



RFL 9745

Teleprotection Channel



Product Features

- One product for audio, digital or fiber applications
- Up to four independent functions per audio system, seven for digital/fiber
- Sequence-of-events recording
- Address and checkback testing
- Bi-directional channel delay measurement
- Trip output failure detection
- User-defined teleprotection logic and alarms
- Remote RS-232 setup and diagnostics
- Diagnostics and setup of remote RFL 9745 through the local RFL 9745
- Three year warranty

The RFL 9745, is a fully programmable Teleprotection Channel suitable for Direct Transfer Trip, Permissive Transfer Trip, Blocking and Unblocking applications. Flash memory and remote RS-232 communications allows new firmware to be loaded making field programming possible without having to open the chassis. The communications interface can be converted in the field to adapt to different types of media. An unprecedented level of diagnostic information is available and easily accessible with the RFL 9745. RFL's sequence-of-events, diagnostics package provides a convenient method for evaluating communications system performance during the fault clearing process.



Applications

The RFL 9745 communications interface can be configured for audio, digital or fiber optic media. It is well suited for all standard and non-standard pilot protections schemes such as:

- Permissive Transfer Trip
- Direct Transfer Trip
- Blocking and Unblocking

Diagnostics and Testing

Diagnostic information is available and easily accessible with the RFL 9745. RFL's diagnostic package takes the guesswork out of power system fault analysis and evaluating communications system performance during the fault-clearing process. The RFL 9745 provides the following standard features:

- Two RS-232 ports for local and remote access
- Trip output circuit failure detection
- 100 Sequence-of-events records
- Internal real-time system clock
- IRIG-B Clock sync input
- Six-digit cumulative operations counters
- System outage timer
- Current status of all system parameters
- Diagnostic information about the remote end
- Checkback testing either locally or remotely initiated
- Automatic checkback by interval time between tests
- Channel propagation delay measured and reported
- Channel delay in each direction available with IRIG-B
- Commissioning can be accomplished remotely or from a single terminal

Figure 1 shows the record number, the name of the parameter that changed state to trigger the event, and the date and time the event occurred. Below this, the status of all inputs, outputs, and alarm outputs at the time of the event are listed. This information can be used to analyze the system conditions at the precise instant the event occurred.

Programmability

Changes in field are no longer necessary for logic functions can be changed or fine-tuned remotely through the RFL 9745's RS-232 port.

User Programmable Logic Functions

Change timer values, logic states and logic functions without ever removing a module or opening the chassis.

User Programmable Inputs and Outputs

The RFL 9745 can be supplied with two Input/Output modules. Each module provides optically isolated inputs, solid-state or dry relay contact outputs, as well as form "C" alarm contacts. The function of all of these inputs and outputs can be individually programmed to meet the application requirements.

Create your own alarm conditions

The RFL 9745 can be equipped with either three or six fully-programmable alarm/annunciator relays.

Record 003	Event Trigger: Annunc Relay 1A Inactive				
	Event Time: 01/01/98, 00:07:06.260				
Input 1A	I	Output 1A	I	Rx Freq High Ch1	I
Input 2A	I	Output 2A	I	Rx Freq High Ch2	A
Input 3A	I	Output 3A	I	Rx Freq High Ch3	I
Input 4A	I	Output 4A	I	Rx Freq High Ch4	A
Input 1B	I	Output 1B	I	Rx Freq Low Ch1	A
Input 2B	I	Output 2B	I	Rx Freq Low Ch2	I
Input 3B	I	Output 3B	I	Rx Freq Low Ch3	A
Input 4B	I	Output 4B	I	Rx Freq Low Ch4	I
Annunc Relay 1A	I	Annunc Output 1	I	Tx Function Ch1	I
Annunc Relay 2A	I	Annunc Output 2	I	Tx Function Ch2	A
Annunc Relay 3A	A	Annunc Output 3	I	Tx Function Ch3	I
Annunc Relay 1B	I	Annunc Output 4	I	Tx Function Ch4	A
Annunc Relay 2B	I	Annunc Output 5	I	Address Test Fail	I
Annunc Relay 3B	I	Annunc Output 6	I	Autotest Timeout	I
Run Auto Test	I	Channel Delay	I	Bus Error	I
FM Noise Ch1	I	AM Noise Ch1	I	Left Power Low	I
FM Noise Ch2	I	AM Noise Ch2	I	Right Power Low	A
FM Noise Ch3	I	AM Noise Ch3	I	Battery Failure	A
FM Noise Ch4	I	AM Noise Ch4	I	RS232 Active	A
Comms CPU Failure	I	Outage Timer Active	I	Test in Progress	I
Autotest Complete	I				

Figure 1. Typical individual event record display for the Audio System



Programming

The RFL 9745 is programmed using RFL's **Asynchronous Programming and Remote Interrogation Language (PC APRIL)**. PC APRIL provides the user with a verbose man/machine interface in an ASCII format. It is accessible using any standard terminal emulation or communication software on a personal computer.

All functions that require adjustments during normal installation and maintenance are also available by using the front-panel display and push-button switches. All programming levels available over the RS-232 interface are password-protected.

Every RFL 9745 is supplied pre-programmed with a default operating program. On the audio tone version, after the standard program is uploaded into the system, all the user needs to do is enter the operating frequencies and bandwidths. Figure 2 shows the parameter settings for the audio tone version, Figure 3 shows the parameter settings required for RFL 9745's configured with any of the several digital interfaces available.

A DOS version of the RFL 9745 PC APRIL software package is supplied with every order. This version allows the application engineer to save revised programming parameters to a disk file for future downloading to the

RFL 9745. The DOS program can also be utilized as a training tool to allow users to become familiar with the equipment.

A specialized software, the RFL Expert System, has been developed to allow graphical design of the system logic by using a specialized symbols library. The RFL Expert System is a WINDOWS™-based application software package which allows the user to develop his own protection schemes. This software is intended for customers who want to create, modify, or simulate applications for their RFL 9745 without having the hardware in front of them.

The RFL Expert System consists primarily of an OrCAD™ Schematic Capture Program coupled with an RFL designed WINDOWS™-based editing system and RFL's easy-to-use PC APRIL programming language. This system includes a digital simulator which allows the user to simulate logic inputs to the newly designed system logic and verify the expected results prior to uploading.

OrCAD™ Software is used to design RFL 9745 alarm logic and primitive logic diagrams. The RFL Expert System software is used to run simulations on the logic diagrams and to combine the primitive and alarm logic diagrams into one set of files for the RFL 9745. These files are then used to program the RFL 9745 using PC April Software.

PARAMETER	SETTING	#	PARAMETER	SETTING
999 System Label	sec/dep			
001 Channel 1	Single			
002 Tone 1 Tx Freq	1540 Hz 1690 Hz			
003 Transmit Level	0.00 dBm	004 Boost Level	0 dB	
005 Tone 1 Rx Freq	1540 Hz 1690 Hz			
006 Rx Bandwidth	225 Hz	007 Rx Level	0 dBm	
008 Rx Alarm -40 dBm		009 AM Noise (SNR)	9 dB	
010 FM Noise 15 %				
016 Channel 2	Single			
017 Tone 2 Tx Freq	1200 Hz 1350 Hz			
018 Transmit Level	0.00 dBm	019 Boost Level	0 dB	
020 Tone 2 Rx Freq	1200 Hz 1350 Hz			
021 Rx Bandwidth	225 Hz	022 Rx Level	0 dBm	
023 Rx Alarm	-40 dBm	024 AM Noise (SNR)	9 dB	
025 FM Noise	15 %			
031 Channel 3	Single			
032 Tone 3 Tx Freq	2220 Hz 2370 Hz			
033 Transmit Level	0.00 dBm	034 Boost Level	0 dB	
035 Tone 3 Rx Freq	2060 Hz 2370 Hz			
036 Rx Bandwidth	225 Hz	037 Rx Level	0 dBm	
038 Rx Alarm	-40 dBm	039 AM Noise (SNR)	9 dB	
040 FM Noise	15 %			
046 Channel 4	Single			
047 Tone 4 Tx Freq	1880 Hz 2030 Hz			
048 Transmit Level	0.00 dBm	049 Boost Level	0 dB	
050 Tone 4 Rx Freq	1880 Hz 2030 Hz			
051 Rx Bandwidth	225 Hz	052 Rx Level	0 dBm	
053 Rx Alarm -40 dBm		054 AM Noise (SNR)	9 dB	
055 FM Noise 15 %				
060 Opt Status Board	No	061 EE Pot J10	B	
062 Chan delay alarm	8 ms	063 Year	1998	
064 Date	01/01	065 Time	02:07:38	
066 Hour Adjust	-1	067 Local Address	0	
068 Remote Address	0	069 Reset Log		

Figure 2. Typical Audio System parameter settings display



System Specifications

Audio Communications

Audio tone versions of the RFL 9745 can be supplied with two, or four FSK audio tone transceivers. All transceivers are bidirectional and can be programmed for any operating frequency, or bandwidth between 300 and 4,000 Hz. channel one can be set to operate as a modem channel. This channel provides a communication link to the remote terminal for remote interrogation, setting changes or system testing from the local terminal.

Audio Interface Configurations

- Single Two-Wire Terminals
- Dual Two-Wire Terminals
- Single Four-Wire Terminals
- Dual Four-Wire Terminals

Recommended Channel Frequencies

Range: 300 Hz to 4000 Hz
Resolution: 1Hz

Transmit Level

Adjustable from -40 dBm +10 dBm in 0.25 dB steps

Receiver Sensitivity

Minimum Input Level: -40 dBm
Maximum Input Level: 0 dBm

Receiver Dynamic Range (referenced to center point)

-17 dB to + 11 dB

Adjacent Channel Rejection

40 dB

60-Hz Rejection

A received tone at -30 dBm will not be affected by a 50 Hz or 60 Hz signal as great as 40 Vrms with optional 50/60 Hz blocking filter.

Amplitude Stability

The Transmit level will vary by no more than ± 1 dB.

Spurious Output

All harmonics and spurious outputs are at least 40 dB lower than the carrier.

Transmitter Stability

The transmitter frequency is stable within 0.02 percent over the full range of temperature and input power variations.

Trip Boost

Amplitude: Adjustable from zero to +12 dB in 1 dB steps.
Duration: Adjustable from zero to 200 ms in 1 ms steps.

Input and Output Impedance

600 Ohms

Digital Communications

The RFL 9745 is available with three types of serial digital interfaces: 56Kbps/RS-449, 64Kbps/G.703 Co-directional and Contra-directional interfaces.

The digital interfaces conform to the standards set forth in their respective specifications (RS-449, CCITT G.703). Figure 3 represents a typical parameter settings display for the digital system.

Fiber Optic Communications

Fiber Optic Communications Interfaces and System Gains are as follows:

Wavelength & Emitter Type	Fiber Type	Connector Type	Output Level	Receiver Sensitivity	System Gain
850 nm LED	Multimode	ST	-18 dBm	-46 dBm	25 dB
1300nm LED	Multimode	ST	-13 dBm	-39 dBm	25 dB
1300nm LED	Singlemode	ST	-17 dBm	-39 dBm	18 dB
1300nm Laser	Singlemode	ST	0 dBm	-39 dBm	36 dB
1550nm Laser	Singlemode	ST	-3 dBm	-39 dBm	30 dB
850 nm LED (short haul)	Multimode	ST	-19dBm	-27dBm	8dB

#	PARAMETER	SETTING	#	PARAMETER	SETTING
999	System Label	sec/dep			
011	Functions 1-7	Digital			
012	Major Data Error	6, 500			
013	Minor Data Error	400, 200000			
014	Alarm BER	1E-04			
060	Opt Status Board	No	062	Chan delay alarm	8 ms
063	Year	2000	064	Date	01/01
065	Time	00:00:21	066	Hour Adjust	-1
067	Local Address	0	068	Remote Address	0
069	Reset Log				

Figure 3. Typical parameter settings display for the Digital System.



Fiber Optic Connector Type ST

Real Time Clock

850 nm Short Haul Fiber Interface

The RFL 9745 is typically located close to the protective relaying equipment. The communications equipment, could be located in a different room or building in the substation. The RFL 9745 when configured with the Short Haul Fiber Interface, eliminates the ground potential rise and induced voltage concerns associated with routing a copper communications cable between two sites.

A pair of 850 nm multimode fiber optic cables are routed between the two locations. The fibers can be up to 1 kilometer (3,280 feet) long and terminated with ST type connectors. As illustrated in Figure 4, a pair of 850 nm multimode fiber optic cables are routed between two locations. At the RFL 9745, the fibers are connected to the Short Haul Fiber Interface. At the communication equipment location, the fiber optic cables are connected to the remote Fiber Optic Service Unit. The digital RS-449 output of the Fiber Optic Service Unit is connected to the communications equipment by a short RS-449 digital cable.

Short Haul Service Unit Fiber Optic Transceivers

Fiber Type: 62.5 Micron core, 850 NM multimode
Optical Budget: 8 dB (typical distances are up to 1 km)
Fiber Connector Type: ST
Digital Connector Type 37 pin DB37, male, compliant to RS-449, DTE configuration.

Input Power

350 mW Load available in the following voltage ranges:
9 Vdc input voltage range 8-12 Vdc
48 Vdc input voltage range 42-56 Vdc
125 Vdc input voltage range 105-140 Vdc

IRIG-B

The RFL 9745 accepts the IRIG-B Standard Time Code on a 1kHz modulated carrier. Nominal signal levels are 3.3 volts peak-to-peak ($\pm 0.5v$) for a logic "1" and 1 volt peak-to-peak ($\pm 0.2v$) for a logic "0". The IRIG-B input presents a 3.7k ohm impedance and is transformer isolated.

Resolution

1 ms

Accuracy

Free Running: Within 1 minute per month
Under IRIG-B Control $\pm 1ms$

Reset

Manual or by IRIG-B code

Isolation

The RFL 9745's RS-232 ports (front and rear panel) are isolated from circuit common and chassis ground to a surge withstand level of 500 Vdc.

Events Storage

Up to 100 events can be stored. After this limit is reached, older events are overwritten. The Events Log keeps a running tally of the number of times each function, input, output and alarm is active along with the time and date the event occurred. Up to 1,000,000 counts can be stored for each item.

RS-232 Interrogation Ports

The 9745 provides two RS-232 Ports, located on the front and rear of the chassis. The RS-232 Port located on the front of the chassis has priority. Front of RS-232 port is configured as a DCE Interface. The rear RS-232 port is configured as a DTE Interface.

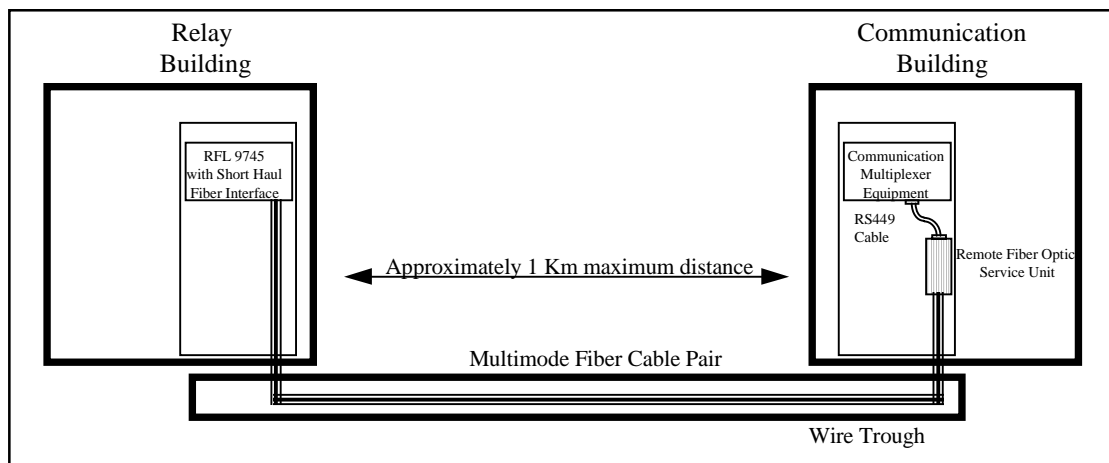


Figure 4. Typical RFL 9745 Short Haul Fiber Optic Application



Relay/Solid-State I/O

Data Rates: 300 bps, 1200 bps, 2400 bps, 9600 bps or 19.2 Kbps. Selection is made using front panel switches.

Communication Parameters:

Number of Data Bits: Eight

Number of Stop Bits: One

Parity: None

Flow Control: XON/XOFF

I/O Options

The RFL 9745 can be configured with a maximum of two I/O modules. There is a Solid-State version and Relay/Solid-State version of I/O modules available. Both versions provide four optically isolated keying inputs and three independent form "C" alarm output contacts. The Solid-State version provides four independent solid-state outputs. The Relay/Solid State version provides three independent jumper selectable form "A" or form "B" output contacts and one solid-state output.

Solid-State I/O

Optically Isolated Inputs

Quantity: Four per module

Required Operation Range:

24 Volt Units: 14.6 to 60 Vdc, Nominal Input
Current 8.8 mA

48 Volt Units: 31 to 60 Vdc, Nominal Input
Current 5.8 mA

125 Volt Units: 75 to 150 Vdc, Nominal Input
Current 4.6 mA

250 Volt Units: 155 to 280 Vdc, Nominal Input
Current 5.25 mA

Input Current: 10 mA maximum

Minimum Acceptable Pulse Width: 100 μ s

Solid-State Outputs

Quantity: Four per solid-state I/O module

Output Current: Maximum 1 ampere continuous,
2 amperes for one minute, or 10 amperes for 100 ms.

Open-Circuit Voltage: 280 Vdc maximum

Alarm Relays

Quantity: Three per I/O module

Contact Configurations: SPDT (Form C)

Maximum Output Current: 1 ampere continuous

Maximum Breaking Current: 1 ampere (non-inductive)

at 125 Vdc; derated to 0.25 amperes at 280 Vdc

Open Circuit Voltage: 280 Vdc Maximum

Optically Isolated Inputs

Quantity: Four per module.

Required Operation Range:

24 Volt Units: 14.6 to 60 Vdc, Nominal Input
Current 8.8 mA

48 Volt Units: 31 to 60 Vdc, Nominal Input
Current 5.8 mA

125 Volt Units: 75 to 150 Vdc, Nominal Input
Current 4.6 mA

250 Volt Units: 155 to 280 Vdc, Nominal Input
Current 5.25 mA

Input Current: 10 mA maximum

Minimum Acceptable Pulse Width: 100 μ s

Solid-State Outputs

Quantity: One per relay/solid-state I/O Module

Output Current: Maximum 1 ampere continuous,
2 amperes for one minute, or 10 amperes for 100 ms.

Open-Circuit Voltage: 280 Vdc maximum

S/S Pick-up Time: 0 msec

Relay Output

Quantity: Three per module

Contact Configuration: SPST Form A or Form B -
Jumper Selectable

Relay Pick-up Time: 7 msec

Output Current Rating: 5 amperes continuous

Surge: 30 amperes for 200 msec

Alarm Relays

Quantity: Three per I/O Module

Contact Configurations: SPDT (Form C)

Maximum Output Current: 1 ampere continuous

Maximum Breaking Current: 1 ampere (non-inductive)

at 125 Vdc; derated to 0.25 amperes at 280 Vdc

Open-Circuit Voltage: 280 Vdc maximum

Annunciator Chassis

The RFL 9745 can be supplied with an optional one rack unit Annunciator Chassis. This additional chassis is mounted below the standard Three Rack Unit Chassis and provides six programmable solid-state outputs. Each output can be individually programmed to provide specific output annunciation, such as Trip Sent, Trip Received, RS-232 Port Active, etc.

Output Ratings

Maximum Output Current: 1 A continuous

Breaking Current: 100 mA (non-inductive)



Auxiliary Trip Relays

The RFL 9745 can be configured with up to two auxiliary high speed trip relays which are mounted in either the primary or redundant power supply I/O module. The relays are typically controlled by one of the solid-state function outputs and provide two normally open and one normally closed contact each.

Relay Ratings:

Pick-up Time: 4 msec

Contact Rating: 5 amperes continuous, 30 amperes for 200 msec

General Specifications

Displayed Level Accuracy

The levels displayed on the front panel and through remote access using PC APRIL will be within 1 dB of the actual values.

Operate Time

Audio-Tone Units (average trip times—Dual-Tone System):

- ± 30 Hz Shift: 26.47 ms
- ± 42.5 Hz Shift: 20.57 ms
- ± 60 Hz Shift: 14.78 ms
- ± 75 Hz Shift: 12.65 ms
- ± 120 Hz Shift: 11.05 ms
- ± 150 Hz Shift: 10.12 ms
- ± 240 Hz Shift: 9.22 ms

Digital and Fiber systems: 3 ms maximum in the most secure mode. "Operate Time" is defined as the time from the receipt of a command input to the response of a solid-state output, less any channel propagation time.

Pre-Trip Timer

Adjustable in 0.5 ms steps

Trip Hold Timer

Adjustable in 0.5 ms steps

Command Extend Timer

Adjustable in 0.5 ms steps

Non-Volatile Storage

All parameters relating to system operation are stored in electric erasable non-volatile RAM. All parameters related to event logging are stored in battery-backed RAM.

RFI Susceptibility

ANSI PC37.90.2 (35 Volts/Meter)
IEC 255-22-3 (RFI Class III)

Interface Dielectric Strength

All contact inputs, solid-state outputs, power supply inputs and relay outputs meet the following specifications:

- ANSI C37.90-1989 (Dielectric)
- ANSI C37.90.1-1989 (SWC and Fast Transient)
- IEC 255-5 (1500 Vrms Breakdown Voltage and Impulse Withstand)
- IEC 255-22-1 (SWC Class III)
- IEC 255-22-2 (ESD Class III)
- IEC 255-22-4 (Fast-Transient Class III)
- IEC 834-1

Input Power Requirements (per IEC 834-1)

- 24 Vdc Supply: 19 to 29 Vdc (1500 mA Typical)
- 48/125 Vdc Supply: 38 to 150 Vdc (750/325 mA Typical)
- 48V Requirement: (750 mA Typical)
- 125V Requirement: (325 mA Typical)
- 250 Vdc Supply: 210 to 280 Vdc (150 mA Typical)

Power Supply

A single or redundant power supply can be provided depending on the reliability of the application. For example a DTT application for a higher voltage level line may demand the dependability of a redundant power supply.

Temperature

Operating: -30° C to +65° C (-22° F to +149° F)
Storage: -40° C to +75° C (-40° F to +165° F)

Relative Humidity

Up to 95 percent at +40° C (+104° F), non-condensing

Chassis Dimension

The RFL 9745 chassis mounts in a standard 19-inch rack or cabinet and is three rack-units high (5.25 inches or 13.3 cm). Front and rear views, cut-out dimensions, and terminal block locations are illustrated in fold Figures 5 and 6. A system block diagram for the RFL 9745, including available options, is shown in fold-out Figure 7. The RFL 9745 can be supplied with plug-in connectors for the Solid-State I/O and the Relay/Solid-State I/O modules. These connectors can accept #14 AWG wire and proved a convenient method to add or replace I/O modules in the field.

Warranty Statement

RFLs standard warranty for the RFL 9745 is *thirty-six* months from date of delivery for replacement or repair of any part which fails during normal operation or service.

Ordering Information

RFL 9745 ordering information can be found on page eight.

Specifications subject to change without notice.

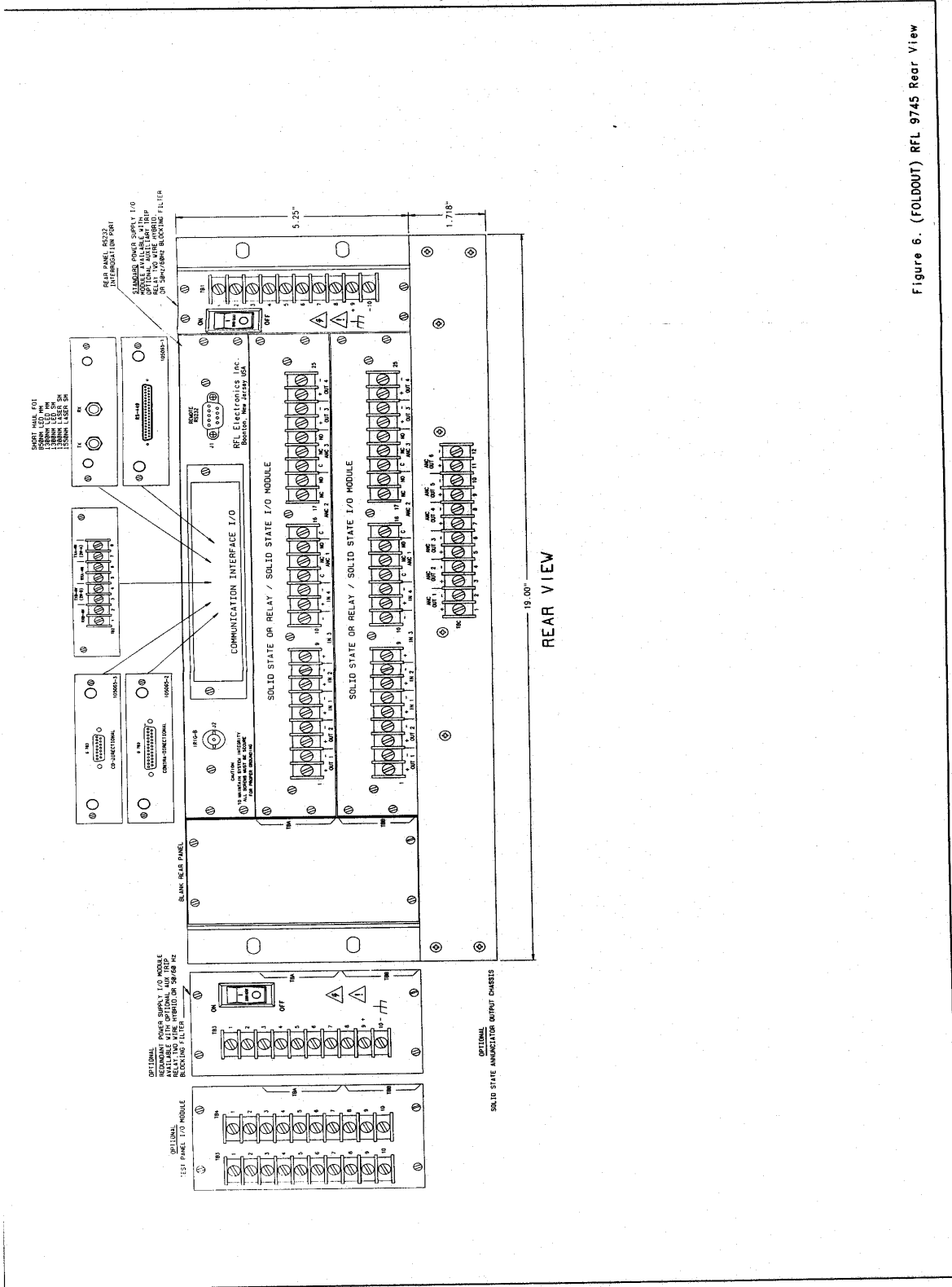


Figure 6. (FOLDOUT) RFL 9745 Rear View

Figure 6 RFL 9745 Rear View

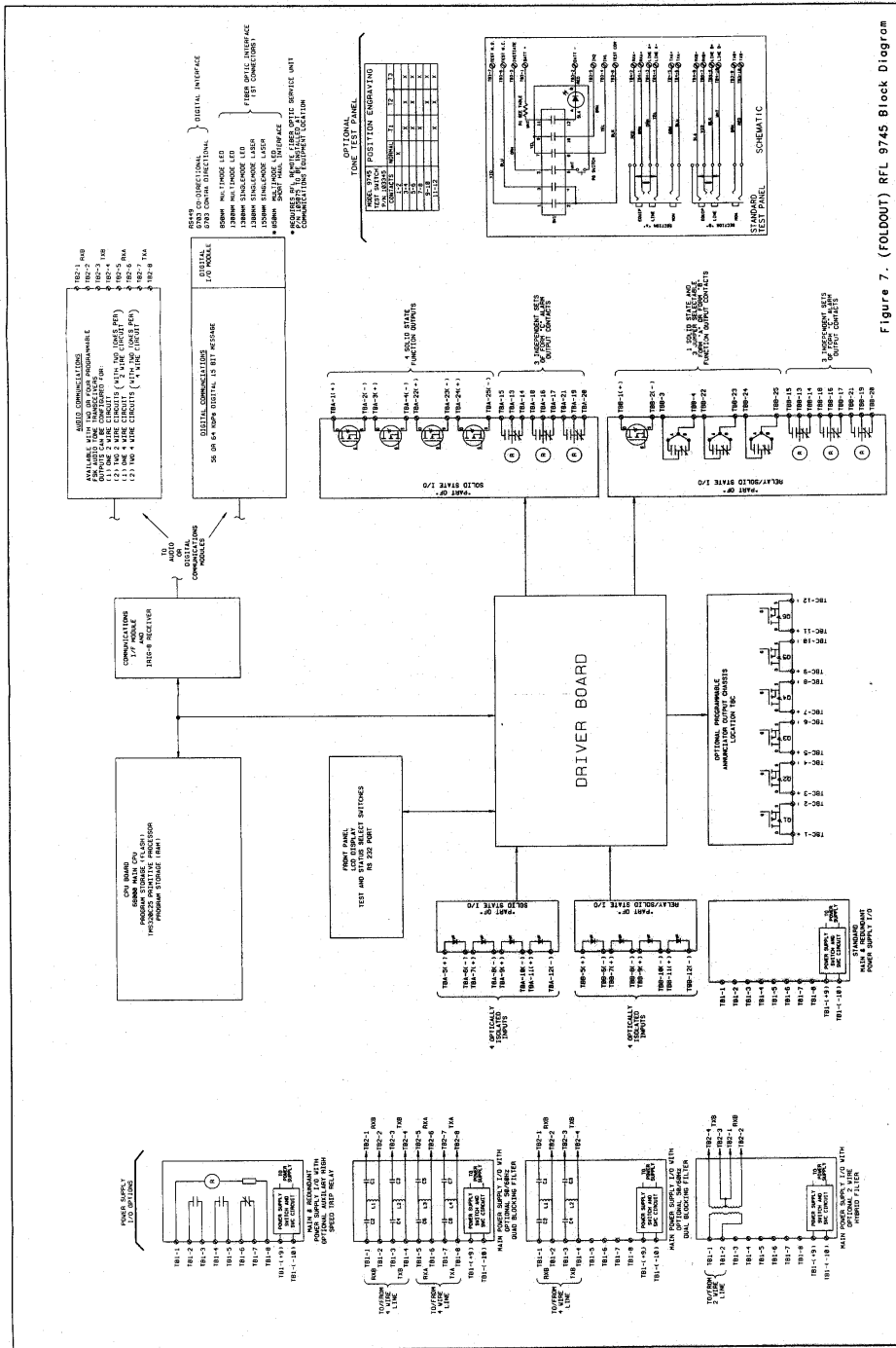


Figure 7. (FOLDOUT) RFL 9745 Block Diagram

Figure 7 RFL 9745 Block Diagram

