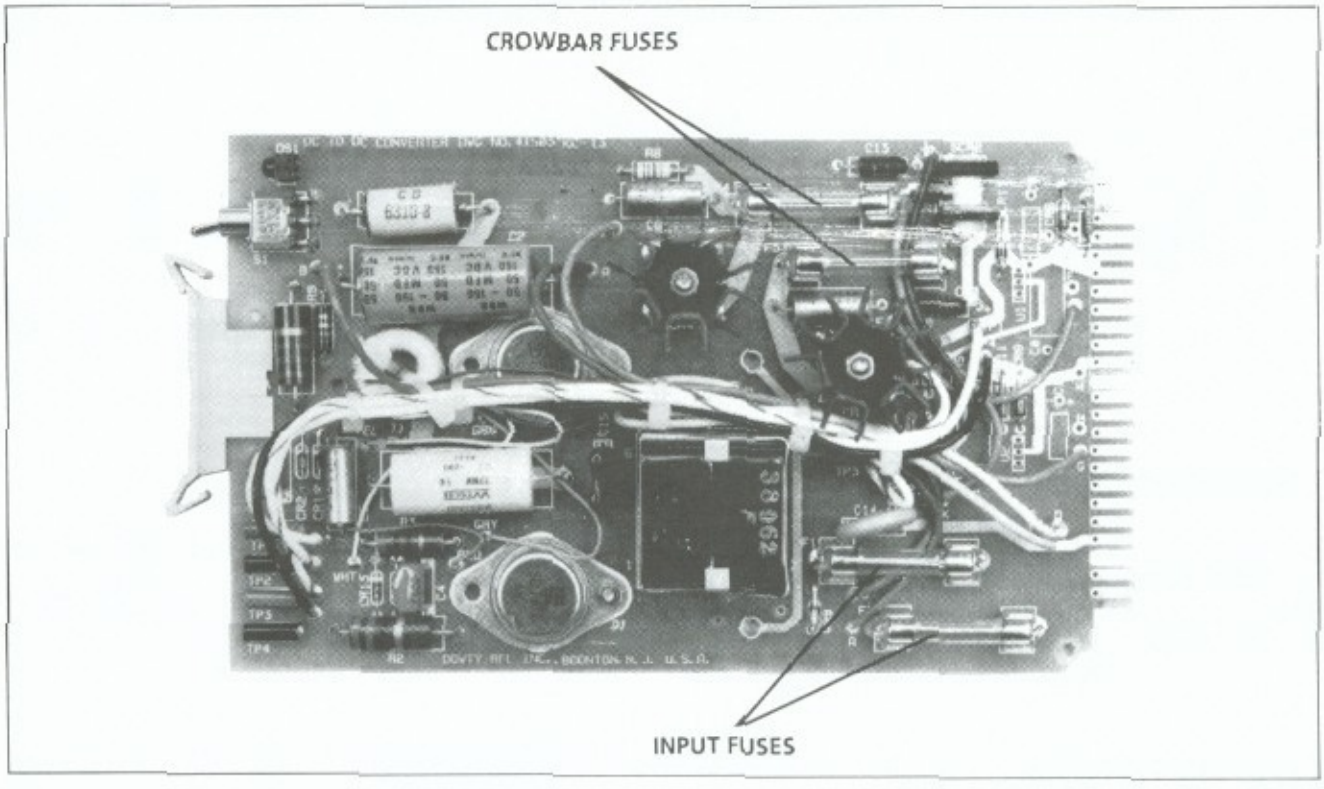


*Figure 4-1. Location of fuses on RFL 68 HPS **DC-1 Dc-dc Converter Power Supplies*

3. Using a screwdriver or fuse puller, remove both crowbar fuses from their fuse clips and inspect for damage.

   If both fuses are good, check for presence of station battery voltage on chassis input terminals. If voltage is present and the dc-dc converter power supply does not function, troubleshoot the dc-dc converter power supply to determine cause of failure. (See Section 11.)

CAUTION

For continued safe operation, always replace fuse with one having the same voltage and current ratings. (See parts list in Section 11.)

4. Insert a fuse of the proper voltage and current ratings into each set of fuse clips and push in until *both ends of each fuse are firmly seated.*

5. Re-insert the dc-dc converter power supply into the chassis.

6. Place the power switch on the dc-dc converter power supply in the on (up) position.

   If power indicator DS1 lights up, dc-dc converter power supply is working properly.

   If DS1 does not light, or if it lights and goes out right away, the crowbar circuit may have fired again. Troubleshoot the dc-dc converter power supply, the external regulator, and the entire chassis to determine the cause of failure. (See Section 11.)

4.3. CORRECTIVE MAINTENANCE

The RFL 6745 has been designed for years of trouble-free service. Should a malfunction occur involving the RFL 6745, use standard troubleshooting techniques to determine if the problem is in the RFL 6745, or in some other connected equipment. If the problem lies *within the RFL 6745, use the schematics in Sections 5* through 11 to try and determine which module is defective. Once the trouble is isolated to a particular circuit module, replace it; this should solve the problem.

Defective circuit board modules can be repaired locally, or they can be returned to RFL for repair (para 4.5).

4.4. HOW TO ARRANGE FOR SERVICING

If necessary, RFL 6745 circuit board modules may be returned to RFL for repair. Contact our Customer Service Department using the telephone number listed on the cover of this manual. You will be given a Returned Material Authorization (RMA) and shipping instructions.

Section 5. INTERFACE MODULES

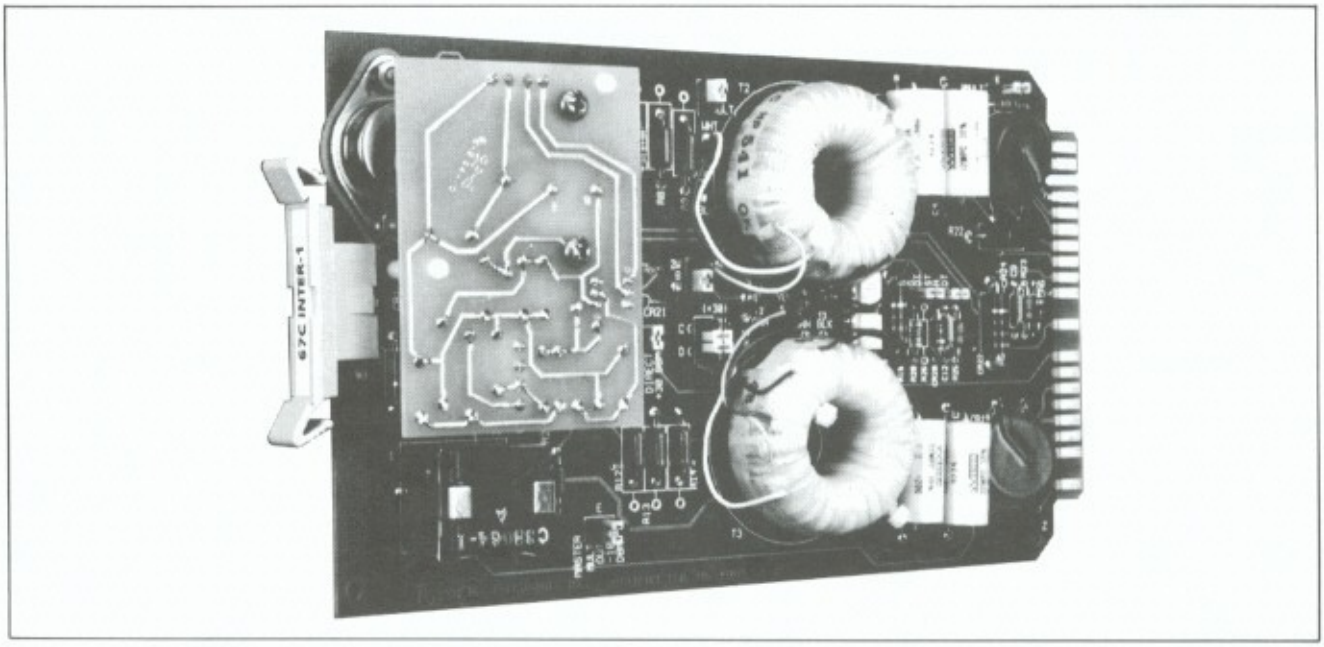


Figure 5-1. Typical RFL 6745 interface module

5.1. DESCRIPTION

Interface modules accept trip inputs from the equipment used with the RFL 6745 system, and scale these inputs for use by the dual-subchannel transmitter module (Section 6). They also serves as the link between the communication line, the transmitter output, and the inputs for the wideband receiver modules (Section 7). Trip outputs are also provided. The interface module also protects the RFL 6745 system from any transients that may be induced in the input or output lines. A typical interface module is shown in Figure 5-1.

There are two different interface modules available for RFL 6745 equipment. The RFL 67C INTER provides a single optically-isolated trip output, while the RFL 67C INTER-1 is fitted with a second trip output circuit for use in installations where redundant circuitry is required for system security.

5.2. SPECIFICATIONS

As of the date this manual was published, the following specifications apply to all RFL 6745 interface modules. Because all RFL products undergo constant refinement and improvement, these specifications are subject to change without notice.

Tone Input and Output: 600-ohm impedance, balanced, jumper-selectable for either two-wire or four-wire circuits.

Input and Output Filters: High-pass, with greater than 30-db rejection @ 50/60 Hz. A received signal as low as -30 dBm will not be affected by an extraneous 50/60-Hz input signal as great as 40 Vrms.

Trip Input: 20 to 30 mA into floating opto-isolator input, from 24, 48, or 129-volt dc source.

Trip Output: Base drive to a floating NPN transistor capable of 1-amp collector current and 150-volt dc open-circuit voltage. Open-circuit leakage current is less than 2 mA.

Interface Dielectric Strength: Trip input, trip output, and tone lines are isolated from ground and from all other circuits. Breakdown is 1500 Vrms @ 50/60 Hz, 2200 Vdc, and 2500 V @ 1.5 MHz in accordance with IEEE SWC Specification 472-1974 (ANSI C.37.90a-1974).

Interface dielectric strength can be enhanced with the addition of SWC interface boards. (See Section 12 for more information.)

Operating Temperature: -30°C to +60°C (-22°F to +140°F).

Power Requirements:

+12-volt Supply: None.
-12-volt Supply: 50 mA.
10-kHz Supply: 35 mA.

Dimensions:

Height: 4.713 inches (12 cm).
Depth: 8.00 inches (20.3 cm).
Width: 1.0 inch (2.54 cm); requires two module spaces in chassis.

5.3. THEORY OF OPERATION

Each RFL 6745 interface module contains two trip input circuits, a trip output circuit, and a signal interface circuit. (RFL 67C INTER-1 modules also contain a second trip output circuit.) Paragraphs 5.3.1 through 5.3.3 describe these circuits. The discussions apply to all RFL 6745 interface modules; any differences between interface modules will be noted. A block diagram for the interface modules appears in Figure 5-2; a schematic can be found in Figure 5-3 at the end of this section.

5.3.1. Trip Input Circuits

The trip input circuits use optical isolators IC3 and IC4 and their associated components to couple trip input signals into the RFL 6745 system.

Trip input signals are applied across edge connector terminals 9 and 13 for Subchannel A, and terminals K and N for Subchannel B. A network of resistors, Zener diodes, and capacitors protect the inputs of these isolators against damage due to excessive current or voltage surges. Even more protection is provided by current limiting resistors installed at the rear panel terminal blocks; the value of these resistors is determined by the station battery voltage being used. (See Section 2.)

Jumpers G and H select the desired trip mode. With both jumpers in the ST (single trip) position, the transmitter will be keyed to trip if the trip input connected across edge connector terminals 9 and 13 is energized. If both jumpers are in the DT (dual trip) position, the transmitter will only be keyed to trip if both trip inputs are energized.

5.3.2. Trip Output Circuit

The heart of the trip output circuit is a floating electronic switch, in which optical isolator IC1 drives the base of NPN transistor Q1. Transformer T1, diodes CR2 through CR4, Zener diode CR8, resistor R2, and capacitor C1 form a floating power supply, which is driven by the 10-kHz output of the dc-dc converter (Section 11). The output of this supply drives the electronic switch, resulting in a trip output that is completely isolated from chassis ground and the rest of the equipment.

The electronic switch is driven by the trip signal generated on the logic module (Section 9). Zener diode CR21 and resistors R4 and R21 protect the input of IC1 against overvoltage or overcurrent. When the LED at the input of IC1 senses a trip signal, it lights. This causes a phototransistor in its output to turn on, and this drives Q1. Varistor CR16 protects the electronic switch against transients.

5.3.3. Second Trip Output Circuit (RFL 67C INTER-1 only)

The second trip output circuit on RFL 67C INTER-1 modules is identical to the main trip output circuit (para 5.4.2). It is driven by the redundant trip output of the logic module, and also derives its power from the 10-kHz output of the dc-dc converter.

5.3.4. Signal Interface Circuit

Transformers T2 and T3 match the transmitter output and receiver inputs to the communication line. Varistors CR18 and CR19 protect the RFL 6745 system against high transient voltages, which may be induced on the line. Along with the inductance of T2 and T3, capacitors C4, C5, C7, and C8 form high-pass filters, with a low-frequency cutoff at about 375 Hz. Jumpers A through F adjust the signal interface circuit for two-wire or four-wire operation, and select the transmitter output range. (See paragraph 5.3.)

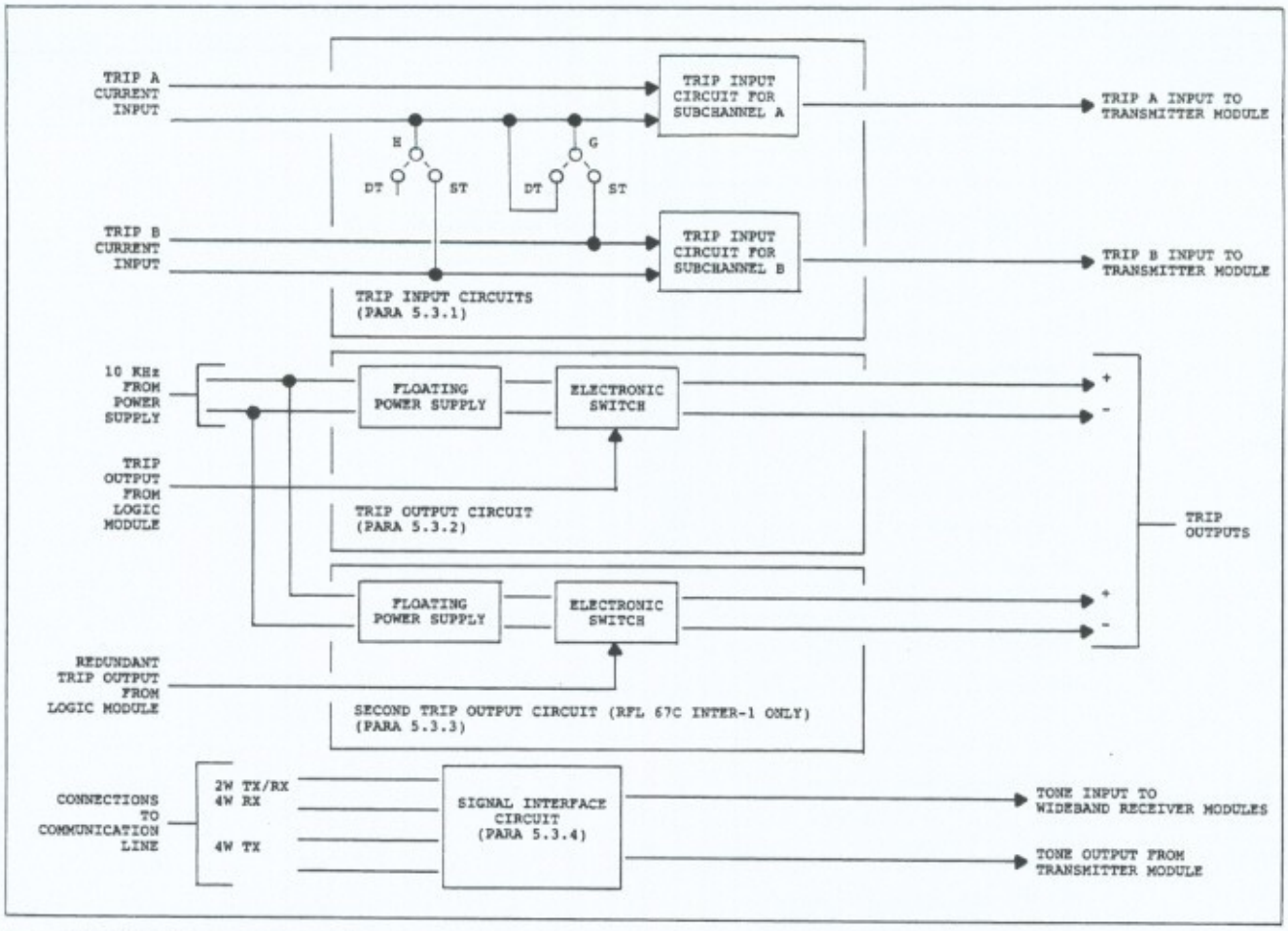


Figure 5-2. Block diagram, RFL 6745 interface modules

Table 5-1. Replaceable parts, RFL 6745 interface modules
RFL 67C INTER (Single trip output circuit) - Assembly No. 104695
RFL 67C INTER-1 (Dual trip output circuits) - Assembly No. 104695-1

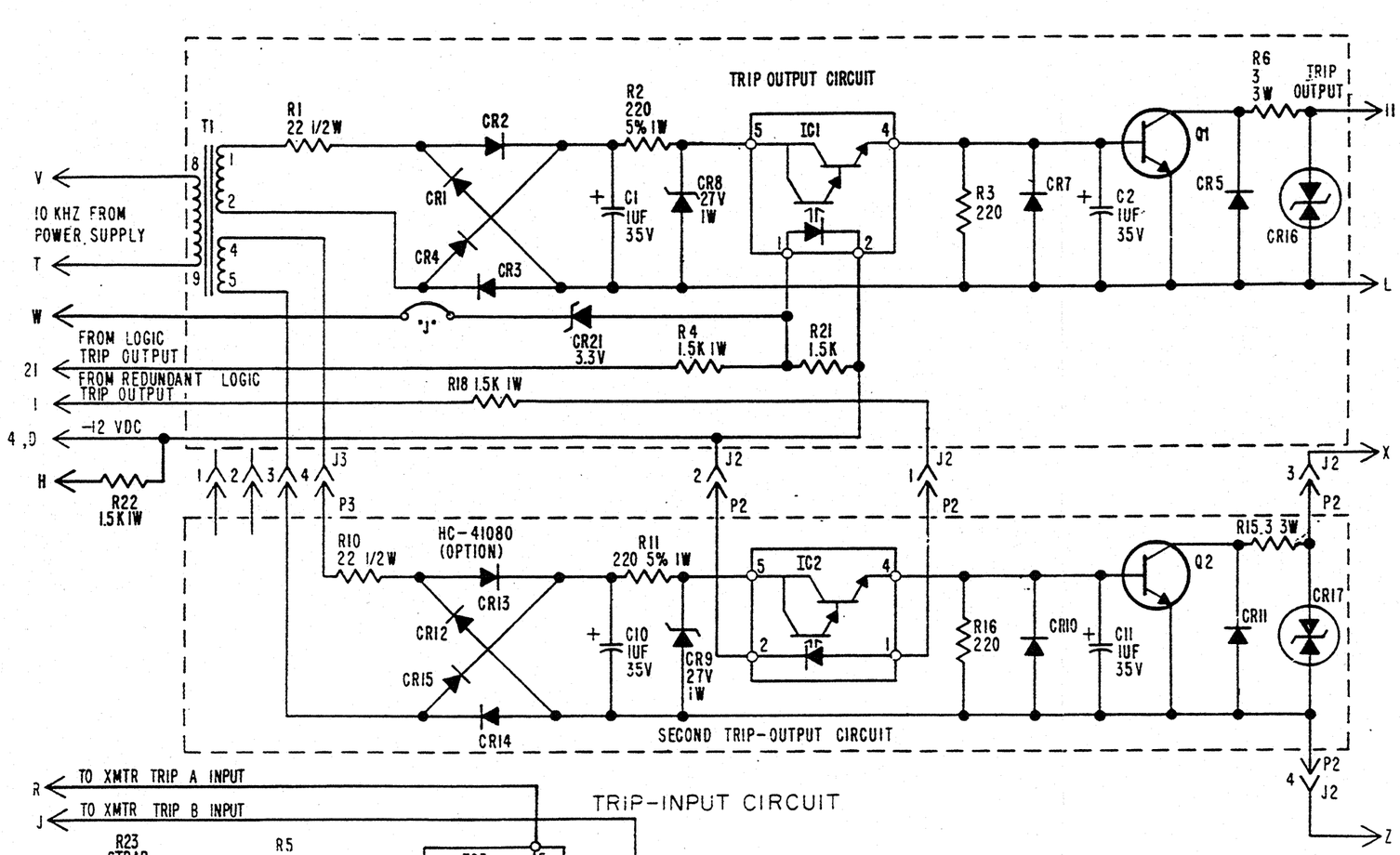
Circuit Symbol (Fig. 5-3)	Description	Part Number
	CAPACITORS	
C1,2	Capacitor,tantalum,1μF,10%,35V,Kemet T110A105K035AS or equiv.	1007 1156
C3	Capacitor,polyester,0.02μF,2%,100V,Wesco 32P or equiv.	5115 49
C4,5,7,8	Capacitor,metallized polycarbonate,1μF,200V,Wesco 32MPC or equiv.	1007 1286
C6	Not used.	
C9,12	Capacitor,tantalum,0.47μF,10%,35V,Kemet T322A474K035AS or equiv.	1007 511
C10,11	Part of second trip output circuit. (See below.)	
	RESISTORS	
R1	Resistor,composition,22Ω,5%,1/2W, Allen-Bradley EB Series or equiv.	1009 239
R2	Resistor,composition,220Ω,5%,1W, Allen-Bradley GB Series or equiv.	1009 316
R3	Resistor,metal film,221Ω,1%,1/4W, Type RN1/4	0410 1225
R4,18,22	Resistor,composition,1.5KΩ,5%,1W, Allen-Bradley GB Series or equiv.	1009 7

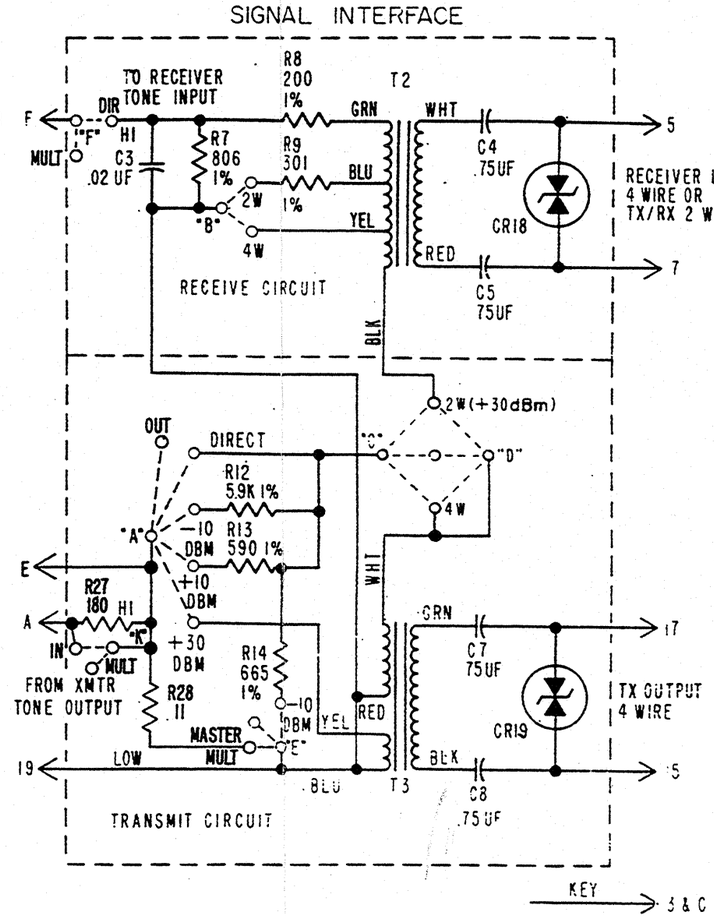
Table 5-1. Replaceable parts, RFL 6745 interface modules - continued.

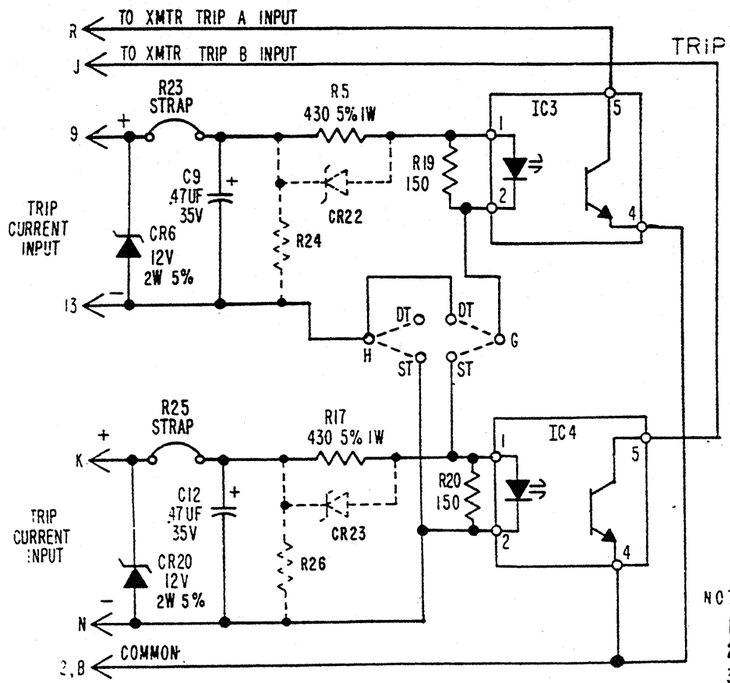
Circuit Symbol (Fig. 5-3)	Description	Part Number
	RESISTORS - continued.	
R5,17	Resistor,composition,430Ω,5%,1W, Allen-Bradley GB Series or equiv.	1009 258
R6	Resistor,wirewound,3Ω,5%,3.25W,Ohmite 4342 Style 995-3A or equiv.	1100 667
R7	Resistor,metal film,806Ω,1%,1/2W, Type RN1/2	0410 2279
R8	Resistor,metal film,200Ω,1%,1/2W, Type RN1/2	0410 2221
R9	Resistor,metal film,301Ω,1%,1/2W, Type RN1/2	0410 2238
R10,11,15,16	Part of second trip output circuit. (See below.)	
R12	Resistor,metal film,5.9KΩ,1%,1/2W, Type RN1/2	0410 2362
R13	Resistor,metal film,590Ω,1%,1/2W, Type RN1/2	0410 2266
R14	Resistor,metal film,665Ω,1%,1/2W, Type RN1/2	0410 2271
R19,20	Resistor,metal film,150Ω,1%,1/4W, Type RN1/4	0410 1209
R21	Resistor,metal film,1.5KΩ,1%,1/4W, Type RN1/4	0410 1305
R23,25	Resistor,zero-ohm,1/4-watt size,Corning OMA07 or equiv.	1510 2217
R27	Resistor,metal film,182Ω,1%,1/4W, Type RN1/4	0410 1217
R28	Resistor,metal film,11.0Ω,1%,1/4W, Type RN1/4	0410 1100
	SEMICONDUCTORS	
CR1-4	Diode,silicon,1N914B or 1N4448	26482
CR5	Diode,silicon,200 PIV,1N4003	30769
CR6,20	Diode,Zener,12V,5%,2W,Semicon ZBC12B or equiv.	35319
CR7	Diode,avalanche,600V,1A,1N4005	26935
CR8	Diode,Zener,27V,5%,1W,1N4750	29758
CR9-15,17	Part of second trip output circuit. (See below.)	
CR16,18,19	Varistor,130-Vac input,184-volt peak idle,General Electric V130LA20B or equiv.	41079
CR21	Diode,Zener,3.3V,5%,1W,1N4728A	28056
IC1	Optically isolated photo-Darlington,6-pin DIP,General Instrument MCA230 or equiv.	41084
IC2	Part of second trip output circuit. (See below.)	
IC3,4	Photo-coupled isolator,6-pin DIP,General Electric 4N35 or equiv.	47104
Q1	Transistor,NPN Darlington,400V,15A peak,175W,Motorola MJ10012 or equiv.	91124
Q2	Part of second trip output circuit. (See below.)	
	MISCELLANEOUS COMPONENTS	
T1	Transformer,power,10 kHz	38064
T2	Transformer,line,receive,600Ω primary,1200/600Ω secondary	55555
T3	Transformer,line,transmit,10Ω primary,dual 600Ω secondary	55554
. . .	Shorting bar,single,Molex 90059-0009 or equiv.	98306

Table 5-2. Replaceable parts, second trip output circuit (RFL 67C INTER-1 only)
Assembly No. 104685

Circuit Symbol (Fig. 5-3)	Description	Part Number
C10,11	Capacitor,tantalum,1μF,10%,35V,Kemet T110A105K035AS or equiv.	1007 1156
CR9	Diode,Zener,27V,5%,1W,1N4750	29758
CR10	Diode,avalanche,600V,1A,1N4005	26935
CR11	Diode,silicon,200 PIV,1N4003	30769
CR12-15	Diode,silicon,1N914B or 1N4448	26482
CR17	Varistor,130-Vac input,184-volt peak idle,General Electric V130LA20B or equiv.	41079
IC2	Optically isolated photo-Darlington,6-pin DIP,General Instrument MCA230 or equiv.	41084
Q2	Transistor,NPN Darlington,400V,15A peak,175W,Motorola MJ10012 or equiv.	91124
R10	Resistor,composition,22Ω,5%,1/2W, Allen-Bradley EB Series or equiv.	1009 239
R11	Resistor,composition,220Ω,5%,1W, Allen-Bradley GB Series or equiv.	1009 316
R15	Resistor,wirewound,3Ω,5%,3.25W,Ohmite 4342 Style 995-3A or equiv.	1100 667
R16	Resistor,metal film,221Ω,1%,1/4W, Type RN1/4	0410 1225







MODE OF OPERATION	MAX OUTPUT LEVEL	JUMPERS A	B	C	D	E	K
2W	-10 dBm	-10dBm	2W	2W	—	-10dBm	
2W	+10 dBm	+10dBm	2W	2W	—	—	
2W	+20dBm	+30dBm	2W	—	+30 dBm	—	
4W	-10 dBm	-10dBm	4W	4W	—	-10dBm	
4W	+10 dBm	+10dBm	4W	4W	—	—	
4W	+30dBm	+30dBm	4W	4W	—	—	
DIRECT	SELECT JUMPER LEVELS FROM ABOVE						IN
MULTIPLEX	SELECT JUMPER LEVELS FROM ABOVE						MULT

NOTE:

1. DT DENOTES DUAL TRIP; ST DENOTES SINGLE TRIP.
2. R24 & R26, CR22 & CR23 FOR SPECIAL APPLICATIONS.
3. "—" DASH REPRESENTS A VACANT HOLE (NO CONNECTIONS) ON THE P.C. BOARD.
4. R24, R26, CR22 AND CR23 ARE NOT USED. THEY ARE USED ON THE 67B INTERFACE ASSEMBLY.

Figure 5-3. Schematic, RFL 6745 interface modules (Assembly No. 104695-X; Schematic No. D-45794, Rev. C)

Section 6. TRANSMITTER MODULE *

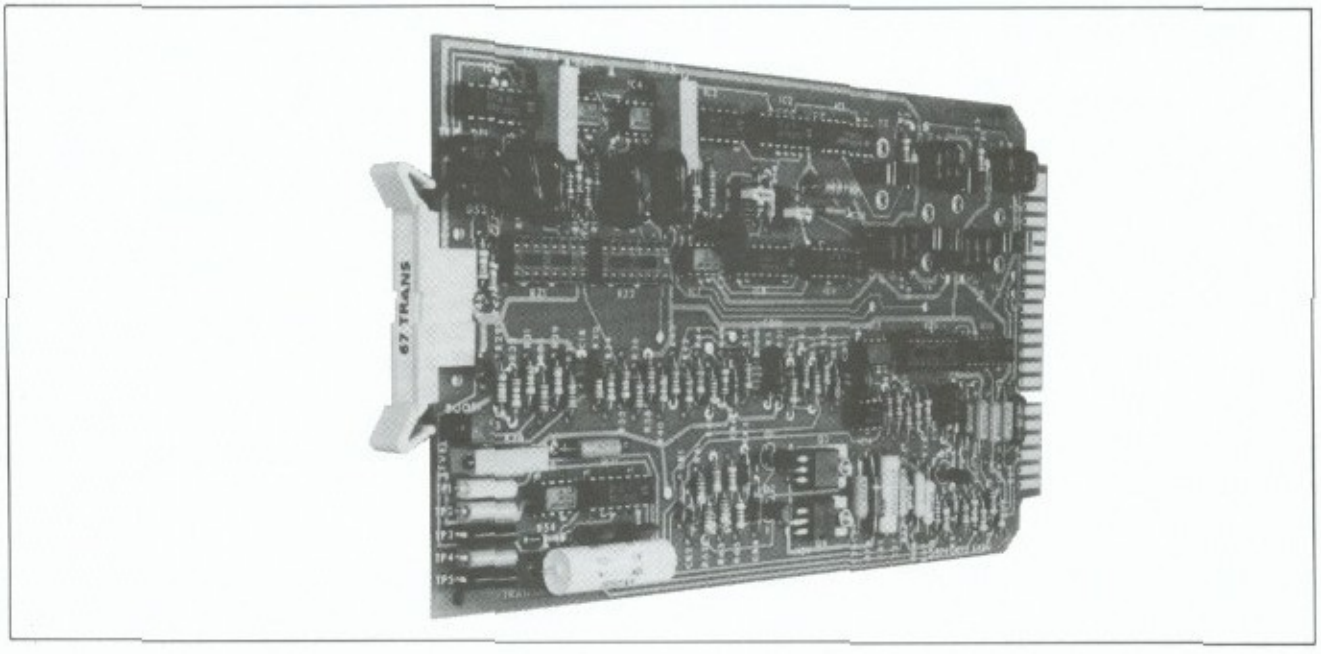


Figure 6-1. RFL 67 TRANS Dual Subchannel Transmitter Module

6.1. DESCRIPTION

The RFL 67 TRANS Dual-Subchannel Transmitter Module (Fig. 6-1) generates the guard and trip tones for both subchannels. Under normal conditions, both subchannels will be at the guard frequency, but if a trip command is received from the interface module (Section 5), trip frequencies will be generated. Trip signals can also be boosted to a predetermined level for a specific amount of time. Figure 6-2 shows the format of the transmitted signals during guard, trip boost, trip, and return-to-guard conditions.

6.2. SPECIFICATIONS

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

Tone Frequency Tolerance: ±0.02%, crystal-controlled.

Trip Boost:

Level: Set by plug-in networks to 0 dB (no boost), 3 dB, 6 dB, 9 dB, or 12 dB.

Duration: Adjustable from zero to 200 ms.

Output Level:

Two-Wire Operation: -40 dBm to +20 dBm.

Four-Wire Operation: -40 dBm to +30 dBm (1 watt).

Harmonic Output: All harmonics in output signal are more than 40 dB below the level of the fundamental frequency.

Amplitude Stability: Output amplitude will not vary more than ±1 dB over the specified input voltage and operating temperature ranges.

Relative Output Amplitudes: The guard outputs of each subchannel will be within 1.5 dB of each other. The guard and trip outputs of the same subchannel will be within 0.5 dB of each other.

Trip Time Delay (typical): 12 ms for systems with *340-Hz subchannel spacing, 8 ms for systems with* 680-Hz spacing. Times are measured with transmitter and receiver connected back-to-back. Shorter times are available for permissive trip applications, with reduced security.

* - U.S. Patent No. 4,015,220.

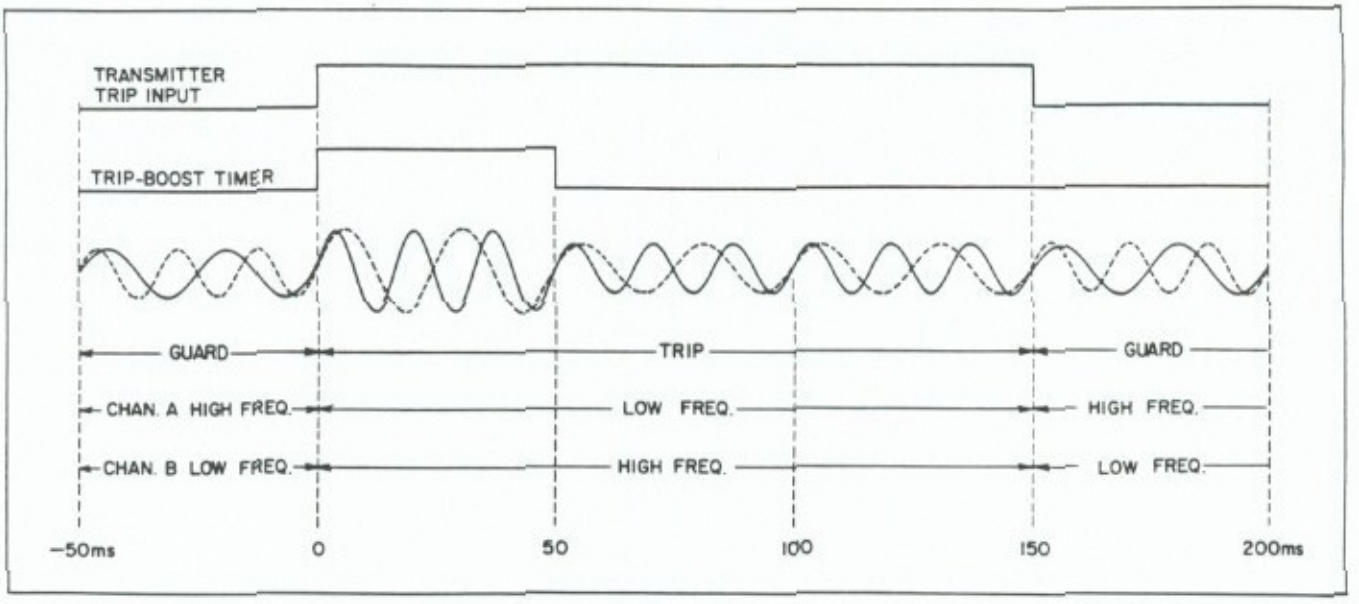


Figure 6-2. Signals during Guard, Trip Boost, Trip and return to Guard

Operating Temperature: -30°C to +60°C (-22°F to +140°F).

Power Requirements:

+12-volt Supply: 110 mA.
-12-volt Supply: 20 mA.

Dimensions:

Height: 4.713 inches (12 cm).
Depth: 8.00 inches (20.3 cm).
Width: 1.0 inch (2.54 cm); requires two module spaces in chassis.

6.3. THEORY OF OPERATION

The RFL 67 TRANS Dual Subchannel Transmitter Module contains trip logic circuits, two identical subchannel transmitters, a summing amplifier which combines the outputs of the transmitters, an output amplifier which boosts the signals to the desired output level, a trip boost timer, and diagnostic circuits. Paragraphs 6.3.1 through 6.3.6 describe these circuits. A block diagram of the RFL 67 TRANS appears in Figure 6-3; its schematic appears in Figure 6-4 at the end of this section.

6.3.1. Trip Logic Circuits

Operational amplifiers IC10/A and IC10/B and their associated components form the trip logic circuits. These amplifiers are connected as Schmitt triggers, and monitor the TRIP A INPUT and TRIP B INPUT lines from the interface module (Section 5). Normally, these lines are held high, but if one or both of them go to a logic low, a signal will be sent to the subchannel transmitters that will switch them from the guard frequency to the trip frequency. These signals also serve as the TRIP A OUTPUT and TRIP B OUTPUT diagnostic signals.

If the output of either trip logic circuit goes high, the trip boost timer will be enabled.

6.3.2. Subchannel Transmitters

The subchannel transmitters react to the outputs from the trip logic circuits and apply either trip or guard frequencies to the summing amplifier. Each subchannel transmitter contains a crystal-controlled oscillator, a digital frequency divider, and a bandpass filter.

Under normal conditions, each subchannel transmitter produces a signal at its guard frequency. When a subchannel transmitter receives a trip command, its output will shift to the trip frequency. Movable jumpers and plug-in crystals and resistor networks permit the subchannel transmitters to operate on a wide range of frequencies, as described in paragraph 6.3.2.

Because the subchannel transmitters are identical, this paragraph will describe the operation of the transmitter for Subchannel A; the transmitter for Subchannel B uses different components to perform the same functions.

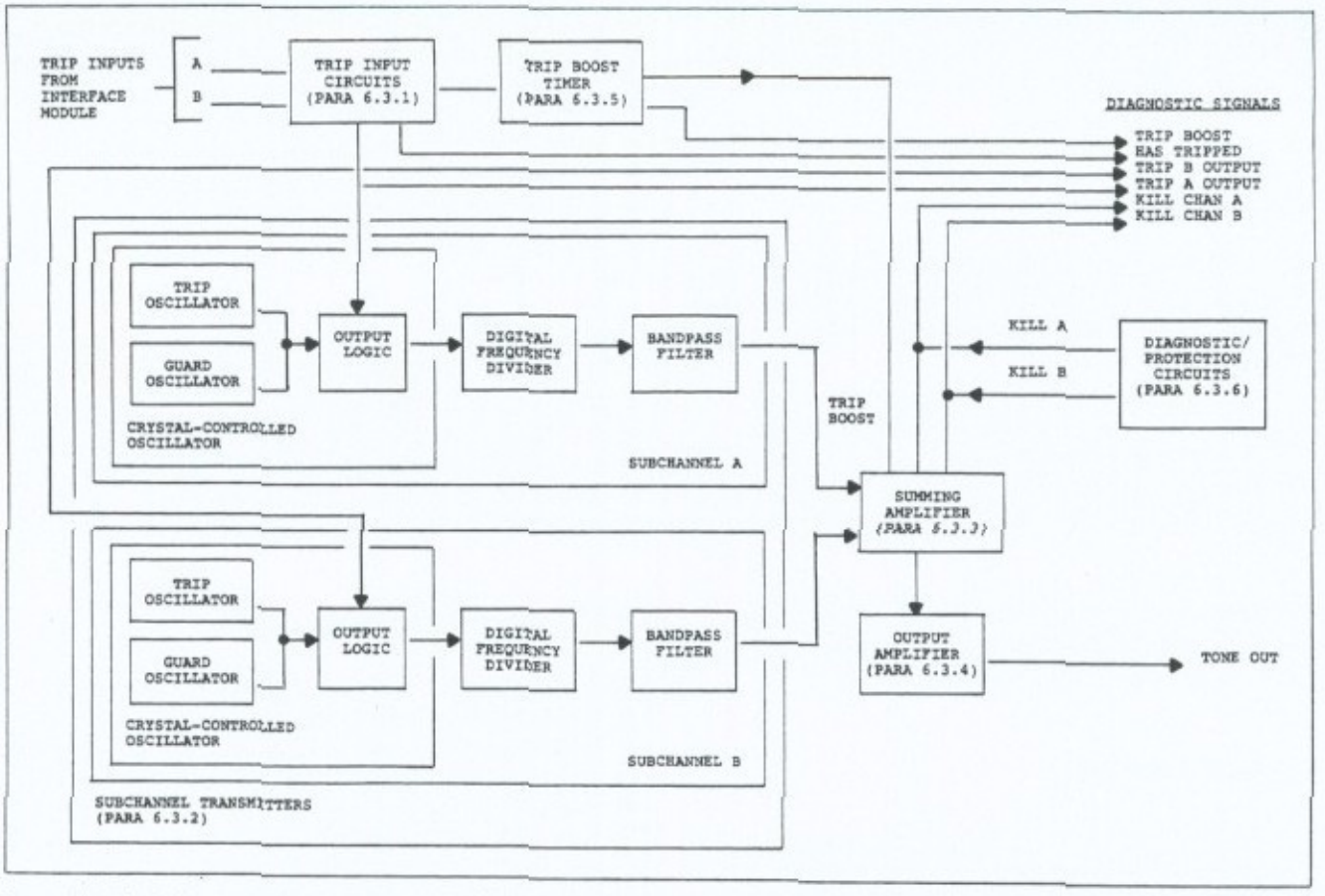


Figure 6-3. Block diagram, RFL 67 TRANS Dual Subchannel Transmitter Module

a. Crystal-Controlled Oscillator. The crystal-controlled oscillator is actually two free-running oscillators operating at different frequencies. For Subchannel A, the trip oscillator is formed from crystal Y1, inverter IC1/B, and their associated components; crystal Y3, inverter IC1/A, and their associated components form the guard oscillator.

The outputs of these oscillators are fed to the output logic, which is formed from NAND gates IC2/A, IC2/B, and IC2/D. As long as the output of the trip logic circuit is low, the gates will allow the guard oscillator output to be passed on to the digital frequency divider. If the output of the trip logic circuit goes high, the gates will shift, passing the trip oscillator output to the digital frequency divider and lighting TRIP CHAN A indicator DS1 through NAND gate IC2/C, which is connected as an inverter.

b. Digital Frequency Divider. Twelve-stage binary counter IC3 serves as the digital frequency divider. It accepts the square-wave output of the oscillator and divides it by 2^9, 2^{10}, 2^{11}, and 2^{12}. One of these outputs is coupled to the bandpass filter, through the movable jumper (positions A through D). The position selected is determined by the desired operation frequency, as shown in Table 6-1.

c. Bandpass Filter. Operational amplifiers IC4/B, IC5/A, and IC5/B are the active components of the bandpass filter, which shapes the squarewave output of the digital frequency divider into a pure sine wave. The resonant frequency of the bandpass filter is determined by capacitors C13 and C15 and plug-in resistor network RZ1, which is selected for the specific channel on which the RFL 67 TRANS will be operating.

6.3.3. Summing Amplifier

The output from each subchannel transmitter is applied to operational amplifier IC12/A, which is the active component of the summing amplifier. Its output is a combination of the output of both subchannel transmitters. The gain of IC12/A (during normal operation or trip boost) is determined by plug-in resistor network RZ3, and is always less than unity.

The output of IC12/A (pin 1) is passed through coupling capacitor C24 to TRANS LEVEL potentiometer R56, which controls the amount of signal sent on to the output amplifier.

6.3.4. Output Amplifier

The output amplifier accepts the combined signal output of the summing amplifier and boosts it to the level required for driving the line interfacing circuits on the interface module.

The signal from the summing amplifier is applied to pin 2 of operational amplifier IC14, which serves as a driver amplifier. The output of IC14 (pin 6) drives transistors Q1 through Q4, and their associated components.

The output amplifier produces the TONE OUT signal, which is sent to the interface module via edge connector terminals 9 (high) and 1 (common).

6.3.5. Trip Boost Timer

The trip boost timer is used to increase the output of the summing amplifier while a trip signal is being sent. The amount of boost (in dB) and the duration (in seconds) are controlled by plug-in resistor network RZ3.

NOTE

In order for trip boost to function properly, the receiver modules that will be receiving the output of the RFL 67 TRANS module must be set for slow AGC response. (Refer to Section 7 for more information.)

The trip boost timer is driven by the outputs of the trip logic circuits. These outputs are applied to NAND gate IC11/B; its output is combined with a guard-signal level at NAND gate IC11/A to produce a positive pulse at pin 3 of IC11/A. This positive pulse forces the output of voltage comparator IC12/B to go low. This low lights TRIP BOOST indicator DS3 through NAND gate IC11/D (connected as an inverter), and opens analog switch IC13/A.

When switch IC13/A opens, the resistance of the summing amplifier feedback loop is increased; this raises its gain. When the charge on capacitor C21 reached the point where the voltage comparator changes states again, the trip boost timer will return to its normal condition and switch IC13/A will close, terminating trip boost.

6.3.6. Diagnostic/Protection Circuits

Analog switches IC13/C and IC13/D are used during routine maintenance and diagnostic work on the RFL 67 TRANS module. These switches are normally closed, but when opened they will disable one or both of the subchannel transmitters. IC13/C controls Subchannel A, and is opened when a jumper is placed between KILL A CHAN test point TP4 and COMMON test point TP5. When a jumper is placed between KILL B CHAN test point TP3 and common, IC13/D will open, disabling Subchannel B.

These switches are also controlled by transistor Q5 and its associated components, which form a low-voltage monitor. If the monitor senses a drop in supply voltage below +9.8 volts, Q5 will turn off, its collector will fall to ground potential, and both subchannels will be disabled.

Table 6-1. Replaceable parts, RFL 67 TRANS Dual Subchannel Transmitter Module Assembly No. 41010

Circuit Symbol (Fig. 6-4)	Description	Part Number
	CAPACITORS	
C1-4	Capacitor,dipped mica,47pF,2%,500V, Type DM15	16515
C5-12	Capacitor,dipped mica,56pF,2%,500V, Type DM15	16517
C13-16	Capacitor,dipped mica,0.002µF,2%,500V, Type DM19	16222
C17,18	Capacitor,ceramic disc,0.002µF,20%,1000V,Sprague C023B102F202M or equiv.	1007 942
C19	Capacitor,ceramic disc,220pF,10%,500V,Erie 831-000-X5FO-221K or equiv.	1007 493
C20	Capacitor,ceramic disc,0.02µF,+80/-20%,25V,Tusonix 5835-000-Y5U-203Z or equiv.	1007 754
C21	Capacitor,mylar,0.470µF,2%,100V,Wesco 32M or equiv.	1007 448
C22	Capacitor,dipped mica,100pF,2%,500V, Type DM15	16600
C23,25	Capacitor,dipped mica,33pF,5%,500V, Type DM15	16511
C24,30	Capacitor,tantalum,1µF,20%,35V,Kemet T322B105M035AS or equiv.	1007 496
C26-29,33	Capacitor,tantalum,15µF,20%,20V,Kemet T322D156M020AS or equiv.	1007 716
C31	Capacitor,tantalum,33µF,20%,10V,Kemet T322D336M010AS or equiv.	1007 653
C32	Capacitor,polyester,0.047µF,10%,100V,Cornell-Dubilier WMF-1S47 or equiv.	1007 631
C34,35	Capacitor,ceramic disc,0.1µF,+80/-20%,25V,Erie 5815-000-Y5U-104Z or equiv.	1007 646
	RESISTORS	
R1-4,9,10	Resistor,metal film,1.0MΩ,1%,1/4W, Type RN1/4	0410 1576
R5-8,47,48,54	Resistor,metal film,2.21KΩ,1%,1/4W, Type RN1/4	0410 1321
R11,12	Resistor,metal film,2KΩ,1%,1/4W, Type RN1/4	0410 1317
R13,14,49	Resistor,metal film,100KΩ,1%,1/4W, Type RN1/4	0410 1480
R15-22,27,28,55,73	Resistor,metal film,10KΩ,1%,1/4W, Type RN1/4	0410 1384
R23,24	Resistor,variable,15-turn cermet,2KΩ,10%,3/4W,Beckman Helipot 89PHR2K or equiv.	39537
R25,26	Resistor,metal film,121KΩ,1%,1/4W, Type RN1/4	0410 1488
R29,30	Resistor,metal film,2.74KΩ,1%,1/4W, Type RN1/4	0410 1330
R31,32	Resistor,metal film,27.4KΩ,1%,1/4W, Type RN1/4	0410 1426
R33,34	Resistor,metal film,274Ω,1%,1/4W, Type RN1/4	0410 1234
R35-38	Resistor,metal film,20KΩ,1%,1/4W, Type RN1/4	0410 1413
R39,40	Resistor,metal film,39.2KΩ,1%,1/4W, Type RN1/4	0410 1441
R41-44,50,53,71,72	Resistor,metal film,15KΩ,1%,1/4W, Type RN1/4	0410 1401
R45,46	Resistor,metal film,47.5KΩ,1%,1/4W, Type RN1/4	0410 1449
R51	Resistor,metal film,59KΩ,1%,1/4W, Type RN1/4	0410 1458
R52	Resistor,metal film,34.8KΩ,1%,1/4W, Type RN1/4	0410 1436
R56	Resistor,variable,15-turn cermet,10KΩ,10%,3/4W,Beckman Helipot 89PHR10K or equiv.	39539
R57,58	Resistor,metal film,33.2KΩ,1%,1/4W, Type RN1/4	0410 1434
R59	Resistor,metal film,274KΩ,1%,1/4W, Type RN1/4	0410 1522
R60-63	Resistor,metal film,4.75KΩ,1%,1/4W, Type RN1/4	0410 1353
R64,65,68	Resistor,metal film,475Ω,1%,1/4W, Type RN1/4	0410 1257
R66,67	Resistor,wirewound,1Ω,5%,1 1/2W,Ohmite 4030 Style 995-1A or equiv.	1100 585

Table 6-1. Replaceable parts, RFL 67 TRANS Dual Subchannel Transmitter Module - continued.

Circuit Symbol (Fig. 6-4)	Description	Part Number
	CAPACITORS	
R69	Resistor,wirewound,10Ω,5%,3.25W,Ohmite 4361 Style 995-3A or equiv.	1100 479
R70	Resistor,metal film,1KΩ,1%,1/4W, Type RN1/4	0410 1288
R74	Resistor,metal film,3.32KΩ,1%,1/4W, Type RN1/4	0410 1338
R75	Resistor,metal film,332Ω,1%,1/2W, Type RN1/2	0410 2242
R76	Resistor,composition,22Ω,5%,1/2W, Allen-Bradley EB Series or equiv.	1009 239
RZ1,2	Resistor network with values determined by desired operating frequencies. (See Section 3.)	
RZ3	Resistor network with values determined by desired output levels. (See Section 3.)	
	SEMICONDUCTORS	
CR1,2,5,6	Diode,silicon,1N914B or 1N4448	26482
CR3,4	Diode,silicon,200 PIV,1N4003	30769
CR7	Diode,Zener,6.2V,5%,500mW,1N5234	29227
CR8	Diode,Zener,9.1V,5%,400mW,1N960B	41014
DS1-3	Light-emitting diode,red,Dialight 550-0102 or equiv.	39568
IC1	MOS hex inverter,high-speed,16-pin DIP,Signetics HEF4049BP or equiv.	0615 248
IC2,9	MOS quad 2-input NOR gate,14-pin DIP,RCA CD4001BE or equiv.	0615 3
IC3,8	MOS 12-stage ripple-carry binary counter/divider,16-pin DIP,RCA CD4040BE or equiv.	0615 21
IC4,5,7,10,12	Linear operational amplifier,dual,8-pin DIP,Texas Instruments MC1458P or equiv.	0620 51
IC6,13	MOS quad bilateral switch,14-pin DIP,RCA CD4016BE or equiv.	0615 15
IC11	MOS quad 2-input NAND gate,14-pin DIP,RCA CD4011BE or equiv.	0615 5
IC14	Linear operational amplifier,8-pin DIP,National Semiconductor LM741CN or equiv.	0620 52
Q1	Transistor,NPN,TO-92 case,2N3903	21562
Q2	Transistor,PNP,2N3906	21565
Q3	Transistor,PNP,60V,1A,plastic case similar to TO-220,Texas Instruments TIP30A or equiv.	36996
Q4	Transistor,NPN,60V,1A,plastic case similar to TO-220,Texas Instruments TIP29A or equiv.	36995
Q5	Transistor,PNP,TO-106 case,2N4249	41919
	MISCELLANEOUS COMPONENTS	
L1	Inductor,molded,100μH,10%,Stanwyck 41000M or equiv.	26480
Y1-4	Crystal,quartz,value determined by desired operating frequencies. (See Section 3.)	
. . .	Shorting bar,single,Molex 90059-0009 or equiv.	98306

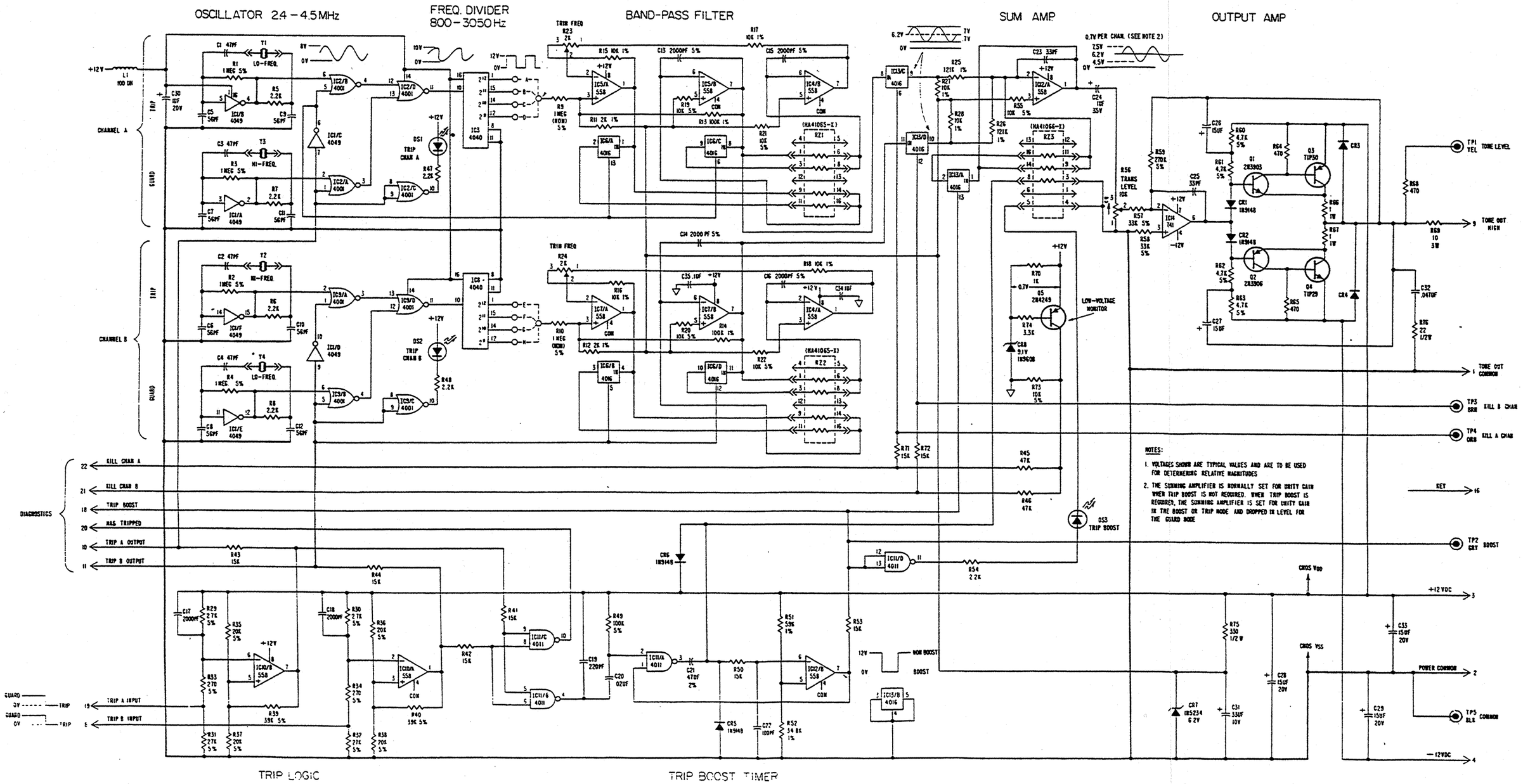


Figure 6-4. Schematic, RFL 67 TRANS Dual-Subchannel Transmitter Module (Assembly No. 41010; Schematic No. E-41012, Rev. F)

Section 7. WIDEBAND RECEIVER MODULE

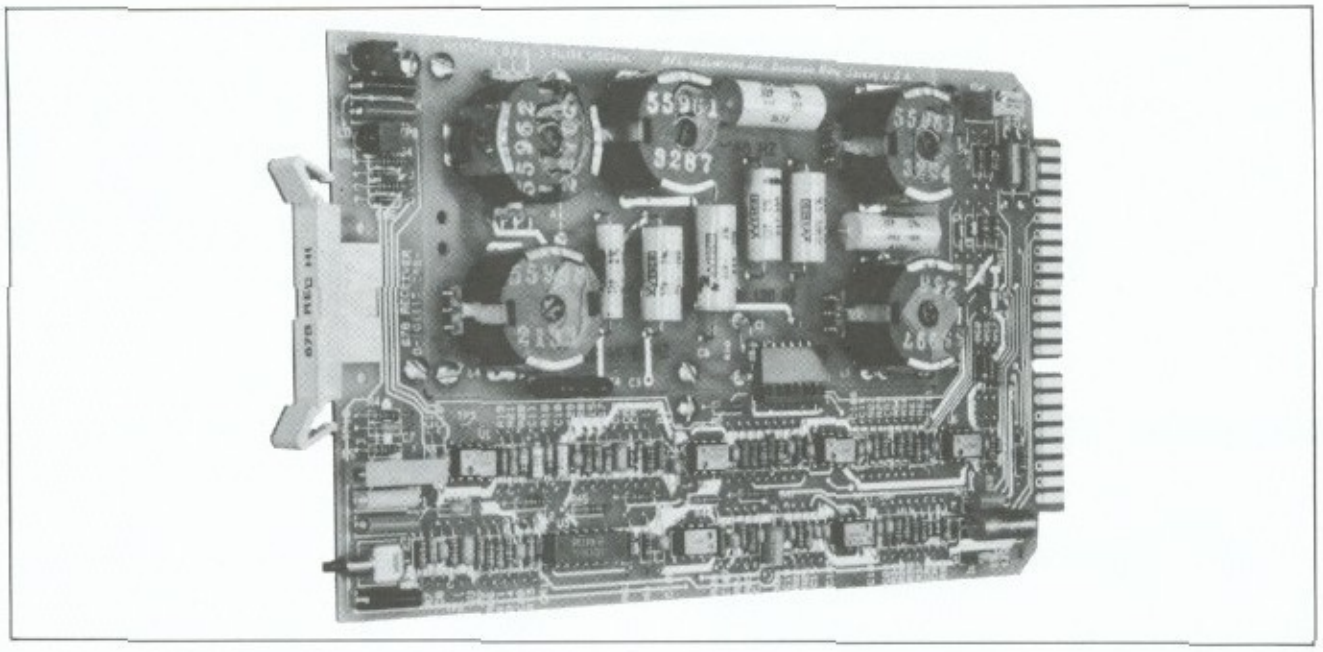


Figure 7-1. RFL 67B REC Wideband Receiver Module

7.1. DESCRIPTION

The RFL 67B REC Wideband Receiver Module (Fig. 7-1) is used in pairs; one module monitors each subchannel for presence of trip or guard frequencies. Each wideband receiver module produces two outputs (AM and FS), which are passed on to the detector module (Section 8). All frequency-determining components are mounted on a detachable discriminator/filter assembly, which can be replaced to change the operating frequency.

7.2. SPECIFICATIONS

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

Operating Frequency: Standard receiver modules can operate at frequencies between 800 and 3300 Hz. Operation can be extended to as high as 10 kHz on special order.

Sensitivity: Adjustable from -40 dBm to 0 dBm.

AGC Dynamic Range: 20 dB.

Bandwidth And Discriminator Response: Determined by discriminator filter used. (See para 7.3.2.)

Operating Temperature: -30°C to +60°C (-22°F to +140°F).

Power Requirements:
+12-volt Supply: 30 mA.
-12-volt Supply: 30 mA.

Dimensions:
Height: 4.713 inches (12 cm).
Depth: 8.00 inches (20.3 cm).
Width: 0.75 inch (1.9 cm); requires two module spaces in chassis.

7.3. THEORY OF OPERATION

The RFL 67B REC Wideband Receiver contains an input bandpass filter, a preamplifier, a voltage-controlled amplifier, a frequency discriminator, a quadrature signal network, an automatic gain control (AGC) circuit, a pair of signal level detectors, and a reference voltage generator. The bandpass filter and the frequency-dependent components in the discriminator and the quadrature network are located on a detachable

discriminator/filter assembly. This assembly can be replaced to change the subchannel on which the wideband receiver module will operate.

Paragraphs 7.3.1 through 7.3.8 describe the circuits on the RFL 67B REC. Figure 7-3 is a block diagram of the RFL 67B REC; its schematic appears in Figure 7-2.

NOTE

Throughout this theory of operation discussion, integrated circuit pin numbers are indicated by the circuit symbol number, followed by a dash and the pin number (U1-1, U1-2, etc).

7.3.1. Input Bandpass Filter

The incoming signal from the interface module is applied to the input bandpass filter, a passive four-coil Cauer (elliptical) filter that attenuates out-of-band signals by at least 35 dB. It is part of the discriminator/filter assembly, which is selected for the specific subchannel center frequency. The output of the input bandpass filter can be monitored at test point TP1 (yellow).

LEV potentiometer R3 is connected across the output of the filter, and controls how much signal is sent on to the preamplifier. This controls the input sensitivity of the entire receiver module. The signal level being delivered to the preamplifier can be monitored at turret-type test point TP10.

7.3.2. Preamplifier

The output of LEV potentiometer R3 is applied to U1A-3. Operational amplifier U1A serves as the preamplifier; its gain is controlled by switch S1. When S1 is not being pressed, the gain of U1A is determined by resistor R7. Pressing S1 connects resistor R8 across R7. This temporarily reduces the gain of U1A by about 12 dB for when level adjustments are made. The output of the preamplifier is fed to the voltage-controlled amplifier.

7.3.3. Voltage-Controlled Amplifier

The voltage-controlled amplifier comprises multiplier U3, operational amplifiers U1B and U2A and their associated components.

Multiplier U3 accepts the output of the preamplifier, and multiplies it by a dc voltage that is generated by the automatic gain control (AGC) system (para 7.3.6).

The differential (double-ended) signal output of U3 appears across U3-2 and U3-14. This signal is applied to U1B, where it is converted into a single-ended signal which can be monitored at turret-type test point TP3. U2A increases the tone level before it is passed on to the detector module through edge connector terminal 7. U2A-1 also drives the frequency-shift discriminator and the quadrature signal network.

7.3.4. Frequency-Shift Discriminator

Operational amplifier U7A (U7A-2 and U7A-3 in, U7A-1 out) is the active element of the frequency-shift discriminator. The center frequency of this discriminator is determined by inductor L5 and capacitor C23 on the discriminator/filter assembly. The output of the discriminator is fed to the detector module through edge connector terminal 9. Discriminator output leads the received tone signal by 90 degrees for low frequency, and lags by 90 degrees for high frequency.

7.3.5. Quadrature Signal Network

The active element of the quadrature signal network is operational amplifier U7B (U7B-5 and U7B-6 in, U7B-7 out). Its input is the same signal applied to the frequency-shift discriminator, but its output signal will lag the received signal by 90 degrees because of the phase shift produced by resistor R16 and capacitor C16 at its non-inverting input (U7B-5). The output signal from this network (U7B-7) is passed on to the detector module through edge connector terminal 8.

7.3.6. Automatic Gain Control (AGC) System

The RFL 67B REC uses an AGC system to regulate its output signal levels. The AGC system contains a voltage comparator stage, a rectifier stage, and a summing/inverting stage.

a. Voltage Comparator Stage. Operational amplifier U2B is connected as a linear voltage comparator with a limited slew rate. It is used to compare the level of the of the received signal to a reference voltage. The reference voltage magnitude is determined by the level of trip boost selected for the specific application, and is controlled by a plug-in resistor network on the logic module.

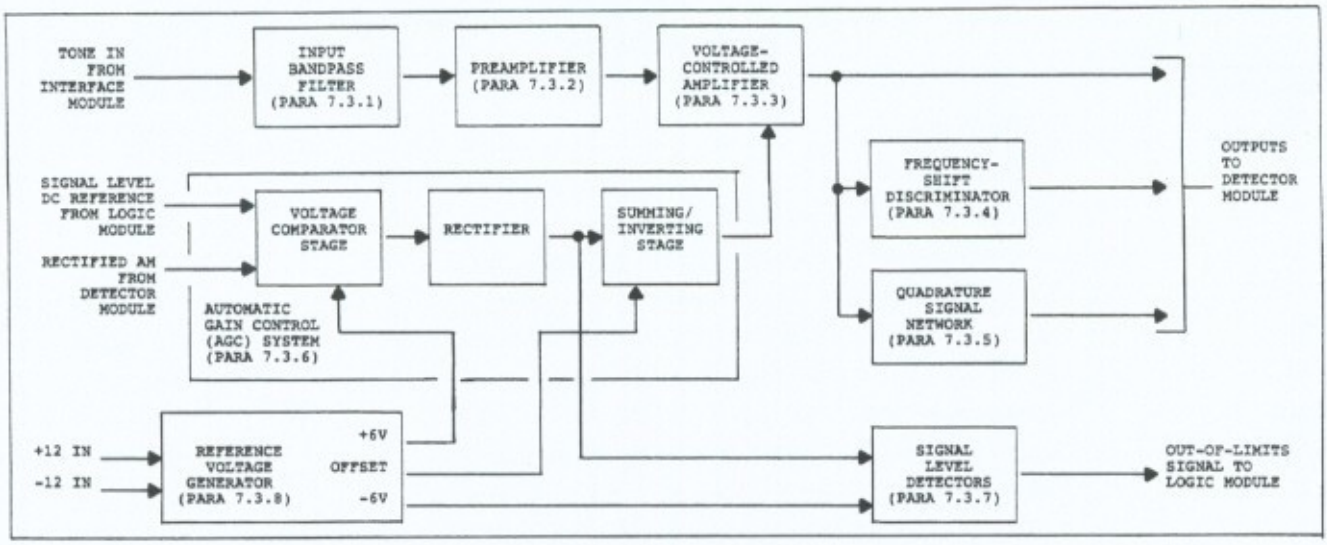


Figure 7-2. Block diagram, RFL 67B REC Wideband Receiver Module

The reference voltage from the logic module enters the receiver module at edge connector terminal 6 and is applied to U2B-6. The rectified AM signal generated on the detector module is applied to U2B-5 by way of edge connector terminal 5. If these voltages are not equal, a difference voltage will be present at U2B-7.

The output of the voltage comparator is constantly changing. Diodes CR1 and CR2 clamp this output to a value between -6.7 volts and +0.7 volts. This varying voltage is averaged by resistor R38 and capacitor C21. If trip boost is being used, capacitor C22 is connected across C21 when jumper J1 is placed in the S (slow) position. The resulting average voltage is buffered by operational amplifier U4 (U4-2 and U4-3 in, U4-6 out).

b. Rectifier Stage. The buffered output of the voltage comparator is applied to the rectifier stage, which comprises operational amplifier U5B, diodes CR3 and CR4, and their associated components. The output of the rectifier stage is a positive dc voltage, which can be monitored at turret-type test point TP9.

c. Summing/Inverting Stage. Operational amplifier U5A and its associated components combine the output of the rectifier stage with an offset voltage created by the reference voltage generator (para 7.3.8). Once these voltages are combined, the result is inverted to produce a negative voltage, which is applied to U3-8 to control the gain of the voltage-controlled amplifier.

7.3.7. Signal Level Detectors

Both halves of dual operational amplifier IC6 are connected as voltage comparators to serve as signal level detectors. IC6B is the low-signal detector, and IC6A is the high-signal detector. Both detectors monitor the signal produced by the rectifier stage of the AGC system (para 7.3.6).

If either signal level detector senses an out-of-limits signal, its output will light one of the LED indicators on the front edge of the module (LO SIG indicator DS1 or HI SIG indicator DS2). Their outputs are combined by diodes CR5 and CR7 to form the OUT OF LIMIT signal delivered to the logic module by way of edge connector terminal 10.

7.3.8. Reference Voltage Generator

The reference voltage generator produces the dc voltages the RFL 67B REC needs for proper operation. Precision Zener diode CR9 and resistor R50 produce an output of -6 volts, which is applied to the anode of diode CR1 for clamping the output of the voltage comparator stage. The +6 volts required by the signal level detectors is generated by precision Zener diode CR10 and resistor R51.

Resistors R52 and R53 and potentiometer R54 form a voltage divider which is connected across CR9 and CR10. The setting of R54 determines the amount of offset voltage that is applied to the summer/inverter stage.

Table 7-1. Replaceable parts, RFL 67B REC Wideband Receiver Module
Assembly No. 101110

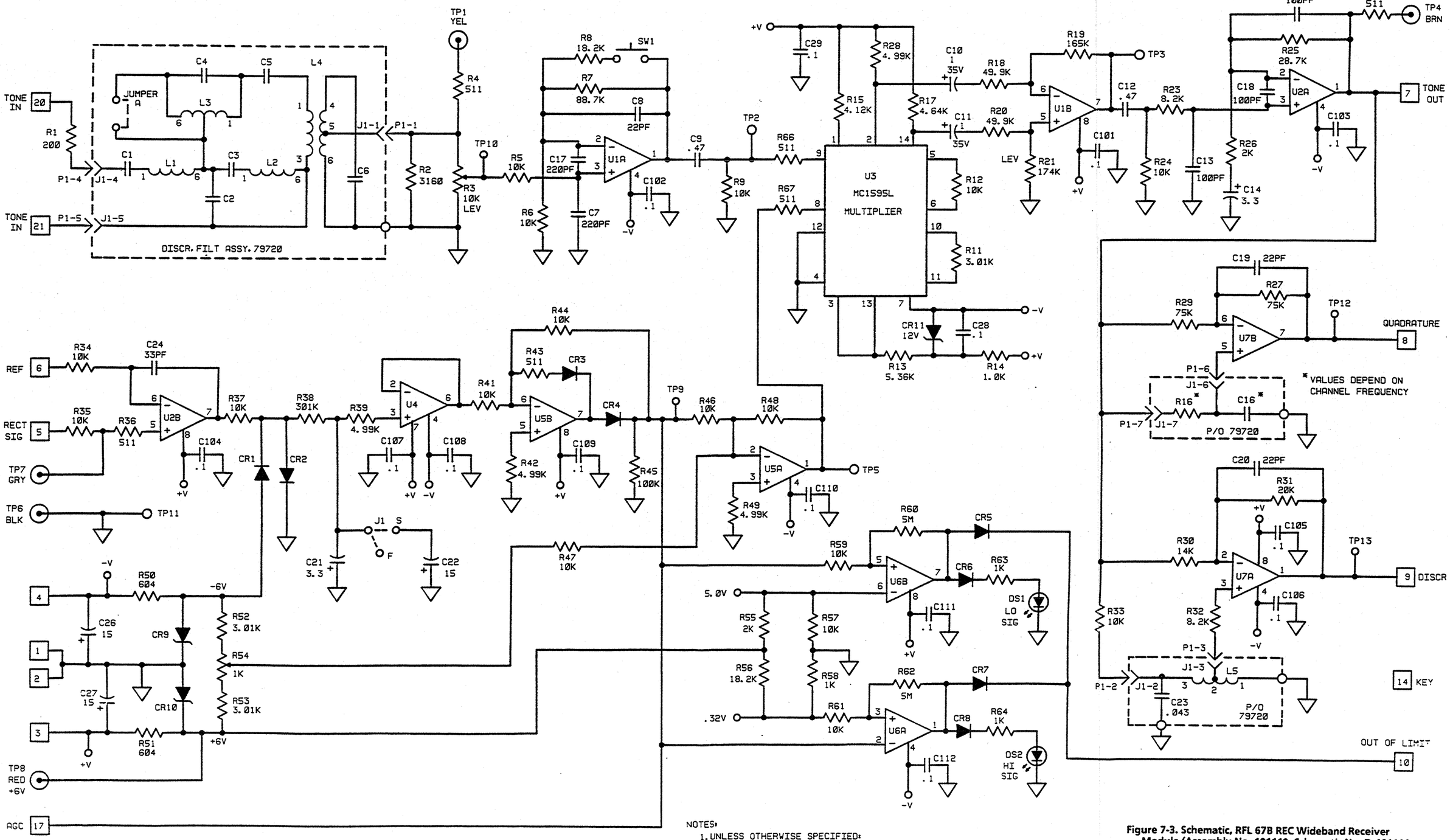
Circuit Symbol (Fig. 7-3)	Description	Part Number
	CAPACITORS	
C1-6,16,23	Part of discriminator/filter assembly. (See below.)	
C7,17	Capacitor,ceramic,220pF,10%,100V,AVX SA101A221KAA or equiv.	0125 12211
C8,19,20	Capacitor,ceramic,22pF,5%,100V,AVX SA101A220JAA or equiv.	0125 12205
C9,12	Capacitor,Z5U ceramic,0.47µF,20%,50V,AVX SA405E474MAA or equiv.	0135 54742
C10,11	Capacitor,tantalum,1µF,10%,35V,Kemet T110A105K035AS or equiv.	1007 1156
C13,15,18	Capacitor,ceramic,100pF,10%,100V,AVX SA101A101KAA or equiv.	0125 11011
C14,21	Capacitor,tantalum,3.3µF,20%,35V,Kemet T322C335M035AS or equiv.	1007 1260
C22	Capacitor,tantalum,15µF,20%,35V,Corning CCZ-035-156-20 or equiv.	1007 654
C24	Capacitor,ceramic,33pF,5%,100V,AVX SA101A330JAA or equiv.	0125 13305
C25,30-100	Not used.	
C26,27	Capacitor,tantalum,15µF,20%,20V,Kemet T322D156M020AS or equiv.	1007 716
C28,29,101-112	Capacitor,X7R ceramic,0.1µF,10%,50V,AVX SA305C104KAA or equiv.	0130 51041
	RESISTORS	
R1	Resistor,metal film,200Ω,1%,1/4W, Type RN1/4	0410 1221
R2	Resistor,metal film,3.16KΩ,1%,1/4W, Type RN1/4	0410 1336
R3	Resistor,variable,15-turn cermet,10KΩ,10%,3/4W,Beckman Helipot 89PHR10K or equiv.	39539
R4,22,36,43,66,67	Resistor,metal film,511Ω,1%,1/4W, Type RN1/4	0410 1260
R5,6,9,12,24,33-35,37, 41,44,46-48,57,59,61	Resistor,metal film,10KΩ,1%,1/4W, Type RN1/4	0410 1384
R7	Resistor,metal film,88.7KΩ,1%,1/4W, Type RN1/4	0410 1475
R8,56	Resistor,metal film,18.2KΩ,1%,1/4W, Type RN1/4	0410 1409
R10,40	Not used.	
R11,52,53	Resistor,metal film,3.01KΩ,1%,1/4W, Type RN1/4	0410 1334
R13	Resistor,metal film,5.36KΩ,1%,1/4W, Type RN1/4	0410 1358
R14,58,63,64	Resistor,metal film,1KΩ,1%,1/4W, Type RN1/4	0410 1288
R15	Resistor,metal film,4.12KΩ,1%,1/4W, Type RN1/4	0410 1347
R16	Part of discriminator/filter assembly. (See below.)	
R17	Resistor,metal film,4.64KΩ,1%,1/4W, Type RN1/4	0410 1352
R18,20	Resistor,metal film,49.9KΩ,1%,1/4W, Type RN1/4	0410 1451
R19	Resistor,metal film,165KΩ,1%,1/4W, Type RN1/4	0410 1501
R21	Resistor,metal film,174KΩ,1%,1/4W, Type RN1/4	0410 1503
R23,32	Resistor,metal film,8.25KΩ,1%,1/4W, Type RN1/4	0410 1376
R25	Resistor,metal film,28.7KΩ,1%,1/4W, Type RN1/4	0410 1428
R26,55	Resistor,metal film,2KΩ,1%,1/4W, Type RN1/4	0410 1317
R27,29	Resistor,metal film,75KΩ,1%,1/4W, Type RN1/4	0410 1468
R28,39,42,49	Resistor,metal film,4.99KΩ,1%,1/4W, Type RN1/4	0410 1355
R30	Resistor,metal film,14KΩ,1%,1/4W, Type RN1/4	0410 1398

Table 7-1. Replaceable parts, RFL 67B REC Wideband Receiver Module - continued.

Circuit Symbol (Fig. 7-3)	Description	Part Number
	RESISTORS - continued.	
R31	Resistor,metal film,20KΩ,1%,1/4W, Type RN1/4	0410 1413
R38	Resistor,metal film,301KΩ,1%,1/4W, Type RN1/4	0410 1526
R45	Resistor,metal film,100KΩ,1%,1/4W, Type RN1/4	0410 1480
R50,51	Resistor,metal film,604Ω,1%,1/4W, Type RN1/4	0410 1267
R54	Resistor,variable,18-turn cermet,1KΩ,10%,1/2W,Beckman Helipot 68WR1K or equiv.	49995
R60,62	Resistor,metal film,5.11MΩ,1%,1/4W, Type RN1/4	0410 1644
	SEMICONDUCTORS	
CR1-8	Diode,silicon,1N914B or 1N4448	26482
CR9,10	Diode,Zener,6V,1%,500mW,1N5233D	30122
CR11	Diode,Zener,12V,5%,1W,1N4742A	29755
DS1,2	Light-emitting diode,red,Dialight 550-0102 or equiv.	39568
U1,2,5-7	Linear operational amplifier,JFET input,8-pin DIP,Texas Instruments TL082CP or equiv.	0620 155
U3	Linear variable-transconductance multiplier,14-pin DIP,Motorola MC1595L or equiv.	0620 277
U4	Linear operational amplifier,high-performance,8-pin DIP, Texas Instruments LM307N or equiv.	0620 93
	MISCELLANEOUS COMPONENTS	
J1	Shorting bar,single,Molex 90059-0009 or equiv.	98306
L1-4	Part of discriminator/filter assembly. (See below.)	
S1	Switch,momentary pushbutton,SPDT,C & K Components TP12-A or equiv.	32321

NOTE

The discriminator/filter assembly (Assembly No. 79720-X) is not field-repairable. Do not attempt to change component values to alter its operating frequencies. If the RFL 67B REC is being modified to operate on another frequency, refer to Section 3 for information on the proper discriminator/filter assembly to order.



NOTES:
1. UNLESS OTHERWISE SPECIFIED:
   ALL RESISTOR VALUES ARE IN OHMS, 1/4W, 1%
   ALL CAPACITORS ARE IN MICROFARADS

Figure 7-3. Schematic, RFL 67B REC Wideband Receiver Module (Assembly No. 101110; Schematic No. D-101114, Rev. A)

Section 8. DETECTOR MODULE *

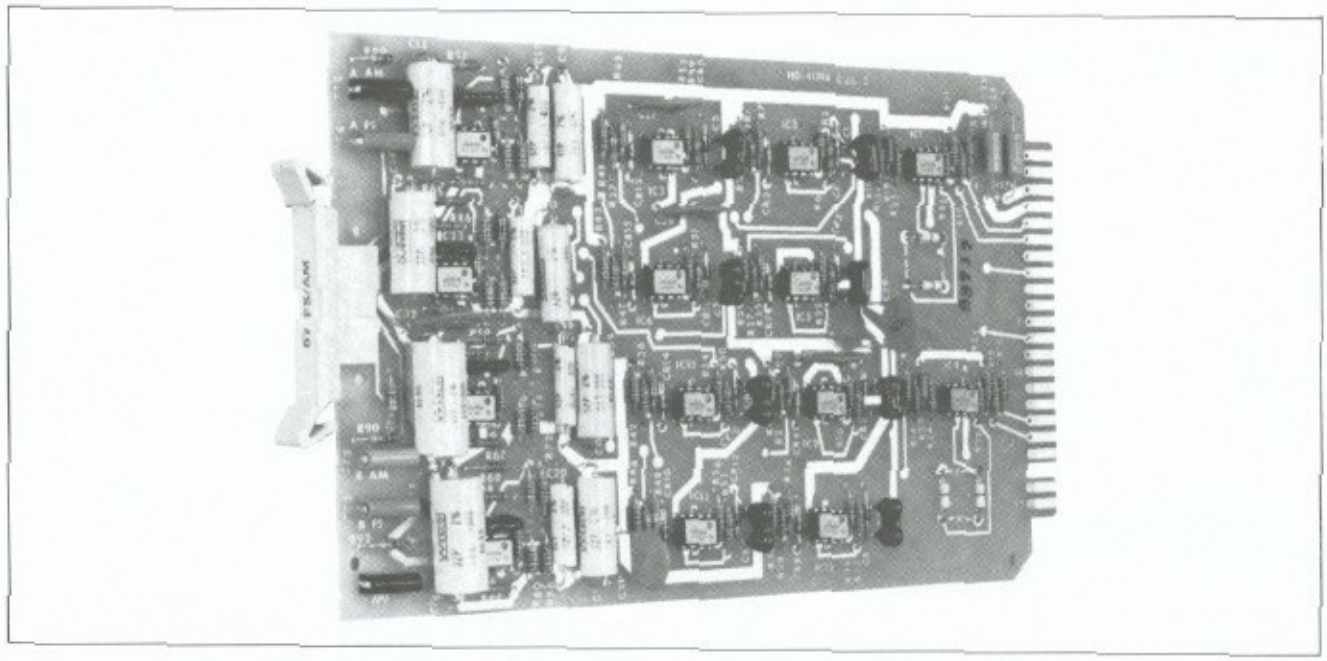


Figure 8-1. RFL 67 FS/AM Detector Module

8.1. DESCRIPTION

The RFL 67 FS/AM detector module (Fig. 8-1) accepts the tone, quadrature, and discriminator outputs produced by the two wideband receiver modules (Section 7). These signals are passed through a series of detectors, which produce four outputs. These outputs represent the AM signal levels and the amount of frequency shift on each subchannel, and this information is passed on to the logic module (Section 9).

8.2. SPECIFICATIONS

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

Inputs: Tone, quadrature, and discriminator outputs from Subchannel A and Subchannel B receiver modules.

Outputs: AM and FS outputs for each subchannel sent to logic module.

Operating Temperature: *-30°C to +60°C (-22°F to* +140°F).

Power Requirements:
+12-volt Supply: 55 mA.
-12-volt Supply: 55 mA.

Dimensions:
Height: 4.713 inches (12 cm).
Depth: 8.00 inches (20.3 cm).
Width: 1.0 inch (2.54 cm); requires two module spaces in chassis.

8.3. THEORY OF OPERATION

The RFL 67 FS/AM contains two identical sets of FS and AM detectors: one for Subchannel A (low frequency), and one for Subchannel B (high frequency). Paragraphs 8.3.1 and 8.3.2 describe the detector circuits for Subchannel A; the circuits for Subchannel B function in the same manner, but use different components. Also, in Subchannel A, trip is the low frequency (shift below center frequency) and guard is the

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* - U.S. Patent No. 4,015,220.

high frequency (shift above center frequency; in Subchannel B, guard is low and trip is high.

The block diagram in Figure 8-2 shows the circuits for both subchannels; waveforms at the indicated points in the Subchannel A circuits are shown in Figure 8-3.

8.3.1. AM Detector

The AM detectors monitor the output of the receiver module for AM signals. There are two AM detectors: one for Subchannel A, and one for Subchannel B. Each AM detector contains two active rectifier circuits, a summing/inverting amplifier, and a low-pass filter. This paragraph will discuss the AM detector for Subchannel A; the detector for Subchannel B works the same, but uses different components.

a. Active Rectifiers. Dual operational amplifier IC3 and its associated components form the Subchannel A tone rectifier, which accepts and rectifies the amplified and gain-controlled tone output of the receiver module (signal A on Figure 8-3). Dual operational amplifier IC6 and its associated components form the Subchannel A quadrature rectifier, which accepts and rectifies the quadrature output of the receiver module (signal B). These signals are identical in amplitude and shape, but the quadrature signal lags the tone signal by 90 degrees. The outputs of the active rectifiers (signals K and L) are fed to the summing/inverting amplifier.

b. Summing/Inverting Amplifier. Operational amplifier IC4/B and its associated components form a summing/inverting amplifier, which combines the outputs of the active rectifiers and inverts the amplified sum. The result (signal M) has a ripple frequency four times that of the input signals. This reduces the time constant requirements of the low-pass filter, and improved the response time of the AM detector.

c. Low-Pass Filter. Operational amplifier IC4/A and its associated components form an active low-pass filter. The output of this filter is a dc voltage (signal N), which is returned to the receiver module for AGC control; it is also sent to the logic module for use in its signal level and noise detection logic functions.

8.3.2. FS Detector

The operation of the FS detector is based on the fact that the quadrature and discriminator signals from the receiver module are in-phase when a high frequency is received, and 180 degrees out-of-phase when a low frequency is received. There are two FS detectors: one for Subchannel A, and one for Subchannel B. Each FS detector contains an input amplifier and an operational rectifier.

a. Input Amplifiers. Operational amplifiers IC1/A and IC1/B and their associated components form the input amplifiers. These amplifiers accept the quadrature tone (signal B) and discriminator output (signal C) signals from the receiver module. IC1/B produces a summed output (B + C, or signal D), and IC1/A produces a difference output (C - B, or signal E).

b. Operational Rectifiers. Dual operational amplifiers IC2 and IC5 and their associated components form the operational amplifiers for the FS detector. IC2 is connected so its output (IC2-1) goes positive when guard is present, as shown in Figure 8-3 (signal F). IC5-1 goes negative when trip is present (signal G).

c. Summing/Inverting Amplifier. The summing/inverting amplifier works the same as the summing/inverting amplifier in the AM detector (para 8.3.1). Operational amplifier IC11/B and its associated components form the summing/inverting amplifier, which combines the outputs of the active rectifiers and inverts the amplified sum. This produces signal H, a signal with a ripple frequency four times that of the input signals. This reduces the time constant requirements of the low-pass filter, and improved the response time of the FS detector.

d. Low-Pass Filter. Operational amplifier IC11/A and its associated components form an active low-pass filter. The output of this filter is a dc voltage (signal J), which is sent to the logic module. This output is negative for guard and positive for trip.

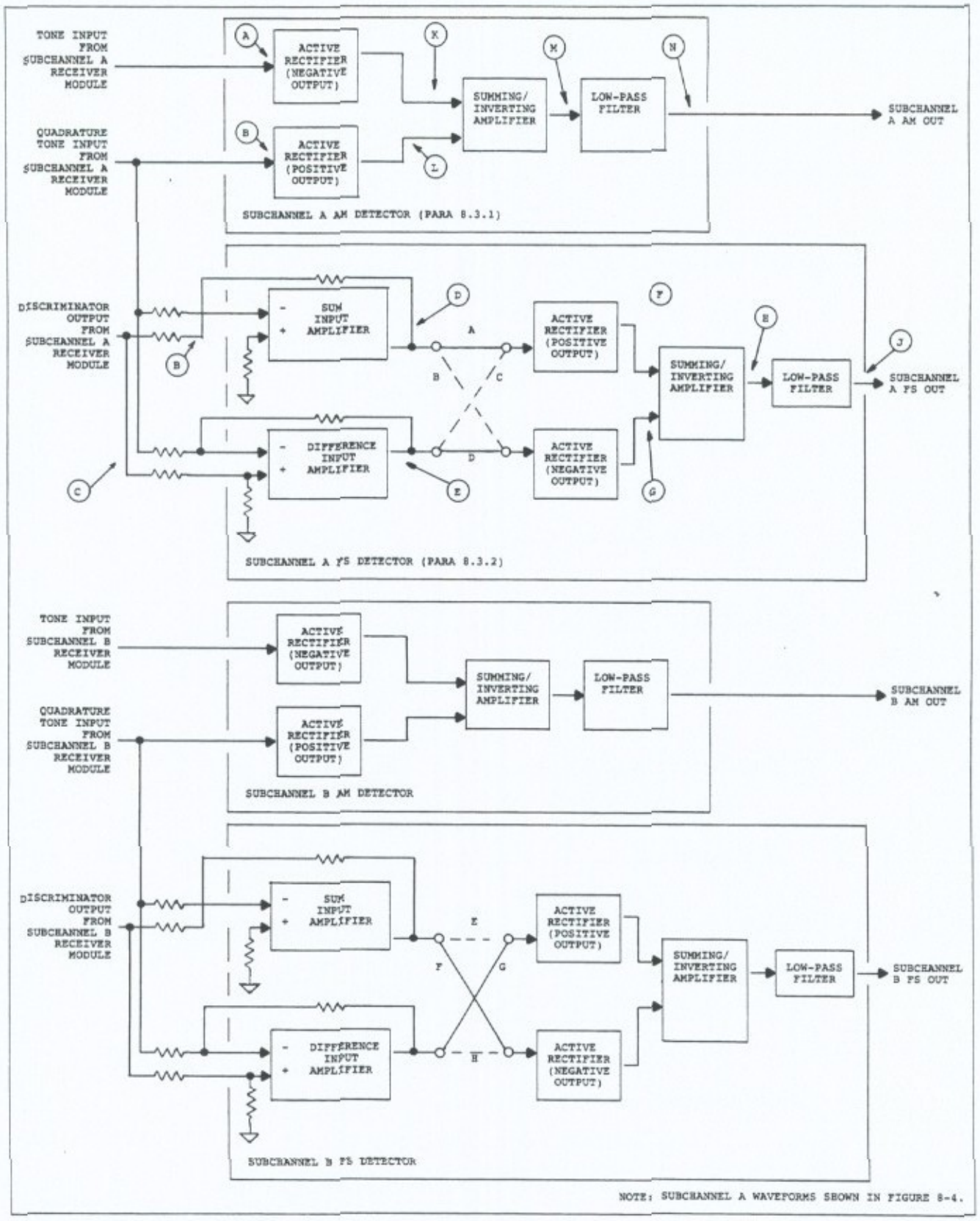


Figure 8-2. Block diagram, RFL 67 FS/AM Detector Module

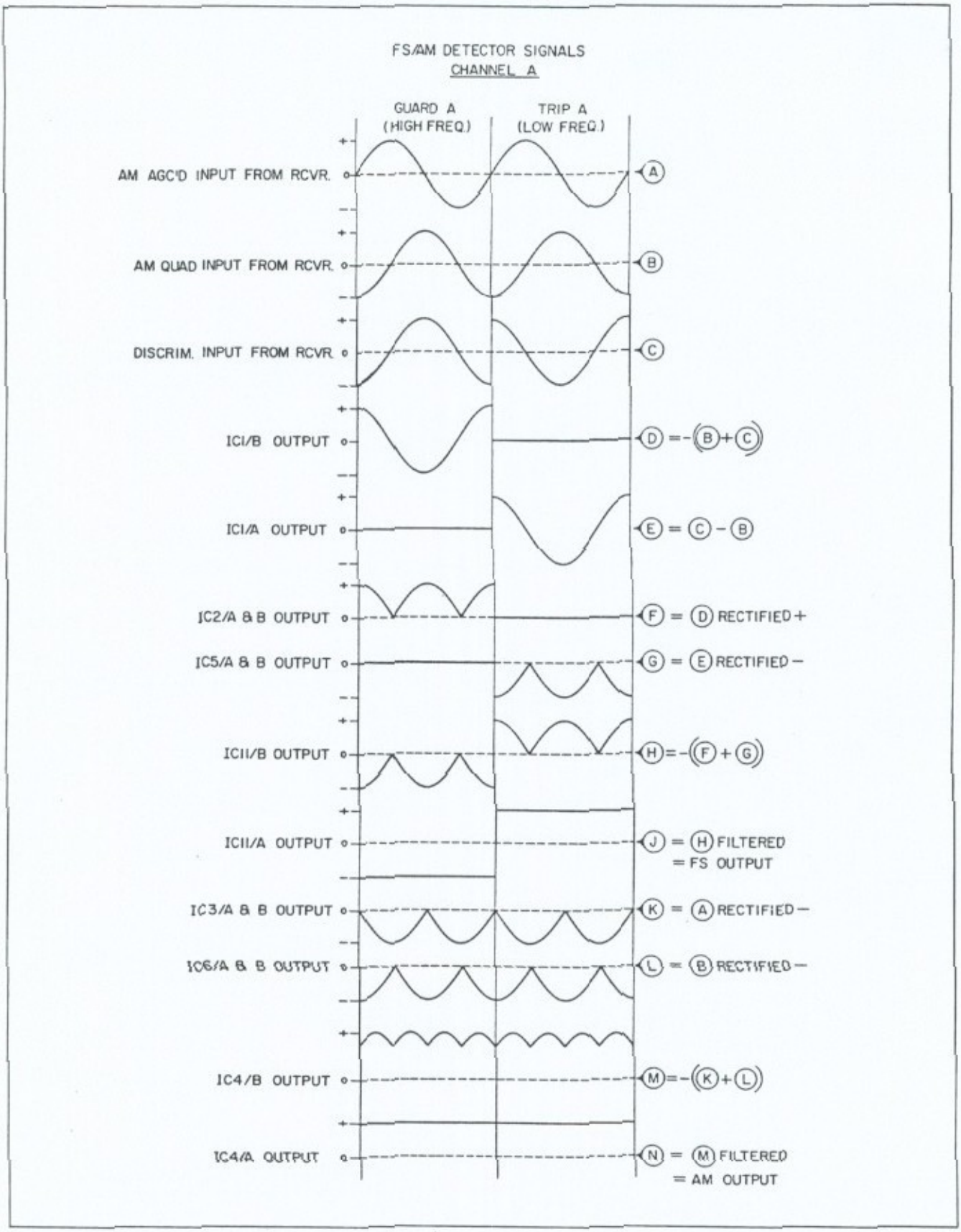


Figure 8-3. Subchannel A waveforms, RFL 67 FS/AM Detector Module

Table 8-1. Replaceable parts, RFL 67 FS/AM Detector Module Assembly No. 41015

Circuit Symbol (Fig. 8-4)	Description	Part Number
	CAPACITORS	
C1-8,21-24	Capacitor,ceramic,33pF,5%,100V,AVX SA101A330JAA or equiv.	0125 13305
C9,10	Capacitor,polyester,0.022µF,2%,100V,Wesco 32P or equiv.	5115 51
C11,12	Capacitor,polyester,0.043µF,2%,100V,Wesco 32P or equiv.	5115 65
C13,14	Capacitor,polyester,0.056µF,2%,100V,Wesco 32P or equiv.	5115 71
C15,16	Capacitor,polyester,0.105µF,2%,100V,Wesco 32P or equiv.	5115 84
C17,18	Capacitor,polyester,0.00315µF,2%,100V,Wesco 32P or equiv.	5115 10
C19,20	Capacitor,polyester,0.0062µF,2%,100V,Wesco 32P or equiv.	5115 25
C25,26	Capacitor,tantalum,15µF,20%,20V,Kemet T322D156M020AS or equiv.	1007 716
C27-32	Capacitor,X7R ceramic,0.1µF,10%,100V,AVX SA401C104KAA or equiv.	0130 11041
	RESISTORS	
R1,2,5,6,27,28,31,32, 37,38-40,49-52,69-72	Resistor,metal film,20KΩ,1%,1/4W, Type RN1/4	0410 1413
R3,4,9-18,21-26,29,30, 35,36,41-44,53-56, 59,60,63,64,73-84	Resistor,metal film,10KΩ,1%,1/4W, Type RN1/4	0410 1384
R7,8,33,34,45-48	Resistor,metal film,22.1KΩ,1%,1/4W, Type RN1/4	0410 1417
R19,20	Resistor,metal film,3.32KΩ,1%,1/4W, Type RN1/4	0410 1338
R57,58,61,62	Resistor,metal film,14KΩ,1%,1/4W, Type RN1/4	0410 1398
R65,66	Resistor,metal film,4.75KΩ,1%,1/4W, Type RN1/4	0410 1353
R67,68	Resistor,metal film,8.25KΩ,1%,1/4W, Type RN1/4	0410 1376
R85-88	Resistor,metal film,30.1KΩ,1%,1/4W, Type RN1/4	0410 1430
R89-92	Resistor,metal film,475Ω,1%,1/4W, Type RN1/4	0410 1257
	SEMICONDUCTORS	
CR1-16	Diode,silicon,1N914B or 1N4448	26482
IC1-14	Linear operational amplifier,dual,8-pin DIP,Texas Instruments MC1458P or equiv.	0620 51

Section 9. LOGIC MODULES

9.1. INTRODUCTION

RFL 6745 logic modules are used to evaluate incoming signals and determine whether valid trip or guard signals are received, or if an invalid condition exists. The logic module will then direct the RFL 6745 system to respond accordingly.

Each RFL 6745 chassis requires at least one logic module for its operation. Two basic types of logic modules are available. The RFL 67 LOGIC Standard-Range Logic Module (para 9.3) is used in most applications. The RFL 67A LOGIC Wide-Dynamic-Range Logic Module (para 9.4) is used in applications where signals of varying level will be received, or where large amounts of noise may be present.

Both modules have similar slow AGC attack times. However, the RFL 67 LOGIC has a fast attack capability of -3 dB to +1 dB, where the RFL 67A LOGIC can respond to an instantaneous level change of 30 dB (except at signal levels of +10 dB or -20 dB).

RFL 67 LOGIC modules can be connected in parallel for redundant applications. If a RFL 67A LOGIC module is being used, one or more RFL 67A LOGIC-1 modules can be used with it for redundancy or to enable some of their special functions.

9.2. GLOSSARY OF LOGIC MODULE TERMS

AM NOISE
The noise that appears at the AM output terminals of the detector module.

BLOCK
Any condition that prevents the logic module from indicating a trip. A block is removed after the condition causing it ceases to exist.

DEPENDABILITY
The ability of the logic module to detect a trip in the presence of noise. It is measured as the percentage of trips detected with respect to the S/N ratio of the input signal.

FLASHER
A circuit that keys the transmitter to rapidly switch between trip and guard frequencies when a trip command is given. Normally, flasher circuits switch between frequencies once every 25 ms.

FS NOISE
The noise that appears at the FS output terminals of the detector module.

GUARD
A state that exists when both subchannels are receiving guard frequency signals.

GUARD OVERRIDE
A function that negates the action of the trip-hold timer immediately upon return to a guard state. In the RFL 67A LOGIC, guard override is selected by jumper placement.

GUARD-BEFORE-TRIP (G/T)
A condition that requires reception of a valid guard signal for a specific amount of time before a trip can be recognized.

HARD BLOCK (squelch)
A requirement that the condition causing the block be removed for at least 100 ms before the block will be removed. In RFL 6745 equipment, hard block is imposed when the system is in block for 100 ms or more. In certain applications, hard block will not be removed until a valid guard signal is received.

PRE-GUARD TIMER
A timer that requires outputs from both guard detectors for at least 5.4 ms before the guard is accepted as valid. It is used to evaluate the condition of a guard signal, and it functions as a protection against noise.

PRE-TRIP TIMER
A timer that requires outputs from both trip detectors for at least 5.4 ms before the trip is accepted as valid. It is used to evaluate the condition of a trip signal, and it functions as a protection against noise-induced false trips.

REDUNDANCY
A design philosophy which provides two or more identical circuits that perform the same function. With redundancy, the failure of a single component will not produce a false trip.

SECURITY
The ability of the equipment to exclude an erroneous trip condition in the presence of white noise.

TRIP

A state that exists when both subchannels are receiving trip frequency signals.

TRIP HOLD

A timer that keeps the trip output of the logic module high for a specified interval, even if the trip condition ceases to exist.

TRIP HOLD/HOLD OFF

A delay imposed on the trip hold timer. The trip hold timer will not recognize the presence of a valid trip signal until it exists for a predetermined amount of time.

TRIP-AFTER-GUARD (T/G)

A condition that requires a trip condition to occur within a specified time after the loss of a guard state.

9.3. RFL 67 LOGIC STANDARD-RANGE LOGIC MODULE

9.3.1. Description

The RFL 67 LOGIC Standard-Range Logic Module (Figure 9-1) accepts and interprets outputs produced by the RFL 67 FS/AM Detector Module. Two RFL 67 LOGIC modules can be connected in parallel for installations where redundancy is required.

9.3.2. Specifications

As of the date this manual was published, the following specifications apply to the RFL 67 LOGIC Standard-Range Logic Module. Because all RFL products undergo constant refinement and improvement, these specifications are subject to change without notice.

Inputs: All inputs are taken from the RFL 67 FS/AM Detector Module (Section 8).

Outputs:

TRIP OUT: Provides input signal for trip output circuit on interface module (Section 5).

BLOCK OUT: Used to drive block relay on relay module (Section 10).

ALARM OUT: Used to drive alarm relay on relay module (Section 10).

LOGIC BLOCK OUT: Used to connect block circuits of two logic modules when used in redundant applications.

Operating Temperature: -30°C to +60°C (-22°F to +140°F).

Power Requirements:

For Single Logic Module:

+12-volt Supply: 60 mA.

-12-volt Supply: 50 mA.

For Each Additional Logic Module:

+12-volt Supply: 40 mA.

-12-volt Supply: 10 mA.

Dimensions:

Height: 4.713 inches (12 cm).

Depth: 8.00 inches (20.3 cm).

Width: 1.0 inch (2.54 cm); requires two module spaces in chassis.

9.3.3. Timing Circuits

The RFL 67 LOGIC module contains nine RC timing circuits. The time constants of these circuits contribute to the operation of the protective logic on the module. Each timer is arranged so its capacitor must charge or discharge for about one time constant to reach a new voltage level. When this new level is reached, an operational amplifier comparator will change states. An alternate path through another resistor and a diode quickly resets the timer circuit when the input pulse is no longer present.

All timing capacitors are returned to circuit ground, except capacitor C9 in the alarm timer (number 9 below), which is returned to the +12-volt line. In this way, if supply power is lost and then restored, the alarm will not cease until guard signals are received on both subchannels for at least 100 ms. In general, the timing circuits provide three distinct levels of protection:

1. For abnormal conditions lasting less than 100 ms, the system blocks during the fault, but then returns to normal operation when the fault is eliminated.

2. For abnormal conditions lasting more than 100 ms but less than 2 seconds, the system waits for about 120 ms after the block condition is removed before a trip is possible.

3. For abnormal conditions lasting more than 2 seconds, the alarm circuits alert supervisory personnel, who must take corrective action.

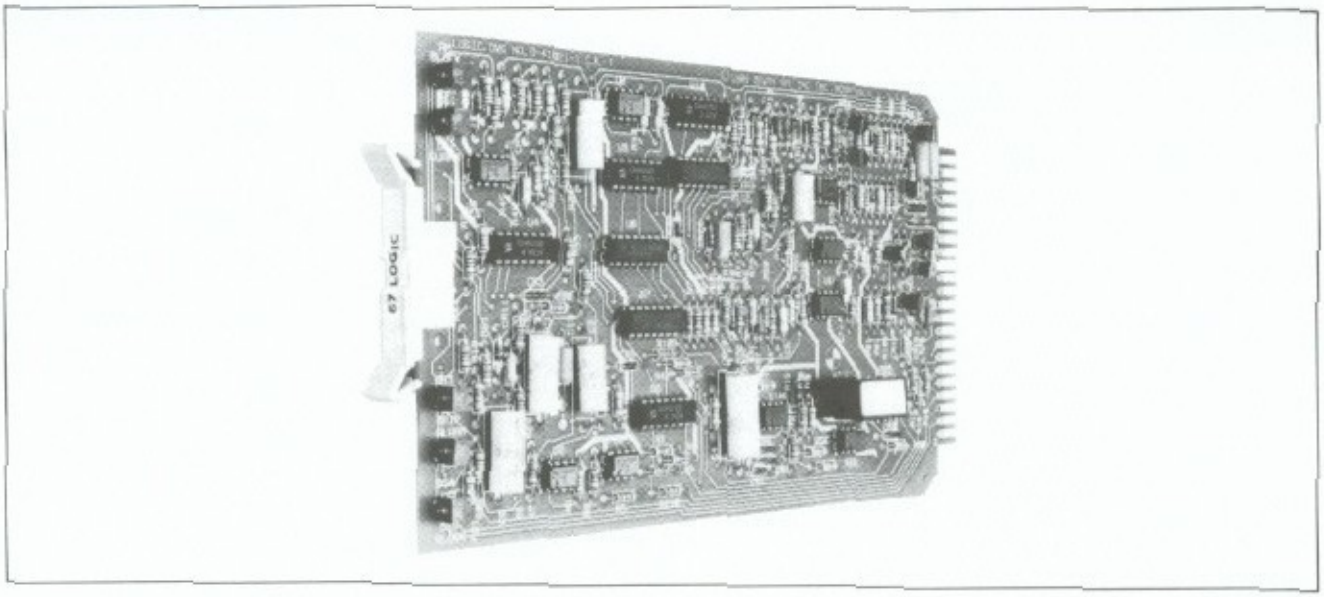


Figure 9-1. RFL 67 LOGIC Standard-Range Logic Module

The nine timers are described below. The resistor and capacitor that controls each timer is identified, and the standard period for each timer is given. Some of the periods are subject to change to adapt the RFL 67 LOGIC module to the requirements of a specific application.

a. Pre-Trip Timer (C1/R33). The time constant of the pre-trip timer is about 5.4 ms for systems with 340-Hz channel spacing, and about 2.5 ms for 680-Hz systems. This timer holds off response to a trip command for about 5.4 ms; this assures that the system does not trip on short bursts of noise. If a trip signal does not persist for at least the time constant of this timer, there will be no trip output from the logic module.

b. Trip Sequence Timer (C2/R39, 10 ms). This timer delays the transmission of low-level trip signals for a period greater than the delay of the pre-trip timer, which only operates on high-level trip signals.

c. Guard-Before-Trip Timer (C3/R48, 10 ms). This timer makes sure that there was an acceptable guard signal present for at least 10 ms before a trip signal can be developed. The guard-before-trip time is extended to 900 ms when capacitor C13 is added into the circuit. This is done in applications using slow AGC response (such as trip-boost).

With guard signal present, IC5/D-11 is low and C3 is discharged through R48. Loss of guard signal causes C3 to charge almost instantly through diode CR5. This will change IC13/A-1 from high to low, where it will stay until IC13/A-3 drops below 6 volts.

When guard signal returns, C3 will discharge slowly through R48 and IC5/D. About 10 ms later, its potential will drop below 6 volts; this will cause IC13/A to change states and acknowledge receipt of a valid guard signal for the specified amount of time.

To unblock the system after a hard-block condition has occurred, an undisturbed guard signal must be received for at least 100 ms to enable the system to be ready to accept another trip signal.

d. Trip Hysteresis Timer (C4/R66, 20 ms). There is always the possibility that extraneous noise can be present along with a valid trip signal. The trip hysteresis timer allows an established trip signal to be maintained without being invalidated by short noise bursts.

When a trip signal is received, C4 is quickly charged through diode CR13 and resistor R65. If the trip signal is lost for brief intervals once C4 is charged, it will discharge slowly through R66, holding IC9/C-8 high for about one time constant. This prevents the block signal at IC9/C-9 (due to absence of guard) from becoming effective at IC9/C-10.

e. Block Timer (C5/R31, 100 ms). The block timer delays transmission of a block signal from IC11/A-6 for about 100 ms. Block signals of shorter duration are considered transient, so the system is protected only during the period of the disturbance, and no longer. Block signals of greater duration, as sensed by the block timer, initiate further protective action by activating the restore timer (described below). A new 100-ms

period of undisturbed guard is required to remove the block condition.

f. Pulse Stretcher (C6/R50, 20 ms). Whenever a short noise spike is received, C6 charges rapidly through diode CR11 and then holds the block condition for about 20 ms. It also stretches a loss-of-guard signal, so it requires a good-quality guard signal for at least 20 ms before the block is released.

g. Restore Timer (C7/R57, 100 ms). The restore timer requires that all prohibitions against trip must have been removed for at least 100 ms before trip is permitted. It restores permission to trip about 100 ms after the output of IC7/C goes high, but it restores a block condition rapidly through diode CR12 if a logic-low block signal appears at the output of IC7/C.

h. Trip Hold/Hold Off Timer (C8/R83/R84). This is an optional timer, with a time constant determined by the values chosen for C8, R83, and R84. C8 charges rapidly when trip is received, and holds IC12-2 high. It is used to ensure completion of the trip action, even though the communication system may have failed or become noisy.

i. Alarm Timer (C9/R69, 2 seconds). The alarm timer delays receipt of the block signal at IC18/B-6 until it times out. Once IC18/B receives the block signal and its output (IC18/B-7) changes states, an alarm signal is sent to transistor Q8 and ALARM indicator DS4 lights.

9.3.4. Theory Of Operation

The RFL 67 LOGIC Standard-Range Logic Module continually monitors the outputs from the detector module and determines whether one of three conditions exists:

1. A valid trip is received.
2. A valid guard is received.
3. An invalid condition exists.

In each case, the logic module will direct the RFL 6745 system to take appropriate action.

In order for the logic module to signal a received trip at its output terminal, the following conditions must be satisfied:

1. The AM signals in each subchannel must be within set amplitude limits; this is referred to as the "window".
2. Guard signals must have been received on both subchannels for at least 100 ms before the arrival of a trip signal.
3. Both trip signals must arrive within 100 ms after the loss of guard signal.
4. The trip signals must last for at least 5.4 ms.
5. No block conditions can be received from any source, either internal or external to the RFL 6745 equipment.

A block diagram of the RFL 67 LOGIC module appears in Figure 9-2; its schematic can be found in Figure 9-3.

9.3.4.1. AM Window Detectors

The AM window detectors continually monitor the signal level received on both channels. As long as the signals are within the established limits for the window, the system will function normally. If the signal level on either subchannel falls below or rises above the window limits, the AM window detectors will respond by generating a block signal. In systems that do not use trip boost, the signal level will normally be about +4 volts; signals less than +3.0 volts or more than +5.2 volts will be out of the window, and cause a block condition.

For Subchannel A, dual operational amplifier IC1 is connected as a dual voltage comparator. The "A" portion of IC1 monitors the top of the window; if the signal level exceeds +5.2 volts, its output will go high. The "B" portion of IC1 monitors the bottom of the window; its output will go high if the signal level falls below +3.0 volts.

The outputs of both halves of IC1 are fed to the inputs of NAND gate IC4/D (IC4/D-12 and IC4/D-13) . As long as the signal levels on both subchannels are within the window, both inputs to IC4/D will be low, and its output (IC4/D-11) will be high. If the signal level on either subchannel goes outside the window (whether because of in-band signal or excessive noise), the output of IC4/D will go low for as long as that condition exists.

For Subchannel B, dual operational amplifier IC2 serves as the dual voltage comparator and the outputs are combined in NAND gate IC4/A.

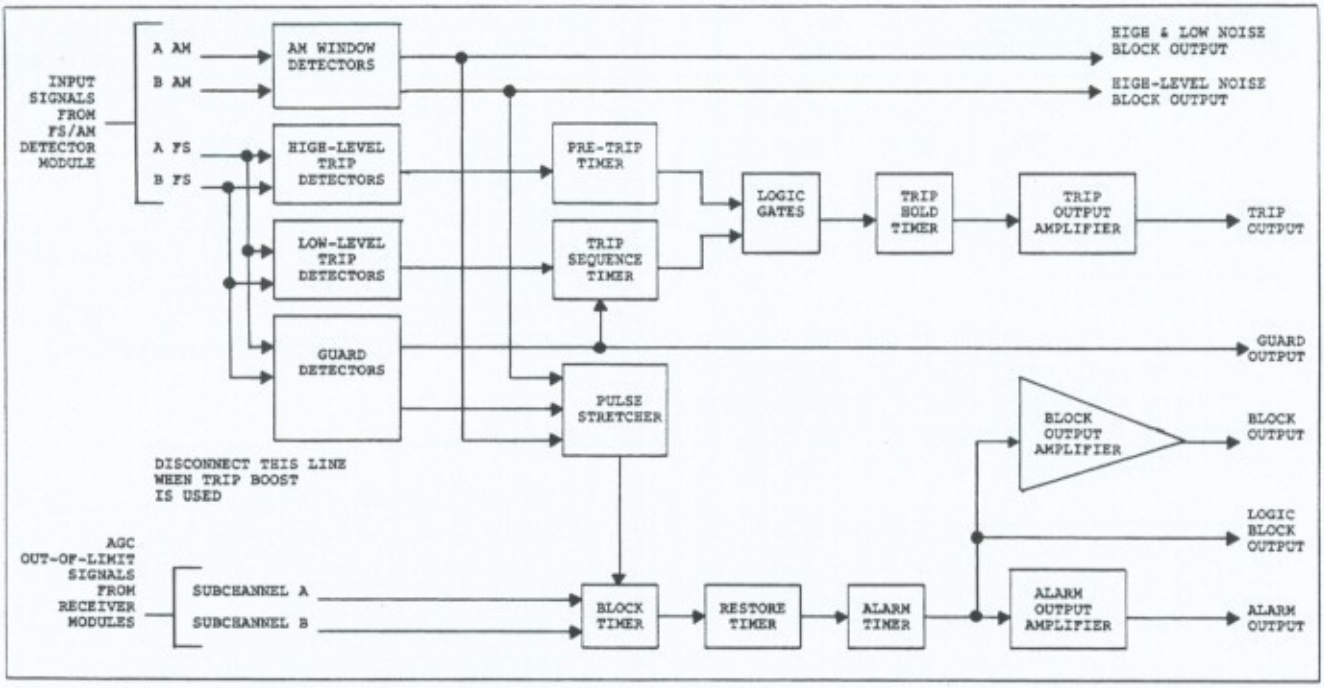


Figure 9-2. Block diagram, RFL 67 LOGIC Standard-Range Logic Module

The outputs of IC4/D and IC4/A are fed to the input of NOR gate IC5/A. A level change on either subchannel will cause IC5/A-3 to go high; this state is known as "AM Noise Block", and this signal is available on edge connector terminal U. This signal also drives AM BLOCK indicator DS1 (through inverter IC6/B) to indicate a "block" condition. In addition, the output of the AM window detectors is also applied to the input of the pre-trip timer (IC7/A-3) and to the input of the pulse stretcher (IC7/B-8) in systems that do not use trip boost.

Another NAND gate (IC4/B) monitors the outputs of the high-level detectors for both subchannels. If the output of either detector changes state, IC4/B-4 will go low. This logic low is then inverted by inverter IC6/A to create the HIGH-LEVEL NOISE BLOCK OUTPUT signal at edge connector terminal I; this signal is also fed to the input of the pulse stretcher (IC7/B-2).

9.3.4.2. FS Detectors

Dual operational amplifiers IC3, IC14, and IC15 serve as FS detectors. They are connected as voltage comparators, and they monitor the FS outputs of the detector module for the dc voltage levels that correspond to guard, trip, or trip boost. Typical voltage levels are shown on the schematic (Fig. 9-16).

a. FS Guard Detection And Logic. IC14/A monitors the CHAN A FS IN line for guard signals; IC15/A does this for the CHAN B FS IN line. As long as guard is present, the outputs of IC14/A and IC15/A are high; these outputs are fed into NOR gate IC5/D, so its output (IC5/D-11) will be low. This logic low becomes the GUARD OUTPUT signal at edge connector terminal S. It is also applied to pin 2 of operational amplifier IC13/A, causing its output (IC13/A-1) to go low, lighting GUARD indicator DS1.

While guard signals are being received, the outputs of the remaining FS detectors are all at logic low; this prevents trips by holding capacitor C2 charged through NOR gate IC5/B and by holding the output of NAND gate IC7/B high. At the same time, NAND gate IC7/A is holding capacitor C1 fully discharged. In order to initiate and sustain a trip, the outputs of IC7/A, IC7/B, and IC5/B must all change states at the same time; failure of any one to change state will either inhibit or cancel the trip action.

b. FS Trip Detection And Logic. When the received FS signals change from guard to trip, the outputs of all six FS detectors will change state. This will cause the outputs of NOR gates IC5/B, IC5/C, and IC5/D to all change states. Assuming no protective actions are prevailing, the following actions will occur:

1. The output of NAND gate IC7/A will go high. This high is used to charge capacitor C1 in the pre-trip timer, which is incorporated into the circuit to

prevent the system from responding to trip-frequency noise that lasts less than 5.4 ms.

The pre-trip timer drives operational amplifier IC8/A; its output (IC8/A-1) will not change state until C1 charges above +6 volts, which takes about 5.4 ms. Protective signals at IC7/A-3 and IC7/A-4 can defeat this action; these signals will be discussed later.

2. The output of operational amplifier IC8/B (IC8/B-7) will not change state until capacitor C2 has discharged through resistor R39; this will take about 10 ms. In this way, IC8/A will respond to a trip signal before IC8/B.

3. The output of NAND gate IC7/B (pin 9) will go low when guard is removed, providing there are no protective signals present at IC7/B-2 and IC7/B-8; these signals will be discussed later.

In other words, except for protective signals, the following conditions are necessary and sufficient to initiate and sustain a trip:

1. The output of IC7/A must be high, indicating that the high-level trip detector senses a trip.

2. The output of IC5/B must be low, indicating that the low-level trip detector senses a trip.

3. The output of IC7/B must be low. This indicates that guard is absent, and no more than 100 ms can elapse between loss of guard and the establishment of conditions (a) and (b) above.

When the output of IC7/A goes high (indicating a trip), IC8/A-2 will go high about 5.4 ms later, owing to the action of the pre-trip timer. The output of IC8/A will place a logic low on pin 1 of NOR gate IC10/A.

Next, the logic low at IC5/B-4 will result in a delayed low at IC8/B-6, because of the action of the trip sequence timer (capacitor C2 and resistor R39). As soon as the low arrives at IC8/B, its output (ICB/B-7) goes high; this logic high is applied to pin 6 of NOR gate IC10/B.

From this point, the trip signal is fed through a series of gates, which combine it with trip and block signals from accessory equipment, such as a diagnostic module or a narrowband receiver (Section 12). The output of this series of gates (IC11/B-9) feeds both IC12-2 (through the trip hold/hold off timer) and the base of transistor Q2. IC12's output pin drives TRIP indicator DS3 through inverter IC6. A logic low at the collector of Q2 or the output of IC12 will energize Q1; this produces a TRIP OUT signal at edge connector terminal H. The signal path through Q2 and the parallel path through IC12 form an OR gate; trip signals pass through Q1 with no delay. The signal through IC12 may be delayed and/or lengthened, depending on the component values chosen for the trip hold/hold off timer (capacitor C8 and resistors R83 and R84). R83 and C8 determine the trip hold time; R83, R84, and C8 determine the amount of time a valid trip signal must be present before a trip hold condition is established.

9.3.4.3. Protective Logic

The RFL 67 LOGIC module contains several protective logic features. Some are intended to prevent delivery of a trip signal when the received signal does not meet certain established standards. Others only permit trip after certain conditions have been met, such as validity, amplitude, duration, and signal sequence. All help the RFL 6745 system achieve a balance between security and dependability.

a. Loss Of Guard Signal. When guard is present, IC5/D-11 is held low; this presents a low to IC7/B-1. If guard is lost, these points will go high, placing a low on IC7/B-9. This causes IC9/B-4 to go high, quickly charging capacitor C6 in the pulse stretcher through diode CR11. This changes the output state of operational amplifier IC13/B and NAND gate IC9/C. The output of IC9/B is fed to pin 3 of three-input NAND gate IC11/A, which serves as a collecting point for several protective-block signals.

IC11/A-6 changes to a logic low, discharging capacitor C5 in the block timer through resistor R31. The voltage across C31 drives IC17/A-2. IC17/A is connected as a voltage comparator; if guard is lost for more than 120 ms, IC17/A-1 will go high; this logic high is the loss-of-guard signal, which is fed to IC7/C-11.

Three-input NAND gate IC7/C is another collecting point for protective-block signals. Under normal conditions, its output (IC7/C-10) is high, holding capacitor C7 in the restore timer fully charged; this holds the output of operational amplifier IC17/B (IC17/B-7) low.

When any block information (such as a loss-of-guard signal) forces the output of IC7/C low, capacitor C7 rapidly discharges through resistor R58 and diode CR12. This forces IC17/B-7 high, and the following conditions will occur, indicating a block:

1. Edge connector terminal 11 (LOGIC BLOCK OUT) will go high. This signal is used elsewhere in the RFL 6745 system.

2. The alarm timer (which will be discussed later) begins timing.

3. The base voltage on transistor Q7 goes high; this turns Q7 off, de-energizing relay K1. The shift in relay contacts will indicate a block condition; the exact means will vary with the installation.

4. BLOCK indicator DS5 will light to provide a visual indication that a block condition exists.

5. A logic high will be present at IC9/A-1. This produces a logic low at IC9/A-3, which holds of IC12-2 low through diode CR26. At the same time, IC9/A forces inverter IC6/F to place a logic high at IC7/A-4. This shuts down the trip output circuit, because a logic high at any input of IC7/A inhibits the passage of a trip signal.

6. A logic high will also be present at IC9/D-12 (if the jumper was set to Position G/T).

b. Loss Of Trip Signal. In order to prevent false trips, the RFL 67 LOGIC module will not accept trip signals as valid unless they are at least 5.4 ms long. This makes the RFL 6745 system immune to spurious noise that may conform to the pattern of a trip signal.

To accomplish this, the trip signal represented by a logic high at IC7/A-6 will not be transmitted to IC8/A-2 until the pre-trip timer (capacitor C1 and resistor R33) has charged to a voltage higher than the reference voltage on IC8/A-3; this takes about 5.4 ms.

If the T-G/T jumper was placed in Position G/T, each trip signal must be preceded by a valid guard. If the jumper is in Position T, only the first trip signal has to be preceded by a valid guard; should the trip signal be lost as a result of carrier failure or line disturbances, the equipment will return to trip status when the trip signal returns, without requiring a guard signal first.

If the system has been placed in a block mode by the absence of guard and trip signals, and short bursts of guard are received that are shorter than the time constant of the restore timer, the system will not be prepared to receive another trip. Only a guard signal that lasts longer than the time constant of the restore timer can clear the block.

For terminals using trip boost or trip boost with flasher, the T/G-T jumper must be in Position T. If it isn't and the trip signal has been absent long enough to place the terminal in a block mode, the reappearance of a valid low-level trip signal will not cause a trip. This is because flip-flops IC10/C and IC10/D have changed states, blocking the low-level trip path. If this happens, a high-level trip signal will then have to be received for a long enough period of time to reset the flip-flops.

c. Trip Too Late After Guard. Condition (1) above states that if guard is lost for 100 ms or more, a logic high will be present at IC7/A-4, resulting in a block. This causes a block at IC12-2, which means that if a guard signal has not been present within the 100 ms period just prior to the arrival of the trip signal, no trip can occur.

d. Signal Level Out-Of-Limit. Signal detectors in the wideband receivers (Section 7) constantly monitor the received signal level. If either subchannel rises above or falls below the established limits, a logic high will appear at the logic module (edge connector terminal 21 for Subchannel A, and terminal Y for Subchannel B). A logic high at either point will produce a logic high at IC11/A-5, which will cause block timer capacitor C5 to discharge through resistor R31. If either subchannel is out-of-limits for 100 ms or more, the voltage across C5 will drop below the reference voltage on IC17/A-3; this will initiate a block condition.

e. High- And Low-Limit Noise. In order for the logic module to respond to the out-of-limit signal levels discussed in Condition (4) above, they must last for a period of time determined by the AGC circuit in the wideband receiver (Section 7). To protect against short bursts of noise, the four AM window detectors on the logic module monitor the incoming signal levels. The outputs of these detectors change state when their reference levels are crossed. The four possibilities of high-limit and low-limit noise are collected in IC5/A, where any noise signal appears as a logic high at IC5/A-3. This places a block at IC7/A.

f. High-Limit Noise. Noise signals exceeding the predetermined high limit are collected at IC4/B and appear as a block at the input of IC7/B. From there, they cause a logic high at the input of IC9,B. This quickly charges capacitor C6 through diode CR11, which passes a block condition to the input of IC11/A.

When the noise disappears, this block will continue for about 20 ms, while C6 discharges through resistor R50. For non-boost systems, this same action will occur with high- and low-limit noise signals at IC7/B-8. In

all systems, a valid guard signal must be present at IC7/B-1 for 20 ms before block is released by the discharge of C6.

g. Block Input For Delayed Response. Block signals generated elsewhere in the RFL 6745 system are fed into the logic module at edge connector terminal 13. Logic highs applied to this terminal will be delayed by the block timer (capacitor C5 and resistor R31) for about 100 ms, and then the system will be blocked.

h. Block Input For Fast Response. If the logic module is to respond to block signals without any delay, they are applied to edge connector terminal A. Logic highs at this terminal bypass the block timer and are fed to the input of the restore timer.

If two logic modules are used in the system, the block output of the second module (edge connector terminal 11) is connected to terminal A on the first module.

i. Noise Block Input. When the RFL 6745 system is equipped with either a narrowband receiver or a diagnostic module, a block signal representing noise is applied to edge connector terminal 22 and delivered to the input of IC9/A. The trip circuit will respond to this block input the same way it does to a block generated on the logic module itself.

j. Block Input. Edge connector terminal 14 (BLOCK IN) is provided as a block input from a diagnostic module, although it can accept block inputs from other sources.

k. Block And Alarm Circuit. If a block condition exists for two seconds or more, the logic high at IC17/B-7 will appear at IC18/B-6, because capacitor C9 discharges through resistor R69. A low is produced at the output of IC18/B, which lights ALARM indicator DS4 and removes the base current that was supplied to transistor Q8 through IC6/D. Alarm relay K2 on the relay module will release its contacts, initiating an alarm.

l. Undervoltage Protection. Provisions are made to inhibit the output of a trip signal and to establish a block and alarm condition when the voltage produced by either regulated supply in the dc-dc converter (Section 11) falls below 9.8 volts.

Transistors Q3 through Q6 form a voltage monitor circuit, along with their associated components. The collector of Q6 supplies emitter drive current for trip output transistors Q1 and Q2, block output transistor Q7, and alarm output transistor Q8. If Q6 is turned off, none of the output transistors will produce an output signal.

Q3 monitors the +12-volt supply line. As long as this supply line is higher than +9.8 volts (9.1 volts across Zener diode CR21 plus 0.7 volts base-emitter voltage in Q3), Q3 will be saturated. This will hold the base of Q5 at about zero volts through the divider formed from resistors R98 and R100. Q4 monitors the -12-volt line in the same way, holding the emitter supply of Q5 at about -11.8 volts if the supply line is more negative than -9.8 volts (9.1 volts across Zener diode CR22 plus 0.7 volts base-emitter voltage in Q4). As long as both supply lines are above the 9.8-volt limit, Q5 will be conducting, Q6 will be forward-biased and saturated, and the output transistors will be furnished with a supply voltage of 9.8 volts or more. This assures system dependability.

If either power supply falls below the 9.8-volt limit, Q5 will turn off. This will cut off Q6 and remove supply voltage from the output transistors.

9.3.4.4. Voltage Reference

Operational amplifier IC18/A is connected as a voltage follower. Its input (IC18/A-3) is set to about +6 volts by a voltage divider formed from resistors R102 and R103. Its output (IC18/A-1) provides a +6-volt output with very low source impedance. This output is used as a reference voltage by many of the voltage comparators on the logic module.

9.3.4.5. Trip Boost Operation

Up to this point, the discussion of logic module operation has been based on a system without trip boost. The following describes the changes that take place when trip boost is added.

The amount and duration of trip boost are determined by plug-in networks on the logic module and the transmitter module (Section 6). Any amount of boost can be used, although increases beyond 12 dB are not recommended. When telephone circuits are used, other amplitude and time limitations apply; contact the factory for further information.

For this discussion, it is assumed that a 12-dB boost of 70 ms duration has been selected. Resistor network 41037-3 has been installed for RZ16, which provides the following:

1. Resistor R4 (between RZ16-4 and RZ16-5) is not installed. This opens the line from the AM window detector output to the pulse stretcher input, enabling trip boost.

2. Resistors R7 (between RZ16-2 and RZ16-7) and R8 (between RZ16-10 and RZ16-15) provide a reference voltage of -0.375 volts to the guard detectors.

3. Resistors R5 (between RZ16-9 and RZ16-14) and R6 (between RZ16-11 and RZ16-16) provide a reference voltage of +0.375 volts to the low-level trip detectors.

4. Resistors R2 (between RZ16-1 and RZ16-6) and R3 (between RZ16-3 and RZ16-8) provide an AGC reference voltage of 1.0 volts. This reference voltage is sent to the wideband receiver modules (Section 7), to set the signal levels that will be delivered to the logic module.

The incoming AM signals will be at 1 volt, as determined by the AGC reference voltage. Because the reference voltages for the AM window detectors have not been changed, a block will be present at IC7/A. This is because the 1-volt signals are below the low-level limit of 3.0 volts. With R4 omitted from network RZ16, this block is not delivered to IC7/B, and guard is not blocked. AM BLOCK indicator DS1 will be lit, and will remain lit in a boosted system except during periods of trip boost.

The FS input signals for both subchannels, which were just above 1.5 volts during non-boost operation, are now about 0.7 volts. Because the reference voltages to the detectors were changed by RZ16, the FS detectors will still function as before, and all protective features will be operational.

When the boosted trip signal arrives, the AM signal will rise to about 4 volts, removing the block signal at IC7/A. The boosted FS trip signal at high-level detector IC3 will be processed the same way it was in a non-boost system. At the same time, the trip output signal from the low-level detectors passed through the trip sequence timer, to the input of IC8/B, and causes a logic high at IC10/B-6. IC10/B-5 will be at a logic high because of the loss of guard. These combine for a logic low at IC10/B-4, which is passed to IC10/A-2.

IC10/A-1 is low, because of the high-level trip signal; IC10/A-3 will go high. At the end of the boost period, the AM detectors will return to block, canceling the signal from the high-level detectors and placing a logic high at IC10/A-1. The low-level trip signal is still present, so the trip output signal from IC10/A will continue as long as a trip signal is present at the input, even though it is at a low level. However, a high-level trip signal will be required to initiate the next trip.

Table 9-1. Replaceable parts, RFL 67 LOGIC Standard-Range Logic Module
Assembly No. 41020

Circuit Symbol (Fig. 9-3)	Description	Part Number
	CAPACITORS	
C1	Capacitor,polyester,0.047µF,2%,100V,Wesco 32P or equiv.	5115 67
C2,3	Capacitor,polyester,0.033µF,2%,100V,Wesco 32P or equiv.	5115 59
C4	Capacitor,polyester,0.1µF,2%,100V,Wesco 32P or equiv.	5115 83
C5,7	Capacitor,tantalum,1µF,10%,35V,Kemet T110A105K035AS or equiv.	1007 1156
C6	Capacitor,polyester,0.056µF,2%,100V,Wesco 32P or equiv.	5115 71
C8	Capacitor,metallized polycarbonate,0.1µF,2%,50V,Wesco 32MPC or equiv.	1007 1476
C9,11,12	Capacitor,tantalum,15µF,20%,20V,Kemet T322D156M020AS or equiv.	1007 716
C10	Capacitor,tantalum,0.33µF,20%,35V,Kemet T322A334M035AS or equiv.	1007 871
C13	Capacitor,tantalum,3.3µF,20%,35V,Kemet T322C335M035AS or equiv.	1007 1260
	RESISTORS	
R1	Resistor,metal film,1.33KΩ,1%,1/4W, Type RN1/4	0410 1300
R2,4,10,32,35,51,58, 83,91,94,96,97, 99,101	Resistor,metal film,1KΩ,1%,1/4W, Type RN1/4	0410 1288
R3	Resistor,metal film,3.01KΩ,1%,1/4W, Type RN1/4	0410 1334
R5-8,11,13,15-18,20, 22,24,26,34,36,40, 43-45,47,52-55,59, 60,65,71,72,74-76, 85,86,92,98,100, 109-112,115	Resistor,metal film,10KΩ,1%,1/4W, Type RN1/4	0410 1384
R9	Resistor,metal film,6.98KΩ,1%,1/4W, Type RN1/4	0410 1369
R12,14,19,21,23,25, 27-30,49,62,63, 73,77,88	Resistor,metal film,47.5KΩ,1%,1/4W, Type RN1/4	0410 1449
R31,57	Resistor,metal film,137KΩ,1%,1/4W, Type RN1/4	0410 1493
R33	Resistor,metal film,154KΩ,1%,1/4W, Type RN1/4	0410 1498
R37,42,46,56,61,67,79	Resistor,metal film,1.0MΩ,1%,1/4W, Type RN1/4	0410 1576
R38,64,68,80-82,90	Resistor,metal film,2.21KΩ,1%,1/4W, Type RN1/4	0410 1321
R39,48	Resistor,metal film,402KΩ,1%,1/4W, Type RN1/4	0410 1538
R41	Resistor,metal film,150KΩ,1%,1/4W, Type RN1/4	0410 1497
R50	Resistor,metal film,332KΩ,1%,1/4W, Type RN1/4	0410 1530
R66	Resistor,metal film,221KΩ,1%,1/4W, Type RN1/4	0410 1513
R69	Resistor,metal film,226KΩ,1%,1/4W, Type RN1/4	0410 1514
R70	Resistor,metal film,4.75KΩ,1%,1/4W, Type RN1/4	0410 1353
R78	Resistor,metal film,825Ω,1%,1/4W, Type RN1/4	0410 1280
R84	Resistor,metal film,factory-selected value	Contact factory
R87	Resistor,metal film,61.9KΩ,1%,1/4W, Type RN1/4	0410 1460
R89	Resistor,metal film,4.02KΩ,1%,1/4W, Type RN1/4	0410 1346
R93,113	Resistor,metal film,475Ω,1%,1/4W, Type RN1/4	0410 1257
R95	Resistor,metal film,3.32KΩ,1%,1/4W, Type RN1/4	0410 1338

Table 9-1. Replaceable parts, RFL 67 LOGIC Standard-Range Logic Module - continued.

Circuit Symbol (Fig. 9-3)	Description	Part Number
	RESISTORS - continued.	
R102,103	Resistor,metal film,4.99KΩ,1%,1/4W, Type RN1/4	0410 1355
R104	Resistor,metal film,4.75KΩ,1%,1/2W, Type RN1/2	0410 2353
R105-107	Resistor,metal film,47.5Ω,1%,1/2W, Type RN1/2	0410 2161
R108,117	Resistor,metal film,1.82KΩ,1%,1/4W, Type RN1/4	0410 1313
R116	Resistor,metal film,14.3KΩ,1%,1/4W, Type RN1/4	0410 1399
RZ1-15	Not used.	
RZ16	Resistor network with values determined by desired input levels. (See Section 3.)	
	SEMICONDUCTORS	
CR1-20,23-30	Diode,silicon,1N914B or 1N4448	26482
CR21,22	Diode,Zener,9.1V,5%,400mW,1N960B	41014
DS1-5	Light-emitting diode,red,Dialight 550-0102 or equiv.	39568
IC1-3,8,13-15,17,18	Linear operational amplifier,dual,8-pin DIP,Texas Instruments MC1458P or equiv.	0620 51
IC4,9	MOS quad 2-input NOR gate,14-pin DIP,RCA CD4001BE or equiv.	0615 3
IC5,10	MOS quad 2-input NAND gate,14-pin DIP,RCA CD4011BE or equiv.	0615 5
IC6	MOS hex inverter/buffer,16-pin DIP,RCA CD4049AE or equiv.	0615 7
IC7,11	MOS triple 3-input NOR gate,14-pin DIP,RCA CD4025BE or equiv.	0615 20
IC12	Linear operational amplifier,8-pin DIP,National Semiconductor LM741CN or equiv.	0620 52
Q1,6-8	Transistor,PNP,plastic package,2N2907A	37439
Q2,4,5	Transistor,NPN,plastic package,2N2222A	37445
Q3	Transistor,PNP,TO-106 case,2N4249	41919
	MISCELLANEOUS COMPONENTS	
. . .	Shorting bar,single,Molex 90059-0009 or equiv.	98306

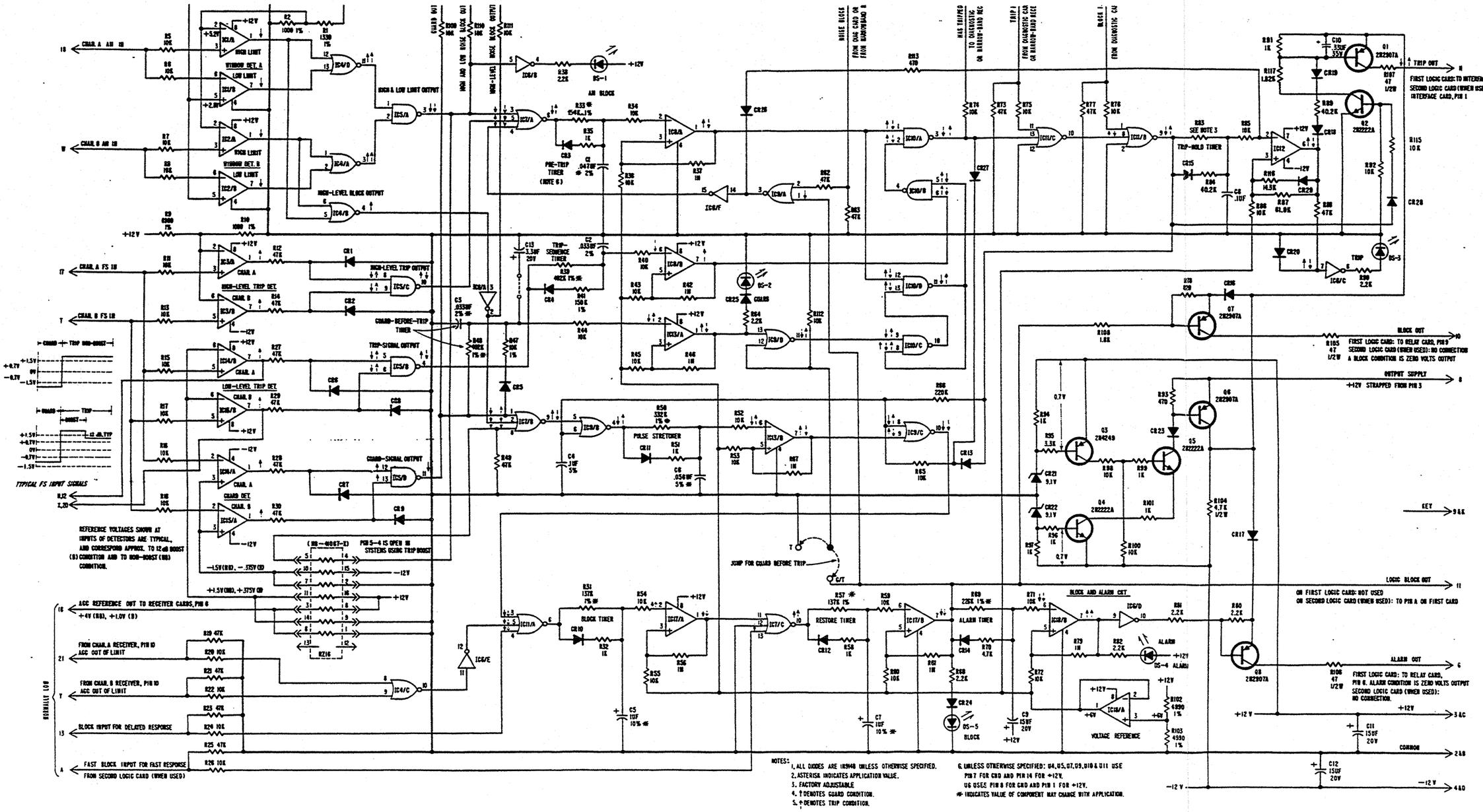


Figure 9-3. Schematic, RFL 67 LOGIC Standard-Range Logic Module (Assembly No. 41020; Schematic No. E-41022-1, Rev. L)

9.4. RFL 67A LOGIC WIDE-DYNAMIC-RANGE LOGIC MODULE

9.4.1. Description

The RFL 67A LOGIC Wide-Dynamic-Range Logic Module (shown in Figure 9-4) is characterized by its ability to perform its logic functions while accepting instantaneous signal changes of varying amplitude or with large amounts of noise.

9.4.2. Differences Between Models

There are two different RFL 67A LOGIC modules: the basic RFL 67A LOGIC module, and the RFL 67A LOGIC-1, which is used when more than one digital module is required. The differences between these modules are summarized in Table 9-1.

Table 9-2. Differences between wide-dynamic-range logic modules

Model Number	Digital Circuit Board 47010	Analog Circuit Board 47015	Interconnect Circuit Board 47020	Use
67A LOGIC	X	X	...	Main logic module
67A LOGIC-1	X	...	X	Redundant logic module

9.4.3. Functions

The following is a list of some of the functions that RFL 67A LOGIC and RFL 67A LOGIC-1 modules can perform. Additional functions may also be possible; contact the factory for further information.

1. True guard and trip outputs.
2. Individual guard and trip outputs for each sub-channel (two digital circuit boards required).
3. Guard return negates trip-hold timer.
4. Individual pre-trip and pre-guard timers.
5. True guard-before-trip timer.
6. True trip-after-guard timer.
7. Individual block timer.
8. Individual restore timer.
9. Guard-before-trip requirement on first trip only.
10. Component redundancy (two digital circuit boards required).
11. Combination of direct and permissive tripping functions in the same system (two digital circuit boards required).

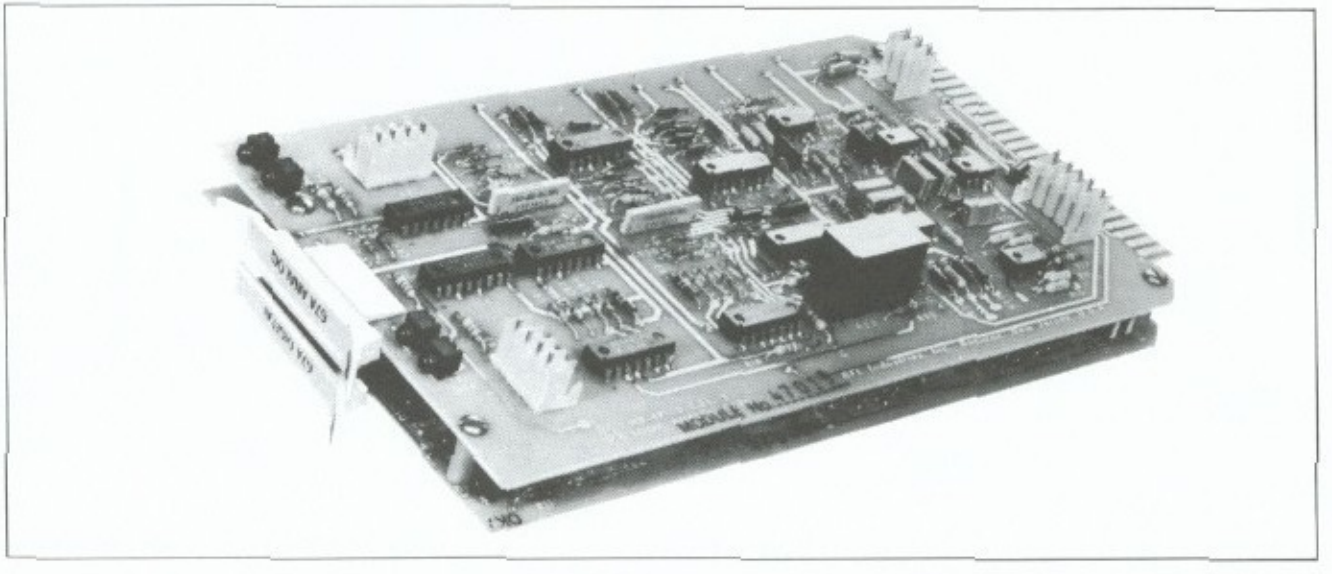


Figure 9-4. RFL 67A LOGIC Wide-Dynamic-Range Logic Module

12. Component redundancy with combination of direct and permissive tripping functions in the same system (two digital circuit boards required).

13. Out-of-limit detection in individual subchannels (two analog circuit boards required).

14. Plug-in network to accommodate signals of different dynamic range from different communication media, such as phone lines, microwave circuits, powerline carrier systems, and systems using trip boost.

15. Will accommodate trip boost and flasher.

16. In unblocking systems, a loss of carrier will produce a trip condition.

17. In unblocking systems, the trip can be removed after loss of carrier for a period of 100 ms.

18. Will accommodate instantaneous signal level shifts within a 30-dB dynamic range.

19. Provides logic output for uniflex transfer trip systems.

9.4.4. Specifications

As of the date this manual was published, the following specifications apply to all RFL 67A LOGIC and RFL 67A LOGIC-1 Wide-Dynamic-Range Logic Modules; any exceptions are noted. Because all RFL products undergo constant refinement and improvement, these specifications are subject to change without notice.

Inputs:

Digital Circuit Board: All inputs are high-impedance digital CMOS circuits.

Analog Circuit Board: All inputs are taken from the RFL 67 FS/AM Detector Module (Section 8).

Outputs: Transistors are provided on digital circuit board for driving relays for trip, guard, block, and alarm signals. CMOS logic outputs are also provided for these and all other outputs.

Security: Less than one false trip in 40,000 noise bursts, with a signal-to-noise ratio of -16 dB. S/N ratios greater or less than -16 dB will result in increased security.

Dependability: About 2 dB less than the RFL 67 LOGIC, with no variation in signal level. During a shift in level, dependability is superior.

Redundancy: Obtained by using an additional digital circuit board.

Options:

Plug-In Network: Selected at time of purchase to match requirements of communication medium. (See Section 3.)

Trip-Hold Timer Time Constant: May be specified at time of purchase; a time constant of zero is standard.

Trip Hold/Hold Off Time Constant: May be specified at time of purchase; a time constant of zero is standard.

All Other Options: Selected by jumper placement. (See Section 3.)

Operating Temperature: -30°C to +60°C (-22°F to +140°F).

Power Requirements:

Digital Circuit board:
+12-volt Supply: 135 mA.
-12-volt Supply: 25 mA.

Analog Circuit board:
+12-volt Supply: 45 mA.
-12-volt Supply: 45 mA.

Dimensions:

Height: 4.713 inches (12 cm).
Depth: 8.00 inches (20.3 cm).
Width: 1.5 inch (3.81 cm); requires two module spaces in chassis.

9.4.5. Timing Circuits

There are thirteen timing circuits used on the RFL 67A LOGIC module to perform many critical functions. The security and dependability of the systems depends in part on these circuits, and changes in their periods can have a significant effect on system performance. Before making any timing changes, always consider the effect the changes will have on the operation of the entire system.

The thirteen timing circuits are described below. The resistor and capacitor that control each timer are identified, and the standard time period for each circuit is given. Some of the periods are subject to change to adapt the RFL 67A LOGIC module to the requirements of a specific application.

a. Pre-Trip Timer (C11/R74, 5.4 ms). This timer requires that a trip signal be present for at least 5.4 ms before any further action will be taken.

b. Trip Hold/Hold Off Timer (C6/R53/R54). This timer circuit performs two functions. C6 and R53 work together to sustain a trip output signal for a specific period of time after the trip input signal has been removed. The trip hold timer can be overridden by the presence of guard signal if jumper 9 is placed in Position A. The standard period for this timer is zero, but it can be set to any required period by selecting values for R53 and C6.

c. Pre-Guard Timer (C10/R69, 5.4 ms). This timer requires that a guard signal be present for at least 5.4 ms before any further action will be taken.

d. Guard-Before-Trip (G/T) Timer (C7/R61, 20 ms). This timer requires that a valid guard signal be present for at least 20 ms before a trip signal is received in order for the trip signal to be accepted.

e. Trip-After-Guard (T/G) Timer (C7/R58, 100 ms). This timer requires that a trip signal be detected no later than 100 ms after the loss of a guard signal; if the guard signal is not detected, the trip signal will not be accepted.

f. Bipolar Noise Detector Timer (C9/R64, 20 ms). This timer requires that when an incorrect transition from guard to trip occurs (which may happen due to excessive noise), the system will not try to pass a trip signal for at least 20 ms.

g. Guard-Before-Trip Restore Timer (C12/R78, 300 ms). When jumper 7 is in Position A and guard is present and lasts for 300 ms or more, this timer requires that guard must precede the next trip signal.

h. Guard-Before-Trip Disable Timer (C13/R79, 300 ms). When jumper 7 is in Position A and a trip signal is present and lasts for 300 ms or more before it is momentarily interrupted, this timer allows the trip to be accepted upon its return without having to accept a guard signal first.

i. Pulse Stretcher Timer (C15/R81, 20 ms). This timer converts short block pulses such as noise blocks or level-too-high indications to pulses that are 20 ms wide.

j. Pulse Stretcher Restore Timer (C14/R75, 15 ms). This timer resets the pulse stretcher timer (above) after the trip signal has ceased to exist for 15 ms or more.

k. Block Timer (C3/R4, 100 ms). After a block condition has continued for 100 ms, this timer will establish a hard block condition, which can only be removed by the restore timer (below).

l. Restore Timer (C3/R6, 100 ms). This timer holds the system in a block mode for 100 ms after a block condition is corrected before it will remove the hard block generated by the block timer (above).

m. Alarm Timer (C4/R14, 2 seconds). An alarm condition will be announced after a hard block exists for more than 2 seconds. The alarm is canceled when the restore timer (above) times out.

9.4.6. Applications

RFL 67A LOGIC module and RFL 67A LOGIC-1 modules are capable of operation in many different operating modes. Four basic applications are described below, and illustrated in Figures 9-5 through 9-8; contact the factory for information on other applications.

a. Permissive Or Direct Transfer Trip. Figure 9-5 shows a block diagram for a permissive or direct transfer trip application with no component redundancy. The trip output of the RFL 67A LOGIC module drives the interface module. Tables within Figure 9-5 show how the jumpers on the analog and digital circuit boards must be placed for this application.

b. Direct Transfer-Trip System With Redundancy. Figure 9-6 shows a block diagram for a direct transfer-trip application with component redundancy. The component redundancy is achieved by using two logic modules: a RFL 67 LOGIC and a RFL 67 LOGIC-1. A second trip output circuit is added to the interface module; this circuit is driven by the RFL 67A LOGIC-1 module.

The tables in Figure 9-6 show the jumper placements required to operate this system over a telephone line. Different settings may be required by different communication media. Jumper placement is similar to the system shown in Figure 9-5, except that jumper 13 must be in Position B on the first logic module.

c. Dual-Function System. In a direct transfer trip system, both subchannels are required to change from a guard to a trip condition. In a permissive transfer-trip system, only one subchannel has to change. In a dual-function system, both subchannels must change for a direct transfer trip, while only Subchannel B is required for a permissive transfer trip.

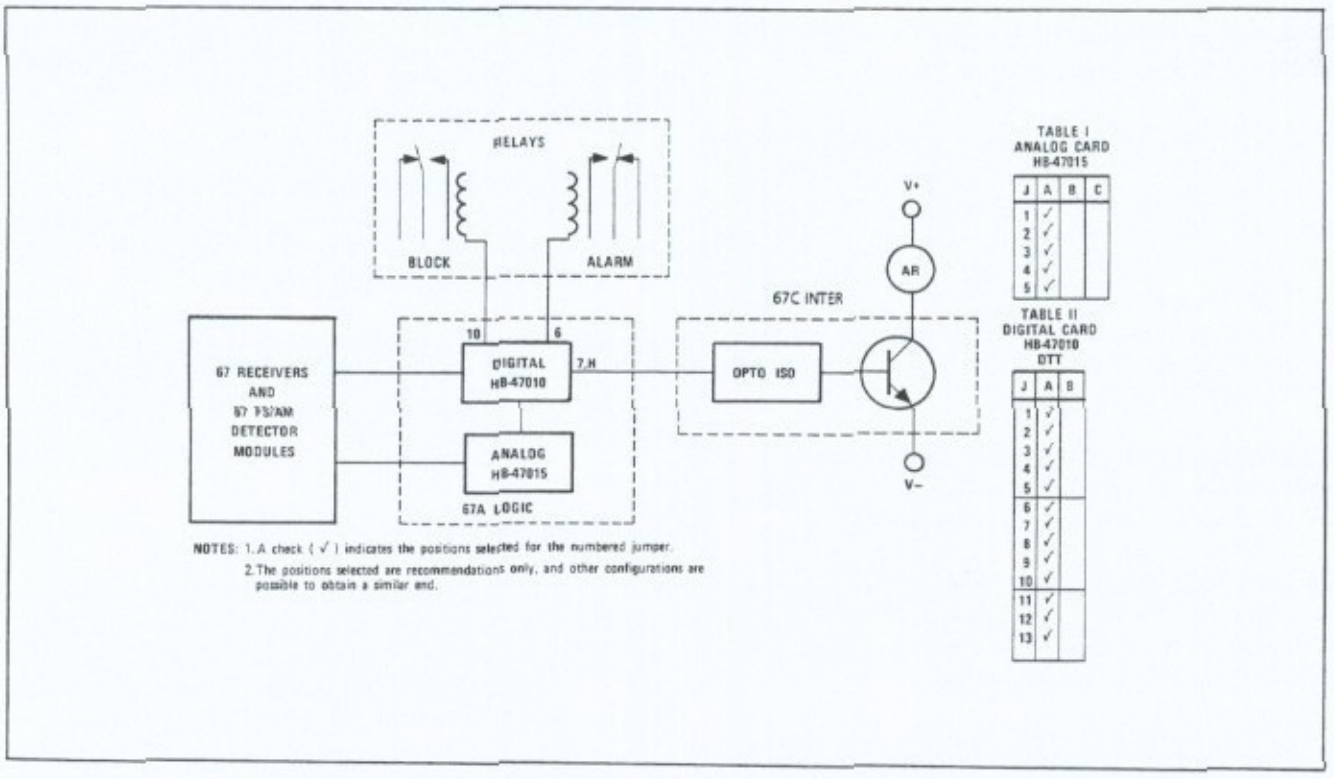


Figure 9-5. Use of the RFL 67A LOGIC in permissive or direct transfer trip applications

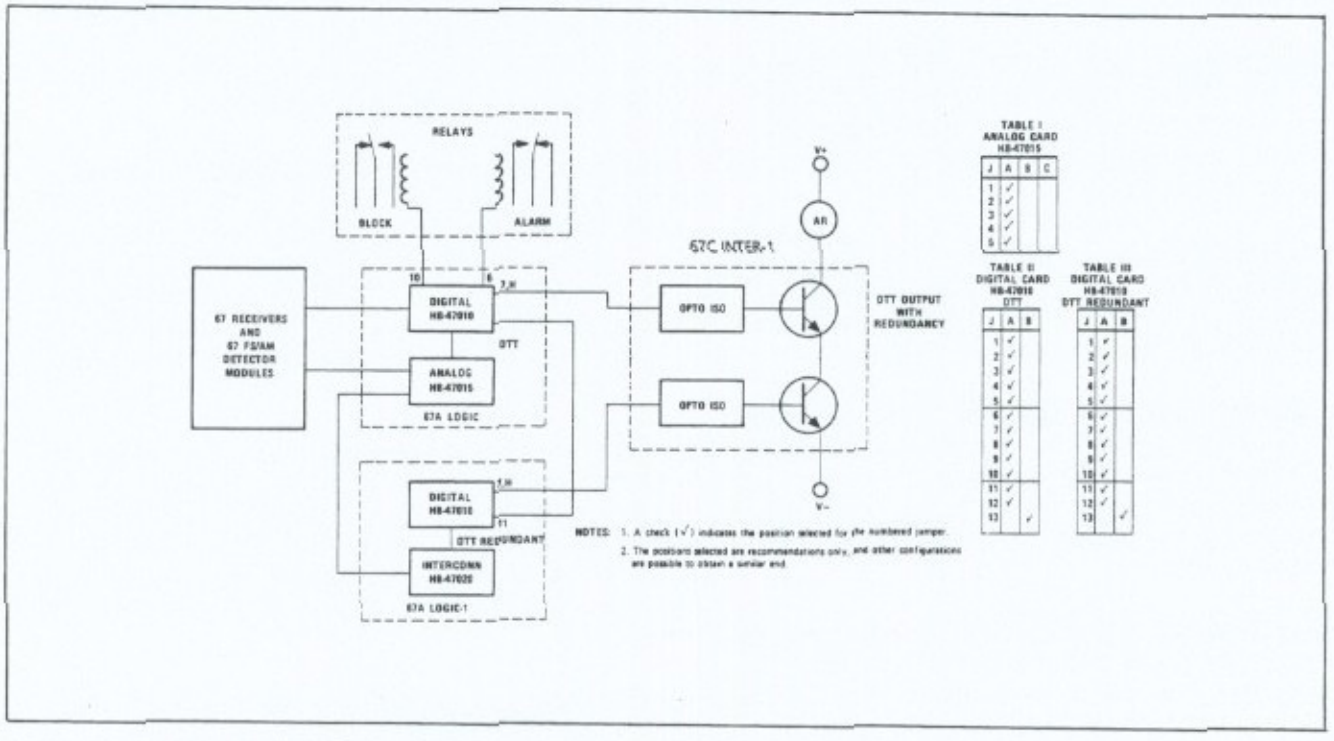


Figure 9-6. Use of the RFL 67A LOGIC and RFL 67A LOGIC-1 in direct transfer applications trip with component redundancy

Figure 9-7 shows a block diagram for a dual-function system, incorporating both direct transfer trip (DTT) and permissive transfer trip (PTT). The direct transfer trip portion of this system is similar to the system shown in Figure 9-5, with a slight change in jumper placement. A RFL 67A LOGIC-1 logic module is used for the permissive trip function.

Tables in Figure 9-7 show how the jumpers on both logic modules are to be set. Block and alarm relays are shown as being driven by the DTT logic module. By using this connection method, the same relays can be used to indicate failure in both the DTT and the PTT portions of the system.

If desired, a second set of relays can be driven by the PTT logic module to indicate a failure in the PTT portion of the system only.

When a PTT condition is detected, the trip output transistor on the PTT logic module will conduct and provide an output at terminals 3 and 4 of terminal block TB3 on the rear of the chassis. If a DTT condition were to follow, the trip output transistor on the DTT logic module would provide an output at terminals 1 and 2 of TB3 and terminals 3 and 4 would open. Should it be required that the DTT condition not override the PTT condition and that a contact closure appear at the PTT contacts when a DTT condition occurs, jumper 13 on the DTT logic module must be placed in Position B.

d. Redundant Dual-Function System. Figure 9-8 shows a block diagram for a dual-function system with component redundancy. The difference between this system and the dual-function system in Figure 9-7 is the addition of another DTT logic module and another trip output circuit. The two DTT logic modules perform the same function, and each one drives a separate trip output circuit on the logic module (Section 5). The trip output circuits may be connected independently, or they may be wired in series.

The block output circuit on the redundant DTT logic module is connected to the block input of the first DTT logic module, so that a block generated on the redundant module will drive the block and alarm relays connected to the first module. The LOGIC BLOCK OUTPUT of the redundant module (edge connector terminal 11) is connected to the FAST BLOCK INPUT (terminal A) of the first module. Jumper 3 and edge connector terminal S on the first DTT logic module determine whether DTT action will override PTT action.

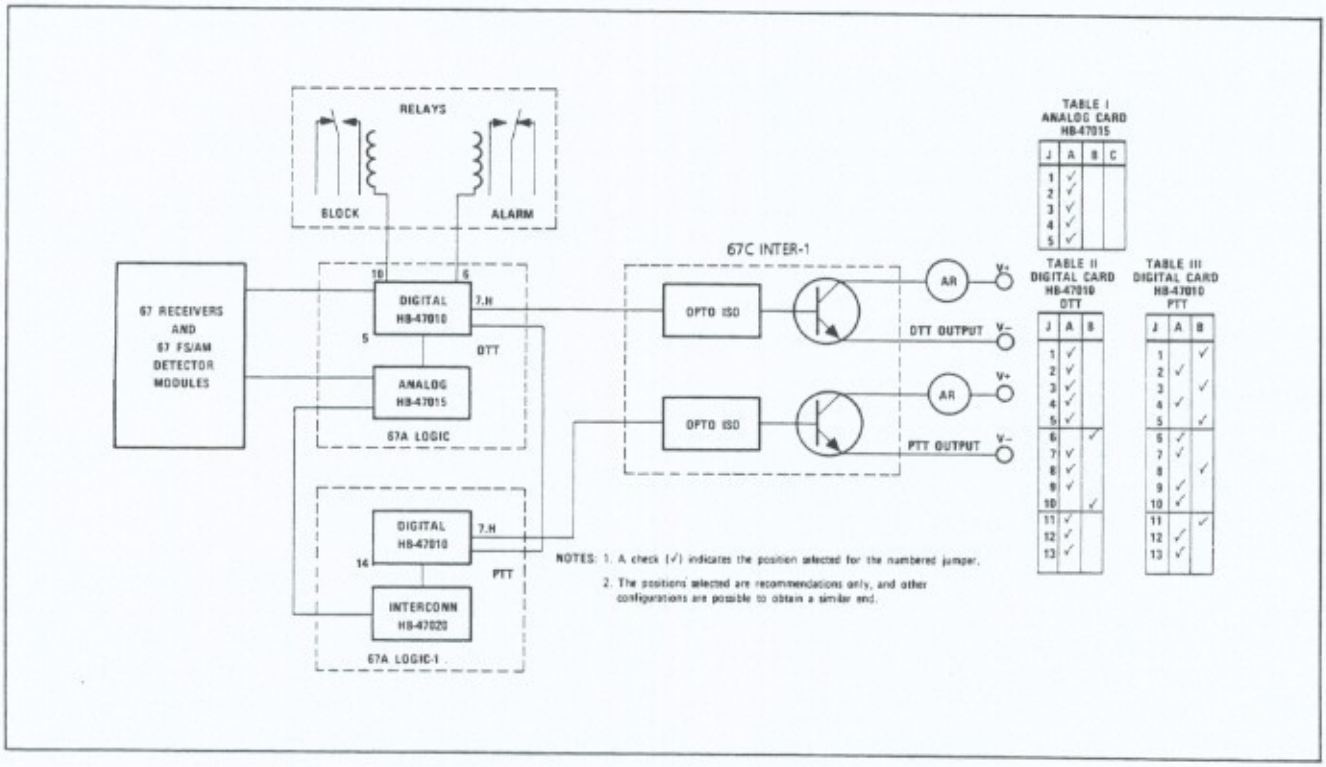


Figure 9-7. Use of the RFL 67A LOGIC and RFL 67A LOGIC-1 in dual-function systems (direct and permissive trip)

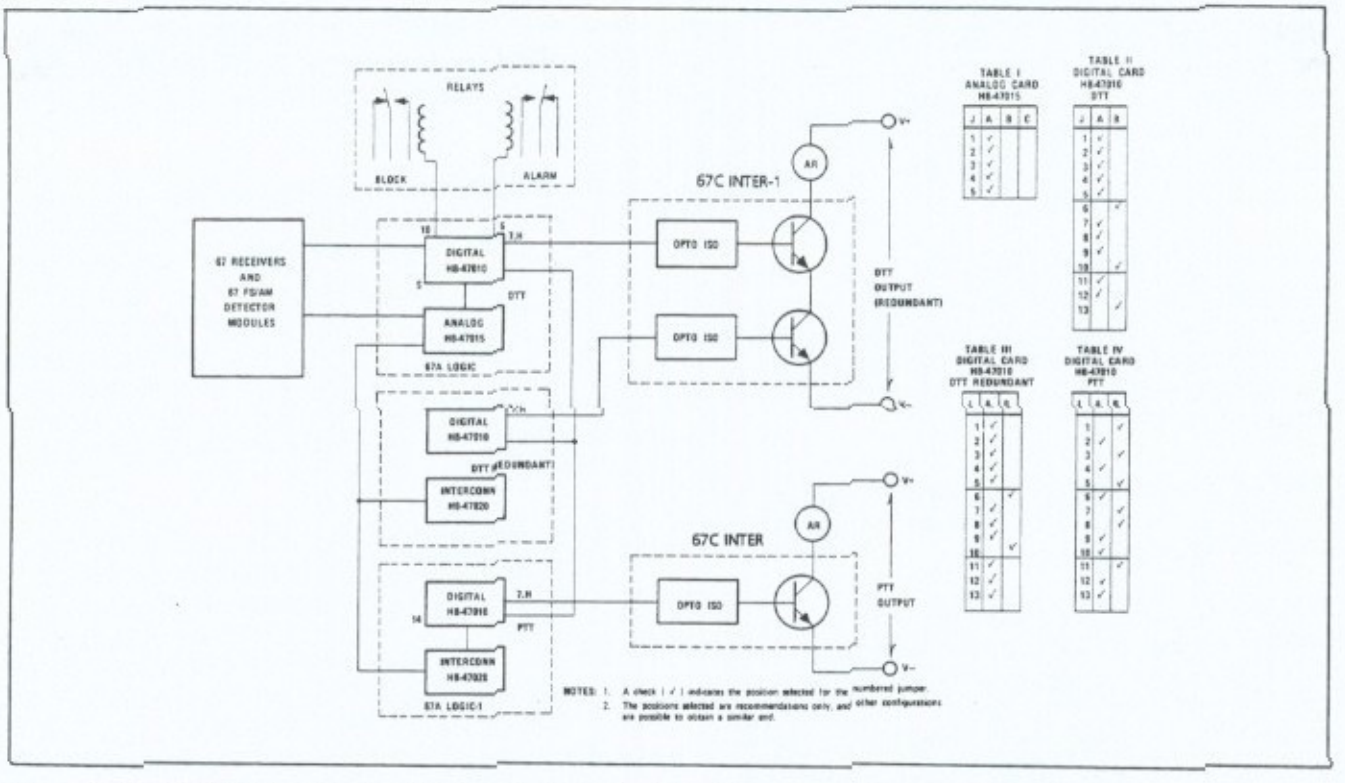


Figure 9-8. Use of the RFL 67A LOGIC and RFL 67A LOGIC-1 in dual-function systems with component redundancy for the direct transfer trip

9.4.7. Theory Of Operation

The RFL 67A LOGIC and RFL 67A LOGIC-1 Wide-Dynamic-Range Logic Modules both contain a digital circuit board. The RFL 67A LOGIC module also contains an analog circuit board; the RFL 67A LOGIC-1 module contains an interconnect circuit board, which takes the place of the analog circuit board.

9.4.7.1. Digital Circuit Board

The digital circuit board has three main circuits: a trip detection circuit, a guard detection circuit, and a blocking circuit. These main circuits are supported by many subcircuits (such as timers) which serve to qualify or evaluate operating conditions. A logic diagram for the digital circuit board appears in Figure 9-10.

a. Timers. Thirteen timers are used on the digital circuit board to time events or inhibit the action of particular circuits until a predetermined period of time has elapsed. The specific functions of the timers are discussed in paragraph 9.4.5. A typical timer is shown in Figure 9-9.

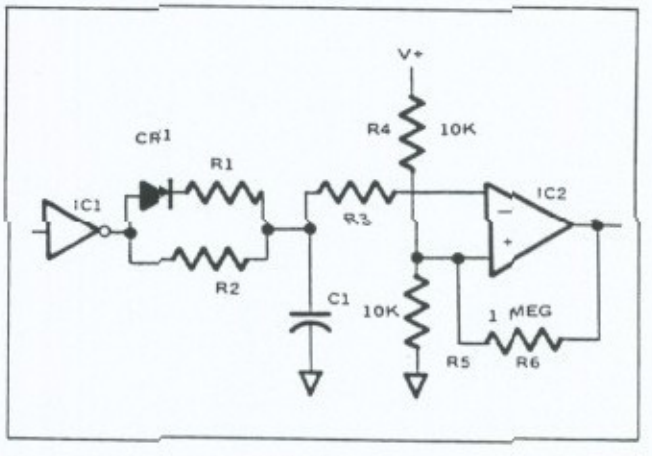


Figure 9-9. Schematic of typical timer

The input to inverter IC1 in Figure 9-9 is normally a logic low, so its output is high, capacitor C1 is charged, and the output of operational amplifier IC2 is a logic low. As soon as the input to IC1 goes high, its output goes low and C1 begins to discharge through resistor R2. When the voltage across C1 drops below the threshold level set for IC2 by resistors R4 and R5, the output of IC2 will go high.

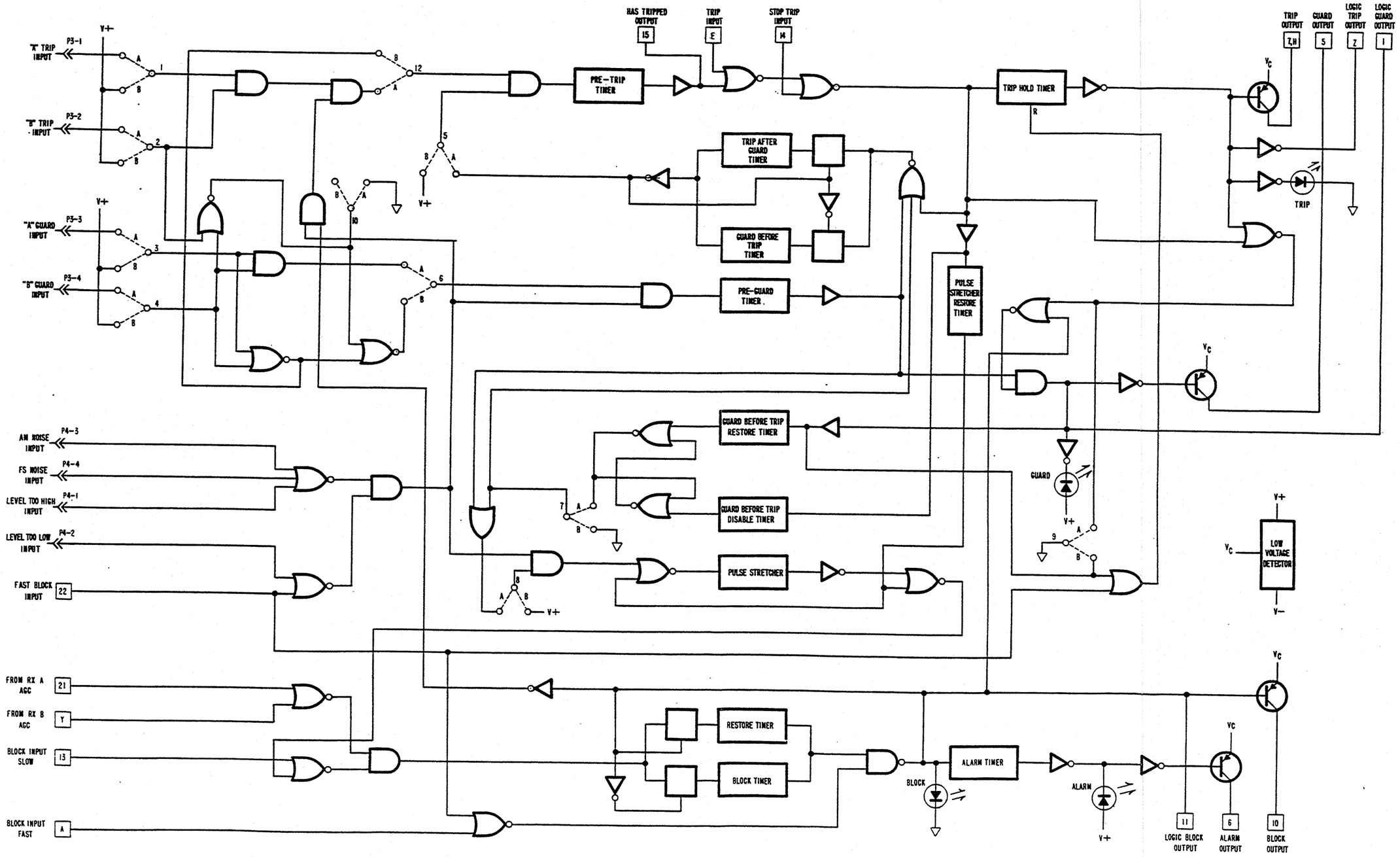


Figure 9-10. Logic diagram, digital circuit board for RFL 67A LOGIC and RFL 67A LOGIC-1 Wide-Dynamic-Range Logic Modules (Assembly No. 47010; Drawing No. E-47011, Rev. B)

If the input of IC1 should go low again at any point in the timing interval, C1 will be quickly recharged through resistor R1 and diode CR1. This will reset the timer.

b. Trip Detector Circuit. The trip detector circuit, as its name implies, monitors the trip outputs from the analog circuit board and produces an output signal if the trip is valid.

In order to simplify the discussion of the trip detector circuit, it is assumed that no blocks are being generated, the cathode of diode CR15 is high (enabling a trip output), jumpers 1, 2, and 12 have been placed in Position A, and jumpers 5 and 11 have been placed in Position B.

The trip signals received from the analog circuit board through connectors P3-1 and P3-2 are at a logic high when a trip signal has been detected. These are fed to AND gate IC12B, which will produce a logic high at its output (IC12B-4). This high is passed through AND gates IC12A, IC16A, and IC16B, where it is combined with other signals and timer outputs.

The pre-trip timer requires that a logic high be present at IC16B-4 for at least 5.4 ms before IC8C-8 can go low. This prevents the system from responding to false trips that may be caused by noise bursts. With jumpers 1 and 2 both in Position A, both subchannels must go to a trip condition and remain there for at least 5.4 ms before a trip output is created. This means that in order for noise to generate a false trip, noise bursts corresponding to the trip frequency of each subchannel must exist simultaneously and last for at least 5.4 ms. Studies have shown that the chances of these conditions occurring are very small.

From IC8C, the combined trip signal will pass through inverter IC9C and on to NOR gates IC7D and IC7C, where it is combined with TRIP INPUT and STOP TRIP INPUT signals generated elsewhere in the system. The signal at IC7C-10 drives the base of Q8 and the input of the trip hold/hold-off timer. The trip hold delay can be varied by changing the component values for capacitor C6 or resistors R53 and R54. These three components also determine the amount of trip hold. Unless other delay values were specified at the time the equipment was ordered, the components installed at the factory for this timer will result in a zero delay; trip signals will pass through neither delayed nor held.

Q7 can be turned on by either Q8 or the output of the trip hold/hold off timer; this will pull edge connector terminals 7 and H high for a trip. The path through Q8 has no delays or holds. If the cathode of diode CR15 is pulled low, any existing trip hold will be removed.

If jumper 11 was placed in Position A, the first trip signal would have to appear on both subchannels for at least 5.4 ms, and neither subchannel could return to guard during this period. If either subchannel returns to guard, the output of the bipolar noise detector (IC9B-4) will go low. This would inhibit a trip until the bipolar noise detector timer times out.

If jumper 5 is placed in Position A, the guard-before-trip and trip-after-guard timers are incorporated into the trip detection circuit. The guard-before-trip timer requires that a guard signal exist for at least 20 ms before IC8A-1 will go low, allowing a trip signal to be detected. The trip-after-guard timer requires that a trip signal be detected at IC7C within 20 ms after the guard signal is lost. If a trip signal is not received by that time, IC8A-1 will go low, inhibiting the output of AND gate IC16A.

If jumper 12 is placed in Position B, the system will enter a trip condition whenever guard is lost. This function is used in an unblocking arrangement where loss of guard is intended to cause a trip.

If jumper 1 and jumper 2 are not set identically (one in Position A and one in Position B), a trip signal will only be required on the subchannel with its jumper set to Position A.

c. Guard Detector Circuit. The guard detector circuit monitors the guard outputs from the analog circuit board and produces an output signal if the guard inputs are valid.

In order to simplify the discussion of the guard detector circuit, it is assumed that IC12C-9 is high, IC4A-1 is high, and jumpers 3, 4, 6, and 10 have been placed in Position A.

The guard signals are received from the analog circuit board through connectors P3-3 and P3-4 are at a logic high when a guard signal has been detected. These are fed to AND gate IC14C, which will produce a logic high at its output (IC14C-10). This will start the pre-guard timer. After 5.4 ms, IC8B-7 will go low.

If either guard signal goes low during the 5.4-ms timer interval, the pre-guard timer will be reset through resistor R70 and diode CR19, and the circuit will not pass a guard signal until the next time both guard inputs go high. If jumper 6 is placed in Position B, a logic high will only be required on one guard input line to start the pre-guard timer.

After the pre-guard timer times out, IC9D-10 will go high. This is passed on to AND gate IC4A. IC4A-3 drives inverter IC5F, which lights GUARD indicator DS1 to indicate that guard is present and produces the inverted guard output at edge connector terminal S. The output of IC4A also appears at edge connector terminal 1 as the logic guard output, and drives transistors Q9 and Q10 to produce the non-inverted guard output at edge connector terminals 5.

At this point, the only thing that could prevent IC4A-3 from going high and producing the guard outputs would be to have IC4A-1 held low; this could be caused by a trip being detected or by blocking action at operational amplifier IC3B that would be driving NOR gate IC7B low. If the system returns to guard from a trip while the trip hold timer is still timing out and jumper 9 is in Position B, the guard outputs would not be activated until the end of the trip hold interval. This is because the trip hold timer would drive IC4A-1 low through NOR gates IC7A and IC7B.

If jumper 9 was placed in Position A, the trip hold would have been overridden by the detected guard signals.

At the beginning of the discussion of this circuit, it was assumed that IC12C-9 was high. This would be the case when valid signals are present; IC12C-9 would go low if there is excessive noise on the AM or FS inputs, the signal level is either too high or too low, or if edge connector terminal 22 (FAST BLOCK INPUT) is driven high by an external source.

If jumper 10 had been placed in Position B, only Subchannel A has to be in the guard condition for guard to be indicated. This is useful in dual-function applications such as simultaneous DTT and PTT.

If jumper 3 and jumper 4 are not set identically (one in Position A and one in Position B), a guard signal will only be required on the subchannel with its jumper set to Position A in order for the guard detector circuit to indicate the presence of guard.

d. Blocking Conditions. There are two basic types of blocking conditions: "block" and "hard block". In a block condition, the trip output is disabled as long as the cause of the block condition persists. As soon as the cause is eliminated, the block is released. In a hard block, the block will not be released until the cause has been eliminated for 100 ms and all other conditions or qualifications have been met. Usually, if a block persists for more than 100 ms, it automatically becomes a hard block. There are two basic types of blocking systems: "direct" and "indirect".

In **direct blocking**, the cause of the block will directly activate the block timer or block the system. This can be done one of three ways:

1. By placing a logic high at edge connector terminal 13 (BLOCK INPUT FOR DELAYED RESPONSE), 21 (CHAN A AGC OUT OF LIMIT) or Y (CHAN B AGC OUT OF LIMIT). A logic high at any of these points will cause a block condition, which will become a hard block if the logic high persists for more than 100 ms.

2. By placing a logic high at edge connector terminals 22 (FAST BLOCK INPUT) or A (FAST BLOCK INPUT FROM SECOND LOGIC CARD). A logic high at either of these points will force the logic module into a hard block condition. Once hard block has been established, the logic high that caused it will have to go low for 100 ms for the restore timer to time out and remove the block condition.

3. By placing a logic high at edge connector terminal terminal 14 (STOP TRIP INPUT). This will prevent the trip detector circuit from generating a trip output, or it will terminate a trip if one is present. However, this will not put the system into a hard block condition if it is not already in trip.

Indirect blocks can be caused by any one of the following sets of conditions. Any of these abnormalities will activate the block timer, and if they persist for more than 100 ms, the system will enter a hard block condition.

1. One or more events occurring out of sequence. An example of this would be a trip signal appearing on only one subchannel, with a trip signal appearing on the other subchannel 30 ms later. By this time, the trip-after-guard timer would have timed out and prevented the later trip from being recognized.

   With the loss of the valid guard condition when both subchannels were in guard, the frequency for one subchannel shifted from guard to trip and triggered the input to the pulse stretcher. Because trip was not recognized, the pulse stretcher was never reset, so it will not function; instead, the block timer is activated.

   Once the block timer times out, it prevents tripping action by requiring that the system return to a guard state before it can go to a trip state.

2. If a specific event doesn't occur. An example of this would be the receipt of a trip signal on only one subchannel when the jumpers have been set to require a trip on both subchannels. This would result in both a loss of guard and an invalid trip. A block would be established.

3. If a specific event occurs too late. An example of this would be loss of guard, which may have been caused by loss of carrier. If this condition continues for more than 100 ms, the block timer is activated by the output of the pulse stretcher. This prevents any trip signals that may appear from being recognized.

4. If an invalid condition (such as AM or FS noise) is present for too long. The block timer will be activated, and if the invalid condition persists for more than 100 ms, the system will go into a hard block condition.

e. Bipolar Noise Detector. The bipolar noise detector prevents a trip from being detected for a predetermined period if a "double transition", which can only be caused by noise, occurs before the trip signal is received. An example of a double transition would be the system being in a guard state when a noise spike drives it into trip and then back to guard. With the system in guard, the signal will return to guard once the noise disappears. When this happens, the bipolar noise detector timer is triggered, preventing a trip from being detected until the timer times out.

When the system is in guard and a noise burst occurs, the predominant signal is a guard signal, so the system will return to guard after the noise stops. This return to guard is what triggers the bipolar noise detector timer. If a trip had occurred at the same time as the noise burst, the normal noise blocking operation would have blocked the trip until the noise stopped. Once the noise stopped, the system would go to trip, because the trip signal would be the predominant signal. The bipolar noise detector timer would not be triggered in this case, because the signal did not return to a guard state.

f. Trip Hold And Guard Override. Trip hold allows the system to remain in a trip state for a specific period of time after the trip input signal to the digital circuit board disappears. Loss of signal or a block due to excessive noise are examples of actions that may remove the trip input signal. Trip hold is desirable in some applications where a minimum trip output pulse is required. The trip hold function can be disabled by placing jumper 9 in Position A; the system would then go from trip to guard as soon as a guard signal was detected.

9.4.7.2. Analog Circuit Board

The analog circuit board accepts the inputs from the FS/AM detector module (Section 8) and converts them into digital signals that can be processed by the logic circuits on the digital circuit board. A logic diagram for the analog circuit board appears in Figure 9-12.

a. Window Detectors. A window detector is a circuit whose output changes state whenever its input signal is not within specific limits. A typical window detector is shown in Figure 9-11. Voltage dividers on its inputs set the window limits; in this case, +3 volts minimum and +6 volts maximum. As long as the input voltage is within these limits, there will be no output signal.

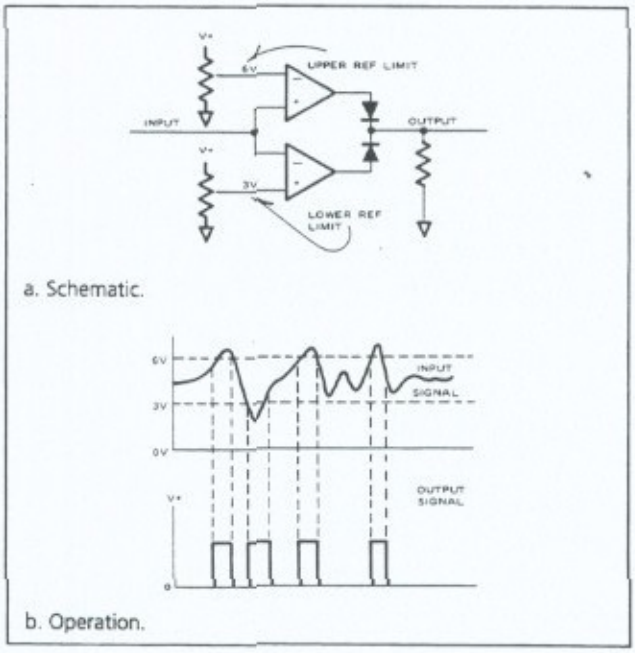


Figure 9-11. Typical window detector

As soon as the input voltage falls below +3 volts or rises above +6 volts, the output will go high. When the input voltage returns to within the window, the output will go low again.

b. Noise Detection. Dc signals are presented to the RFL 67A LOGIC module by the FS/AM detector module (Section 8). When noise is present on the communication lines, it will also appear on the detector outputs, as shown in Figure 9-13.

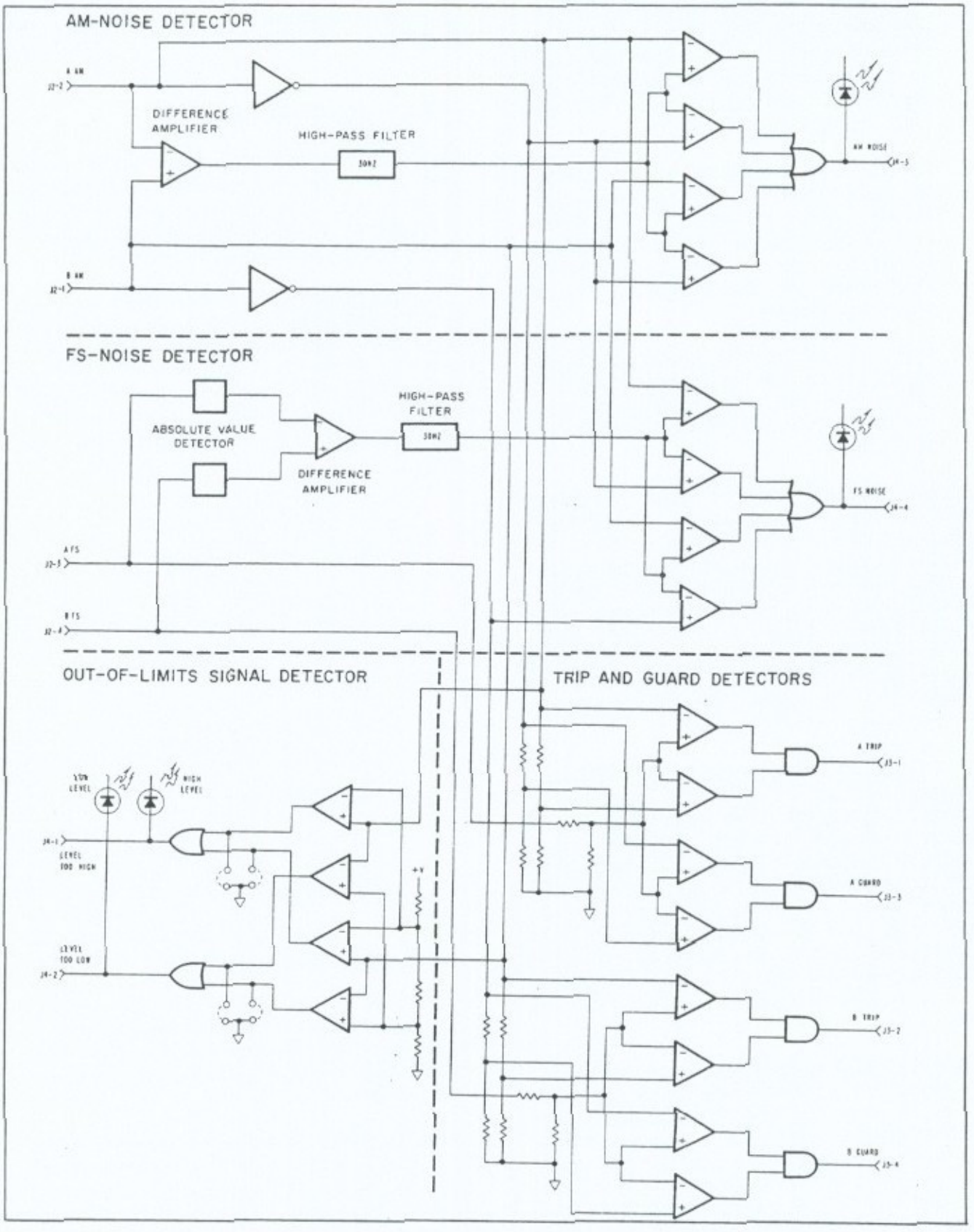


Figure 9-12. Logic diagram, analog circuit board for RFL 67A LOGIC Wide-Dynamic-Range Logic Module (Assembly No. 47015; Drawing No. D-47016, Rev. B)

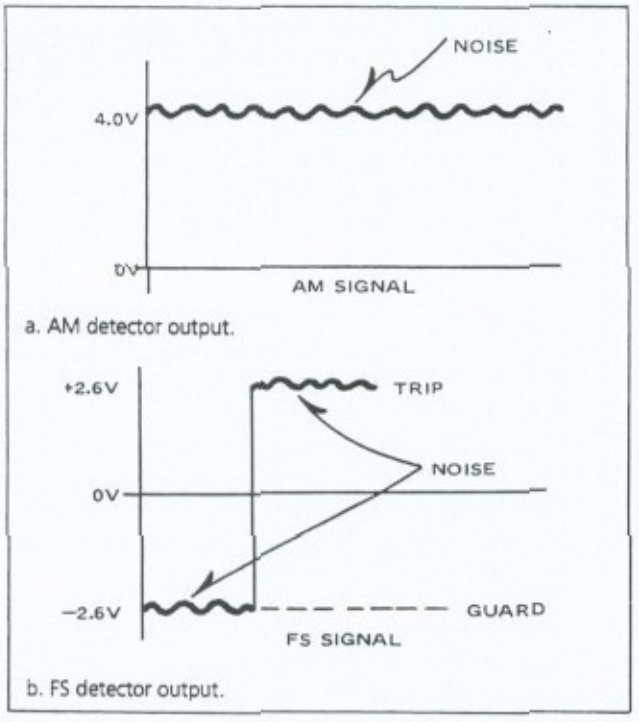


Figure 9-13. Typical detector outputs from FS/AM detector module (with noise)

Figure 9-14 illustrates the operation of the AM noise detectors.

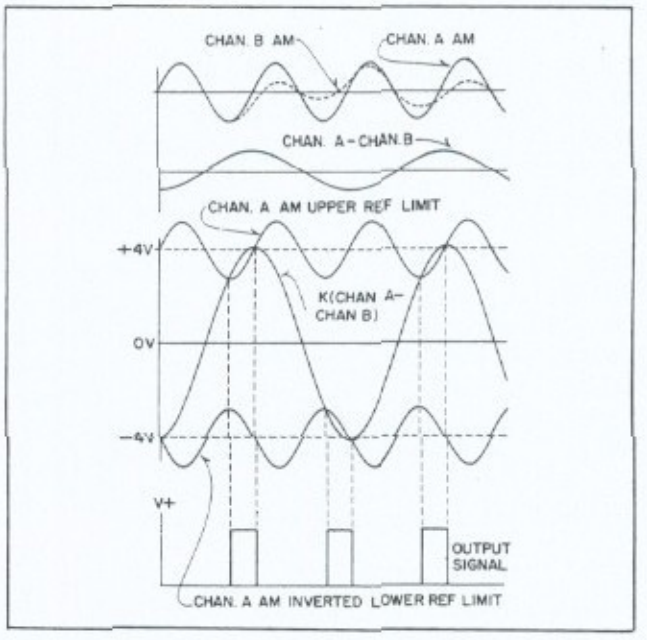


Figure 9-14. Operation and output of AM noise detectors

(1) AM Noise Detection. The AM signal from Subchannel A is fed to IC1A-2, where it becomes the upper reference limit for a window detector. The same signal is also inverted by operational amplifier IC9B to become the lower reference limit applied to IC1B-5. In the same way, the AM signal from Subchannel B is fed to IC1C-9 as the upper limit, and inverted to become the lower reference limit for operational amplifier IC1D.

The AM signals from both subchannels are fed to operational amplifier IC10A, which amplifies the difference between these signals. Under normal conditions there will be no difference, since both signals are of equal amplitude. However, if noise is present on one signal, its amplitude will be different than the amplitude of the other signal, and this difference will appear at IC10A-1. The noise in each subchannel will be different, because of the different center frequencies for each subchannel.

When the difference between the subchannel levels exceeds the limits set by the window detectors (quad operational amplifier IC1 and its associated components), IC3A-3 will go high. This creates the AM NOISE output, which lights AM NOISE indicator DS1. This signal is also fed to the digital circuit board through connector J4-3 and to edge connector terminal 19 for use elsewhere in the RFL 6745 system.

(2) FS Noise Detection. A similar technique is used to detect FS noise. The same upper and lower reference levels are used for the FS window detectors (formed from quad operational amplifier IC2). Unlike the AM circuit, which feeds the inputs into a difference amplifier, the incoming FS signals are fed first to a set of operational rectifiers. The rectifier for Subchannel A is formed from operational amplifiers IC11A and IC11B; operational amplifiers IC12A and IC12B form the rectifier for Subchannel B. The outputs of these rectifiers represent the absolute value of the FS signals, regardless of whether the system is in guard or trip mode. These absolute values are then fed to the difference amplifier (operational amplifier IC13B), which functions the same as its counterpart in the AM circuit. The outputs of the FS window detectors are combined in an OR gate formed from diodes CR5 through CR8, which feeds AND gate IC3, which acts as a buffer. IC3-4 drives FS NOISE indicator DS2 and becomes the FS NOISE output at edge connector terminal 18, this signal is also passed to the digital circuit board through connector J4-4.

c. Trip And Guard Detectors. The analog circuit board contains two identical sets of trip and guard detector circuits. Each set of circuits monitors one subchannel, and works the same as the window detectors discussed earlier. The trip and guard detectors are formed from quad operational amplifiers IC6 and IC7,

quad AND gate IC5, and their associated components. The circuits for Subchannel A are discussed below; the Subchannel B circuits work in a similar fashion, using different components.

The AM input signals, their inverted equivalents, and the FS input signals for each subchannel are fed to voltage dividers at the inputs of the guard detectors. The dividers are formed from resistors R29 through R40, and set the reference levels for the detectors.

Under normal conditions with no noise present, the limits set for the guard detectors are -0.42 volts (lower) and -4.0 volts (upper). A signal within these limits is accepted as a valid guard signal. The limits for the trip detectors are +0.42 volts (lower) and +4.0 volts (upper). While the system is operating, these limits will vary as noise and attenuation varies the AM signal level. This permits the system to function properly as signal level changes, as shown in Figure 9-15.

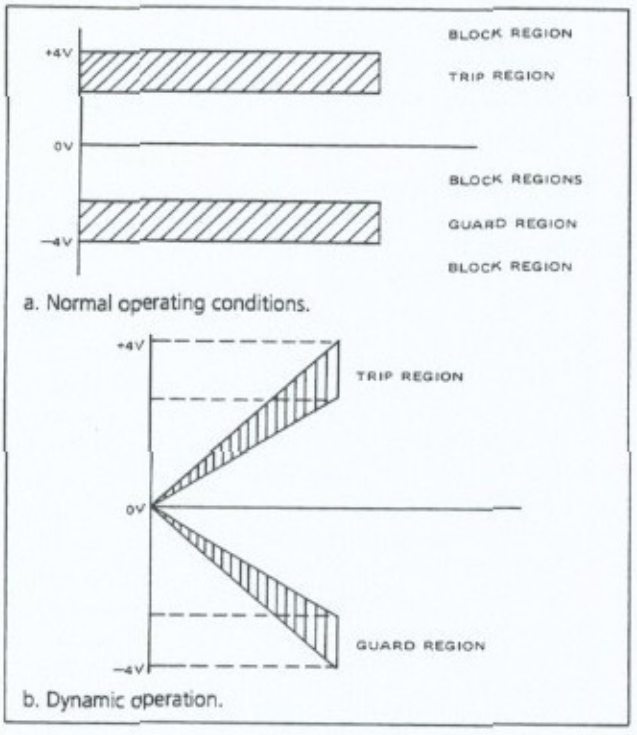


Figure 9-15. Operation of guard and trip signal window detectors

d. Out-Of-Limit Signal Detection. Quad operational amplifier IC8 and its associated components check to make sure the incoming signal is within established limits. If the signal level falls below or rises above these limits, an indicator will light and a logic output will be produced. The limits are set by plug-in resistor network RZ3, which also established the AGC voltage to be fed back to the wideband receivers (Section 7). RZ3 is selected for the communication medium being used with the RFL 6745 system, as described in Section 3 of this manual.

IC8B and IC8D serve as the window detector for Subchannel A; IC8A and IC8C perform the same function for Subchannel B. Input signals for the window detectors are the non-inverted AM signals. Logic outputs will be produced if the signal goes beyond the established limits, and jumpers J3 and J4 make it possible to use signals from one or both subchannels to indicate an out-of-limit condition. The logic outputs are fed to the digital circuit board for further processing.

Figure 9-16 shows the operation of the out-of-limit signal detector circuit under steady-state conditions (Fig. 9-16a) and the dynamic operating region of one subchannel (Fig. 9-16b).

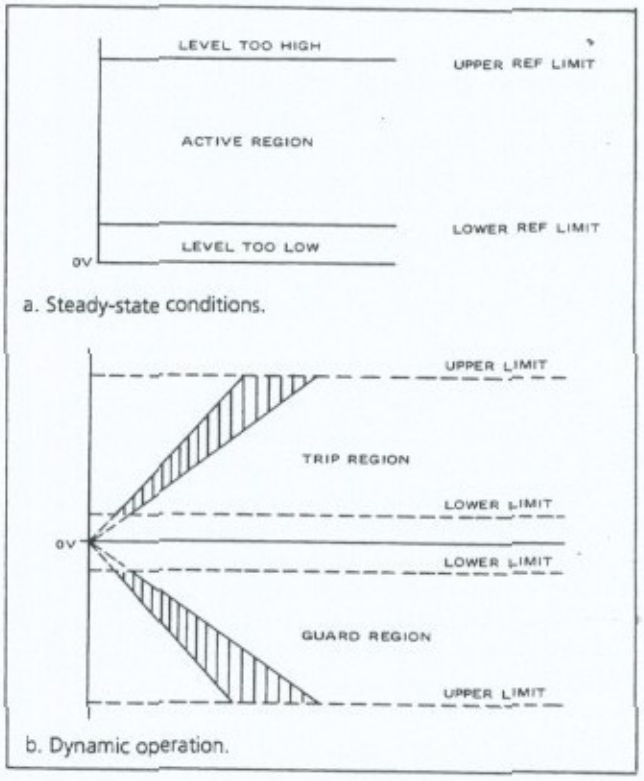


Figure 9-16. Operation of out-of-limit signal detectors

Table 9-3. Replaceable parts, analog circuit board for RFL 6745 wide-dynamic-range logic modules Assembly No. 47015

Circuit Symbol (Fig. 9-17, Sh. 2)	Description	Part Number
	CAPACITORS	
C1,2	Capacitor,tantalum,1µF,10%,35V,Kemet T110A105K035AS or equiv.	1007 1156
C3,4,8,9	Capacitor,metallized polyester,0.22µF,5%,100V, Siemens Type MKH # B32561 .22/5/250 or equiv.	1007 1406
C5,10	Capacitor,metallized polyester,0.01µF,5%,250V, Siemens Type MKH # B32560 .01/5/250 or equiv.	1007 1369
C6,7	Capacitor,mica,33pF,5%,500V,Type DM-15	16511
	RESISTORS	
R1,2,10	Resistor,metal film,15KΩ,1%,1/4W, Type RN1/4	0410 1401
R3-6	Resistor,metal film,2.21KΩ,1%,1/4W, Type RN1/4	0410 1321
R7-9	Resistor,metal film,47.5KΩ,1%,1/4W, Type RN1/4	0410 1449
R11,12,15,16,41,44, 45,48	Resistor,metal film,20KΩ,1%,1/4W, Type RN1/4	0410 1413
R13,14,19,43,47,49, 50,52,53	Resistor,metal film,10KΩ,1%,1/4W, Type RN1/4	0410 1384
R17,18,26,28,33,35	Resistor,metal film,4.75KΩ,1%,1/4W, Type RN1/4	0410 1353
R20	Resistor,metal film,10.7KΩ,1%,1/4W, Type RN1/4	0410 1387
R21,22	Resistor,metal film,21KΩ,1%,1/4W, Type RN1/4	0410 1415
R23,57	Resistor,metal film,16.9KΩ,1%,1/4W, Type RN1/4	0410 1406
R24,56	Resistor,metal film,34KΩ,1%,1/4W, Type RN1/4	0410 1435
R25,51	Resistor,metal film,1KΩ,1%,1/4W, Type RN1/4	0410 1288
R27,58	Resistor,metal film,33.2KΩ,1%,1/4W, Type RN1/4	0410 1434
R29,30,37,39	Resistor,metal film,9.31KΩ,1%,1/4W, Type RN1/4	0410 1381
R31,32,38,40	Resistor,metal film,1.07KΩ,1%,1/4W, Type RN1/4	0410 1291
R34,36	Resistor,metal film,5.23KΩ,1%,1/4W, Type RN1/4	0410 1357
R42,46	Resistor,metal film,22.1KΩ,1%,1/4W, Type RN1/4	0410 1417
R54,55	Resistor,metal film,24.3KΩ,1%,1/4W, Type RN1/4	0410 1421
RZ1,2	Resistor network,seven 15KΩ 2% resistors,1.1W total,8-pin SIP, CTS of Berne 750-81-R15K or equiv.	47888
	SEMICONDUCTORS	
CR1-26	Diode,silicon,1N914B or 1N4448	26482
DS1-4	Light-emitting diode,red,Dialight 550-0102 or equiv.	39568
IC1,2,6-8	MOS programmable UART,40-pin DIP,RCA CDP1854ACE or equiv.	0620 123
IC3,5	MOS quad 2-input AND gate,14-pin DIP,RCA CD4081BE or equiv.	0615 31
IC4	MOS hex inverter/buffer,RCA CD4049AE or equiv.	0615 7
IC9-13	Linear operational amplifier,dual,8-pin DIP,Texas Instruments MC1458P or equiv.	0620 51
	MISCELLANEOUS COMPONENTS	
. . .	Shorting bar,single,Aries LP300 or equiv.	42904

Table 9-4. Replaceable parts, digital circuit board for RFL 6745 wide-dynamic-range logic modules Assembly No. 47010

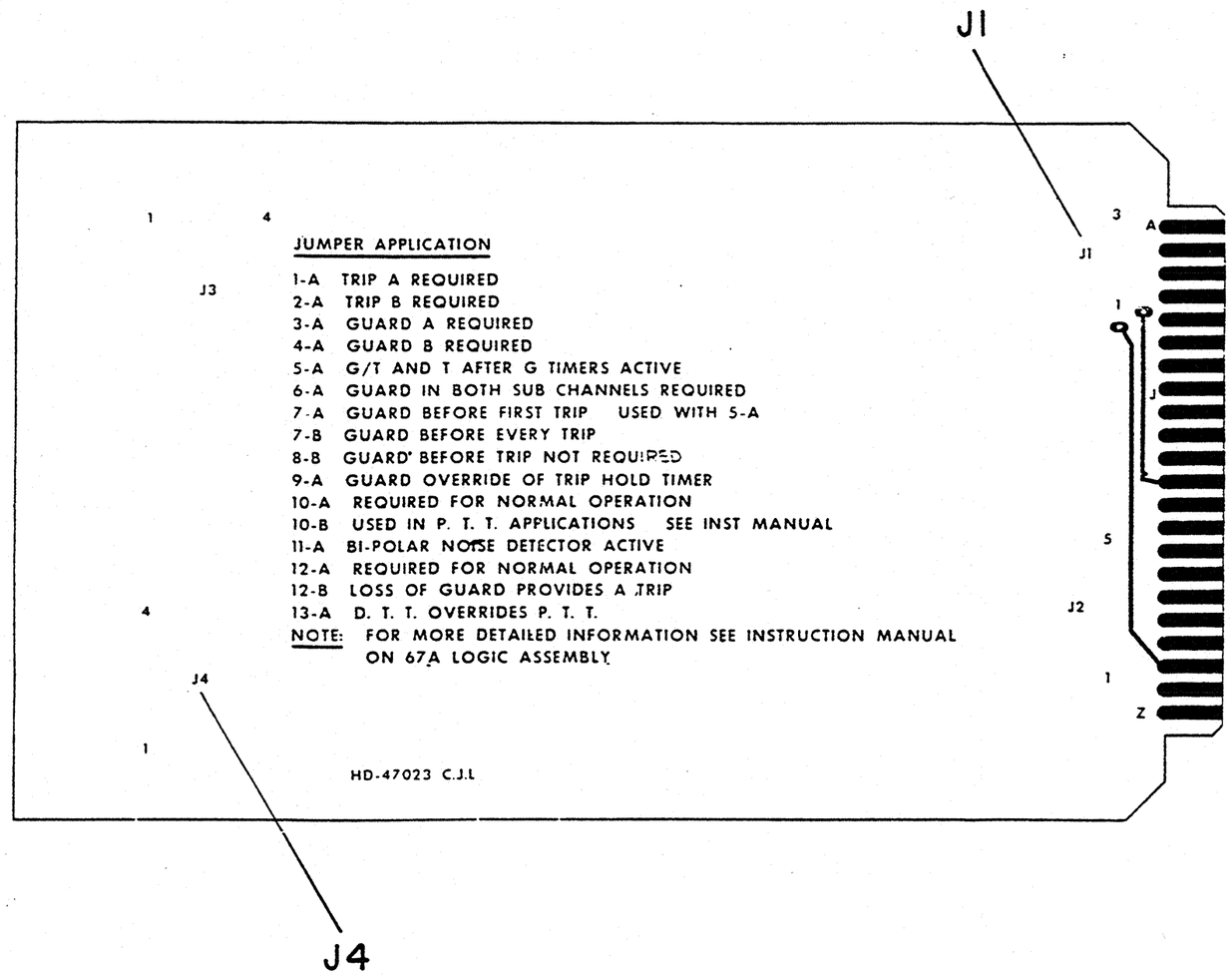
Circuit Symbol (Fig. 9-17, Sh. 3)	Description	Part Number
	CAPACITORS	
C1,2	Capacitor,tantalum,1µF,10%,35V,Kemet T110A105K035AS or equiv.	1007 1156
C3,12,13	Capacitor,tantalum,1µF,5%,35V,Kemet T110A105J035AS or equiv.	1007 1475
C4	Capacitor,tantalum,15µF,5%,20V,Kemet T322D156J020AS or equiv.	1007 1473
C5	Capacitor,tantalum,0.33µF,20%,35V,Kemet T322A334M035AS or equiv.	1007 871
C6	Capacitor,metallized polycarbonate,0.1µF,2%,50V,Wesco 32MPC or equiv.	1007 1476
C7	Capacitor,tantalum,0.33µF,5%,35V,Kemet T322A334J035AS or equiv.	1007 1474
C8	Not used.	
C9-11	Capacitor,metallized polyester,0.047µF,2.5%,250Vdc/140Vac, NIC Components NRM Series or equiv.	1007 1472
C14	Capacitor,metallized polyester,0.1µF,5%,250V, Siemens Type MKH # B32561 .1/5/250 or equiv.	1007 1405
C15	Capacitor,metallized polycarbonate,0.056µF,5%,250V, Siemens Type MKM # B32541.056/5/250 or equiv.	1007 1404
	RESISTORS	
R1,18,51	Resistor,metal film,475Ω,1%,1/4W, Type RN1/4	0410 1257
R2	Resistor,metal film,15.0MΩ,1%,1/4W, Type RN1/4	0410 1689
R3,5,15,19,50	Resistor,metal film,4.75KΩ,1%,1/4W, Type RN1/4	0410 1353
R4,6,69	Resistor,metal film,143KΩ,1%,1/4W, Type RN1/4	0410 1495
R7,8	Resistor,metal film,4.99KΩ,1%,1/4W, Type RN1/4	0410 1355
R9,16,20,22,37,52,55, 62,63,68,71,76,83,87	Resistor,metal film,10KΩ,1%,1/4W, Type RN1/4	0410 1384
R10,12,17	Not used.	
R11,13,31,34,43,46	Resistor,metal film,2.21KΩ,1%,1/4W, Type RN1/4	0410 1321
R14	Resistor,metal film,169KΩ,1%,1/4W, Type RN1/4	0410 1502
R21,23-25,27,30,36, 44,45,48,53,54,59, 60,65,70,73,82	Resistor,metal film,1KΩ,1%,1/4W, Type RN1/4 NOTE: R53 and R54 may be replaced with factory-selected values; replace with value installed on board.	0410 1288
R26	Resistor,metal film,3.32KΩ,1%,1/4W, Type RN1/4	0410 1338
R28	Resistor,metal film,825Ω,1%,1/4W, Type RN1/4	0410 1280
R29,89	Resistor,metal film,1.82KΩ,1%,1/4W, Type RN1/4	0410 1313
R32,33,35,47	Resistor,composition,47Ω,5%,1/2W,Allen-Bradley EB Series or equiv.	1009 388
R38	Resistor,metal film,4.02KΩ,1%,1/4W, Type RN1/4	0410 1346
R39	Resistor,metal film,61.9KΩ,1%,1/4W, Type RN1/4	0410 1460
R40,41	Resistor,metal film,20KΩ,1%,1/4W, Type RN1/4	0410 1413
R42,56,57,66,67,72,84	Resistor,metal film,47.5KΩ,1%,1/4W, Type RN1/4	0410 1449
R49	Resistor,metal film,1.5KΩ,1%,1/4W, Type RN1/4	0410 1305
R58	Resistor,metal film,432KΩ,1%,1/4W, Type RN1/4	0410 1541
R61	Resistor,metal film,64.9KΩ,1%,1/4W, Type RN1/4	0410 1462
R64	Resistor,metal film,604KΩ,1%,1/8W,Mepco/Electra SPR5053YD604K000F or equiv.	1515 1848
R74	Resistor,metal film,162KΩ,1%,1/4W, Type RN1/4	0410 1500

Table 9-4. Replaceable parts, digital circuit board for RFL 6745 wide-dynamic-range logic modules - continued.

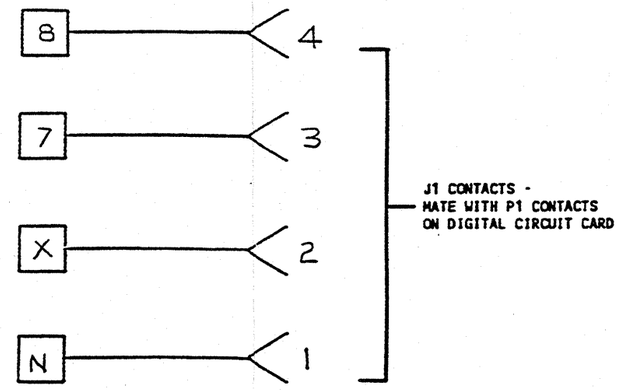
Circuit Symbol (Fig. 9-17, Sh. 3)	Description	Part Number
	RESISTORS - continued.	
R75	Resistor,metal film,150KΩ,1%,1/4W, Type RN1/4	0410 1497
R77,80	Resistor,metal film,8.25KΩ,1%,1/4W, Type RN1/4	0410 1376
R78,79	Resistor,metal film,511KΩ,1%,1/4W, Type RN1/4	0410 1548
R81	Resistor,metal film,357KΩ,1%,1/4W, Type RN1/4	0410 1533
R88	Resistor,metal film,14.3KΩ,1%,1/4W, Type RN1/4	0410 1399
R90	Resistor,metal film,1.0MΩ,1%,1/4W, Type RN1/4	0410 1576
RZ1,12	Resistor network,seven 47KΩ 2% resistors,1.1W total,8-pin SIP, CTS of Berne 750-81-R47K or equiv.	47880
RZ2,4,8-11	Resistor network,four 47KΩ 2% resistors,1.1W total,8-pin SIP, CTS of Berne 750-83-R47K or equiv.	47879
RZ3	Resistor network,five 10KΩ 2% resistors,0.75 W total,6-pin SIP, Bourns 4306R-101-103 or equiv.	32664
RZ5,7	Resistor network,four 510KΩ 2% resistors,2W total,8-pin SIP, Dale MSP-08-C-03-514-G or equiv.	47881
RZ6	Resistor network,seven 10KΩ 2% resistors,1.1W total,8-pin SIP, CTS of Berne 750-81-R10K or equiv.	47878
	SEMICONDUCTORS	
CR1-6,9-30	Diode,silicon,1N914B or 1N4448	26482
CR7,8	Diode,Zener,9.1V,5%,400mW,1N960B	41014
DS1-4	Light-emitting diode,red,Dialight 550-0102 or equiv.	39568
IC1,7,10,13,15,17	MOS quad 2-input NOR gate,RCA CD4001BE or equiv.	0615 3
IC2,11	MOS quad bilateral switch,14-pin DIP,RCA CD4016BE or equiv.	0615 15
IC3,8	Operational amplifier,quad,14-pin DIP,Motorola MC3403P or equiv.	0620 123
IC4,12,14,16	MOS quad 2-input AND gate,14-pin DIP,RCA CD4081BE or equiv.	0615 31
IC5,9	MOS hex inverter/buffer,RCA CD4049AE or equiv.	0615 7
IC6	Linear operational amplifier,8-pin DIP,National Semiconductor LM741CN or equiv.	0620 52
IC18	MOS triple 3-input NOR gate,14-pin DIP,RCA CD4025BE or equiv.	0615 20
Q1,5-7,9	Transistor,PNP,plastic package,2N2907A	37439
Q2,4,8,10	Transistor,NPN,plastic package,2N2222A	37445
Q3	Transistor,PNP,TO-106 case,2N4249	41919
	MISCELLANEOUS COMPONENTS	
. . .	Shorting bar,single,Molex 90059-0009 or equiv.	98306

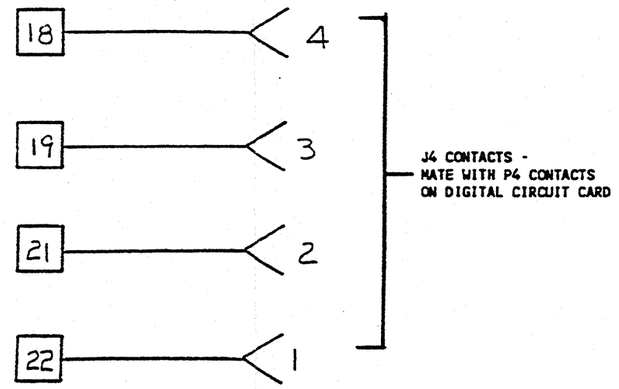
NOTE

The interconnect circuit board (Assembly No. 47020) contains no field-replaceable parts. Its schematic appears on Sheet 1 of Figure 9-17.



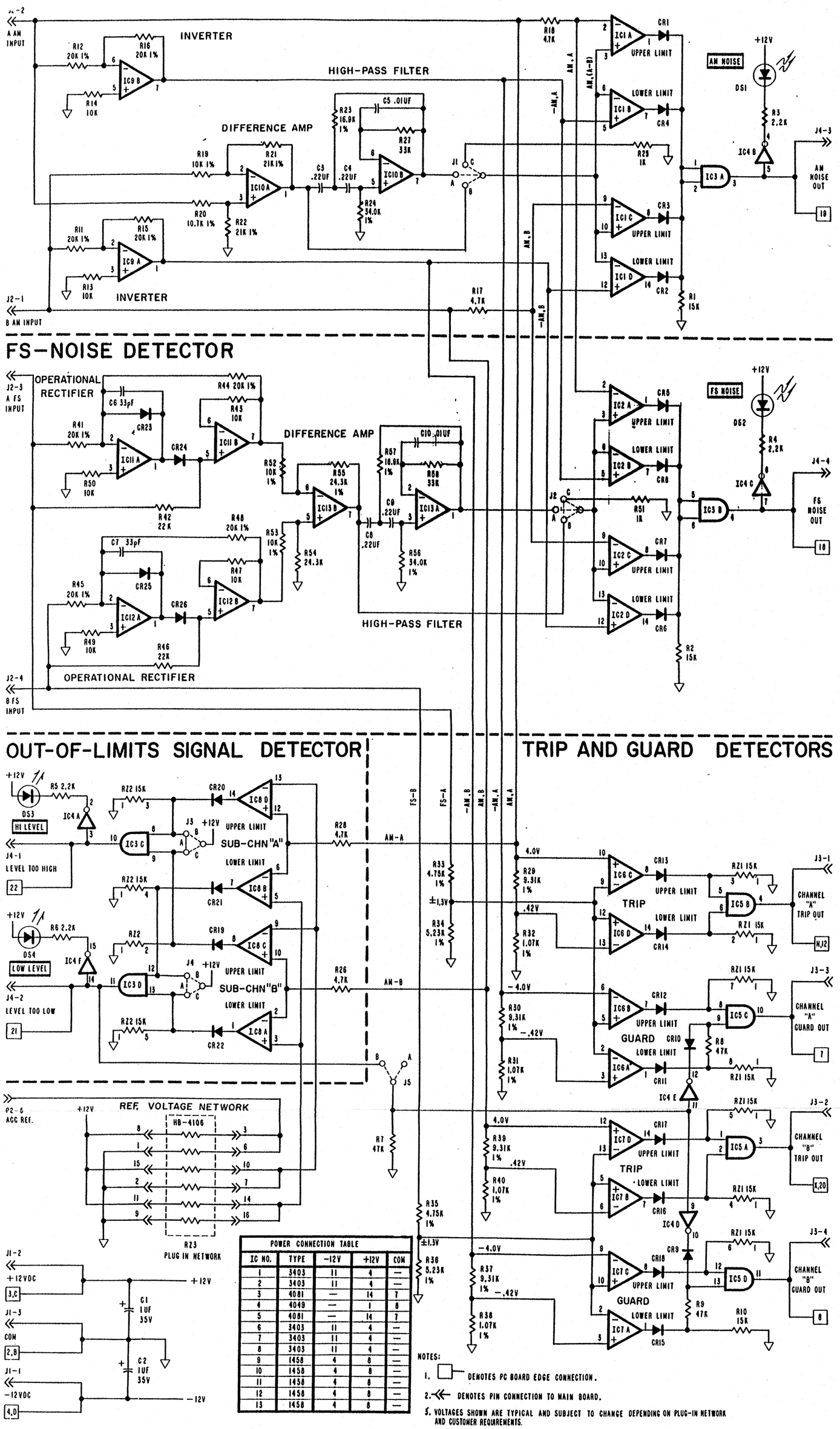
CONNECTOR LOCATIONS





SCHEMATIC

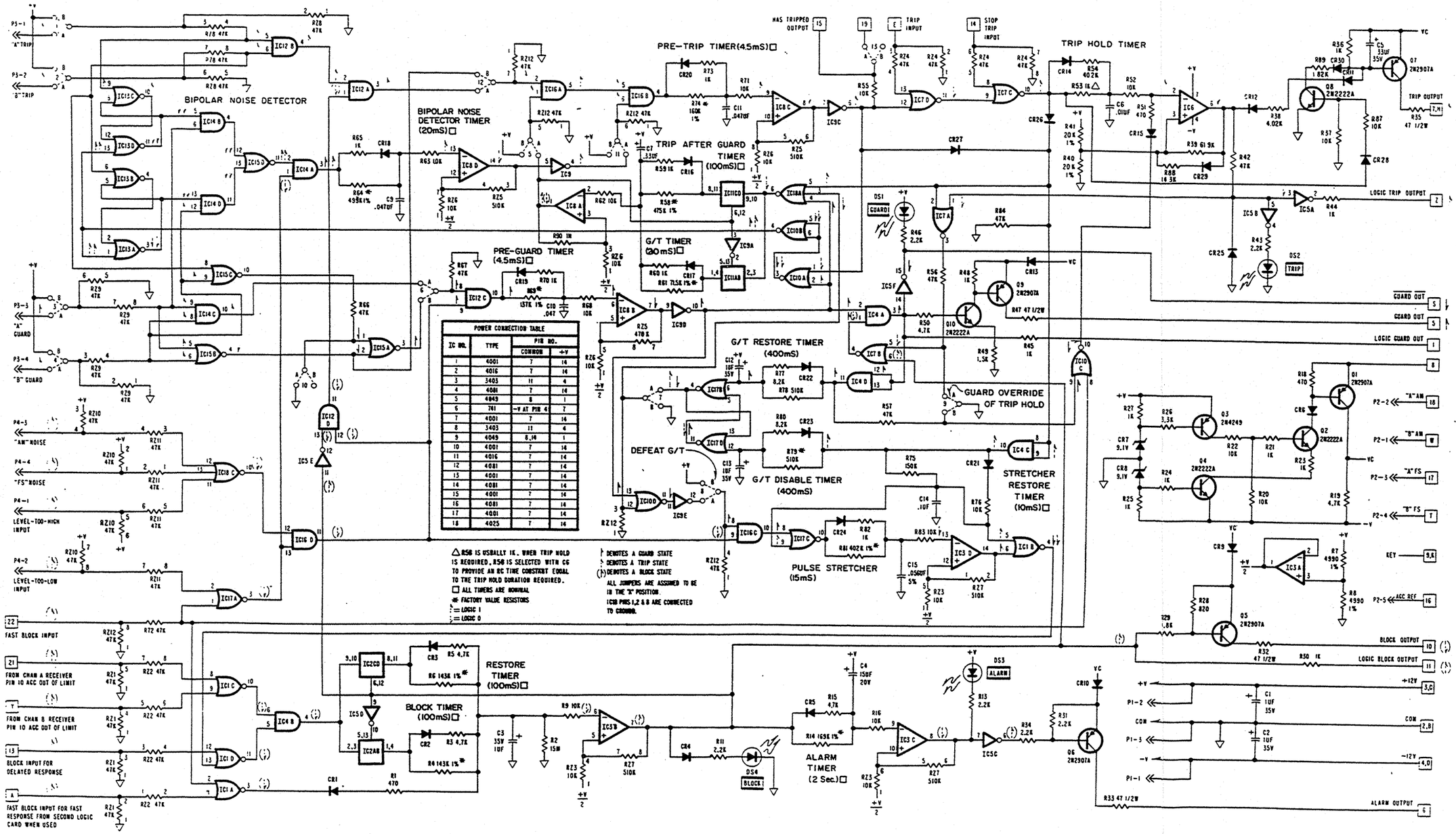
Figure 9-17. Schematic, RFL 6745 wide-dynamic-range logic modules (Sheet 1 of 3 - Interconnect Circuit Board; Assembly No. 47020; Schematic No. 47024, Rev. A)



POWER CONNECTION TABLE				
IC NO.	TYPE	-12V	+12V	COM
1	3403	11	4	—
2	3403	11	4	—
3	4081	—	14	7
4	4049	—	1	8
5	4081	—	14	7
6	3403	11	4	—
7	3403	11	4	—
8	3403	11	4	—
9	1458	4	8	—
10	1458	4	8	—
11	1458	4	8	—
12	1458	4	8	—
13	1458	4	8	—

NOTES:
1. ☐ DENOTES PC BOARD EDGE CONNECTION.
2. ⋘ DENOTES PIN CONNECTION TO MAIN BOARD.
3. VOLTAGES SHOWN ARE TYPICAL AND SUBJECT TO CHANGE DEPENDING ON PLUG-IN NETWORK AND CUSTOMER REQUIREMENTS.

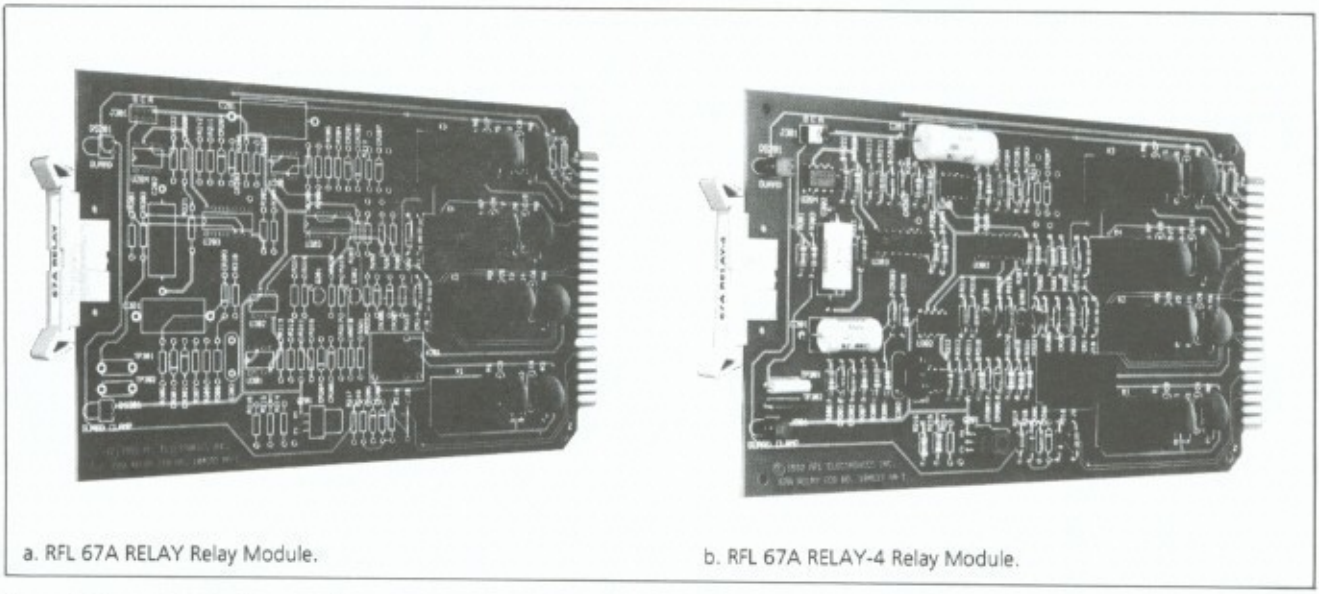
Figure 9-17. Schematic, RFL 6745 wide-dynamic-range logic modules (Sheet 2 of 3 - Analog Circuit Board: Assembly No. 47015; Schematic No. 47019, Rev. D)



IC NO.	TYPE	PIN NO. COMMON	PIN NO. +V
1	4001	7	14
2	4016	7	14
3	3403	11	4
4	4081	7	14
5	4049	8	1
6	741	-V AT PIN 4	7
7	4001	7	14
8	3403	11	4
9	4049	8,16	1
10	4001	7	14
11	4016	7	14
12	4081	7	14
13	4001	7	14
14	4081	7	14
15	4001	7	14
16	4081	7	14
17	4001	7	14
18	4025	7	14

Figure 9-17. Schematic, RFL 6745 wide-dynamic-range logic modules (Sheet 3 of 3 - Digital Circuit Board; Assembly No. 47010; Schematic No. 47014, Rev. J)

Section 10. RELAY MODULES



a. RFL 67A RELAY Relay Module.

b. RFL 67A RELAY-4 Relay Module.

Figure 10-1. RFL 6745 relay modules

10.1. DESCRIPTION

RFL 6745 relay modules (Fig. 10-1) are used to increase the current capacity of the logic module outputs (Section 9). The RFL 67A RELAY relay module (Fig. 10-1a) is the standard module, and contains two relays: one for block, and one for alarm. Under normal system operation, these relays are held energized by circuits on the logic module. As soon as a block condition occurs, the block relay will drop out and its contacts will move. The alarm relay will drop out 2 seconds later if the block condition still exists. Depending on how the RFL 6745 system is being used, the block relay contacts can be used to sound an alarm, to automatically transfer a dual-channel system to single-channel operation, or to perform the guard relay contact function that is required in some TT-12 relays.

The RFL 67A RELAY-4 relay module (Fig. 10-1b) contains the same relays as the RFL 67A RELAY module, plus guard output and flasher circuits. The guard output circuit provides two different guard outputs (a set of relay contacts and a solid-state output). These outputs both signify the presence or loss of guard signal; an LED indicator also shows guard status. The flasher circuit causes the output of the transmitter (Section 6) to alternate between trip and guard frequencies when it is keyed to trip. The flasher is used in direct transfer trip applications to overcome the guard-before-trip requirement in the event that a noise block should occur shortly after the system starts to transmit a trip command.

NOTE

Although the RFL 67A RELAY and RFL 67A RELAY-4 (Assembly Numbers 104690 and 104690-4) are similar to the older RFL 67 RELAY and RFL 67 RELAY-4 modules (Assembly Numbers 41035 and 41035-4), the older RFL 67 RELAY or RFL 67 RELAY-4 modules cannot be used to replace RFL 67A RELAY or RFL 67A RELAY-4 modules. This would reduce the SWC and fast-transient capabilities of RFL 6745 terminals equipped with the fast-transient option.

10.2. SPECIFICATIONS

As of the date this manual was published, the following specifications apply to all RFL 6745 relay modules, unless otherwise noted. Because all RFL products undergo constant refinement and improvement, these specifications are subject to change without notice.

Block Output: Two sets of Form C relay contacts; each set rated for 2A @ 48 Vdc or 1A @ 125 Vdc, resistive load. For use at higher voltages, current must be derated. The block output relay will de-

energize after 100 milliseconds if abnormal signal or power failure is sensed.

Alarm Output: Two sets of Form C relay contacts; each set rated for 2A @ 48 Vdc or 1A @ 125 Vdc, resistive load. For use at higher voltages, current must be derated. The block output relay will de-energize after 2 seconds if abnormal signal or power failure is sensed.

Guard (RFL 67A RELAY-4 Only):
Input: Signal generated on logic module.
Output: One set of Form C relay contacts (dry contacts standard, mercury-wetted optional).
Delay: 4.5 ms.
Hold: Adjustable from zero to 250 ms.

Flasher (RFL 67A RELAY-4 Only):
Input: Signals generated on logic module.
Output: Diode clamp to guard condition at transmitter's output.
Period: 25-ms alternation between trip and guard frequencies standard; other periods available.

NOTE

The period of the guard signal contained in the cycle of the flasher must be about 25 percent greater than the period of the guard-before-trip timer on the logic module (Section 9).

Operating Temperature: -30°C to +60°C (-22°F to +140°F).

Power Requirements:
RFL 67A RELAY:
+12-volt Supply: None.
-12-volt Supply: 45 mA.
RFL 67A RELAY-4:
+12-volt Supply: 40 mA.
-12-volt Supply: 90 mA.

Dimensions:
Height: 4.713 inches (12 cm).
Depth: 8.00 inches (20.3 cm).
Width: 1.0 inch (2.54 cm); requires two module spaces in chassis.

10.3. THEORY OF OPERATION

Both RFL 6745 relay modules contain a block and alarm relay section. In addition, The RFL 67A RELAY-4 relay module contains a guard output section and a flasher section. Paragraphs 10-5.1 through 10-5.3 describe the circuits in these sections. A block diagra of the RFL 6745 relay modules appears in Figure 10 its schematic appears in Figure 10-4.

10.3.1. Block And Alarm Relay Section

The block and alarm relay section is present on all RFL 6745 relay modules. It contains the block relay and the alarm relay.

a. Block Relay. Relay K1 serves as the block relay. The coil of K1 is connected across the BLOCK RELAY COIL input (edge connector terminal 9) and ground. As long as the logic module does not detect a block condition, K1 will remain energized. If the logic module enters a block condition, the BLOCK RELAY COIL line will go low and coil voltage will no longer be supplied to K1; its contacts will shift, and this shift can be used to operate other equipment (such as annunciators) external to the RFL 6745 system. The contacts can also be used to shift a dual-channel system to single-channel operation.

Diode CR1 suppresses voltage spikes that may be generated by the relay coil when the potential across it is changed. This protects the drive circuits on the logic module that produce the BLOCK RELAY COIL voltage.

b. Alarm Relay. Relay K2 serves as the alarm relay. The coil of K2 is connected across the ALARM RELAY COIL input (edge connector terminal 6) and ground. As long as the logic module does not detect an alarm condition, K2 will remain energized. If an alarm condition is detected, the ALARM RELAY COIL line will go low and coil voltage will no longer be supplied to K2; its contacts will shift, and this shift can be used to operate alarm equipment external to the RFL 6745.

Diode CR2 suppresses voltage spikes that may be generated by the relay coil when the potential across it is changed. This helps protect the drive circuits on the logic module that produce the ALARM RELAY COIL voltage.

10.3.2. Guard Output Section

The guard output section (RFL 67A RELAY-4 modules only) accepts several inputs from the logic module and combines them to produce the guard output signal. The guard output section contains a guard input buffer, a buffer for block input signals, two timers (pre-guard and guard hold), and an output circuit that generates the solid-state output and drives the output relay.

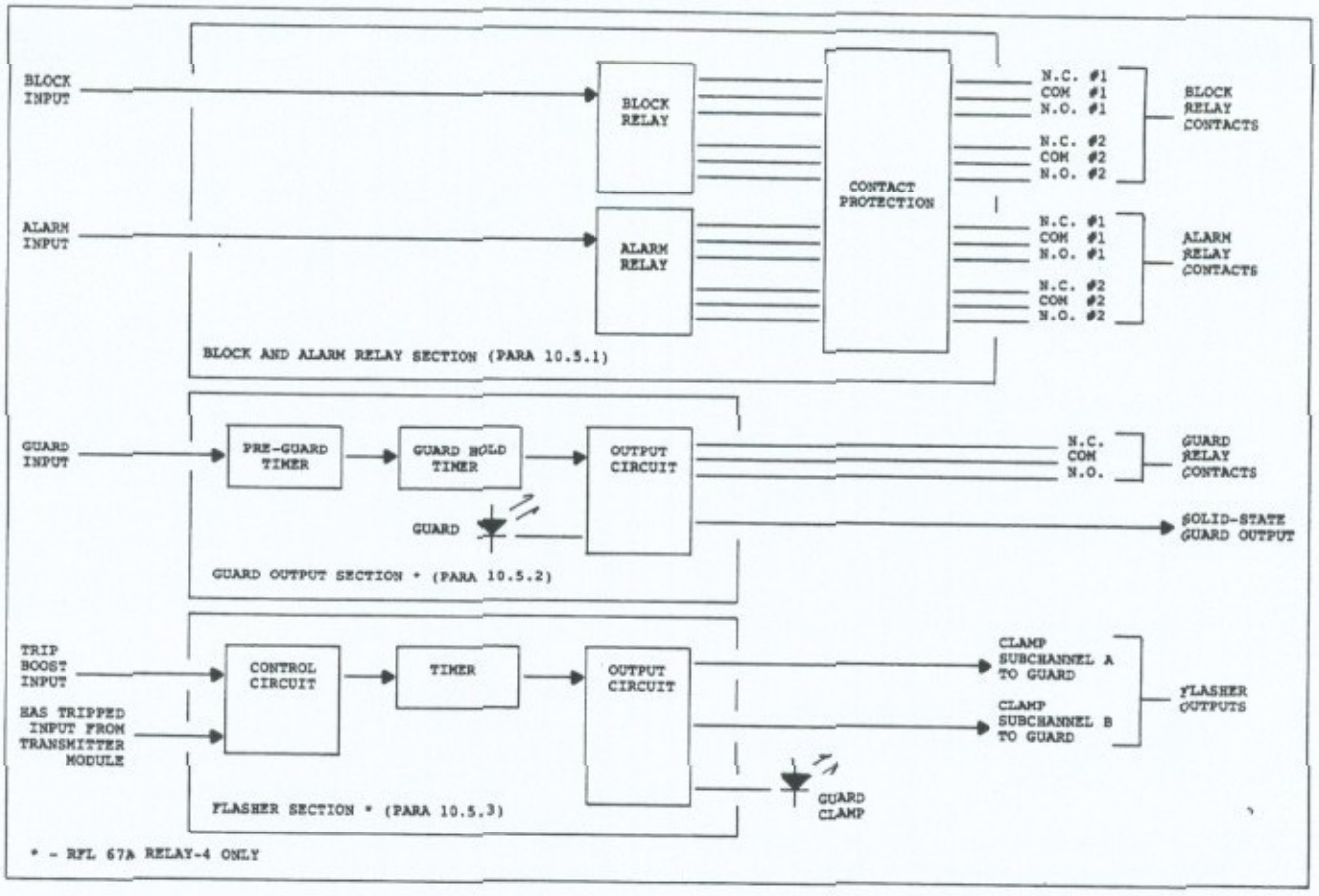


Figure 10-2. Block diagram, RFL 6745 relay modules

When the RFL 6745 system is in a guard state, all inputs to the guard output section are low. If the RFL 6745 system contains redundant logic modules, these inputs are obtained from the first logic module.

a. Pre-Guard Timer. Operational amplifier IC201 is the active element of the pre-guard timer. Capacitor C201 charges through resistor R205 to set the attack time; it discharges through resistor R204 to determine the dropout time. Normal times are 4.5 ms for attack and zero for dropout; these values can be altered by substituting different resistors for R204 and R205. The output of IC201 (pin 6) must stay continuously low for the entire attack time for a guard output to be indicated. Only an instantaneous return to logic high at pin 11 of OR gate IC303D will discharge C201 through R204 and reset the timer.

b. Guard Hold Timer. NAND gate IC203D and its associated components form the guard hold timer. This timer holds the guard output condition in the presence of noise or other interference for a preset period of time, usually about 4.5 ms. If the output of the pre-guard timer goes high for only an instant, capacitor C202 will rapidly charge through resistor R211 and CR203. C202 discharges through resistor R212 and diode CR204 to reset the timer.

The guard hold function is not required in many applications, so capacitor C202 is not supplied unless specified. The exact values of C202, R211 and R212 are selected for the holding period desired.

c. Output Circuit. When the output of the guard hold timer goes low, Darlington transistor Q201 turns on. This energizes guard output relay K201, and its contacts can be used to obtain an isolated guard output. GUARD indicator DS201 also lights when guard is present.

10.3.3. Flasher Section

The flasher section (RFL 67A RELAY-4 Only) forces both subchannel transmitters on the transmitter module (Section 6) to switch back and forth between trip and guard when the transmitter module has been keyed to trip. When needed, a trip-boost input permits

the flasher to operate only after the trip boost period has passed. The flasher section comprises a control circuit, a timer, and an output circuit.

a. Control Circuit. OR gate IC303A, AND gates IC203B and IC203C, and their associated components form the control circuit. The flasher section will only operate if the output of the control circuit (pin 3 of IC303A) goes low. This will occur if the HAS TRIPPED input (edge connector terminal X) is low and both inputs to IC203B are high.

If the flasher is to be inhibited during the trip boost interval, jumper J301 is connected to position B; this will cause the TRIP BOOST INPUT (edge connector terminal V) to hold one input of IC203B low. If the flasher is to operate during trip boost, J301 is connected to position A; this ties pin 5 of IC203B to the +12-volt rail. If J301 is placed in position C, pin 5 of IC203B will be low, and the flasher section will be disabled.

For diagnostic purposes, test points TP301 and TP302 can be shorted together; this will inhibit the flasher by holding pin 6 of IC203B low.

b. Timer. Operational amplifiers IC301 and IC302, OR gate IC303B, and their associated components form the timer. The timer controls the rate at which the flasher section will send clamp-to-guard signals to the subchannel transmitters. Capacitor C301 and resistors R317 and R318 determine this rate; normally, these components are selected for 25 ms of trip, followed by 25 ms of guard.

c. Output Circuit. Transistors Q301 and Q302 and their associated components form the output circuit. The output circuit produces two clamp-to-guard outputs, one for each subchannel. These outputs are used to clamp the trip output signals on the transmitter module to a logic low; this returns the subchannel transmitters to the guard condition. GUARD CLAMP indicator DS301 lights when the transmitter is clamped to guard.

d. Flasher Section Operation. When the output of the control circuit is high (flasher inhibited), current drawn through resistor R314 causes transistor Q301 to conduct. This cuts off transistor Q302. The collector of Q302 is connected to the outputs of the trip input circuits on the transmitter module through diodes CR306 and CR307 and resistors R322 and R323. When Q302 conducts, it forces both subchannel transmitters back to their guard frequencies, even though their trip input circuits have been keyed to trip.

At the same time, pin 6 of OR gate IC303B is driven high by the same voltage applied to the base of Q301. The output of IC303B (pin 4) goes high, charging capacitor C301 through resistor R317 and diode CR304. C301 is also charged by a current supplied through resistor R306 and diode CR301. This second source ensures that C301 is charged very rapidly, regardless of the flashing frequency.

Diode CR303 clamps the maximum voltage on C301 to about 9 volts; this establishes an initial level of charge so that the first cycle of oscillation will be the same length as all those that follow. To set this initial level, the voltage at the junction of resistors R312 and R313 is slightly less than 9 volts. Operational amplifier IC301 is a source follower, and its output resistance is low; it functions as a constant-voltage source for clamping the voltage level on C301. It is the bias voltage across CR303 that raises the clamping level for C301 to just above 9 volts.

When the transmitter is tripped, pin 3 of IC303A goes low and diode CR301 is reversed biased, pin 4 of IC303B becomes low, and the base of Q301 becomes low; this turns off the transistor. At the same time, the output of IC301 goes high because its inverting input has been driven low through diode CR302 and resistor R307. Diode CR303 becomes reverse-biased and has no further effect on C301, which remains at its maximum clamping level. With pin 2 of IC302 held at a slightly higher voltage than pin 3, the output of IC302 (pin 6) will go low. This forces the output of IC303B low, which reduces the voltage at pin 3 of IC302 to about 3 volts. Transistor Q302 turns off, removing the clamps from the subchannel transmitters on the transmitter module. With these clamps removed, both subchannel transmitters will return to the trip frequency.

Capacitor C301 discharges through resistor R318 and diode CR305 until its charge drops below 3 volts. At that point, the outputs of IC302 and IC303B will go high, causing Q302 to turn on. This will restore the clamp voltage to the two subchannel transmitters.

This cycle is repeated as C301 charges through R317 and CR304 to just above 9 volts. The period for which trip-frequency signals are sent is determined by the values of C301 and R317; the values shown on the schematic (Fig. 10-4) are for equal trip and guard periods of about 25 ms.

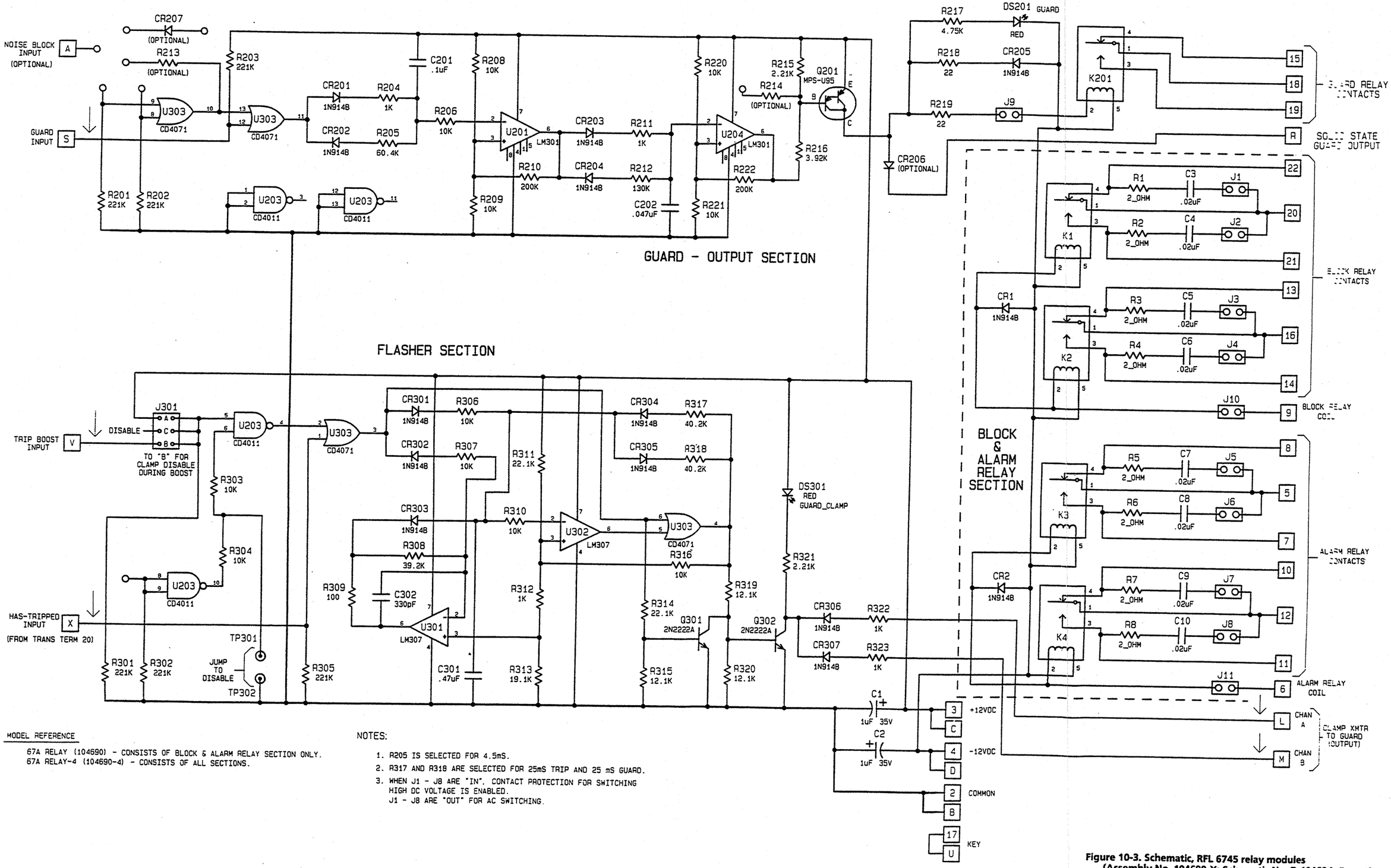
When the output of IC303A again rises in response to the input signals, the guard clamp will be removed, the charge on C301 will return to its initial value, and the circuit will be ready for the next command for flashing trip.

Table 10-1. Replaceable parts, RFL 6745 relay modules
RFL 67A RELAY (BLOCK and ALARM relays only) - Assembly No. 104690
RFL 67A RELAY-4 (BLOCK and ALARM relays, GUARD output circuit, and flasher) - Assembly No. 104690-4

Circuit Symbol (Fig. 10-3)	Usage	Description	Part Number
		CAPACITORS	
C1,2	-4 only	Capacitor,tantalum,1µF,20%,35V,Kemet T322B105M035AS or equiv.	1007 496
C3-10	All	Capacitor,Z5U ceramic,0.02µF,20%,500V,Erie 841-000Z5U0-203M or equiv.	1007 82
C11-200,203-300	. . .	Not used.	
C201	-4 only	Capacitor,polyester,0.1µF,2%,100V,Wesco 32P or equiv.	5115 83
C202	-4 only	Capacitor,polyester,0.047µF,2%,100V,Wesco 32P or equiv.	5115 67
C301	-4 only	Capacitor,metallized mylar,0.47µF,2%,200V,Wesco 32MM or equiv.	1007 1138
C302	-4 only	Capacitor,dipped mica,330pF,2%,500V, Type DM19	16624
		RESISTORS	
R1-8	All	Resistor,composition,2Ω,5%,1/2W,Allen-Bradley EB Series or equiv.	1009 1060
R9-200,207,210,223-300	. . .	Not used.	
R201-203,301,302,305	-4 only	Resistor,metal film,221KΩ,1%,1/4W, Type RN1/4	0410 1513
R204,211,312,322,323	-4 only	Resistor,metal film,1KΩ,1%,1/4W, Type RN1/4	0410 1288
R205	-4 only	Resistor,metal film,60.4KΩ,1%,1/4W, Type RN1/4	0410 1459
R206,208,209,220,221, 303,304,306,307, 310,316	-4 only	Resistor,metal film,10KΩ,1%,1/4W, Type RN1/4	0410 1384
R210,222	-4 only	Resistor,metal film,200KΩ,1%,1/4W, Type RN1/4	0410 1509
R212	-4 only	Resistor,metal film,130KΩ,1%,1/4W, Type RN1/4	0410 1491
R215,321	-4 only	Resistor,metal film,2.21KΩ,1%,1/4W, Type RN1/4	0410 1321
R216	-4 only	Resistor,metal film,3.92KΩ,1%,1/4W, Type RN1/4	0410 1345
R217	-4 only	Resistor,metal film,4.75KΩ,1%,1/4W, Type RN1/4	0410 1353
R218,219	-4 only	Resistor,composition,22Ω,5%,1/4W, Allen-Bradley CB Series or equiv.	1009 613
R308	-4 only	Resistor,metal film,39.2KΩ,1%,1/4W, Type RN1/4	0410 1441
R309	-4 only	Resistor,metal film,100Ω,1%,1/4W, Type RN1/4	0410 1192
R311,314	-4 only	Resistor,metal film,22.1KΩ,1%,1/4W, Type RN1/4	0410 1417
R313	-4 only	Resistor,metal film,19.1KΩ,1%,1/4W, Type RN1/4	0410 1411
R315,319,320	-4 only	Resistor,metal film,12.1KΩ,1%,1/4W, Type RN1/4	0410 1392
R317,318	-4 only	Resistor,metal film,40.2KΩ,1%,1/4W, Type RN1/4	0410 1442
		SEMICONDUCTORS	
CR1,2	All	Diode,silicon,1N914B or 1N4448	26482
CR3-200,206-300	. . .	Not used.	
CR201-205,301-307	-4 only	Same as CR1.	
DS201,301	-4 only	Light-emitting diode,red,Dialight 550-0102 or equiv.	39568
IC1-200,205-300	. . .	Not used.	
IC201,204	-4 only	Linear operational amplifier,high-performance,8-pin DIP, Texas Instruments LM301AP or equiv.	0620 76
IC203	-4 only	MOS quad 2-input NAND gate,14-pin DIP,RCA CD4011BE or equiv.	0615 5

Table 10-1. Replaceable parts, RFL 6745 relay modules - continued.

Circuit Symbol (Fig. 10-3)	Usage	Description	Part Number
		SEMICONDUCTORS - continued.	
IC301,302	-4 only	Linear operational amplifier,high-performance,8-pin DIP, Texas Instruments LM307N or equiv.	0620 93
IC303	-4 only	MOS quad 2-input OR gate,14-pin DIP,RCA CD4071BE or equiv.	0615 24
Q1-200,202-300	. . .	Not used.	
Q201	-4 only	Transistor,PNP Darlington,Motorola MPS-U95 (case 152-02) or equiv.	47509
Q301,302	-4 only	Transistor,NPN,plastic package,2N2222A	37445
		MISCELLANEOUS COMPONENTS	
J1-8,10,11	All	Resistor,zero-ohm,1/4-watt size,Corning OMA07 or equiv.	1510 2217
J9	-4 only	Same as J1.	
K1-4	All	Relay,SPDT,24-volt coil,5A contacts,pc-mount, America Zettler AZ8-1CH-24DE or equiv.	101641
K201	-4 only	Same as K1.	
K5-200	. . .	Not used.	
TP1-300	. . .	Not used.	
TP301	-4 only	Connector,test jack,yellow,E.F. Johnson 105-2207-101 or equiv.	38116 8
TP302	-4 only	Connector,test jack,black,E.F. Johnson 105-2203-101 or equiv.	38116 3
. . .	-4 only	Shorting bar,single,Molex 90059-0009 or equiv.	98306



MODEL REFERENCE

67A RELAY (104690) - CONSISTS OF BLOCK & ALARM RELAY SECTION ONLY.
67A RELAY-4 (104690-4) - CONSISTS OF ALL SECTIONS.

NOTES:

1. R205 IS SELECTED FOR 4.5mS.
2. R317 AND R318 ARE SELECTED FOR 25mS TRIP AND 25 mS GUARD.
3. WHEN J1 - J8 ARE "IN", CONTACT PROTECTION FOR SWITCHING HIGH DC VOLTAGE IS ENABLED.
   J1 - J8 ARE "OUT" FOR AC SWITCHING.

Figure 10-3. Schematic, RFL 6745 relay modules (Assembly No. 104690-X; Schematic No. D-104694, Rev. A)

Section 11. DC-DC CONVERTER POWER SUPPLIES

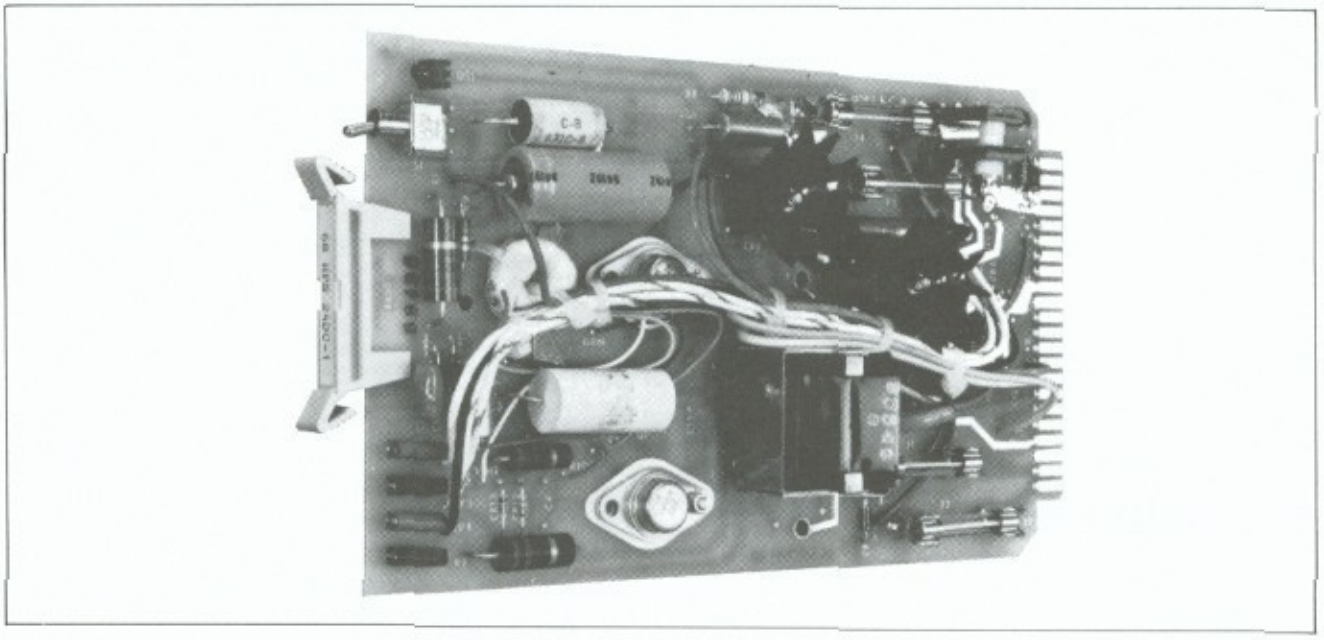


Figure 11-1. Typical RFL 6745 dc-dc converter power supply

11.1. DESCRIPTION

RFL 6745 terminals use dc-dc converter power supplies, which provide regulated dc power from an unregulated dc source. Depending upon the model selected, dc inputs of 24, 48, or 129 volts can be accepted. Dual 12-Vdc outputs are provided, with a current capacitor of one ampere. Additional outputs on these supplies provided unregulated dc and 10-kHz square waves, but these outputs are not used in the RFL 6745. A typical dc-dc converter power supply appears in Figure 11-1.

All RFL 6745 power supplies require the use of a RFL 68 REG External Regulator, which is mounted at the rear of the RFL 6745 chassis.

11.2. SPECIFICATIONS

As of the date this manual was published, the following specifications apply to all three RFL 6745 dc-dc converter power supplies, unless otherwise indicated. Because all RFL products undergo constant refinement and improvement, these specifications are subject to change without notice.

Input Voltage:
RFL 68 HPS 24DC-1: 21 to 28 Vdc.
RFL 68 HPS 48DC-1: 42 to 56 Vdc.
RFL 68 HPS 129DC-1: 104 to 140 Vdc.

Allowable Input Ripple: 1.5 Vrms maximum.

Output Voltages: Two independent outputs, each 11.4 to 12.6 Vdc, not adjustable. Outputs will be within these limits for any combination of input voltage, load, and temperature.

Output Current: 1.0 ampere from each regulated output.

Overvoltage Protection: Internal crowbar circuit on each output, 13.5 to 15.5 Vdc trip point, not adjustable.

Power Consumption: Dependent upon input current. (See Figure 11-3.)

Operating Temperature: -30°C to +70°C (-22°F to +158°F).

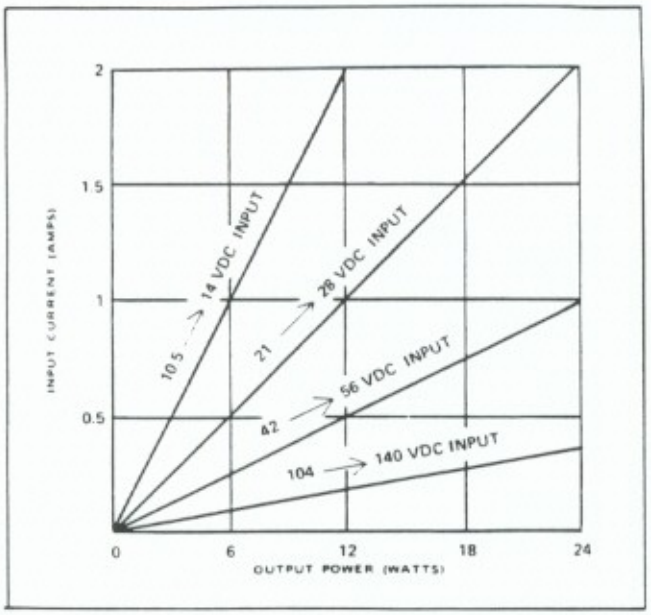


Figure 11-2. Typical input current vs output power curves, RFL 6745 dc-dc converter power supplies

Dimensions:

Dc-dc Converter:

Height: 4.71 inches (120 mm).

Length: 8.0 inches (203 mm)

Width: 1.5 inches (38 mm); requires four module spaces in chassis.

External Regulator:

Height: 5.2 inches (132 mm).

Width: 4.1 inches (104 mm).

Depth: 2.9 inches (73 mm); space and mounting holes provided on rear panel of RFL 6745 chassis.

11.3. THEORY OF OPERATION

RFL 6745 terminals use dc-dc converter power supplies to convert unregulated station battery voltages into regulated dc power. All RFL 6745 dc-dc converter power supplies contain an input section, an inverter, two rectifiers, and two overvoltage protection circuits. Two regulator circuits on the RFL 68 REG External regulator are used in conjunction with these circuits. Paragraphs 11.3.1 through 11.3.6 describe the above circuits. A block diagram of the dc-dc converter/external regulator combination appears in Figure 11-3; schematics appear in Figures 11-4 and 11-5 at the end of this section.

11.3.1. Input Section

The input section controls the dc power being applied to the dc-dc converter. Fuses F1 and F2 provide overcurrent protection. Switch S1 serves as the main power switch for the entire RFL 6745 terminal. Inductor L1, resistor R9, diode CR9, and capacitors C1 through C3 and C14 protect the inverter section (para 11.3.2) against input surges by coupling these surges to chassis ground. Diode CR9 also provides protection against input polarity reversal; if the input polarity is reversed, CR9 acts as a short across the input, causing the input fuses to blow.

11.3.2. Inverter Section

The inverter section converts the single dc input into two 10-kHz square wave voltages. Two transistors (Q1 and Q2) are switched on and off by transformer T1 to produce the square wave.

As Q1 turns on, the voltage increases across its section of the primary winding of transformer T2. A separate winding in T2 senses this increased voltage and applies it to the primary of T1. The secondary windings of T1 hold Q1 on and prevent Q2 from turning on. The inverter section will stay in this state until T1 reaches saturation; when T1 saturates, its secondary voltages fall to zero, and then reverse. The reversed voltages turn off Q1 and turn on Q2. Q2 will stay on until T1 reaches saturation again. This sequence will continue as long as dc voltage is being applied by the input section (para 11.3.1).

Two secondary windings in T2 deliver isolated 10-kHz square wave pulses to the rectifiers (para 11.3.3).

Resistor R1 and diodes CR1 and CR2 bias the emitters of Q1 and Q2. Capacitor C5 and diodes CR12 and CR13 protect the transistors by bypassing voltage spikes to ground. Resistors R2 and R3 and capacitor C4 form a timing circuit together with the T1 primary and the T2 sense winding. This timing circuit holds the oscillation frequency of the inverter section around 10 kHz. Capacitor C15 filters the voltage across the T2 primary to prevent spikes from being coupled to the secondaries.

An additional 10-kHz output is obtained from one of the T2 secondaries. This 34- to 52-volt square wave signal is available at edge connector terminals 17 and 18, although it is not needed by any of the RFL 6745 modules.

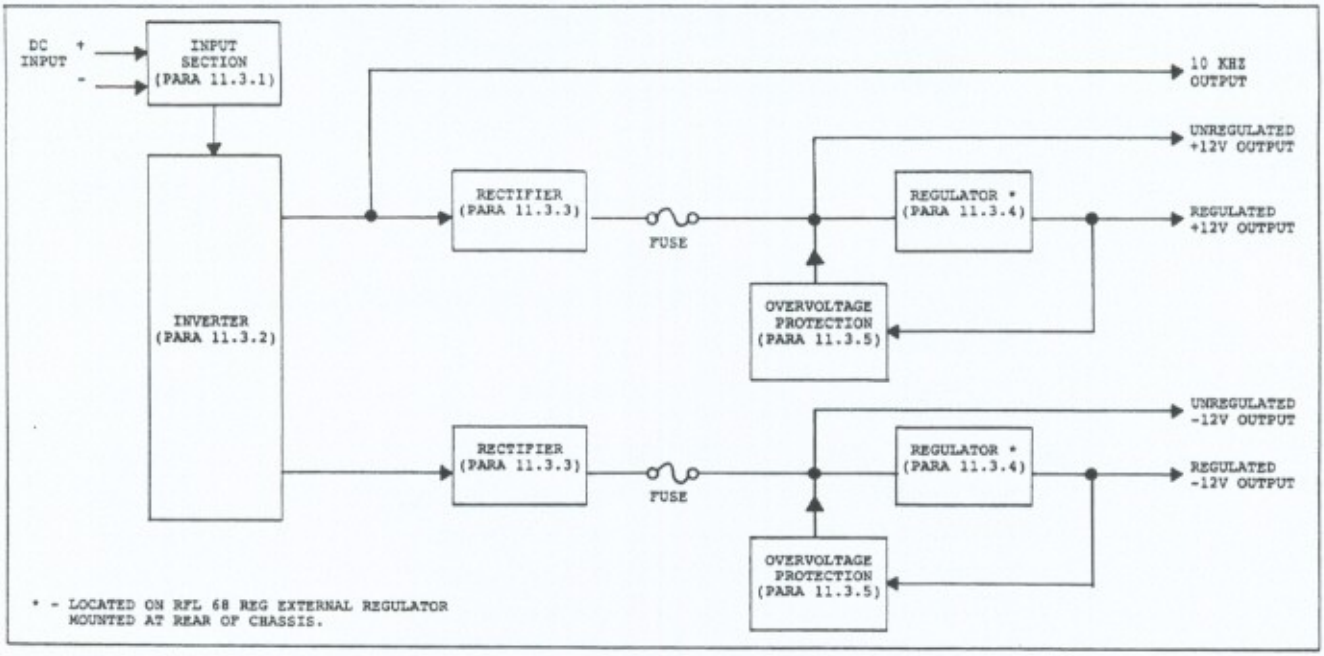


Figure 11-3. Block diagram, RFL 6745 dc-dc converter power supplies

11.3.3. Rectifiers

The two main 10-kHz outputs of the inverter section are fed to the input terminals of bridge rectifiers CR3 and CR4, where they are converted into unregulated voltages between 15 and 35 Vdc. Capacitors C6 and C7 filter the rectifier outputs before they are fed to the regulators (para 11.3.4).

POWER indicator DS1 and series resistor R8 monitor the output of CR4. DS1 lights when voltage is present, and serves as a pilot lamp for the entire power supply.

11.3.4. Regulators

The output of each rectifier (para 11.3.3) is sent to a regulator on the RFL 68 REG External Regulator, mounted on the rear panel of the RFL 6745 chassis. The rectifier outputs are applied across the IN and COM terminals of 12-volt regulators IC1 and IC2. Regulated outputs are obtained across the OUT and COM terminals of each regulator, and are fed back to the RFL 68 HPS module.

Capacitors C1 through C4 filter the inputs and outputs of each regulator and prevent oscillations. Diodes CR1 and CR4 work together with diodes CR10 and CR11 on the RFL 68 HPS module to clamp the voltages applied to the regulators; this prevents damage caused by overvoltage.

11.3.5. Overvoltage Protection

The regulated output voltages are monitored by Zener diodes CR5 and CR7. Resistors R5 and R7 limit the current through the Zener diodes, and bias the gates of silicon-controlled rectifiers SCR1 and SCR2. Resistors R4 and R6 limit the gate currents. As long as the regulated output voltages are below the Zener breakdown voltages, the voltages across R5 and R7 will be low and SCR1 and SCR2 will be off. If either regulated output voltage exceeds the Zener voltage, the voltage across R5 or R7 will increase and an SCR will fire. When an SCR fires, it will draw more current from the rectifier and blow the fuse in series with the rectifier output (para 11.3.2). This will shut down the regulator.

11.3.6. Dc Outputs

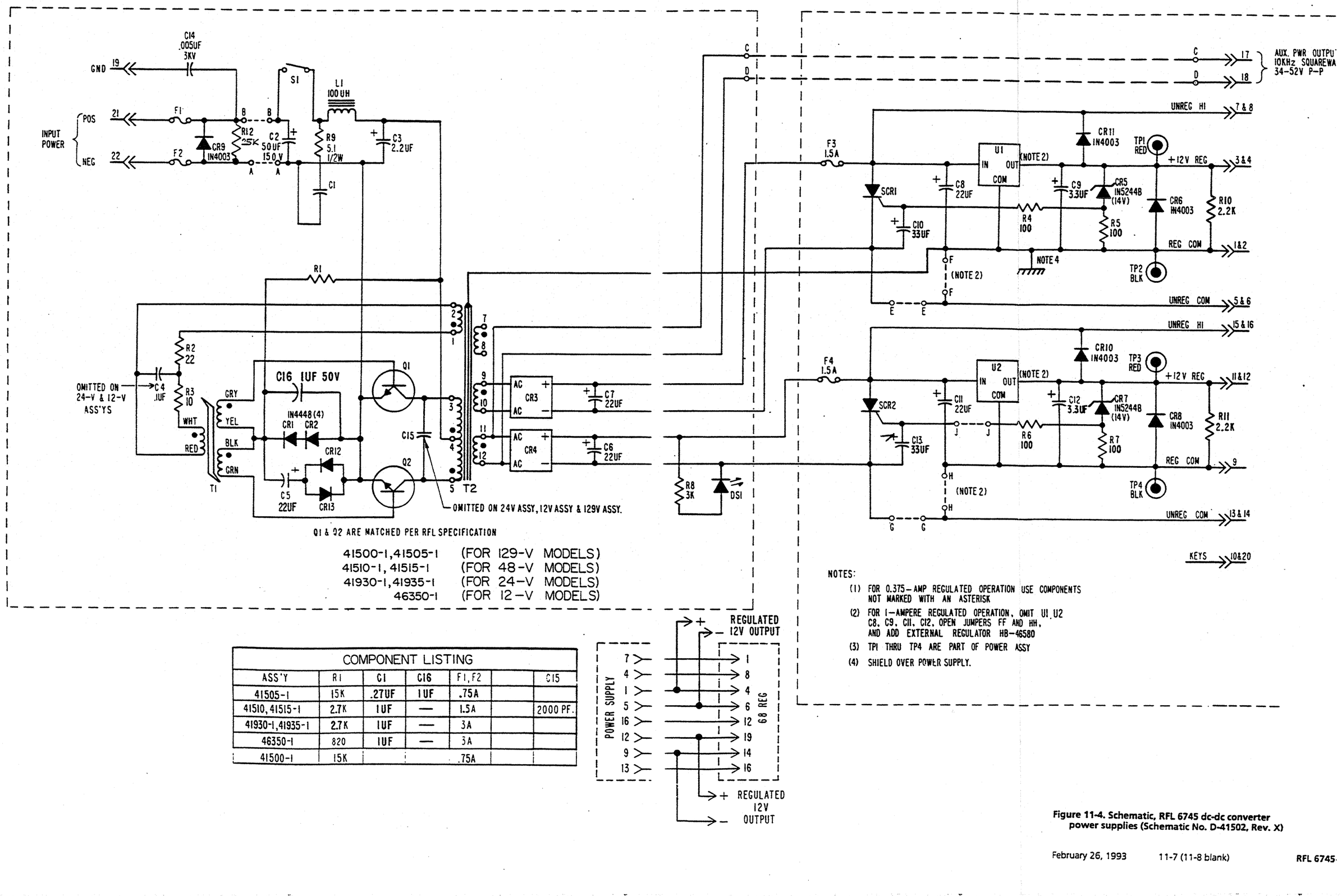
Four dc outputs are obtained from the dc-dc converter: two are regulated, and two are unregulated. The unregulated outputs are obtained from the input terminals of the regulator IC's and the regulated outputs are obtained from their output terminals. Diodes CR6 and CR8 protect the regulated outputs from reverse voltages that may be applied to the output terminals. Resistors R10 and R11 are load resistors for the regulated outputs.

Table 11-1. Replaceable parts, RFL 6745 dc-dc converter power supplies
RFL 68 HPS 24DC-1 (24-Vdc Input) - Assembly No. 41935-1
RFL 68 HPS 48DC-1 (48-Vdc Input) - Assembly No. 41515-1
RFL 68 HPS 129DC-1 (129-Vdc Input) - Assembly No. 41505-1

Circuit Symbol (Fig. 11-4)	Description	Part Number
	CAPACITORS	
C1	Capacitor,value and type dependent upon model: RFL 68 HPS 24DC-1 and RFL 68 HPS 129DC-1: Metallized polycarbonate,0.27µF,2%, 200V,Wesco 32MPC or equiv. RFL 68 HPS 48DC: Same as C4.	1007 1215
C2	Capacitor,electrolytic,50µF,+100/-10%,150V,w/plastic sleeve, Cornell-Dubilier WBR-50-150 or equivalent.	1007 1263
C3	Capacitor,metallized mylar,2.2µF,5%,200V,Wesco 32MM or equiv.	1007 833
C4	Capacitor,metallized polyester,0.1µF,10%,250V,Seacor 106-0.1Uf or equiv.	1007 1255
C5-7	Capacitor,tantalum,22µF,20%,35V,Corning CCZ-035-226-20 or equiv.	1007 657
C10,13	Capacitor,tantalum,33µF,10%,10V,Kemet T322D336K010AS or equiv.	1007 1142
C14	Capacitor,ceramic disc,0.005µF,20%,3kV,Centralab DD30-502 or equiv.	1007 1264
C15	Capacitor,dipped mica,value dependent upon model: RFL 68 HPS 24DC-1, RFL 68 HPS 129DC-1: Not used. RFL 68 HPS 48DC-1: 0.002µF,2%,500V, Type DM19	16222
C16	Capacitor,value and type dependent upon model: RFL 68 HPS 24DC-1 and RFL 68 HPS 129DC-1: Ceramic,1µF,10%,50V,Type CK06 RFL 68 HPS 48DC: Not used.	0110 6
	RESISTORS	
R1	Resistor,composition,5%,2W; value dependent upon model: RFL 68 HPS 24DC-1, RFL 68 HPS 129DC-1: 15KΩ,Allen-Bradley HB Series or equiv. RFL 68 HPS 48DC-1: 2.7KΩ,Allen-Bradley HB Series or equiv.	1009 251 1009 1062
R2	Resistor,composition,22Ω,5%,2W,Allen-Bradley HB Series or equiv.	1009 1063
R3	Resistor,composition,10Ω,5%,1W, Allen-Bradley GB Series or equiv.	1009 4
R4-7	Resistor,metal film,100Ω,1%,1/4W, Type RN1/4	0410 1192
R8	Resistor,metal film,3.01KΩ,1%,1/2W, Type RN1/2	0410 2334
R9	Resistor,composition,5.1Ω,5%,1/2W,Allen-Bradley EB Series or equiv.	1009 712
R10,11	Resistor,metal film,2.21KΩ,1%,1/4W, Type RN1/4	0410 1321
R12	Resistor,wirewound,25KΩ,5%,5W,Ohmite 4664 Style 995-5B or equiv.	1100 480
	SEMICONDUCTORS	
CR1,2,12,13	Diode,silicon,1N914B or 1N4448	26482
CR3,4	Bridge rectifier,100V,2A,Varo VS-148X or equiv.	39509
CR5,7	Diode,Zener,14V,5%,500mW,1N5244B	41075
CR6,8-10,11	Diode,silicon,200 PIV,1N4003	30769
DS1	Light-emitting diode,red,Dialight 550-0102 or equiv.	39568
Q1,2	Transistors,matched set (must be replaced together)	46756 1
SCR1,2	Silicon-controlled rectifier,50V,8A,TO-220 case: Recommended: 2N4441 Alternate: General Electric C122F or equiv.	41072 41073

Table 11-1. Replaceable parts, RFL 6745 dc-dc converter power supplies - continued.

Circuit Symbol (Fig. 11-4)	Description	Part Number
	MISCELLANEOUS COMPONENTS	
F1,2	Fuse,3AG slow-blow,250V, current rating dependent upon model:	
	RFL 68 HPS 24DC-1, RFL 68 HPS 129DC-1: 3/4A; Littelfuse 313.750 or equiv.	10780
	RFL 68 HPS 48DC-1: 1.5A; Littelfuse 31301.5 or equiv.	17765
F3,4	Fuse,3AG normal-blow,1.5A,250V,Littelfuse 312 01.5 or equiv.	41524
L1	Choke,ferrite,100µH,10%,2A,0.103Ω,Caddell-Burns 6310-8 or equiv.	41074
S1	Switch,toggle,SPDT,ON-NONE-ON,C & K Components 7101AG or equiv.	39562
T1	Transformer,inverter/driver	38366
T2	Transformer,power,10 kHz, part number dependent upon model:	
	RFL 68 HPS 48DC-1	38062
	RFL 68 HPS 24DC-1, RFL 68 HPS 129DC-1	38061 1
TP1,3	Connector,test jack,red,E.F. Johnson 105-2212-101 or equiv.	38116 2
TP2,4	Connector,test jack,black,E.F. Johnson 105-2203-101 or equiv.	38116 3



COMPONENT LISTING						
ASS'Y	R1	C1	C16	F1, F2		C15
41505-1	15K	.27UF	1UF	.75A		
41510, 41515-1	2.7K	1UF	—	1.5A		2000 PF.
41930-1, 41935-1	2.7K	1UF	—	3A		
46350-1	820	1UF	—	3A		
41500-1	15K			.75A		

NOTES:

(1) FOR 0.375-AMP REGULATED OPERATION USE COMPONENTS NOT MARKED WITH AN ASTERISK

(2) FOR 1-AMPERE REGULATED OPERATION, OMIT U1, U2 C8, C9, C11, C12, OPEN JUMPERS FF AND HH, AND ADD EXTERNAL REGULATOR HB-46580

(3) TP1 THRU TP4 ARE PART OF POWER ASSY

(4) SHIELD OVER POWER SUPPLY.

Figure 11-4. Schematic, RFL 6745 dc-dc converter power supplies (Schematic No. D-41502, Rev. X)

Table 11-2. Replaceable parts, RFL 68 REG External Regulator
Assembly No. 46580

Circuit Symbol (Fig. 11-5)	Description	Part Number
C1,2	Capacitor,tantalum,22µF,20%,35V,Corning CCZ-035-226-20 or equiv.	1007 657
C3,4	Capacitor,tantalum,3.3µF,20%,35V,Kemet T322C335M035AS or equiv.	1007 1260
CR1-4	Diode,silicon,200 PIV,1N4003	30769
IC1,2	Linear voltage regulator,+12-volt,3-terminal TO-220 case, National Semiconductor LM340T-12 or equiv.	0620 69
R1-9	Not used.	
R10,11	Resistor,metal film,2.21KΩ,1%,1/4W, Type RN1/4	0410 1321

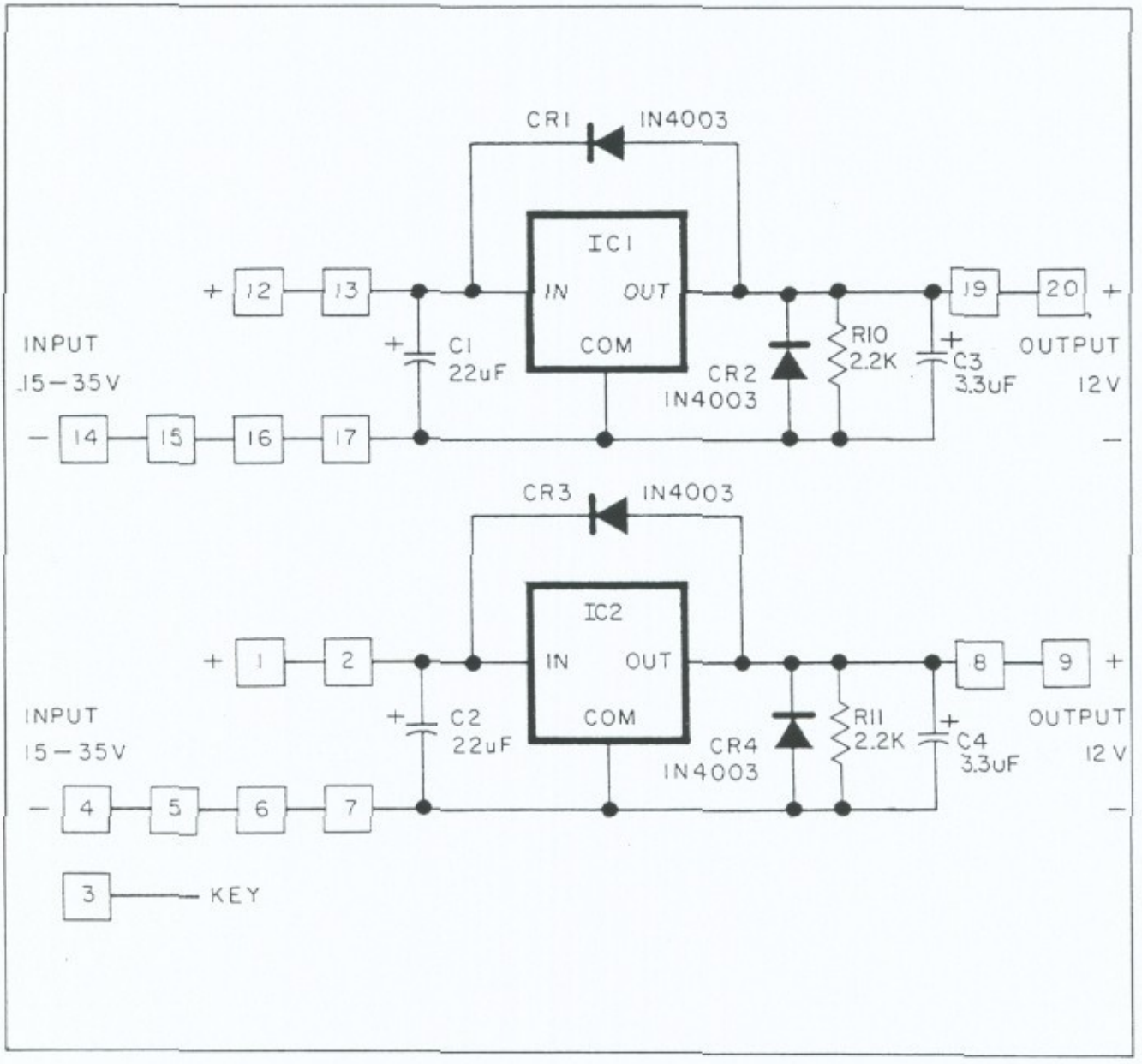


Figure 11-5. Schematic, RFL 68 REG External Regulator (Assembly No. 46580; Schematic No. B-46584, Rev. F)

Section 12. CHASSIS, BACKPLANE MOTHERBOARDS, AND SWC INTERFACE BOARDS

12.1. INTRODUCTION

This section provides information on the major assemblies that make up the RFL 6745's chassis. The chassis itself is described in paragraph 12.2, and the backplane motherboard is covered in paragraph 12.3. The SWC interface boards that are used in RFL 6745 terminals equipped with the Fast-Transient Option are described in paragraph 12.4.

A typical chassis is shown in Figure 12-1. A typical fast-transient chassis is shown in Figure 12-2. Interface boards are mounted to rear panel of the fast-transient chassis to provide SWC-protected customer connections.

12.2. CHASSIS

Each RFL 6745 is housed in an RFL 68 CHAS chassis, which occupies 5.25 inches (3 rack units) of vertical space in a 19-inch rack or cabinet. All chassis dimensions conform to EIA standards.

Terminal blocks on the rear panel of the RFL 68 CHAS provide connections to external equipment. Space is also provided on the rear panel for mounting an RFL 68 REG External Regulator, which is used in conjunction with the RFL 6745's dc-dc converter power supply (Section 12.) Fast-transient versions of the RFL 68 CHAS are equipped with interface boards; they are mounted to the rear panel in place of the terminal blocks.

The RFL 68 CHAS itself contains no field-replaceable components; because of this, there is no replaceable parts list in this section for the chassis.

12.3. MOTHERBOARDS

There are two different types of motherboards for the RFL 6745. Standard motherboards are described in paragraph 12.3.1; they provide interconnections for standard RFL 6745 chassis. Fast-transient motherboards are described in paragraph 12.3.2; they provide interconnections for RFL 6745 chassis equipped with the fast-transient option.

12.3.1. Standard Motherboards

Standard RFL 6745 motherboards are mounted toward the rear of each chassis that is not equipped with the fast-transient option. Each standard motherboard provides all electrical interconnections between the standard complement of RFL 6745 modules; accessory equipment installed within the chassis may be hard-wired to the motherboard. Cables hard-wired to the motherboard bring input signals onto the motherboard, and pass output signals to the terminals blocks, where they can be fed to external equipment.

Two different motherboards are available: one for terminals containing a single logic module (RFL P/N 47040), and one for terminals with dual logic modules (RFL P/N 47030). There are no field-replaceable components on either of these motherboards; because of this, there are no replaceable parts lists in this section for either motherboard.

12.3.2. Fast-Transient Motherboards

RFL 6745 motherboards are mounted toward the rear of the chassis. Each motherboard provides all electrical interconnections between the modules. Cables hard-wired to the motherboard bring input signals onto the motherboard, and pass output signals to the terminals blocks on the SWC interface boards, where they can be fed to external equipment.

Two different motherboards are available: one for terminals containing a single logic module (RFL P/N 104605), and one for terminals with dual logic modules (RFL P/N 104610). A parts list for both of these motherboards appears in Table 12-1.

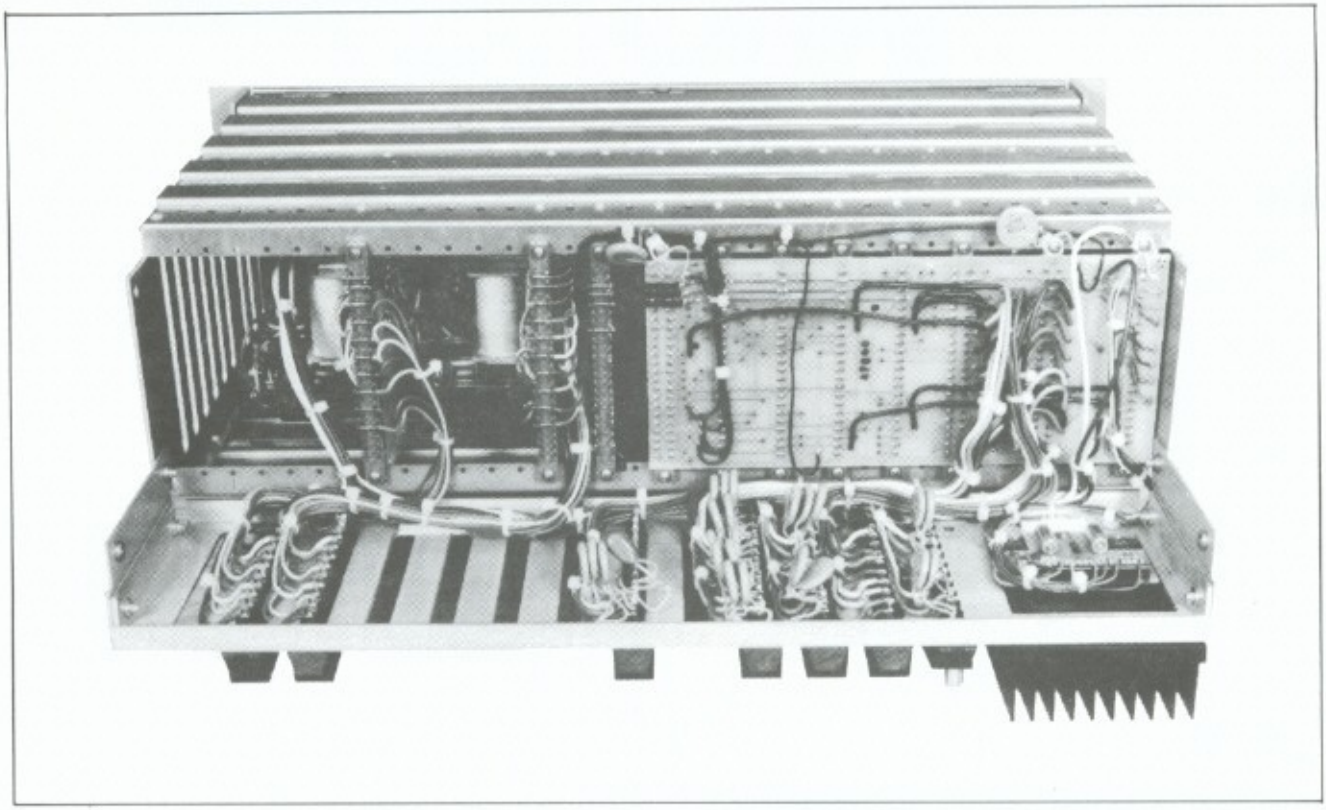


Figure 12-1. Typical standard RFL 6745 chassis with rear panel lowered to show location of motherboard

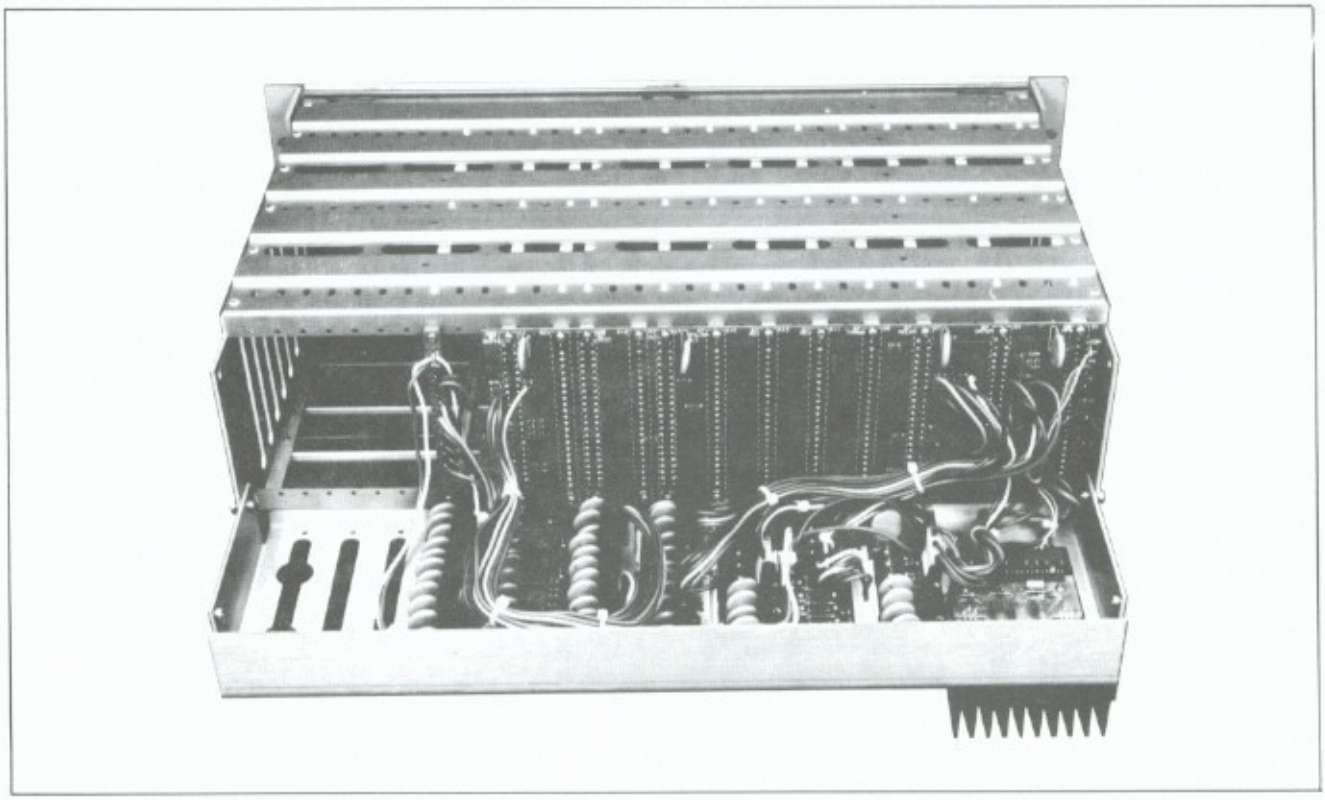
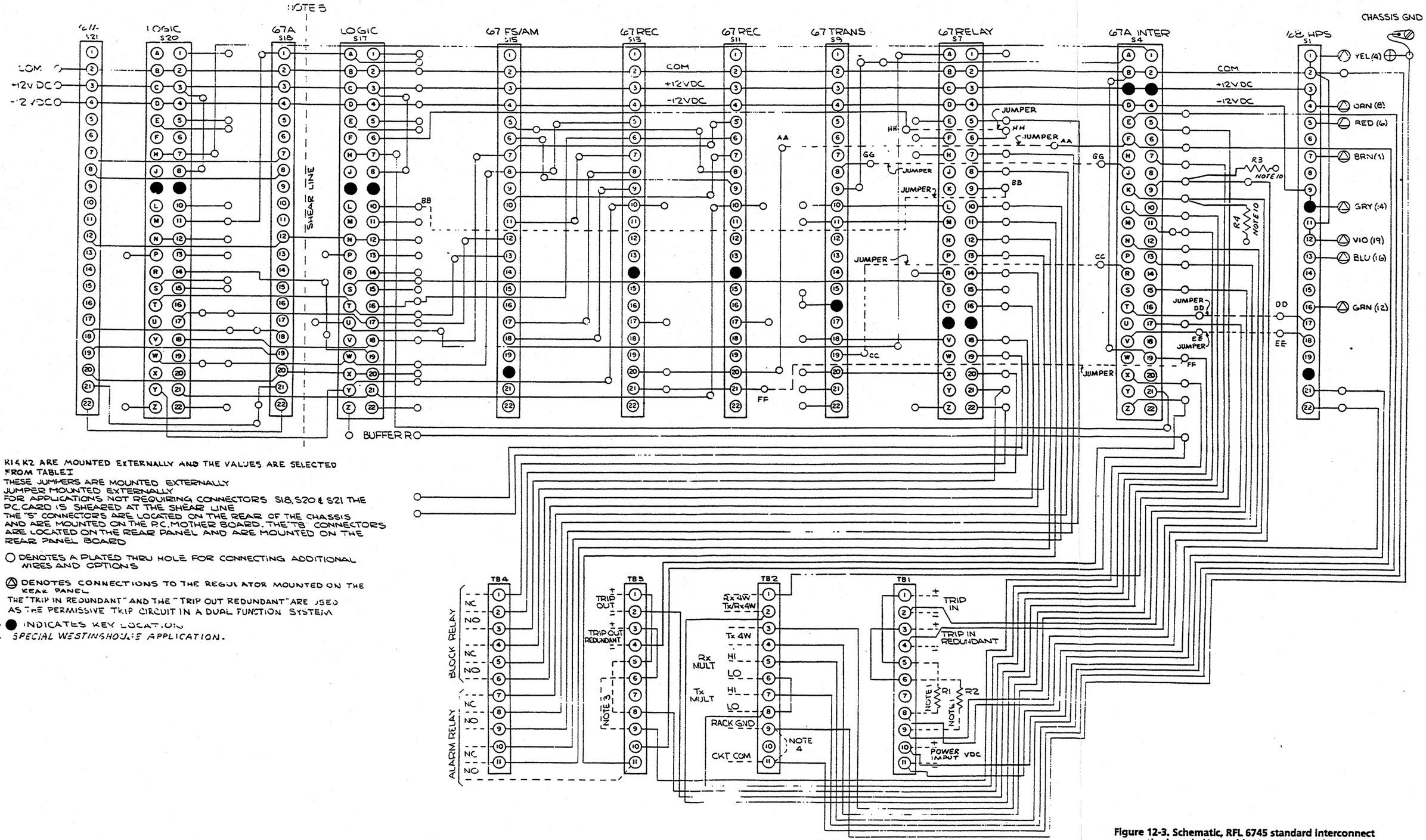


Figure 12-2. Typical fast-transient RFL 6745 chassis with rear panel lowered to show location of motherboard and interface boards

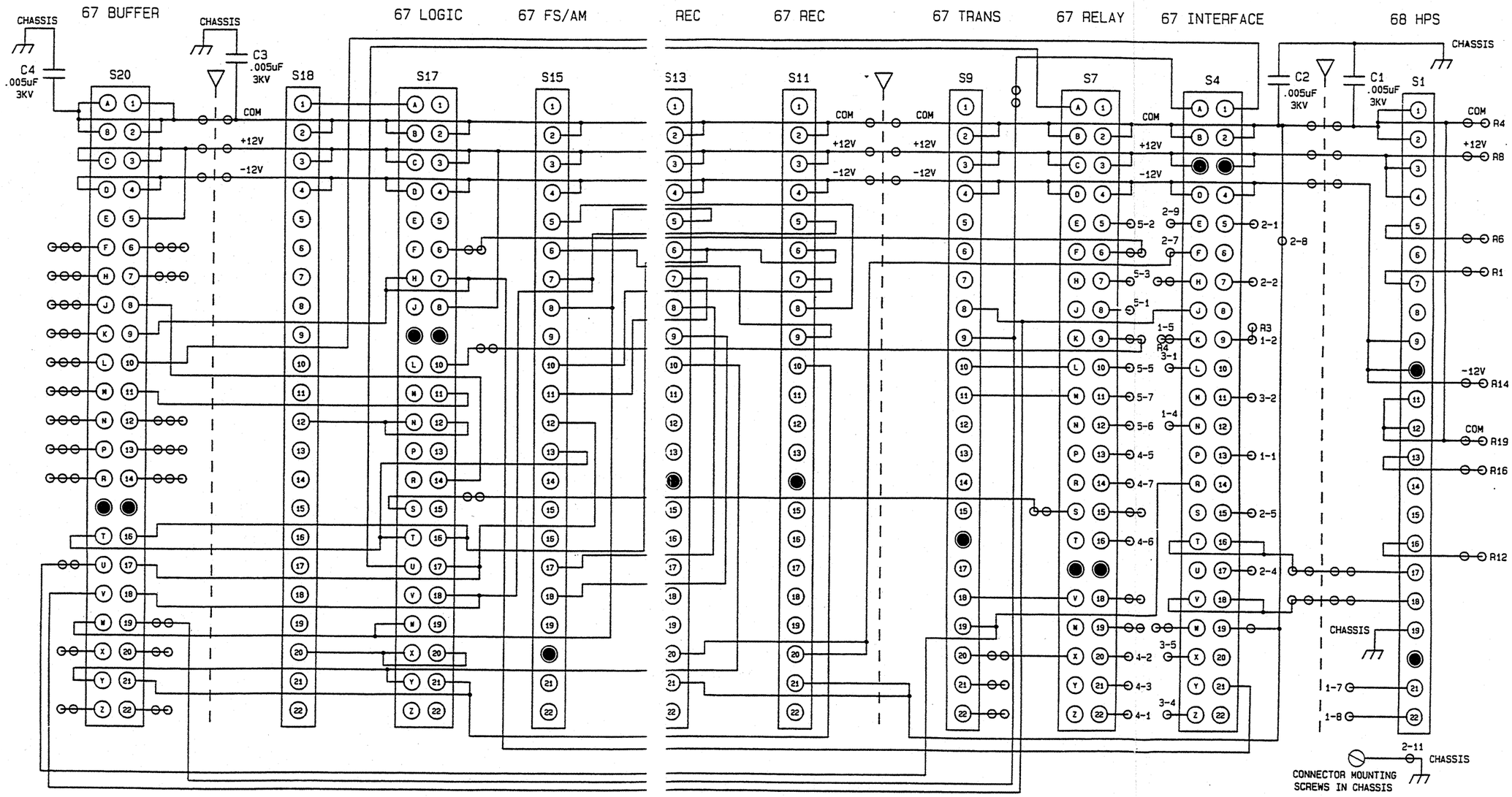
Table 12-1. Replaceable parts, RFL 6745 fast-transient interconnect motherboards
Single Logic Module - Assembly No. 104605
Dual Logic Modules - Assembly No. 104610

Circuit Symbol (Figs. 12-4 & 12-5)	Description	Part Number
C1-4	Capacitor,ceramic disc,0.005µF,20%,3kV,Centralab DD30-502 or equiv.	1007 1264



1. K1 & K2 ARE MOUNTED EXTERNALLY AND THE VALUES ARE SELECTED FROM TABLE I
2. THESE JUMPERS ARE MOUNTED EXTERNALLY
3. JUMPER MOUNTED EXTERNALLY
4. FOR APPLICATIONS NOT REQUIRING CONNECTORS S18, S20 & S21 THE P.C. CA2D IS SHEARED AT THE SHEAR LINE
5. THE "S" CONNECTORS ARE LOCATED ON THE REAR OF THE CHASSIS AND ARE MOUNTED ON THE P.C. MOTHER BOARD. THE "TB" CONNECTORS ARE LOCATED ON THE REAR PANEL AND ARE MOUNTED ON THE REAR PANEL BOARD
6. ○ DENOTES A PLATED THRU HOLE FOR CONNECTING ADDITIONAL WIRES AND OPTIONS
7. △ DENOTES CONNECTIONS TO THE REGULATOR MOUNTED ON THE REAR PANEL
8. THE "TRIP IN REDUNDANT" AND THE "TRIP OUT REDUNDANT" ARE USED AS THE PERMISSIVE TRIP CIRCUIT IN A DUAL FUNCTION SYSTEM
9. ● INDICATES KEY LOCATION
10. SPECIAL WESTINGHOUSE APPLICATION.

Figure 12-3. Schematic, RFL 6745 standard interconnect motherboards (Assembly Nos. 47030 and 47040; Schematic No. D-47034, Rev. F)



P5 1 — ALARM N.C. — 5-1
P5 2 — ALARM C. — 5-2
P5 3 — ALARM N.O. — 5-3
P5 4 — NOTE 6
P5 5 — ALARM N.C. — 5-5
P5 6 — ALARM C. — 5-6
P5 7 — ALARM N.O. — 5-7

22 AWG 3000V

P4 1 — BLOCK N.C. — 4-1
P4 2 — BLOCK C. — 4-2
P4 3 — BLOCK N.O. — 4-3
P4 4 — NOTE 6 (KEY)
P4 5 — BLOCK N.C. — 4-5
P4 6 — BLOCK C. — 4-6
P4 7 — BLOCK N.O. — 4-7

22 AWG 3000V

HARNESSING TO SWC INTERFACE ASSY 104615

P3 1 — TRIP OUT - — 3-1
P3 2 — TRIP OUT + — 3-2
P3 3 — NOTE 6 (KEY)
P3 4 — TRIP OUT REDUN - — 3-4
P3 5 — TRIP OUT REDUN + — 3-5

22 AWG 3000V

2 1 — 2W/4W RX — 2-1
2 2 — 2W/4W RX — 2-2
2 3 — NOTE 6
2 4 — 4W TX — 2-4
2 5 — 4W TX — 2-5
2 6 — NOTE 6
2 7 — RX MULT HI — 2-7
2 8 — COM — 2-8
2 9 — TX MULT HI — 2-9
2 10 — NOTE 6 (KEY)
2 11 — CHASSIS — 2-11

22 AWG 3000V

P1 1 — TRIP IN - — 1-1
P1 2 — TRIP IN + — 1-2
P1 3 — NOTE 6
P1 4 — TRIP REDUN - — 1-4
P1 5 — TRIP REDUN + — 1-5

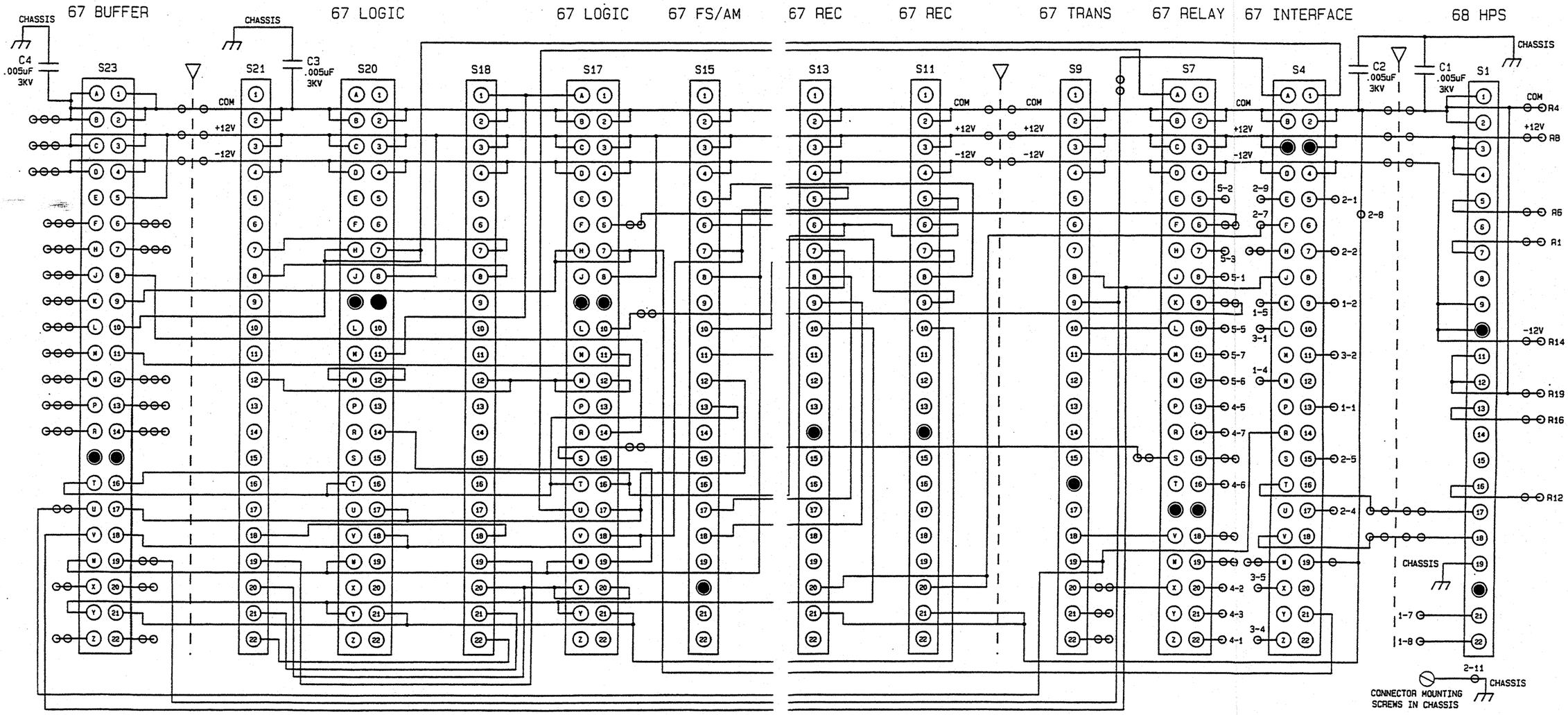
22AWG 3000V

P1 6 — NOTE 6 (KEY)
P1 7 — S.B. + — 1-7
P1 8 — S.B. - — 1-8

18AWG 3000V

NOTES :
1) S - INDICATES CARD EDGE CONNECTORS
2) ● INDICATES KEY LOCATION
3) RELAY CONTACTS MARKED UN-ENERGIZED
4) ▽ INDICATES SHEAR POINTS
5) ▽▽ INDICATES TWISTED PAIRS
6) BLANK FOR ISOLATION.

Figure 12-4. Schematic, RFL 6745 fast-transient interconnect motherboard for single logic module (Assembly No. 104605; Drawing No. D-104609, Rev. B)



HARNESSING TO SWC INTERFACE-1 ASSY 04615

P5 1	ALARM N.C.	5-1	
P5 2	ALARM C.	5-2	
P5 3	ALARM N.O.	5-3	
P5 4	NOTE 6		
P5 5	ALARM N.C.	5-5	
P5 6	ALARM C.	5-6	
P5 7	ALARM N.O.	5-7	

22 AWG 3000V

P4 1	BLOCK N.C.	4-1	
P4 2	BLOCK C.	4-2	
P4 3	BLOCK N.O.	4-3	
P4 4	NOTE 6 (KEY)		
P4 5	BLOCK N.C.	4-5	
P4 6	BLOCK C.	4-6	
P4 7	BLOCK N.O.	4-7	

22 AWG 3000V

P3 1	TRIP OUT -	3-1	
P3 2	TRIP OUT +	3-2	
P3 3	NOTE 6 (KEY)		
P3 4	TRIP OUT REDUN -	3-4	
P3 5	TRIP OUT REDUN +	3-5	

22 AWG 3000V

P2 1	2W/4W RX	2-1	
P2 2	2W/4W RX	2-2	
P2 3	NOTE 6		
P2 4	4W TX	2-4	
P2 5	4W TX	2-5	
P2 6	NOTE 6		
P2 7	RX MULT HI	2-7	
P2 8	COM	2-8	
P2 9	TX MULT HI	2-9	
P2 10	NOTE 6		
P2 11	CHASSIS	2-11	

22 AWG 3000V

P1 1	TRIP IN -	1-1	
P1 2	TRIP IN +	1-2	
P1 3	NOTE 6		
P1 4	TRIP REDUN -	1-4	
P1 5	TRIP REDUN +	1-5	
P1 6	NOTE 6		
P1 7	S.B. +	1-7	
P1 8	S.B. -	1-8	

22AWG 3000V

18AWG 3000V

NOTES :

1) S - INDICATES CARD EDGE CONNECTORS
2) ● INDICATES KEY LOCATION
3) RELAY CONTACTS MARKED UN-ENERGIZED
4) ▽ INDICATES SHEAR POINTS
5) ⩛ INDICATES TWISTED PAIRS
6) BLANK FOR ISOLATION.

Figure 12-5. Schematic, RFL 6745 fast-transient interconnect motherboard for dual logic modules (Assembly No. 104610; Drawing No. D-104614, Rev. B)

12.4. SWC INTERFACE BOARDS

SWC interface boards help the RFL 6745 achieve compliance with the SWC requirements of ANSI C.37.90-1989, and the Fast-Transient requirements of ANSI C.37.90.1-1989. These boards reduce transient amplitudes to levels that do not exceed the dielectric capabilities of the isolating components. The isolating components include components mounted on many of the circuit board modules in the chassis, the SWC interface boards, the motherboard, and all interconnecting wires and cables. The transient rise time is also decreased; this reduces the amount of radiated energy that could be induced into the RFL 6745's circuitry, causing system misoperation.

There are three different SWC interface boards available for use in the RFL 6745: the 6745 SWC INTFC-1 (Fig. 12-6a), the 6745 SWC INTFC-2 (Fig. 12-6b), and the 6745 SWC INTFC-3 (Fig. 12-6c).

The 6745 SWC INTFC-1 provides protection for the RFL 6745's basic connections: trip input, trip output, power input, ALARM and BLOCK relay contacts, and all tone lines except TX MULT and RX MULT. It is described in paragraph 12.4.1.

The 6745 SWC INTFC-2 provides eleven protected I/O circuits. These circuits can be used as required to make connections to any accessory equipment installed in the RFL 6745 chassis. The 6745 SWC INTFC-2 is described in paragraph 12.4.2.

The 6745 SWC INTFC-3 is similar to the 6745 SWC INTFC-2, except the circuits are grouped as three independent circuits and four circuit pairs. Each circuit pair is bridged with a transient overvoltage protector to provide transverse voltage clamping. Paragraph 12.4.3 provides additional information on the 6745 SWC INTFC-3.

12.4.1. 6745 SWC INTFC-1

The 6745 SWC INTFC-1 supports the first four terminal blocks on the RFL 6745's rear panel. These terminal blocks include the basic user connections to the RFL 6745: trip input, trip output, power input, ALARM and BLOCK relay contacts, and all tone lines except TX MULT and RX MULT.

a. Trip Input. The trip input lines are protected by LC filters formed from inductors L1 through L4 and capacitors C1 through C4. Resistors R1 and R2 limit the input current. Zener diodes CR6 and CR20 on the interface module (Section 5) provides additional protection in the transverse mode.

b. Power Input. The power input lines are protected by LC filters formed from inductors L5 and L6 and capacitors C5 and C6. Transient overvoltage suppressor CR1 limits transverse voltages to 180 volts.

c. Tone Lines. Transient overvoltage suppressor CR2 through CR5 are used in pairs to limit the common-mode voltage (balanced tone line to chassis) to 68 Vpeak. They also effectively limit the transverse (or "metallic") voltages to 136 volts. Transient overvoltage protectors CR18 and CR19 on the interface module (Section 5) provides additional protection with a 184-volt threshold. In order to minimize longitudinal unbalance, LC filters were not used to protect the tone lines.

CAUTION

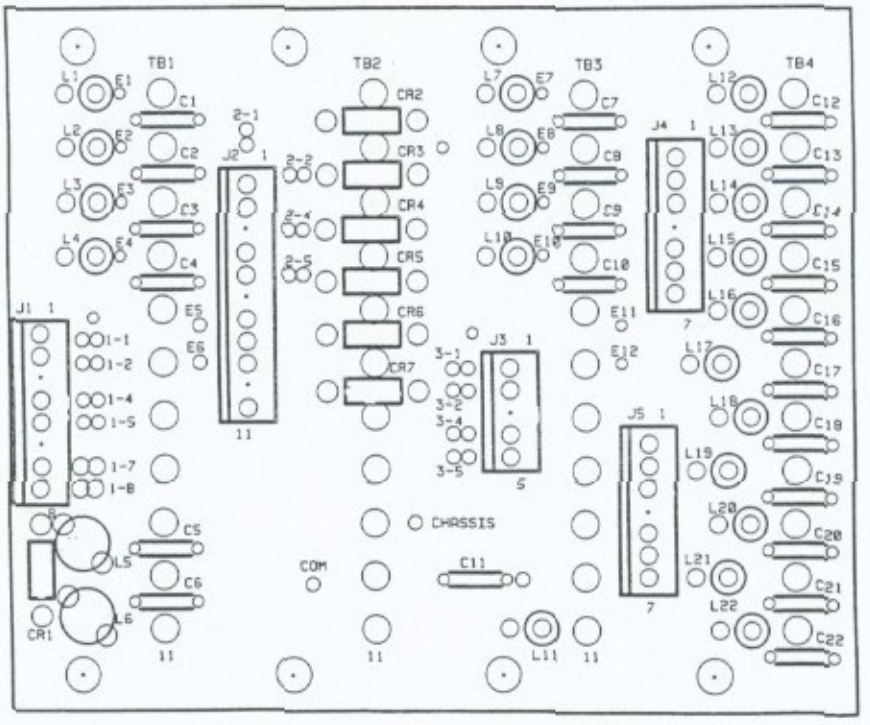
Terminals TB2-5 through TB2-8 (TX MULT and RX MULT) are not equipped with SWC or fast-transient protection circuits. Any attempt to subject these terminals to SWC test voltages may result in component damage.

d. Trip Output. The trip output lines are protected by LC filters formed from inductors L7 through L10 and capacitors C7 through C10. Transient overvoltage protectors CR16 and CR17 on the interface module (Section 5) limits transverse voltages to 184 Vpeak.

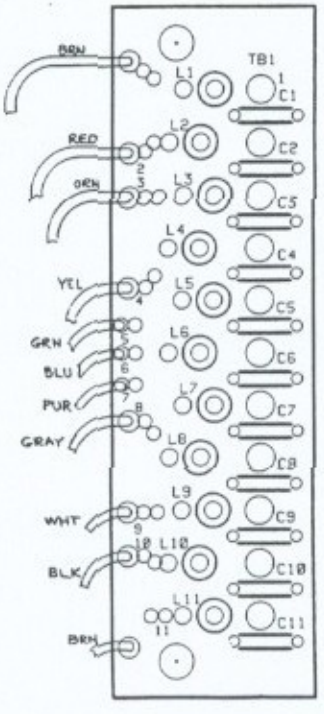
e. ALARM and BLOCK relay contacts. Voltage transients are fed through LC filters formed from inductors L11 through L22 and capacitors C11 through C22. These filters reduce the voltage transients to a point where no contact arcing occurs.

12.4.2. 6745 SWC INTFC-2

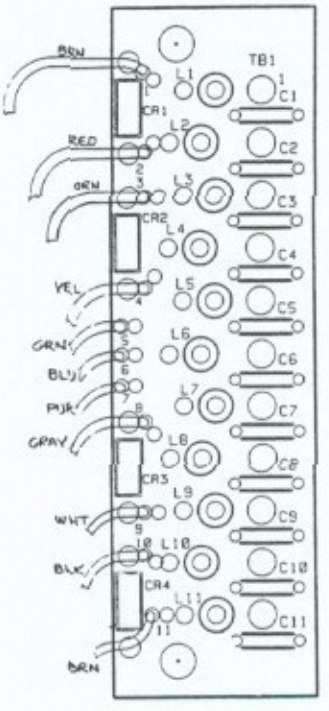
The 6745 SWC INTFC-2 can be used in chassis that contain accessory equipment to provide SWC-capable customer connections. Each 6745 SWC INTFC-2 supports an additional 11-position terminal block; each terminal on the block feeds a separate LC filter circuit. Each filter circuit has 1500 Vrms isolation from all other circuits and chassis ground (or 2121 Vdc). The maximum dc current that can be passed by each circuit is 1.5 amperes. If the terminals are isolated from common-referenced circuitry by 1500 Vrms or more, the 6745 SWC INTFC-2 makes them SWC-compatible.



a. 6745 SWC INTFC-1.



b. 6745 SWC INTFC-2.



c. 6745 SWC INTFC-3.

Figure 12-6. RFL 6745 SWC interface boards

12.4.3. 6745 SWC INTFC-3

The 6745 SWC INTFC-3 is similar to the 6745 SWC INTFC-2, except that some of the filter circuits are bridged by a transient overvoltage protector to provide transverse voltage clamping. Wiring assignments are as follows:

Terminals 1 And 2:

These terminals feed the first circuit pair (Circuit Pair 1). Inductors L1 and L2 and capacitors C1 and C2 form two LC filters. Their outputs are connected by transient overvoltage protector CR1.

Terminals 3 And 4

These terminals feed the second circuit pair (Circuit Pair 2). Inductors L3 and L4 and capacitors C3 and C4 form two LC filters. Their outputs are connected by transient overvoltage protector CR2.

Terminals 5 through 7

These terminals feed three independent LC filters formed from inductors L5 through L7 and capacitors C5 through C7. These filters are not connected by transient overvoltage protectors, and are suitable for relay output lines.

Terminals 8 And 9

These terminals feed the third circuit pair (Circuit Pair 3). Inductors L8 and L9 and capacitors C8 and C9 form two LC filters. Their outputs are connected by transient overvoltage protector CR3.

Terminals 10 And 11

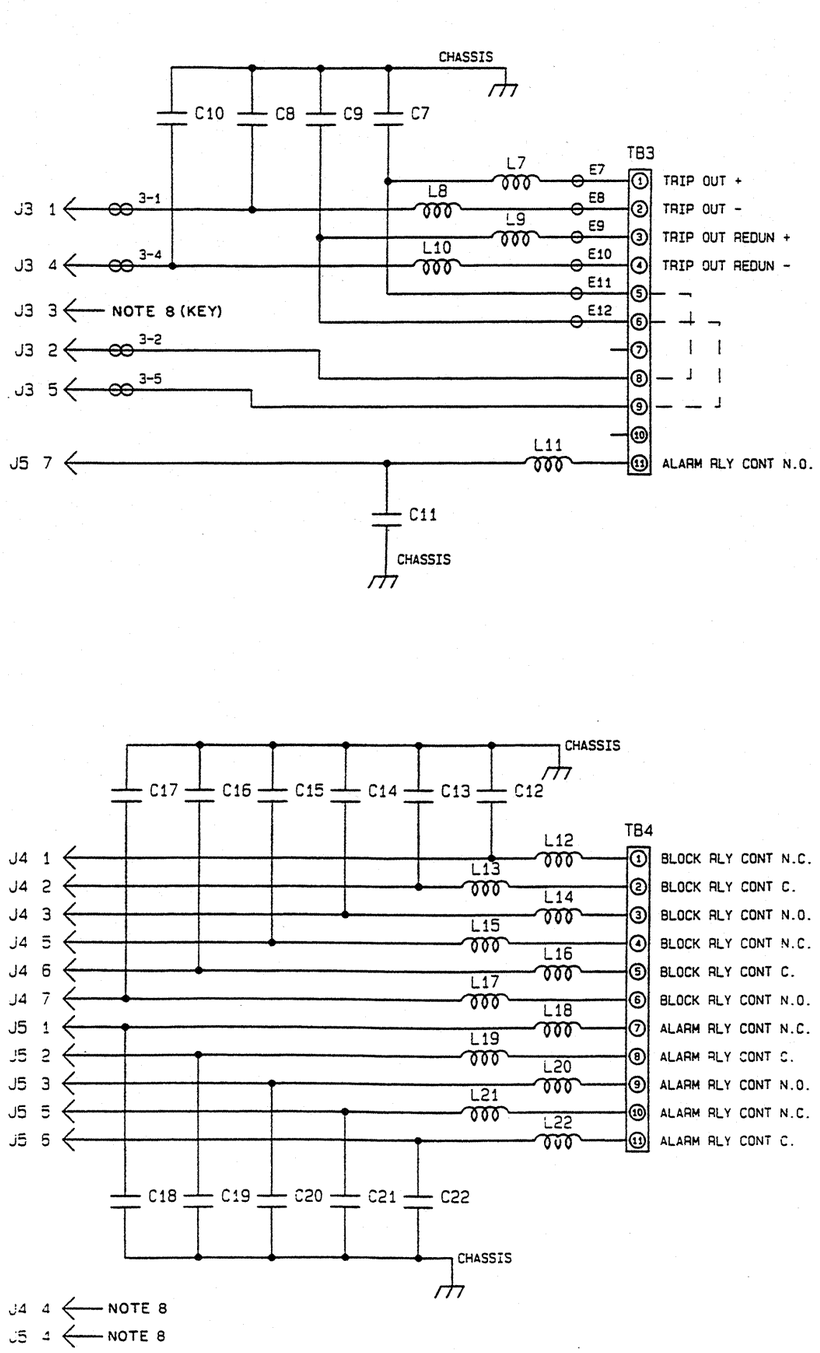
These terminals feed the fourth circuit pair (Circuit Pair 4). Inductors L10 and L11 and capacitors C10 and C11 form two LC filters. Their outputs are connected by transient overvoltage protector CR4.

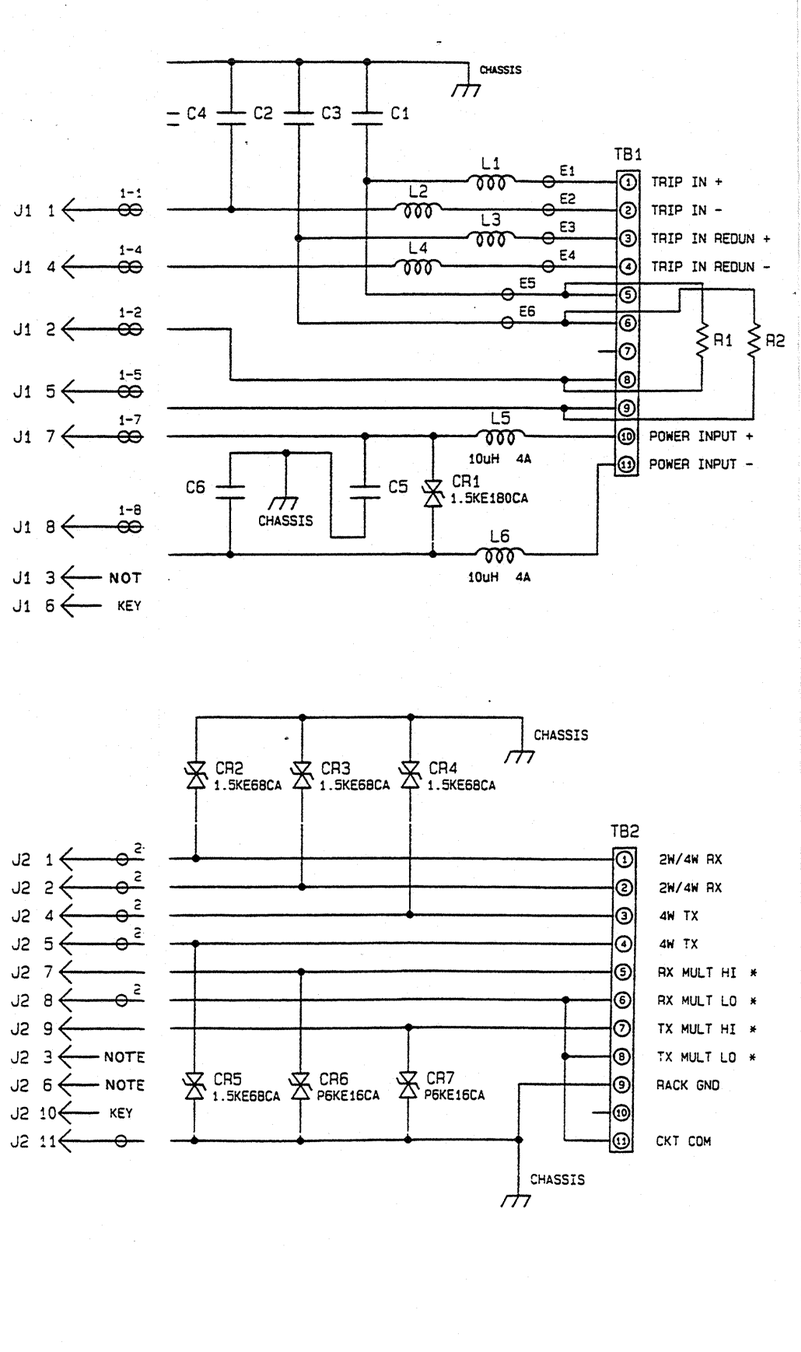
Table 12-2. Replaceable parts, 6745 SWC INTFC-1 Fast-Transient Interface Board Assembly No. 104615

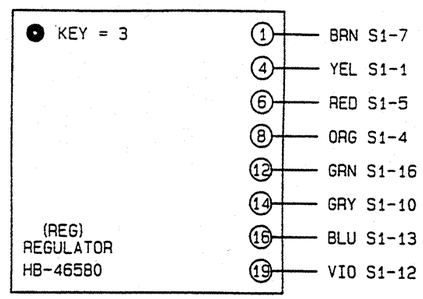
Circuit Symbol (Fig. 12-7)	Description	Part Number
C1-22	Capacitor,ceramic disc,0.005µF,20%,3kV,Centralab DD30-502 or equiv.	1007 1264
CR1	Transient voltage suppressor,171- to 189-volt breakdown, General Semiconductor 1.5KE180CA or equiv.	42064
CR2-5	Transient voltage suppressor,64.6 to 71.4-volt breakdown,1.5A peak, General Semiconductor 1.5KE68CA or equiv.	48101
CR6,7	Transient voltage suppressor,bidirectional,15.2 to 16.8-volt breakdown, General Semiconductor P6KE16CA or equiv.	100572
L1-4,7-22	Inductor,rf,10µH,5%,J.W. Miller 4622 or equiv.	30285
L5,6	Inductor,power line,10µH,Renco RLS1283-10-43 or equiv.	101967

Table 12-3. Replaceable parts, single terminal block fast-transient interface boards
6745 SWC INTFC-2 (11 independent filters) Assembly No. 104630
6745 SWC INTFC-3 (3 independent filters, 4 filter pairs with transient suppressors) - Assembly No. 104635

Circuit Symbol (Figs. 12-8 and 12-9)	Description	Part Number
C1-11	Capacitor,ceramic disc,0.005µF,20%,3kV,Centralab DD30-502 or equiv.	1007 1264
L1-11	Inductor,rf,10µH,5%,J.W. Miller 4622 or equiv.	30285
CR1-4 (-3 only)	Transient voltage suppressor,presence dependent upon model: 6745 INTFC-2: Not used. 6745 INTFC-3: 171- to 189-volt breakdown, General Semiconductor 1.5KE180CA or equiv.	42064







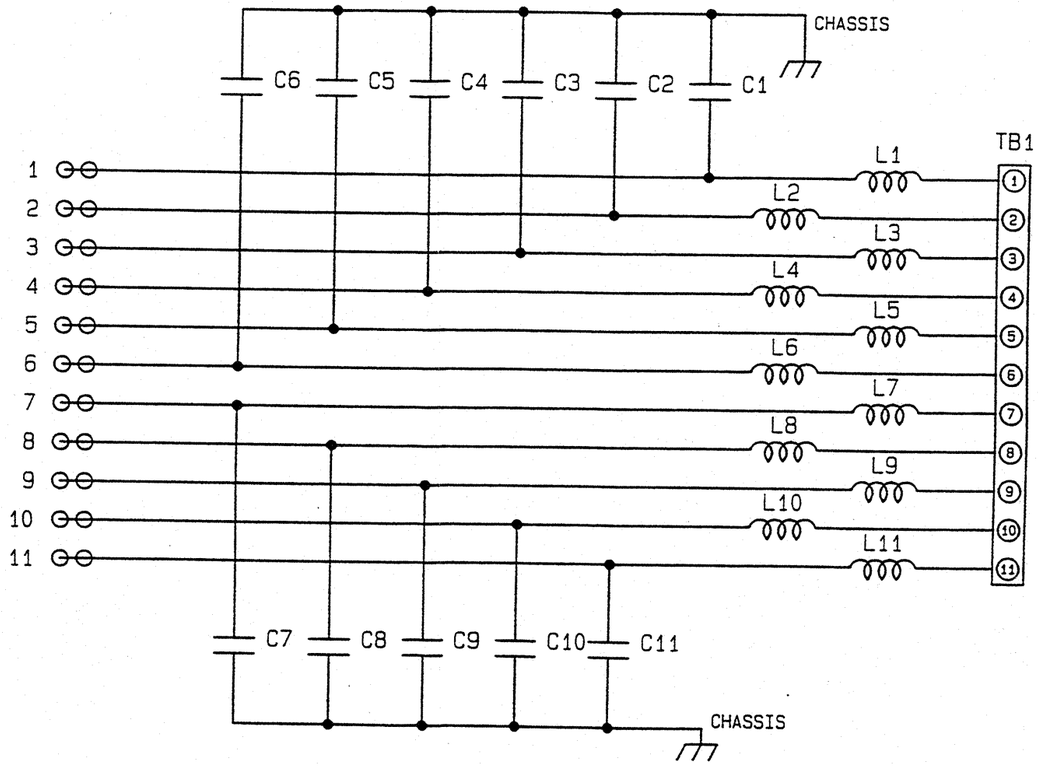
MOUNTED ON REAR PANEL

TABLE 1 (PER S.O.)			
DC VOLTAGE	24V	48V	125V
R1 & R2 P/N	500 1100-308	1.5K 1220-35	4.5K 1100-690

NOTES:

1) TB - INDICATES BARRIER STRIPS
2) RELAY CONTACTS SHOWN UNENERGIZED
3) RESISTORS R1 & R2 ARE MOUNTED EXTERNALLY
4) CHASSIS EQUIPED WITH EXTERNAL JUMPER BETWEEN CIRCUIT COMMON AND CHASSIS GND
5) UNLESS OTHERWISE MARKED
   ALL CAPS ARE .005 uF 3KV
   ALL INDUCTORS 10uH 1.5 A MAX
6) ○ - INDICATES SOLDER PAD FOR EXTRA WIRING
7) * - INDICATES CIRCUITRY WITHOUT ISOLATION AND SHOULD NOT BE DIRECTLY EXPOSED TO TRANSIENTS.
8) BLANK FOR ISOLATION.

Figure 12-7. Schematic, 6745 SWC INTFC-1 Fast-Transient Interface Board (Assembly No. 104615; Schematic No. D-104619, Rev. B)



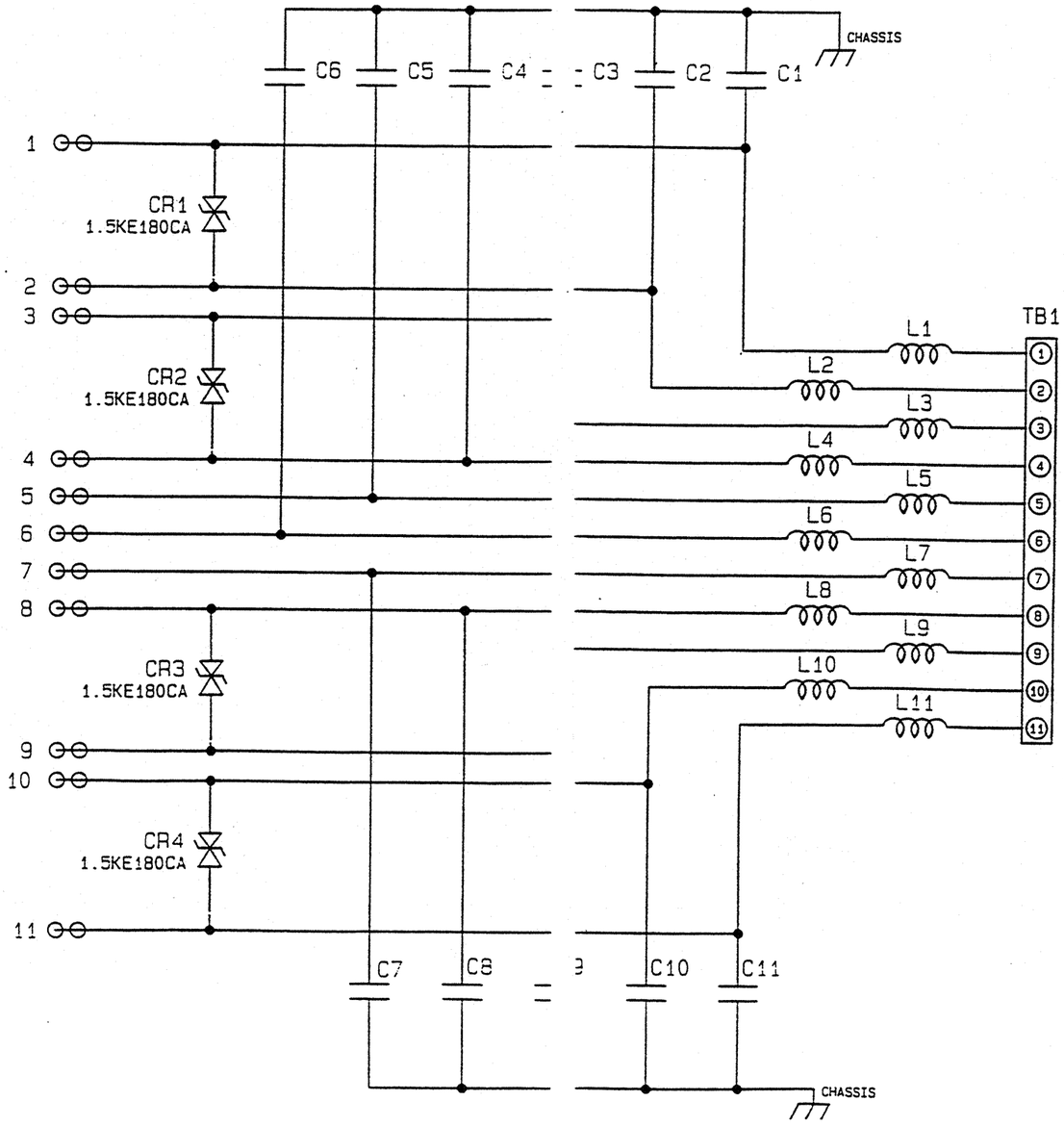
NOTES:

1) TB1 - UNIVERSAL TERMINAL BLOCK

2) UNLESS OTHERWISE MARKED
   ALL CAPS ARE .005 uF 3KV
   ALL INDUCTORS 10uH 1.5 A MAX

3) ◯ INDICATES SOLDER PAD

Figure 12-8. Schematic, 6745 SWC INTFC-2 Fast-Transient Interface Board (Assembly No. 104630; Schematic No. C-104634, Rev. B)



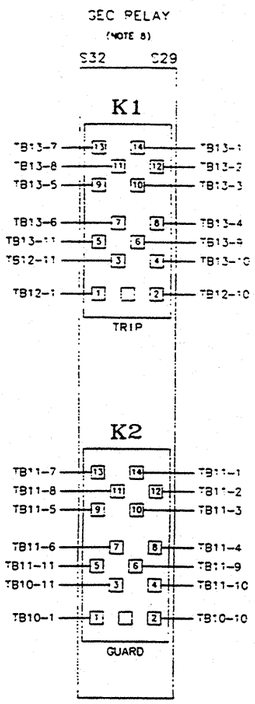
NOTES:

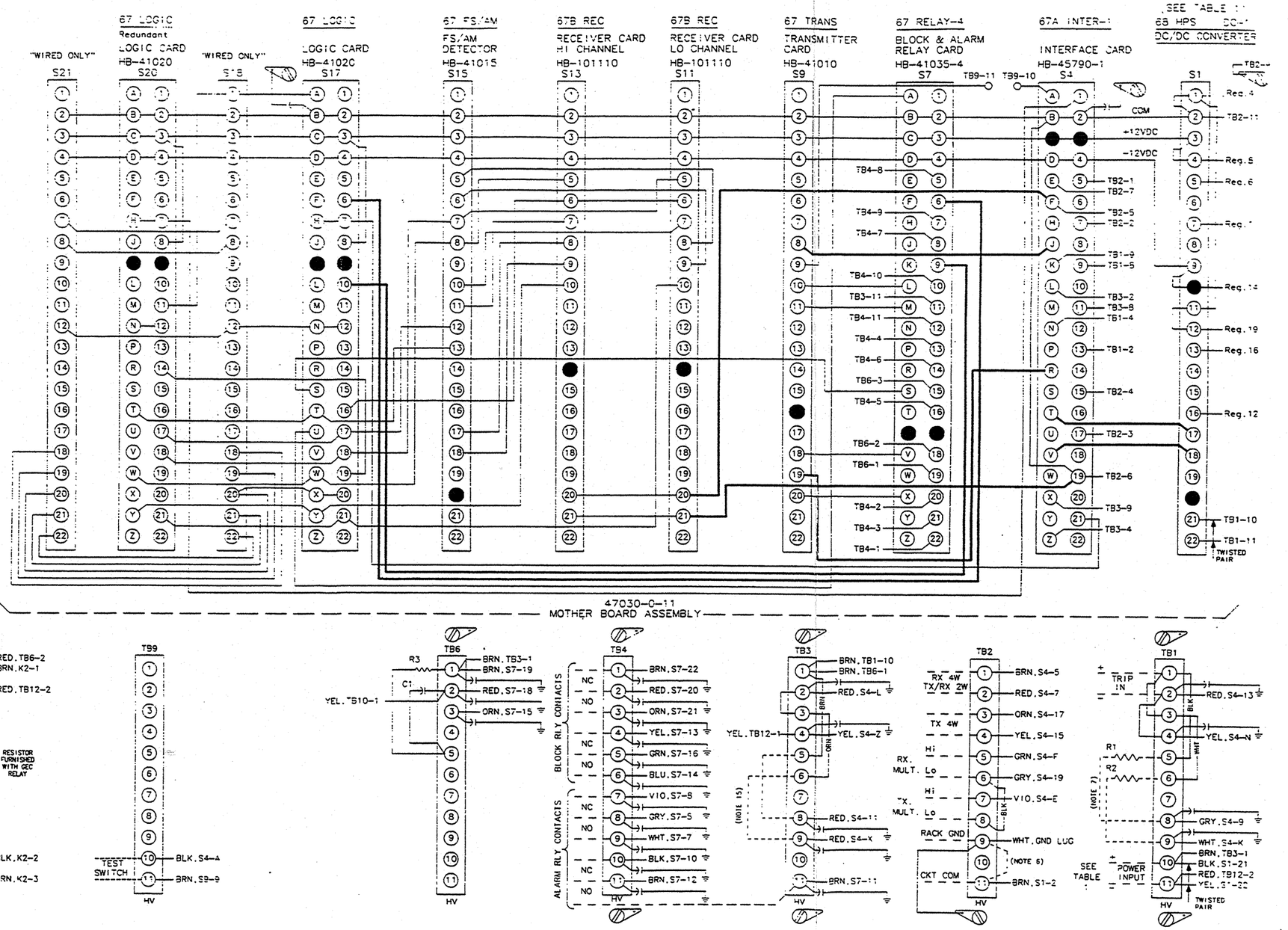
1) TB1 - UNIVERSAL TERMINAL BLOCK

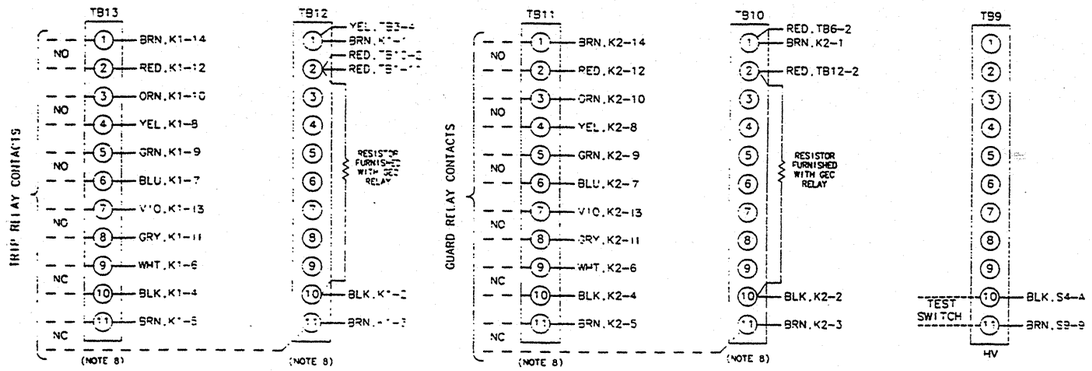
2) UNLESS OTHERWISE MARKED
ALL CAPS ARE .005 uF 3KV
ALL INDUCTORS 10uH 1.5 A MAX

3) ◯ INDICATES SOLDER PAD

Figure 12-9. Schematic, 6745 SWC INTFC-3 Fast-Transient Interface Board (Assembly No. 104635; Schematic No. C-104639, Rev. B)







NOTES (WHERE APPLICABLE)

1. S – INDICATES PRINTED CIRCUIT BOARD SOCKETS.
2. TB – INDICATES BARRIER STRIPS.
3. ● – INDICATES KEY LOCATION
4. WIRING TO BE NO.22 STRANDED OF COLOR MARKED. UNMARKED WIRE S BUS WIRING AND/OR PART OF CIRCUIT BOARD DEPENDING UPON APPLICATION.
5. RELAY CONTACTS ARE SHOWN UNENERGIZED.
6. CHASSIS EQUIPPED WITH EXTERNAL JUMPER BETWEEN CIRCUIT COMMON AND RACK GROUND.
7. MOUNT RESISTORS EXTERNAL. PRODUCTION PLEASE NOTE.
8. TRIP & GUARD RELAY CONTACTS WIRING (#20AWG) TO BE ROUTED IN SEPARATE HARNESS.
9. HEAVY LINES ON MOTHER BOARD INDICATE JUMPERS.
10. HV – INDICATES HIGH VOLTAGE WIRE #22AWG (3000V).
11. * – INDICATES NOT EQUIPPED.
12. UNLESS OTHERWISE NOTED, ALL CAPACITORS ARE [illegible]

PARTS LIST:

(1)	46963-001	FRONT PANEL
(1)	46954-002	REAR PANEL
(2)	46552	EXT BRACKET
(1)	46950	CHASSIS
(1)	1037-1359	CAPACITOR .1uF (C1)
(1)	0410-1225	RESISTOR 220Ω (R3)
(1)	301057	RELAY MTG. BRACKET

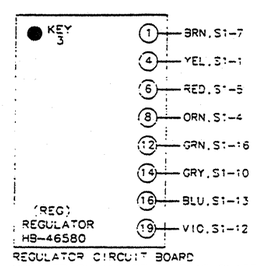
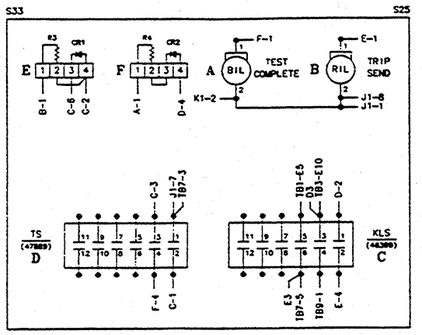
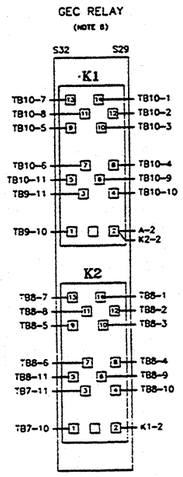


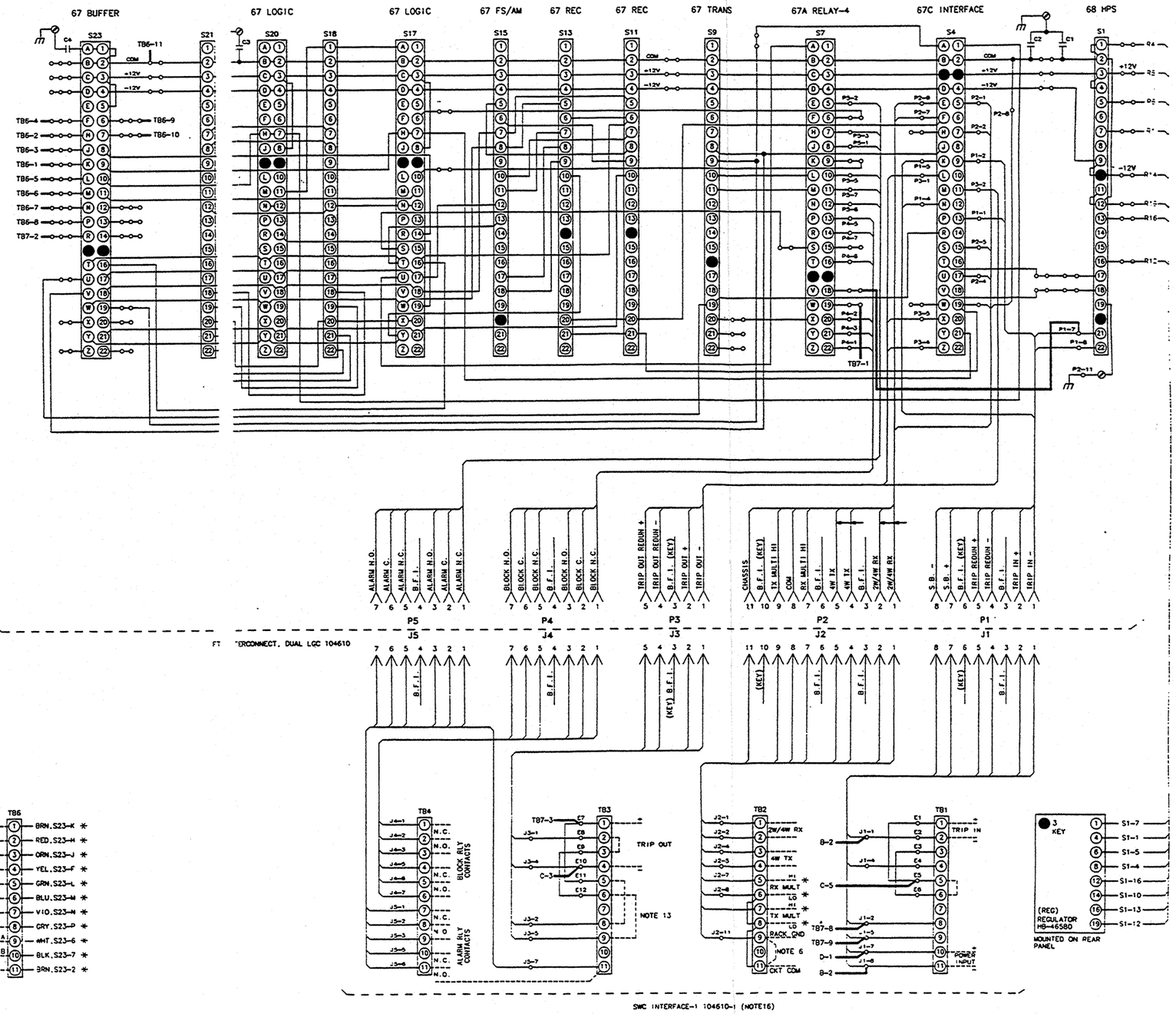
TABLE 1 (PER S.C.)

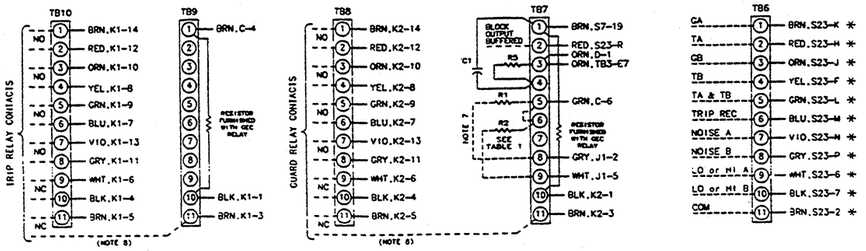
DC VOLTAGE	24V	48V	125V
R1 & R2 PART NUMBER	500Ω 1100-308	1.5k 1220-35	4.5k 1100-690
S1 DC – DC CONVERTER	41935-1	41515-1	41505-1
GEC (K1&K2) TRIP & GUARD RELAYS		301086	301068

Figure 12-10. Typical chassis wiring diagram, RFL 6745 Protective Relaying System (standard configuration) (Drawing No. CD-35044, Rev. A)









NOTES

1. S – INDICATES EDGE CONNECTOR ON MOTHER BOARD.
2. "B – INDICATES BARRIER STRIPS.
3. ● – INDICATES KEY LOCATION
4. WIRING TO BE NO 22 STRANDED OF COLOR MARKED UNMARKED WIRE S BUS WIRING AND/OR PART OF CIRCUIT BOARD DEPENDING UPON APPLICATION
5. RELAY CONTACTS ARE SHOWN UNENERGIZED.
6. CHASSIS EQUIPPED WITH EXTERNAL JUMPER BETWEEN CIRCUIT COMMON AND RACK GROUND
7. MOUNT RESISTORS EXTERNAL, PRODUCTION PLEASE NOTE
8. TRIP AND GUARD RELAY CONTACTS WIRING (#20AWG) TO BE
9. HV – INDICATES HIGH VOLTAGE WIRE #22AWG (3000V).
10. ✳ – INDICATES CIRCUITRY WITHOUT ISOLATION AND SHOULD NOT BE DIRECTLY EXPOSED TO TRANSIENTS.
11. UNLESS OTHERWISE NOTED, ALL CAPACITORS ARE 1007-1264. .005μF,3kV,20%
12. CONNECT TB3-2 TO TB3-4 WHEN SINGLE LOGIC IS USED.
13. RESISTORS REQUIRED FOR KEYING VOLTAGE ABOVE 125 VDC.
14. △ – INDICATES OPTIONAL EQUIPMENT
15. ○ – INDICATES SOLDER PAD FOR EXTRA WIRING.
16. SEE 6745 MANUAL FOR DETAILED SWC CIRCUIT INFORMATION.

PARTS LIST:

(1)	46963-001 FR	PANEL
(1)	46954-161 PC	ANEL
(2)	46552 EXT SR	
(1)	46950 CHASSI	
(1)	1007-1359 CA	OR (C1)
(1)	3410-1225 PC	OR (R5)

TABLE 1 (PER S.O.)				
DC VOLTAGE	24V	48V	125V	
R1 & R2 PART NUMBER	500Ω, 1100-308	5k, 1220-35	4.5k, 1100-690	
K1 & K2 GEC RLY TRIP & GUARD		301086	301068	
R3 & R4 PART NUMBER		5k, 1220-35	2k, 1100-684	

Figure 12-11. Typical chassis wiring diagram, RFL 6745 Protective Relaying System (fast-transient configuration) (Drawing No. CD-38341, Rev. A)

Section 13. ACCESSORY EQUIPMENT

13.1. INTRODUCTION

This section describes some of the accessory equipment which can be used with the RFL 6745 to perform useful auxiliary functions. If your RFL 6745 terminal is equipped with any accessory items, Instruction Data sheets for these items will be found later in this section. For further information on these and other accessory items, contact the factory or any RFL Sales Representative.

13.2. RFL 67 BUFFER OUTPUT BUFFER MODULE

The RFL 67 BUFFER Output Buffer Module (Fig. 13-1) provides the following buffered outputs, which can be used for diagnostic purposes:

1. Trip (both subchannels).
2. Guard (both subchannels).
3. Noise squelch (both subchannels).
4. HI/LO Signal level (both subchannels).
5. Both trip signals combined in an AND gate without guard-before-trip logic.
6. Standard trip output (supervised trip after the logic).
7. Standard block output.

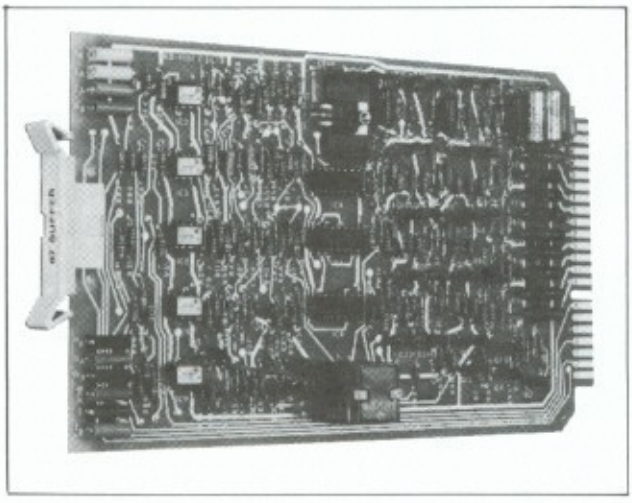


Figure 13-1. RFL 67 BUFFER Output Buffer Module

The buffer circuits can be set for either 12-volt or 18-volt outputs at 10 mA. The RFL 67 BUFFER can be used along with an optional RFL 6745 front panel equipped with plug-in LED indicators. This allows the operator to visually monitor the buffered outputs. A target-display seal-in circuit with a manual reset button can also be provided to hold any condition.

13.3. RFL 67 NB REC NARROWBAND RECEIVER MODULE

The RFL 67 NB REC Narrowband Receiver Module (Fig. 13-2) improves the dependability of RFL 6745 equipment that must operate through a communication medium with high noise levels. The RFL 67 NB REC's signal-to-noise ratio (S/N) is 10 dB higher than the RFL 67B REC Wideband Receiver Module (Section 7).

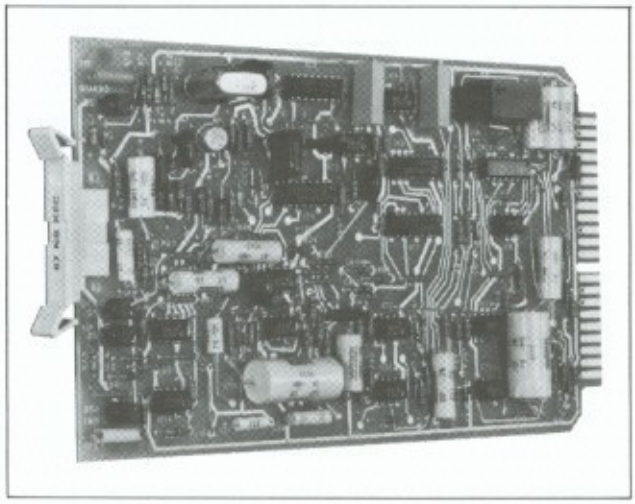


Figure 13-2. RFL 67 NB REC Narrowband Receiver Module

The RFL 67 NB REC does not respond to trip signals as fast as the RFL 67B REC does. Because of this, the RFL 67 NB REC does not replace the RFL 67B REC; they work side-by-side, with the RFL 67 NB REC only delivering a trip signal when the RFL 67B REC is forced into a blocked condition by excessive line noise.

Each RFL 67 NB REC narrowband receiver works on one subchannel, so two modules will be required per terminal.

13.4. RFL 67A LEV IND SIGNAL LEVEL INDICATOR

The RFL 67A LEV IND Signal Level Indicator And Monitor (Fig. 13-3) monitors the receiver input for presence of a tone signal. If the signal drops below a preset limit, an alarm relay will drop out. An edge-reading analog meter shows relative level of the received signal, and a switch allows the meter to monitor either subchannel. One RFL 67A LEV IND module can monitor signal levels in two RFL 6745 terminals.

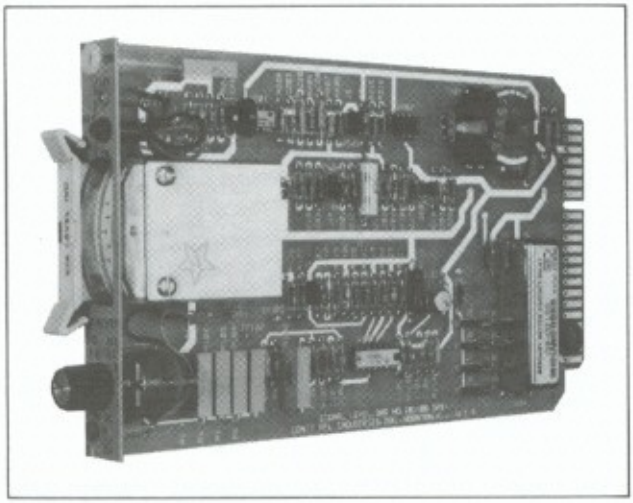


Figure 13-3. RFL 67A LEV IND Signal Level Indicator

13.5. RFL 67 TEST MANUAL TEST MODULE

The RFL 67 TEST Manual Test Module (Fig. 13-4) is used to perform diagnostic tests on each subchannel. Pressing a test switch on the front of the module will trip each subchannel in sequence, one at a time, for 60 milliseconds. When a trip is detected by the receiver for the subchannel under test, a lamp lights for eight seconds to indicate that the test was successfully completed. If a valid trip signal is received during the test, the test will be automatically overridden.

If a three-frequency transmitter and receiver are added to the system operating in a simplex mode, bi-directional tests can be performed on transfer trip systems without having an operator at both terminals.

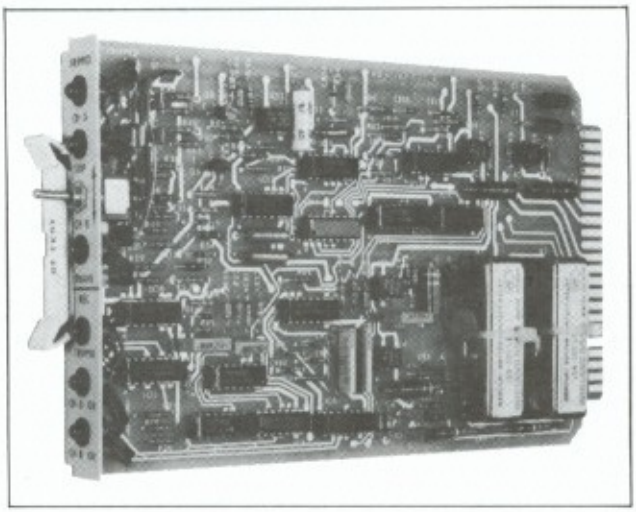


Figure 13-4. RFL 67 TEST Manual Test Module

13.6. RFL 67 MAN DIAG MANUAL DIAGNOSTIC PANEL

The RFL 67 MAN DIAG (Fig. 13-5) allows continui tests to be performed on the transmitter, the receive and the communications medium. The trip relay wi not be tested.

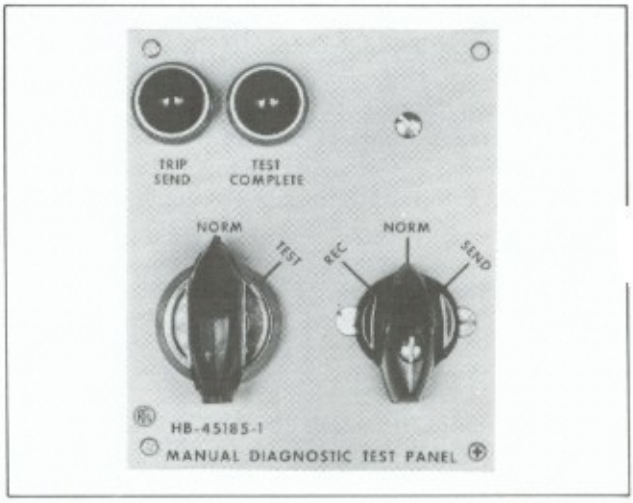


Figure 13-5. RFL 67 MAN DIAG Manual Diagnostic Panel

The RFL 67 MAN DIAG mounts in the RFL 6745 chassis, directly behind the front door. Indicator lamps, a send/receive test switch, and a key-lock enabling switch allow the system to be tested without tripping the associated breakers.

13.7. RFL 67 AR (XXX) AUXILIARY RELAY MODULE

Figure 13-6 shows the RFL 67 AR (XXX) Auxiliary Relay Module, which provides mounting and connection points for one or two ABB AR Series auxiliary relays. Several standard contact arrangements and coil voltages are available.

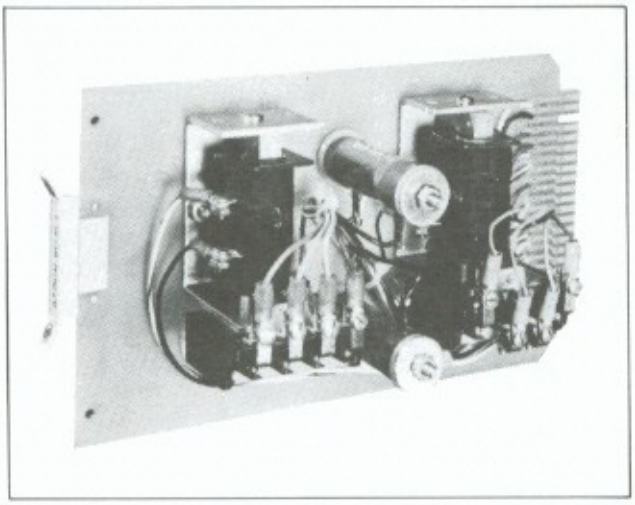


Figure 13-6. RFL 67 AR (XXX) Auxiliary Relay Module

13.8. FIBER OPTIC AUDIO LINKS

Fiber optic audio links are transceivers used to interface analog signals to fiber optic cables. Communication is possible over optic cables several miles long. This produces a wide-band communications link with a linear frequency response. A typical fiber optic audio link is shown in Figure 13-7.

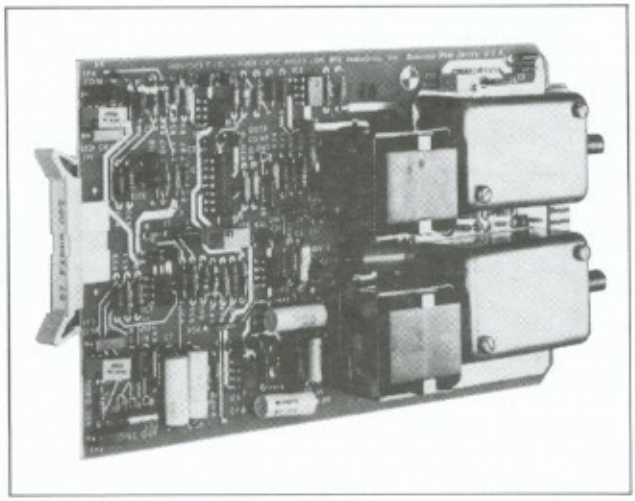


Figure 13-7. Typical RFL 6745 fiber optic audio link

Two different fiber optic audio links are available. The RFL 67A FIBER OPT transmits signals by amplitude-modulating the intensity of light applied to the optic cable by a 850-nm LED light source. The RFL 67B FIBER OPT works in the same way, but uses a 1300-nm laser light source.

Each module contains high- and low-pass filters, which normally limit the circuit from 300 Hz to 4 kHz; if desired, the filters may be bypassed for a total bandwidth of 5 Hz to 100 kHz. A predistortion circuit and the narrow bandwidth available with the filters in place enables the fiber optic audio links to operate over 60 dB of optic cable system losses (often called "system gain").

13.9. RFL 67 PER COOR PERMISSIVE COORDINATING MODULE

The RFL 67 PER COOR Permissive Coordination Module (Fig. 13-8) is used to interface the RFL 6745 to line relays and auxiliary devices used in directional comparison permissive overreaching transfer-trip systems (including unblocking).

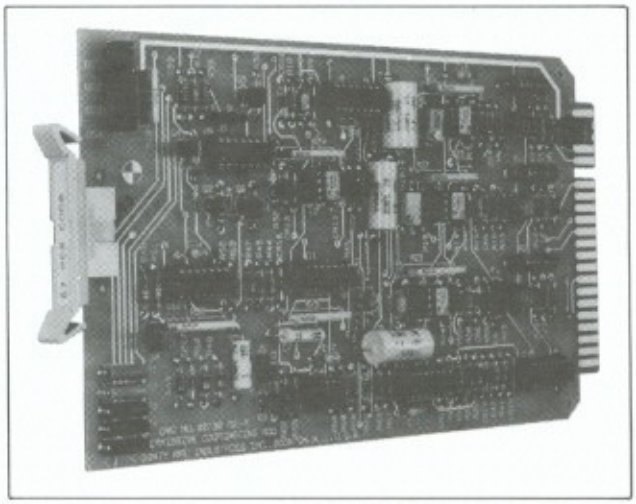


Figure 13-8. RFL 67 PER COOR Permissive Coordinating Module

The RFL 67 PER COOR provides the following functions:

1. High-speed tripping for internal faults.
2. Timing coordination for current-reversal conditions.
3. Echo keying to enable switch-into-fault and weak-feed protection.

4. Prolonged keying control.

5. Trip hold capability.

6. Checkback test capability.

7. One-way test capability.

13.10. RFL 675 TONE RELAYING TEST SET

The RFL 675 (Fig. 13-9) is a self-contained unit, specifically designed for guesswork-free evaluation of tone-transfer-trip equipment and systems. It can also be used to diagnose on-line performance under adverse conditions.

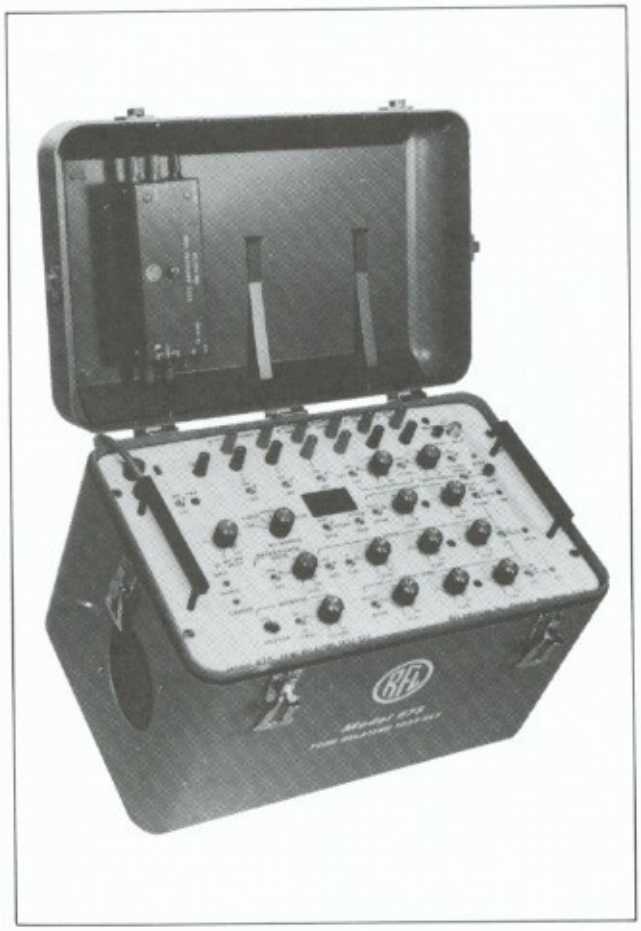


Figure 13-9. RFL 675 Tone Relaying Test Set

The RFL 675 simulates background noise, white noise, power fault noise, interfering tones, 60-Hz arcing, and abrupt level changes. Adjustable start/stop gating circuits allow independent adjustment of tripping and noise-burst rates, as well as signal stepping functions. For testing dependability and security, a two-digit display indicates the number of trips sent and received.

13.11. INTERFACE ASSEMBLIES

Four interface assemblies are available which allow the use of standardized auxiliary interface circuits in the RFL 6745. By using these auxiliary circuits, the system designer can custom-tailor RFL 6745 terminals for specific applications:

1. The RFL 67 UNIV Universal Interface Assembly (Fig. 13-10a) provides space and interconnections for up to eight auxiliary circuits. It usually occupies two module spaces in the RFL 6745 chassis, depending upon the type of auxiliary circuits installed on it.

2. The RFL HB-90100-1 Interface Assembly (Fig. 13-10b) contains a RFL HB-41080 Isolated Trip-Output Circuit and space for up to five auxiliary circuits. It usually occupies two module spaces in the RFL 6745 chassis, depending upon the type of auxiliary circuits installed on it.

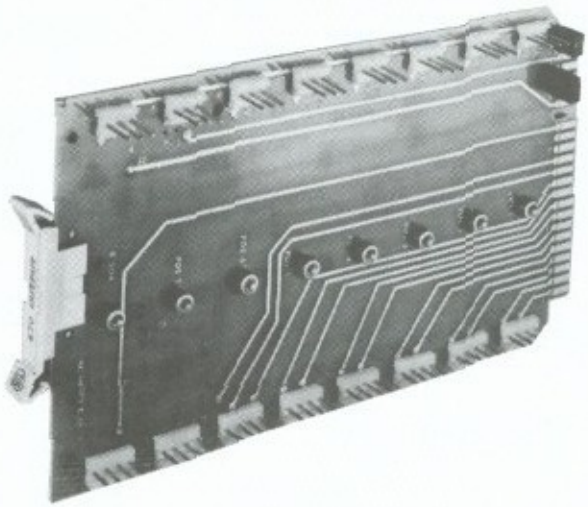
3. The RFL HB-90100-2 Interface Assembly (not shown) contains two isolated trip-output circuits and space for two auxiliary circuits. It usually occupies two module spaces in the RFL 6745 chassis, depending upon the type of auxiliary circuits installed on it.

4. The RFL 67 MINI UNIV Miniature Universal Interface Assembly (Fig. 13-10c) mounts in the rear of the chassis and provides space for one or two auxiliary circuits. It allows auxiliary circuits to be used in chassis where there is no space for mounting one of the other interface assemblies.

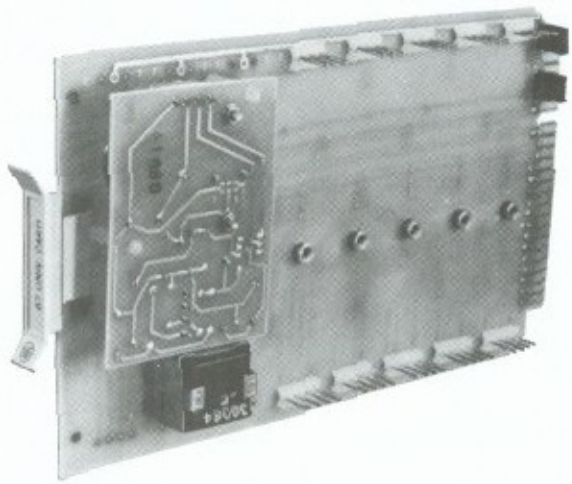
The following are some of the standardized circuits available for use with RFL 6745 interface assemblies. Additional information on these and other standardized circuits can be found in the Interface Assembly Instruction Data Sheet.

Customized interface assemblies can also be designed for special applications. For more information, contact the factory.

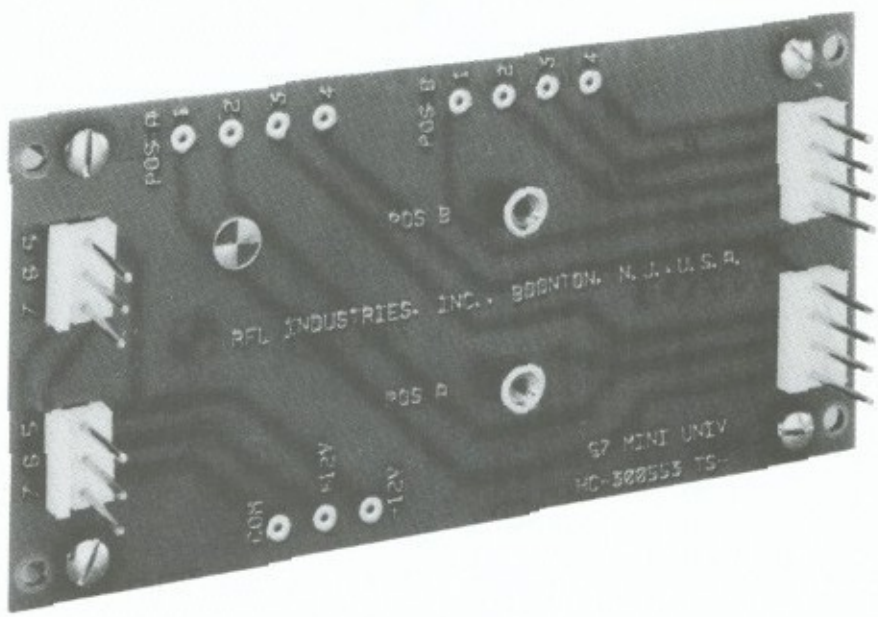
a. RFL HB-90110 600-Ohm Attenuator. This is a 600-ohm bridged-T attenuator with adjustable attenuation to a maximum of 45 dB.



a. RFL 67 UNIV Universal Interface Assembly



b. RFL HB-90100-1 Interface Assembly; RFL HB-90100-2 is similar in appearance.



c. RFL 67 MINI UNIV Miniature Universal Interface Assembly.

Figure 13-10. Interface assemblies

b. RFL HB-90120 Seal-In Circuit. This is an SCR-controlled latch circuit which will hold a relay energized after an initiating pulse has disappeared.

c. RFL HB-90130 CMOS-Driven Mercury Relay. In this circuit, a CMOS-level logic input will cause a Form C mercury-wetted reed relay to change states.

d. RFL HB-90140 AND Driver. This circuit uses a two-input AND gate to drive an open-collector PNP output transistor capable of pulling 100 mA.

e. RFL HB-90145 One-Shot Timer. The one-shot timer provides a buffer and a driver for operating a totalizing counter or similar device. Its output is an open-collector transistor which pulls up to +12 volts for a predetermined period (usually 100 ms).

f. RFL HB-90150 Mercury Relay. This is a reed relay with a single set of Form C mercury-wetted contacts.

g. RFL HB-90155 Signal-Boost Timer. This signal determines the duration of the boosted signal sent from a transmitter equipped with a signal-boost network.

h. RFL HB-90160 DPDT Relay. This is a multiple-leaf armature relay with a single set of Form C contacts.

i. RFL HB-90165 Delay Timer. This is a Schmitt-trigger timer designed to require that its input be at a logic high for at least 100 milliseconds before the output will go high. Override provisions are available.

j. RFL HB-90175 Hold Timer. This is a Schmitt-Trigger timer that holds its output at a logic high for at least 100 milliseconds after its input goes low. Provision for an override is available.

k. RFL HB-90180 Uniflex Input Buffer. This circuit provides electrical isolation between two circuits. It is usually used for keying circuits.

l. RFL HB-96890 Low Transmit Signal Detector. This circuit monitors the output of the transmitter, and holds a relay in an energized state as long as the tone level is above a preset limit. If the tone level falls below the limit, the relay will drop out and an alarm will be indicated. A solid-state output is also provided, with a 30-mA sinking capacity.