INSTRUCTION MANUAL

RFL 9780
PROGRAMMABLE FSK
POWERLINE CARRIER SYSTEM

NOTICE

This manual has been compiled and checked for accuracy. The information in this manual does not constitute a warranty of performance. RFL Electronics Inc. reserves the right to revise this manual and make changes to its contents from time to time. We assume no liability for losses incurred as a result of out-of-date or incorrect information contained in this manual.

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Revised April 8, 2003

RFL Electronics Inc.

WARRANTY

Except where noted, all RFL Electronics Inc. products come with a one-year warranty from date of delivery for replacement of any part, which fails during normal operation. RFL will repair or, at its option, replace components that prove to be defective at no cost to the Customer. All equipment returned to RFL Electronics Inc. must have an RMA (Return Material Authorization) number, obtained by calling the RFL Customer Service Department. A defective part should be returned to the factory, shipping charges prepaid, for repair or replacement FOB Boonton, N.J.

RFL Electronics Inc. is not responsible for warranty of peripherals, such as printers and external computers. The warranty for such devices is as stated by the original equipment manufacturer. If you have purchased peripheral equipment not manufactured by RFL, follow the written instructions supplied with that equipment for warranty information and how to obtain service.

WARRANTY STATEMENT

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

This warranty does not apply if the equipment has been damaged by accident, neglect, misuse, or causes other than performed or authorized by RFL Electronics Inc.

This warranty specifically excludes damage incurred in shipment to or from RFL. In the event an item is received in damaged condition, the carrier should be notified immediately. All claims for such damage should be filed with the carrier.

NOTE

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

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

RFL Electronics Inc.
353 Powerville Road
Boonton Township, NJ 07005-9151

CAUTION

FOR YOUR SAFETY

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

WARNING:

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

SAFETY SUMMARY

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

GROUND THE CHASSIS

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

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

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

KEEP AWAY FROM LIVE CIRCUITS

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

DO NOT SUBSTITUTE PARTS OR MODIFY EQUIPMENT

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

READ THE MANUAL

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

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

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

WARNING!

POWER MUST BE TURNED OFF BEFORE REMOVING OR INSTALLING ANY RFL 9780 MODULES. FAILURE TO DO SO MAY RESULT IN COMPONENT DAMAGE.

WARNING!

ON INITIAL INSTALLATION, ENSURE THAT ALL MODULES ARE FULLY SEATED INTO CONNECTORS BEFORE POWERING ON UNIT.

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When revisions are made to the RFL 9780 Instruction Manual, the entire section where revisions were made is replaced. For the edition of this manual dated April 8, 2003 the sections are dated as follows:

Front Matter	April 8, 2003
Section 1	Latest revision
Section 2	April 8, 2003
Section 3	March 10, 2000
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Section 5	October 12, 1999
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Section 7	November 1, 2000
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Section 19	April 8, 2003
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Section 21	October 12, 1999
Section 22	April 8, 2003

REVISION RECORD

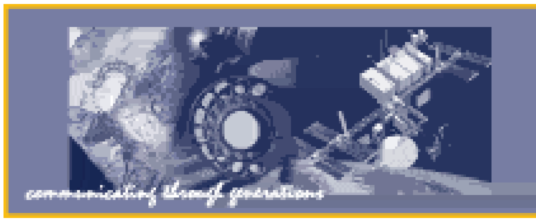
Rev.	Description	Date	Approval
6-29-99	New Document Release	08/03/99	CS
10-12-99	Revised in accordance with new design information	11/03/99	CS
03-10-00	Revised in accordance with ECO No. 9780-005, 014, 016, 017, 021, 023, 034	06-26-00	CS
05-19-00	Revised in accordance with RFA No. 7288. Revised in accordance with ECO No. 9780-004, 007, 045. Revised in accordance with ECO No. 9785-012, 026. Added Section 7 on Tx Logic Module.	02-16-01	CS
11-01-00	Revised in accordance with ECO No. 9780-050, 058, 060, 065, 067 Revised in accordance with RFA No. 6504.	03-09-01	CS
2-28-01	Added External Power Amp I/O to Section 17. Added Dual Hybrid module to Section 18. Added information on all five types of Mother Boards to Section 20. Revised in accordance with ECO No: 9780-064: (Added –5 to output filter schematic) 9780-079: (Revised SOE board, parts list & schematic)	07-16-01	CS
5-11-01	Revised in accordance with RFA No: 8006 Revised Receiver unblocking function logic Added Figure 6-5 (Unblocking function timing diagram) Revised in accordance with ECO No: 9780-081: (Added capacitor to power supply) 9780-082: (Revised I/O panel markings) 9780-086: (Clarified use of jumper J2) 9780-087: (Delete & replace U3, N/A R38, C42 & C43)	7-16-01	CS
9-8-01	Revised in accordance with ECO No: 9780-088: (Added LM/SL test points to Section 14) 9780-089: (Common PC board for all hybrids to Section 18) 9780-092: (Added “modules fully seated” warning label to Section 0) Revised Table 2-2 in Section 2	09-10-01	CS
01-10-02	Revised in accordance with ECO No: 9780-085: (Replaced SW1 with K1 on Output Filter Module, Section 10)	01-10-02	CS

REVISION RECORD - continued

Rev.	Description	Date	Approval
7-22-02	Revised in accordance with ECO No: 9780-118 and CAR# C9780-0071: (Adds 3W Guard setting and independent TX/RX Trip frequency shift direction settings, and removes Voice support, from Logic Module, Section 6) (This revision of the manual was never printed)	7-22-02	CS
4-8-03	Revised in accordance with ECO No: 9780-093 9780-098 9780-099 9780-100 9780-101(CLI) Section 13 9780-102(LM/SL) Section 14 9780-109(I/Os) 9780-110(RX/RX mother board) Section 20 9780-114(CLI) Section 13 9780-116(CLI) Section 13 9780-122(TX/RX mother board) Section 20 9780-123(SS In/Out I/O) 9780-124(RX/RX RF Line I/O) Section 17 9780-125(CLI) Section 13 9780-128(LM/SL) Section 14 9780-131(Power Supply) Section 19 9780-132(mother boards) Section 20 Revised in accordance with CAR No: C9780-0026 C9780-0038 C9780-0041(CLI) Section 13 C9780-0042 C9780-0046 C9780-0065(RX/RX mother board) Section 20 C9780-0085(RX/RX RF Line I/O) Section 17 C9780-0089(RX/RX RF Line I/O) Section 17 C9780-0091(TX/RX mother board) Section 20 C9780-0103(CLI) Section 13 Added reflected power meter option to Sections 1, 10&16 Added errata sheets	4-8-03	CS

SECTION 1: PRODUCT INFORMATION

For Powerline Carrier and Reflected Power Measurement Product Information sheets, Please see next page.



LITERATURE

RFL 9780
Programmable FSK Powerline Carrier System

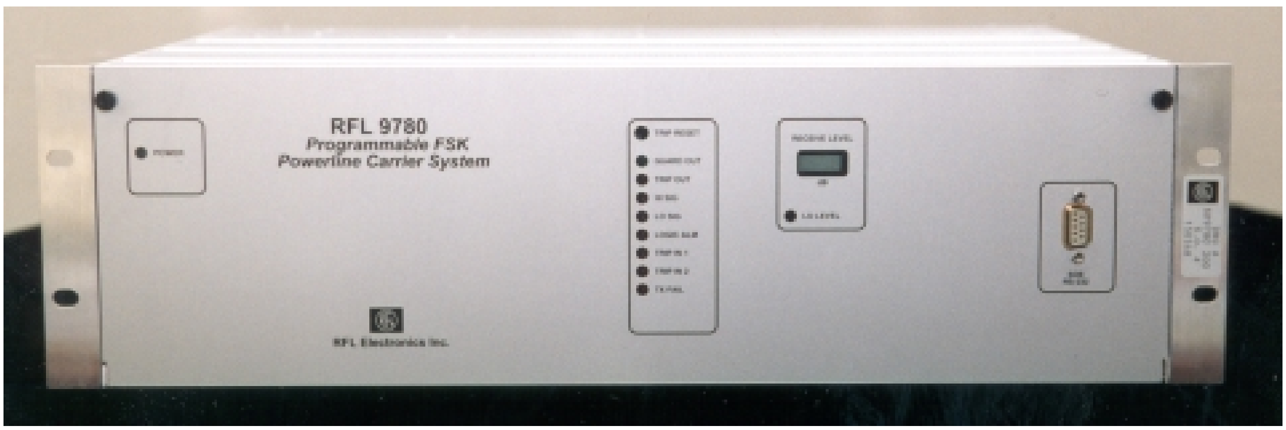


Figure 1. Typical RFL 9780 Programmable FSK Powerline Carrier

The RFL 9780 is a Programmable frequency-shift keyed (FSK) power line carrier system, which can be supplied as a transceiver (Tx/Rx), Transmit-only (Tx), Receive-only (Rx), dual transmitter (Tx/Tx), or dual receiver (Rx/Rx). All versions are available with redundant power supplies. The RFL 9780 is the next generation of the field-proven Series 6780P, with enhanced features to meet today's market demands. These features include improved RFI and Surge Withstand Capabilities (meeting the requirements of ANSI/IEEE C93.5), ESD protection (per IEEE PC 37.90.3, draft A, 1/8/99) and increased flexibility through field-programmable frequencies and logic.

Typical applications for the 9780 include Direct Transfer Trip (DTT-single or dual channel), Permissive Transfer Trip (PTT), Directional Comparison Unblocking (DCU), and dual phase comparison. For protective relaying applications, the universal I/O capabilities of the RFL 9780 allow its use with all protective relay designs currently in use, as well as many vintage relays. Often a 9780 can be configured as a direct drop-in replacement for an older PLC set.

The unit has a front panel direct reading (in dB) digital meter to indicate signal strength. Numerous indicators are available on the front panel to provide the user with an 'at-a-glance' indication of system status. The major status signals within the chassis are constantly monitored by an optional sequence of events (SOE) module. This module detects and records any changes in the system status. The SOE log may be downloaded via an RS-232 connection (both front and rear connections provided) to provide a time and date stamped record of events.

The RFL 9780 has an extensive number of user programmable features. A two frequency transmitter may be configured for 1W/1W, 1W/10W, or 10W/10W operation (additional modes are available for three frequency operation). The receive logic boasts a comprehensive array of programmable functions.

A complete RFL 9780 transceiver is provided in a single chassis. It is 3 rack units high (5.25 inches, or 13.3 cm). The Tx, Rx, Rx/Rx and Tx/Tx systems are also available in a single 3 rack unit high chassis. A block diagram for a typical RFL transceiver station appears in Figure 2. Mounting dimensions for the RFL 9780 are given in Figure 5.

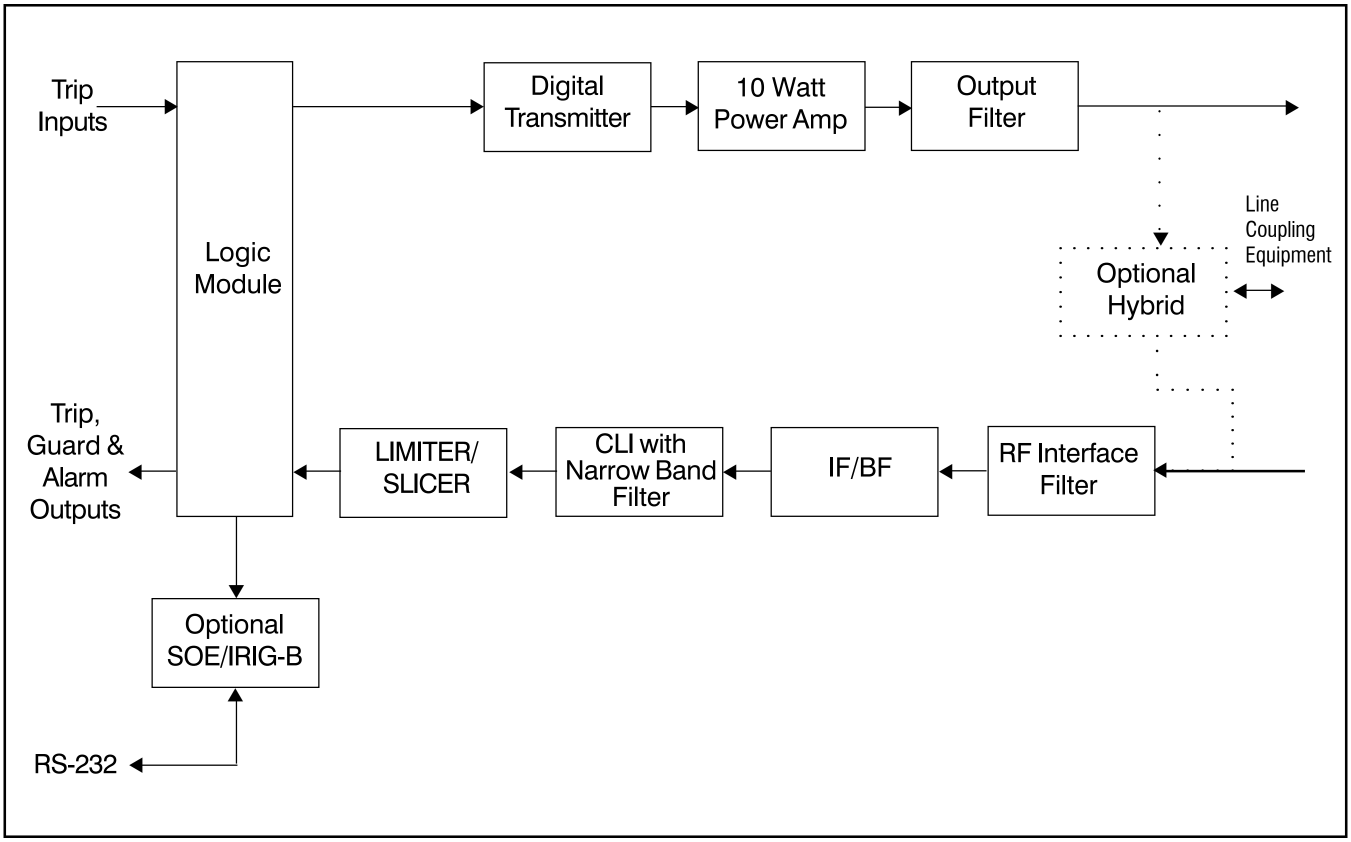


Figure 2. Block diagram, of typical RFL 9780 Programmable FSK Powerline Carrier System

PROGRAMMING

The transmitter frequency and shift are selected by programmable rotary type switches on the transmitter module. The operating frequency can be programmed from 30 to 535 kHz, in 10-Hz steps; frequency shifts of up to ± 990 Hz can be programmed, in 10-Hz increments. 2F and 3F operation with different shift bandwidths are also possible.

The receive frequency is set by DIP switches to any frequency from 30 to 535 kHz, in 250-Hz steps.

STANDARD FEATURES

- Tested in compliance to the requirements specified in ANSI C93.5 -1997 Single Function Powerline Carrier transmitter/ Receiver equipment.
- ESD protection (per IEEE PC 37.90.3, draft A, 1/8/99)
- Tx/Rx, Tx/Tx, Rx/Rx, Tx only, and Rx only configurations are supplied in an single three rack unit chassis
- Compliant to C37.90.2. EMI Susceptibility Tested as specified in ANSI C93.5 - 1997
- Programmable RF receiver input filter provides improved noise rejection.

STANDARD FEATURES CON'T.

- Redesigned logic module provides the following user selectable functions:

Timer	Total Duration	Resolution
Pre Trip Timer	0 -31.75 msec	0.25 msec
Pre-Guard Timer	0 -31 msec	1.0 msec
Guard Hold Timer	0 -31 msec	1.0 msec
Trip Hold Timer	0 -310 msec	10 msec
Unblock Trip Window	50 -350 msec	50 msec
Unblock Security Timer	0 -70 msec	10 msec
Alarm Pick-Up Timer	50,100 -1500 msec	100 msec
Alarm Drop-Out Timer	50,100 -1500 msec	100 msec
Guard Before Trip Timer	50 -190 msec	10 msec
Trip After Guard Timer	50 -190 msec	10 msec
Bi-Polar Noise Detector	2 -14 msec	2.0 msec

Table 1. User Programmable Logic.

All timer values are factory set for optimum performance for each application. All settings are recorded on customer specific applications drawings.

- Each RFL 9780 station is pre-wired so that all input and output connections for the standard features are made to the same terminals on each station.

- All RFL 9780 stations are equipped with carrier level indicators, a transmitter output power alarm, and a low receiver input alarm as standard equipment. Skewed or transformer hybrid modules are also available for use with the RFL 9780 and fit within the same chassis.
- RF interface withstands a 3KV 1.2/50 µs pulse as specified in C93.5-1997
- 48V/125V and 250V internal power supply options. Systems may be equipped with redundant supplies in a single chassis.

OPTIONS

Options for the RFL 9780 include permissive coordinating, and more. RFL's sales and engineering staff can custom configure the 9780 for virtually any input, output, or logic requirement, making it the most flexible single function powerline carrier system available to date.

The optional Sequence of Events (SOE) Module provides a record of 40 events. Table 2 below, shows the data points monitored for a standard TX/RX Terminal.

1.	Trip Key Input #1
2.	Trip Key Input #2
3.	Guard Output
4.	Trip Output
5.	Transmitter Fail
6.	Logic Alarm
7.	Low Level Alarm
8.	Power-up
9.	Power supply #1 Fail
10.	Power supply #2 Fail

Table 2. SOE Data Points

Custom application requirements, such as functional test panels, additional trip & guard contacts, redundant channels, and 50 and 100 Watt RF power amplifiers can be accommodated. Options may require an additional accessory chassis.

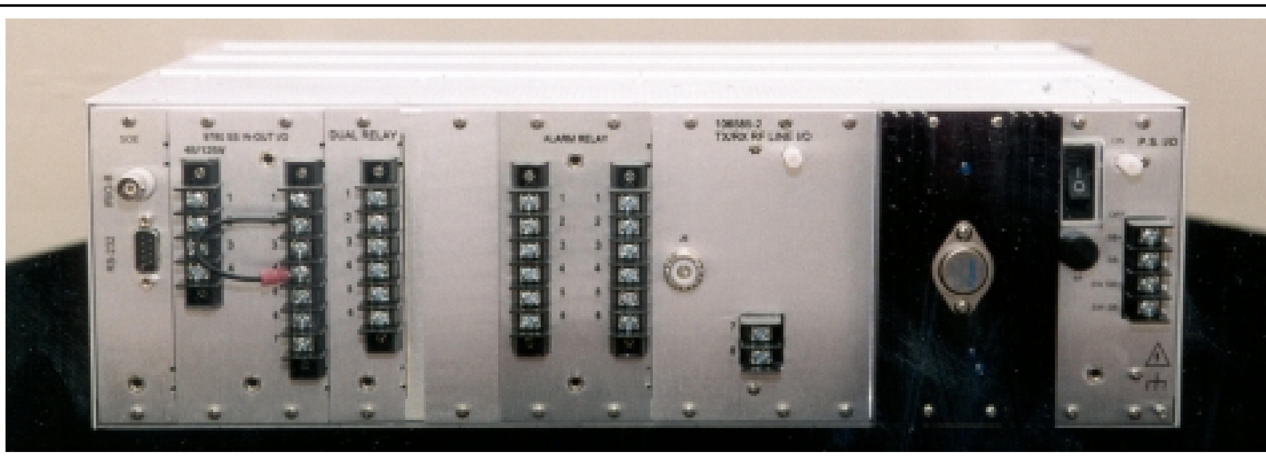


Figure 3. Typical RFL 9780 Programmable FSK Powerline Carrier System Rear View.

SPECIFICATIONS

General:
The 9780 is a programmable 10W FSK power line carrier system which fully complies with ANSI C93.5. The standard Tx/Rx system is packaged in a single 3U high chassis and includes full-feature transmitter and receiver sections. The unit may optionally be equipped with a hybrid, SOE module, and redundant supply in the same chassis. External amplifiers can be used to boost the output power if required.

Dimensions: 19" x 5.25" x 15.25"

Supply voltage: 48/125 Vdc (38 to 150 Vdc, 85W)
250 Vdc (200 to 300 Vdc, 85W)

Weight: Approximately 18 lbs.

Operating Temperature: -20°C to 60°C

Humidity: 0 to 95% non-condensing

Dielectric and surge withstand: Per ANSI C93.5

ESD Protection: per IEEE PC37.90.3, Draft A, 1-8-99

Transmitter:
The transmitter is a fully programmable three-frequency Direct Digital Synthesis (DDS) generator followed by a 10 W power amplifier and filter. The unit may be configured for 1W/1W, 1W/10W, or 10W/10W operation (for a two-frequency system, three-frequency systems have additional modes).

Number of frequency presets: 3

Frequency step size: 10 Hz

Frequency setting method: Direct reading rotary switches

Rated output power: 10 Watts rms

Output impedance: 50 Ohms
(with load-matching adjustment)

Receiver: The receive circuit consists of an input normalizer, programmable frequency detector, and carrier level indicator.

Receiver sensitivity: 5 mVrms

Maximum receive level: >25 Vrms

Frequency Shift ±Hz	Nominal Bandwidth	Delay Time	Unidirectional Channel Spacing	Bi-Directional Channel Spacing
100 Hz	200 Hz	12 ms	500 Hz	1000 Hz
250 Hz	500 Hz	7 ms	1250 Hz	2500 Hz
500 Hz	1000 Hz	5 ms	2500 Hz	5000 Hz

Table 3. Minimum permissible channel spacings and delay times.

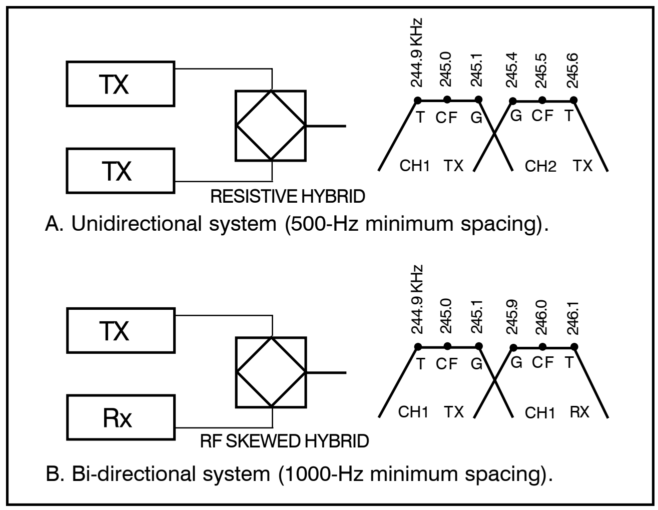


Figure 4. Typical Channel Spacings.

Carrier Level Indicator:
Display: Front panel 3-1/2 digit direct reading (in dB)

Range: ±10dB

External meter output: 0 to 100 µAmp or ±1Volt, jumper selectable

Receiver Logic Functions:
The FSK's received signals are sent into a user configurable logic module which processes the information. Each of the individual timers and signal qualifiers may be independently disabled or set to a desired value (in mSec) see table 2.

Sequence of Events

The units may be equipped with a Sequence Of Events (SOE) data log. System status points are checked every millisecond and changes in system status (events) are recorded in the log with time and date stamps. The events are stored in non-volatile memory and are recalled most recent event first. The forty most recent events are retained. The local clock is automatically synchronized to an externally supplied IRIG-B signal if available.

Clock functions: Y2K compliant

IRIG-B input: 1000 Hz modulated or direct TTL

Output Ratings

(2) Solid State Outputs
(1) guard, (1) trip:
Maximum continuous current: 1 Amp
Maximum 1 minute current: 2 Amps
Maximum 100 mSec current: 10 Amps
Maximum open circuit voltage: 280 Volts

(2) Form "C" Contacts/Relay Outputs
(1) guard (1) trip:
Maximum continuous current: 5 Amps
Maximum 200 mSec current: 30 Amps
Maximum open circuit voltage: 280 Volts

(5) Form "C": Alarm Relay Contact Outputs:
Tx Sent, PS Fail, Tx Fail, Low Level, Logic Fail
Maximum continuous current: 1 Amp
Maximum breaking current (125 Vdc):
1 Amp, non-inductive
Maximum breaking current (280 Vdc):
0.25 Amp, non-inductive
Maximum open circuit voltage: 280 Volts

Note: Logic level (5 volt nominal) outputs are available.

RF Output

Maximum continuous output power: 10 Watts
Nominal output impedance: 50 Ohms (with matching adjustment)

Input Ratings

(2) Trip key inputs 1 & 2

48 Volt Inputs
Will not operate at or below: 28 Volts
Will operate at or above: 35 Volts
Minimum pulse duration: 100 μSec
Input Current: <10mA, 5mA typical

125 Volt Inputs
Will not operate at or below: 70 Volts
Will operate at or above: 90 Volts
Minimum pulse duration: 100 μSec
Input Current: <10mA, 5mA typical

250 Volt Inputs
Will not operate at or below: 140 Volts
Will operate at or above: 175 Volts
Minimum pulse duration: 100 μSec
Input Current: <10mA, 5mA typical

Note: Logic level (5 volt nominal) inputs are available.

RF Input

Input impedance (termination enabled): 50 or 75 Ohms, selectable
Maximum continuous termination power dissipation: 1 W
Input impedance (termination disabled): >30 K-Ohms

Input Protection

>50 Vrms continuous without damage to receiver (excluding termination resistors).

Input Surge

3KV per C93.5

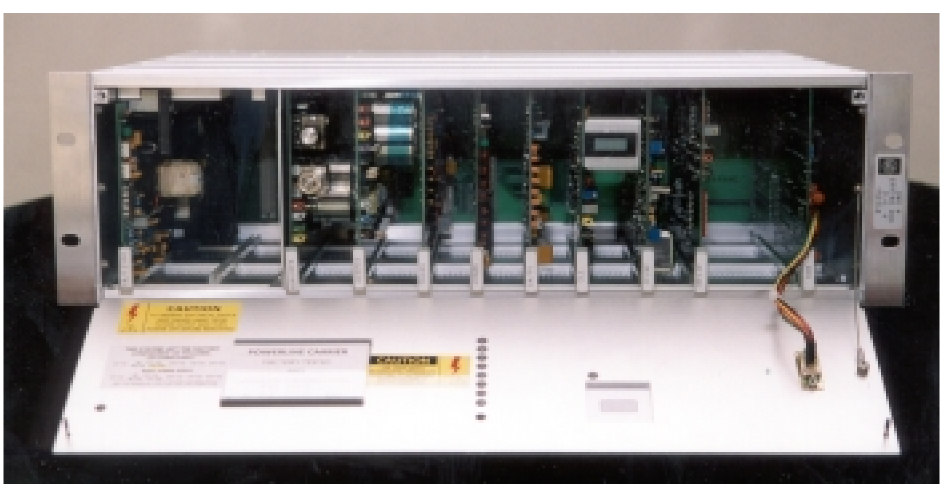


Figure 5. Typical RFL 9780 Programmable FSK Powerline Carrier Front Panel Down.

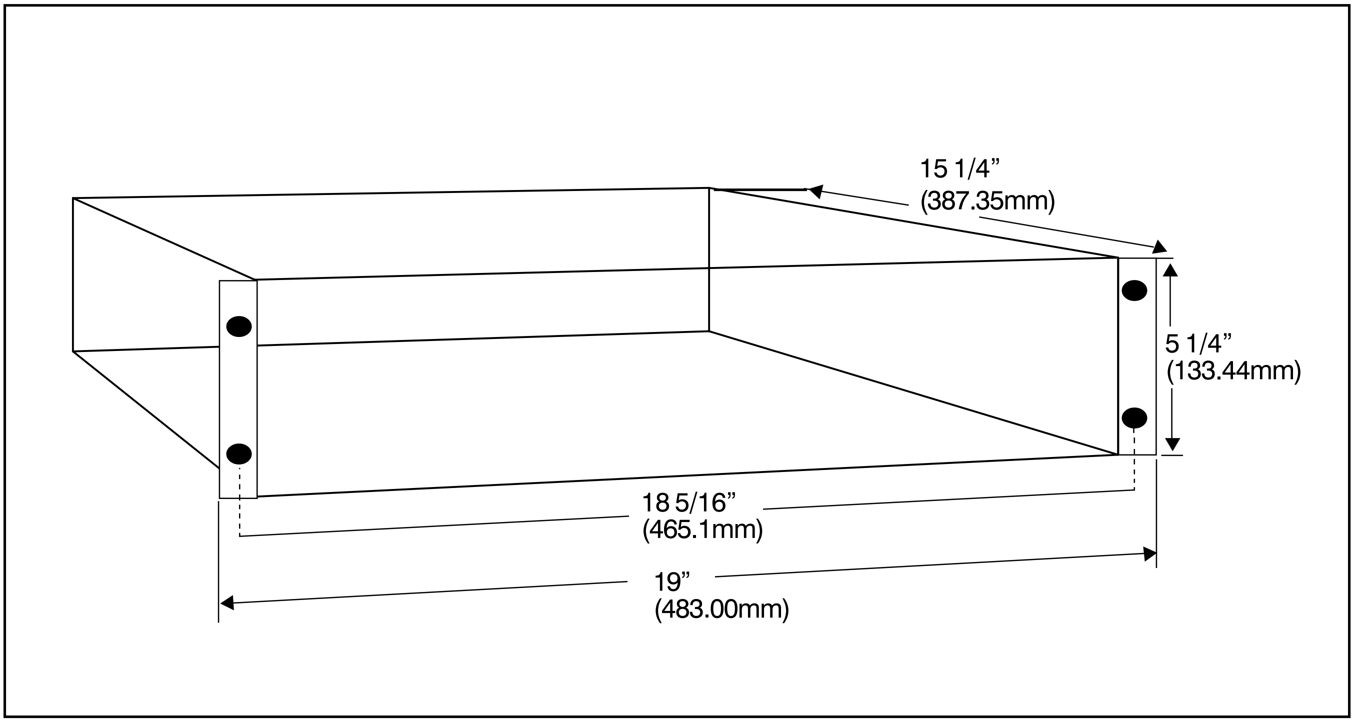


Figure 6. RFL 9780 Programmable FSK Powerline Carrier

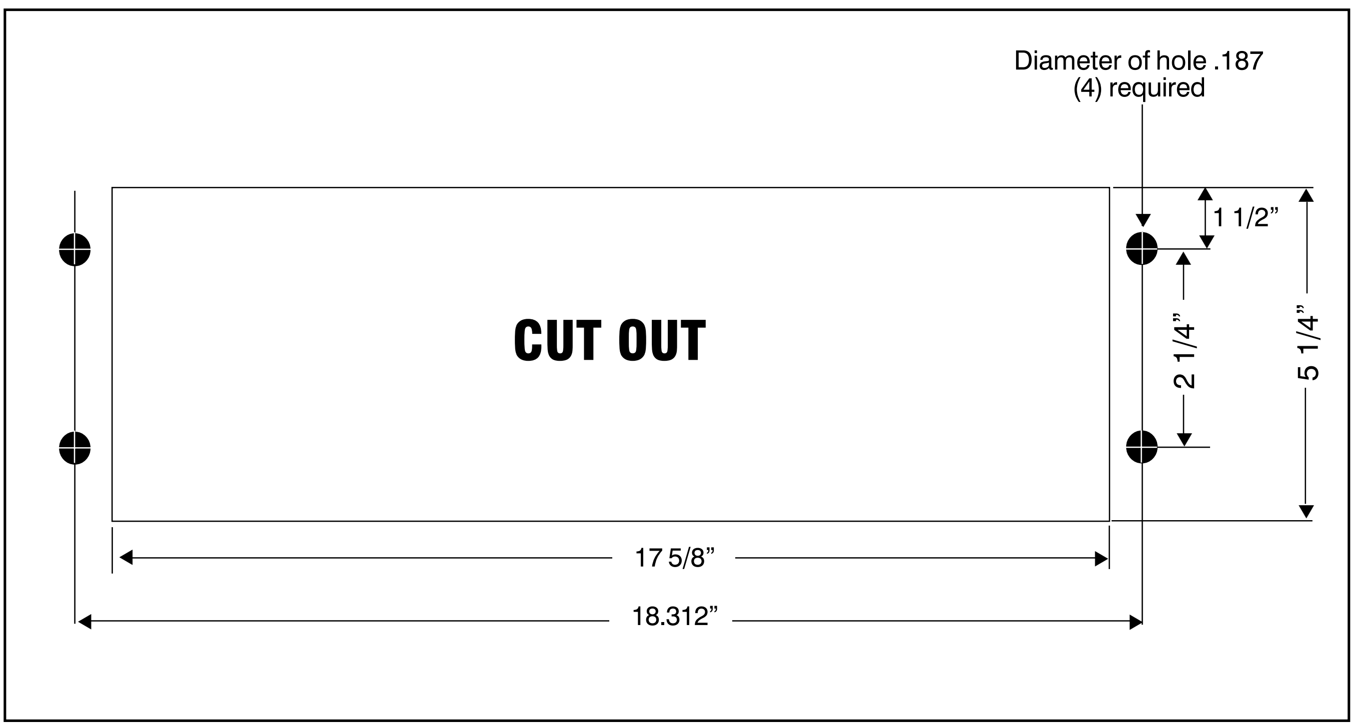


Figure 7. RFL 9780 Programmable FSK Powerline Carrier Panel Mounting

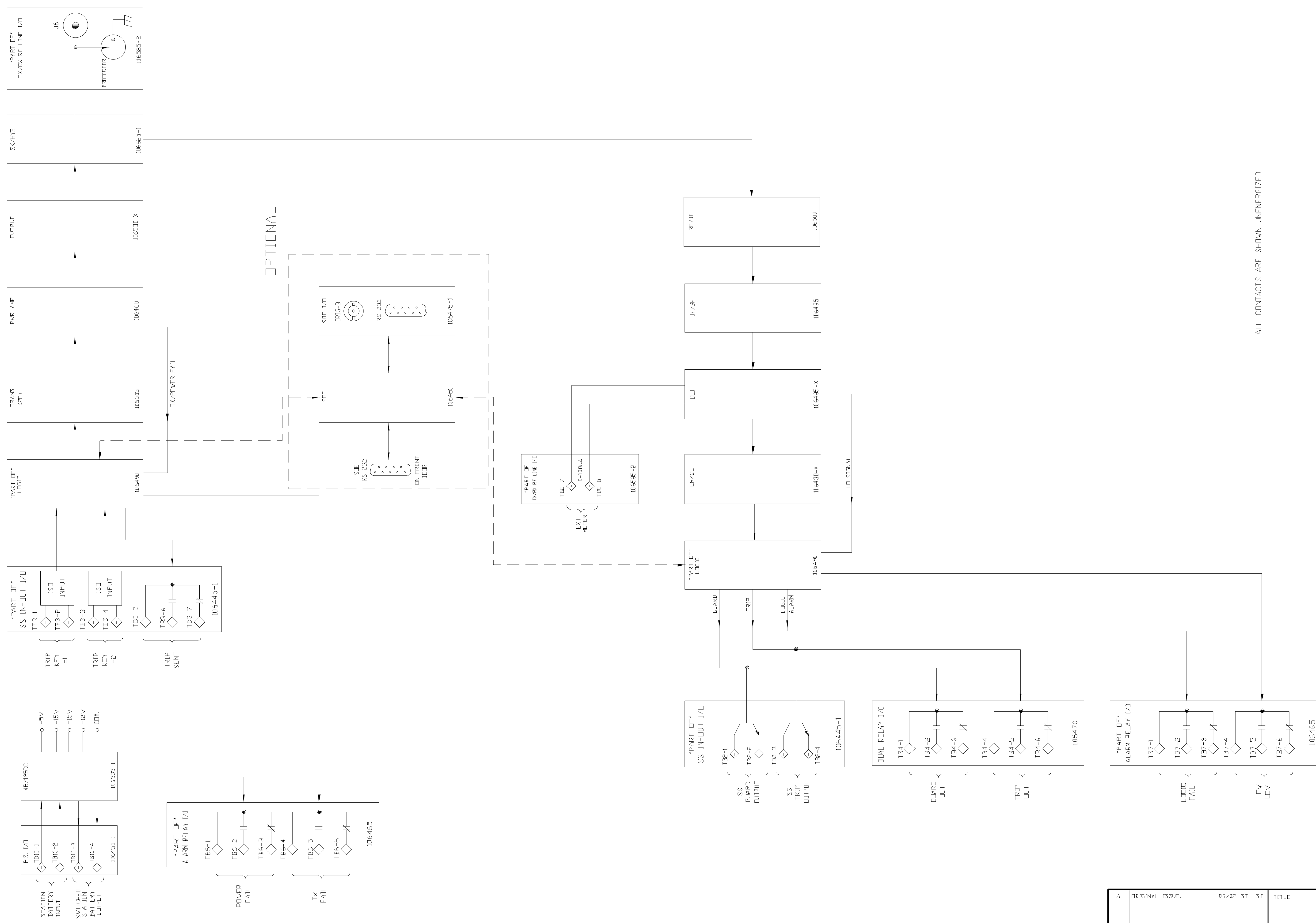


FIGURE 8. TYPICAL BLOCK DIAGRAM RFL 9780 PROGRAMMABLE FSK POWERLINE CARRIER SYSTEM

ISSUE	CHANGE	DATE	CHK	APP
A	ORIGINAL ISSUE.	06/02	ST	ST

TITLE: FIGURE 8
9780 TX/RX
BLOCK DIAGRAM

CUST: RFL ELECTRONICS INC. S.O.
DRN: S.T. APP: S.T. DATE: 06/02

RFL Electronics Inc.
Boonton New Jersey, USA

DWG NO. CD - 49877 - A
SHEET 1 OF 1

GUARD & TRIP SOLID-STATE OUTPUT CONNECTIONS	
GUARD OUT +	TB2-1
GUARD OUT -	TB2-2
TRIP OUT +	TB2-3
TRIP OUT -	TB2-4

TRIP KEYING INPUT CONNECTIONS	
TRIP KEY #1 +	TB3-1
TRIP KEY #1 -	TB3-2
TRIP KEY #2 +	TB3-3
TRIP KEY #2 -	TB3-4

ALARM RELAY CONNECTIONS		
POWER FAIL RELAY (NORMALLY ENERGIZED)	COM	TB6-1
	NO	TB6-2
	NC	TB6-3
TRANSMITTER FAIL RELAY (NORMALLY ENERGIZED)	COM	TB6-4
	NO	TB6-5
	NC	TB6-6
LOGIC FAIL RELAY (NORMALLY ENERGIZED)	COM	TB7-1
	NO	TB7-2
	NC	TB7-3
LOW LEVEL RELAY (NORMALLY ENERGIZED)	COM	TB7-4
	NO	TB7-5
	NC	TB7-6

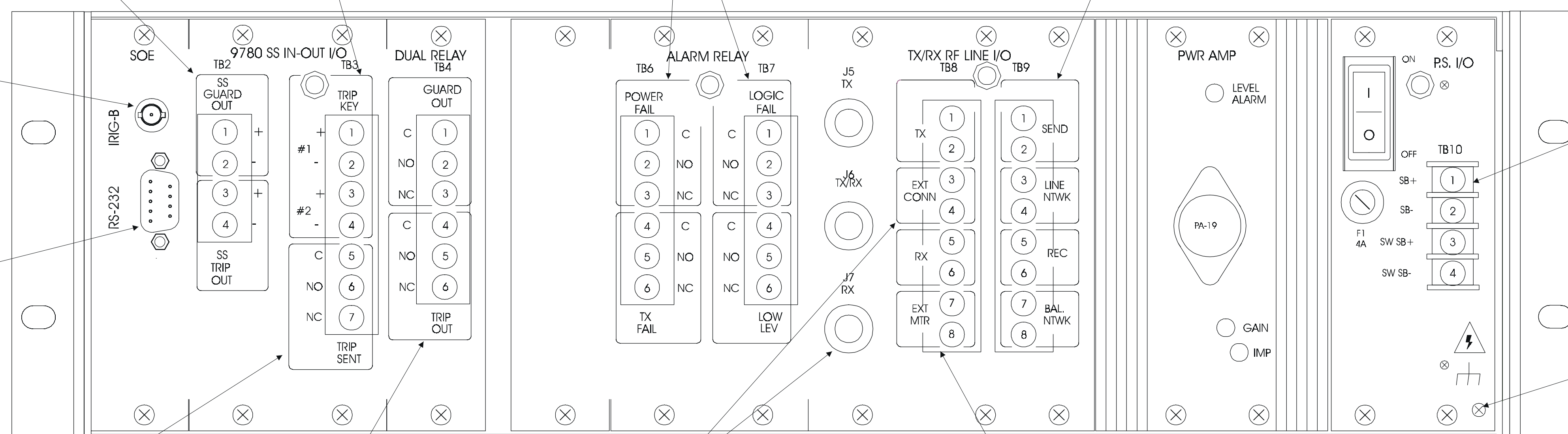
HYBRID CONNECTIONS		
SEND	SIG +	TB9-1
	SIG -	TB9-2
LINE	SIG +	TB9-3
	SIG -	TB9-4
RECEIVE	SIG +	TB9-5
	SIG -	TB9-6
BALANCE NETWORK	SIG +	TB9-7
	SIG -	TB9-8

IRIG-B CONNECTOR

RS-232 CONNECTOR

INPUT POWER CONNECTIONS	
STATION BATTERY +	TB10-1
STATION BATTERY -	TB10-2
SWITCHED STATION BATTERY +	TB10-3
SWITCHED STATION BATTERY -	TB10-4

CHASSIS GROUNDING STUD (#8 LUG)



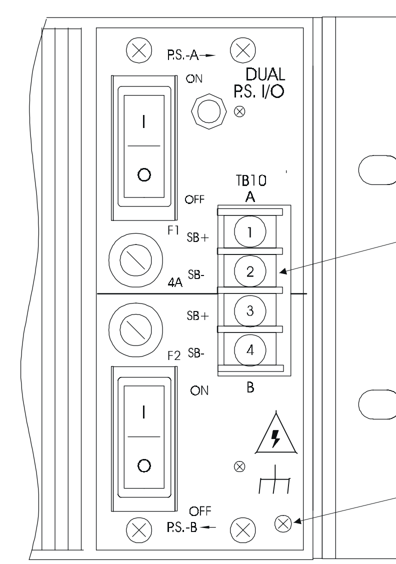
SINGLE P.S.

TRIP SENT RELAY CONNECTIONS		
TRIP SENT RELAY	COM	TB3-5
	NO	TB3-6
	NC	TB3-7

EXTERNAL CARRIER TRANSMIT & RECECEIVE CONNECTIONS		
TRANSMIT	UHF	J5
	SIG	TB8-1
	GND	TB8-2
TRANSMIT & RECEIVE (TO LINE TUNING)	UHF	J6
	SIG	TB8-3
	GND	TB8-4
RECEIVE	UHF	J7
	SIG	TB8-5
	GND	TB8-6

EXTERNAL CARRIER RECEIVE LEVEL METER CONNECTIONS	
METER +	TB8-7
METER -	TB8-8

GUARD AND TRIP RELAY CONNECTIONS		
GUARD RELAY	COM	TB4-1
	NO	TB4-2
	NC	TB4-3
TRIP RELAY	COM	TB4-4
	NO	TB4-5
	NC	TB4-6



INPUT POWER CONNECTIONS	
STATION BATTERY 1 +	TB10-1
STATION BATTERY 1 -	TB10-2
STATION BATTERY 2 +	TB10-3
STATION BATTERY 2 -	TB10-4

CHASSIS GROUNDING STUD (#8 LUG)

REDUNDANT P.S.

Figure 9. Typical Rear View RFL 9780 Programmable FSK Powerline Carrier System.

RFL 9780 FSK Powerline Carrier Tx/Rx, Tx only or Rx only
Smart Number Ordering Information

RFL Part Number (fill in blanks): **9780** ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

Base System		
9780 Transmitter/Receiver		TR
9780 Transmit only		TX
9780 Receive only		RX
Power Supply		
48 to 125 Vdc Single Supply		1
48 to 125 Vdc Dual Supplies		2
250 Vdc Single Supply		3
250 Vdc Dual Supplies		4
External Supplies		5
10 W Power Amplifer and Power Output Filter		
External amplifier or Rx Only		0
30 to 65 KHz, 10 W		1
65 to 156 KHz, 10 W		2
156 to 392 KHz, 10 W		3
392 to 535 KHz, 10 W		4
114 to 288.5 KHz, 10W		5
Relay Control Voltage I/O		
48 Vdc		1
125 Vdc		2
250 Vdc		3
Logic Level Interface		4
Receive Bandwidth		
Tx Only		0
200 Hz - Line Frequency 50 Hz		1
500 Hz - Line Frequency 50 Hz		2
1000 Hz - Line Frequency 50 Hz		3
200 Hz - Line Frequency 60 Hz		4
500 Hz - Line Frequency 60 Hz		5
1000 Hz - Line Frequency 60 Hz		6
RF Interface		
Tx Only or Rx Only		A
Single Tx/Rx port with skewed hybrid		B
Three ports (Tx, Rx, Spare) no hybrid		C
Three ports (Tx, Rx, Tx/Rx) with hybrid		D
Three ports (Tx, Rx, Tx/Rx) with hybrid, and ext. hybrid connections		E
Three ports, with X hybrid and Skewed Hybrid		F
Sequence of Events		
No SOE Module		0
With SOE Module		1
Other Custom Configuration		
No user specified customization		A
Phase Comparison Application		B
External Hybrid Chassis		C
Additional system details provided by customer		Z

*- For Rx/Rx please consult the factory

RFL 9780 FSK Powerline Carrier Tx/Tx
Smart Number Ordering Information

RFL Part Number (fill in blanks): **9780** **TT** ☐ ☐ ☐ ☐ ☐ ☐ ☐

Base System		
Chassis, motherboard & standard modules		TT
Power Supply		
48 to 125 Vdc Dual Supplies		1
250 Vdc Dual Supplies		3
External Supplies		5
10 W Power Amplifer and Power Output Filter (F1)		
External amplifier		0
30 to 65 KHz, 10 W		1
65 to 156 KHz, 10 W		2
156 to 392 KHz, 10 W		3
392 to 535 KHz, 10 W		4
114 to 288.5 KHz, 10W		5
10 W Power Amplifer and Power Output Filter (F2)		
External amplifier		0
30 to 65 KHz, 10 W		1
65 to 156 KHz, 10 W		2
156 to 392 KHz, 10 W		3
392 to 535 KHz, 10 W		4
114 to 288.5 KHz, 10W		5
Relay Control Voltage		
48 Vdc		1
125 Vdc		2
250 Vdc		3
RF Interface		
Single Port TX/TX with Transformer Hybrid		A
Three Port TX/TX without Hybrid		B
Three Port TX/TX with X Hybrid and Skewed Hybrid		C
Sequence of Events		
No SOE Module		0
With SOE Module		1
Other Custom Configuration		
No user specified customization		0
Additional system details provided by customer		1

RFL Model 9780 / 9785 One Rack Unit Hybrid Chassis
Smart Number Ordering Information

HYB			

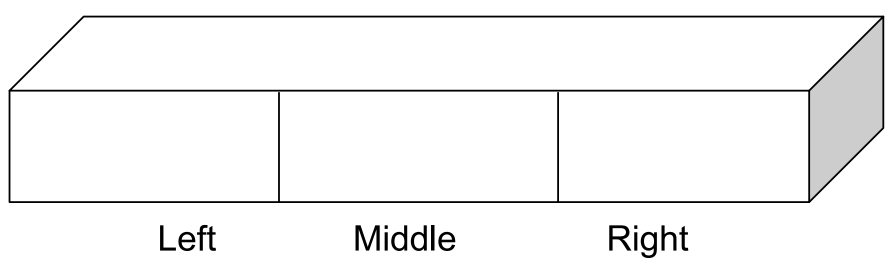
Chassis	
1 Rack Unit Chassis	HYB

Left Position	
Blank Panels	**B**
Transformer Hybrid	**T**
Skewed Hybrid	**S**

Middle Position	
Blank Panels	**B**
Transformer Hybrid	**T**
Skewed Hybrid	**S**

Right Position	
Blank Panels	**B**
Transformer Hybrid	**T**
Skewed Hybrid	**S**

Notes:
Left, Middle, and Right chassis positions are as viewed from the front of the chassis



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PRODUCT INFORMATION

RFL 9780/RFL 9785 Power Line Carrier

Reflected Power Measurement Using RFL Sequence of Events Module Option

Innovation from RFL:

An essential part of any powerline carrier commissioning, or maintenance program requires verifying the efficient transfer of power from the powerline carrier equipment to the transmission line. Previously this test required taking the powerline carrier system out of service, and connecting SWR meters, and often, frequency selective voltmeters, in the switchyard, at the line tuning equipment. RFL Electronics Inc.'s Sequence of Events module now offers a convenient, alternative to this testing method.

The RFL Sequence of Events option now offers the ability to locally, or remotely verify the transmitter reflected power, as well as both the transmit, and receive signal levels. Besides providing instant channel status , this feature provides the answer to the question, "which end of the line has the problem?" without even leaving the office.

Features

- *Built-in optional module for RFL 9780 and RFL 9785 Power Line Carrier*
- *Display of Received Signal Level (Rx) in dB, Transmit Power (Tx) in dB and Reflected Power in percent*
- *Eliminates the need for reflected power meter test equipment*
- *Displays the true reflected power as seen by each carrier set in dual-carrier applications*
- *Easy detection of any standing wave or other channel problem reducing field service troubleshooting time*
- *Enables optimization of carrier performance and line tuning*
- *Can be read off locally or remotely*
- *Received Level (Rx) display verifies correctly received signal from remote end*
- *Transmit Power (Tx) and Reflected Power display verifies that there is no problem with losses/reflected power from the local end*
- *Remote interrogation enables diagnostics of both ends from one location*
- *Easy, remote, checking of increased losses due to weather and/or contamination*
- *Provides the ability to identify loss of carrier due to line impedance, or attenuation changes*
- *Part of the RFL Browser-based HMI Interface for Setting, Configuration and Diagnostics*
- *Existing RFL 9780/RFL 9785 can be upgraded in the field*

RFL Reflected Power Meter

A check of reflected power is an essential part of commissioning power line carrier equipment. An excessive percentage (>10%) reflected power at the transmitter indicates mismatch of impedances and should be corrected by adjusting the line tuner.

The built-in Reflected Power Meter in RFL 9780/RFL 9785 makes this easy, both at commissioning and for maintenance.

Weather and temperature changes affect the characteristic impedance of the line and might warrant readjustment of the tuner. The RFL Reflected Power Meter can be read-off remotely and makes it easy to check received signal level and reflected power during adverse weather conditions without the need for traveling to the substation.

Reflected Power

The reflection coefficient r *is simply a mismatch seen at the line tuner. This is a complex number, that varies from -1 for a shorted line to +1 for an open line. For a matched load* r *is 0.*

$$r=\frac{Z - Z_0}{Z + Z_0}$$

where

r *= the reflection coefficient*

Z = the load impedance

Z_0 = the line impedance

Return loss *is a measure in dB of the ratio of power in the incident wave to that in the reflected wave, and it is always a positive value. A return loss of 10 dB means that 1/10th of the incident power is reflected. Return loss is related to the reflection coefficient by*

$$R.L. = -20 \log_{10} |r|$$

Reflected Power *is the proportion of forward power that is reflected back towards the transmitter by a mismatched load, and is determined by the reflection coefficient at the load:*

$$r_r (\%) = 1 \quad r^2$$

Voltage Standing Wave Ratio (VSWR) *is the ratio between the maximum to the minimum voltage.*

*The relationships between the standing wave ratio (VSWR), the reflection coefficient (*r*), return loss (R.L.) and reflected power (P_r) are:*

$$VSWR = \frac{\text{Incident Wave + Reflected Wave}}{\text{Incident Wave - Reflected Wave}}$$

Reflected Power Relationship Chart

VSWR	Reflection Coefficient	Return Loss (dB)	Power Ratio	Percent Reflected
1.01	0.005	46.10 dB	0.00002	0.0020 %
1.02	0.010	40.10 dB	0.00010	0.0100 %
1.04	0.020	34.20 dB	0.00038	0.0380 %
1.06	0.029	30.70 dB	0.00085	0.0850 %
1.08	0.039	28.30 dB	0.00148	0.1480 %
1.10	0.048	26.40 dB	0.00227	0.2270 %
1.20	0.091	20.80 dB	0.00826	0.8260 %
1.30	0.130	17.70 dB	0.01701	1.7000 %
1.40	0.167	15.60 dB	0.02778	2.8000 %
1.50	0.200	14.00 dB	0.04000	4.0000 %
1.60	0.231	12.70 dB	0.05325	5.3000 %
1.70	0.259	11.70 dB	0.06722	6.7000 %
1.80	0.286	10.90 dB	0.08163	8.2000 %
1.90	0.310	10.20 dB	0.09631	9.6000 %
2.00	0.333	9.50 dB	0.11111	11.1000 %
2.20	0.375	8.50 dB	0.14063	14.1000 %
2.40	0.412	7.70 dB	0.16955	17.0000 %
2.60	0.444	7.00 dB	0.19753	19.8000 %
2.80	0.474	6.50 dB	0.22438	22.4000 %
3.00	0.500	6.00 dB	0.25000	25.0000 %
3.50	0.556	5.10 dB	0.30864	30.9000 %
4.00	0.600	4.40 dB	0.36000	36.0000 %
4.50	0.636	3.90 dB	0.40496	40.5000 %
5.00	0.667	3.50 dB	0.44444	44.4000 %
6.00	0.714	2.90 dB	0.51020	51.0000 %
7.00	0.750	2.50 dB	0.56250	56.3000 %
8.00	0.778	2.20 dB	0.60494	60.5000 %
9.00	0.800	1.90 dB	0.64000	64.0000 %
10.00	0.818	1.70 dB	0.66942	66.9000 %
15.00	0.875	1.20 dB	0.76563	76.6000 %
20.00	0.905	0.90 dB	0.81859	81.9000 %
30.00	0.936	0.60 dB	0.87513	87.5000 %
40.00	0.951	0.40 dB	0.90482	90.5000 %
50.00	0.961	0.30 dB	0.92311	92.3000 %

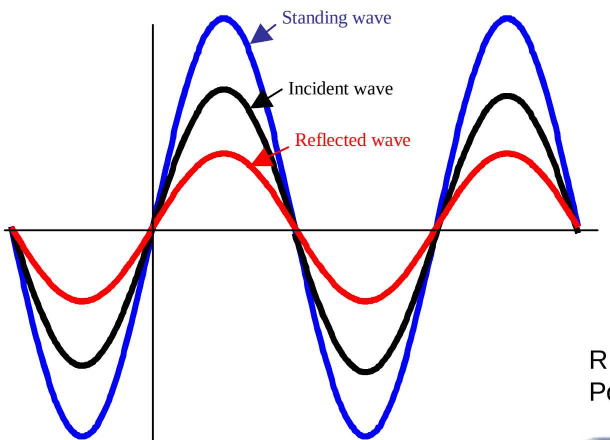
The values of reflected power are "good" if below 1%, "typical" (acceptable) if below 9% and "poor" if above 9%.

As the loss is directly related to the reflected power, measurement of reflected power and tuning to minimize this value is an efficient way to obtain optimum performance of the carrier channel.

Standing Wave

Standing waves are a phenomenon that exist, and are detrimental to transmission on all transmission lines that are not terminated in their characteristic impedance.

A line not properly terminated carries two signals; the transmitted signal and the reflected signal. At certain points along the line these signals are in phase and add, while at other points they are out-of-phase and subtract. Part of the power is reflected back and reflected waves create a voltage standing wave pattern on the transmission line.



Standing Wave

In the example shown above, the **Voltage Standing Wave Ratio (VSWR)** *is:*

$$VSWR = \frac{2+1}{2-1} = 3:1$$

Line Impedance

The line impedance depends on type of conductor and PLC coupling method. The range of characteristic line impedance, at power line carrier frequencies, is from 200 to 800 ohms. Factors influencing the impedance are:

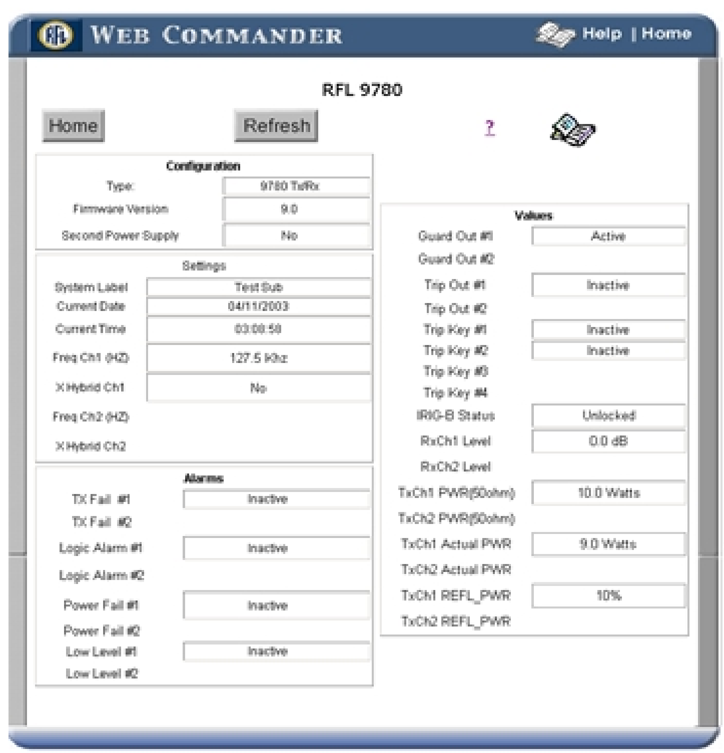
- *Line resistance*
- *Line inductance*
- *Capacitance*
- *Conductor radius*
- *Height above the ground*
- *Phase separation*
- *Line taps*

A tap can present a low impedance at the carrier frequency depending on the length and termination.

Transmission Line Characteristic Impedance

Transmission Line Conductor	Characteristic Impedance Phase to Ground Coupling (Ohms)	Characteristic Impedance Phase to Phase Coupling (Ohms)
Single Wire	350 to 500	650 to 800
Bundled Conductor (2 Wire)	250 to 400	500 to 600
Bundled Conductor (4 Wire)	200 to 350	420 to 500

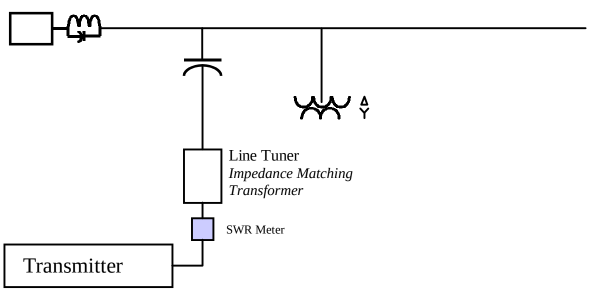
RFL Web Commander User Interface that includes Reflected Power values:



RFL 9780/RFL 9785 Reflected Power Meter

Traditionally, reflected power is measured at the line tuner by use of an SWR meter. Reflected power measurement is generally performed during commissioning, and possibly when analyzing carrier channel performance.

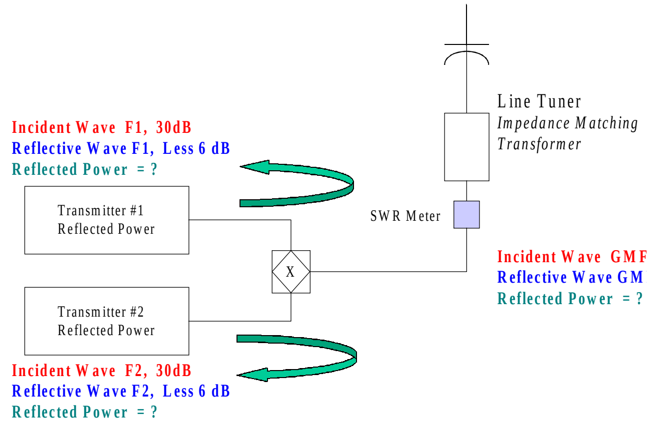
With the RFL 9780/RFL 9785 built-in Reflected Power Meter, reflected power can be measured at any time. The metered value is available remotely as well as locally and the carrier channel performance at all line ends can be evaluated from one location.



Single Carrier Application

For dual-carrier applications, reflected power is often measured at the line tuner as for a single carrier application.

In this case, the reflected power reading displayed in the RFL carrier equipment will be different than a value measured at the line tuner due to different frequency, circuit losses and signal voltage levels.



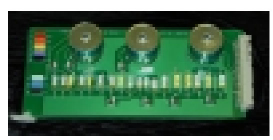
Dual-carrier application

The advantage with the built-in reflected power meter is that the true loss, as seen by each carrier set, is measured.

Field Upgrade of Existing Carriers

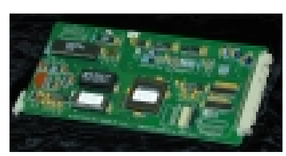
Existing RFL 9780/RFL 9785 carrier sets are field upgradable to provide this feature. Upgrades to the 9780 will require replacing the SOG/IRIG module, RF Power Output Filter and the CLI Level Indicator modules. Upgrading the 9785 involves replacing the SOG/IRIG filter, TRDGT modules.

An interconnecting harness is provided to route the transmit, and receive signals to the Sequence of Events module for processing.

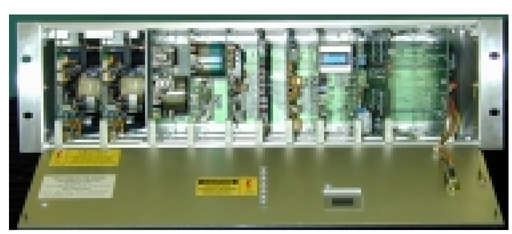


RF Power Output Filter

CLI Level Indicator



Sequence of the Events Module



Please contact RFL Customer Service Department for additional information.

RFL Electronics Inc.
(973) 334-3100
February 2003

SMART NUMBER FOR
9780/9785 RPM UPGRADE KIT

BASE SYSTEM	106507					

TYPE OF CHASSIS	
9780 TX/RX (106506-1) (106480-1)	1
9780 TX/TX (106506-2) (106480-1)	2
9780 RX/RX (106506-3) (106480-1)	3
9780 TX/RX (106506-4) (106480-1)	4

CLI (9780) or RX/DET (9785)	
NONE (9780 TX/TX only)	0
106485-4 CLI 200Hz	1
106485-5 CLI 500Hz	2
106485-6 CLI 1000Hz	3
106485-6 RX/DET 500Hz	4
106485-7 RX/DET 1000Hz	5
106485-8 RX/DET 1500Hz	6

Second CLI FOR 9780 RX/RX ONLY	
NONE	0
106485-4 CLI 200Hz	1
106485-5 CLI 500Hz	2
106485-6 CLI 1000Hz	3

OUTPUT FILTER	
NONE (9780 RX/RX ONLY)	0
106530-11 30-65 kHz	1
106530-12 65-156 kHz	2
106530-13 156-392 kHz	3
106530-14 392-535 kHz	4
106530-15 114-288 kHz	5

Second Output Filter FOR 9780 TX/TX ONLY	
NONE	0
106530-11 30-65 kHz	1
106530-12 65-156 kHz	2
106530-13 156-392 kHz	3
106530-14 392-535 kHz	4
106530-15 114-288 kHz	5

APRIL 2003

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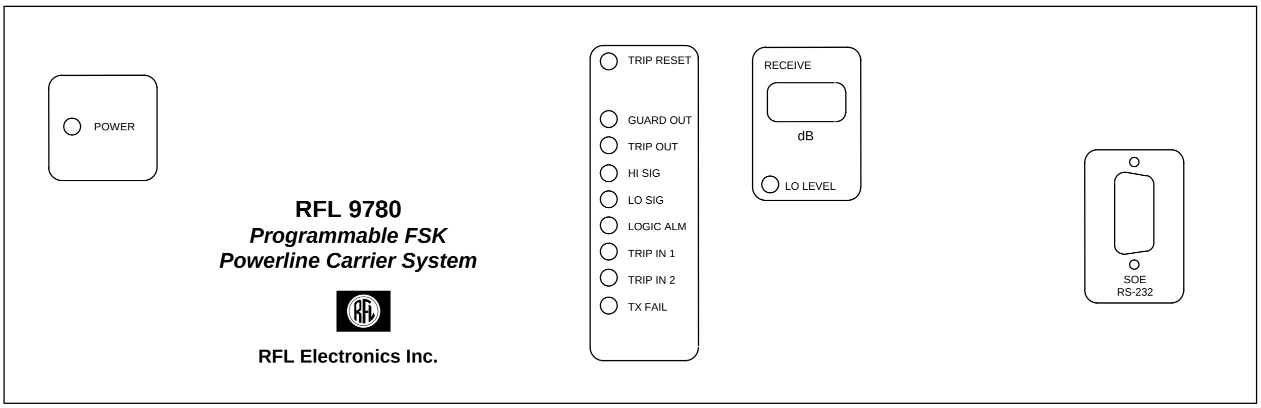
ISO 9001 Registered Company

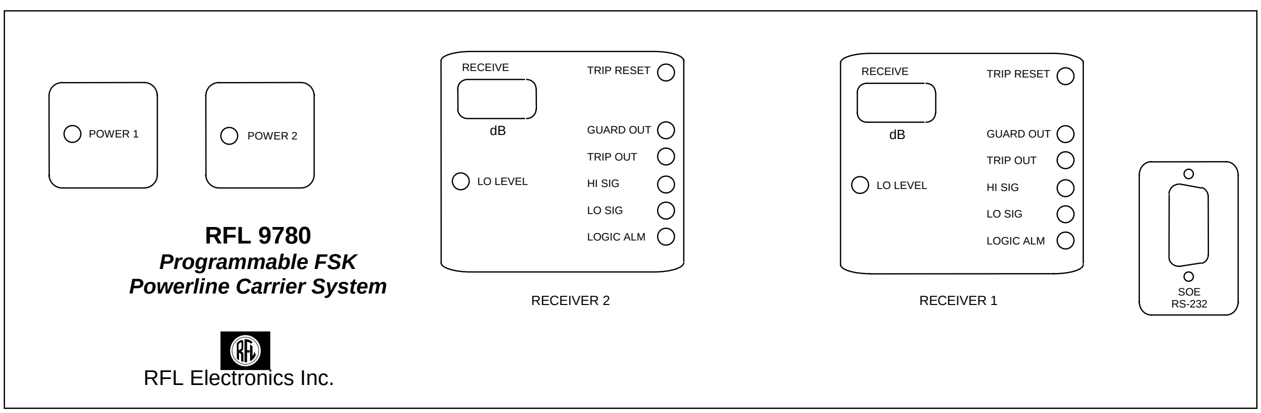
SECTION 2. GENERAL INFORMATION

2.1 INTRODUCTION

The RFL 9780 is available in five different configurations as follows: TX/RX, RX/RX, TX/TX, RX only and TX only. The front panels of each of these configurations are shown in Figure 2-1.



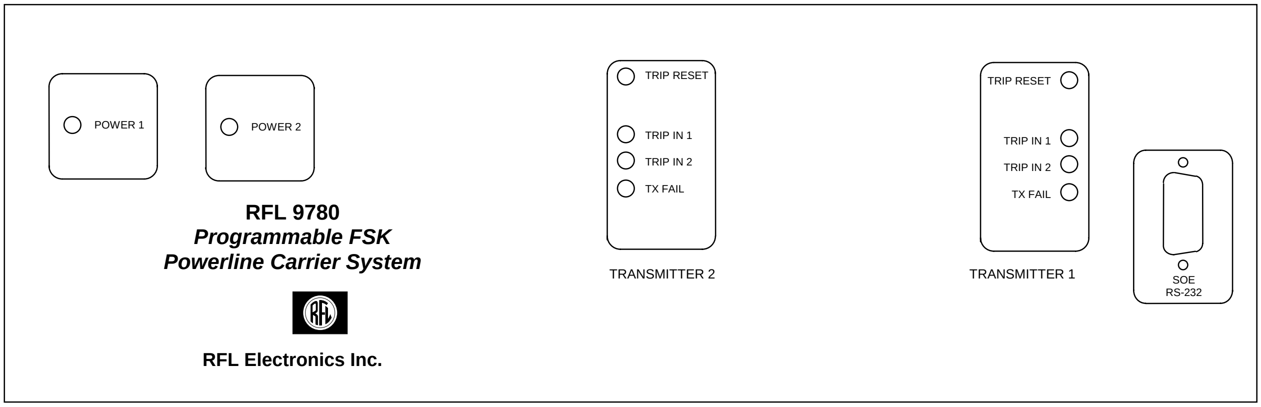
a. 9780 Front Panel, TX/RX



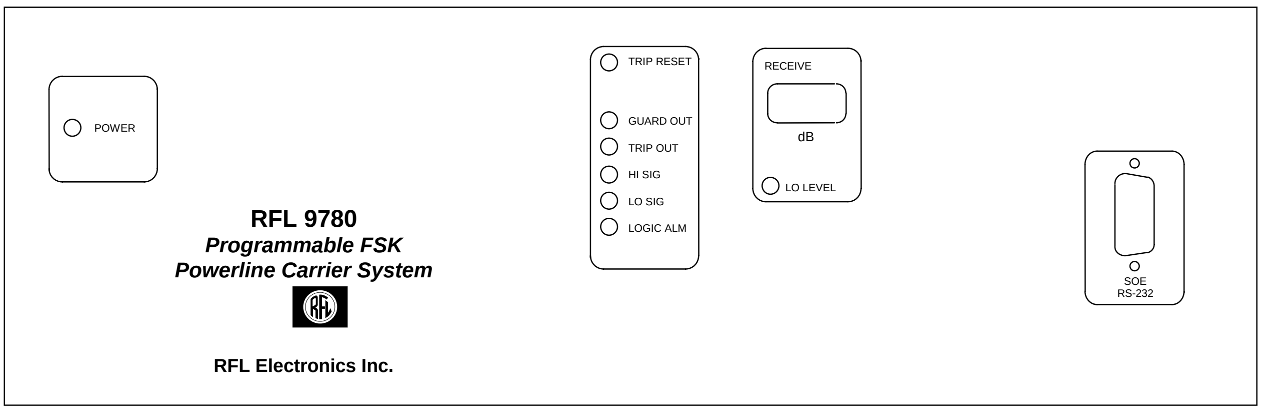
b. 9780 Front Panel, RX/RX

Figure 2-1. Various Configurations Of RFL 9780 Programmable FSK Powerline Carrier System

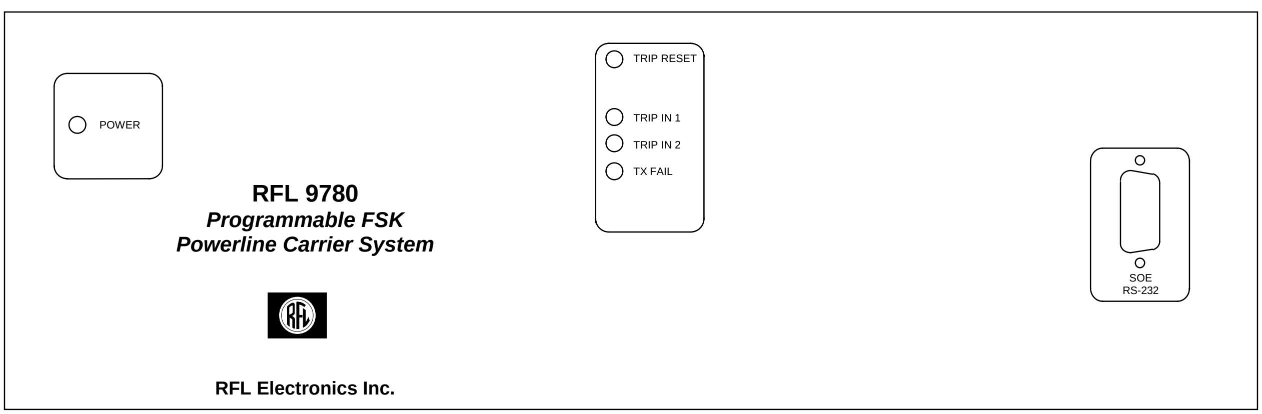
>> Figure 2-1. Continues on next page <<



c. 9780 Front Panel, TX/TX



d. 9780 Front Panel, RX only



e. 9780 Front Panel, TX only

Figure 2-1. Continued - Various Configurations Of RFL 9780 Programmable FSK Powerline Carrier System.

NOTE

Throughout this manual, specific terminal block terminals, DIP switch sections, and IC pin numbers are noted by the circuit symbol number followed by a dash and the terminal, section, or pin number (TB1-1, SW1-1, IC1-1, etc).

The circuit boards in the RFL 9780 use DIN 41612 Type C connectors, which contain columns of 32 pins. All modules have pins in columns A and C and provide a total of 64 pins per connector. In addition to this, the Logic Module has pins in column B giving an additional 32 pins for a total of 96 pins. Note that the pins extend from the front to the back of the unit into the I/O Module connector.

The I/O connector pins are a mirror image of the front connector pins. In order to clarify signal flow, the signal on pin 1 of a front module goes directly through the mother board to pin 1 of the rear module, as marked on the rear module circuit board. Note, however, that this may not be marked as pin 1 on the housing of the rear module's connector.

2.2 PURPOSE OF THIS MANUAL

This manual provides operation and maintenance information for the RFL 9780 Programmable FSK Powerline Carrier System. Included are an overall functional description of its purpose, a physical description and specifications, installation instructions, operating procedures, maintenance procedures, theory of operation, and parts information for all circuit card modules. The various RFL 9780 front panels are shown in Figure 2-1.

WARNING

MANY OF THE CIRCUITS IN THE RFL 9780 ARE FACTORY TUNED ACTIVE CIRCUITS. NONE OF THE PARTS IN THESE CIRCUITS ARE FIELD REPLACEABLE. UNAUTHORIZED MODIFICATIONS OR ALTERATIONS TO THESE CIRCUITS WILL COMPROMISE SYSTEM PERFORMANCE.

2.3 PURPOSE OF EQUIPMENT

The RFL 9780 is a frequency-shift keyed (FSK) transmitting and receiving terminal. It is an enhanced version of the field-proven technology used in the RFL 6780 and 6780P. The RFL 9780 requires half of the chassis space of the RFL 6780P, offers fully programmable timers, simplifies the setup process and fully complies with ANSI/IEEE C93.5-1997.

The RFL 9780 was designed to transmit guard and trip commands from one point to another over a powerline system, either alone or in multiplex with other communication channels. The RFL 9780 is capable of two-frequency (2F) or three-frequency (3F) FSK operation. The 2F mode can be used to send either a single guard or a single trip command, or the 3F mode can be used to send three-state information.

The RFL 9780 can be used in any of the following protection schemes:

1. Permissive Transfer Trip
2. Direct Transfer Trip
3. Phase Comparison
4. Dual-Channel Direct Transfer Trip
5. Directional Comparison Relaying (Blocking or Unblocking)

2.4 FEATURES

Programmability

The transmit frequencies (low and high for 2F operation, or low, center, and high for 3F operation) can be set over a range of 30Hz to 535kHz, adjustable in 10-Hz steps. The receiver frequency range is 30 to 535kHz, adjustable in 250Hz steps.

Wide Output Range

The transmitter output power level can be up to 10 watts in a single chassis. Higher output powers are available with external amplifiers.

Saves Rack Mounting Space

Each RFL 9780 terminal is housed in a single chassis three rack-units high (5.25 inches, or 133mm).

Conserves Frequency Spectrum

When configured as a dual-function 3F system, the RFL 9780 provides two relaying channels in less bandwidth than that's needed for two separate channels. Only one transmitter is required, reducing equipment costs. Besides providing better utilization of the carrier frequency spectrum, reliability is improved because less equipment is used.

Station Battery Isolation

A dc-dc converter supplies regulated voltage to all RFL 9780 modules. All inputs and outputs are made through optically-isolated transistors or electromechanical relays.

Flexible Trip Outputs

Trip outputs can be made through optically-isolated, high-current transistors, output relays, or both. An ABB RXMS-1 Series, ABB AR Series, or GEC GPR101 Series relay can also be supplied, mounted and wired inside an expansion chassis.

Compatibility With Existing Equipment

The RFL 9780 is backwards compatible with existing RFL 6780 and 6780P units presently in the field, and can communicate with virtually any other PLC equipment in the field.

Carrier Level Indicator

The RFL 9780 continuously monitors incoming carrier level with a digital panel meter providing a visual indication through the front panel. The contacts of an alarm relay will change state if the carrier level falls below a preset limit.

Manual Test Panel Option

A manual test panel can be supplied to allow the operator to manually test the continuity of the communications channel up to the trip output relay. This optional panel mounts inside an expansion chassis.

Reflected Power Meter

A built-in set of modules can automatically measure the amount of transmitted power reflected back to the local receiver. The reflected power can be read locally or remotely using RFL Web Commander or Hyper-terminal.

2.5 PHYSICAL DESCRIPTION

Each RFL 9780 terminal is a group of circuit board modules housed in a chassis three rack-units high (5.25 inches, or 133 mm). Interconnections between modules are made by a motherboard in the chassis. External equipment is connected to the chassis through I/O modules, which plug into the rear panel.

2.6 SYSTEM SPECIFICATIONS

As of the date this manual was published, the following specifications apply to all RFL 9780 terminals, except where indicated. Because all RFL products undergo constant refinement and improvement, these specifications are subject to change without notice.

2.6.1 TRANSMITTER SECTION

Frequency Range: 30 to 535 kHz, switch-selectable in 10-Hz steps.

Modulation: Can be either two-frequency or three-frequency FSK. Each shift can be independently programmed between 10 and 990Hz from the center frequency, in 10Hz steps.

Frequency Stability: ±10 Hz, crystal-controlled.

Output Power: Up to 10 watts, measured at the amplifier output. Additional power is available when the RFL 9780 is used with one or more external amplifiers.

Trip boost can be enabled by using switches on the logic module.

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

Trip Key Inputs (2):

48 Volt Inputs

Will not operate at or below: 28 Volts
Will operate at or above: 35 Volts
Minimum pulse duration: 100μSec

125 Volt Inputs

Will not operate at or below: 70 Volts
Will operate at or above: 90 Volts
Minimum pulse duration: 100μSec

250 Volt Inputs

Will not operate at or below: 140 Volts
Will operate at or above: 175 Volts
Minimum pulse duration: 100μSec

2.6.2 RECEIVER SECTION

Sensitivity: 5mVrms minimum signal.

Dynamic Range: 30 dB.

Input Impedance: 50Ω , 75Ω, or greater than 30,000Ω for bridging.

Response Time: 5 to 15 ms, with transmitter and receiver connected back-to-back and using solid-state outputs, depending on bandwidth choice and logic.

Trip And Guard Outputs:

Standard:

Solid-State (2):

Maximum continuous current: 1 Amp
Maximum 1 minute current: 2 Amps
Maximum 100 mSec current: 10 Amps
Maximum open circuit voltage: 280 Volts

Relay (2 Form C):

Maximum continuous current: 5 Amps
Maximum 200 mSec current: 30 Amps
Maximum open circuit voltage: 280 Volts

Optional:

Choice of ABB AR Series, ABB RXMS-1 Series, or GEC GPR101 Series relay.

2.6.3 GENERAL

Channel Spacings And Delay Times: See Table 2-1 and Figure 2-2.

Logic: Can accommodate any of the following protection schemes:

1. Directional Comparison Relaying (Blocking or Unblocking)

2. Permissive Transfer Trip

3. Direct Transfer Trip

4. Phase Comparison

5. Dual-Channel Direct Transfer Trip

The guard-before-trip function can be disabled for permissive and blocking applications.

Alarms: There are four standard alarms: transmitter output level (TX Fail), low received signal level (Low Sig), communications channel failure (Logic Alarm), and power supply failure.

Alarm Relay Characteristics:
Maximum continuous current; 1 Amp
Maximum breaking current (125 Vdc): 1 Amp, non-inductive
Maximum breaking current (280 Vdc): 0.25 Amp, non-inductive
Maximum open circuit voltage; 280 Volts

Interface Dielectric Strength: All input and output circuits are isolated from ground and from all other circuits. Breakdown is 1500 Vrms @ 50/60 Hz, 2500 Vdc, and 2500 Vrms @ 1.5 MHz, in accordance with IEEE Surge Withstand Capability Specification 472-1978 (ANSI C.37.90-1978). The RFL 9780 also meets the requirements of ANSI-IEEE Fast Transient Specification C.37.90.1-1988.

Input Power Requirements:
Voltage Range:
48-Vdc Systems: 40 Vdc to 58 Vdc.
125-Vdc Systems: 103 Vdc to 155 Vdc.
250-Vdc Systems: 200 Vdc to 300 Vdc.
Power Consumption: 85 watts max.

Operating Temperature: -20^{o}C to +60^{o}C (-4^{o}F to +140^{o}F).

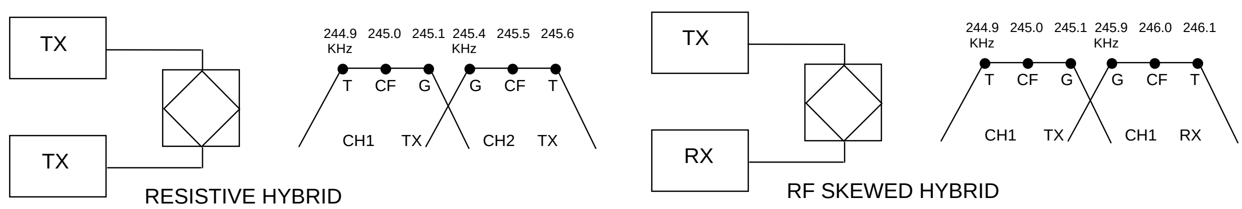
Dimensions:
Height: 10.5 inches (267 mm).
Depth: 13.0 inches (330 mm).
Overall Width: 19 inches (483 mm).

Weight: Less than 30 lbs (13.6 kg).

**Table 2-1. Minimum permissible channel spacings and delay time,
RFL 9780 Programmable FSK Powerline Carrier System**

Frequency Shift	Nominal Bandwidth	Delay Times* Normal	High Security	Unidirectional Channel Spacing	Bidirectional Channel Spacing
100 Hz	200 Hz	12 ms	20 ms	500 Hz	1000 Hz
250 Hz	500 Hz	7 ms	15 ms	1250 Hz	2500 Hz
500 Hz	1000 Hz	5 ms	13 ms	2500 Hz	5000 Hz

* Selected by switches on the 9780 Logic Module. The High security setting provides a ten-fold increase in security, when tested per ANSI C93.5-1997.



a. Unidirectional system
(500-Hz minimum spacing, 100 Hz shift)

b. Bidirectional system
(1000-Hz minimum spacing, 100 Hz shift)

Figure 2-2. Typical channel spacings RFL 9780 Programmable FSK Powerline Carrier System

2.7 TERMINAL CONFIGURATION

The RFL 9870 is housed in a single 3U high rack mounted chassis. Depending upon options and the configuration selected, an expansion chassis may be required, bringing the height to 6U. Table 2-2 shows general information about the available modules for the RFL 9780. Figures 2-3, 2-4 and 2-5 show block diagrams of the Tx/Rx, Tx/Tx and Rx/Rx terminal configurations. A summary of each module is included in paragraphs 2.8.1 through 2.8.12. Detailed descriptions of the modules can be found in Sections 6 through 20.

2.8 RFL 9780 SUBASSEMBLIES

Each RFL 9780 terminal contains several circuit board modules and I/O modules. Paragraphs 2.8.1 through 2.8.12 describe the different modules used in the RFL 9780 terminal.

Table 2-2. RFL 9780 modules, general information

Module Description	Used on					Assy. No.	Module Location (Front or Rear)	Additional Information
	TX/RX	RX/RX	TX/TX	RX only	TX only			
Logic Module	X	X		X		106490	F	Section 6
TX Logic Module			X		X	106490-1	F	Section 7
Transmitter Module	X		X		X	106505	F	Section 8
Power Amplifier Module	X		X		X	106460	R	Section 9
Output Filter Modules:								Section 10
30 Khz to 67 KHz	X		X		X	106530-1, -11	F	
64 Khz to 157 KHz	X		X		X	106530-2, -12	F	
154 Khz to 393 KHz	X		X		X	106530-3, -13	F	
390 Khz to 537 KHz	X		X		X	106530-4, -14	F	
114 Khz to 288 KHz						106530-5, -15		
RF Interface Module	X	X		X		106500	F	Section 11
IF/BF Module	X	X		X		106495	F	Section 12
Carrier Level Indicator Modules:								Section 13
200 HzBW	X	X		X		106485-4	F	
500 HzBW	X	X		X		106485-5	F	
1000 HzBW	X	X		X		106485-6	F	
Limiter/Slicer Modules:								Section 14
200 HzBW, 60 Hz line	X	X		X		106430-1	F	
500 HzBW, 60 Hz line	X	X		X		106430-2	F	
1000 HzBW, 60 Hz line	X	X		X		106430-3	F	
200 HzBW, 50 Hz line	X	X		X		106430-11	F	
500 HzBW, 50 Hz line	X	X		X		106430-12	F	
1000 HzBW, 50 Hz line	X	X		X		106430-13	F	
Seq Of Events/IRIG-B Module	X	X	X	X	X	106480-1	F	Section 15
Seq Of Events/IRIG-B I/O	X	X	X	X	X	106475-1	R	
I/O Modules:								Section 17
Solid State Input I/O:								
48/125 Vdc					X	106435-1	R	
250 Vdc					X	106435-2	R	
Solid State Output I/O:								
48/125 Vdc		X		X		106440-1	R	
250 Vdc		X		X		106440-2	R	
Solid State In/Out I/O:								
48/125 Vdc	X					106445-1	R	
250 Vdc	X					106445-2	R	
Dual Relay I/O	X	X		X		106470	R	
Alarm Relay I/O	X	X		X		106465	R	
Input/Alarm I/O								
48/125 Vdc			X			106600-1	R	
250 Vdc			X			106600-2	R	
Line I/Os:								
TX/RX RF Line I/O	X					106585-1 to -5	R	
TX RF Line I/O						106585-6	R	
RX RF Line I/O				X		106585-7	R	
TX/RX RF Line I/O	X					106585-8	R	
TX/RX RF Line I/O	X					106585-9	R	
TX/TX RF Line I/O			X			106590	R	
RX/RX RF Line I/O		X				106605	R	

<< Table continues on next page >>

Table 2-2. continued - RFL 9780 modules, general information

Module Description	Used On					Assy. No.	Module Location (Front Or Rear)	Additional Information
	TX/RX	RX/RX	TX/TX	RX only	TX only			
Hybrid Modules:								Section 18
X-Hybrid Module:			X	X	X	106420-1	F	
Skewed Hybrid Module:	X			X	X	106425-1	F	
Power Supply:								Section 19
48/125 Vdc	X	X	X	X	X	106535-1	F	
250 Vdc	X	X	X	X	X	106535-2	F	
Single Power Supply I/O:								
48/125 Vdc	X	X		X	X	106455-1	R	
250 Vdc	X	X		X	X	106455-2	R	
Dual Power Supply I/O:								
48/125 Vdc	X	X	X	X	X	106455-3	R	
250 Vdc	X	X	X	X	X	106455-4	R	
Chassis Assemblies:								Section 20
TX/RX with TX/RX motherboard	X					106400-1		
RX/RX with RX/RX motherboard		X				106410		
TX/TX with TX/TX motherboard			X			106405-1		
RX only with TX/RX motherboard				X		106615		
TX only with TX/RX motherboard					X	106610		
Accessory Equipment:								Section 21
Expansion Chassis								
Voice Module								

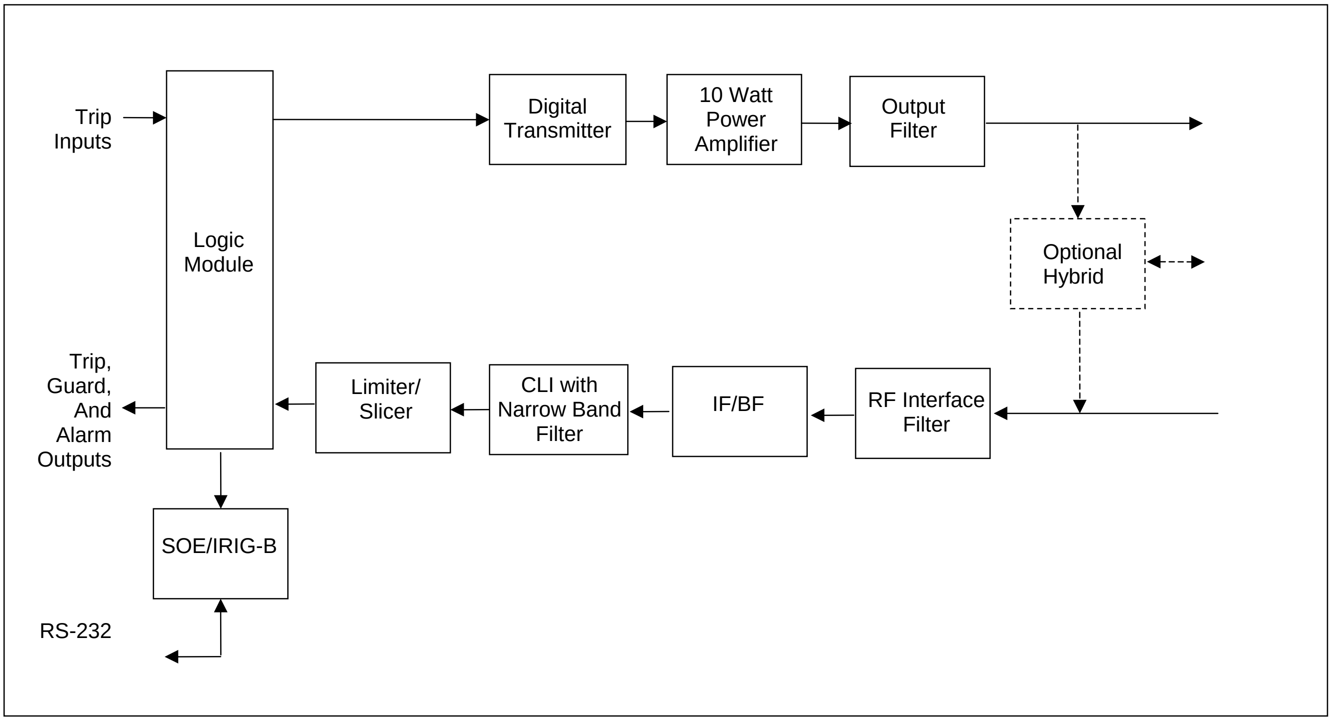


Figure 2-3. Block diagram of typical RFL 9780 Tx/Rx terminal

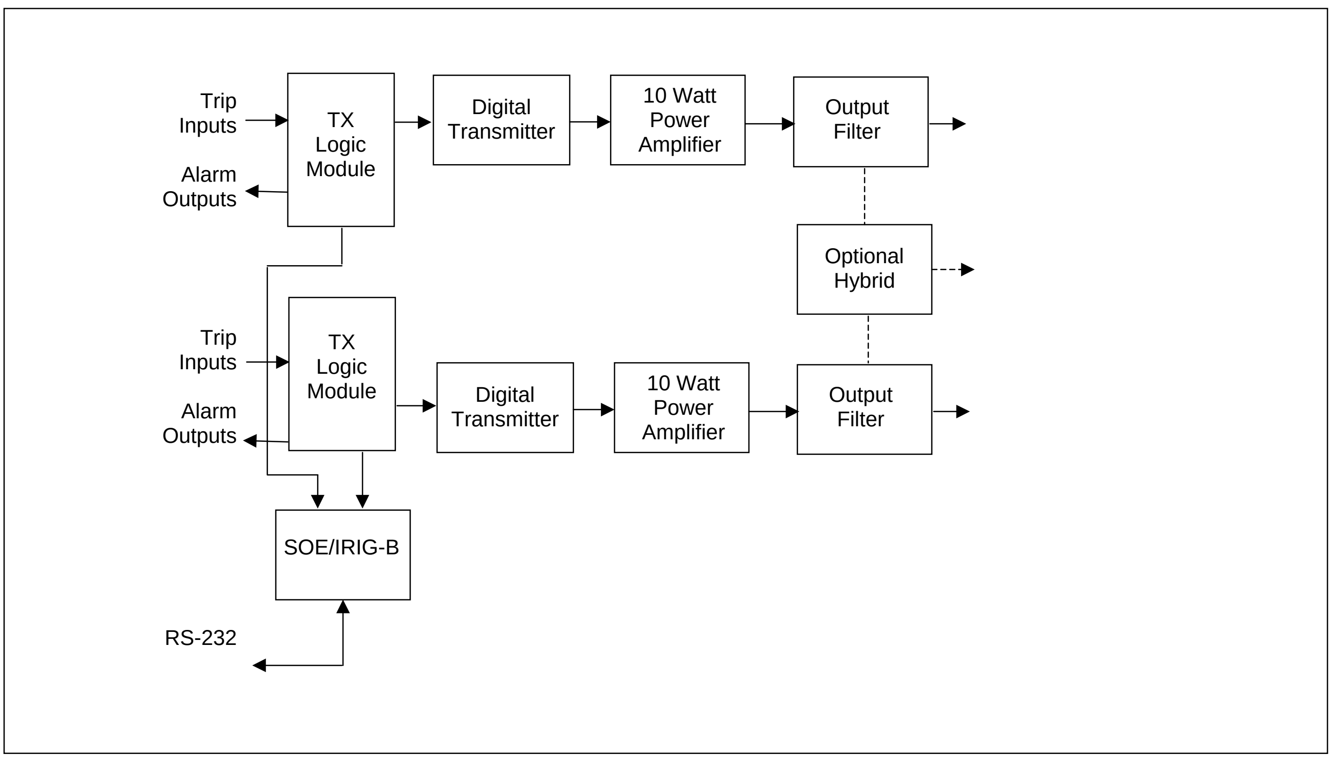


Figure 2-4. Block diagram of typical RFL 9780 Tx/Tx terminal

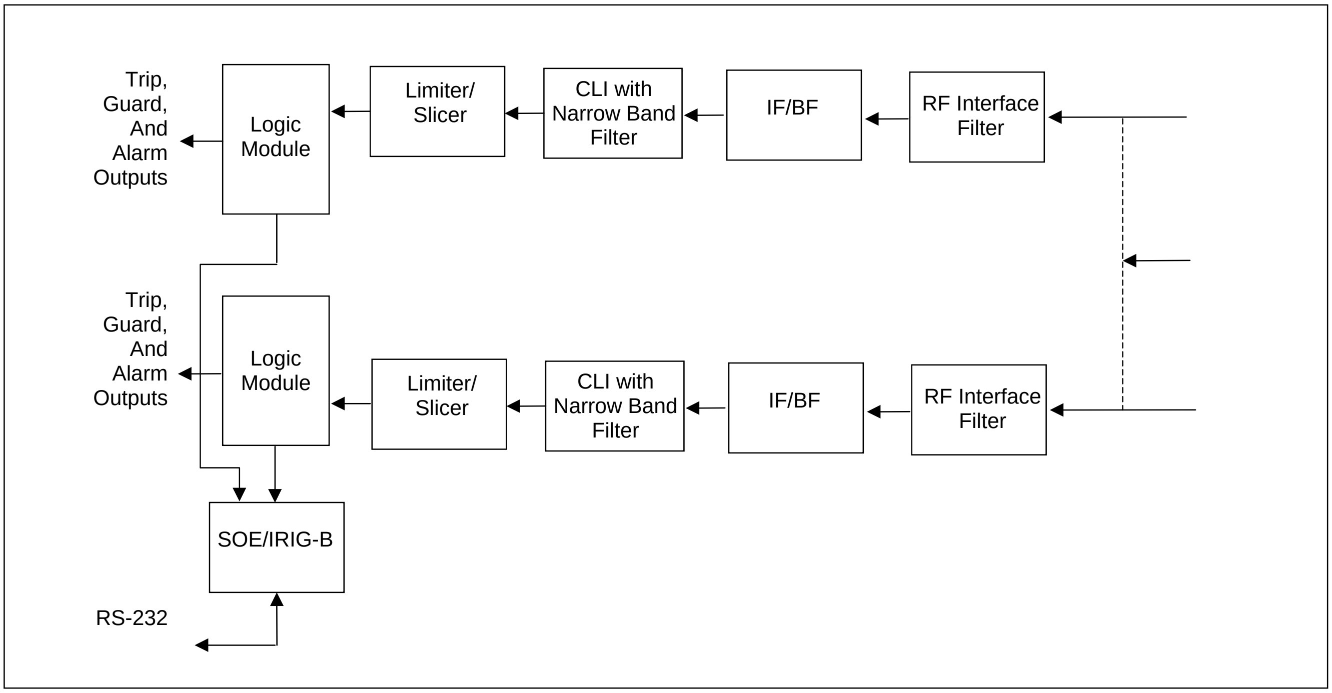


Figure 2-5. Block diagram of typical RFL 9780 Rx/Rx terminal

2.8.1 LOGIC MODULE

The RFL 9780 Logic Module interfaces with most of the receiver and transmitter modules within the system. The Logic module uses guard, trip, and noise input information that it receives from various parts of the system to build security and dependability into the receiver. In addition, it monitors trip input signals and generates signals for the Transmitter Module to control frequency shift and power level. The Logic Module also provides status information for the Sequence of Events Module. Additional information on the RFL 9780 Logic Module can be found in Section 6 of this manual.

2.8.2 TX LOGIC MODULE

The RFL 9780 Tx Logic Module interfaces with most of the transmitter modules within the system. It monitors trip input signals and generates signals for the Transmitter Module to control frequency shift and power level. The Tx Logic Module also provides status information for the Sequence of Events Module. The Tx Logic Module is used in place of the Logic Module in systems that do not have any receive functions. Additional information on the RFL 9780 Tx Logic Module can be found in Section 7 of this manual.

2.8.3 TRANSMITTER MODULE

The 9780 Transmitter Module utilizes Direct Digital Synthesis (DDS) to generate precise carrier signals. The desired frequency is selected by a bank of direct reading switches. The user selects the desired center frequency and shift-up and shift-down. The standard transmitter module can be used in a two or three frequency system.

The output section of the module adjusts the amplitude to provide the desired output power. Additional information on the RFL 9780 Transmitter Module can be found in Section 8 of this manual.

2.8.4 POWER AMPLIFIER MODULE

The RFL 9780 Power Amplifier is driven by the transmitter module, and raises the power of the transmitter to the level chosen for the application. It also includes a level monitoring circuit that will send a TX FAIL alarm to the logic module if the transmitter fails. The amplifier has a transformer-isolated output, and a 50Ω output impedance. Section 9 of this manual contains additional information on the RFL 9780 Power Amplifier.

2.8.5 OUTPUT FILTER MODULES

RFL 9780 Output Filter modules are used to reduce the harmonic content of the RFL 9780 Power Amplifier's output signal to a level that is at least 55 dB below the carrier level. In order to cover the RFL 9780's entire operating range (30 kHz to 537.5 kHz), there are four different RFL 9780 Output Filters. A fifth Output Filter module is available which covers a wider frequency range. Refer to Table 2-2 for approximate filter ranges. Four out of the five filters listed are equipped with jumpers for selecting the desired passband frequency range and the fifth has a fixed range, which covers the top of the RFL 9780's frequency band. All five filters are entirely passive, and require no input power for proper operation. Some of the Filter modules have additional circuitry to sense impedance mismatch to the load (reflected power). For additional information on the RFL 9780 Output Filter modules, refer to Section 10 of this manual.

2.8.6 RECEIVING SECTION

The RFL 9780 Receiving section consists of the following 4 modules: RF Interface, IF/BF, Carrier Level Indicator and Limiter/Slicer. Each of these modules is described briefly in paragraphs 2.8.6.1 through 2.8.6.4. Additional information on these modules can be found in Sections 11 through 14 of this manual.

2.8.6.1 RF Interface Module

The RFL 9780 RF Interface Module provides an interface between the Input I/O module and the IF/BF module. It consists of an attenuator, an amplifier, and a programmable filter, which is used to attenuate excess rf energy from the receiver input. The filter is programmable from 30Khz to 535Khz using a bank of DIP switches, SW1 through SW4.

2.8.6.2 IF/BF Programmable Demodulator Module

The RFL 9780 IF/BF Programmable Demodulator Module demodulates the received input signal and brings it down to the 9780's baseband frequency of 4 kHz.

2.8.6.3 Carrier Level Indicator Module

The input stage of the Carrier Level Indicator Module is a narrow band filter, which sets the basic bandwidth for the receiver section. 200, 500 and 1000 Hz filters are available.

The module also contains circuitry to monitor and display the received signal level. The display is a digital panel meter which reads directly in dB and is visible with the front panel of the unit closed. The module also monitors the signal and sets an alarm bit in the logic module if the level falls below a user settable limit.

2.8.6.4 Limiter/Slicer Module

The signal is converted into a square wave, which is then sent to the detector circuit. The detector is configured to provide a 90 degree phase shift at the center frequency. The shifted signal is then also converted into a square wave. The pre- and post- discriminator square waves are combined to generate a square wave of twice the baseband frequency. As the frequency of the signal is varied, the percent duty cycle of this signal changes. The duty cycle is monitored to determine whether the frequency is high or low. This information is displayed on the board’s LEDs and passed on to the Logic Module for further processing.

2.8.7 SOE/IRIG-B MODULE AND SOE/IRIG-B I/O MODULE

The IRIG-B Module is a status monitor card for the RFL 9780 which monitors system status every 1 ms. Sequence Of Events are recorded when any point changes state or if the CPU gets reset. The Sequence Of Events log is a record of the state of each point, the state of CPU reset, and the date and time the record was saved. The system can record up to 40 events. The module has a free running clock which is synchronized every ten seconds to the IRIG-B clock if IRIG-B is available. The SOE data is retrieved via a 3-wire RS-232 port.

2.8.8 I/O MODULES

The I/O modules serve as an interface for input and output signals between the RFL 9780 and the line coupling equipment. There are several types of I/O modules that can be used with the RFL 9780. These are shown and described in Section 17.

2.8.9 HYBRID MODULES

Hybrids are optional interface modules for RFL 9780 terminals, used to connect transmitter outputs and receiver inputs to line tuning units. Two basic types of hybrids are available: the RFL 9780 X- Hybrid and the RFL 9780 Skewed Hybrid. By installing these hybrids in the RFL 9780 chassis and making all interconnections as part of the chassis wiring, all external interface wiring is eliminated, except for a single coaxial cable to the line tuning unit. A coaxial connector at the rear of the chassis is provided for this purpose. Section 18 of this manual contains additional information on the RFL 9780 hybrids.

2.8.10 POWER SUPPLY MODULES

The RFL 9780 power supply accepts the incoming station battery voltage and produces four regulated dc output voltages: $\pm$15 Vdc for the analog circuits, +5 Vdc for the logic circuits, and +12 Vdc for powering the relays. Two different versions of the power supply are available: one for 38 to 150 Vdc input, and one for 200 to 300 Vdc input. Additional information on these power supplies can be found in Section 19 of this manual.

2.8.11 CHASSIS

Most RFL 9780 terminals consist of a single chassis, which houses all transmitter and receiver modules. Each chassis contains a motherboard, which provides all electrical interconnections between its modules and a few coax cables for RF signals. Coaxial connectors on the rear panels are used to connect the RFL 9780 to the line tuning equipment.

Isolation boards mounted to the rear panel of each contains optically-isolated input circuits, isolated output drivers, output relays, and high-voltage and transient suppression circuits. Terminal blocks on the isolation boards extend out of the rear panel, and are used to connect external equipment to the RFL 9780. Section 20 of this manual provides additional information on the chassis, motherboards, and isolation boards.

2.8.12 ACCESSORY EQUIPMENT

Other circuit card modules and assemblies are available to enhance the operation of the RFL 9780 terminal, or to adapt it to special applications. If any accessory equipment was furnished with your system, an Instruction Data Sheet for each item will appear in Section 21 of this manual.

2.9 SYSTEM THEORY OF OPERATION

The RFL 9780 has four functional blocks: the transmitter section; the receiver section; the logic (or control) functions; and, the sequence of events functions. All of these functions are tied together by the chassis (with motherboard) and powered by the power supply.

2.9.1 TRANSMITTER SECTION

The function of the transmitter section is to provide the desired carrier frequency, at the desired power level at the transmitter port. For clarity, the functions which determine the desired output frequency and power level are discussed in Section 8. The transmitter section consists of three basic modules, the Transmitter Module, the Power Amplifier Module, and the Output Filter Module. This may also be followed by a hybrid.

The Transmitter Module generates a clean, precise, carrier at the desired frequency and level. A single module is capable of transmitting three frequencies, a center frequency, a shift-down, and a shift-up frequency. The two shift frequencies may be independently selected by the user.

The transmitter may be instructed to generate one of three carrier levels (which correspond to 1, 3, and 10 watts transmit power after the Power Amplifier). (Although rarely used, the module also has provisions for modulating the carrier envelope to a supplied voice signal and a “reserve” feature which reduces the output power by a factor of 10.) See Section 8 for more information about the Transmitter Module.

The output of the Transmitter Module is fed into the Power Amplifier Module. (The Power Amplifier is the only rear-mounted module other than I/O modules.) The Power Amplifier boosts both the voltage and current to provide the specified 10 watts of transmit power.

The Power Amplifier also contains a circuit which detects a loss of transmit carrier. This is used to indicate a failure of the transmit circuits. Additionally, the Power Amplifier uses advanced feedback techniques to emulate the desired 50 ohm output impedance. Not only does this increase the inherent efficiency of the amplifier, but allows for the output impedance to be adjustable to match the actual impedance of the line. See Section 9 for more information about the Power Amplifier Module.

In order to remove any unwanted harmonics from the amplified carrier signal, the output of the Power Amplifier is followed by the Output Filter. The Output Filter is a passive bandpass filter. In order to avoid having to make detailed adjustments to the filter or, worse, risking poor impedance matching at either the input or output of the filter, several filters are available, several with jumper-selectable sub-bands. This provides an easy and accurate method of setup. See Section 10 for more information about the Output Filter Module.

Often the output of the Output Filter will be sent through a hybrid. The hybrid may be used to combine the signals of two transmitters or to combine a transmitter and receiver without swamping the received signal by the strong transmit signal. See Section 18 for more information about Hybrid Modules.

The output of the transmitter circuits must be fed out to the field wiring. This is accomplished on a Line I/O Module. Various Line I/O Modules are available to meet the varied needs in the industry. All of the modules provide one or more UHF connectors for the carrier and protection circuits. See Section 17 for more information about the Line I/O Modules.

One significant alteration to the transmit description above is when an external power amplifier is used. This may be required if more than 10 watts of output power is needed. In this case, the Power Amplifier Module is omitted from the chassis. Additionally, there would be no need for the 9780 Output Filter or Hybrid, as these would be required after the external power amplifier.

2.9.2 RECEIVER SECTION

The function of the receiver section is to monitor the received signal for the proper sequence of carrier signals. For clarity, this Section discusses only the analog functions that detect the received frequencies, interpreting this information is discussed in Section 14. The receiver consists of Line I/O Module, RF Input Module, IF/BF Module, CLI Module, and LM/SL Module. There may also be a hybrid in the receive path.

The received signal enters the 9780 chassis through a Line I/O Module. Various Line I/O Modules are available to meet the varied needs in the industry. All of the modules provide one or more UHF connectors for the carrier and protection circuits. Line I/Os used for received signals have additional circuits for impedance matching and to protect the sensitive receiver front end. See Section 17 for more information about the Line I/O Modules. If a hybrid is used to separate transmit and receive signals, the protection and impedance matching circuits are located on the hybrid.

The signal is then fed to the RF Interface Module. The RF Interface front end consists of attenuators and gain sections to normalize the received level to the design level. This allows a wide dynamic range of signals to be accepted by the unit. Once the signal level is normalized, it is passed through a bandpass filter. The filter has a bandwidth of approximately 10 KHz with a programmable center frequency. This reduces the extraneous noise content and energy to be processed. See Section 11 for more information about the RF Interface Module.

The signal is then sent into the IF/BF Module. This module shifts the received carrier from the customer specified center frequency down to the 9780's baseband frequency of 4 KHz. There are three mixers on this module. There is a very sharp cutoff crystal bandpass filter located between the first and second mixer. The bandwidth of this filter is approximately 4 KHz; further reducing noise and energy levels. See Section 12 for more information about the IF/BF Module.

The 4 KHz signal out of the IF/BF is then sent to the CLI Module. The CLI contains a narrow-band (bandpass) filter. The bandwidth of the filter is selected based upon the frequency shifts used in the system, 200, 500, and 1000 Hz filters are available. The filter is generally chosen to be as narrow as practical while still passing the received signals.

This filtered signal is then sent to the LM/SL Module and is further processed on the CLI Module. On the CLI Module the level of the carrier is extracted. This level signal is then compared to a user selectable threshold to alert the user to a low received level. The level is also sent into a log- amplifier circuit to convert the level to a dB measurement. This dB measurement is displayed on a front panel display and also made available for external meters. See Section 13 for more information about the CLI Module.

The filtered signal sent into the LM/SL Module follows two paths. The level of the carrier is again extracted and sent through a corona filter. The corona filter is a triple notch filter. The notches are tuned for the grid frequency (50/60 Hz) and it's harmonics. The signal is then used by the logic functions to detect noise and loss of carrier.

The signal is also fed through a limiter followed by a discriminator which shifts signals at the baseband frequency by 90°. The output of the discriminator is also limited and then combined with the output of the first limiter. The combined signal is a rectangle-wave whose duty cycle varies depending upon the frequency of the received signal. (The module allows one of the two limited signals to be inverted, which reverses the phase relationship.) The average value of the rectangle-wave is extracted and used to determine the frequency of the received signal. This is then used to generate a trip or guard signal. See Section 14 for more information about the LM/SL Module.

2.9.3 LOGIC FUNCTIONS

The Logic Module provides features related to both the transmit and receive functions. For the transmit path, the user has two keying inputs, how they are interpreted in 2F and 3F systems is configurable by the user. The Logic Module is also responsible for telling the Transmitter Module which frequency and power level to transmit.

On the receive side, the Logic Module is fed information regarding the presence of guard or trip frequencies, low carrier level, and signals from analog noise detector circuits. These signals are processed to validate both the trip and guard inputs per the customer specified configuration.

The logic module is also responsible for various housekeeping and alarm functions. See Section 6 for more information about the Logic Module.

2.9.4 SEQUENCE OF EVENTS

The Sequence Of Events (SOE) Module provides a computer interface to the RFL 9780. The module monitors the system status at all times and records any changes in a log. There are two RS-232 connectors on the 9780 to access the SOE Module, one on the rear and one on the front of the unit. The rear connector is intended for permanent connection to monitoring equipment (if available) while the front connector is intended for short-term connection to a PC or terminal for system interrogation. The front connector input overrides the rear connector.

The user may request the present status of the 9780 chassis on a one-time or continuous update basis. Additionally, the module saves the forty most recent changes in status in a log with time and date stamping. This data may be viewed (or downloaded) one record at a time or the complete log may be dumped.

The SOE Module contains a Y2K compliant clock that is automatically synchronized to an IRIG-B input signal if available. When a valid IRIG-B signal is not available, the clock continues to run in a free-running mode. See Section 15 for more information about the SOE Module.

2.9.5 CHASSIS AND POWER SUPPLY

The 9780 chassis houses all of the modules and contains a full-system motherboard. The motherboard distributes power to all of the modules and interconnects signals between modules. As a result, the motherboard (and thus chassis) are specific for a particular configuration of 9780. The Tx/Rx chassis differs from the Tx/Tx and Rx/Rx chassis.

Each chassis can be equipped with either one or two power supplies. Two supplies may be used to provide a backup power source should one supply fail. Each supply contains monitoring circuits to detect a failure of any of the supplied voltages. (Note that in a Tx/Tx chassis, two supplies are required to provide the energy required for two 10 watt transmitters.) See Sections 19 and 20 for more information about the Power Supplies and Chassis.

2.9.6 ALTERNATE CONFIGURATIONS

The previous discussion has dealt primarily with the Tx/Rx chassis. Alternate configurations are available for the 9780: Tx only, Rx only, Tx/Tx, and Rx/Rx. In these cases, some of the information presented above will not be applicable, and some may apply to more than one channel.

SECTION 3. INSTALLATION

WARNING

ALL RFL 9780 TERMINALS ARE EQUIPPED WITH A PROTECTIVE COVER THAT EXTENDS ACROSS THE REAR OF THE CHASSIS. THIS COVER IS INTENDED TO PROTECT THE OPERATOR FROM POTENTIALLY HAZARDOUS VOLTAGES WHICH MAY BE PRESENT ON THE REAR-PANEL TERMINAL BLOCKS. THIS COVER MUST ONLY BE REMOVED BY QUALIFIED SERVICE PERSONNEL WHEN ACCESS TO THE REAR PANEL IS REQUIRED. IT MUST BE REPLACED BEFORE PLACING THE 9780 TERMINAL IN SERVICE.

3.1 INTRODUCTION

This section contains installation instructions for the RFL 9780, including unpacking, mounting, and inter connection wiring.

3.2 UNPACKING

RFL 9780 equipment may be supplied as individual chassis or interconnected with other chassis or assemblies as part of a system. Paragraph 3.2.1 provides unpacking instructions for individual chassis, and paragraph 3.2.2 provides instructions for interconnected chassis.

3.2.1 INDIVIDUAL CHASSIS

RFL 9780 terminals supplied as individual chassis are packed in their own shipping cartons:

1. Open each carton carefully to make sure the equipment is not damaged.

2. After the chassis is removed from the carton, carefully examine all packing material to make sure no items of value are discarded.

3. Carefully remove any packing materials inserted into the chassis to hold circuit cards in place during transit.

3.2.2 INTERCONNECTED CHASSIS

RFL 9780 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 circuit cards in place during transit.

3.3 MOUNTING

After unpacking, RFL 9780 equipment must be securely mounted, following the instructions in paragraphs 3.3.1 through 3.3.3.

3.3.1 INDIVIDUAL CHASSIS

RFL 9780 terminals housed in individual chassis have two mounting ears (one on each side). Hole sizes and spacings conform to EIA standards, so the RFL 9780 can be mounted in any standard 19-inch rack or cabinet. Complete chassis dimensions are shown in Figure 3-1.

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

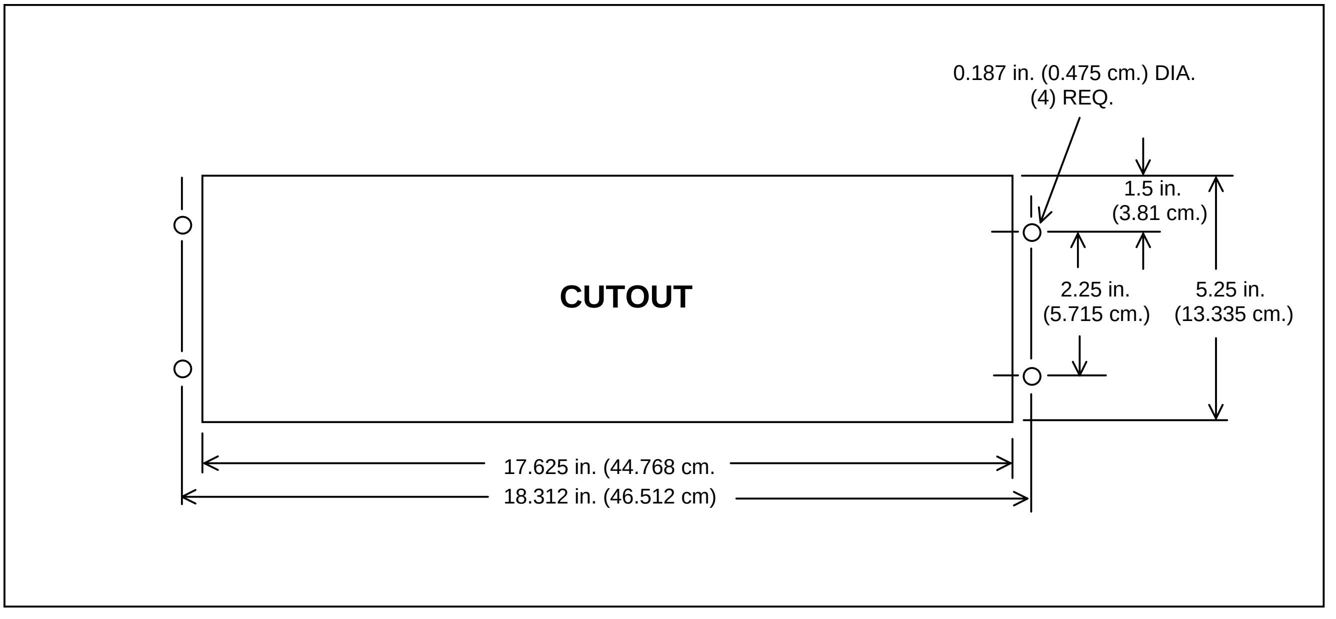


Figure 3-1. Mounting dimensions, RFL 9780 Programmable FSK Powerline Carrier System

3.3.2 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.

3.3.3 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

3.4 VENTILATION

The specified operating temperature range for RFL 9780 equipment is -20^{o}C to +60^{o}C (-4^{o}F to +140^{o}F). Operation at higher temperatures may affect system reliability and performance. Systems installed in enclosed cabinets should be ventilated to keep the temperature inside the cabinet within limits. To insure adequate ventilation, leave several inches of space above and below each RFL 9780 chassis when mounted in a rack or cabinet.

CAUTION

DURING NORMAL SYSTEM OPERATION, THE SWITCHING OF RELAY CONTACTS CAN PRODUCE VOLTAGE SPIKES. THESE SPIKES CAN TRAVEL DOWN THE RELAY OUTPUT LEADS AND INDUCE CURRENTS IN OTHER LEADS. THESE INDUCED CURRENTS CAN RESULT IN FALSE TRIPS. TO REDUCE THIS POSSIBILITY, USE A SHIELDED TWISTED PAIR FOR EACH INPUT LEAD, AND GROUND THE SHIELD AT THE RFL 9780 CHASSIS ONLY. AS AN ADDED PRECAUTION, DO NOT BUNDLE INPUT, OUTPUT, AND POWER LEADS INTO THE SAME HARNESS, AND KEEP THEM AS FAR APART AS POSSIBLE

3.5 CONNECTIONS

Electrical connections are made to each RFL 9780 chassis through the terminal blocks and connectors on the chassis rear panel. A rear panel view of a typical RFL 9780 Tx/Rx terminal is shown in Figure 3-2. Refer to this figure when making connections. Paragraphs 3.5.1 through 3.5.9 provide basic descriptions of all the connections that must be made. Refer to the "as supplied" drawings furnished with your RFL 9780 for more detailed descriptions of the connections that must be made to your system.

3.5.1 MAKING CONNECTIONS TO TERMINAL BLOCKS

NOTE

Before making connections to terminal blocks, check the configuration of all rear panel modules in accordance with Table 4-2 as applicable. It is easier to configure the rear panel modules prior to connecting field wiring. The configuration of these modules usually requires the setting of programmable jumpers and DIP switches.

The terminal blocks on the rear of the RFL 9780 chassis are conventional screw-type barrier blocks. Wires can either be stripped or terminated in spade lugs, depending on local practice. To connect wires to the terminal blocks, proceed as follows:

1. Remove the transparent protective cover from the rear of the chassis by loosening the mounting screws and sliding the panel up and off of the standoffs holding it in place.

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

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

4. Use the marking on the protective cover to help locate the terminal to which the wire is to be connected.

   All terminals blocks are numbered. Terminal numbers appear on the rear panel, on the right or left side of each terminal block. Terminal block numbers are located directly above each terminal block.

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

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

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

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

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

3.5.2 SOLID-STATE INPUT CONNECTIONS

Solid-state input connections are made to terminal block TB3 on the rear of the RFL 9780 chassis. Terminal assignments are as follows. Be sure to observe proper polarity when making these connections:

Signal Name	Positive	Negative
TRIP KEY 1	TB3-1	TB3-2
TRIP KEY 2	TB3-3	TB3-4

3.5.3 SOLID-STATE OUTPUT CONNECTIONS

Solid-state output connections are made to terminal block TB2 on the rear of the RFL 9780 chassis. Terminal assignments are as follows. Be sure to observe proper polarity when making these connections:

Signal Name	Positive	Negative
SS GUARD OUT	TB2-1	TB2-2
SS TRIP OUT	TB2-3	TB2-4

3.5.4 RELAY OUTPUT CONNECTIONS

Relay output connections are made to terminal blocks TB3 and TB4 on the rear of the RFL 9780 chassis. Terminal assignments are as follows:

Signal Name	Contact Type	Terminal Assignments
TRIP SENT	Common	TB3-5
	Normally Open	TB3-6
	Normally Closed	TB3-7
GUARD OUT	Common	TB4-1
	Normally Open	TB4-2
	Normally Closed	TB4-3
TRIP OUT	Common	TB4-4
	Normally Open	TB4-5
	Normally Closed	TB4-6

All output relays are normally de-energized.

3.5.5 ALARM OUTPUT CONNECTIONS

Alarm output connections are made to terminal blocks TB6 and TB7 on the rear of the RFL 9780 chassis. Terminal assignments are as follows:

Signal Name	Contact Type	Terminal Assignments
POWER FAIL	Common	TB6-1
	Normally Open	TB6-2
	Normally Closed	TB6-3
TX FAIL	Common	TB6-4
	Normally Open	TB6-5
	Normally Closed	TB6-6
LOGIC FAIL	Common	TB7-1
	Normally Open	TB7-2
	Normally Closed	TB7-3
LOW LEV	Common	TB7-4
	Normally Open	TB7-5
	Normally Closed	TB7-6

All alarm relays are normally energized.

3.5.6 OTHER CONNECTIONS

There may be unused terminals on some RFL 9780 rear-panel terminal blocks. These may be used for making connections to any accessory equipment supplied with your RFL 9780 terminal. Refer to the "as supplied" drawings furnished with your terminal for further information.

3.5.7 RF INPUT/OUTPUT CONNECTIONS

There are two rf connectors on the rear of the RFL 9780 chassis which are marked "TX" and "RX". The outgoing coaxial cable is connected to the TX connector, and the incoming coaxial cable is connected to the RX connector.

If the RFL 9780 terminal is equipped with an optional hybrid module (Section 18), a single coaxial cable is used to carry both the transmitter output and receiver input signals. In these terminals, the single coaxial cable is connected to the RX connector.

WARNING

THE RFL 9780 CHASSIS MUST BE PROPERLY GROUNDED AS DESCRIBED IN THE FOLLOWING PARAGRAPH BEFORE ATTEMPTING TO CONNECT INPUT POWER. IMPROPER GROUND CONNECTIONS MAY RESULT IN SYSTEM MALFUNCTIONS, EQUIPMENT DAMAGE, OR ELECTRICAL SHOCK.

3.5.8 CHASSIS GROUND CONNECTIONS

A threaded ground stud at the rear lower right of the RFL 9780 chassis is the main ground for the RFL 9780 terminal. Grounding is accomplished by connecting a wire 6AWG or larger between the ground stud and rack ground. The grounding wire should be kept as short and straight as possible, to keep its resistance and inductance to a minimum.

Before attempting to make power connections, make sure the RFL 9780 terminal is equipped with a power supply designed to operate at the available input supply voltage. This can be determined by checking the model designator on the module handle. If an external power supply is being used, check the markings on the external power supply. If the wrong voltage is connected to the power supply, component damage will result.

3.5.9 POWER CONNECTIONS

After all other connections have been made to the RFL 9780, power connections can be made. The terminal battery voltage is connected to terminal block TB10, positive to TB10-1, and negative to TB10-2. Depending on the power supply installed in the terminal, 48-volt, 125-volt or 250-volt terminal batteries can be accommodated.

A switched station battery output is also available on terminal block TB10, positive at TB10-3, and negative to TB10-4. This output can be used to shut down external equipment in the event that the RFL 9780 is shut down for any reason.

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Figure 3-2. Rear panel View of Typical RFL 9780 TX/RX Chassis (Dwg. No. D-106431-A)

Please see Figure 3-2 in Section 22

SECTION 4. OPERATING INSTRUCTIONS

WARNING

ALL RFL 9780 TERMINALS ARE EQUIPPED WITH A CLEAR PLASTIC PROTECTIVE COVER THAT EXTENDS ACROSS THE REAR OF THE CHASSIS. THIS COVER IS INTENDED TO PROTECT THE OPERATOR FROM POTENTIAL HAZARDOUS VOLTAGES THAT MAY BE PRESENT ON THE REAR-PANEL TERMINAL BLOCKS. THIS COVER MUST ONLY BE REMOVED BY QUALIFIED SERVICE PERSONNEL WHEN ACCESS TO THE REAR PANEL IS REQUIRED. IT MUST BE REPLACED BEFORE PLACING THE TERMINAL IN SERVICE.

WARNING

THE MODULES IN THE RFL 9780 ARE NOT HOT PLUGGABLE. CHASSIS POWER MUST BE TURNED OFF BEFORE REMOVING OR INSTALLING ANY MODULES. FAILURE TO DO SO MAY RESULT IN COMPONENT DAMAGE.

4.1 INTRODUCTION

This section contains the instructions necessary for operating the RFL 9780. All front panel controls and indicators are shown and described, and an initial startup procedure is included for verifying operation before placing the RFL 9780 into continuous service.

4.2 FRONT PANEL CONTROLS AND INDICATORS

The front panel of the RFL 9780 terminal contains controls and indicators which are used to monitor system functions during normal operation. These controls and indicators are shown in Figure 4-1 and are described in Table 4-1. Module locations for the front and rear panels are shown in Figure 4-2.

4.3 JUMPERS AND SWITCH SETTINGS

Most RFL 9780 circuit board modules and assemblies are equipped with programmable jumpers, DIP switches, potentiometers and LED indicators which are used to prepare the system for use. Circuit board modules and assemblies supplied as part of a system have their jumpers, DIP switches and potentiometers set at the factory, according to the overall system configuration and the requirements of the specific application. Under normal circumstances these settings should only have to be changed in the field if a replacement module is being installed or a change in system configuration is desired. If changes in jumper, DIP-switch or potentiometer settings have to be made to a particular module, refer to the applicable section of Table 4-2.

If your RFL 9780 was equipped with any accessory equipment containing controls and indicators, refer to Section 21 of this manual for further information.

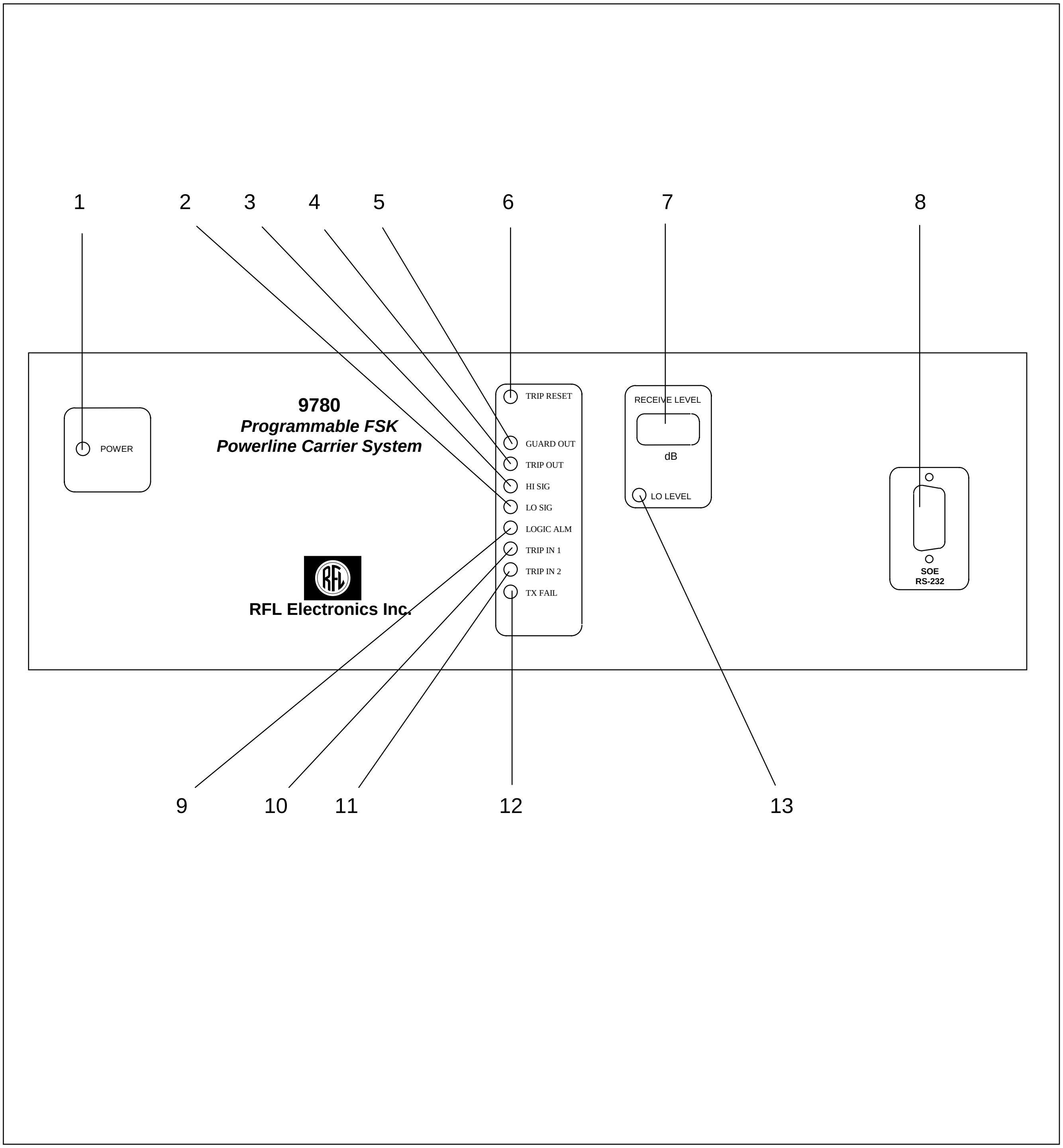

Figure 4-1. Controls and indicators, RFL 9780 front panel

Table 4-1. Controls and indicators, RFL 9780 Front Panel

Item Number	Name/ Description	Function
1	POWER ON indicator	Lights green when system power is ON and the supply is operating properly
2	LO SIG indicator	Lights red to indicate an extreme low-level signal condition
3	HI SIG indicator	Lights red to indicate an extreme high-level signal condition
4	TRIP OUT indicator	Lights red to indicate that a valid trip input has been received and a trip output has been generated.
5	GUARD OUT indicator	Lights green to indicate that a valid guard input has been received and a guard output has been generated.
6	TRIP RESET pushbutton	When the trip latch option is enabled, this switch is used to unlatch the TRIP IN 1, TRIP IN 2, and TRIP OUT LEDs, and de-energize the trip sent relay.
7	RECEIVE LEVEL display	Displays the power level of the received carrier signal in dB. The range is –10 dB to +10 dB.
8	SOE RS-232 connector	Allows a user to view the SOE log using a dumb terminal or a PC with terminal emulation software. (See Section 16)
9	LOGIC ALM indicator	Lights red to indicate that an abnormal condition has been detected by the receiver logic.
10	TRIP IN 1 indicator	Lights red to indicate that solid state input #1 has been keyed.
11	TRIP IN 2 indicator	Lights red to indicate that solid state input #2 has been keyed.
12	TX FAIL indicator	Lights red to indicate that the transmitter has failed.
13	LO LEVEL indicator	Lights red to indicate that a low level signal is being received.

Table 4-2. Controls and indicator information for RFL 9780 system modules

Module Description	USED ON			Controls and Indicators Information	Refer to Section:
	TX/ RX	TX/ TX	RX/ RX		
Logic module	X	X	X	Table 6-1 & Figure 6-2	6
TX logic module		X		Table 7-2 & Figure 7-2	7
Transmitter module	X	X		Table 8-1 & Figure 8-2	8
Power amplifier module	X	X		Table 9-1 & Figure 9-2	9
Output filter module	X	X		Table 10-1 & Figure 10-2	10
RF Interface module	X		X	Table 11-1 & Figure 11-2	11
IF/BF module	X		X	Table 12-1 & Figure 12-2	12
Carrier level indicator module	X		X	Table 13-1 & Figure 13-2	13
Limiter/Slicer module	X		X	Table 14-1 & Figure 14-2	14
SOE/IRIG-B module	X	X	X	Table 15-1 & Figure 15-2	15
SOE/IRIG-B I/O module	X	X	X	Table 15-2 & Figure 15-3	15
Solid State Input I/O			X	Table 17-1 & Figure 17-2	17
Solid State Output I/O			X	Table 17-2 & Figure 17-3	17
Solid State Input/Output I/O	X			Table 17-3 & Figure 17-4	17
Dual Relay I/O	X		X	Table 17-4 & Figure 17-5	17
Alarm Relay I/O	X		X	Table 17-5 & Figure 17-6	17
Input/Alarm I/O		X		Table 17-6 & Figure 17-7	17
RF Line I/O	X	X	X	Table 17-7 & Figure 17-8	17
Transformer Hybrid module	X	X		Table 18-1 & Figure 18-2	18
Skewed Hybrid module	X	X		Table 18-3 & Figure 18-5	18
Power supply module	X	X	X	Table 19-2 & Figure 19-2	19
Power supply I/O module	X	X	X	Table 19-5 & Figure 19-4	19
Chassis Assembly	X	X	X	Paragraph 20.2	20

Figure 4-2. Locations of Circuit Board Modules in a Typical RFL 9780 TX/RX Chassis (Dwg. No. D-106431-A)

Please see figure 4-2 in Section 22.

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4.4 POWER SUPPLY CONSIDERATIONS

There are three standard station battery voltages which can be used to power the 9780 chassis: 48 Vdc, 125 Vdc, or 250 Vdc. Both the 48 V and 125 V requirements are fulfilled with a single, wide-range supply. The 250 V requirement uses a different chassis power supply. In addition to this, the chassis can be equipped with single or dual supplies.

A single supply 48 or 125 Vdc system (38 to 150 Vdc) requires:

one	106455-1	48/125 Vdc Single Supply I/O and
one	106535-1	48/125 Vdc Power Supply.

A dual supply 48 or 125 Vdc system (38 to 150 Vdc) requires:

one	106455-3	48/125 Vdc Dual Supply I/O and
two	106535-1	48/125 Vdc Power Supply.

A single supply 250 Vdc system (200 to 300 Vdc) requires:

one	106455-2	250 Vdc Single Supply I/O and
one	106535-2	250 Vdc Power Supply.

A dual supply 250 Vdc system (200 to 300 Vdc) requires:

one	106455-4	250 Vdc Dual Supply I/O and
two	106535-2	250 Vdc Power Supply.

See section 19 for more information on the power supplies and power supply I/Os.
There are other power supply configurations that may be appropriate under certain circumstances. For example, if more than 10 W of transmit power is required, an external amplifier will be required and the external amplifier may be able to supply power to the 9780 chassis.

4.5 INPUT AND OUTPUT VOLTAGES

The inputs and outputs of the 9780 (other than the carrier signals) are typically either 48, 125, or 250 Vdc nominal. As with the power supply, both the 48 and 125 Vdc systems utilize the same modules, while the 250 Vdc I/Os require that a different I/O Module be installed in the chassis. Normally, the inputs and outputs in a chassis operate at the same nominal voltage (usually the station battery voltage), however, special applications can be accommodated. The I/O Modules are installed in the rear of the 9780 chassis. A single Module accommodates both 48 and 125 V systems, and a jumper is used to select the desired configuration. The Module must be removed from the chassis to change the jumper. See Section 17 for more information. Refer to Section 1, page 5 for input and output, voltage and current specifications.

4.6 TRANSMIT FUNCTIONS

This section covers the configuration requirements which are related to the transmit functions of the 9780. The user must select the transmit frequencies (center frequency and shifts), the transmit power level(s), and how to combine the two keying input signals.

4.6.1 TRANSMIT FREQUENCIES

The user must know what transmit center frequency and shifts are required for the system. Both the Transmitter Module, which generates the carrier, and the Output Filter, must be configured.
There are four Output Filters available to cover the specified 30 to 535 KHz carrier frequency. Normally only one filter is required per installation. Three of the Output Filters have jumpers to select one of three frequency bands within the overall range of the Module. See Section 10 for details on selecting and configuring the Output Filter. The Transmitter Module must be set to generate the required carrier frequencies. There are three banks of direct-reading rotary switches on the module. The middle bank contains five switches which are used to set the center frequency of the system with 10 Hz resolution. The upper bank sets the 'up-shift' frequency using two switches with 10 Hz resolution. The lower band sets the 'down-shift' frequency using two switches with 10 Hz resolution. See Section 8 for more information on the Transmitter Module.

4.6.2 TRANSMIT POWER (POWER BOOST LEVELS)

The system can be configured for various combinations of output power (1W/10W, 10W/10W, etc). The output levels are configured using switches SW7-2 through SW7-4 on the Logic Module. See paragraph 6.3.12 for more information. Note that for systems with external power amplifiers, these settings will be scaled by the external amplifier. For example with a 50 W external amplifier, a 9780 configured for 10W/10W would be a 50W/50W system, a 1W/10W 9780 would provide a 5W/50W system. The standard 10:1 power boost ratio can be modified at the factory if required.

4.6.3 KEYING MODES

The 9780 can be configured for 2F Single-Trip, 2F Dual-Trip, 2F Start/Stop, or 3F Dual-Function Keying. This is configured using switches SW7-7 and SW7-8 on the Logic Module. See Paragraph 6.3.15 for more information.

4.7 RECEIVER FUNCTIONS

There are many user configurable features in the 9780. Two fundamental configuration requirements include line termination (for impedance matching) and setting the receive frequencies. Adjusting for the actual receive level is covered in Paragraph 4.8.3. If any external carrier level meter is to be installed, the system must be configured for the type of meter connected. The Alarm Output Relay has programmable pick-up and drop-out times and the visual (and external) trip-sent and trip-received indicators can be configured as latching signals. Trip and Guard processing logic functions are fully programmable and must be configured prior to placing the 9780 in service. Note that improper configuration can result in unreliable or faulty operation of the unit. Consult RFL if you have any questions regarding the proper configuration of the 9780.

4.7.1 LINE TERMINATION

The 9780 receiver section can be configured to terminate the incoming line or not. Note that the input of the RF Interface Module is a high impedance input. The termination and protection circuits are located in the Line I/O assembly in the rear of the unit. To change the termination setting, the Line I/O Module must be removed from the chassis and the jumper selected for "50Ω" "75Ω" or "OUT". If the receive sections of several chassis are interconnected; only one of them should be terminated. Note that the termination impedance is only specified up to one watt maximum. See Section 17 for more information.

Also note that if a hybrid is installed inside the unit, the hybrid can provide the required impedance matching and circuit protection.

4.7.2 RECEIVE FREQUENCIES

The user must know the carrier center frequency, the frequency shifts, and whether a shift-up indicates a guard or a trip. Once the center frequency is known, the RF Interface Module must be properly configured. This module is a 10 KHz bandpass filter that helps remove unwanted energy from the incoming signal. The receive center frequency is configured using switches SW1 through SW4; see Paragraph 11.4.3 for more information.

The receive center frequency must also be programmed into the IF/BF module which is used to translate the received signal down to the desired 4 KHz baseband frequency. This is accomplished using switches SW1 and SW2, see paragraph 12.4.1 for more information.

The bandwidth of the received signal (twice the frequency shift) determines which CLI and LM/SL Modules are required in the system:

A 200 Hz bandwidth system (±100 Hz shift) requires:

	one	106430-1	200 Hz BW CLI Module and
	one	106430-1	200 Hz BW LM/SL Module for 60 Hz grids,
OR	one	106430-11	200 Hz BW LM/SL Module for 50 Hz grids.

A 500 Hz bandwidth system (±250 Hz shift) requires:

	one	106430-2	500 Hz BW CLI Module and
	one	106430-2	500 Hz BW LM/SL Module for 60 Hz grids,
OR	one	106430-12	500 Hz BW LM/SL Module for 50 Hz grids.

A 1000 Hz bandwidth system (±500 Hz shift) requires:

	one	106430-3	1000 Hz BW CLI Module and
	one	106430-3	1000 Hz BW LM/SL Module for 60 Hz grids,
OR	one	106430-13	1000 Hz BW LM/SL Module for 50 Hz grids.

Additionally, the system must be configured to properly interpret the frequency shifts. Switch SW2-8 is used to select shift-up or shift-down for trip. See paragraph 6.4.17 for more information.

4.7.3 EXTERNAL METER TYPE

Two types of external carrier level meters are supported by the 9780. The nominal ±10 dB range can be mapped to either a 0 to 100 μA range, or to ±1.0 Vdc. The desired meter type is selected using jumper J1 on the CLI Module, see Paragraph 13.4.1 for more information.

4.7.4 TRIP LATCH CONFIGURATION

The trip indicators (the front panel trip sent and trip received LEDs and the Trip Sent relay) can be set for momentary or latching operation using SW7-1 on the Logic Module. See Paragraph 6.3.11 for more information.

4.7.5 ALARM PICK-UP AND DROP-OUT

In order to avoid momentary (nuisance) changes of state of the alarm condition, pick-up and drop-out timers are provided. The pick-up timer requires a constant alarm condition for a prescribed amount of time prior to actually placing the 9780 in an alarm state. The drop-out timer requires a constant absence of alarm conditions for a prescribed amount of time prior to clearing a 9780 alarm state. Each timer is individually programmable. The pick-up timer is configured using SW6-1 through SW6-4. The drop-out timer is configured using switches SW6-5 through SW6-8. See Paragraph 6.3.10 for more information.

4.7.6 PRE-TRIP AND TRIP-HOLD TIMERS

The desired amount of pre-trip is configured using SW2-2 through SW2-8 on the Logic Module, see Paragraph 6.3.4 for more information.
The desired amount of trip-hold is configured using SW4-4 through SW4-8 on the Logic Module, see Paragraph 6.3.8 for more information.

4.7.7 PRE-GUARD AND GUARD HOLD TIMERS

The desired amount of pre-guard is configured using SW1-4 through SW1-8 on the Logic Module, see Paragraph 6.3.2 for more information.
The desired amount of guard-hold is configured using SW3-4 through SW4-8 on the Logic Module, see Paragraph 6.3.6 for more information.

4.7.8 TRIP AFTER GUARD / GUARD BEFORE TRIP TIMERS

The desired amount of trip after guard (TAG) is configured using SW5-1 through SW5-4 on the Logic Module. The desired amount of guard before trip (GBT) is configured using SW5-4 through SW5-8. To disable the TAG and GBT functions, turn off SW5-1 through SW5-8, see Paragraph 6.3.9 for more information.

4.7.9 UNBLOCK SECURITY TIMER AND UNBLOCK TRIP WINDOW TIMER

The unblock security timer is configured using SW4-1 through SW4-3 on the Logic Module. The unblock trip window timer is configured using SW3-1 through SW3-3. To disable the unblocking functions, turn off SW4-1 through SW4-3. See Paragraphs 6.3.7 and 6.3.5 for more information.
When using the unblocking feature, switch SW2-1 on the Logic Module can be used to select the criteria for a trip restore. The unblock restore criteria can be selected as either 50 msec of valid guard or clear channel.

4.7.10 BI-POLAR NOISE DETECTOR

The bipolar noise detector is used to automatically extend the pre-trip timer. The amount the pre-trip timer is extended is determined by switches SW1-1 through SW1-3 on the Logic Module. Turning all of these switches off disable the bi-polar noise feature. See Paragraph 6.3.1 for more information.

4.7.11 CARRIER ENVELOPE NOISE DETECTOR DISABLE

The carrier-envelope noise detector can be disabled by setting switch SW8-1 on the logic module to the OFF position. See Paragraph 6.3.16 for more information.

4.8 INITIAL STARTUP PROCEDURE

After the 9780 is installed and prior to being placed in service, a few basic adjustments and measurements must be performed to ensure proper operation. The output power of the system should be verified and adjusted if required, the output impedance of the transmitter must be adjusted to match the actual impedance of the line, and the receiver must be adjusted for the actual receive signal level.

This section assumes that the equipment has been installed and configured for the required application in accordance with Section 3 and paragraph 4.3. Note that the modules in the 9780 are not hot pluggable. The power to the chassis must be turned off prior to plugging or unplugging any modules.

4.8.1 EQUIPMENT REQUIREMENTS

The following equipment is required to perform the initial startup procedures:

1. Frequency-selective voltmeter (FSVM)
2. Potentiometer adjustment tool (or small flat-blade screwdriver)
3. 50 ohm (non-inductive) dummy load
4. PLC Test Set (Signal Crafters Model 70 or equivalent)
5. Optional module extender card (RFL part number 9547-1870)

4.8.2 TRANSMITTER

It is advisable to verify the operation of the transmitter after installation into the system. This allows checking the 9780 and line tuning equipment.

4.8.2.1 Output Power

The 9780 transmitter is specified to provide 10 W into a 50 ohm load. Adjustments to the output power are made with a 50 ohm dummy load connected. Any additional devices in the transmit path, such as hybrids, will reduce the effective output power. This adjustment should be performed at the rated 10 W level.

1. Connect the dummy load to the system output (the “Tx” port if there is no hybrid in the system or the “Line” port if a hybrid is installed.

2. Connect the FSVM across the output of the Output Filter Module at TP2 (blue) and TP1 (brown). Set the FSVM to the transmitter output frequency.

3. Set the transmitter to output the full 10 W level (such as keying the trip input on a typical 1W/10W system). Verify that the “PWR 3” LED on the Transmitter Module is lit. Note that it is preferable to set the transmit level at 10 W, however, the adjustment can be made at 1 W or 3 W.

4. Adjust the Power Amplifier Gain control (R2 on the rear of the chassis) to achieve 22.36 Vrms (40 dBm). If it is impractical to set the transmitter for 10 W, the level can be adjusted to 12.25 Vrms (34.8 dBm) for 3 W or 7.07 Vrms (30 dBm) for 1W.

5. Disconnect the dummy load and restore the line connection.

4.8.2.2 Output Impedance

Once the 9780 has been connected to the line the output impedance should be adjusted to match that of the actual line. Impedance mismatches can cause signal reflections and other undesirable effects. The 9780 Power Amplifier provides an output impedance adjustment to accommodate small variations in actual line conditions. When the load and source impedance of a device are matched, the loaded output voltage is exactly one half of the unloaded output voltage (the internal and external impedances form a 50% voltage divider). This fact is used to set the amplifiers output impedance. However, the power amplifier is not able to supply twice the rated output voltage when configured for 10 W operation. (The output impedance is simulated by active circuits in the 9780 and the output compliance voltage is limited.) For this reason, the adjustment must be made at less than 10 W output power.

1. Set the transmitter for either 3 W or 1 W operation (the “PWR 2” or “PWR1” LED on the Transmitter Module should be lit).
2. Disconnect all loads from the amplifier, including any hybrids. To do this, remove the Output Filter Module from the 9780 chassis. Unplug jumper J1 after noting which position it was in (“A”, “B”, or “C”) and replace the module into the chassis. This will remove the filter and all downstream components from the transmit path, while retaining the “INPUT” test point on the front of the filter module.
3. Measure the amplifier output voltage using a FSVM across TP3 (white) and TP1(brown) on the Output Filter Module and record.
4. Connect the 9780 to the line by replacing jumper J1 on the Output Filter Module.
5. While continuing to measure the amplifiers output voltage at TP3 and TP1 of the Output Filter, adjust the Power Amplifiers Impedance Adjustment (potentiometer R16 on the rear of the chassis) to achieve 50% of the previously measured open-circuit voltage.

4.8.2.3 Reflected Power

It is strongly recommended that the reflected power (SWR) on the installed line be verified. This is most easily accomplished by using a PLC Test Set, such as the Signal Crafters Model 70. Following the instructions for the test set and the tuning equipment, the line tuning unit should be adjusted to obtain the lowest possible reflected power.

The RFL 9780 can be upgraded to automatically measure the amount of transmitted power reflected back to the local receiver. The reflected power can be read locally or remotely using RFL Web Commander or Hyper-terminal.

4.8.3 RECEIVER

After the transmitters at each end of the line have been setup, the receive portions of the 9780 must be adjusted for the actual receive signal level. There is a coarse (attenuator) and fine (level) adjustment for the receive level.

4.8.3.1 Input Attenuator

Adjust the input attenuator as follows:

1. Set the input attenuator (J2 on the RF Interface Module) to “50 dB”.

2. With the system in place and the far end transmitting a guard signal (either 1 W or 10 W), measure the receive level using a FSVM. (The FSVM must be set to frequency being transmitted by the far end at the time of measurement, including any active frequency shifts.) The level should be measured at the receive test points on the hybrid module if supplied, or at the rear connector if there is no internal hybrid.

3. Using Table 4-3, determine the appropriate input attenuator setting and configure the RF Interface Module accordingly.

Table 4-3. Input Attenuator settings, RFL Interface Module

Input Range at Full Power (Adjust R13 for 200mVrms @ TP10)	Input Range at 1/10 x Full Power (Adjust R13 for 63.3mVrms @ TP10)	Jumper J2 (attenuation)	Jumper J3 (gain)
5 - 15 mVRMS	1.5 - 5 mVRMS	0 dB	HI
15 - 75 mVRMS	5 - 25 mVRMS	0 dB	LO
75 - 150 mVRMS	25 - 50 mVRMS	10 dB	LO
150 - 500 mVRMS	50 - 150 mVRMS	20 dB	LO
0.5 – 1.5 VRMS	150 – 500 VRMS	30 dB	LO
1.5 - 5 VRMS	0.5 – 1.5 VRMS	40 dB	LO
above 5 VRMS	Above 1. 5 VRMS	50 dB	LO

4.8.3.2 Input Level Adjust

Using the Frequency Selective Voltmeter, measure the signal at TP10 on the RF Interface module. If the received guard is 1/10 the trip level, adjust R13 to obtain 63.3 mVrms at TP10. If the received guard is the full trip level (no trip boost), adjust R13 to obtain 200 mVrms at TP10.

SECTION 5. MAINTENANCE

WARNING

HAZARDOUS VOLTAGES CAN BE PRESENT INSIDE RFL 9780 TERMINALS. BEFORE ATTEMPTING MAINTENANCE, BE SURE TO READ AND COMPLY WITH THE HIGH VOLTAGE WARNING AND SAFETY SUMMARY INFORMATION ON PAGES iii AND iv OF THIS MANUAL.

ALL RFL 9780 TERMINALS ARE EQUIPPED WITH PROTECTIVE COVERS THAT EXTEND ACROSS THE REAR OF THE CHASSIS. THESE COVERS ARE INTENDED TO PROTECT THE OPERATOR FROM POTENTIALLY HAZARDOUS VOLTAGES, WHICH MAY BE PRESENT ON THE REAR PANEL TERMINAL BLOCKS. THESE COVERS MUST ONLY BE REMOVED BY QUALIFIED SERVICE PERSONNEL WHEN ACCESS TO THE REAR PANEL IS REQUIRED. IT MUST BE REPLACED BEFORE PLACING THE TERMINAL BACK IN SERVICE.

5.1 INTRODUCTION

This section provides maintenance instructions for the RFL 9780. Topics discussed include removal and replacement procedures, fuse replacement and corrective maintenance information. Information is also provided on how to arrange for service by RFL personnel.

CAUTION

EACH MODULE POSITION IN THE RFL 9780 CHASSIS IS DEDICATED TO A SPECIFIC MODULE TYPE, AS INDICATED BY A LABEL ALONG THE FRONT OF THE CHASSIS. EVEN THOUGH THE MODULES ARE KEYED, THEY CAN STILL SUFFER COMPONENT DAMAGE, DUE TO DIFFERENT COMPONENT HEIGHTS, IF THEY ARE INSTALLED IN THE WRONG CHASSIS SLOT. WHEN REMOVING AND REPLACING MODULES, USE THE LABEL IN THE CHASSIS AS A GUIDE TO MAKE SURE EACH MODULE IS IN THE PROPER SLOT.

MAKE SURE THE POWER SWITCH ON THE RFL 9780'S POWER SUPPLY MODULE IS IN THE OFF POSITION BEFORE ATTEMPTING TO REMOVE OR REPLACE ANY CIRCUIT BOARD MODULE OR I/O MODULE. SYSTEM PERFORMANCE CANNOT BE GUARANTEED IF MODULES ARE REMOVED OR REPLACED WITH THE POWER SUPPLY ENERGIZED.

5.2 REMOVAL AND REPLACEMENT

The following paragraphs provide procedures to be used when removing and replacing RFL 9780 circuit board modules and I/O modules.

5.2.1 CIRCUIT BOARD MODULES

All RFL 9780 front panel circuit board modules are held in place by card guides at the top and bottom of the chassis, and fit into mating connectors in the chassis motherboard. To remove any RFL 9780 front panel module, with the exception of the power supply module, proceed as follows:

1. Lower the front cover of the RFL 9780.

2. Place the POWER switch(es) on the power supply I/O module at the rear of the chassis to the OFF position.
   The green power indicator(s) on the front of the power supply module(s) will go out, indicating that the terminal is turned off.

3. Lower the lever at the front of the module until the module connector disengages with the motherboard connector.

4. Slide the module out of the chassis.

To replace a circuit board module, with the exception of the power supply module, proceed as follows:

1. Using the label along the front of the chassis as a guide, determine the slot in the chassis where the module is to be installed.

2. Line up the edges of the module circuit board with the card guides in the chassis.

3. Place the lever in the full up position.

4. Slide the module into the chassis, and then push firmly until its connector is fully engaged with the motherboard connector.

5. Place the POWER switch(es) on the power supply I/O module to the ON position.
   The green power indicator(s) on the front of the power supply module(s) will light, indicating that the terminal is turned on.

6. Raise the door on the front of the chassis to its vertical position, and turn the knobs clockwise as far as they will go to lock the door.

5.2.2 POWER SUPPLY MODULE

The RFL 9780 power supply module is held in place by card guides at the top and bottom of the chassis, and fits into a mating connector in the chassis motherboard. The top guide is made of aluminum and has a locking lever to insure good heat transfer to a heat sink at the top of the chassis. To remove the 9780 power supply module proceed as follows:

1. Lower the front cover of the RFL 9780.

2. Place the POWER switch(es) on the power supply I/O module at the rear of the chassis to the OFF position.

   The green power indicator(s) on the front of the power supply module(s) will go out, indicating that the terminal is turned off.

3. Raise the locking lever at the top of the module to unlock the heat sink.

4. Lower the lever at the front of the module until the module connector disengages with the motherboard connector.

5. Slide the module out of the chassis.

To replace the power supply module proceed as follows:

1. Using the label along the front of the chassis as a guide, determine the slot in the chassis where the power supply is to be installed. Power supply modules can only be installed in the two left hand slots of the 9780 chassis.

2. Line up the edges of the module circuit board with the grooves in the chassis.

3. Place the lever at the top of the module to the unlocked position and place the lower lever to the fully closed position.

4. Slide the module into the chassis, and then push firmly until its connector is fully engaged with the motherboard connector.

5. Lock the heat sink by setting the black lever to the full down position.

6. Place the POWER switch(es) on the power supply I/O module to the ON position.

   The green power indicator(s) on the front of the power supply module(s) will light, indicating that the terminal is turned on.

7. Raise the door on the front of the chassis to its vertical position, and turn the knobs clockwise as far as they will go to lock the door.

5.2.3 I/O MODULES

All RFL 9780 I/O modules are mounted at the rear of the chassis. Each I/O module is held in place by screws at the top and bottom of the I/O module, and fit into mating connectors in the chassis motherboard. To remove any RFL 9780 I/O module, proceed as follows:

1. Place the POWER switch(es) on the power supply module in the OFF position.
   The green indicator(s) at the front of the power supply module(s) will go out, indicating that the station is turned off.

2. Remove the protective cover.

3. Disconnect all wiring from the I/O module to be removed.
   Tag all wires before removal. This will simplify rewiring once the I/O module is replaced.

4. Using a phillips head screw driver , remove the two screws that hold the I/O module in place.

5. Pull the I/O module out of the chassis.

To replace an RFL 9780 I/O module, proceed as follows:

1. Using the label on the rear plastic panel as a guide, determine the slot in the chassis where the I/O module is to be installed.

2. Line up the edges of the module with the grooves in the chassis.

3. Slide the module into the chassis, and then push until it is firmly seated in its mating connector.

4. Install and then tighten the two mounting screws.

5. Reconnect all wiring.

6. Place the protective cover into position.

7. Place the POWER switch(es) on the power supply module in the ON position.
   The green power indicator(s) on the front of the power supply module(s) will light, indicating that the station is turned on.

5.3 FUSE REPLACEMENT

CAUTION

NEVER ATTEMPT TO REMOVE OR REPLACE A FUSE WITH THE POWER SUPPLY MODULE ENERGIZED, SINCE COMPONENT DAMAGE MAY RESULT.

The input fuse for RFL 9780 power supply I/O module is located on the rear of the power supply I/O module. The fuse can be changed without removing the power supply I/O module from the chassis. To check and/or replace the fuse, proceed as follows:

1. Place the POWER switch on the power supply I/O module to the OFF position.

2. Remove the input fuse from its fuseholder by using a screwdriver and turning it counter clockwise about 1/4 turn.

3. Remove the fuse from the fuseholder cap and inspect it for damage. If the fuse is bad, it must be replaced. If the fuse is good, check for the presence of input voltage across TB1-1 and TB1-2 on the rear panel. If voltage is present and the power supply does not function, troubleshoot the supply to determine the cause of failure.

4. Insert a fuse with the proper voltage and current ratings into the fuseholder cap and push it in until it is firmly seated. Using a flat-blade screwdriver, push in on the cap and turn clockwise about one quarter-turn. This will secure the fuse in place.

   For continued safe operation, always replace a fuse with one having the same voltage and current ratings. Refer to Table 5-1 or Section 19 for proper fuse replacements.

5. Once the fuse has been checked and/or replaced, place the power switch to the ON position. If the green power indicator of the front of the power supply lights, the power supply module is working properly. If the indicator does not light or if the fuse blows again, troubleshoot the power supply module.

Table 5-1. Fuse replacement data, RFL 9780 power supply I/O module.

Model	Assembly Number	Fuse Rating	Manufacturers type	Part Number
48/125Vdc	106455-1	3AG, slo-blow, 250V, 4A	Littlefuse or equiv.	301122
250Vdc	106455-2	3AG, slo-blow, 250V, 4A	Littlefuse or equiv.	301122

5.4 CORRECTIVE MAINTENANCE

The RFL 9780 Programmable FSK Powerline Carrier System has been designed for years of trouble-free service. Should a malfunction occur involving the RFL 9780, use standard troubleshooting techniques to determine if the problem is in the RFL 9780, or in some other connected equipment. If the problem lies within the RFL 9780, use the schematics at the end of Sections 6 through 18 to try and determine which module is defective. Once this is done, replace the module; this should solve the problem.

Defective modules can be repaired locally, or they can be returned to RFL for repair (para 5.6).

5.5 HOW TO ARRANGE FOR SERVICING

If necessary, RFL 9780 modules and subassemblies may be returned to RFL for repair. Contact our Customer Service Department using the telephone number listed below. You will be given a Returned Material Authorization (RMA) and shipping instructions.

SECTION 6. LOGIC MODULE

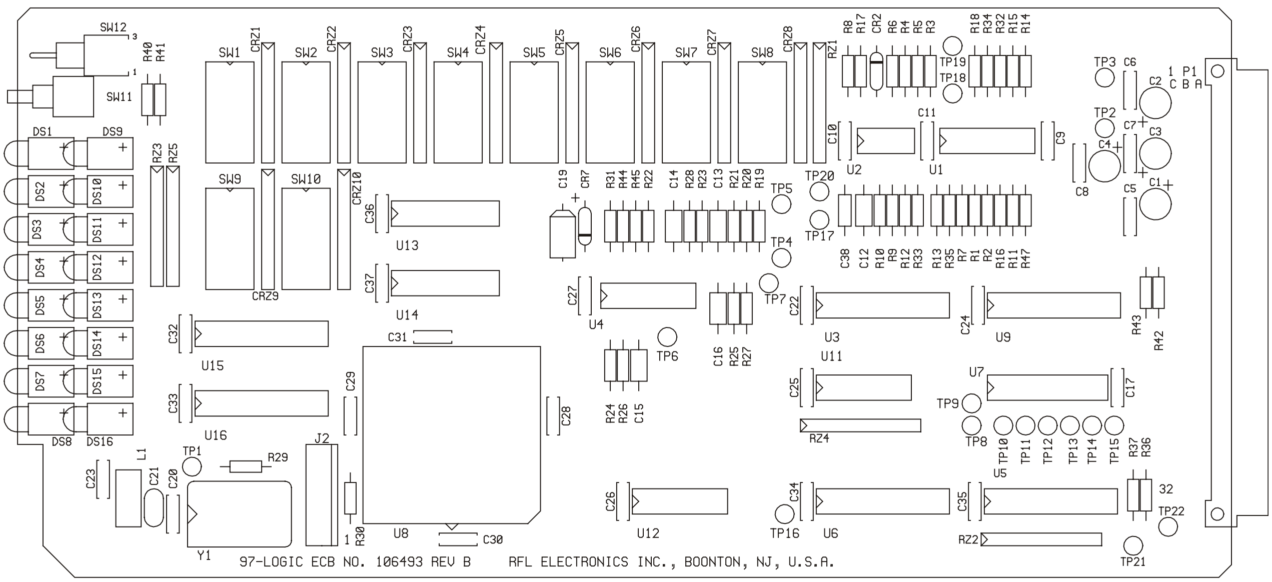

Figure 6-1. RFL 9780 Logic Module

6.1 DESCRIPTION

The RFL 9780 Logic Module interfaces with most of the receiver and transmitter modules within the system. The Logic module uses guard, trip, and noise input information that it receives from various parts of the system to build security and dependability into the receiver. In addition, it monitors trip input signals and generates signals for the Transmitter Module (Section 8) to control frequency shift and power level. The Logic Module also provides status information for the Sequence of Events Module (Section 15).

The RFL 9780 Logic Module has eight LED indicator lamps on its front edge which protrude through the front panel of the RFL 9780. These include GUARD OUT , TRIP OUT, HI SIGNAL, LO SIGNAL, LOGIC ALARM, TRIP IN 1, TRIP IN 2, and TX FAIL. All LEDs are red with the exception of GUARD OUT, which is green.

Open-collector transistors are provided on the RFL 9780 Logic Module to drive relays with guard, trip, logic alarm, and transmitter fail alarm output signals.

6.2 SPECIFICATIONS

As of the date this manual was published, the following specifications apply to the RFL 9780 Logic Module. Because all RFL products undergo constant refinement and improvement, these specifications are subject to change without notice.

Timer Specifications:

Timers	Range (ms)	Resolution (ms)	Accuracy+/- (ms)
Pre-Trip	0 - 31.75	0.25	0.03
Pre-Guard	0 - 31	1	0.125
Guard Hold	0 - 31	1	0.125
Trip Hold	0 - 310	10	1.25
Unblock Trip Window	150 - 500	50	6.25
Unblock Security	10 - 70	10	1.25
Alarm Pick-Up	50, 100 - 1500	100	12.5
Alarm Drop-Out	50, 100 - 1500	100	12.5
Guard Before Trip	50 - 190	10	1.25
Trip After Guard	50 - 190	10	1.25
Bi-Polar Noise Delay	2 - 14	2	0.25

Crystal Specifications: The frequency of clock oscillator Y1 is 3.584 MHz ± 50 ppm.

NOTE

This section discusses Logic Modules with version 005 software. To determine which version your Logic Module has, remove the Logic Module from the chassis and read the version number of the label on device U8. If the number is SW9780LC005-A your system has the latest software. The label will be similar to the one shown below. Consult the factory or earlier versions of this manual for information on earlier versions of this module.

U8 (03-24-03)
SW9780LC005-A
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6.3 TYPICAL CONFIGURATION SETTINGS

The Tables below list some typical configuration settings for the 9780 FSK PLC. Note that these settings are typical, and are not standard settings. Each RFL 9780 application is unique and should be carefully evaluated by a knowledgeable Engineer. Normally, when a unit is shipped from RFL it is shipped configured for the user's application. If, however, RFL is not aware of application specifics, the system will be supplied with the typical settings. RFL Sales and Customer Support personnel are always available to answer questions or assist in configuring a system.

Table 6-1. 9780 DTT Application

Function	Typical Setting	Switch Positions						
Bi-Polar Noise Detector	12 msec	SW1-1	SW1-2	SW1-3				
		ON	ON	OFF				
Pre-Guard Timer	4 msec	SW1-4	SW1-5	SW1-6	SW1-7	SW1-8		
		OFF	OFF	ON	OFF	OFF		
Unblock Trip Rectore	N/A	SW2-1						
		OFF						
Pre-Trip Timer	5.25 msec in a ±100 Hz shift system,	SW2-2	SW2-3	SW2-4	SW2-5	SW2-6	SW2-7	SW2-8
	Providing a 12 msec TCT.	OFF	OFF	ON	OFF	ON	OFF	ON
Unblock Trip Window	N/A	SW3-1	SW3-2	SW3-3				
		OFF	OFF	OFF				
Guard Hold Timer	10 msec, to avoid nuisance guard dropouts	SW3-4	SW3-5	SW3-6	SW3-7	SW3-8		
	(a valid trip will always override the guard).	OFF	ON	OFF	ON	OFF		
Unblock Security Timer	Disabled	SW4-1	SW4-2	SW4-3				
		OFF	OFF	OFF				
Trip Hold Timer	0 msec	SW4-4	SW4-5	SW4-6	SW4-7	SW4-8		
		OFF	OFF	OFF	OFF	OFF		
Trip After Guard	100 msec	SW5-1	SW5-2	SW5-3	SW5-4			
		OFF	ON	ON	OFF			
Guard Before Trip	100 msec	SW5-5	SW5-6	SW5-7	SW5-8			
		OFF	ON	ON	OFF			
Alarm Pick-Up	300 msec	SW6-1	SW6-2	SW6-3	SW6-4			
		OFF	OFF	ON	ON			
Alarm Drop-Out	50 msec	SW6-5	SW6-6	SW6-7	SW6-8			
		OFF	OFF	OFF	OFF			
Trip Latch	Disabled	SW7-1						
		OFF						
Power Boost Level	1W/10W	SW7-2	SW7-3	SW7-4	SW7-5			
		OFF	OFF	ON	OFF			
Not Used	N/A	SW7-6						
		OFF						
Keying Mode	2F, Dual-Trip Keying	SW7-7	SW7-8					
		OFF	ON					
Carrier Envelope Noise Detect	Enabled	SW8-1						
		ON						
TX Trip Shift Direction	TX Guard=Shift Up, TX Trip=Shift Down	SW8-2						
		OFF						
Trip 1 Polarity	De-energized	SW8-3						
		OFF						
Trip 2 Polarity	De-energized	SW8-4						
		OFF						
RX Trip Shift Direction	RX Guard=Shift Up, RX Trip=Shift Down	SW8-5						
		OFF						
Not Used	N/A	SW8-6	SW8-7	SW8-8				
		OFF	OFF	OFF				

Table 6-2. 9780 PTT Application

Function	Typical Setting	Switch Positions						
Bi-Polar Noise Detector	Disabled	SW1-1	SW1-2	SW1-3				
		OFF	OFF	OFF				
Pre-Guard Timer	4 msec	SW1-4	SW1-5	SW1-6	SW1-7	SW1-8		
		OFF	OFF	ON	OFF	OFF		
Unblock Trip Rectore	N/A	SW2-1						
		OFF						
Pre-Trip Timer	3 msec in a ±250 Hz shift system, Providing a 7 msec TCT.	SW2-2	SW2-3	SW2-4	SW2-5	SW2-6	SW2-7	SW2-8
		OFF	OFF	OFF	ON	ON	OFF	OFF
Unblock Trip Window	N/A	SW3-1	SW3-2	SW3-3				
		OFF	OFF	OFF				
Guard Hold Timer	10 msec, to avoid nuisance guard dropouts (a valid trip will always override the guard).	SW3-4	SW3-5	SW3-6	SW3-7	SW3-8		
		OFF	ON	OFF	ON	OFF		
Unblock Security Timer	Disabled	SW4-1	SW4-2	SW4-3				
		OFF	OFF	OFF				
Trip Hold Timer	0 msec	SW4-4	SW4-5	SW4-6	SW4-7	SW4-8		
		OFF	OFF	OFF	OFF	OFF		
Trip After Guard	100 msec	SW5-1	SW5-2	SW5-3	SW5-4			
		OFF	ON	ON	OFF			
Guard Before Trip	100 msec	SW5-5	SW5-6	SW5-7	SW5-8			
		OFF	ON	ON	OFF			
Alarm Pick-Up	300 msec	SW6-1	SW6-2	SW6-3	SW6-4			
		OFF	OFF	ON	ON			
Alarm Drop-Out	50 msec	SW6-5	SW6-6	SW6-7	SW6-8			
		OFF	OFF	OFF	OFF			
Trip Latch	Disabled	SW7-1						
		OFF						
Power Boost Level	1W/10W	SW7-2	SW7-3	SW7-4	SW7-5			
		OFF	OFF	ON	OFF			
Not Used	N/A	SW7-6						
		OFF						
Keying Mode	2F, Dual-Trip Keying	SW7-7	SW7-8					
		OFF	ON					
Carrier Envelope Noise Detect	Disabled	SW8-1						
		OFF						
TX Trip Shift Direction	TX Guard=Shift Up, TX Trip=Shift Down	SW8-2						
		OFF						
Trip 1 Polarity	De-energized	SW8-3						
		OFF						
Trip 2 Polarity	De-energized	SW8-4						
		OFF						
RX Trip Shift Direction	RX Guard=Shift Up, RX Trip=Shift Down	SW8-5						
		OFF						
Not Used	N/A	SW8-6	SW8-7	SW8-8				
		OFF	OFF	OFF				

Table 6-3. 9780 DCU Application

Function	Typical Setting	Switch Positions						
Bi-Polar Noise Detector	Disabled	SW1-1	SW1-2	SW1-3				
		OFF	OFF	OFF				
Pre-Guard Timer	4 msec	SW1-4	SW1-5	SW1-6	SW1-7	SW1-8		
		OFF	OFF	ON	OFF	OFF		
Unblock Trip Rectore	Reset on Guard	SW2-1						
		ON						
Pre-Trip Timer	3 msec in a ±250 Hz shift system, Providing a 7 msec TCT.	SW2-2	SW2-3	SW2-4	SW2-5	SW2-6	SW2-7	SW2-8
		OFF	OFF	OFF	ON	ON	OFF	OFF
Unblock Trip Window	150 msec	SW3-1	SW3-2	SW3-3				
		OFF	OFF	OFF				
Guard Hold Timer	10 msec, to avoid nuisance guard dropouts (a valid trip will always override the guard).	SW3-4	SW3-5	SW3-6	SW3-7	SW3-8		
		OFF	ON	OFF	ON	OFF		
Unblock Security Timer	20 msec	SW4-1	SW4-2	SW4-3				
		OFF	ON	OFF				
Trip Hold Timer	0 msec	SW4-4	SW4-5	SW4-6	SW4-7	SW4-8		
		OFF	OFF	OFF	OFF	OFF		
Trip After Guard	100 msec	SW5-1	SW5-2	SW5-3	SW5-4			
		OFF	ON	ON	OFF			
Guard Before Trip	100 msec	SW5-5	SW5-6	SW5-7	SW5-8			
		OFF	ON	ON	OFF			
Alarm Pick-Up	300 msec	SW6-1	SW6-2	SW6-3	SW6-4			
		OFF	OFF	ON	ON			
Alarm Drop-Out	50 msec	SW6-5	SW6-6	SW6-7	SW6-8			
		OFF	OFF	OFF	OFF			
Trip Latch	Disabled	SW7-1						
		OFF						
Power Boost Level	1W/10W	SW7-2	SW7-3	SW7-4	SW7-5			
		OFF	OFF	ON	OFF			
Not Used	N/A	SW7-6						
		OFF						
Keying Mode	2F, Dual-Trip Keying	SW7-7	SW7-8					
		OFF	ON					
Carrier Envelope Noise Detect	Disabled	SW8-1						
		OFF						
TX Trip Shift Direction	TX Guard=Shift Up, TX Trip=Shift Down	SW8-2						
		OFF						
Trip 1 Polarity	De-energized	SW8-3						
		OFF						
Trip 2 Polarity	De-energized	SW8-4						
		OFF						
RX Trip Shift Direction	RX Guard=Shift Up, RX Trip=Shift Down	SW8-5						
		OFF						
Not Used	N/A	SW8-6	SW8-7	SW8-8				
		OFF	OFF	OFF				

6.4 CONTROLS AND INDICATORS

Figure 6-2 shows the location of all controls and indicators on the RFL 9780 Logic Module. These controls and indicators are described in Table 6-4. Some of the controls and indicators are accessible when the module is installed in the chassis and others are accessible only when the module is removed from the chassis or is on a card extender.

Table 6-4. Controls and indicators, RFL 9780 Logic Module

Component Designator	Name/Description	Function		For more information See paragraph:
DS1	LED Indicator (Guard Out)	Lights when valid guard is received.		NA
DS2	LED Indicator (Trip Out)	Lights when valid trip is received		NA
DS3	LED Indicator (High Signal)	Lights when higher than nominal level are received.		NA
DS4	LED Indicator (Low Signal)	Lights when lower than nominal level are received.		NA
DS5	LED Indicator (Logic Alarm)	Lights when logic alarm condition exists.		NA
DS6	LED Indicator (Trip Input 1)	Lights when trip key input 1 is active.		NA
DS7	LED Indicator (Trip Input 2)	Lights when trip key input 2 is active.		NA
DS8	LED Indicator (Tx Fail)	Lights when transmitter failure has occurred.		NA
SW1	DIP Switch	SW1 (1-3)	Bipolar noise detector and timer	6.4.1
		SW1 (4-8)	Pre-guard timer	6.4.2
SW2	DIP Switch	SW2 (1)	Trip restore	6.4.3
		SW2 (2-8)	Pre-trip timer	6.4.4
SW3	DIP Switch	SW3 (1-3)	Unblock trip window timer	6.4.5
		SW3 (4-8)	Guard hold timer	6.4.6
SW4	DIP Switch	SW4 (1-3)	Unblock security timer	6.4.7
		SW4 (4-8)	Trip hold timer	6.4.8
SW5	DIP Switch	SW5 (1-4)	Trip after guard timer	6.4.9
		SW5 (5-8)	Guard before trip timer	6.4.9
SW6	DIP Switch	SW6 (1-4)	Alarm pick-up timer	6.4.10
		SW6 (5-8)	Alarm drop-out timer	6.4.10
SW7	DIP Switch	SW7 (1)	Trip latch (TX and RX)	6.4.11
		SW7 (2-5)	Power boost level	6.4.12
		SW7 (6)	Not Used	N/A
		SW7 (7-8)	Keying modes (System type)	6.4.13
SW8	DIP Switch	SW8 (1)	Carrier Envelope Noise detector	6.4.14
		SW8 (2)	TX Trip Shift Direction	6.4.15
		SW8 (3)	Trip 1 polarity	6.4.16
		SW8 (4)	Trip 2 polarity	6.4.16
		SW8 (5)	RX Trip Shift Direction	6.4.17
		SW8 (6-8)	Not Used	N/A

Table 6-4. continued - Controls and indicators, RFL 9780 Logic Module

Component Designator	Name/Description	Function	For more information See paragraph:
SW11	Push button Switch	Trip reset pushbutton (used with Trip latch option)	NA
TP1	Test point (Oscillator Y1	Clock frequency of 3.584 MHz.	NA
TP2	Test point (Analog Ground)	Signal ground	NA
TP3	Test point (Digital Ground)	Signal ground	NA
TP4	Test point (Receive Guard)	Guard input from 97 LM/SL	NA
TP5	Test point (Receive Trip)	Trip input from 97 LM/SL	NA
TP6	Test point (Trip Input 1)	Monitor solid-state relay keying input #1.	NA
TP7	Test point (Trip Input 2)	Monitor solid-state relay keying input #2.	NA
TP8	Test point (Trip Relay Output 1)	Received Trip validated by logic module that drives trip relay.	NA
TP9	Test point (Trip SS Output)	Received Trip validated by logic module that drives solid-state trip relay.	NA
TP10	Test point (Guard Relay Output)	Received Guard validated by logic module that drives guard relay.	NA
TP11	Test point (Guard SS Output)	Received Guard validated by logic module that drives solid-state guard relay.	NA
TP12	Test point (Trip Relay Output 2)	Received Trip validated by logic module that drives Trip relay.	NA
TP13	Test point (Logic Alarm)	Logic alarm processed by logic module that drives Logic alarm relay.	NA
TP14	Test point (Transmitter Fail)	Transmitter fail signal received from Power Amp that drives TX Fail alarm relay.	NA
TP15	Test point (Trip Sent Relay)	Trip command keyed.	NA
TP16	Test point (Block Out)	Block output to Limiter Slicer Module.	NA
TP17	Test point (Hi Signal Input)	High signal level threshold detector.	NA
TP18	Test point (Low Signal Input)	Low signal level threshold detector.	NA
TP19	Test point (CE_Low)	Low carrier envelope noise detector.	NA
TP20	Test point (CE_High)	High carrier envelope noise detector.	NA
TP21	Test point (SS IN 1)	Optional – not defined.	NA
TP22	Test point (SS IN 2)	Optional – not defined.	NA

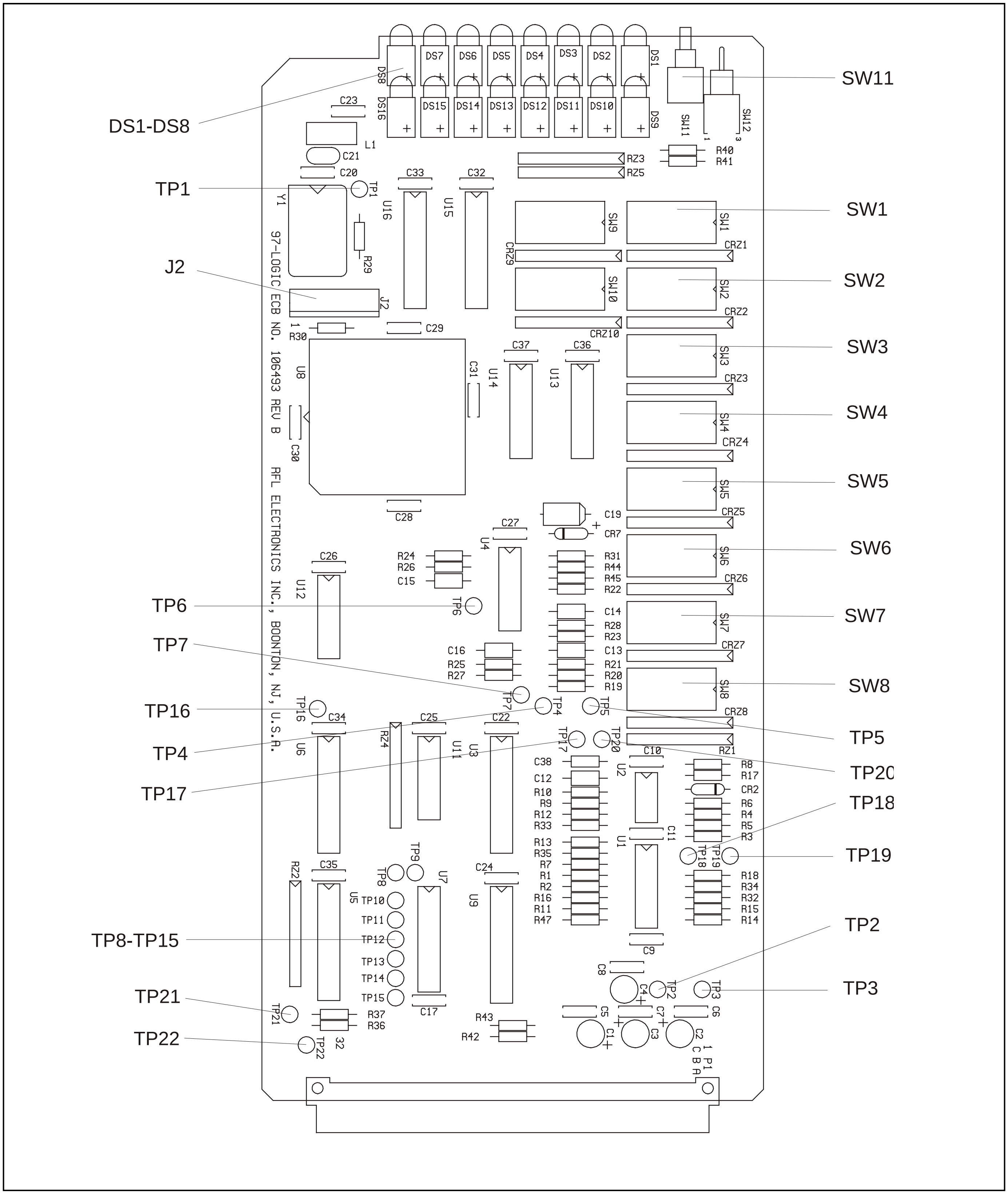


Figure 6-2. Controls and indicators, RFL 9780 Logic Module

6.4.1 CONFIGURATION OF BI-POLAR NOISE DETECTOR

The position of switches SW1-1 through SW1-3 determines the total period of time that the Pre-trip timer is extended when bi-polar noise is detected. The time period shown in Table 6-5 for each switch position is cumulative. A switch in the ON position enables its corresponding time period. The selectable timer range is between 2ms and 14ms in 2ms increments.
NOTE: When all switches are in the OFF position, the Bi-polar Noise Detector is disabled.

Table 6-5. Configuration of Bi-Polar Noise Detector

Switch	SW1-1	SW1-2	SW1-3
Time (ms)	8	4	2

Example: The Bi-polar Noise Detector configured to extend the Pre-trip timer for an additional period of 12ms would be set as follows:

SW1-1: ON	8ms
SW1-2: ON	4ms
SW1-3: OFF	0ms
TOTAL	12ms

6.4.2 CONFIGURATION OF PRE-GUARD TIMER

The position of switches SW1-4 through SW1-8 determines the total period of time required to validate a received Guard signal. The time period shown in Table 6-6 for each switch position is cumulative. A switch in the ON position enables its corresponding time period. The selectable timer range is between 0ms and 31ms in 1ms increments. When all switches are in the OFF position, the Guard signal passes through without being qualified.

Table 6-6. Configuration of Pre-Guard Timer

Switch	SW1-4	SW1-5	SW1-6	SW1-7	SW1-8
Time (ms)	16	8	4	2	1

Example: The Pre-guard Timer configured to receive a Guard signal for 12ms before being considered to be a valid Guard would be set as follows:

SW1-4: OFF	0ms
SW1-5: ON	8ms
SW1-6: ON	4ms
SW1-7: OFF	0ms
SW1-8: OFF	0ms
TOTAL	12ms

6.4.3 CONFIGURATION OF TRIP RESTORE

The position of switch SW2-1 determines the criteria used to unblock the low-level trip channel when returning to a normal condition from a low-level condition. When SW2-1 is in the ON position, 50ms of valid Guard condition is selected. When SW2-1 is OFF, 50ms of clear channel (normal level) is selected. This configuration is used only if the Unblock Function is enabled.

6.4.4 CONFIGURATION OF PRE-TRIP TIMER

The position of switches SW2-2 through SW2-7 determines the total period of time required to validate a received TRIP signal. The time period shown in Table 6-7 for each switch position is cumulative. A switch in the ON position enables its corresponding time period. The selectable timer range is between 0ms and 31.75ms in 0.25ms increments. When all switches are in the OFF position, the TRIP signal passes through without being qualified.

Table 6-7. Configuration of Pre-Trip Timer

Switch	SW2-2	SW2-3	SW2-4	SW2-5	SW2-6	SW2-7	SW2-8
Time (ms)	16	8	4	2	1	0.50	0.25

Example: The Pre-trip Timer configured to receive a Trip signal for 5.25ms before being considered to be a valid Trip would be set as follows:

SW2-2: OFF	0ms
SW2-3: OFF	0ms
SW2-4: ON	4ms
SW2-5: OFF	0ms
SW2-6: ON	1ms
SW2-7: OFF	0ms
SW2-8: ON	0.25ms
TOTAL	5.25ms

6.4.5 CONFIGURATION OF UNBLOCK TRIP WINDOW TIMER

The position of switches SW3-1 through SW3-3 determines the total period of low level trip which will be generated once the Unblock Security Timer (See 6.3.7) has been satisfied. The time period shown in Table 6-8 for each switch position is cumulative. A switch in the ON position enables its corresponding time period. An offset of 150ms is added to this in order to calculate the total time period. The selectable timer range is between 150ms and 500ms in 50ms increments. This timer is used only if the Unblock Function is enabled.

Table 6-8. Configuration of Unblock Trip Window Timer

Switch	SW3-1	SW3-2	SW3-3
Time (ms)	200	100	50

Example: The Unblock Trip Window Timer configured to generate a low level trip for 300ms would be set as follows:

SW3-1: OFF	0ms
SW3-2: ON	100ms
SW3-3: ON	50ms
OFFSET	150ms
TOTAL	300ms

6.4.6 CONFIGURATION OF GUARD HOLD TIMER

The position of switches SW3-4 through SW3-8 determines the minimum period of time a Guard will be held once a valid guard has been established. The time period shown in Table 6-9 for each switch position is cumulative. A switch in the ON position enables its corresponding time period. The selectable timer range is between 0ms and 31ms in 1ms increments. When all switches are in the OFF position, the Guard signal is not held.

Table 6-9. Configuration of Guard Hold Timer

Switch	SW3-4	SW3-5	SW3-6	SW3-7	SW3-8
Time (ms)	16	8	4	2	1

Example: The Guard Hold Timer configured to hold a valid Guard signal for a minimum of 12ms would be set as follows:

SW3-4: OFF	0ms
SW3-5: ON	8ms
SW3-6: ON	4ms
SW3-7: OFF	0ms
SW3-8: OFF	0ms
TOTAL	12ms

6.4.7 CONFIGURATION OF UNBLOCK SECURITY TIMER

The position of switches SW4-1 through SW4-3 determines the threshold at which a signal is considered to be at a low-level condition. The time period shown in Table 6-10 for each switch position is cumulative. A switch in the ON position enables its corresponding time period. The selectable timer range is between 10ms and 70ms. **NOTE: Any combination of switches in the ON position enables the Unblocking Function. All switches in the OFF position disables the Unblocking Function.**

Table 6-10. Configuration of Unblock Security Timer

Switch	SW4-1	SW4-2	SW4-3
Time (ms)	40	20	10

Example: The Unblock Security Timer configured for a threshold of 50ms would be set as follows:

SW4-1: ON	40ms
SW4-2: OFF	0ms
SW4-3: ON	10ms
TOTAL	50ms

6.4.8 CONFIGURATION OF TRIP HOLD TIMER

The position of switches SW4-4 through SW4-8 determines the minimum period of time a Trip will be held once a valid Trip has been established. The time period shown in Table 6-11 for each switch position is cumulative. A switch in the ON position enables its corresponding time period. The selectable timer range is between 0ms and 310ms in increments of 10ms. When all switches are in the OFF position, the Trip signal is not held.

Table 6-11. Configuration of Trip Hold Timer

Switch	SW4-4	SW4-5	SW4-6	SW4-7	SW4-8
Time (ms)	160	80	40	20	10

Example: The Trip Hold Timer configured to hold a valid Trip signal for a minimum of 130ms would be set as follows:

SW4-4: OFF	0ms
SW4-5: ON	80ms
SW4-6: ON	40ms
SW4-7: OFF	0ms
SW4-8: ON	10ms
TOTAL	130ms

6.4.9 CONFIGURATION OF GUARD BEFORE TRIP/TRIP AFTER GUARD TIMERS

Trip After Guard (TAG): The position of switches SW5-1 through SW5-4 determines the time the Trip channel will remain open after a loss of valid Guard.

Guard Before Trip (GBT): The position of switches SW5-5 through SW5-8 determine the amount of valid Guard time required before the Trip channel is opened /re-opened (GBT).

The time period shown in Table 6-12 for each switch position is cumulative. A switch in the ON position enables its corresponding time period. An offset of 40ms is added to this in order to calculate the total time period. The selectable timer range is between 50ms and 190ms in increments of 10ms. **NOTE: When all switches (SW5-1 through SW5-8) are in the OFF position, the GBT/TAG function is disabled. Additionally, setting only GBT or TAG to all OFF is not valid.**

Table 6-12. Configuration of Guard Before Trip / Trip After Guard Timers

TAG Switches	SW5-1	SW5-2	SW5-3	SW5-4
GBT Switches	SW5-5	SW5-6	SW5-7	SW5-8
Time (ms)	80	40	20	10

Example: The Guard Before Trip configured for a time period of 150ms would be set as follows:

SW5-5: ON	80ms
SW5-6: OFF	0ms
SW5-7: ON	20ms
SW5-8: ON	10ms
OFFSET	40ms
TOTAL	150ms

NOTE

Because many of the timer functions interact, careful selection of these is necessary. When GBT/TAG is enabled, the alarm pickup timer must be set to a value greater than the TAG setting. It is also recommended that the alarm dropout timer be set to a value less than the GBT setting.

6.4.10 CONFIGURATION OF ALARM PICK-UP/ALARM DROP-OUT TIMERS

Alarm Pick-Up (APU): The position of switches SW6-1 through SW6-4 determines the amount of alarm condition required for the logic module to go into an alarm state.

Alarm Drop-Out (ADO): The position of switches SW6-5 through SW6-8 determines the amount of no alarm condition required for the logic module to return to normal no alarm state.

The time period shown in Table 6-13 for each switch position is cumulative. A switch is in the ON position enables its corresponding time period. The selectable timer range is either 50ms or between 100ms and 1500ms in increments of 100ms. When switches (SW6-1 through SW6-4) are in the OFF position, the APU is configured for 50ms. When switches (SW6-5 through SW6-8) are in the OFF position, the ADO is configured for 50ms.

Table 6-13. Configuration of Alarm Pick-Up / Alarm Drop-Out Timers

APU Switch	SW6-1	SW6-2	SW6-3	SW6-4
ADO Switch	SW6-5	SW6-6	SW6-7	SW6-8
Time (ms)	800	400	200	100

Example: The Alarm Drop-out Timer configured for a time period of 1000ms would be set as follows:

SW6-5: ON	800ms
SW6-6: OFF	0ms
SW6-7: ON	200ms
SW6-8: OFF	0ms
TOTAL	1000ms

NOTE

Because many of the timer functions interact, careful selection of these is necessary. When GBT/TAG is enabled, the alarm pickup timer must be set to a value greater than the TAG setting. It is also recommended that the alarm dropout timer be set to a value less than the GBT setting.

6.4.11 CONFIGURATION OF TRIP LATCH OPTION

The position of switch SW7-1 determines whether the Trip Latch option is enabled. Placing SW7-1 in the ON position enables the Trip Latch option. The Trip Latch option latches the LEDs for Trips that are transmitted and received. The Trip Sent relay, which picks-up when a Trip is transmitted is latched as well. Pushbutton switch SW11 is used to un-latch the LEDs and the Trip Sent relay once the Trip condition has been acknowledged.

6.4.12 CONFIGURATION OF POWER-BOOST LEVELS

The position of switches SW7-2 through SW7-5 determines the boost modes for 2F and 3F systems for each of the following conditions: Guard, TRIPIN_1 keyed, and TRIPIN_2 keyed. See Table 6-11 for configuration of Power-boost levels. Refer to the Keying Modes in Table 6-14 to determine the state of the system when TRIPIN_1 and/or TRIPIN_2 are keyed for the mode in which the system is being configured.

Table 6-14. Configuration of Power Boost Levels

SW7 -2	SW7-3	SW7-4	SW7-5	MODE		POWER BOOST LEVELS		
				2F	3F	GUARD	TRIPIN_1	TRIPIN_2
OFF	OFF	OFF	OFF	X		1W	1W	1W*
OFF	OFF	ON	OFF	X		1W	10W	1W*
OFF	ON	OFF	ON	X		3W	10W	10W
OFF	ON	OFF	OFF	X		10W	10W	10W*
OFF	ON	ON	OFF		X	1W	1W	1W
ON	OFF	OFF	OFF		X	1W	10W	1W
ON	OFF	ON	OFF		X	1W	1W	10W
ON	ON	OFF	OFF		X	1W	10W	10W
ON	ON	ON	ON		X	3W	10W	10W
ON	ON	ON	OFF		X	10W	10W	10W

Power Boost levels indicated with an asterisk for TRIPIN_2 for 2F Mode apply to 2F Start/Stop systems only. TRIPIN_2 (STOP) overrides TRIPIN_1 (START) reducing the power level to the same as guard power level as indicated in Table 6-11.

6.4.13 CONFIGURATION OF KEYING MODES

The position of switches SW7-7 and SW7-8 determines the Keying Mode of the system. Refer to Table 6-15 for system configuration.

2F Single-Trip Keying: A TRIP is generated when TRIPIN_1 is keyed. TRIPIN_2 is not used.
2F Dual-Trip Keying: A TRIP is generated when TRIPIN_1 and TRIPIN_2 are simultaneously keyed (TRIPA and TRIPB).
2F Start/Stop Keying: A START is generated when TRIPIN_1 is keyed. A STOP is generated when TRIPIN_2 is keyed. A STOP overrides a START.
3F Dual-Function: A BLOCK is generated when TRIPIN_1 is keyed. A TRIP is generated when TRIPIN_2 is keyed. A TRIP has priority over a BLOCK.

Table 6 15. Configuration of Keying Modes

SW7-7	SW7-8	KEYING MODE	TRIPIN_1	TRIPIN_2
OFF	OFF	2F Single-Trip Keying	TRIP	N/A
OFF	ON	2F Dual-Trip Keying	TRIP A	TRIP B
ON	OFF	2F Start/Stop Keying	START	STOP
ON	ON	3F Dual-Function	BLOCK	TRIP

6.4.14 CONFIGURATION OF CARRIER ENVELOPE NOISE DETECTOR

The position of switch SW8-1 determines if the carrier envelope noise detector is enabled. Placing SW8-1 in the ON position enables the carrier envelope noise detector. Placing SW8-1 in the OFF position disables the carrier envelope noise detector.

6.4.15 CONFIGURATION OF TX TRIP SHIFT DIRECTION

The position of switch SW8-2 determines trip shift direction as shown in Table 6-16.

Table 6-16. TX Trip Polarity

SW8-2	ON	TX Guard = shift down TX Trip = shift up
	OFF (default)	TX Guard = shift up TX Trip = shift down

6.4.16 CONFIGURATION OF TRIPIN_1/TRIPIN_2 SOLID-STATE CONTACTS

The position of switches SW8-3 and SW8-4 determine the solid-state input configuration of Tripin 1 and Tripin 2 shown in Table 6-17.

Table 6-17. Solid State Input Configuration

SW8-3	ON	Tripin 1 is normally energized
	OFF	Tripin 1 is normally de-energized
SW8-4	ON	Tripin 2 is normally energized
	OFF	Tripin 2 is normally de-energized

6.4.17 CONFIGURATION OF RX TRIP SHIFT DIRECTION

The position of switch SW8-5 determines trip shift direction as shown in Table 6-18.

Table 6-18. RX Trip Polarity

SW8-5	ON	RX Guard = shift down RX Trip = shift up
	OFF (default)	RX Guard = shift up RX Trip = shift down

6.5 THEORY OF OPERATION

All digital inputs to the Logic Module are buffered before being processed by the A42MX16-PL84I "Actel" FPGA. The "Actel", U8, is the heart of the Logic Module. The Actel performs all of the transmit and receive digital logic control functions. External interface to the Actel consists of eight banks of switches, one push-button switch, eight LEDs, input and output buffering, and a 2.584 MHz (color-burst) crystal clock source.

All Logic Module programmable timers and configuration settings are programmed via the eight switch banks, SW1 through SW8. Each switch bank is strobed in consecutive order by its respective strobe signal from the Actel. The switch data is latched within the Actel and configures the Logic Module based upon the switch settings.

The Logic Module utilizes digital timers instead of RC time constants used by its predecessor, the 6780P. All timers are programmable via DIP switches allowing for application specific changes without having to calculate time-constants or modify hardware.

The Logic Module design can be broken down into two sections: Receiver Logic and Transmitter Logic. The block diagrams shown in Figures 6-3, 6-5 and 6-6, and the 9780 Logic Module schematic diagram shown in Figure 6-8 should be referenced to follow the circuit flow throughout the discussion.

6.5.1 RECEIVER LOGIC

The Logic Module receives its input from the modules in the RFL 9780's receiving section (Sections 11, 12, 13 and 14). It tests the validity of the inputs it receives to optimize security, dependability, and speed. If the validity tests are successful, it will produce output signals for guard, trip, or logic alarm.

The Logic Module's guard and trip channels are protected by slow-to-operate, fast-to-release timers. Short noise bursts cannot cause false trips or guard outputs. A bipolar noise detector provides protection against signals that shift from guard to trip and back, but not lasting long enough to create an output from the pre-trip timer

A guard-before-trip/trip-before-guard (GBT/TAG) timer ensures that a noise free guard has been received for a preset time interval before the trip channel is opened. The trip channel will be closed again if a valid trip signal is not received within a preset time interval after the guard-input ceases. However, this added security is unnecessary once a valid trip command has already passed through the pre-trip timer. A valid trip input will defeat the GBT/TAG timer. Automatic defeat of this timer is important in many applications, such as the case where a continuous trip signal is used to hold open a breaker, taking a line out of service. The GBT/TAG timer can only be re-enabled when a solid guard signal is received for a minimum of 100ms.

Threshold detectors monitor the incoming signal. If the signal level is too low or too high, the trip channel will be blocked. The low-level signal is optionally applied to the unblocking function of the Logic Module to generate a low signal trip.

An alarm timer will be activated if an abnormal condition is detected. If the condition persists for the preset time interval, the alarm circuit will be triggered, and the trip and guard outputs will be blocked until the abnormal condition has ceased and the alarm drops out.

6.5.1.1 PRE-GUARD TIMER

The pre-guard timer ensures that a valid guard input has been received for a preset time interval before a trip input can be processed. This is done to reduce the possibility of false trips.

Guard commands from the receiving section of the RFL 9780 appear as a logic-high guard input at edge connector pin C13 (GUARD_INPUT) and can be monitored at TP4. When the guard input goes high and remains high for a preset time interval, the output of the pre-guard timer will be high. The output of the pre-guard timer is passed to the guard-hold timer.

6.5.1.2 GUARD-HOLD TIMER

The guard-hold timer ensures that the valid guard input it receives is sustained to prevent brief instances of guard loss or from causing guard chatter. It accomplishes this by maintaining the guard output for an additional preset time interval when the valid guard is no longer present, or if a noise burst were to interrupt the valid guard for a short period.

If the trip-hold timer holds a valid trip, the output of the guard-hold timer (GUARD_VAL) is immediately blocked, and the guard output will **not** be sustained for the remainder of the guard-hold time interval. Note that the guard-hold timer is not used for all applications, in which case, the GUARD_VAL output would be programmed to go low at the same time as its input goes low. The GUARD_VAL signal triggers the guard output circuit.

6.5.1.3 GUARD OUTPUT CIRCUIT

The guard-hold timer output signal, GUARD_VAL, will produce a guard output if the pre-guard timer determines that a valid guard condition exists and a hard block (ALARM) condition does not exist. If these conditions are met, the transistor will drive the GDOUT_RLY and GDOUT_SS outputs at edge connectors C21 and C23, energizing the electro-mechanical and solid state guard relays. The active output of GDOUT_SS is a 32Khz 50% duty-cycle signal. The GUARD indicator DS1 will illuminate to show that a valid guard input has been received and a guard output has been generated. The guard outputs will remain energized for the duration of a valid guard, including any preset time interval of the guard-hold timer.

If an abnormal condition causes the alarm to pickup, the guard output will be blocked until the abnormal condition ceases and the alarm drops out.

If an under-voltage condition is detected, the PWR_FAIL and/or POWERFAIL2 inputs to the 9780 Logic Module will be logic-low. Both signals in the logic-low state will generate a logic-low POWER signal to block the guard outputs for the period of the under-voltage condition plus an additional 600 ms.

The status of the guard output circuit is recorded by the sequence of events module (Section 15).

6.5.1.4 PRE-TRIP TIMER

The pre-trip timer ensures that a valid trip input has been received before a trip output can be generated. This timer enhances security, since it is unlikely that noise corresponding to a trip signal will persist for any length of time causing a false trip.

Trip commands from the receiving section appear as a logic-high trip input at edge connector pin C14 (TRIP_INPUT). If INHIBIT, BLOCK, and GUARD_INPUT signals are not active, the pre-trip timer will begin to count up to the preset time interval. Once the pre-trip timer is satisfied, the output of this timer, PRE_TRIP, will go high. Once the trip input is no longer present, the pre-trip timer will return to its original state to wait for the next trip input. This signal is applied to the bipolar timer where it may be further qualified depending upon the state of the bipolar noise detector.

6.5.1.5 TRIP-HOLD TIMER

The trip-hold timer ensures that the valid trip inputs it receives are sustained long enough to actuate the circuit breaker on the protected line. It accomplishes this by maintaining the output for an additional preset time interval when the valid trip is no longer present, or if a noise burst were to block the trip channel.

When the HAS_TRIPPED signal goes high, the trip signal applied to the trip-hold timer signal will go high unless a logic-high is applied to the STOP_TRIP input at edge connector pin B25. The output signal of the trip-hold timer, TRIP_HELD, will be high and remain high for the duration of the preset time interval of the trip hold timer. Note that the trip-hold timer is not used for all applications, in which case the TRIP_HELD output signal would be programmed to go low at the same time as the input goes low. The TRIP_HELD signal triggers the trip output circuit. It is also applied to many of the other timers and logic circuits. LOW_SIGNAL trip is passed through and is not held for any additional time. A logic high TRIPPED signal is applied to the GBT/TAG timer when either HAS_TRIPPED or LOW_SIGNAL_TRIP is active.

6.5.1.6 TRIP OUTPUT CIRCUIT

The trip-hold timer output circuit signal, TRIP_HELD, will produce trip outputs if the combined pre-trip and bipolar timers determine that a valid trip condition exists. If a valid trip does exist, the transistors will drive the TROUT_RLY1 (C20) and TROUT_SS (A22) outputs, energizing the electro-mechanical and solid-state trip relays. The active TROUT_SS output is a 32 kHz 50% duty-cycle signal. The trip outputs will remain energized for the duration of a valid trip, including any preset time interval of the trip-hold timer.

TRIP indicator DS2 will illuminate to show that a valid trip input has been received and a trip output has been generated. If desired, the 9780 Logic Module can be configured to latch the TRIP indicator (DS2). The TRIP RESET button (SW11) located at the front of the board (protruding through the 9780 chassis) is used to reset the indicators.

If an abnormal condition causes the alarm to pick up, the output will be blocked until the abnormal condition ceases and the alarm drops out.

If an under-voltage condition is detected, the PWR_FAIL and/or POWERFAIL2 inputs to the 9780 Logic Module will be logic-low. Both signals in the logic-low state will generate a logic-low POWER signal to block the trip outputs for the period of the under-voltage condition plus an additional 600 ms.

The status of the trip output circuit is recorded by the sequence of events module (Section 15).

6.5.1.7 GUARD-BEFORE-TRIP AND TRIP-AFTER-GUARD TIMER

The guard-before-trip/trip-after-guard (GBT/TAG) timer ensures that a noise-free guard input has been received for a preset time interval before the trip channel is opened. The guard can disappear because of excessive noise on the communications channel, a disconnected line, equipment failure, or other reasons. The only valid reason for the guard to disappear is when the transmitting 9780 shifts from guard to trip; when this happens, the guard should be replaced by a trip input. If a trip input is not detected within a preset time interval after the guard input ceases, the GBT/TAG timer assumes that the condition was not valid, and the trip channel is disabled.

If the pre-guard timer has been satisfied, the logic-high GUARD_VAL signal will activate the GBT/TAG timer. Once guard before trip requirements are satisfied, the trip channel is opened by the INHIBIT signal, and will remain open for a period including a preset time after guard is no longer valid. If the trip after guard requirements are not satisfied, the trip channel will be closed by the INHIBIT signal and will remain closed until the pre-guard and GBT timers are once again satisfied. When a logic-high TRIPPED input is applied to the GBT/TAG timer (indicating a valid trip is received), the GBT/TAG timer is defeated, keeping the trip channel open. The GBT/TAG can only be re-enabled by a logic-high GUARD_VAL signal, indicating that a solid guard signal is received for a minimum of 100ms.

When neither trip nor guard are present, an abnormal condition exists which will trigger the alarm timer.

6.5.1.8 BIPOLAR NOISE DETECTOR AND TIMER

The bipolar noise detector allows the 9780 Logic Module’s security and speed to adapt to the environment; fast for clear-channel conditions, or slower and more secure when subjected to high noise levels. Bipolar noise is defined as a noise that causes a bipolar system to change from present state to the alternate state and then back to its original state. In the 9780, this would be a change from guard to trip to guard, or from trip to guard to trip. The bipolar detector (if enabled) recognizes this condition and enables the bipolar timer; this effectively lengthens the time-out period of the pre-trip timer when this abnormality occurs. The noise detector will not be active when a valid trip is received, because after noise has disappeared, a trip will be detected with no return to guard.

If either a valid trip or guard output is being produced (which is the normal state), the logic-high NORMAL signal will disable the bipolar detector. The bipolar detector’s output signal, BNOISE, will be a logic-high preventing the bipolar timer from adding the additional time requirement to the to open the trip channel.

When the received signal goes from guard to trip, the guard output will disappear. Because there is momentarily no valid guard or trip output, the NORMAL signal will be initially logic-low. The logic-high TRIP_INPUT command from the receiver along with a logic-low GUARD_INPUT (absence of guard) will drive the NORMAL signal high if the trip satisfies the pre-trip timer without a disturbance. The noise detector circuit is disabled, its output BNOISE will remain logic-high, and the additional time requirement is not required to open the trip channel.

If however, the trip input was actually noise, the receiver section's output will return to guard before the pre-trip timer times out. This condition will trigger the bipolar noise detector, enabling the bipolar noise timer with its logic-low BNOISE output signal. The bipolar noise timer adds an additional preset time requirement to that of the pre-trip timer's preset time requirement. The bipolar noise detector forces this state for the period of the noise plus an additional 50 ms. Additional noise pulses will re-trigger and extend the bipolar noise if they occur before the 50 ms time-out. If a trip occurs within 50 ms after the noise pulse, the trip would have to satisfy the combined pre-trip and bipolar time requirement before being considered a valid trip.

The output signal of the bipolar timer is HAS_TRIPPED. This output can be monitored at edge connector pin C2.

The bipolar noise detector is also fed to the alarm timer. A bipolar noise condition, which lasts longer than the preset time of the alarm timer, will result in an alarm output.

6.5.1.9 THRESHOLD DETECTORS

The signal level detector is a window detector that uses two comparators and associated components to detect signals that are above or below established limits.

If the SIGNAL_ENVELOPE input at edge connector pin C17 exceeds **7.17 volts**, the logic-high HI SIG signal will be fed to the blocking logic circuits. Indicator DS3 will light to indicate an extreme high-level signal condition.

If the SIGNAL_ENVELOPE input at edge connector pin C17 falls below **0.094 volts**, the logic-high LO SIG signal will be fed to the blocking logic circuits and to the optional unblocking circuit function. Indicator DS4 will light to indicate an extreme low-level signal condition. A low signal output is available at edge connector pin C27 (LO_SIG_OUT).

6.5.1.10 CARRIER ENVELOPE NOISE DETECTOR

The carrier envelope noise detector monitors the SIGNAL_ENVELOPE input at edge connector pin C17 and produces a signal that is applied to the blocking path if a channel is too noisy. It is formed from three operational amplifiers and its associated components. The carrier envelope noise detectors are enabled when SW8-1 is placed in the ON position, and are disabled when placed in the OFF position. The SIGNAL_ENVELOPE input is smoothed by a 50 Hz low-pass filter formed by the first operational amplifier (U2A). The output of opamp U2A feeds the input of two other operational amplifiers (U1B and U1C). The SIGNAL_ENVELOPE signal is also directly connected to each of the operational amplifier's other input. Both of these operational amplifiers serve as comparators. The outputs of these comparators form the open-collector active low outputs CE_HIGH and CE_LOW.

If noise is present, it will modulate the SIGNAL_ENVELOPE input, causing its average level to decrease or increase. If the modulation exceeds the nominal carrier level by 29%, CE_HIGH will go low indicating high-level carrier envelope noise may be present. If the modulation decreases below the nominal carrier level by 35%, CE_LOW will go low indicating low-level carrier envelope noise may be present. CE_HIGH and CE_LOW signals are applied to the blocking logic circuit within the Actel FPGA for further digital processing.

6.5.1.11 BLOCKING LOGIC CIRCUIT

The CE_HIGH, CE_LOW, LO SIG and HI SIG signals are applied to the blocking logic circuit where the noise is further processed and evaluated. The logic-low BLOCK output signal will block the TRIP_INPUT signal when any of these signals is active. However, the CE_HIGH and CE_LOW signals will not block the trip channel if the TRIP_HELD signal is active indicating a valid trip. The BLOCK signal is also applied to output pin BLK_OUT (C15) at the module edge connector; this drives logic on the LM/SL Module.

6.5.1.12 30 MS PULSE STRETCHER

Noise disturbances are usually a series of short-duration pulses. Although they indicate an abnormal condition, they may not be long enough to trigger the alarm timer. The pulse stretcher is used to elongate these short pulses so that the alarm timer can respond to them. This pulse stretcher can be triggered by a logic-low BLOCK signal generated by the threshold detectors or carrier envelope noise detector. The pulse duration will be equal to the period of the disturbance plus the 30 ms period of the pulse stretcher. For example, 1 ms noise disturbances occurring every 20 ms for 100 ms will generate a 130 ms pulse, triggering an alarm if the alarm pick-up timer were preset to 100ms. The logic-high output pulse, NOISE_STRETCH, will trigger the alarm timer. A logic-high TRIP_HELD generated by a valid trip, or logic-high applied to STOP_ALARM at edge connector pin C29 will prevent any disturbances from triggering the pulse stretcher that may activate the alarm timer.

6.5.1.13 ALARM TIMER

The alarm timer is triggered by any abnormal condition detected by the receiver logic of the 9780 Logic Module. The logic-high NOISE_STRETCH signal applied to the input signal of the alarm timer indicates this condition. If the condition persists for the entire preset alarm pick-up time interval, the alarm output circuit will be activated, indicating that the 9780 is in alarm mode. The LOGIC ALARM indicator DS5 will be lit, the logic alarm relay will be de-energized, and the guard output and trip output will be blocked.

In order to clear the alarm, the NOISE_STRETCH input must be low for a period exceeding the preset alarm dropout time interval.

In the no-alarm state, the following conditions are present in the alarm timer:

1. The carrier envelope noise detector outputs (CE_HIGH and CE_LOW) are not active.
2. The threshold detector outputs (LO SIG and HI SIG) are not active.
3. Bipolar noise (BNOISE) is not active.
4. A valid trip or guard is being received.
5. The PWR_FAIL and POWERFAIL2 inputs (edge connector pins A17 and C16) received from the power supply are not active. Both must be active simultaneously to be considered a critical power fail condition. POWERFAIL2 is forced active when optional redundant supply is not installed.
6. The LOGIC ALARM indicator DS5 is off.
7. The alarm output circuit is turned on, and the 9780 logic alarm relay is energized. Note that a constant logic-high applied to the STOP_ALARM input at edge connector pin C29 can manually turn off an active alarm. However, it will not turn off an active alarm triggered by a power failure condition.

6.5.1.14 ALARM OUTPUT CIRCUIT

The alarm output circuit will produce a LOGIC_ALM output at edge connector pin A20 whenever the 9780 Logic Module is not in an alarm state. This output is used to energize the alarm relay in the (normal) no-alarm condition. If an alarm condition occurs, the transistor associated with the alarm output circuit is turned off causing the alarm relay to dropout. ALARM LED (DS5) will also light to indicate that the 9780 is in the alarm state. The LOGIC_ALM output will block the guard and trip outputs when the alarm picks up and until the alarm drops out. The input to the unblock trip restore timer will be blocked as well.

Once the alarm timer clears the alarm condition, the transistor will turn on again, and DS5 will go out. The alarm relay will pull in again, which is the normal condition.

If an under-voltage condition is detected, the PWR_FAIL and/or POWERFAIL2 inputs to the 9780 Logic Module will be logic-low. Both signals in the logic-low state will generate a logic-low POWER signal that will force an alarm condition for the combined period of the under-voltage condition, alarm drop-out timer, and an additional 600 ms.

The status of the alarm output circuit is recorded by the sequence of events module.

6.5.1.15 UNBLOCK SECURITY TIMER

For the following discussion refer to Figure 6-4.

The unblock security timer is used to disable the unblock trip output for shorter losses of channel than its preset time interval. The unblock security timer is only applicable for valid low signal conditions.

A VALID_LOW signal condition is applied to the unblock security timer once the following conditions are satisfied:

1. A logic-high LO SIG input signal from the threshold detector is applied to AND1.
2. UNBLOCK_CHANNEL signal is logic-high indicating the unblock trip restore timer has been satisfied by 50ms of Guard or non-low level condition. The SR Flip-Flop is SET by the UNBLOCK signal, and its high output is applied to AND1.
3. A logic-low BLOCK_CHANNEL signal is applied to AND1 indicating a LOW_SIGNAL_TRIP is not currently active, and did not occur within the last 5ms.

If a logic-high VALID_LOW signal exceeds the preset time interval of the unblock security timer, the PASS_SECURITY signal will go to a logic-high. A logic-high PASS_SECURITY signal triggers the unblock window timer.

6.5.1.16 UNBLOCK WINDOW TIMER

The unblock window timer is a non-retriggerable one shot which will hold the trip output for a preset time interval once a logic-high PASS_SECURITY signal is applied to its input. The LOW_SIGNAL_TRIP is ultimately applied to the trip output circuitry, energizing electro-mechanical and solid-state relays. The LOW_SIGNAL_TRIP also RESETS the SR Flip-Flop, limiting the operation to only one unblock trip output per channel disturbance.

If an abnormal condition causes the alarm to pickup, the LOW_SIGNAL_TRIP will be blocked until the abnormal condition ceases and the alarm drops out.

If an under-voltage condition is detected by the power supply, the PWR_FAIL and/or POWERFAIL2 inputs to the 9780 Logic Module will be logic-low. This will generate a logic-low POWER signal to prevent the LOW_SIGNAL_TRIP signal from going active for the period of the under-voltage condition plus an additional 600 ms. The unblock trip output will effectively be blocked.

6.5.1.17 5 MS HOLD

The 5 ms hold circuit extends the LOW_SIGNAL_TRIP for an additional 5 ms. The extended logic-high output signal, BLOCK_CHANNEL, is applied to AND1. The output of AND1, VALID_LOW, is held low for the extended period. This prevents the unblock security timer from incrementing.

6.5.1.18 UNBLOCK TRIP RESTORE TIMER

Unblock trip restore timer is used to enable the unblock trip output after 50 ms of clear channel (a logic-low LO SIG) or 50 ms of valid guard (a logic-high GUARD_RLY) output depending upon the 9780 Logic Module configuration. This circuit adds security by requiring a valid guard output or clear channel before a trip can be generated.

If an abnormal condition causes LOGIC_ALM to go active following an unblock trip, the input to the trip restore timer will be blocked until the abnormality ceases and the alarm drops out.

Once the 50 ms timer is satisfied, the logic-high UNBLOCK_CHANNEL signal will SET the SR Flip-Flop. The logic-high output of the SR Flip-Flop is applied to AND1 allowing the unblock security timer to monitor the LO SIG input. If significant channel loss occurs to satisfy the unblock security timer, a valid low signal trip will occur.

6.5.2 TRANSMITTER LOGIC

The 9780 Logic Module accepts trip inputs and voice enable signals and uses them to generate control signals for the transmitter module. It also contains a circuit that monitors the output of the power amplifier module, and generates a transmitter fail (TX_FAIL) output.

6.5.2.1 TRIP INPUT CIRCUITS

The trip-input circuits accept trip inputs from solid-state input relays at the rear of the 9780 chassis and passes them to the logic circuits.

In order for the 9780 to produce a valid trip command, a zero-volt signal must appear at one or both trip inputs (edge connector pins B21 and C22) depending upon the configuration.

The first trip input accepts a signal applied to the TRIPIN_1 input (edge connector pin B21). An RC network filters out any contact bounce. The output of this filter is applied to a Schmitt trigger. Its output is passed on to the logic circuits.

The second trip input accepts a signal applied to the TRIPIN_2 input (edge connector pin C22). An RC network filters out any contact bounce. The output of this filter is applied to a Schmitt trigger. Its output is passed on to the logic circuits.

TRIPIN_1 is used for tripping in 2F systems, and TRIPIN_2 is used for tripping in 3F systems. A trip will always override any other condition in any system, with the exception of a 2F-START/STOP system. TRIPIN_2 is used to override a START applied to TRIPIN_1 in a 2F-START/STOP system.

A logic-low TRIPSENT_RLY signal will energize the trip sent relay when a trip condition is keyed in 2F and 3F systems.

TRIP IN 1 LED indicator DS6 and TRIP IN 2 LED indicator DS7 light when corresponding trip inputs are keyed. Optionally, the 9780 Logic Module can be configured to keep the trip sent relay energized after a trip has been keyed. The relay can be de-energized with the TRIP RESET button on the front of the module.

Optionally, the 9780 Logic Module can be configured to latch the DS6 and/or DS7 indicators for a trip condition depending upon the system. The LEDS are reset with the TRIP RESET button on the front of the module.

The status of the TRIP IN_1 and TRIP IN_2 inputs are recorded by the sequence of events module.

6.5.2.2 TRANSMITTER FREQUENCY LOGIC CIRCUIT

The outputs produced by the trip-input circuits are fed to the transmitter frequency logic circuit. The configuration of the 9780 Logic Module determines whether one or both trips must be present before a valid trip is accepted by this logic circuit. The transmitter frequency logic circuit generates the OSC1_2 and OSC3 outputs that are located at edge connector pins A13 and B13 respectively. The transmitter module uses these signals to control the output frequency for 2-frequency (2F) and 3 frequency (3F) systems. The following table defines all valid states of these signals for 2F and 3F systems:

Table 6-19. Valid states of 2F and 3F signals

OSC_3	OSC_12	TX FREQ	FUNCTION	
			2F	3F
0	0	F1	DTT / START	DTT
0	1	F2	N/A (CF)	GUARD / BLOCK
1	0	F3	GUARD / STOP	UNBLOCK

Under normal power conditions, a logic-low CARRIER_ENABLE signal is applied to the Transmitter Module, allowing it to respond to the frequency control signals. However, during under-voltage conditions, a logic-high CARRIER_ENABLE is applied to the Transmitter Module, preventing it from responding to the frequency control signals.

6.5.2.3 TRANSMITTER POWER LEVEL LOGIC CIRCUIT

The outputs produced by the trip-input circuits are fed to the transmitter power level logic circuit. The configuration of the 9780 Logic Module determines how the logic circuit will react to the inputs. The transmitter power logic circuit generates the A SWITCH and B SWITCH outputs which are located at edge connector pins A14 and B14 respectively. The transmitter module uses these to control the output power level. The following table defines all valid states of these signals:

Table 6-20. Transmitter Power Levels

A_SWITCH	B_SWITCH	POWER LEVEL
0	0	10W
0	1	10W
1	0	3W
1	1	1W

6.5.2.4 TRANSMITTER FAIL ALARM CIRCUIT

The HI signal applied to edge connector pin A16 is received from the power amplifier module. In the non-alarm state, an open-collector transistor is turned on which drives the TX_FAIL signal low, energizing the transmitter fail alarm relay. If the HI signal input is logic-high for a period greater than 125μs, the open-collector transistor is turned off. This drives the TX_FAIL signal high, de-energizing the transmitter alarm relay. The TX_FAIL signal is held in the de-energized state for an additional 150ms once the HI signal returns to the normal logic-low state. DS8 lights in the transmitter fail alarm state. The status of the transmitter circuit is recorded by the sequence of events module.

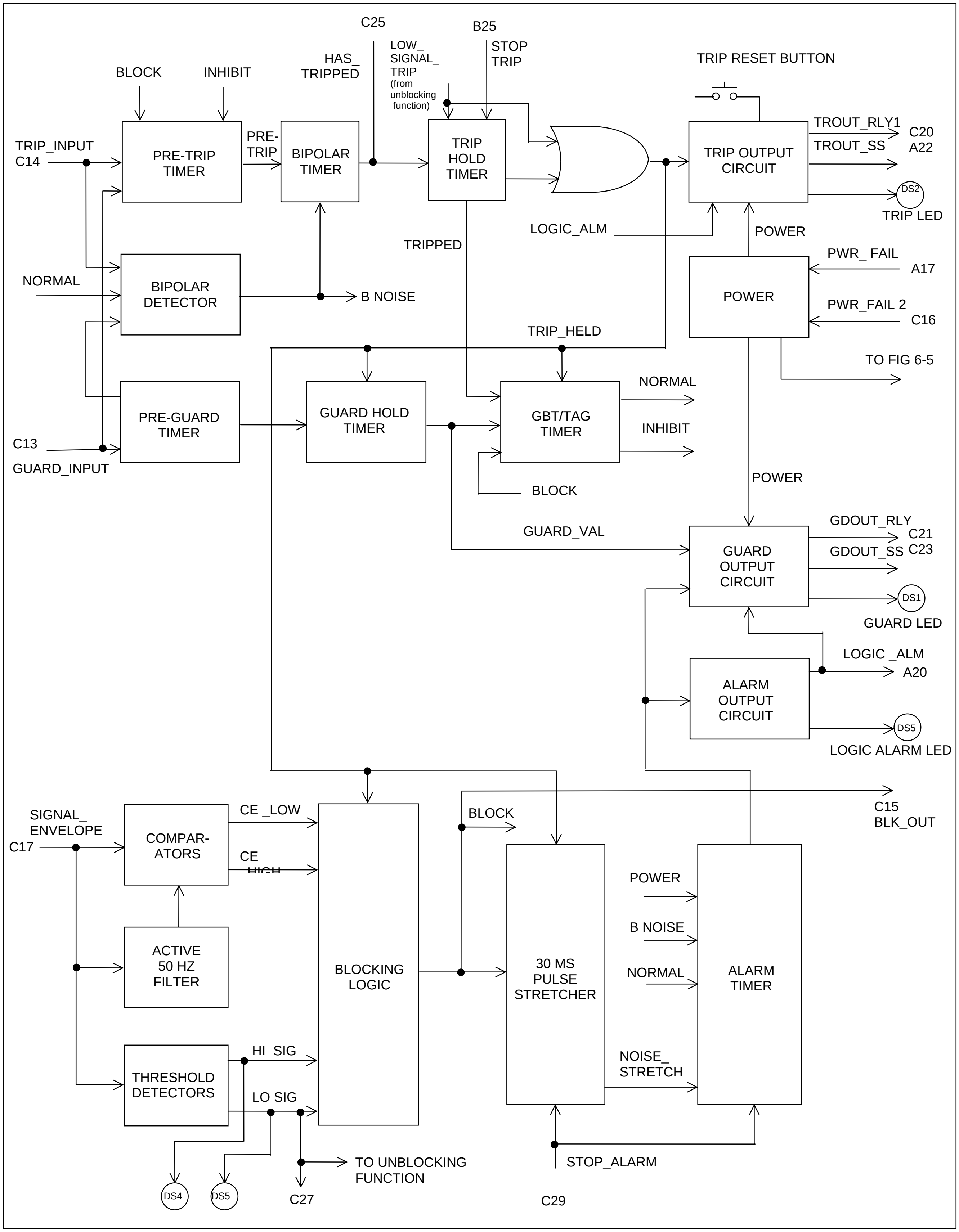


Figure 6-3 Receiver logic block diagram (figure continues on next page)

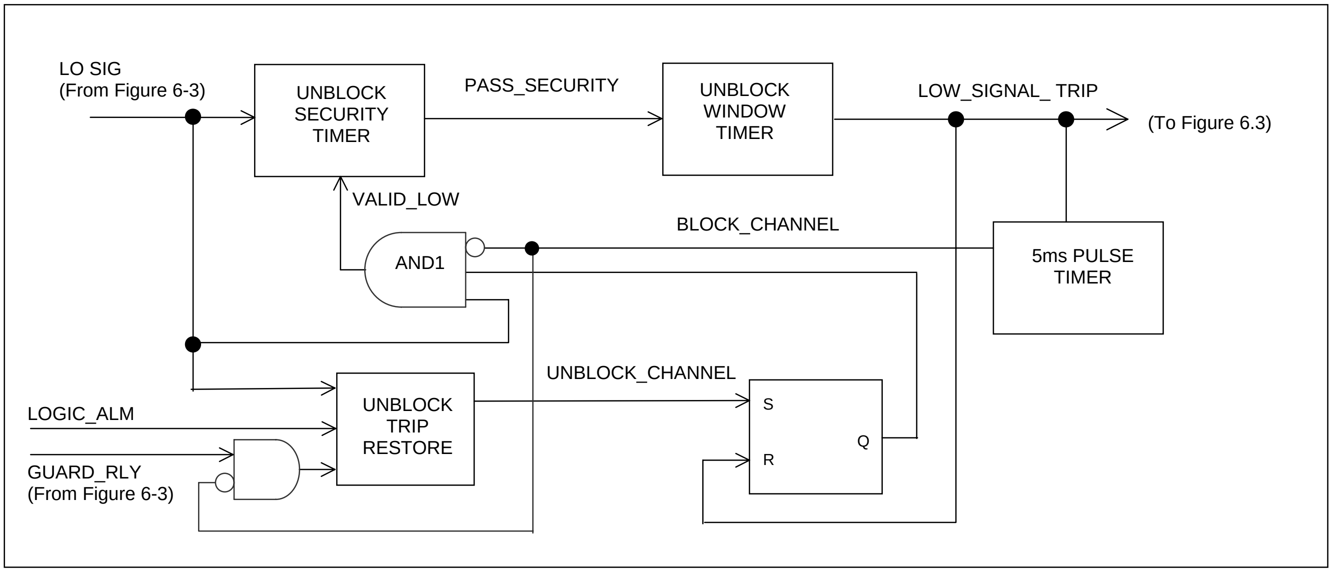
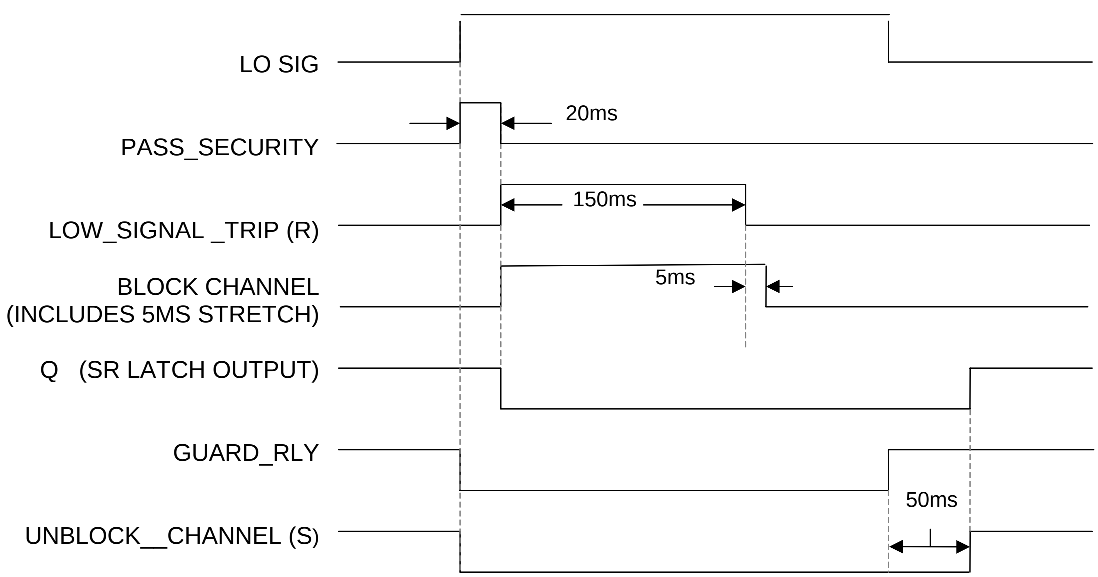


Figure 6-4. Receiver Unblocking Function Logic (part of Figure 6-3)



The timing diagram shown above is based on default Unblock Logic as follows: 20ms Unblock Security Timer, 150ms Unblock Trip Window, and “Reset on Guard” for Unblock Trip Restore. Logic “gate delays” are negligible and are not indicated on timing diagram.

The “Unblock Security Timer” is used to disable trip output for short losses of “LO SIG” (<20ms). The “PASS_SECURITY” signal is the output of this timer; it goes active for “LO SIG” equal or greater than 20ms, and triggers the “Unblock Window Timer”. The “Unblock Window Timer” holds the trip output (“LOW_SIG_TRIP”) for 150ms. The “LOW_SIG_TRIP” also triggers the “R” input of the S-R Latch and the “5ms Pulse Timer”, preventing additional trip outputs until “GUARD_RLY” is qualified (>50ms) by the “Unblock Trip.

Refer to Paragraphs 6.5.1.15 through 6.5.1.18, and Figures 6-3 and 6-4 for additional information.

Figure 6-5. Unblocking Function Timing Diagram

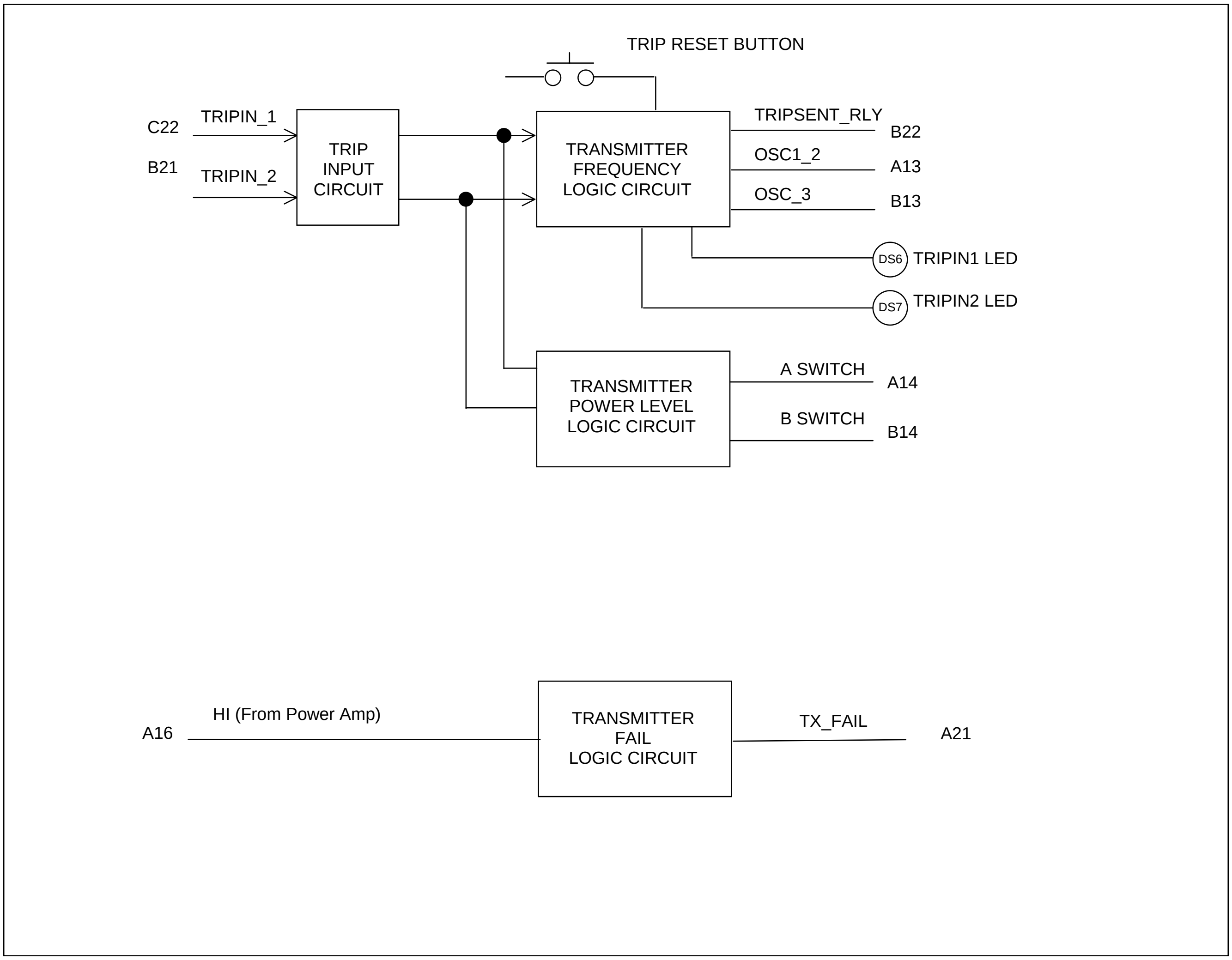


Figure 6-6. Transmitter Logic block diagram

Table 6-21. Replaceable parts, RFL 9780 Logic Module
Assembly No. 106490

Circuit Symbol (Figs. 6-7 & 6-8)	Description	Part Number
	CAPACITORS	
C1-4	Capacitor, electrolytic, 47μF, 20%, 35V	1007 1578
C5-11, 17, 20, 22-32	Capacitor, ceramic dip, 0.1μF, 10%, 50V	0120 38
C12	Capacitor, ceramic, 0.056μF, 10%, 50V	0130 55631
C15, 16	Capacitor, ceramic, 0.0056μF, 5%, 100V	0125 15625
C18	Capacitor, ceramic, 0.0039μF, 5%, 100V	0125 13925
C19	Capacitor, tantalum, 4.7μF, 10%, 35V	1007 1623
C21	Capacitor, ceramic dip, 0.01μF, 5%, 100V	1007 1645
C33	Capacitor, ceramic, 0.033μF, 10%, 50V	0130 53331
	RESISTORS	
R1	Resistor, metal film, axial, 6.49K, 1%, 1/4W	0410 1366
R2	Resistor, metal film, axial, 2.05K, 1%, 1/4W	0410 1318
R3, 7, 8, 18, 21, 22, 31-33, 40, 42, 45	Resistor, metal film, axial, 10K, 1%, 1/4W	0410 1384
R4	Resistor, metal film, axial, 127K, 1%, 1/4W	0410 1490
R5, 12, 29, 44	Resistor, metal film, axial, 1K, 1%, 1/4W	0410 1288
R6	Resistor, metal film, axial, 100K, 1%, 1/4W	0410 1480
R9, 10	Resistor, metal film, axial, 75K, 1%, 1/4W	0410 1468
R11	Resistor, metal film, axial, 6.98K, 1%, 1/4W	0410 1369
R13	Resistor, metal film, axial, 4.53K, 1%, 1/4W	0410 1351
R14	Resistor, metal film, axial, 15K, 1%, 1/4W	0410 1401
R15, 17	Resistor, metal film, axial, 20K, 1%, 1/4W	0410 1413
R16, 34, 35	Resistor, metal film, axial, 1M, 1%, 1/4W	0410 1576
R20, 28	Resistor, metal film, zero ohm, 1/4W size	1510 2217
R24, 25, 46	Resistor, metal film, axial, 33.2K, 1%, 1/4W	0410 1434
R26, 27	Resistor, metal film, axial, 3.92K, 1%, 1/4W	0410 1345
R30	Resistor, metal film, axial, 49.9K, 1%, 1/4W	0410 1451
R43	Resistor, metal film, axial, 4.75K, 1%, 1/4W	0410 1353
R47	Resistor, metal film, axial, 7.15K, 1%, 1/4W	0410 1370
RZ1	Resistor network, 4.7K, 8R/PKG, SIP	101676
RZ2	Resistor network, 10K, 8R/PKG, SIP	95571
RZ3	Resistor network, 330Ω, 8R/PKG, SIP	44532

Table 6-21. continued, Replaceable parts, RFL 9780 Logic Module
Assembly No. 106490

Circuit Symbol (Figs. 6-7 & 6-8)	Description	Part Number
	SEMICONDUCTORS	
CR2, 7	Diode, silicon, 1N914B/1N4448	26482
CRZ1-8	Diode array, 8-diode, common cathode	103444
U1	Integrated circuit, linear QUAD comparator	0620 377
U2	Integrated circuit, linear JFET OP-AMP	0620 227
U3, 5, 6, 9	Integrated circuit, MOS	0615 297
U4	Integrated circuit, MOS HEX inverter, Schmitt trigger	0615 242
U7	Transistor array, ULN2803A	0720 7
U8	Integrated circuit, MOS field programmable gate array	0615 473
U10	Integrated circuit, MOS tri-state octal buffer	0615 176
	MISCELLANEOUS COMPONENTS	
DS-1	Opto device, LED, green	99799
DS2-8	Opto device, LED, red	98534
J1	Connector, header, single, 3-circuit	32802 3
L1	Inductor, coated, 100µH, 10%	103472
P1	Connector, plug, male, 96 connections, DIN	101681
SW1-8	Switch, DIP, SPST, 8-position, 16-pin	98493
SW9	Switch, SPDT, right angle, pc board mounting	98488
TP1-16	Test point, terminal, orange	98441 3
Y1	Crystal, hybrid, clock oscillator, 3.584Mhz	103347

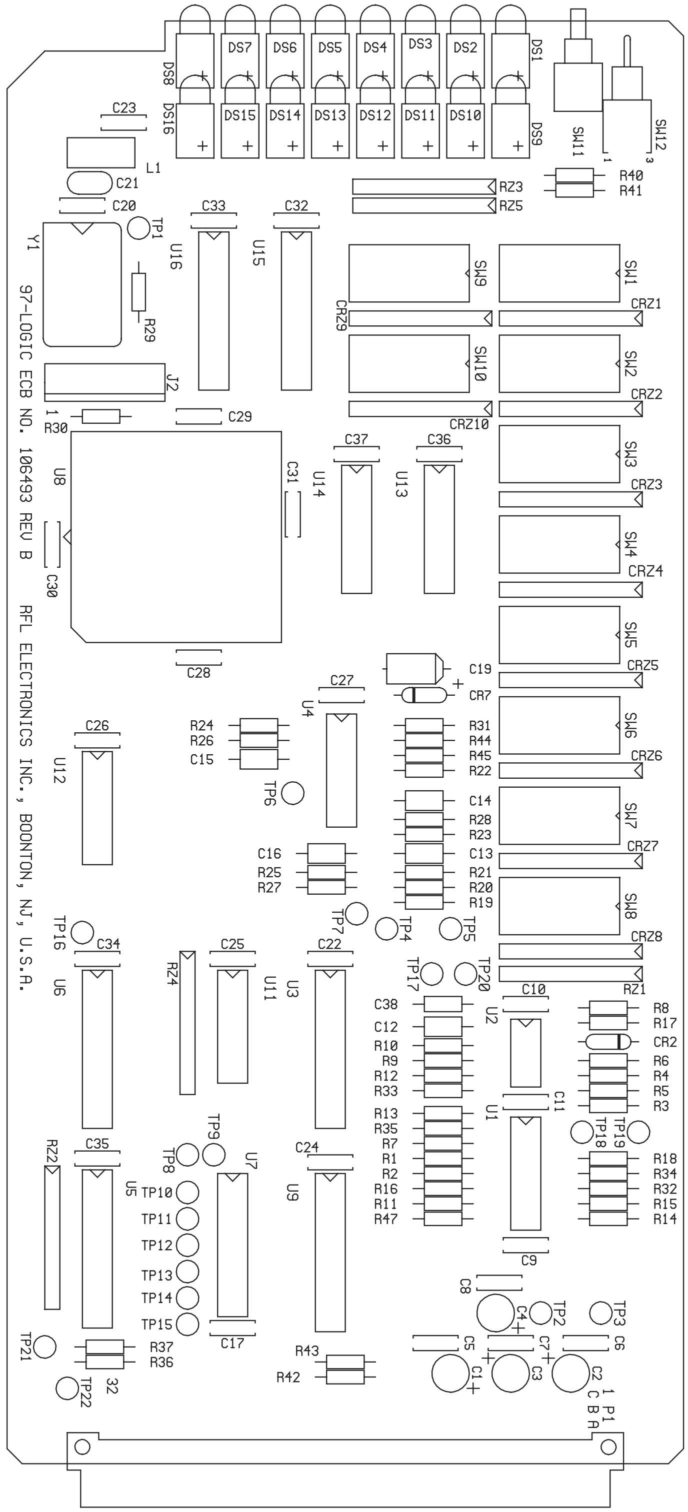


Figure 6-7. Component locator drawing, RFL 9780 Logic Module (Assembly No. 106490)

Figure 6-8. Schematic, RFL 9780 Logic Module (Dwg. No. D-106494-A) Sheet 1 of 2

Please see Figure 6-8 in Section 22.

Figure 6-8 Schematic, RFL 9780 Logic Module (Dwg. No. D-106494-A) Sheet 2 of 2

Please see Figure 6-8 in Section 22.

SECTION 7. TX LOGIC MODULE

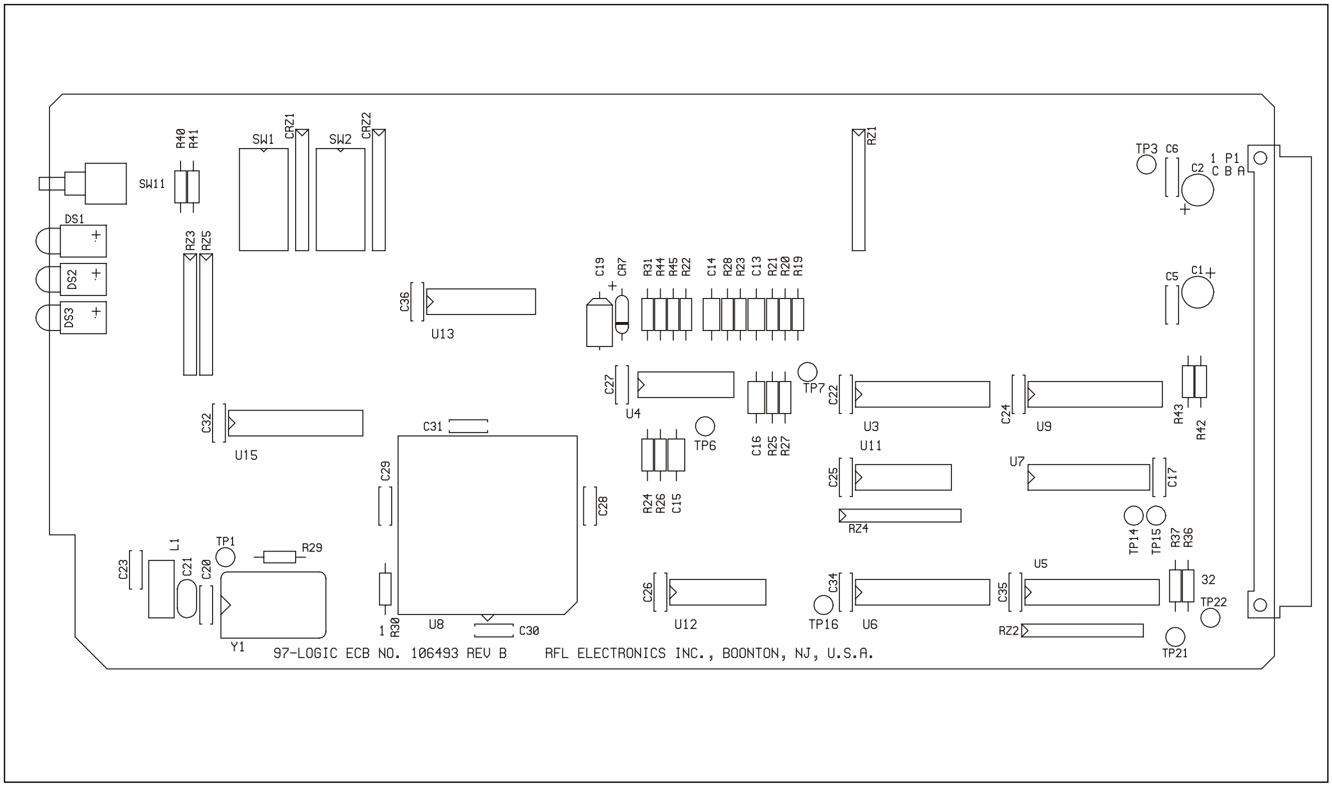


Figure 7-1. RFL 9780 Tx Logic Module

7.1 DESCRIPTION

The RFL 9780 Tx Logic Module interfaces with most of the transmitter modules within the system. It monitors trip input signals and generates signals for the Transmitter Module (Section 8) to control frequency shift and power level. The Tx Logic Module also provides status information for the Sequence of Events Module (Section 15).

The RFL 9780 Tx Logic Module has three LED indicator lamps on its front edge which protrude through the front panel of the RFL 9780. These include TRIP IN 1, TRIP IN 2, and TX FAIL. All LEDs are red.

Open-collector transistors are provided on the RFL 9780 Tx Logic Module to drive relays with trip sent and transmitter fail alarm output signals.

7.2 SPECIFICATIONS

As of the date this manual was published, the following specifications apply to the RFL 9780 Logic Module. Because all RFL products undergo constant refinement and improvement, these specifications are subject to change without notice.

Crystal Specifications: The frequency of clock oscillator Y1 is 3.584 MHz ± 50 ppm.

7.3 TYPICAL CONFIGURATION SETTINGS

Table 7-1 lists some typical configuration settings for the 9780 FSK PLC. Note that these settings are typical, and are not standard settings. Each RFL 9780 application is unique and should be carefully evaluated by a knowledgeable Engineer. Normally, when a unit is shipped from RFL it is shipped configured for the user's application. If, however, RFL is not aware of application specifics, the system will be supplied with the typical settings. RFL Sales and Customer Support personnel are always available to answer questions or assist in configuring a system.

Table 7-1. Typical Configuration Settings for 9780 DTT, PTT and DCU Applications

Function	**Typical Setting**	**Switch Positions**		
Trip Latch	Disabled	SW1-1		
		OFF		
Power Boost Level	1W/ 10W	SW1-2	SW1-3	SW1-4
		OFF	OFF	ON
Trip Override Voice	Disabled	SW1-5		
		OFF		
Voice Enable	Disabled	SW1-6		
		OFF		
Keying Mode	2F, Dual-Trip Keying	SW1-7	SW1-8	
		OFF	ON	
Polarity Of Transmitted Trip Frequency *	Trip down in frequency	SW2-1		
		OFF		
TRIPIN_1 Input Contacts **	Normally de-energized	SW2-2		
		OFF		
TRIPIN_2 Input Contacts **	Normally de-energized	SW2-3		
		OFF		

* Depends upon customer preference
** Depends upon contacts required

7.4 CONTROLS AND INDICATORS

Figure 7-2 shows the location of all controls and indicators on the RFL 9780 Tx Logic Module. These controls and indicators are described in Table 7-2. Some of the controls and indicators are accessible when the module is installed in the chassis and others are accessible only when the module is removed from the chassis or is on a card extender.

Table 7-2. Controls and indicators, RFL 9780 Tx Logic Module

Component Designator	**Name/Description**	**Function**	**For more information See paragraph:**
DS1	LED Indicator (Trip Input 1)	Lights when trip key input 1 is active.	NA
DS2	LED Indicator (Trip Input 2)	Lights when trip key input 2 is active.	NA
DS3	LED Indicator (Tx Fail)	Lights when transmitter failure has occurred.	NA
SW1	DIP Switch	SW1 (1) Trip latch (TX)	7.4.1
		SW1 (2-4) Power boost level	7.4.2
		SW1 (5) Trip override (Voice muted during trip)	7.4.3
		SW1 (6) Voice enable	7.4.4
		SW1 (7-8) Keying modes (System type)	7.4.5
SW2	DIP Switch	SW2 (1) Polarity of TRIP frequency to be transmitted	7.4.6
		SW2 (2) TRIPIN_1 input contacts	7.4.7
		SW2 (3) TRIPIN_2 input contacts	7.4.7
		SW2 (4-8) Not Used	NA
SW11	Push button Switch	Trip reset pushbutton (used with Trip latch option)	NA
TP1	Test point (Oscillator Y1)	Clock frequency of 3.584 MHz.	NA
TP3	Test point (Digital Ground)	Signal ground	NA
TP6	Test point (Trip Input 1)	Monitor solid-state relay keying input #1.	NA
TP7	Test point (Trip Input 2)	Monitor solid-state relay keying input #2.	NA
TP14	Test point (Transmitter Fail)	Transmitter fail signal received from Power Amp that drives TX Fail alarm relay.	NA
TP15	Test point (Trip Sent Relay)	Trip command keyed.	NA
TP21	Test point (SS IN 1)	Optional – not defined.	NA
TP22	Test point (SS IN 2)	Optional – not defined.	NA

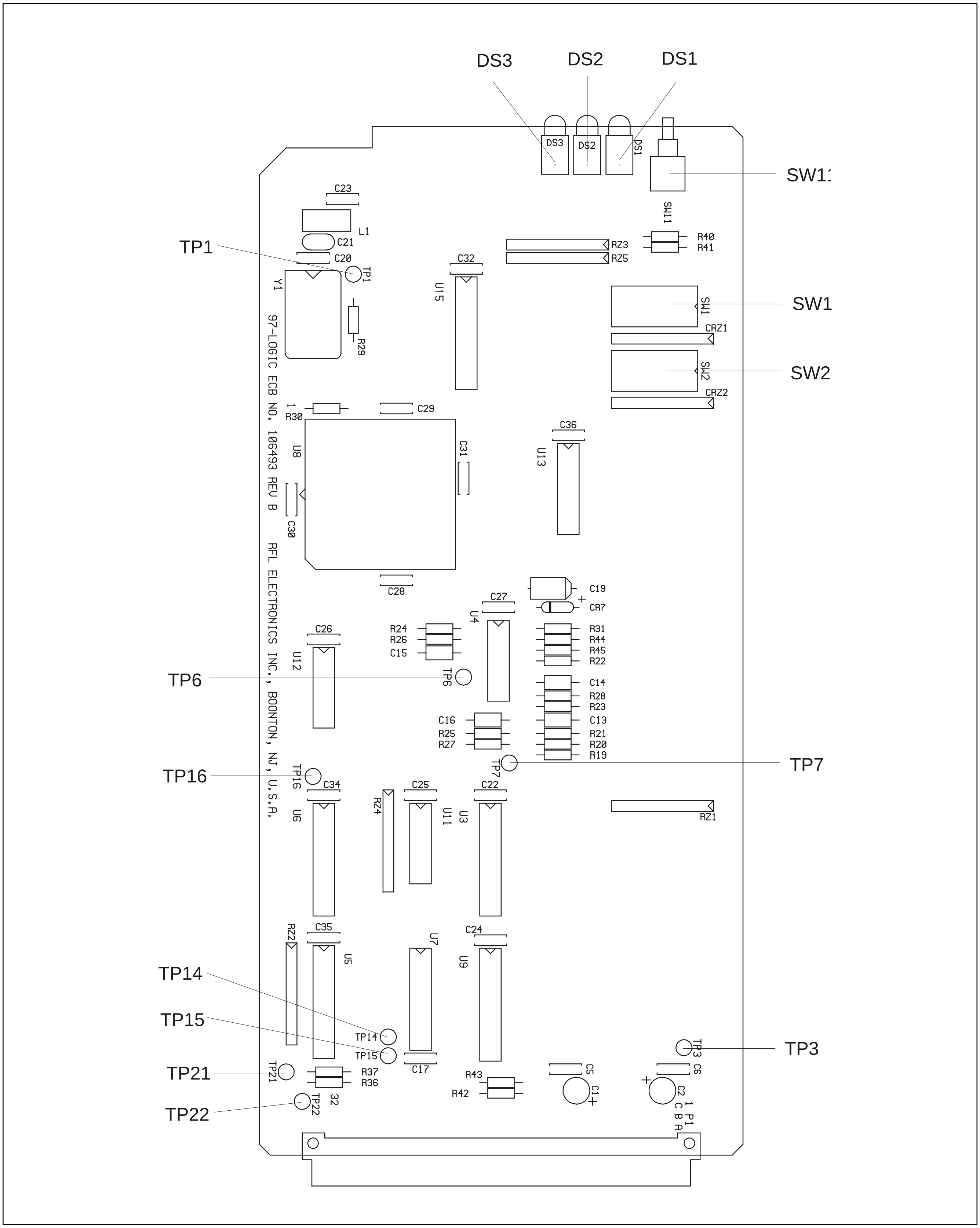


Figure 7-2. Controls and indicators, RFL 9780 Tx Logic Module

7.4.1 CONFIGURATION OF TRIP LATCH OPTION

The position of switch SW1-1 determines whether the Trip Latch option is enabled. Placing SW1-1 in the ON position enables the Trip Latch option. The Trip Latch option latches the LEDs for Trips that are transmitted. The Trip Sent relay, which picks-up when a Trip is transmitted is latched as well. Pushbutton switch SW11 is used to un-latch the LEDs and the Trip Sent relay once the Trip condition has been acknowledged.

7.4.2 CONFIGURATION OF POWER-BOOST LEVELS

The position of switches SW1-2 through SW1-4 determines the boost modes for 2F and 3F systems for each of the following conditions: Guard, TRIPIN_1 keyed, and TRIPIN_2 keyed. See Table 7-3 for configuration of Power-boost levels. Refer to the Keying Modes in Table 7-4 to determine the state of the system when TRIPIN_1 and/or TRIPIN_2 are keyed for the mode in which the system is being configured.

Table 7-3. Configuration Of Power Boost Levels

SW1 -2	SW1-3	SW1-4	MODE		POWER BOOST LEVELS		
			2F	3F	GUARD	TRIPIN_1	TRIPIN_2
OFF	OFF	OFF	X		1W	1W	1W*
OFF	OFF	ON	X		1W	10W	1W*
OFF	ON	OFF	X		10W	10W	10W*
OFF	ON	ON		X	1W	1W	1W
ON	OFF	OFF		X	1W	10W	1W
ON	OFF	ON		X	1W	1W	10W
ON	ON	OFF		X	1W	10W	10W
ON	ON	ON		X	10W	10W	10W

*Power Boost levels indicated with an asterisk for TRIPIN_2 for 2F Mode apply to 2F Start/Stop systems only. TRIPIN_2 (STOP) overrides TRIPIN_1 (START) reducing the power level to the same as guard power level as indicated in Table 7-3.

7.4.3 CONFIGURATION OF TRIP OVERRIDE OPTION

This feature is used with the voice option, which is not being offered at this time. Switch SW1-5 should be in the OFF position.

7.4.4 CONFIGURATION OF VOICE ENABLE OPTION

This feature is used with the voice option, which is not being offered at this time. Switch SW1-5 should be in the OFF position.

7.4.5 CONFIGURATION OF KEYING MODES

The position of switches SW1-7 and SW1-8 determines the Keying Mode of the system. Refer to Table 7-4 for system configuration.

2F Single-Trip Keying: A TRIP is generated when TRIPIN_1 is keyed. TRIPIN_2 is not used.

2F Dual-Trip Keying: A TRIP is generated when TRIPIN_1 and TRIPIN_2 are simultaneously keyed (TRIPA and TRIPB).

2F Start/Stop Keying: A START is generated when TRIPIN_1 is keyed. A STOP is generated when TRIPIN_2 is keyed. A STOP overrides a START.

3F Dual-Function: A BLOCK is generated when TRIPIN_1 is keyed. A TRIP is generated when TRIPIN_2 is keyed. A TRIP has priority over a BLOCK.

Table 7-4. Configuration Of Keying Modes

SW1-7	SW1-8	KEYING MODE	TRIPIN_1	TRIPIN_2
OFF	OFF	2F Single-Trip Keying	TRIP	N/A
OFF	ON	2F Dual-Trip Keying	TRIP A	TRIP B
ON	OFF	2F Start/Stop Keying	START	STOP
ON	ON	3F Dual-Function	BLOCK	TRIP

7.4.6 CONFIGURATION OF TRIP POLARITY

The position of switch SW2-1 determines trip polarity as shown in Table 7-5.

Table 7-5. Trip Polarity

SW2-1	ON	Guard = shift down; Trip = shift up
	OFF	Guard = shift up; Trip = shift down

7.4.7 CONFIGURATION OF TRIPIN_1 AND TRIPIN_2 SOLID-STATE CONTACTS

The position of switches SW2-2 and SW2-3 determine the solid-state input configuration of Tripin 1 and Tripin 2 as shown in Table 7-6.

Table 7-6. Trip Polarity

SW2-2	ON	Tripin 1 is normally energized
	OFF	Tripin 1 is normally de-energized
SW2-3	ON	Tripin 2 is normally energized
	OFF	Tripin 2 is normally de-energized

7.5 THEORY OF OPERATION

All digital inputs to the Logic Module are buffered before being processed by the A42MX0984I "Actel" FPGA. The "Actel", U8, is the heart of the Tx Logic Module. The Actel performs all of the transmit digital logic control functions. External interface to the Actel consists of two banks of switches, one push-button switch, three LEDs, input and output buffering, and a 2.584 MHz (color-burst) crystal clock source.

All Tx Logic Module configuration settings are programmed via the two switch banks, SW1 and SW2. Each switch bank is strobed in consecutive order by its respective strobe signal from the Actel. The switch data is latched within the Actel and configures the Tx Logic Module based upon the switch settings.

The Logic Module design can be broken down into two sections: Receiver Logic and Transmitter Logic. The block diagram shown in Figure 7-3 and the 9780 Logic Module schematic diagram shown in Figure 7-5 should be referenced to follow the circuit flow throughout the discussion.

7.5.1 TRANSMITTER LOGIC

The 9780 Logic Module accepts trip inputs and voice enable signals and uses them to generate control signals for the transmitter module. It also contains a circuit that monitors the output of the power amplifier module, and generates a transmitter fail (TX_FAIL) output.

7.5.1.1 TRIP INPUT CIRCUITS

The trip-input circuits accept trip inputs from solid-state input relays at the rear of the 9780 chassis and passes them to the logic circuits.

SW2-2 selects polarity for TRIPIN_1, and SW2-3 selects polarity for TRIPIN_2. For normally de-energized contacts, in order for the 9780 to produce a valid trip command, a zero-volt signal must appear at one or both trip inputs (edge connector pins B21 and C22) depending upon the keying mode. For normally energized contacts, in order for the 9780 to produce a valid trip command, a TTL level signal must appear at one or both trip inputs (edge connector pins B21 and C22) depending upon the keying mode.

The first trip input accepts a signal applied to the TRIPIN_1 input (edge connector pin B21). An RC network filters out any contact bounce. The output of this filter is applied to a Schmitt trigger. Its output is passed on to the logic circuits.

The second trip input accepts a signal applied to the TRIPIN_2 input (edge connector pin C22). An RC network filters out any contact bounce. The output of this filter is applied to a Schmitt trigger. Its output is passed on to the logic circuits.

TRIPIN_1 is used for tripping in 2F systems, and TRIPIN_2 is used for tripping in 3F systems. A trip will always override any other condition in any system, with the exception of a 2F-START/STOP system. TRIPIN_2 is used to override a START applied to TRIPIN_1 in a 2F-START/STOP system.

A logic-low TRIPSENT_RLY signal will energize the trip sent relay when a trip condition is keyed in 2F and 3F systems.

TRIP IN 1 LED indicator DS6 and TRIP IN 2 LED indicator DS7 light when corresponding trip inputs are keyed. Optionally, the 9780 Logic Module can be configured to keep the trip sent relay energized after a trip has been keyed. The relay can be de-energized with the TRIP RESET button on the front of the module.

Optionally, the 9780 Logic Module can be configured to latch the DS6 and/or DS7 indicators for a trip condition depending upon the system. The LEDS are reset with the TRIP RESET button on the front of the module.

The status of the TRIP IN_1 and TRIP IN_2 inputs are recorded by the sequence of events module.

7.5.1.2 TRANSMITTER FREQUENCY LOGIC CIRCUIT

The outputs produced by the trip-input circuits are fed to the transmitter frequency logic circuit. The configuration of the 9780 Logic Module determines whether one or both trips must be present before a valid trip is accepted by this logic circuit. The transmitter frequency logic circuit generates the OSC1_2 and OSC3 outputs that are located at edge connector pins A13 and B13 respectively. The transmitter module uses these signals to control the output frequency for 2-frequency (2F) and 3 frequency (3F) systems. The trip frequency can be configured to trip "up" or trip "down" in accordance with the setting of SW2-1. The Table 7-5 defines all valid states of these signals for 2F and 3F systems:

Table 7-7. Valid states of 2F and 3F signals for Trip "Down" and Trip "Up'

OSC_3	OSC_12	TX FREQ	TRIP "DOWN"		TRIP "UP"	
			2F	3F	2F	3F
0	0	F1	DTT / START	DTT	GUARD / STOP	UNBLOCK
0	1	F2	N/A (CF)	GUARD / BLOCK	N/A (CF)	GUARD / BLOCK
1	0	F3	GUARD / STOP	UNBLOCK	DTT / START	DTT

Under normal power conditions, a logic-low CARRIER_ENABLE signal is applied to the Transmitter Module, allowing it to respond to the frequency control signals. However, during under-voltage conditions, a logic-high CARRIER_ENABLE is applied to the Transmitter Module, preventing it from responding to the frequency control signals.

7.5.1.3 TRANSMITTER POWER LEVEL LOGIC CIRCUIT

The outputs produced by the trip-input circuits and optional voice module are fed to the transmitter power level logic circuit. The configuration of the 9780 Tx Logic Module determines how the logic circuit will react to the inputs. The transmitter power logic circuit generates the A SWITCH and B SWITCH outputs which are located at edge connector pins A14 and B14 respectively. The transmitter module uses these to control the output power level. The following table defines all valid states of these signals:

Table 7-8. Transmitter power levels

A_SWITCH	B_SWITCH	POWER LEVEL
0	0	10W
0	1	10W
1	0	3W (Voice)
1	1	1W

7.5.1.4 TRANSMITTER VOICE CONTROL LOGIC CIRCUIT

This feature is used with the voice option, which is not being offered at this time.

7.5.1.5 TRANSMITTER FAIL ALARM CIRCUIT

The HI signal applied to edge connector pin A16 is received from the power amplifier module. In the non-alarm state, an open-collector transistor is turned on which drives the TX_FAIL signal low, energizing the transmitter fail alarm relay. If the HI signal input is logic-high for a period greater than 125μs, the open-collector transistor is turned off. This drives the TX_FAIL signal high, de-energizing the transmitter alarm relay. The TX_FAIL signal is held in the de-energized state for an additional 150ms once the HI signal returns to the normal logic-low state. DS8 lights in the transmitter fail alarm state. The status of the transmitter circuit is recorded by the sequence of events module.

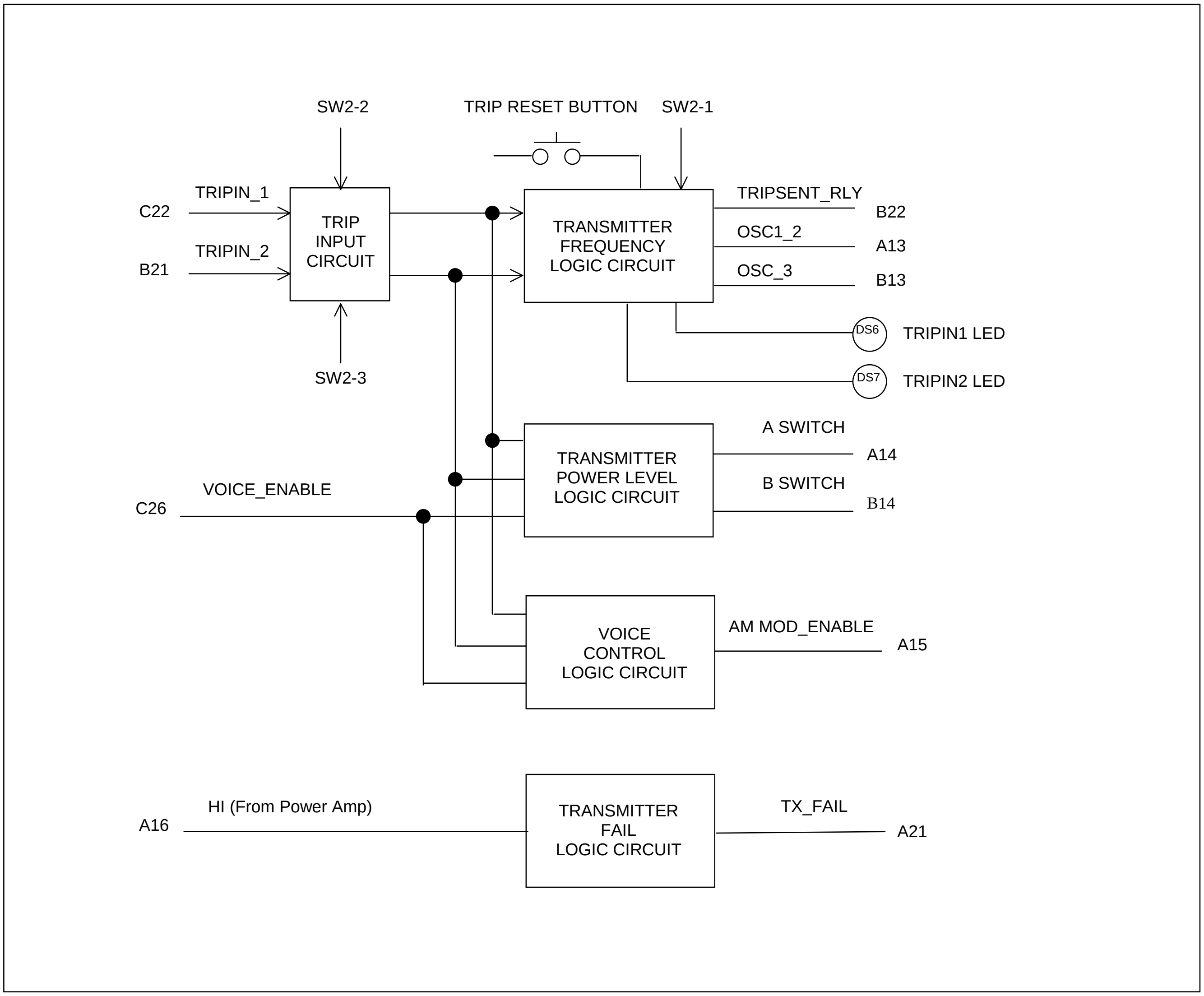


Figure 7-3. Transmitter Logic block diagram

Table 7-9. Replaceable parts, RFL 9780 Tx Logic Module Assemble No. 106490-1

Circuit Symbol (Figs. 7-4 & 7-5)	Description	Part Number
	CAPACITORS	
C1, 2	Capacitor, electrolytic, 47µF, 20%, 35V	1007 1578
C5, 6, 17, 20, 22-24, 26-32, 34-36	Capacitor, ceramic dip, 0.1µF, 10%, 50V	0120 38
C15, 16	Capacitor, ceramic, 0.0056µF, 5%, 100V	0125 15625
C19	Capacitor, tantalum, 4.7µF, 10%, 35V	1007 1623
C21	Capacitor, ceramic dip, 0.01µF, 5%, 100V	1007 1645
	RESISTORS	
R1	Resistor, metal film, axial, 6.49K, 1%, 1/4W	0410 1366
R2	Resistor, metal film, axial, 2.05K, 1%, 1/4W	0410 1318
R21, 22, 31, 36, 37, 40, 42, 45	Resistor, metal film, axial, 10K, 1%, 1/4W	0410 1384
R4	Resistor, metal film, axial, 127K, 1%, 1/4W	0410 1490
R29, 44	Resistor, metal film, axial, 1K, 1%, 1/4W	0410 1288
R24, 25	Resistor, metal film, axial, 33.2K, 1%, 1/4W	0410 1434
R26, 27	Resistor, metal film, axial, 3.92K, 1%, 1/4W	0410 1345
R30	Resistor, metal film, axial, 49.9K, 1%, 1/4W	0410 1451
R43	Resistor, metal film, axial, 4.75K, 1%, 1/4W	0410 1353
RZ1	Resistor network, 4.7K, 8R/PKG, SIP	101676
RZ2	Resistor network, 10K, 8R/PKG, SIP	95571
RZ3	Resistor network, 330Ω, 8R/PKG, SIP	44532
RZ4	Resistor network, 22K, 8R/PKG, SIP	32876
	SEMICONDUCTORS	
CR7	Diode, silicon, 1N914B/1N4448	26482
CRZ1, 2	Diode array, 8-diode, common cathode	103444
U3, 5, 6, 9	Integrated circuit, MOS	0615 297
U4	Integrated circuit, MOS HEX inverter, Schmitt trigger	0615 242
U7	Transistor array, ULN2803A	0720 7
U12	Integrated circuit, MOS, quad, buffer, line driver	0615 292
U13	Integrated circuit, MOS, three to eight line decoder	0615 168
U15	Integrated circuit, MOS, octal, 3-state, DFF	0615 298
	MISCELLANEOUS COMPONENTS	
DS1-3	Opto device, LED, red	98534
L1	Inductor, coated, 100µH, 10%	103472
P1	Connector, plug, male, 96 connections, DIN	101681
SW1, 2	Switch, DIP, SPST, 8-position, 16-pin	98493
SW11	Switch, SPDT, right angle, pc board mounting	98488
TP1, 3, 6, 7, 14, 15, 16, 21, 22	Test point, terminal, orange	98441 3
Y1	Crystal, hybrid, clock oscillator, 3.584Mhz	103347

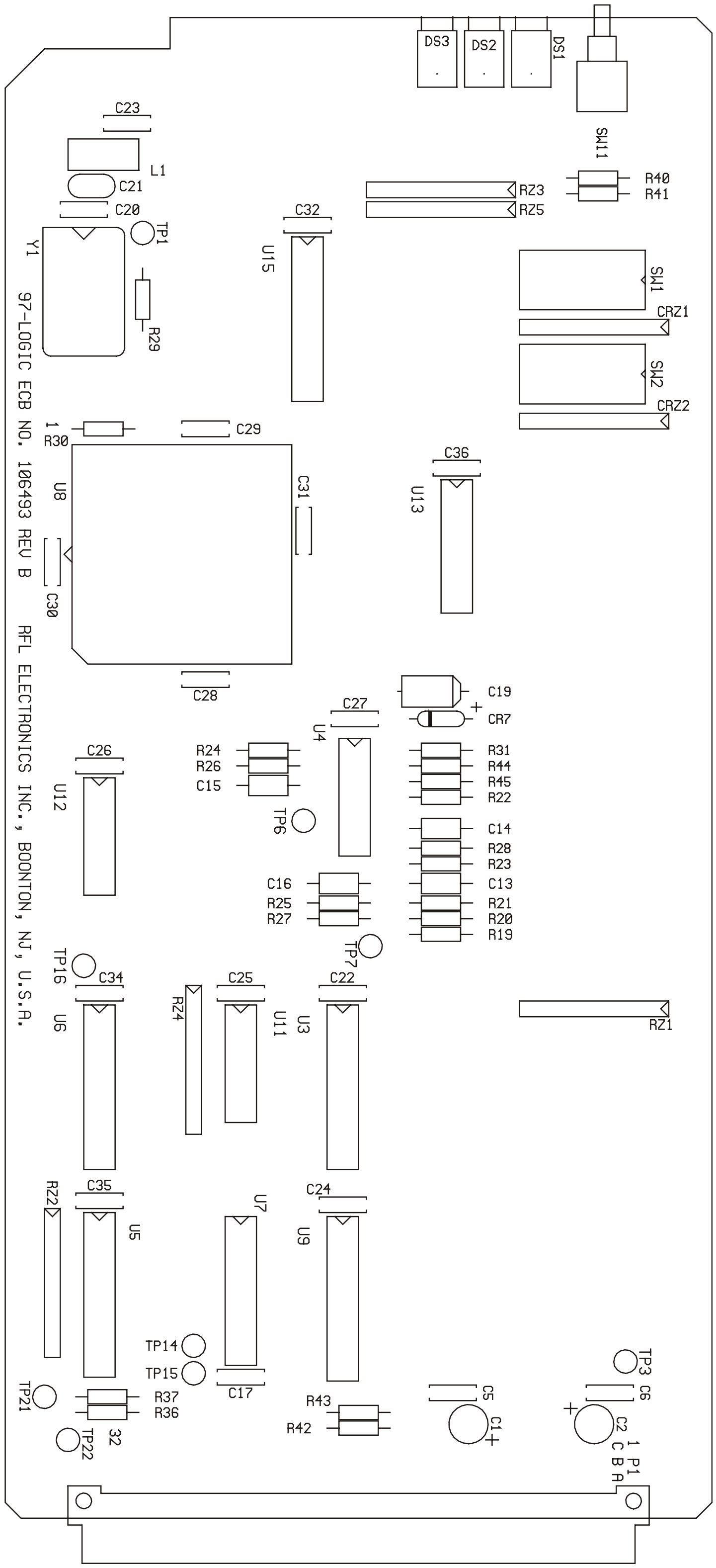


Figure 7-4. Component locator drawing, RFL 9780 Tx Logic Module (Assembly No. 106490-1)

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Figure 7-5. Schematic, RFL 9780 Tx Logic Module (Dwg. No. D-106494-1-B) Sheet 1 of 2

Please see Figure 7-5 in Section 22.

Figure 7-5 Schematic, RFL 9780 Tx Logic Module (Dwg. No. D-106494-1-B) Sheet 2 of 2

Please see Figure 7-5 in Section 22.

SECTION 8. TRANSMITTER MODULE

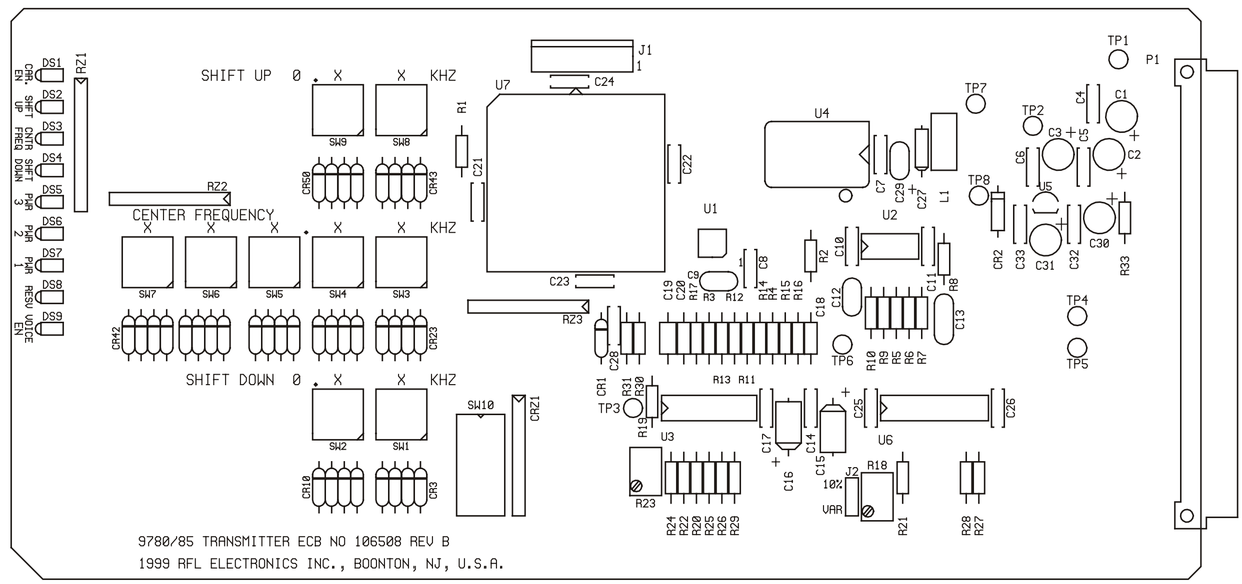

Figure 8-1. RFL 9780 Transmitter Module

8.1 DESCRIPTION

The RFL 9780 Transmitter Module (Figure 8-1) is a programmable powerline carrier transmitter, utilizing Direct Digital Synthesis (DDS). The basic principle of DDS is to generate a stepped sine wave from a high speed digital-to-analog (D/A) converter by reading a sine look-up table stored in ROM. The output of the DDS is fed into an anti-aliasing filter and the signal level is adjusted to achieve the desired overall transmission power (10W, 3W or 1W output of the power amplifier).

The desired output frequency is selected by programming a set of direct reading rotary switches.
The module has presets for the center frequency, a shift up, and a shift down. External signals also select the output level of the module corresponding to 10W, 3W or 1W. An additional “Reserve” input can be used to further reduce transmit power by 10% to 35% of normal. The output of the module can be totally disabled via an input signal.

Nine LEDs display the module status at all times. They indicate which of the three frequencies are selected and which output power level is in use. LEDs also indicate if the transmitter carrier, or reserve is enabled.

8.2 SPECIFICATIONS

As of the date this manual was published, the following specifications apply to all RFL 9780 Transmitter modules. Because all RFL products undergo constant refinement and improvement, these specifications are subject to change without notice.

Output Frequency: 30 kHz to 535 kHz, adjustable in 10-Hz increments.

Frequency Stability: ±10 Hz

Harmonic Content: Less than -55 dB.

Output Range (when used with RFL 9780 Power Amplifier Module):

10-Watt Output: 6.0 Vp-p
3-Watt Output: 3.4 Vp-p
1-Watt Output: 2.0 Vp-p

8.3 THEORY OF OPERATION

The RFL 9780 Transmitter module is a programmable powerline carrier transmitter utilizing a Direct Digital Synthesizer (DDS). The DDS is used to generate a precise sine wave signal by reading a sine look-up table stored in ROM. A block diagram of the transmitter module is shown in Figure 8-2, a block diagram of the DDS is shown in Figure 8-3, and a schematic diagram of the transmitter module is shown in figure 8-5.

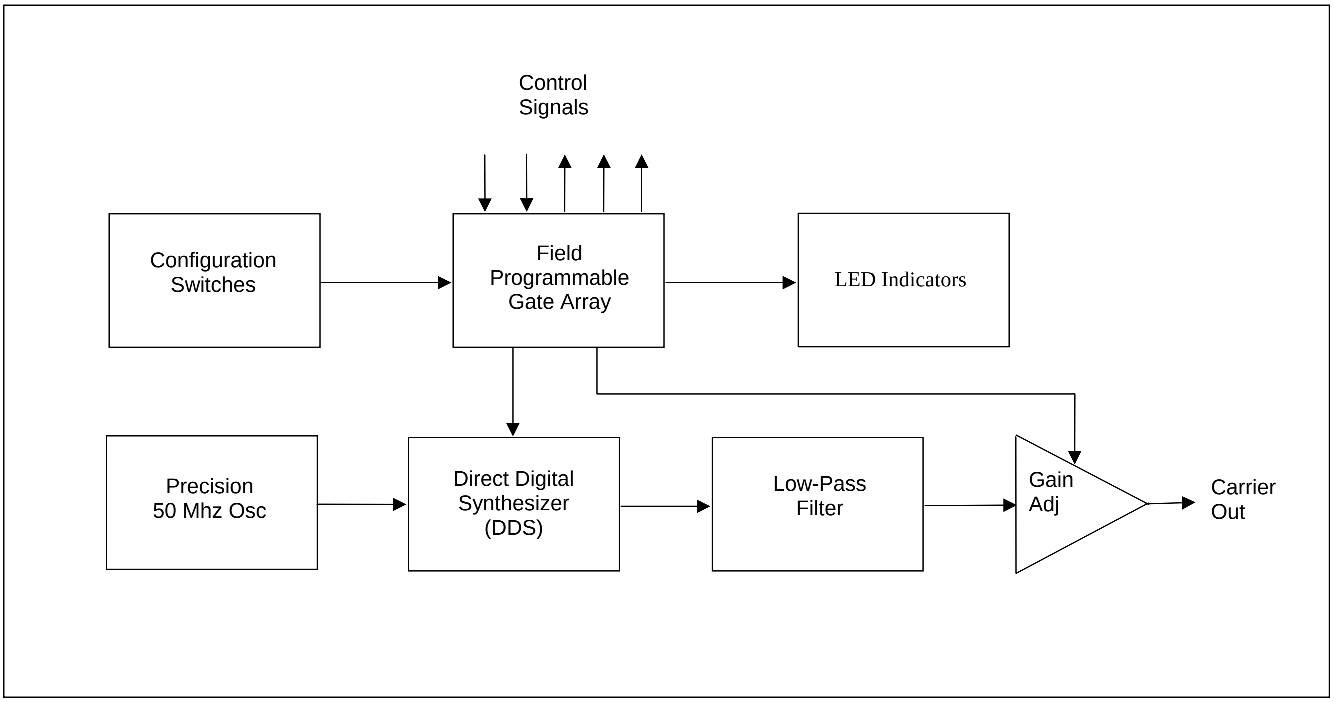

Figure 8-2. Transmitter module block diagram

The output of the look-up table is connected to a D/A converter which generates the sine wave. As the input to the look-up table is incremented, the output of the table via the D/A generates the sine wave. Thus, the input to the look-up table is related to the phase of the output sine wave. The phase information is stored in the phase register.

8.3.1 DIRECT DIGITAL SYNTHESIZER FUNDAMENTALS

A simplified block diagram for a basic DSS is shown in Figure 8-3. The circuit has two inputs, a master clock and a phase step. The master clock should be considerably higher in frequency than the highest frequency to be generated by the DDS. Once each clock cycle, the phase register is incremented by the specified phase step amount. The phase register is configured to roll over at 360^o.

The output of the phase register is sent to a lookup table which generates the value of the sine function for the given phase. The output of the lookup table is in turn sent to a D/A converter which produces the desired output voltage. In this manner, as the phase is gradually increased from 0^o to 360^o, the D/A produces a single sine wave cycle. By allowing the phase register to roll over, the output remains smooth and over time, all discrete phase angles will be sampled.

8.3.2 9780 DIRECT DIGITAL SYNTHESIZER

In the RFL 9780, the master clock frequency is a precision 50 MHz signal providing nearly 100 points per cycle at the maximum output frequency. The phase accumulator is a 32 bit register which provides over 4 billion possible phase values. This results in a very clean output from the DDS circuit.

All of the DDS functions are performed in a single integrated circuit, U1, which has a differential current mode output. Resistors R3 and R4 are used for current to voltage conversion. U3C is configured as a differential amplifier to convert the output of U1 to a single ended signal.

8.3.3 ANTI-ALIASING FILTER

The output of the DDS, after being converted to a single ended signal, is fed into an anti-aliasing filter formed by U3D. The filter has a cutoff frequency of approximately 600 Khz.

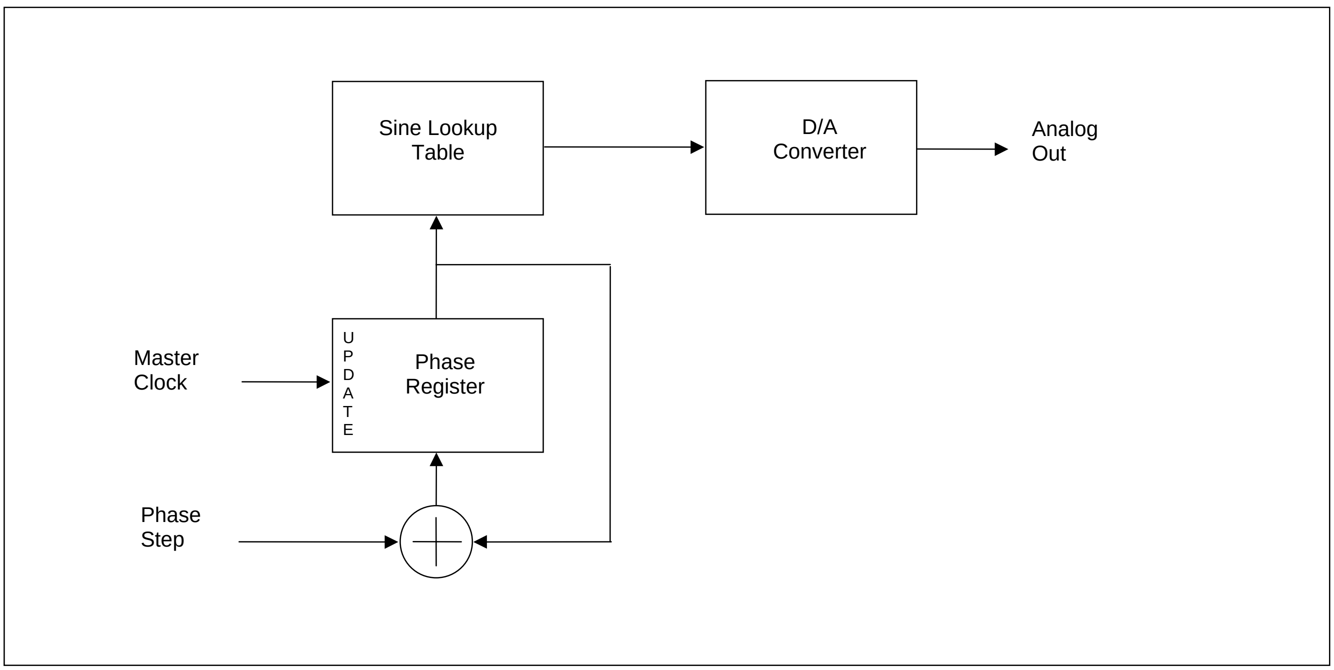

Figure 8-3. Block diagram of a basic DDS

8.3.4 OUTPUT POWER ADJUSTMENT

The output of the filter is sent into an adjustable gain stage formed by U3A. This varies the output level, which determines the system transmission power (10W, 3W or 1W output of the power amplifier stage). Potentiometer R23 adjusts the nominal output voltage of the transmitter. It is set to achieve 10W output with switches U6A, U6B and U6C open. In systems which require a "reserve" 1\10th power output, U6A may be closed to attenuate the output signal to achieve the reduced power. This power reduction can be varied by R18 if jumper J2 is in the "VAR" position. If analog switch U6C is closed, the output power will drop to 3W. If both U6B and U6C are closed, the output power will drop to 1W.

All module functions are controlled by Field Programmable Gate Array (FPGA) U7. The FPGA reads the on board configuration switches and control signals coming from other modules, and controls the local hardware and indicators. It also computes the phase step required to generate the desired output frequency.

8.4 CONTROLS AND INDICATORS

Figure 8-4 shows the locations of all controls and indicators on the transmitter module. These controls and indicators are described in Table 8-1. LEDs DS1 through DS9 are visible with the module installed in the chassis. All other controls are only accessible when the module is removed from the chassis or is on a card extender.

Table 8-1. Controls and Indicators, RFL 9780 Transmitter Module

Component Designator	Name/ Description	Function
DS1	Carrier Enabled LED	Indicates the carrier is being generated
DS2	Frequency 3 LED	The carrier is set for a shift up frequency
DS3	Frequency 2 LED	The carrier is set for a center frequency
DS4	Frequency 1 LED	The carrier is set for a shift down frequency
DS5	Power 3 LED	The system's output power is 10W
DS6	Power 2 LED	The system's output power is 3W
DS7	Power 1 LED	The system's output power is 1W
DS8	Reserve LED	The system is transmitting at reserve power (1/10 of normal power)
DS9	Voice Enabled LED	The voice signal is being AM modulated onto the carrier
J1	Test Connector	For factory use only
J2	Reserve level jumper	Variable or fixed
R18	Potentiometer	Used to vary the reserve level
R23	Potentiometer	Sets the module's nominal output level
SW1-SW2	Switch bank for shift down freq.	Sets the desired shift down frequency
SW3-SW7	Switch bank for center frequency	Sets the desired center frequency
SW8-SW9	Switch bank for shift up freq.	Sets the desired shift up frequency
TP1	Test point	Digital ground
TP2	Test point	Signal ground
TP3	Test point	Oscillator out (Output of DDS following filter)
TP4	Test point	Carrier out (Final output of module)
TP5	Test point	Voice in (Audio input signal in systems having the voice option)
TP6	Test point	Reference
TP7	Test point	+5Vdc (Digital)
TP8	Test point	+5Vdc (Analog)

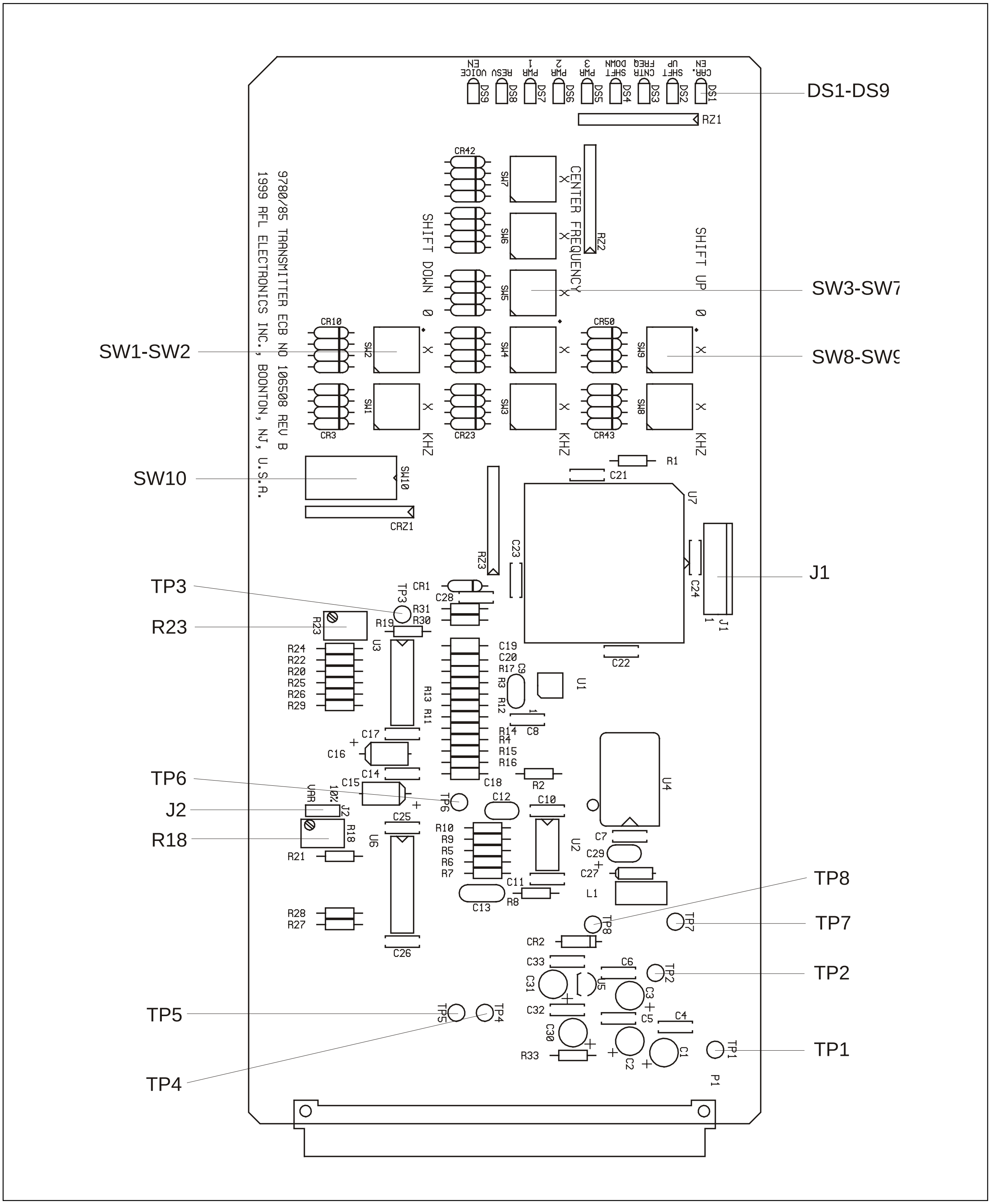

Figure 8-4. Controls and indicators, RFL 9780 Transmitter Module

8.4.1 FREQUENCY SELECT SWITCHES

Up to three carrier frequencies can be preset, depending on the system configuration. The center frequency is set using a set of five rotary DIP switches arranged as “XXX.XX Khz” (SW3-SW7). The shift up frequency is set using two rotary DIP switches arranged as “0.XX Khz” (SW8 and SW9). The shift down frequency is set using two rotary DIP switches arranged as “0.XX Khz” (SW1 and SW2). This allows the frequency to be set to within 10 Hz. Only settings between 30 Hz and 535 Khz are valid.

8.4.2 TRANSMIT AMPLITUDE POTENTIOMETER

Potentiometer R23 is used to set the transmit amplitude of the module to achieve the proper output power, while compensating for variations in installation and setup. The system is normally set to a 10W output, but this setting is automatically scaled down to 3W or 1W as required.

8.4.3 RESERVE LEVEL JUMPER

In systems which use the reserve feature, the reserve level can be fixed at 10% or can be variable between approximately 10% and 35% of the power level. When jumper J2 is in the “VAR” position, R18 is used to adjust the reserve level.

Table 8-2. Replaceable parts, RFL 9780 Transmitter Module
Assembly No. 106505

Circuit Symbol (Figs. 8-3 & 8-4)	**Description**	**Part Number**
	CAPACITORS	
C1, 2, 3	Capacitor, electrolytic, 47µF, 20%, 35V	1007 1578
C4-8, 10, 11, 14, 17, 21-26, 28	Capacitor, ceramic dip, 0.1µF, 10%, 50V	0120 38
C9, 12	Capacitor, ceramic dip, 0.01µF, 5%, 100V	1007 1645
C15, 16	Capacitor, tantalum, 3.3µF, 20%, 35V	1007 1260
C18	Capacitor, ceramic, 470pF, 5%, 100V	0125 14715
C19	Capacitor, ceramic, 0.0015µF, 5%, 100V	0125 11525
C20	Capacitor, ceramic, 33pF, 5%, 200V	0125 23305
C27	Capacitor, tantalum, 1µF, 10%, 35V	1007 1156
	RESISTORS	
R1, 9, 10	Resistor, metal film, axial, 49.9K, 1%, 1/4W	0410 1451
R2, 11-14, 20	Resistor, metal film, axial, 1K, 1%, 1/4W	0410 1288
R3, 4	Resistor, metal film, axial, 51.1Ω, 1%, 1/4W	0410 1164
R5	Resistor, metal film, axial, 32.4K, 1%, 1/4W	0410 1433
R6	Resistor, metal film, axial, 107K, 1%, 1/4W	0410 1483
R7	Resistor, metal film, axial, 3.74K, 1%, 1/4W	0410 1343
R8	Resistor, metal film, axial, 2K, 1%, 1/4W	0410 1317
R15, 16, 17	Resistor, metal film, axial, 787Ω, 1%, 1/4W	0410 1278
R18, 23	Resistor, metal film, variable, 10K, 10%, 1/2W	48548
R19, 25, 26	Resistor, metal film, axial, 10K, 1%, 1/4W	0410 1384
R21	Resistor, metal film, axial, 4.64K, 1%, 1/4W	0410 1352
R22	Resistor, metal film, axial, 22.6K, 1%, 1/4W	0410 1418
R24	Resistor, metal film, axial, 45.3K, 1%, 1/4W	0410 1447
R27	Resistor, metal film, axial, 12.1K, 1%, 1/4W	0410 1392
R28	Resistor, metal film, axial, 7.5K, 1%, 1/4W	0410 1372
R29	Resistor, metal film, axial, 4.99K, 1%, 1/4W	0410 1355
R30	Resistor, metal film, axial, 68.1K, 1%, 1/4W	0410 1464
R31	Resistor, metal film, axial, 1M, 1%, 1/4W	0410 1576
RZ1	Resistor, network, 1K, 8R/PKG SIP	95570
RZ2	Resistor, network, 10K, 8R/PKG SIP	95571

Table 8-2. Continued. Replaceable parts, RFL 9780 Transmitter Module
Assembly No. 106505

Circuit Symbol (Figs. 8-3 & 8-4)	Description	Part Number
	SEMICONDUCTORS	
CR1	Diode, Schottky barrier, SB160	96365
CRZ1,2 ,3 ,4	Diode array, 8-diode, common cathode	103444
U2	Integrated circuit, linear JFET OP AMP	0620 227
U3	Integrated circuit, linear OP AMP, high speed	0620 372
U5	Integrated circuit, MOS, field programmable gate array	0615 450
U6	Integrated circuit, analog switch, QUAD, SPST, CMOS	0606 17
	MISCELLANEOUS COMPONENTS	
DS1	Opto device, LED, green, 5VDC	101762
DS2-8	Opto device, LED, yellow, 5VDC	101763
J1	Connector, wafer assembly, 8-circuit	97223 8
J2	Connector, header, single, 3-circuit	32802 3
L1	Inductor, coated, 100μH, 10%	103472
P1	Connector, JK male, 64 contact, DIN	98457
SW1-9	Switch, rotary, DIP, 10-position	101465

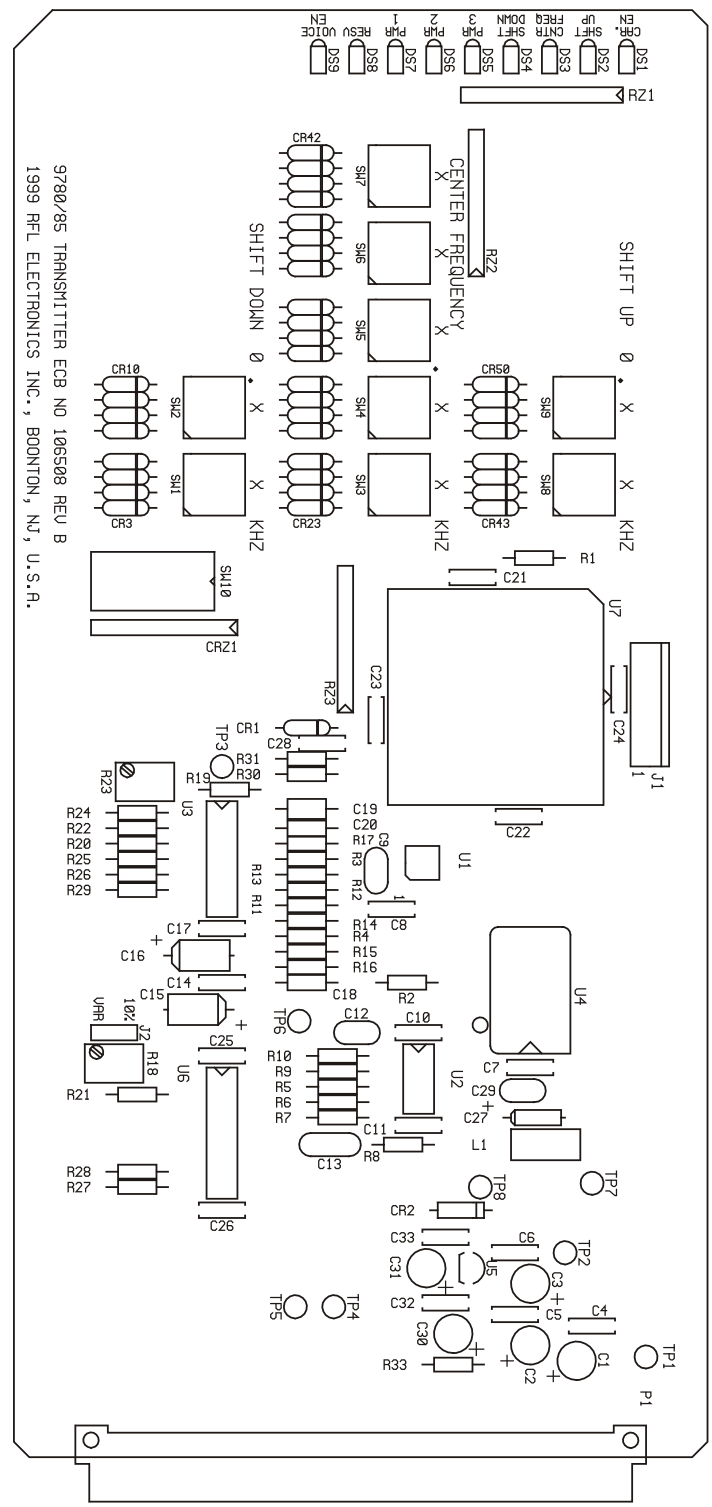

Figure 8-5. Component locator drawing, RFL 9780 Transmitter Module (Assembly No. 106505, Circuit Board No. D-106508, Rev. A)

Figure 8-6. Schematic, RFL 9780 Transmitter Module (Dwg. No. D-106509-C) Sheet 1 of 2

Please see Figure 8-6 in Section 22

Figure 8-6 Schematic, RFL 9780 Transmitter Module (Dwg. No. D-106509-C) Sheet 2 of 2

Please see Figure 8-6 in Section 22

SECTION 9. POWER AMPLIFIER MODULE

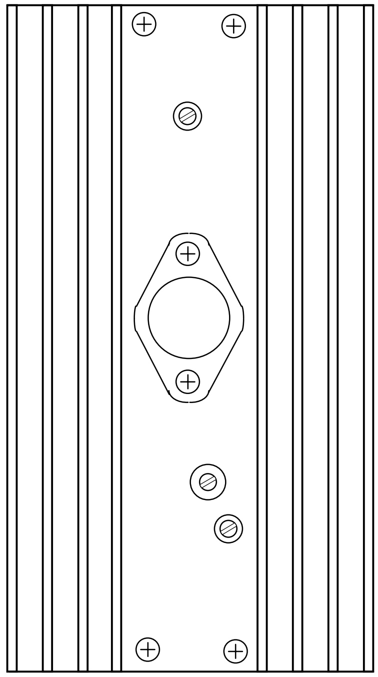

Figure 9-1. RFL 9780 Power Amplifier Module

9.1 DESCRIPTION

The RFL 9780 Power Amplifier module provides both voltage and current gain to the signal coming from the Transmitter module (Section 8). A monitor circuit detects loss of transmit signal and issues a Transmitter Fail Alarm. The output of the amplifier is transformer isolated and presents a 50 ohm nominal impedance. The output impedance is adjustable to compensate for small changes in load impedance.

9.2 SPECIFICATIONS

As of the date this manual was published, the following specifications apply to all RFL 9780 Power Amplifier modules, except where indicated. Because all RFL products undergo constant refinement and improvement, these specifications are subject to change without notice.

Input Impedance: 185 Ω typical

Output Ratings:

Power:	10 Watts rms continuous (50 Ω load)
Voltage:	22.36 Volts rms
Current:	447 ma rms
Impedance:	50 Ω

Frequency Response: 30 to 535 Khz

Total Harmonic Distortion: -42 dB maximum, typical -46 dB.
(@10W rms)

Input Voltage Versus Power Out:
(50 Ω load)

OUTPUT			INPUT	
POWER WATTS (RMS)	VOLTS PEAK	VOLTS RMS	VOLTS PEAK	VOLTS RMS
10	31.62	22.36	3.000000	2.121000
9	30.00	21.21	2.846050	2.012157
8	28.28	20.00	2.683282	1.897080
7	26.46	18.71	2.509980	1.774556
6	24.49	17.32	2.323790	1.642920
5	22.36	15.81	2.121320	1.499773
4	20.00	14.14	1.897367	1.341438
3	17.32	12.25	1.643168	1.161720
2	14.14	10.00	1.341641	0.948540
1	10.00	7.07	0.948683	0.670719

9.3 THEORY OF OPERATION

Refer to the schematic diagram in Figure 9-4 for the following discussion.

The design of the RFL 9780 power amplifier is based on a single hybrid power operational amplifier, U1. The input signal is ac coupled through C1. The voltage gain of the amplifier is determined by the ratio of feedback resistor R4 and input resistors R3 (fixed) and R2 (variable). The output of U1 drives the impedance matching transformer T1. This transformer has a 1:4 turns ratio, provides isolation, and transforms the 3.125 ohm output Z of the amplifier to the 50 ohm line impedance. The 3.125 ohm output Z is controlled by current feedback provided by sense resistor R18 and input resistor R17 (fixed) and R16 (variable). The voltage developed across R18 is proportional to the load current and when combined with voltage feedback the amplifier's virtual output impedance can be determined.

Resistors R5 and R6 provide current limiting to protect the power operational amplifier from over-current conditions. Output over-voltage protection is achieved by high-speed rectifiers CR4 and CR6 and transorbs CR3 and CR5. These devices steer and clamp high voltage transients to safe levels, thus preventing any damage to the power amplifier output stage.

Comparator U2 and its associated components form the Transmitter Fail detect circuit. The input to the circuit comes from the output of U1, which is half-wave rectified by CR7. This signal is then averaged by R8 and C11. Potentiometer R10 is used to set the desired threshold voltage. R15 is included to provide positive feedback for hysteresis.

9.4 CONTROLS AND INDICATORS

Figure 9-2 shows the location of all controls and indicators on the RFL 9780 Power Amplifier module. These controls and indicators are described in Table 9-1. Potentiometers R2, R10 and R16 are accessible with the RFL 9780 Power Amplifier Module installed in the chassis. Test points TP1, TP2 and TP3 are only accessible when the module is removed from the chassis or is on a card extender.

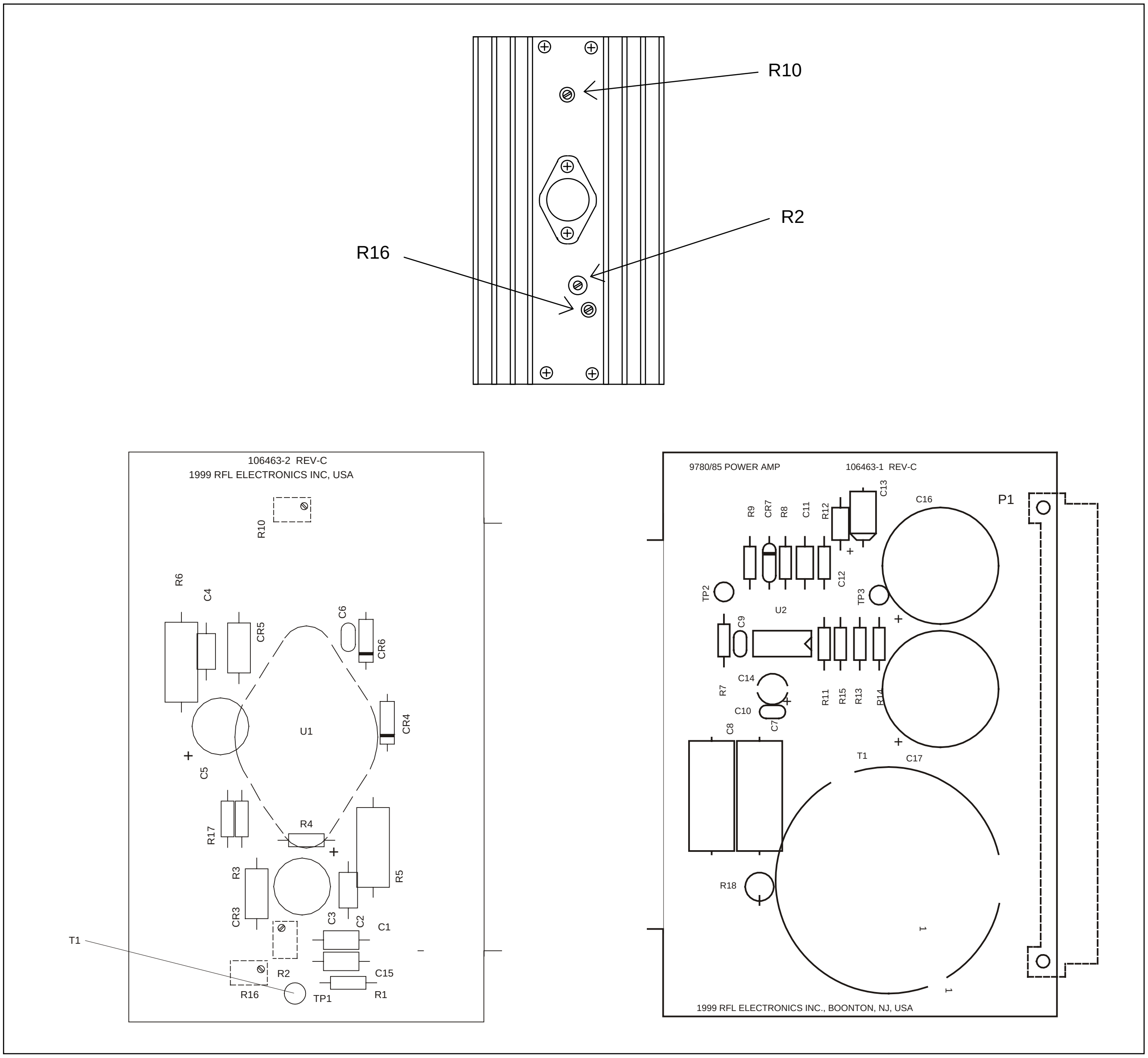

Figure 9-2. Controls and indicators, RFL 9780 Power Amplifier Module

Table 9-1. Controls and indicators, RFL 9780 Power Amplifier Module

Component Designator	Name/Description	Function
R2	Potentiometer	Gain adjustment
R10	Potentiometer	Tx Fail threshold voltage adjustment
R16	Potentiometer	Output impedance adjustment
TP1	Test point	Input signal test point
TP2	Test point	Operational amplifier (U1) output
TP3	Test point	Output signal test point

9.4.1 AMPLIFIER GAIN

The gain potentiometer R2, can be used to vary the output signal level, and thus power. The “Transmit Amplitude” adjustment on the Transmitter Module can also be used to vary the output level.

9.4.2 OUTPUT IMPEDANCE

There are provisions for adjusting the output impedance of the Power Amplifier Module to compensate for circuit variations in actual field installations. This only requires adjustment during initial system installation, or following system changes that impact the impedance the 9780 is driving.

To match the impedance proceed as follows with the system off-line:

1. Set the unit to transmit a 1W or 3W signal . Do not set the unit for a 10W transmit level.

2. Remove the load from the output of the 9780 and measure the output signal voltage.

3. Connect the actual load to the 9780 and adjust potentiometer R16 (impedance adjust) to obtain one-half of the unloaded output signal level.

9.4.3 LOW-LEVEL ALARM THRESHOLD

The low-level alarm threshold can be set as follows:

1. Set the RFL 9780 to generate the lowest normal output level (10W for a 10W/10W system, 1W for a 1W/10W system).

2. Using the gain adjust potentiometer R2, lower the transmit level to the desired threshold level (typically 80% to 90% of nominal).

3. Adjust R10 to trip the Tx Fail output.

4. Readjust R2 to provide the desired output voltage.

Table 9-2. Replacement parts, RFL 9780 Power Amplifier Module
Assembly No. 106460

Circuit Symbol (Figs. 9-3 & 9-4)	Description	Part Number
	CAPACITORS	
C1, 15	Capacitor, ceramic, 1µF, 20%, 50V	0135 51052
C2, 4, 11, 12	Capacitor, ceramic, 0.1µF, 10%, 50V	0130 51041
C3, 5	Capacitor, electrolytic, 220µF, 20%, 35V	1007 1814
C6	Capacitor, ceramic dip, 10pF, 10%, 200V	1007 1462
C7, 8	Capacitor, MPC, 3µF, 5%, 50V	1007 1287
C9	Capacitor, ceramic dip, 0.01µF, 10%, 100V	1007 1390
C10	Capacitor, ceramic, 0.1µF, 20%, 50V	1007 1366
C13	Capacitor, tantalum, 3.3µF, 20%, 35V	1007 1260
C14	Capacitor, tantalum, 3.3µF, 10%, 50V	1007 1466
	RESISTORS	
R1, 4, 7-9, 13, 14	Resistor, metal film, axial, 1K, 1%, 1/4W	0410 1288
R2	Resistor, ceramic, variable, 1K, 10%, 1/4W	32993
R3	Resistor, metal film, axial, 374Ω, 1%, 1/4W	0410 1247
R5, 6, 15	Resistor, wire wound, NI, 0.25Ω, 5%, 3W	1100 743
R10	Resistor, ceramic, variable, 100K, 10%, 1/4W	32999
R11	Resistor, metal film, axial, 47.5K, 1%, 1/4W	0410 1449
R12	Resistor, metal film, axial, 715Ω, 1%, 1/4W	0410 1274
R17	Resistor, metal film, axial, 75Ω, 1%, 1/4W	0410 1180
	SEMICONDUCTORS	
CR3, 5	Suppressor, transient voltage, 1.5KE30CA	100556
CR4, 6	Diode, fast recovery, 1A, 400V	103484
CR7	Diode, silicon, 1N914B/1N4448	26482
U2	Integrated circuit, linear voltage comparator, buffer	0620 188
	MISCELLANEOUS COMPONENTS	
P1	Connector, plug, female, 64 contact, DIN	99134
T1	Transformer assembly, output	102726

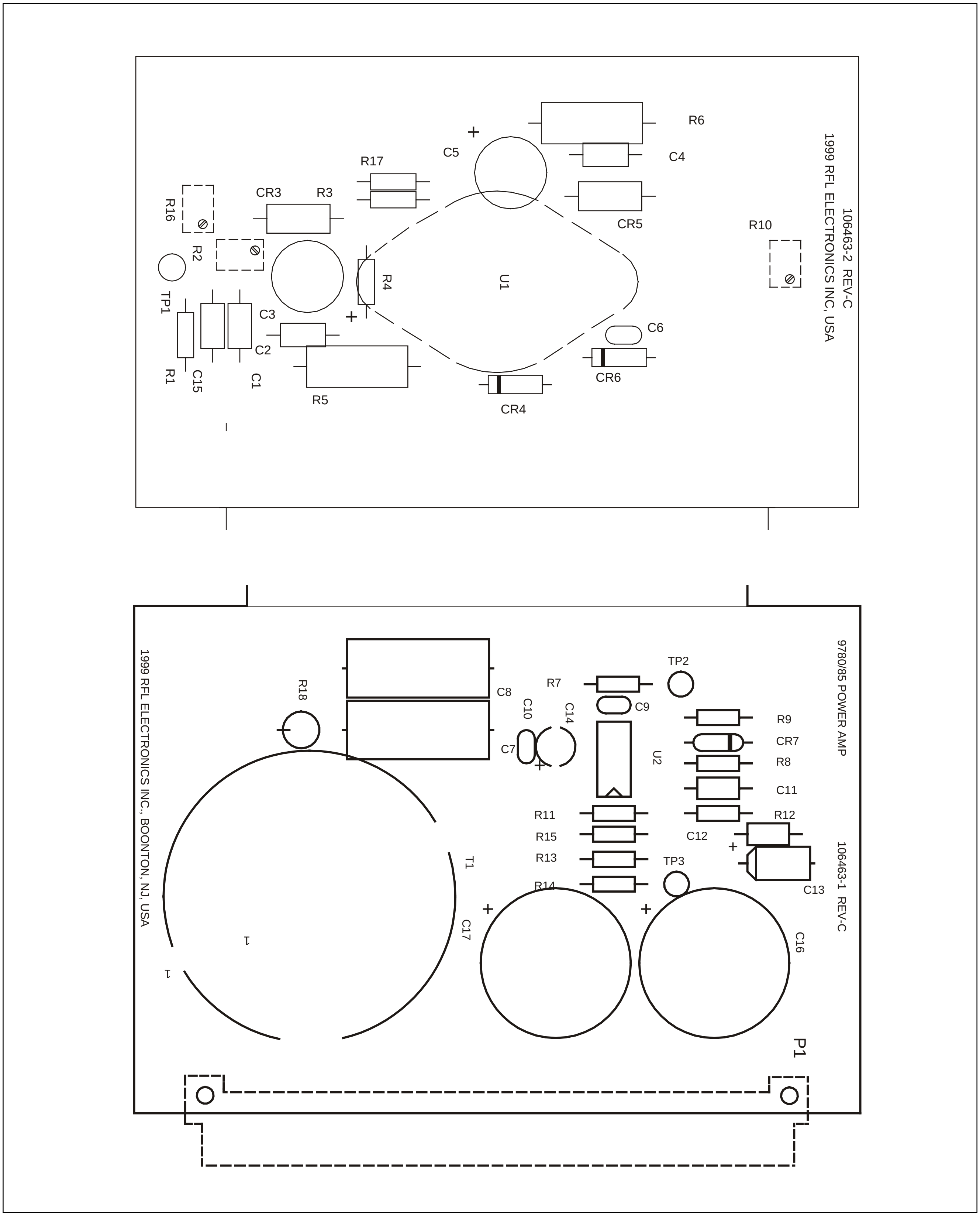

Figure 9-3. Component locator drawing RFL 9780 Power Amplifier Module

Figure 9-4. Schematic, RFL 9780 Power Amplifier (Dwg. No. C-106464-B)

Please see Figure 9-4 in Section 22

SECTION 10. OUTPUT FILTER MODULES

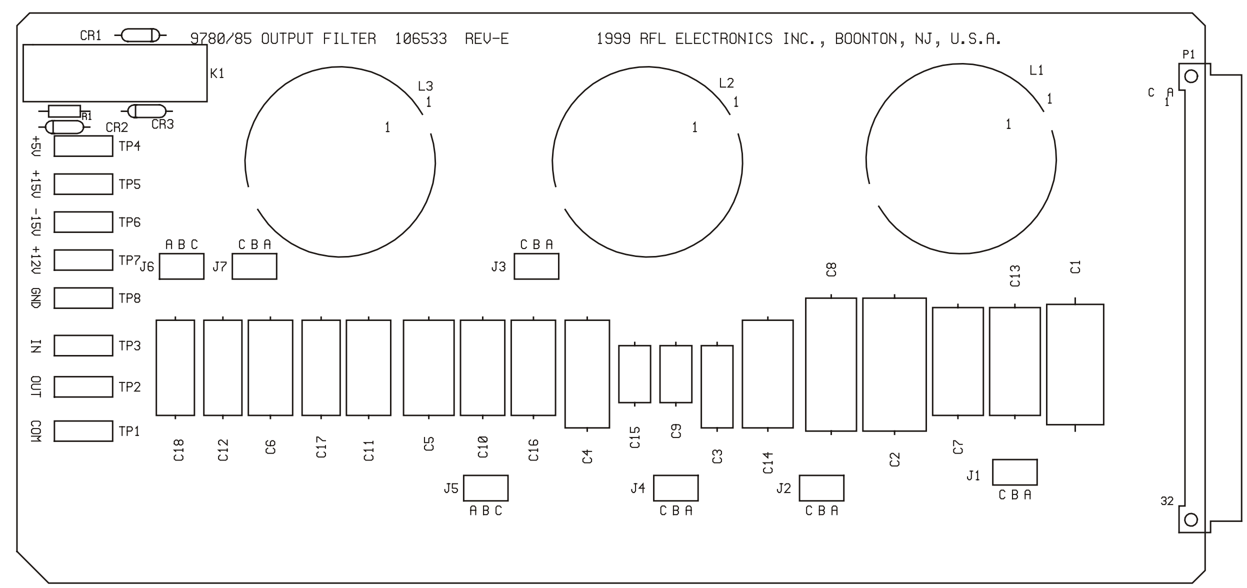

Figure 10-1. Typical RFL 9780 Output Filter Module (without reflected power meter option)

10.1 DESCRIPTION

RFL 9780 Output Filter Modules are used to reduce the harmonic content of the RFL 9780's output signal to a level that is at least 55 dB below the carrier level. A typical RFL 9780 Output Filter Module appears in Figure 10-1.

The filters are entirely passive and require no input power for operation. The filters are located after the power amplifier and are designed to pass the rated full power of 10 watts. Due to the physical size of some of the components used and the required value changes over the selectable frequency ranges of the RFL 9780, several filter modules are required.

Color-coded test points are located on the front edge of the module to monitor power supply voltages as follows: TP4 (red) +5Vdc, TP5 (orange) +15Vdc, TP6 (yellow) –15Vdc, TP7 (purple) +12Vdc, TP8 (black) ground.

Output Filter Modules 106530-11 through -15 have additional circuitry to sense the impedance mismatch to the load (reflected power). The reflected power can be read locally or remotely using RFL Web Commander or Hyper-terminal.

10.2 SPECIFICATIONS

As of the date this manual was published, the following specifications apply to all RFL 9780 Output Filter modules, except as indicated. Because all RFL products undergo constant refinement and improvement, these specifications are subject to change without notice.

Frequency Range:

Assembly No.	Frequency Range	Notes
106530-1 106530-2 106530-3 106530-4 106530-5	30 kHz to 67.5 kHz. 64 kHz to157.5 kHz. 154 kHz to 393.5 kHz. 390 kHz to 537.5 kHz. 114 kHz to 288.5 kHz.	Without reflected power measurement option
106530-11 106530-12 106530-13 106530-14 106530-15	30 kHz to 67.5 kHz. 64 kHz to157.5 kHz. 154 kHz to 393.5 kHz. 390 kHz to 537.5 kHz. 114 kHz to 288.5 kHz.	With reflected power measurement option

Attenuation Notch:

Magnitude: Greater than 55 dB below passband level.
Approximate Frequency: See Table 10-2

Stopband:

Attenuation: Greater than 45 dB below passband level.
Approximate Frequency Range:

106530-1, -11: 90 kHz to 2 MHz.
106530-2, -12: 192 kHz to 2 MHz.
106530-3, -13: 462 kHz to 2 MHz.
106530-4, -14: 1.17 MHz to 2 MHz.
106530-5, -15: 342 kHz to 2mHz.

Passband: 0.75 dB deviation.

Signal Power: 10 watts maximum.

Impedance: 50 ohms.

10.3 THEORY OF OPERATION

RFL 9780 Output filters are elliptical six-pole passive L-C filters, that present less than 0.75 dB of attenuation to frequencies within their passband. They are designed to have the greatest attenuation at approximately the third harmonic of the lowest frequency in the passband. These frequencies are listed in Table 10-2 as the "Approximate frequency of greatest attenuation" and will be attenuated by at least 55 dB. Signals between this frequency and 2 MHz will be at least 45 dB below the passband level.

Output filters 106530-11 through -15 have additional circuitry to sense the impedance mismatch to the load. A low impedance detection circuit is inserted between the filter output and the transmit output, which may drive the load directly, or through hybrids. The detected signals are processed to calculate the value of the reflected power. If a balanced hybrid is used between the transmitter output and the load, the calculations can transform the results to display the value of the equivalent reflected power at the load, with reduced accuracy.

The reflected power can be read using APRIL after a physical connection has been made and communication is established between the RFL 9780 and a PC using the front or rear RS-232 ports. Refer to Section 16 for additional information.

10.4 CONTROLS AND INDICATORS

The RFL 9780 Output Filter Modules 106530-1, -2, -3, -5, -11, -12, -13, and -15 each contain seven, three position jumpers. The 106530-4 and -14 modules do not have jumpers. The jumpers are used to select the desired passband frequency from within the filters overall span. Note that all seven jumpers (J1 through J7) must be installed in the same position for the filter to function properly. Table 10-2 shows the passband and the approximate frequency of greatest attenuation for each jumper position for the filter modules.

Table 10-1. Controls and indicators, RFL 9780 Output Filter Modules

Component Designator	Name/ Description	Function
C26	Trimmer capacitor	Adjusts phase of voltage across one of the transformer secondaries. For factory use only
J1	Jumper	Passband frequency select jumpers. See Table 10-2, and Figures 10-2 and 10-3
J2	Jumper	
J3	Jumper	
J4	Jumper	
J5	Jumper	
J6	Jumper	
J7	Jumper	
R8	Potentiometer	Adjusts circuit gain and calibrates the signal level measurement (VA) for a given transmitter output power level. For factory use only.
R9	Potentiometer	Adjusts amplitude of voltage across one of the transformer secondaries. For factory use only.
R42	Potentiometer	Calibration attenuator. For factory use only.
TP1	Test point	Filter common
TP2	Test point	Filter output
TP3	Test point	Filter input
TP4	Power supply test point	+ 5 Vdc
TP5	Power supply test point	+ 15 Vdc
TP6	Power supply test point	- 15 Vdc
TP7	Power supply test point	+ 12 Vdc
TP8	Power supply test point	Power supply common
TP9	Test point	DC signal, which represents the nominal transmitter signal level. For factory use only
TP10	Test point	DC signal VAMP. Represents the voltage equivalent of the nominal transmitter signal amplitude. For factory use only.
TP11	Test point	Reflected power measurement signal. For factory use only.
TP12	Test point	DC signal QVRP (quadrature component of the reflection coefficient) For factory use only
TP13	Test point	DC signal IVRP(in-phase component of the reflection coefficient) For factory use only.

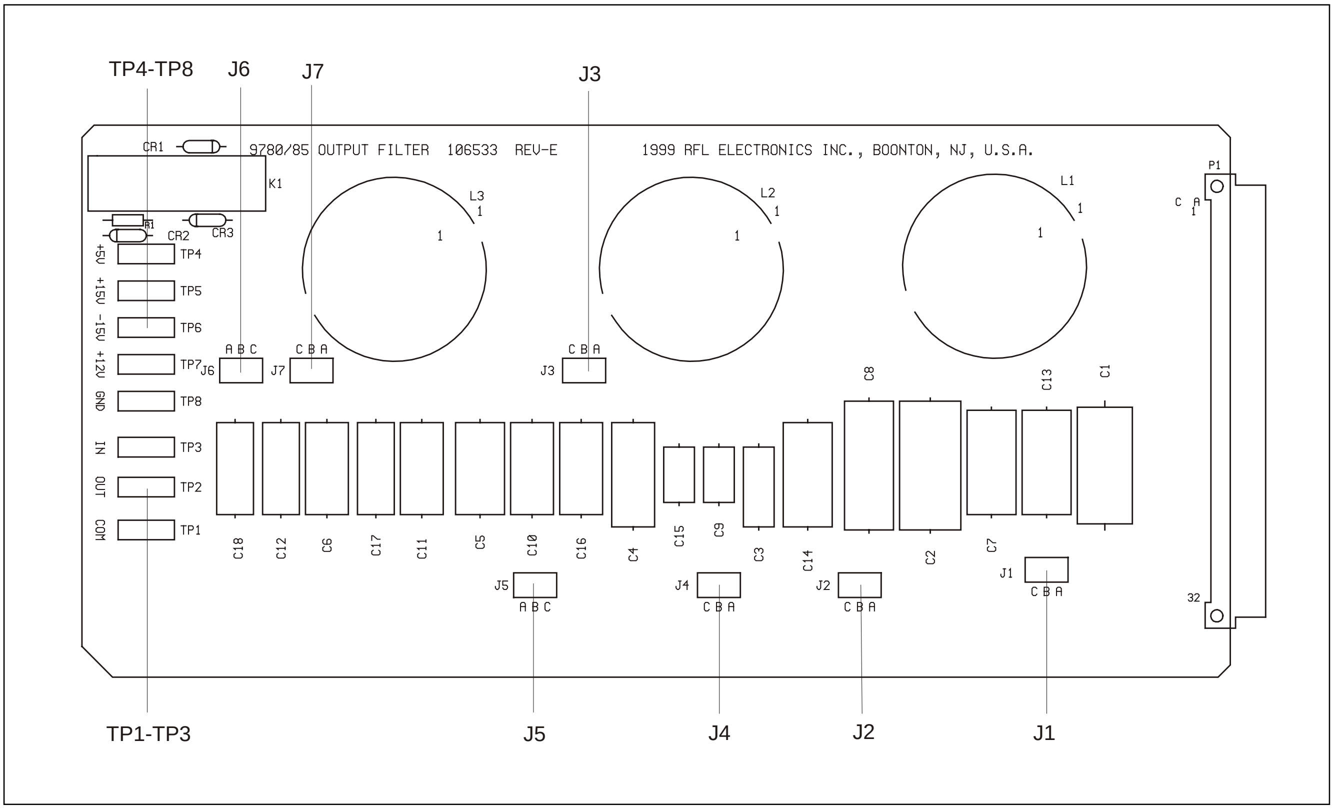

Figure 10-2. Controls and indicators, RFL 9780 Output Filter Modules (106530-1 to 106530-5)

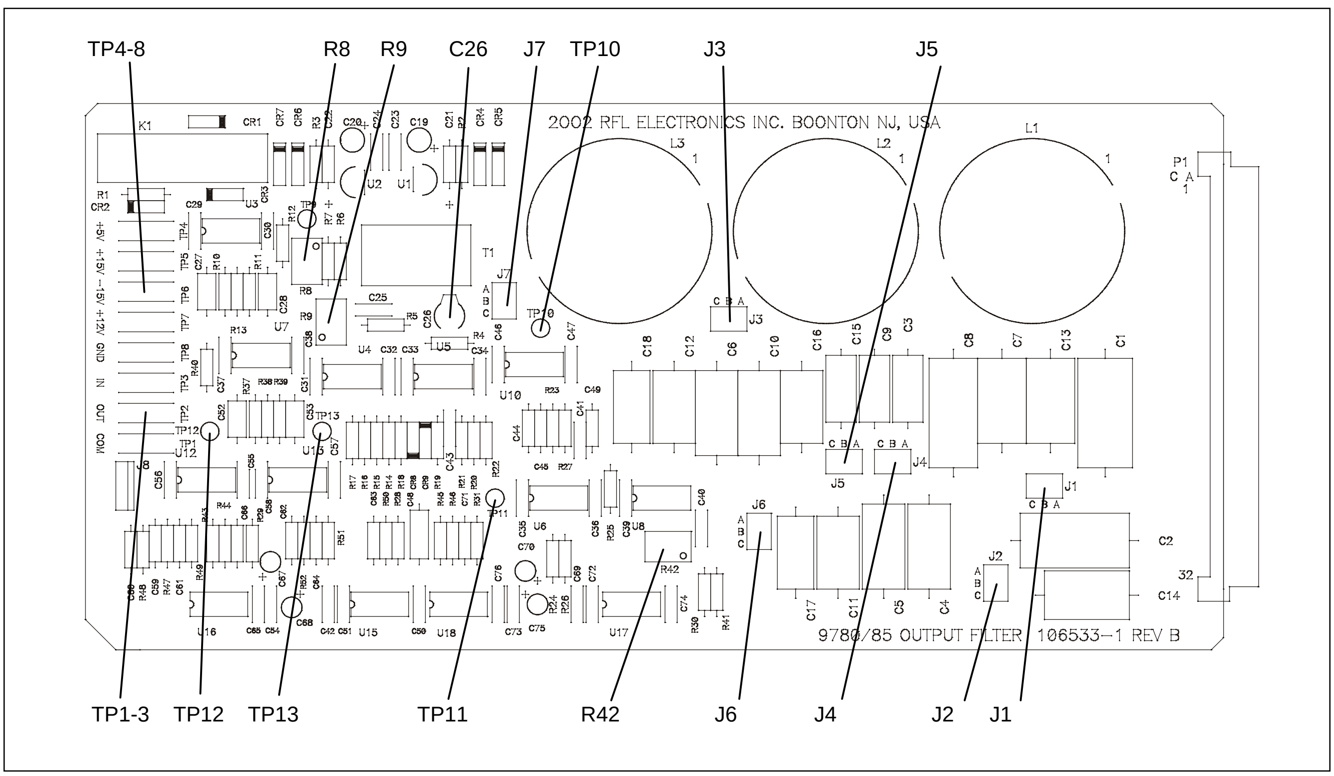

Figure 10-3. Controls and indicators, RFL 9780 Output Filter Modules (106530-11 to 106530-15)

Table 10-2. RFL 9780 Output Filter Modules, frequency ranges

Filter Module Part No.	Jumper Position	Passband Frequency Range	Approximate Frequency Of Greatest Attenuation
106530-1, -11	A	30 to 41.5 kHz	90 kHz
	B	38 to 52.5 kHz	114 kHz
	C	49 to 67.5 kHz	147 kHz
106530-2, -12	A	64 to 88.5 kHz	192 kHz
	B	85 to 117.5 kHz	255 kHz
	C	114 to 157.5 kHz	342 kHz
106530-3, -13	A	154 to 212.5 kHz	462 kHz
	B	209 to 288.5 kHz	627 kHz
	C	285 to 393.5 kHz	855 kHz
106530-4, -14	. . .	390 to 537.5 kHz	1170 kHz
106530-5, -15	A	114 to 157.5 kHz	342 kHz
	B	154 to 212.5 kHz	462 kHz
	C	209 to 288.5 kHz	627 kHz

NOTE: For proper filter operation, all seven jumpers (J1 through J7) on each Filter Module must be placed in the same block (all in A, all in B, or all in C).

Table 10-3. Replaceable parts, RFL 9780 Output Filter modules
30 to 67 kHz - Assembly No. 106530-1, -11
64 to 157 kHz - Assembly No. 106530-2, -12
154 to 393 kHz - Assembly No. 106530-3, -13
390 to 537 kHz - Assembly No. 106530-4, -14
114 to 288 kHz - Assembly No. 106530-5, -15

Circuit Symbol (Figs. 10-3 & 10-4)	**Description**	**Part Number**
	CAPACITORS	
C1	Capacitor, polypropylene, 2%, 100V	
	106530-1, -11: 0.0715µF	0105 21
	106530-2, -12: 0.033µF	0105 121
	106530-3, -13: 0.014µF	0105 92
	106530-4, -14: 0.0056µF	0105 112
	106530-5, -15: 0.018µF	0105 83
C2	Capacitor, polypropylene, 2%, 100V	
	106530-, -11: 0.091µF	0105 23
	106530-2, -12: 0.041µF	0105 81
	106530-3, -13: 0.018µF	0105 83
	106530-4, -14: 0.00715µF	0105 114
	106530-5, -15: 0.024µF	0105 119
C3	Capacitor, polypropylene, 2%, 100V	
	106530-1, -11: 0.00715µF	0105 114
	106530-2, -12: 0.00315µF	0105 107
	106530-3, -13: 0.0014µF	0105 104
	106530-4, -14: 535pF	0105 101
	106530-5, -15: 0.0018µF	0105 105
C4	Capacitor, polypropylene, 2%, 100V	
	106530-1, -11: 0.036µF	0105 14
	106530-2, -12: 0.017µF	0105 47
	106530-3, -13: 0.00715µF	0105 114
	106530-4, -14: 0.00285µF	0105 64
	106530-5, -15: 0.0095µF	0105 76
C5	Capacitor, polypropylene, 2%, 100V	
	106530-1, -11: 0.0285µF	0105 82
	106530-2, -12: 0.013µF	0105 117
	106530-3, -13: 0.0056µF	0105 112
	106530-4, -14: 0.0022µF	0105 62
	106530-5, -15: 0.0075µF	0105 73
C6	Capacitor, polypropylene, 2%, 100V	
	106530-1, -11: 0.024µF	0105 119
	106530-2, -12: 0.011µF	0105 30
	106530-3, -13: 0.0047µF	0105 110
	106530-4, -14: 0.0018µF	0105 105
	106530-5, -15: 0.0062µF	0105 113

Table 10-3. continued - Replaceable parts, RFL 9780 Output Filter modules

Circuit Symbol (Figs. 10-3 & 10-4)	Description	Part Number
	CAPACITORS -continued	
C7	Capacitor, polypropylene, 2%, 100V	
	106530-1, -11: 0.0535µF	0105 15
	106530-2, -12: 0.024µF	0105 119
	106530-3, -13: 0.01µF	0105 11
	106530-4, -14: N/A	NA
	106530-5, -15: 0.014µF	0105 92
C8	Capacitor, polypropylene, 2%, 100V	
	106530-1, -11: 0.068µF	0105 58
	106530-2, -12: 0.0315µF	0105 88
	106530-3, -13: 0.013µF	0105 117
	106530-4, -14: N/A	NA
	106530-5, -15: 0.018µF	0105 83
C9	Capacitor, polypropylene, 2%, 100V	
	106530-1, -11: 0.00535µF	0105 70
	106530-2, -12: 0.0024µF	0105 106
	106530-3, -13: 0.001µF	0105 103
	106530-4, -14: N/A	NA
	106530-5, -15: 0.0014µF	0105 104
C10	Capacitor, polypropylene, 2%, 100V	
	106530-1, -11: 0.027µF	0105 120
	106530-2, -12: 0.0125µF	0105 116
	106530-3, -13: 0.0051µF	0105 111
	106530-4, -14: N/A	NA
	106530-5, -15: 0.00715µF	0105 114
C11	Capacitor, polypropylene, 2%, 100V	
	106530-1, -11: 0.021µF	0105 118
	106530-2, -12: 0.01µF	0105 11
	106530-3, -13: 0.0041µF	0105 109
	106530-4, -14: N/A	NA
	106530-5, -15: 0.0056µF	0105 112
C12	Capacitor, polypropylene, 2%, 100V	
	106530-1, -11: 0.018µF	0105 83
	106530-2, -12: 0.0082µF	0105 115
	106530-3, -13: 0.00345µF	0105 108
	106530-4, -14: N/A	NA
	106530-5, -15: 0.0047µF	0105 110

Table 10-3. continued - Replaceable, RFL 9780 Output filter modules

Circuit Symbol (Figs. 10-3 & 10-4)	Description	Part Number
	CAPACITORS - continued	
C13	Capacitor, polypropylene, 2%, 100V	
	106530-1, -11: 0.043µF	0105 54
	106530-2, -12: 0.018µF	0105 83
	106530-3, -13: 0.0075µF	0105 73
	106530-4, -14: N/A	NA
	106530-5, -15: 0.01µF	0105 11
C14	Capacitor, polypropylene, 2%, 100V	
	106530-1, -11: 0.0535µF	0105 15
	106530-2, -12: 0.024µF	0105 119
	106530-3, -13: 0.0095µF	0105 76
	106530-4, -14: N/A	N/A
	106530-5, -15: 0.013µF	0105 117
C15	Capacitor, polypropylene, 2%, 100V	
	106530-1, -11: 0.0041µF	0105 109
	106530-2, -12: 0.0018µF	0105 105
	106530-3, -13: 750pF	0105 102
	106530-4, -14: N/A	N/A
	106530-5, -15: 0.001µF	0105 103
C16	Capacitor, polypropylene, 2%, 100V	
	106530-1, -11: 0.021µF	0105 118
	106530-2, -12: 0.0095µF	0105 76
	106530-3, -13: 0.00375µF	0105 67
	106530-4, -14: N/A	N/A
	106530-5, -15: 0.0051µF	0105 111
C17	Capacitor, polypropylene, 2%, 100V	
	106530-1, -11: 0.017µF	0105 47
	106530-2, -12: 0.0075µF	0105 73
	106530-3, -13: 0.003µF	0105 65
	106530-4, -14: N/A	N/A
	106530-5, -15: 0.0041µF	0105 109
C18	Capacitor, polypropylene, 2%, 100V	
	106530-1, -11: 0.014µF	0105 92
	106530-2, -12: 0.0062µF	0105 113
	106530-3, -13: 0.00255µF	0105 63
	106530-4, -14: N/A	N/A
	106530-5, -15: 0.00345µF	0105 108

Table 10-3. continued - Replaceable parts, RFL 9780 Output Filter modules

Circuit Symbol (Figs. 10-3 & 10-4)	Description	Part Number
	CAPACITORS - continued	
C19, 20	106530-11 to -15: Capacitor, electrolytic, 47µF, 20%, 16V	1007 1629
C21,22	106530-11 to -15: Capacitor, tantalum, 0.33µF, 10%, 35V	1007 1281
C23, 24, 29-43, 46, 47, 50, 51, 54-58, 65, 69, 72-74, 76	106530-11 to -15: Capacitor, ceramic dip, 0.1µF, 10%, 50V	0120 38
C25	106530-11 to -15: Capacitor, ceramic dip, 1500pF, 5%, 50V	0120 27
C26	106530-11 to -15: Capacitor, variable, ceramic, 5-25pF	
C27, 28, 52, 53	106530-11 to -15: Capacitor, ceramic, 0.47µF, 20%, 50V	0135 54742
C44, 59, 63	106530-11 to -15: Capacitor, ceramic, 0.022µF, 10%, 50V	0130 52231
C45	106530-11 to -15: Capacitor, ceramic, 0.01µF, 10%, 50V	0130 5131
C48	106530-11 to -15: Capacitor, ceramic, 1µF, 20%, 50V	0135 51052
C49	106530-11 to -15: Capacitor, ceramic, 0.001µF, 10%, 100V	0130 11021
C60, 62	106530-11 to -15: Capacitor, ceramic, 0.56µF, 10%, 50V	0130 55631
C61, 64	106530-11 to -15: Capacitor, ceramic, 0.0033µF, 10%, 100V	0130 13321
C66, 71	106530-11 to -15: Capacitor, ceramic, 100pF, 5%, 200V	0125 21015
C67, 68, 70, 75	106530-11 to -15: Capacitor, tantalum, 10µF, 10%, 20V	1007 1465
	RESISTORS	
R1	106530-11 to -15: Resistor, metal film, axial, 140Ω, 1%, 1/4W	0410 1206
R2, 3	106530-11 to -15: Resistor, metal film, axial, 11Ω, 1%, 1/4W	0410 1100
R4	106530-11 to -15: Resistor, metal film, axial, 17.4K, 1%, 1/4W	0410 1407
R5	106530-11 to -15: Resistor, metal film, axial, 1332, 1%, 1/4W	0410 1242
R6	106530-11 to -15: Resistor, metal film, axial, 43.2Ω, 1%, 1/4W	0410 1157
R7	106530-11 to -15: Resistor, metal film, axial, 169Ω, 1%, 1/4W	0410 1214
R8, 9, 42	106530-11 to -15: Resistor, metal film, variable, 100Ω,, 10%, 1/2W	
R10, 11, 15, 16, 18, 21-23, 25, 27, 37, 39, 47-52	106530-11 to -15: Resistor, metal film, axial, 10K, 1%, 1/4W	0410 1384
R12, 13	106530-11 to -15: Resistor, metal film, axial, 26.7K, 1%, 1/4W	0410 1425
R14, 19, 20	106530-11 to -15: Resistor, metal film, axial, 4.99K, 1%, 1/4W	0410 1355
R17	106530-11 to -15: Resistor, metal film, axial, 4.75K, 1%, 1/4W	0410 1353
R24	106530-11 to -15: Resistor, metal film, axial, 2.49K, 1%, 1/4W	0410 1326
R26	106530-11 to -15: Resistor, metal film, axial, 20K, 1%, 1/4W	0410 1413
R28, 30	106530-11 to -15: Resistor, metal film, axial, 511Ω, 1%, 1/4W	0410 1260
R29, 31	106530-11 to -15: Resistor, metal film, axial, 5.11Ω, 1%, 1/4W	0410 1068
R38, 40	106530-11 to -15: Resistor, metal film, axial, 28K, 1%, 1/4W	0410 1427
R41, 43-46	106530-11 to -15: Resistor, metal film, axial, 1K, 1%, 1/4W	0410 1288

Table 10-3. continued - Replaceable parts, RFL 9780 Output Filter modules

Circuit Symbol (Figs. 10-3 & 10-4)	Description	Part Number
	INDUCTORS	
L1, 2, 3	Inductor	
	106530-1, -11: Coil, cup core, 77.5 turns	99403 1
	106530-2, -12: Coil, cup core, 52.5 turns	99403 2
	106530-3, -13: Coil, cup core, 33.5 turns	99403 3
	106530-4, -14: Coil, cup core, 21.5 turns	99404
	106530-5, -15: Coil, cup core, 39.5 turns	99403 4
	MISCELLANEOUS COMPONENTS	
CR1, 2, 3	Diode, silicon, 1N914B/1N4448	26482
CR4-7	Diode, Surmetic, rectifier, 1N4001	38876
CR8, 9	Diode, Schottky, barrier, 1N6263	93631
K1	Relay, 4PDT, 12Vdc	95282
J1-7	Connector , header, dual, 3/6 CKT	32599 6
J8	Connector, wafer assy, 4 CKT	97223 4
P1	Connector, JK male, 64 contact, DIN	98457
T1	Transformer., meter power	106531
TP1	Test point, brown	38116 4
TP2	Test point, blue	38116 7
TP3	Test point, white	38116 1
TP4	Test point, red	38116 2
TP5	Test point, orange	38116 6
TP6	Test point, yellow	38116 8
TP7	Test point, purple	38116 10
TP8	Test point, black	38116 3
TP9-13	Test point, terminal orange	98441 3
U1	Integrated Circuit, linear voltage regulator, 5V pos	0620 204
U2	Integrated Circuit, linear voltage regulator, 5V neg	0620 210
U3-8	Integrated Circuit, linear OP AMP	0620 384
U10, 12, 13	Integrated Circuit, linear precision OP AMP	0620 322
U15, 17	Integrated Circuit, linear voltage comparator	0620 395
U16, 18	Integrated Circuit, analog multiplexer	0620 491

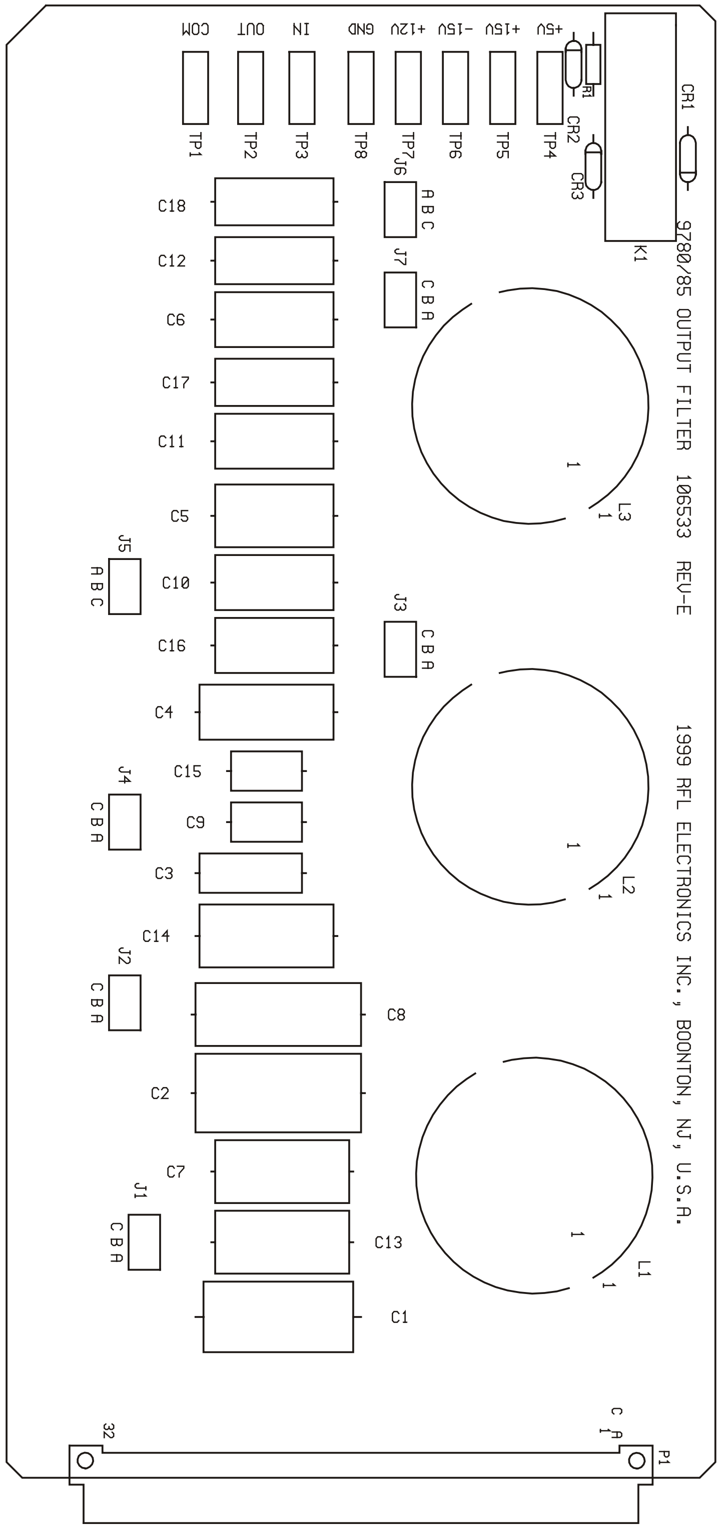

Figure 10-4. Component Locator Drawing, RFL 9780 Output Filter Module (Assy No. 106530-1 to -5)

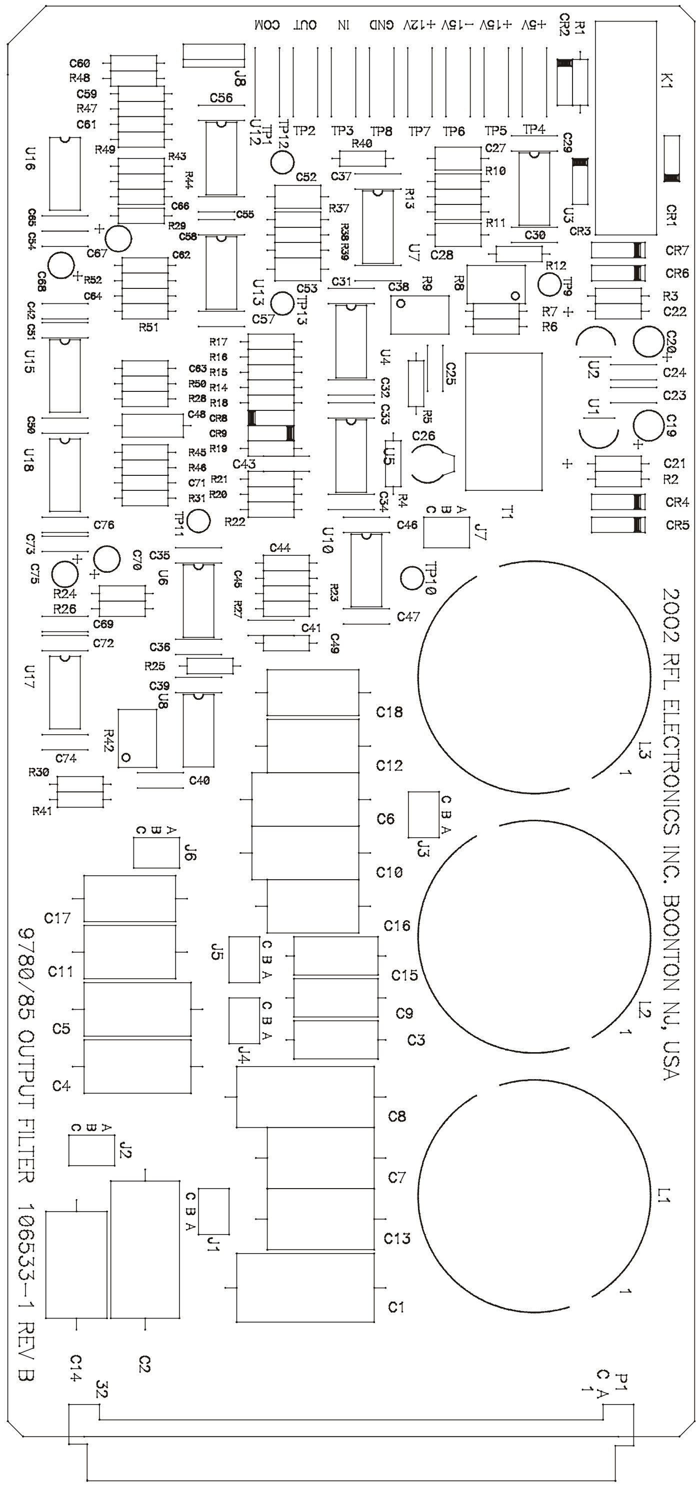

Figure 10-5. Component Locator Drawing, RFL 9780 Output Filter Module (Assy No. 106530-11 to -15)

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Figure 10-6. Schematic, RFL 9780 Output Filters Without Reflected Power Meter, Assy Nos. 106530-1 to -5 (Dwg. No. D-106434-D)

Please see Figure 10-6 in Section 22

Figure 10-7. Schematic, RFL 9780 Output Filters With Reflected Power Meter, Assy Nos. 106530-11 to -15 (Dwg. No. D-106434-1-B)

Please see Figure 10-7 in Section 22

SECTION 11. RF INTERFACE MODULE

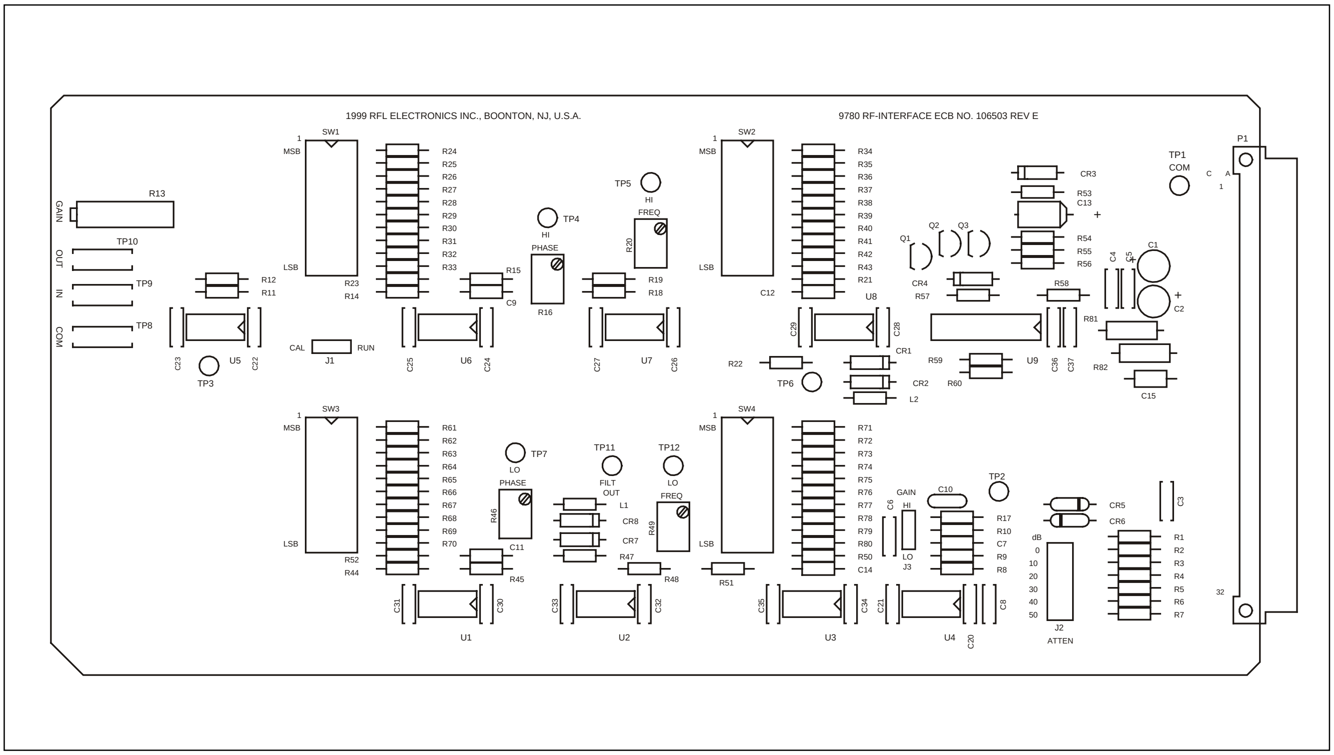

Figure 11-1. RFL 9780 RF Interface Module

11.1 DESCRIPTION

The RFL 9780 RF Interface Module (Figure 11-1) provides an interface between the Input I/O module (Section 17) and the IF/BF module (Section 12). It consists of an attenuator, an amplifier and a programmable filter which is used to attenuate excess rf energy from the receiver input. The filter is programmable from 30Khz to 535Khz using a bank of DIP switches, SW1 through SW4.

11.2 SPECIFICATIONS

As of the date this manual was published, the following specifications apply to all RFL 9780 RF Interface modules, except where indicated. Because all RFL products undergo constant refinement and improvement, these specifications are subject to change without notice.

Input Attenuation: 0dB to 50dB in 10dB steps.

Gain Adjust: 4dB to 40dB.

Center Frequency: 30Khz to 535Khz in 1Khz steps.

Bandwidth of selected center frequency: Approximately 10Khz, independent of center frequency.

11.3 THEORY OF OPERATION

Refer to the block diagram (Figure 11-2) and the schematic diagram (Figure 11-5) for the following discussion.

The RFL 9780 RF Interface module contains attenuator and amplifier circuitry followed by a programmable fourth order band-pass filter, which is used to remove excess energy at the receiver input. The filter consists of two resonant sections, and is adjustable from 30KHz to 535KHz using four DIP switches. The variable resistors (R16, R20, R46, and R49) are preset at the factory and should not require any adjustments. Improper setting of these variable resistors will greatly modify the filter characteristics. The DIP switches are set to the desired center frequency using the “Filter Switch Settings” chart (Table 11-2). A “0” means that the switch is “OFF” and a “1” means that the switch is “ON”. Switch position 1 of each DIP switch is the most significant value, while switch position 10 is the least significant value. The filter maintains a relatively flat bandwidth of approximately 10 kHz independent of center frequency.

The input signal at pin A28 is first attenuated by 0 to 50 dB in 10 dB steps, as selected by J2. Diodes CR5 and CR6 provide high voltage transient protection. The signal is then amplified by U4 and U5. The gain of the first amplifier (U4) is either 4 or 40, depending on the selection of J3. The gain of amplifier U5 is variable between 0.1 and 5.1, as determined by the setting of the GAIN potentiometer R16. The output of this amplifier (TP3) drives the programmable band-pass filter.

The band-pass filter consists of two cascaded state-variable filter sections. Each section consists of three operational amplifiers, two configured as integrators and one as an inverter. Changing the time constants of the integrators controls the resonant frequency. This is accomplished by switching in various resistor values using S1 through S4. R15 and R45 control the Q of the sections. Potentiometers R16 and R46 adjust for small phase errors in the circuits, which can drastically effect the performance at the higher frequencies of operation. R20 and R49 adjust the frequency of the high and low frequency sections, respectively. Jumper J1 allows the same signal to drive both sections in parallel for calibration. Normally, the band-pass output of the low frequency section is used to drive the high-pass section, and the low-pass output of this section is taken as the entire filter output. The low-pass output of the second state-variable filter section is used to provide a more arithmetically symmetrical filter response for the complete band-pass filter.

An analog switch is used to gate the filter output to the output pin (A15) on the board. Switch U9 uses a series-shunt switch configuration to control this output, where one switch is closed when the other is open. A third switch section is used to create an inverted control signal. The control signal is generated from a Schmitt trigger circuit formed by Q2 and Q3. Transistor Q1 is used as an emitter follower to reduce the current drain on the timing circuits formed by C13, R53 and CR3. Zener diode CR4 provides an 8.2 volt offset between the timing circuit and the level comparator circuit. The circuit squelches the output of the filter for about 0.5 seconds at power up to eliminate possible relatively large transient output voltages at startup.

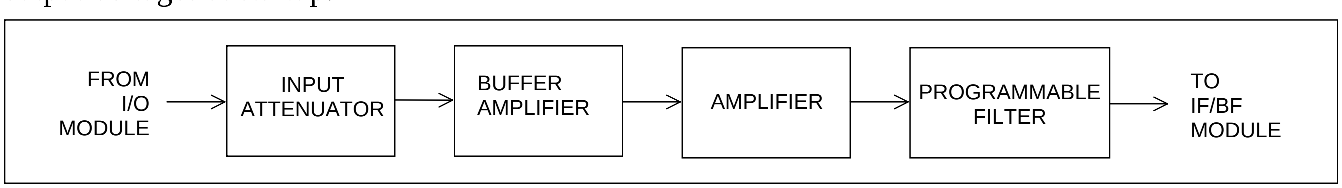

Figure 11-2. RF Interface Module block diagram

11.4 CONTROLS AND INDICATORS

Figure 11-4 shows the location of all controls and indicators on the RF Interface module. These controls and indicators are described in Table 11-1. Potentiometer R13, and test points TP8, TP9 and TP10 are accessible with the module installed in the chassis. All other controls and indicators are accessible only when the module is removed from the chassis or is on a card extender.

Table 11-1. Controls and indicators, RFL 9780 RF Interface Module

Component Designator	Name/ Description	Function
J1	Jumper	Calibration/Run select. Calibration position is for factory use only.
J2	Jumper	Allows input attenuation from 0 dB to 50 dB in 10 dB steps.
J3	Jumper	High or low gain select. High = gain of 40, Low = gain of 4.
R13	Potentiometer	Signal gain adjust. Accessible from front edge of module.
R16	Potentiometer	Phase adjust for high frequency section. For factory use only.
R20	Potentiometer	Frequency adjust for high frequency section. For factory use only.
R46	Potentiometer	Phase adjust for low frequency section. For factory use only.
R49	Potentiometer	Frequency adjust for low frequency section. For factory use only.
SW1	DIP Switch	Center frequency (Fc) select. See Table 11-2.
SW2	DIP Switch	Center frequency (Fc) select. See Table 11-2.
SW3	DIP Switch	Center frequency (Fc) select. See Table 11-2.
SW4	DIP Switch	Center frequency (Fc) select. See Table 11-2.
TP1	Test point	Common signal test point.
TP2	Test point	Output of first gain stage.
TP3	Test point	Output of second gain stage.
TP4	Test point	Band pass output of first state variable filter section. Used for factory calibration.
TP5	Test point	Inverted band pass output of first state variable filter section. Used for factory calibration.
TP6	Test point	Low pass output of first state variable filter section. Used for factory calibration.
TP7	Test point	Band pass output of second state variable filter section. Used for factory calibration.
TP8	Test point	Signal common test point on front edge of module.
TP9	Test point	Output of second gain stage. Accessible from front edge of module.
TP10	Test point	Final output of module.
TP11	Test point	Low pass output of second state variable filter section. Used for factory calibration.
TP12	Test point	Inverted band pass output of second state variable filter section. Used for factory calibration.

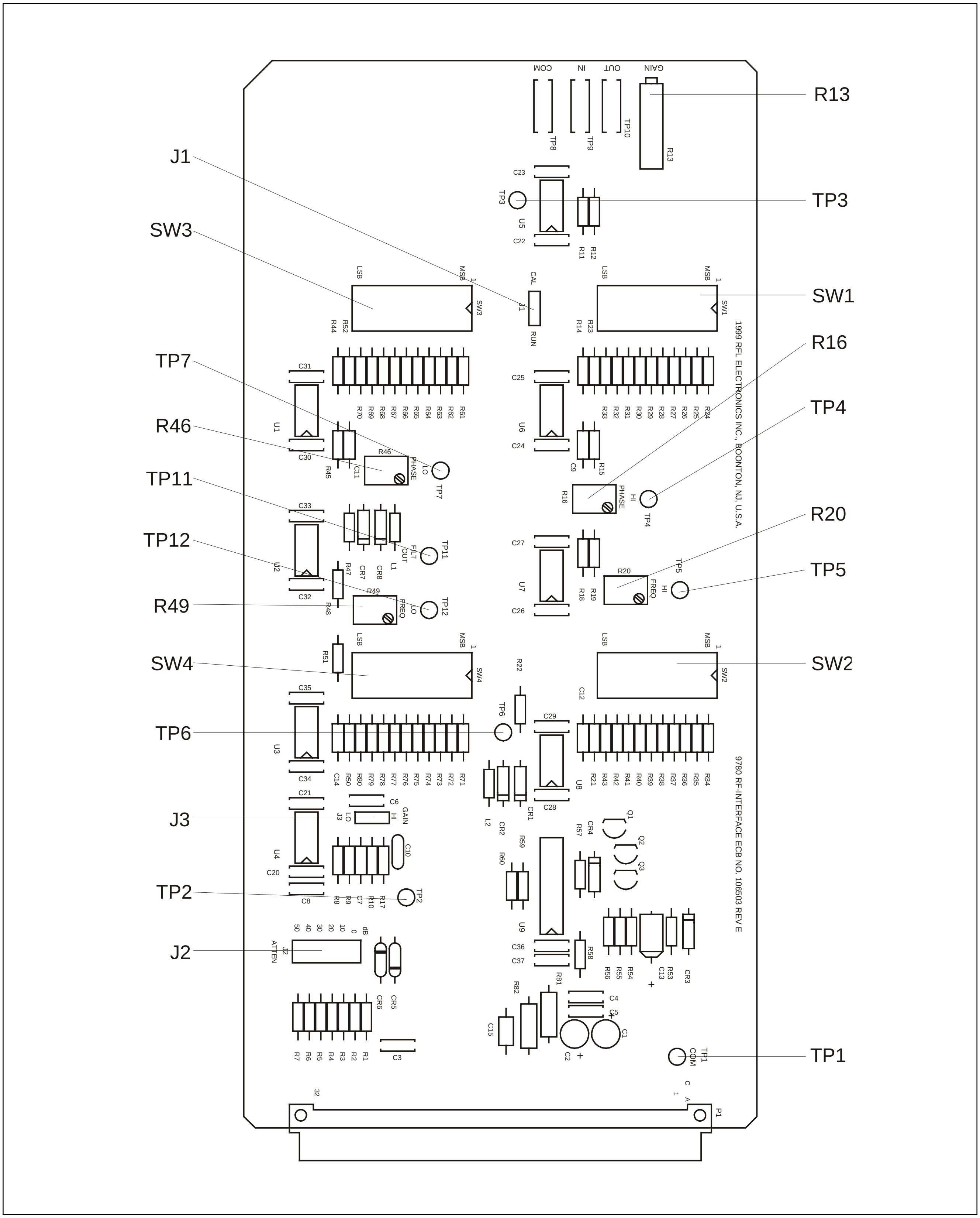

Figure 11-3. Controls and indicators, RFL 9780 RF Interface Module

11.4.1 INPUT ATTENUATOR ADJUST

Jumpers J2 and J3 are used to select the input attenuator depending upon the strength of the incoming signal.

11.4.2 SIGNAL GAIN ADJUSTMENT

Potentiometer R13 is used for signal gain adjustment. This adjustment is used to normalize the received level to the designed nominal level.

11.4.3 RECEIVE FREQUENCY SELECT

The center frequency of the bandpass filter must be configured for the module. Switches SW1 through SW4 are used for this purpose. Each switch-bank changes a different part of the filter circuit and they must all be configured correctly for proper operation.

The center frequency of the receive signal should be looked-up in Table 11-2, which lists the correct settings for each of the ten switches in each of the four switch-banks (SW1 through SW4). A “0” in Table 11-2 indicates that the switch should be “OFF”, while a “1” in the Table indicates that the switch should be “ON”.

Table 11-2. Programmable Filter switch selections

Fc	SW 1	SW 2	SW 3	SW 4
	1 10	1 10	1 10	1 10
30	0000000000	0000000000	0000000000	0000000000
31	0000000010	0000000001	0000000001	0000000011
32	0000000100	0000000011	0000000011	0000000101
33	0000000110	0000000101	0000000101	0000000111
34	0000001000	0000000111	0000000111	0000001001
35	0000001010	0000001010	0000001001	0000001011
36	0000001100	0000001100	0000001011	0000001101
37	0000001110	0000001110	0000001101	0000001111
38	0000010000	0000001111	0000001111	0000010001
39	0000010010	0000010010	0000010001	0000010011
40	0000010100	0000010100	0000010011	0000010101
41	0000010110	0000010110	0000010101	0000010111
42	0000011000	0000011000	0000010111	0000011001
43	0000011010	0000011010	0000011001	0000011011
44	0000011100	0000011100	0000011011	0000011101
45	0000011110	0000011110	0000011110	0000011110
46	0000100000	0000100000	0000011111	0000100001
47	0000100010	0000100010	0000100001	0000100011
48	0000100100	0000100100	0000100011	0000100101
49	0000100110	0000100110	0000100110	0000100110
50	0000101000	0000101000	0000101000	0000101000
51	0000101010	0000101010	0000101010	0000101010
52	0000101100	0000101100	0000101100	0000101100
53	0000101110	0000101110	0000101110	0000101110
54	0000110000	0000110000	0000110000	0000110000
55	0000110010	0000110010	0000110010	0000110010
56	0000110100	0000110100	0000110100	0000110100
57	0000110110	0000110110	0000110110	0000110110
58	0000111000	0000111000	0000111000	0000111000
59	0000111010	0000111010	0000111010	0000111010
60	0000111100	0000111100	0000111100	0000111101
61	0000111110	0000111110	0000111110	0000111111
62	0001000000	0001000000	0000111111	0001000001
63	0001000010	0001000010	0001000010	0001000010
64	0001000100	0001000100	0001000100	0001000100
65	0001000110	0001000110	0001000110	0001000110
66	0001001000	0001001000	0001001000	0001001000
67	0001001010	0001001010	0001001010	0001001010
68	0001001100	0001001100	0001001100	0001001100
69	0001001110	0001001110	0001001110	0001001110
70	0001010000	0001010000	0001010000	0001010000
71	0001010010	0001010010	0001010010	0001010010
72	0001010100	0001010100	0001010100	0001010100
73	0001010110	0001010110	0001010110	0001010110
74	0001011000	0001011000	0001011000	0001011000
75	0001011010	0001011010	0001011010	0001011011
76	0001011100	0001011100	0001011100	0001011101
77	0001011110	0001011110	0001011110	0001011111
78	0001100000	0001100000	0001100000	0001100000
79	0001100010	0001100010	0001100010	0001100011

Table 11-2. –continued. Programmable Filter switch selections

Fc	SW 1 1 10	SW 2 1 10	SW 3 1 10	SW 4 1 10
80	0001100100	0001100100	0001100100	0001100101
81	0001100110	0001100110	0001100110	0001100111
82	0001101000	0001101000	0001101000	0001101001
83	0001101010	0001101010	0001101010	0001101011
84	0001101100	0001101100	0001101100	0001101101
85	0001101110	0001101110	0001101110	0001101111
86	0001110000	0001110000	0001110000	0001110001
87	0001110010	0001110010	0001110010	0001110011
88	0001110100	0001110100	0001110100	0001110101
89	0001110110	0001110110	0001110110	0001110111
90	0001111000	0001111000	0001111000	0001111001
91	0001111010	0001111010	0001111010	0001111011
92	0001111100	0001111101	0001111100	0001111101
93	0001111110	0001111111	0001111110	0001111111
94	0010000000	0010000000	0001111111	0010000010
95	0010000010	0010000010	0010000001	0010000011
96	0010000100	0010000100	0010000011	0010000101
97	0010000110	0010000110	0010000110	0010000110
98	0010001000	0010001000	0010001000	0010001000
99	0010001010	0010001010	0010001010	0010001010
100	0010001100	0010001100	0010001100	0010001100
101	0010001110	0010001110	0010001110	0010001110
102	0010010000	0010010000	0010010000	0010010000
103	0010010010	0010010010	0010010010	0010010010
104	0010010100	0010010100	0010010100	0010010100
105	0010010110	0010010110	0010010110	0010010110
106	0010011000	0010011000	0010011000	0010011000
107	0010011010	0010011010	0010011010	0010011010
108	0010011100	0010011100	0010011100	0010011101
109	0010011110	0010011110	0010011110	0010011111
110	0010100000	0010100000	0010100000	0010100000
111	0010100010	0010100010	0010100010	0010100010
112	0010100100	0010100100	0010100100	0010100101
113	0010100110	0010100110	0010100110	0010100111
114	0010101000	0010101000	0010101000	0010101001
115	0010101010	0010101010	0010101010	0010101011
116	0010101100	0010101100	0010101100	0010101101
117	0010101110	0010101110	0010101110	0010101111
118	0010110000	0010110000	0010110000	0010110001
119	0010110010	0010110010	0010110010	0010110011
120	0010110100	0010110100	0010110100	0010110101
121	0010110110	0010110110	0010110110	0010110111
122	0010111000	0010111000	0010111000	0010111001
123	0010111010	0010111010	0010111010	0010111011
124	0010111100	0010111100	0010111100	0010111101
125	0010111110	0010111111	0010111110	0010111111
126	0011000000	0011000000	0011000000	0011000000
127	0011000010	0011000010	0011000010	0011000011
128	0011000100	0011000100	0011000100	0011000101
129	0011000110	0011000110	0011000110	0011000111

Table 11-2. – continued. Programmable Filter switch selections

Fc	SW 1	SW 2	SW 3	SW 4
	1 10	1 10	1 10	1 10
130	0011001000	0011001000	0011001000	0011001001
131	0011001010	0011001010	0011001010	0011001011
132	0011001100	0011001100	0011001100	0011001101
133	0011001110	0011001110	0011001110	0011001111
134	0011010000	0011010000	0011010000	0011010001
135	0011010010	0011010010	0011010010	0011010011
136	0011010100	0011010100	0011010100	0011010101
137	0011010110	0011010110	0011010110	0011010111
138	0011011000	0011011000	0011011000	0011011001
139	0011011010	0011011010	0011011010	0011011011
140	0011011100	0011011101	0011011100	0011011101
141	0011011110	0011011111	0011011110	0011011111
142	0011100000	0011100000	0011100000	0011100001
143	0011100010	0011100010	0011100010	0011100011
144	0011100100	0011100101	0011100100	0011100101
145	0011100110	0011100111	0011100110	0011100111
146	0011101000	0011101001	0011101000	0011101001
147	0011101010	0011101011	0011101010	0011101011
148	0011101100	0011101101	0011101100	0011101101
149	0011101110	0011101111	0011101110	0011101111
150	0011110000	0011110001	0011110000	0011110001
151	0011110010	0011110011	0011110010	0011110011
152	0011110100	0011110101	0011110100	0011110101
153	0011110110	0011110111	0011110110	0011110111
154	0011111000	0011111001	0011111000	0011111001
155	0011111010	0011111011	0011111010	0011111011
156	0011111100	0011111101	0011111100	0011111101
157	0011111110	0011111111	0011111110	0011111111
158	0011111111	0100000000	0011111111	0100000001
159	0100000001	0100000001	0100000001	0100000001
160	0100000011	0100000011	0100000011	0100000011
161	0100000101	0100000101	0100000101	0100000101
162	0100000111	0100000111	0100000111	0100001000
163	0100001001	0100001001	0100001001	0100001010
164	0100001011	0100001011	0100001011	0100001100
165	0100001101	0100001101	0100001101	0100001110
166	0100001111	0100001111	0100001111	0100010000
167	0100010001	0100010001	0100010001	0100010010
168	0100010011	0100010011	0100010011	0100010100
169	0100010101	0100010101	0100010101	0100010110
170	0100010111	0100010111	0100010111	0100011000
171	0100011001	0100011001	0100011001	0100011010
172	0100011011	0100011011	0100011011	0100011100
173	0100011101	0100011101	0100011101	0100011110
174	0100011111	0100011111	0100011111	0100100000
175	0100100001	0100100001	0100100001	0100100010
176	0100100011	0100100011	0100100011	0100100100
177	0100100101	0100100101	0100100101	0100100110
178	0100100111	0100100111	0100100111	0100101000
179	0100101001	0100101001	0100101001	0100101010

Table 11-2. – continued. Programmable Filter switch selections

Fc	SW 1 1 10	SW 2 1 10	SW 3 1 10	SW 4 1 10
180	0100101011	0100101100	0100101011	0100101100
181	0100101101	0100101110	0100101101	0100101110
182	0100101111	0100110000	0100101111	0100110000
183	0100110001	0100110001	0100110001	0100110010
184	0100110011	0100110100	0100110011	0100110100
185	0100110101	0100110110	0100110101	0100110110
186	0100110111	0100111000	0100110111	0100111000
187	0100111001	0100111010	0100111001	0100111010
188	0100111011	0100111100	0100111011	0100111100
189	0100111101	0100111110	0100111101	0100111110
190	0100111111	0101000000	0100111111	0101000000
191	0101000001	0101000001	0101000001	0101000010
192	0101000011	0101000011	0101000011	0101000100
193	0101000101	0101000101	0101000101	0101000110
194	0101000111	0101001000	0101000111	0101001000
195	0101001001	0101001010	0101001001	0101001010
196	0101001011	0101001100	0101001011	0101001100
197	0101001101	0101001110	0101001101	0101001110
198	0101001111	0101010000	0101001111	0101010000
199	0101010001	0101010010	0101010001	0101010010
200	0101010011	0101010100	0101010011	0101010100
201	0101010101	0101010110	0101010101	0101010110
202	0101010111	0101011000	0101010111	0101011000
203	0101011001	0101011010	0101011001	0101011010
204	0101011011	0101011100	0101011011	0101011100
205	0101011101	0101011110	0101011101	0101011110
206	0101011111	0101100000	0101011111	0101100000
207	0101100001	0101100010	0101100001	0101100010
208	0101100011	0101100100	0101100011	0101100100
209	0101100101	0101100110	0101100101	0101100110
210	0101100111	0101101000	0101100111	0101101000
211	0101101001	0101101010	0101101001	0101101010
212	0101101011	0101101100	0101101011	0101101100
213	0101101110	0101101101	0101101101	0101101110
214	0101101111	0101110000	0101101111	0101110000
215	0101110001	0101110010	0101110001	0101110010
216	0101110011	0101110100	0101110011	0101110100
217	0101110110	0101110101	0101110101	0101110110
218	0101110111	0101111000	0101110111	0101111000
219	0101111010	0101111001	0101111001	0101111010
220	0101111100	0101111011	0101111011	0101111101
221	0101111110	0101111101	0101111101	0101111111
222	0101111111	0110000000	0101111111	0110000000
223	0110000001	0110000001	0110000001	0110000010
224	0110000011	0110000011	0110000011	0110000100
225	0110000101	0110000101	0110000101	0110000110
226	0110000111	0110000111	0110000111	0110001000
227	0110001001	0110001001	0110001001	0110001010
228	0110001011	0110001100	0110001011	0110001100
229	0110001101	0110001110	0110001101	0110001110

Table 11-2. – continued. Programmable Filter switch selections

Fc	SW 1	SW 2	SW 3	SW 4
	1 10	1 10	1 10	1 10
230	0110001111	0110010000	0110001111	0110010000
231	0110010001	0110010001	0110010001	0110010010
232	0110010011	0110010100	0110010011	0110010100
233	0110010101	0110010110	0110010101	0110010110
234	0110010111	0110011000	0110010111	0110011000
235	0110011001	0110011010	0110011001	0110011010
236	0110011011	0110011100	0110011011	0110011100
237	0110011101	0110011110	0110011101	0110011110
238	0110011111	0110100000	0110011111	0110100000
239	0110100001	0110100010	0110100001	0110100010
240	0110100011	0110100100	0110100011	0110100100
241	0110100101	0110100110	0110100101	0110100110
242	0110100111	0110101000	0110100111	0110101000
243	0110101001	0110101010	0110101001	0110101010
244	0110101011	0110101100	0110101011	0110101100
245	0110101101	0110101110	0110101101	0110101110
246	0110101111	0110110000	0110101111	0110110000
247	0110110001	0110110010	0110110001	0110110010
248	0110110011	0110110100	0110110011	0110110100
249	0110110101	0110110110	0110110101	0110110110
250	0110110111	0110111000	0110110111	0110111000
251	0110111001	0110111010	0110111001	0110111010
252	0110111100	0110111011	0110111011	0110111100
253	0110111110	0110111101	0110111101	0110111110
254	0110111111	0111000000	0110111111	0111000000
255	0111000001	0111000010	0111000001	0111000010
256	0111000011	0111000100	0111000011	0111000100
257	0111000101	0111000110	0111000101	0111000110
258	0111000111	0111001000	0111000111	0111001000
259	0111001001	0111001010	0111001001	0111001010
260	0111001011	0111001100	0111001011	0111001100
261	0111001101	0111001110	0111001101	0111001110
262	0111001111	0111010000	0111001111	0111010000
263	0111010001	0111010010	0111010001	0111010010
264	0111010011	0111010100	0111010011	0111010100
265	0111010101	0111010110	0111010101	0111010110
266	0111010111	0111011000	0111010111	0111011000
267	0111011010	0111011001	0111011001	0111011010
268	0111011100	0111011011	0111011011	0111011101
269	0111011110	0111011101	0111011101	0111011111
270	0111011111	0111100000	0111011111	0111100001
271	0111100010	0111100001	0111100001	0111100010
272	0111100100	0111100011	0111100011	0111100101
273	0111100110	0111100101	0111100101	0111100111
274	0111101000	0111100111	0111100111	0111101001
275	0111101010	0111101001	0111101001	0111101011
276	0111101100	0111101011	0111101011	0111101101
277	0111101110	0111101101	0111101101	0111101111
278	0111110000	0111101111	0111101111	0111110001
279	0111110010	0111110001	0111110001	0111110011

Table 11-2. – continued. Programmable Filter switch selections

Fc	SW 1 1 10	SW 2 1 10	SW 3 1 10	SW 4 1 10
280	0111110100	0111110011	0111110011	0111110101
281	0111110110	0111110101	0111110101	0111110111
282	0111111000	0111110111	0111110111	0111111001
283	0111111010	0111111001	0111111001	0111111011
284	0111111100	0111111011	0111111011	0111111101
285	0111111110	0111111110	0111111101	0111111111
286	0111111111	0111111111	0111111111	0111111111
287	0111111111	1000000010	0111111111	1000000011
288	1000000001	1000000010	1000000001	1000000010
289	1000000011	1000000100	1000000011	1000000100
290	1000000110	1000000101	1000000101	1000000110
291	1000001000	1000000111	1000000111	1000001000
292	1000001010	1000001001	1000001001	1000001010
293	1000001100	1000001011	1000001011	1000001101
294	1000001110	1000001101	1000001101	1000001111
295	1000010000	1000001111	1000001111	1000010001
296	1000010010	1000010001	1000010001	1000010010
297	1000010100	1000010011	1000010011	1000010101
298	1000010110	1000010101	1000010101	1000010111
299	1000011000	1000010111	1000010111	1000011001
300	1000011010	1000011001	1000011001	1000011011
301	1000011100	1000011011	1000011011	1000011101
302	1000011110	1000011101	1000011101	1000011111
303	1000100000	1000011111	1000011111	1000100001
304	1000100010	1000100001	1000100001	1000100011
305	1000100100	1000100011	1000100011	1000100101
306	1000100110	1000100101	1000100101	1000100111
307	1000101000	1000100111	1000100111	1000101001
308	1000101010	1000101001	1000101001	1000101011
309	1000101100	1000101011	1000101011	1000101101
310	1000101110	1000101110	1000101101	1000101111
311	1000110000	1000101111	1000101111	1000110001
312	1000110010	1000110001	1000110001	1000110011
313	1000110100	1000110011	1000110011	1000110101
314	1000110110	1000110110	1000110101	1000110111
315	1000111000	1000111000	1000110111	1000111001
316	1000111010	1000111010	1000111001	1000111011
317	1000111100	1000111100	1000111011	1000111101
318	1000111110	1000111110	1000111101	1000111111
319	1001000000	1000111111	1000111111	1001000001
320	1001000010	1001000001	1001000001	1001000011
321	1001000100	1001000011	1001000011	1001000101
322	1001000110	1001000101	1001000101	1001000111
323	1001001000	1001000111	1001000111	1001001001
324	1001001010	1001001010	1001001001	1001001011
325	1001001100	1001001100	1001001011	1001001101
326	1001001110	1001001110	1001001101	1001001111
327	1001010000	1001001111	1001001111	1001010001
328	1001010010	1001010010	1001010001	1001010011
329	1001010100	1001010100	1001010011	1001010101

Table 11-2. – continued. Programmable Filter switch selections

Fc	SW 1 1 10	SW 2 1 10	SW 3 1 10	SW 4 1 10
330	1001010110	1001010110	1001010101	1001010111
331	1001011000	1001011000	1001010111	1001011001
332	1001011010	1001011010	1001011001	1001011011
333	1001011100	1001011100	1001011011	1001011101
334	1001011110	1001011110	1001011101	1001011111
335	1001100000	1001100000	1001011111	1001100001
336	1001100010	1001100010	1001100001	1001100011
337	1001100100	1001100100	1001100011	1001100101
338	1001100110	1001100110	1001100101	1001100111
339	1001101000	1001101000	1001100111	1001101001
340	1001101010	1001101010	1001101010	1001101010
341	1001101100	1001101100	1001101100	1001101100
342	1001101110	1001101110	1001101110	1001101110
343	1001110000	1001110000	1001101111	1001110001
344	1001110010	1001110010	1001110010	1001110010
345	1001110100	1001110100	1001110100	1001110100
346	1001110110	1001110110	1001110110	1001110110
347	1001111000	1001111000	1001111000	1001111000
348	1001111010	1001111010	1001111010	1001111010
349	1001111100	1001111100	1001111100	1001111100
350	1001111110	1001111110	1001111110	1001111111
351	1010000000	1001111111	1001111111	1010000001
352	1010000010	1010000001	1010000001	1010000011
353	1010000100	1010000011	1010000011	1010000101
354	1010000110	1010000101	1010000101	1010000111
355	1010001000	1010000111	1010000111	1010001001
356	1010001010	1010001001	1010001001	1010001011
357	1010001100	1010001011	1010001011	1010001101
358	1010001110	1010001110	1010001101	1010001111
359	1010010000	1010001111	1010001111	1010010001
360	1010010010	1010010001	1010010001	1010010011
361	1010010100	1010010011	1010010011	1010010101
362	1010010110	1010010110	1010010101	1010010111
363	1010011000	1010011000	1010010111	1010011001
364	1010011010	1010011010	1010011001	1010011011
365	1010011100	1010011100	1010011011	1010011101
366	1010011110	1010011110	1010011101	1010011111
367	1010100000	1010100000	1010011111	1010100001
368	1010100010	1010100010	1010100001	1010100011
369	1010100100	1010100100	1010100011	1010100101
370	1010100110	1010100110	1010100101	1010100111
371	1010101000	1010101000	1010100111	1010101001
372	1010101010	1010101010	1010101001	1010101011
373	1010101100	1010101100	1010101011	1010101101
374	1010101110	1010101110	1010101110	1010101110
375	1010110000	1010110000	1010101111	1010110001
376	1010110010	1010110010	1010110001	1010110011
377	1010110100	1010110100	1010110100	1010110100
378	1010110110	1010110110	1010110110	1010110110
379	1010111000	1010111000	1010111000	1010111000

Table 11-2. –continued. Programmable Filter switch selections

Fc	SW 1	SW 2	SW 3	SW 4
	1 10	1 10	1 10	1 10
380	1010111010	1010111010	1010111010	1010111010
381	1010111100	1010111100	1010111100	1010111100
382	1010111110	1010111110	1010111110	1010111110
383	1011000000	1011000000	1010111111	1011000001
384	1011000010	1011000010	1011000001	1011000011
385	1011000100	1011000100	1011000011	1011000101
386	1011000110	1011000110	1011000101	1011000111
387	1011001000	1011001000	1011000111	1011001001
388	1011001010	1011001010	1011001010	1011001010
389	1011001100	1011001100	1011001100	1011001100
390	1011001110	1011001110	1011001110	1011001110
391	1011010000	1011010000	1011001111	1011010001
392	1011010010	1011010010	1011010010	1011010010
393	1011010100	1011010100	1011010100	1011010100
394	1011010110	1011010110	1011010110	1011010110
395	1011011000	1011011000	1011011000	1011011000
396	1011011010	1011011010	1011011010	1011011010
397	1011011100	1011011100	1011011100	1011011100
398	1011011110	1011011110	1011011110	1011011111
399	1011100000	1011100000	1011100000	1011100000
400	1011100010	1011100010	1011100010	1011100010
401	1011100100	1011100100	1011100100	1011100100
402	1011100110	1011100110	1011100110	1011100111
403	1011101000	1011101000	1011101000	1011101001
404	1011101010	1011101010	1011101010	1011101011
405	1011101100	1011101100	1011101100	1011101101
406	1011101110	1011101110	1011101110	1011101111
407	1011110000	1011110000	1011110000	1011110001
408	1011110010	1011110010	1011110010	1011110011
409	1011110100	1011110100	1011110100	1011110101
410	1011110110	1011110110	1011110110	1011110111
411	1011111000	1011111000	1011111000	1011111001
412	1011111010	1011111010	1011111010	1011111011
413	1011111100	1011111100	1011111100	1011111101
414	1011111110	1011111110	1011111110	1011111111
415	1011111111	1100000000	1011111111	1100000000
416	1100000001	1100000000	1100000000	1100000010
417	1100000011	1100000011	1100000010	1100000100
418	1100000101	1100000101	1100000100	1100000110
419	1100000111	1100000111	1100000110	1100001000
420	1100001001	1100001001	1100001000	1100001010
421	1100001011	1100001011	1100001010	1100001100
422	1100001101	1100001101	1100001100	1100001110
423	1100001111	1100001111	1100001111	1100001111
424	1100010001	1100010001	1100010000	1100010010
425	1100010011	1100010011	1100010010	1100010100
426	1100010101	1100010101	1100010100	1100010110
427	1100010111	1100010111	1100010111	1100010111
428	1100011001	1100011001	1100011001	1100011001
429	1100011011	1100011011	1100011011	1100011011

Table 11-2. –continued. Programmable Filter switch selections

Fc	SW 1 1 10	SW 2 1 10	SW 3 1 10	SW 4 1 10
430	1100011101	1100011101	1100011101	1100011101
431	1100011111	1100011111	1100011111	1100011111
432	1100100001	1100100001	1100100001	1100100001
433	1100100011	1100100011	1100100011	1100100011
434	1100100101	1100100101	1100100101	1100100101
435	1100100111	1100100111	1100100111	1100100111
436	1100101001	1100101001	1100101001	1100101001
437	1100101011	1100101011	1100101011	1100101011
438	1100101101	1100101101	1100101101	1100101110
439	1100101111	1100101111	1100101111	1100101111
440	1100110001	1100110001	1100110001	1100110001
441	1100110011	1100110011	1100110011	1100110011
442	1100110101	1100110101	1100110101	1100110110
443	1100110111	1100110111	1100110111	1100111000
444	1100111001	1100111001	1100111001	1100111010
445	1100111011	1100111011	1100111011	1100111100
446	1100111101	1100111101	1100111101	1100111110
447	1100111111	1100111111	1100111111	1101000000
448	1101000001	1101000001	1101000001	1101000001
449	1101000011	1101000011	1101000011	1101000011
450	1101000101	1101000101	1101000101	1101000101
451	1101000111	1101000111	1101000111	1101000111
452	1101001001	1101001001	1101001001	1101001001
453	1101001011	1101001011	1101001011	1101001100
454	1101001101	1101001101	1101001101	1101001110
455	1101001111	1101001111	1101001111	1101010000
456	1101010001	1101010001	1101010001	1101010001
457	1101010011	1101010011	1101010011	1101010100
458	1101010101	1101010101	1101010101	1101010110
459	1101010111	1101010111	1101010111	1101011000
460	1101011001	1101011001	1101011001	1101011010
461	1101011011	1101011011	1101011011	1101011100
462	1101011101	1101011101	1101011101	1101011110
463	1101011111	1101011111	1101011111	1101100000
464	1101100001	1101100001	1101100001	1101100010
465	1101100011	1101100011	1101100011	1101100100
466	1101100101	1101100101	1101100101	1101100110
467	1101100111	1101100111	1101100111	1101101000
468	1101101001	1101101001	1101101001	1101101010
469	1101101011	1101101011	1101101011	1101101100
470	1101101101	1101101110	1101101101	1101101110
471	1101101111	1101101111	1101101111	1101110000
472	1101110001	1101110001	1101110001	1101110010
473	1101110011	1101110011	1101110011	1101110100
474	1101110101	1101110110	1101110101	1101110110
475	1101110111	1101111000	1101110111	1101111000
476	1101111001	1101111010	1101111001	1101111010
477	1101111011	1101111100	1101111011	1101111100
478	1101111101	1101111110	1101111101	1101111110
479	1101111111	1101111111	1101111111	1110000000

Table 11-2. –continued. Programmable Filter switch selections

Fc	SW 1 1 10	SW 2 1 10	SW 3 1 10	SW 4 1 10
480	1110000001	1110000001	1110000001	1110000001
481	1110000011	1110000011	1110000011	1110000011
482	1110000101	1110000101	1110000101	1110000101
483	1110000111	1110000111	1110000111	1110000111
484	1110001001	1110001001	1110001001	1110001001
485	1110001011	1110001011	1110001011	1110001011
486	1110001101	1110001101	1110001101	1110001101
487	1110001111	1110001111	1110001111	1110001111
488	1110010001	1110010001	1110010001	1110010001
489	1110010011	1110010011	1110010011	1110010011
490	1110010101	1110010101	1110010101	1110010110
491	1110010111	1110010111	1110010111	1110011000
492	1110011001	1110011001	1110011001	1110011010
493	1110011011	1110011011	1110011011	1110011100
494	1110011101	1110011101	1110011101	1110011110
495	1110011111	1110011111	1110011111	1110100000
496	1110100001	1110100001	1110100001	1110100010
497	1110100011	1110100011	1110100011	1110100100
498	1110100101	1110100101	1110100101	1110100110
499	1110100111	1110100111	1110100111	1110101000
500	1110101001	1110101001	1110101001	1110101010
501	1110101011	1110101011	1110101011	1110101100
502	1110101101	1110101101	1110101101	1110101110
503	1110101111	1110101111	1110101111	1110110000
504	1110110001	1110110001	1110110001	1110110010
505	1110110011	1110110011	1110110011	1110110100
506	1110110101	1110110101	1110110101	1110110110
507	1110110111	1110110111	1110110111	1110111000
508	1110111001	1110111010	1110111001	1110111010
509	1110111011	1110111100	1110111011	1110111100
510	1110111101	1110111110	1110111101	1110111110
511	1110111111	1110111111	1110111111	1111000000
512	1111000001	1111000001	1111000001	1111000010
513	1111000011	1111000011	1111000011	1111000100
514	1111000101	1111000101	1111000101	1111000110
515	1111000111	1111000111	1111000111	1111001000
516	1111001001	1111001001	1111001001	1111001010
517	1111001011	1111001011	1111001011	1111001100
518	1111001101	1111001110	1111001101	1111001110
519	1111001111	1111001111	1111001111	1111010000
520	1111010001	1111010001	1111010001	1111010010
521	1111010011	1111010011	1111010011	1111010100
522	1111010101	1111010110	1111010101	1111010110
523	1111010111	1111011000	1111010111	1111011000
524	1111011001	1111011010	1111011001	1111011010
525	1111011011	1111011100	1111011011	1111011100
526	1111011101	1111011110	1111011101	1111011110
527	1111011111	1111100000	1111011111	1111100000
528	1111100001	1111100010	1111100001	1111100010
529	1111100011	1111100100	1111100011	1111100100

Table 11-2. – continued. Programmable Filter switch selections

Fc	SW 1	SW 2	SW 3	SW 4
	1 10	1 10	1 10	1 10
530	1111100101	1111100110	1111100101	1111100110
531	1111100111	1111101000	1111100111	1111101000
532	1111101001	1111101010	1111101001	1111101010
533	1111101011	1111101100	1111101011	1111101100
534	1111101101	1111101110	1111101101	1111101110
535	1111101111	1111110000	1111101111	1111110000
536	1111110001	1111110010	1111110001	1111110010
537	1111110011	1111110100	1111110011	1111110100
538	1111110101	1111110110	1111110101	1111110110
539	1111110111	1111111000	1111110111	1111111000
540	1111111001	1111111010	1111111001	1111111010

Table 11-3. Replaceable parts, RFL 9780 RF Interface Module
Assembly No. 106500

Circuit Symbol (Figs. 11-4 & 11-5)	Description	Part Number
	CAPACITORS	
C1, 2	Capacitor, electrolytic, 47µF, 20%, 35V	1007 1578
C3-6, 8, 20-37	Capacitor, ceramic dip, 0.1µF, 10%, 50V	0120 38
C7	Capacitor, ceramic, 47pF, 5%, 200V	0125 24705
C9, 11, 12, 14	Capacitor, ceramic, 390pF, 1%, 100V	1007 1851
C10	Capacitor, ceramic, 1µF, 10%, 50V	0110 6
C13	Capacitor, tantalum, 10µF, 10%, 20V	1007 955
C15	Capacitor, ceramic, 0.47µF, 20%, 50V	0135 54742
	RESISTORS	
R1, 8	Resistor, metal film ,axial, 4.99K, 1%, 1/4W	0410 1355
R2	Resistor, metal film ,axial, 21K, 1%, 1/4W	0410 1415
R3	Resistor, metal film ,axial, 7.15K, 1%, 1/4W	0410 1370
R4	Resistor, metal film ,axial, 2.15K, 1%, 1/4W	0410 1320
R5	Resistor, metal film ,axial, 681 Ω, 1%, 1/4W	0410 1272
R6	Resistor, metal film ,axial, 215 Ω, 1%, 1/4W	0410 1224
R7, 12, 57	Resistor, metal film ,axial, 100 Ω, 1%, 1/4W	0410 1192
R9, 11	Resistor, metal film ,axial, 1K, 1%, 1/4W	0410 1288
R10	Resistor, metal film ,axial, 332 Ω, 1%, 1/4W	0410 1242
R13	Resistor, metal film ,variable, 5K, 10%, 3/4W	39538
R14, 44	Resistor, metal film ,axial, 23.7K, 1%, 1/4W	0410 1420
R15, 45	Resistor, metal film ,axial, 41.2K, 1%, 1/4W	0410 1443
R16, 46	Resistor, metal film ,variable, 20 Ω, 20%, 1/2W	105412
R17	Resistor, metal film ,precision, 27.4 Ω, 1%, 1/8W	1510 1425
R18, 47	Resistor, metal film ,axial, 1.24K, 1%, 1/4W	0410 1297
R19, 48	Resistor, metal film ,axial, 1.13K, 1%, 1/4W	0410 1293
R20, 49	Resistor, metal film ,variable, 100 Ω, 10%, 1/2W	96706
R21, 23	Resistor, metal film ,axial, 11K, 1%, 1/4W	0410 1388
R22, 51	Resistor, metal film ,axial, 11 Ω, 1%, 1/4W	0410 1100
R24, 34, 61, 71	Resistor, metal film ,axial, 1.54K, 1%, 1/4W	0410 1306
R25, 35, 62, 72	Resistor, metal film ,axial, 3.09K, 1%, 1/4W	0410 1335
R26, 36, 63, 73	Resistor, metal film ,axial, 6.19K, 1%, 1/4W	0410 1364
R27, 37, 64, 74	Resistor, metal film ,axial, 12.4K, 1%, 1/4W	0410 1393
R28, 38, 65, 75	Resistor, metal film ,axial, 24.9K, 1%, 1/4W	0410 1422
R29, 39, 66, 76	Resistor, metal film ,axial, 49.9K, 1%, 1/4W	0410 1451
R30, 40, 67, 77	Resistor, metal film ,axial, 100K, 1%, 1/4W	0410 1480
R31, 41, 68, 78	Resistor, metal film ,axial, 200K, 1%, 1/4W	0410 1509
R32, 42, 69, 79	Resistor, metal film ,axial, 402K, 1%, 1/4W	0410 1538
R33, 43, 70, 80	Resistor, metal film ,axial, 806K, 1%, 1/4W	0410 1567
R50	Resistor, metal film ,axial, 16.5K, 1%, 1/4W	0410 1405
R52	Resistor, metal film ,axial, 16.2K, 1%, 1/4W	0410 1404
R53, 54	Resistor, metal film ,axial, 40.2K, 1%, 1/4W	0410 1442
R55	Resistor, metal film ,axial, 499 Ω, 1%, 1/4W	0410 1259

Table 11-3. – continued. Replaceable parts, RFL 9780 RF Interface Module
Assembly No. 106500

Circuit Symbol (Figs. 11-4 & 11-5)	**Description**	**Part Number**
	RESISTORS - continued	
R56	Resistor, metal film ,axial, 10K, 1%, 1/4W	0410 1384
R58	Resistor, metal film ,axial, 6.49K, 1%, 1/4W	0410 1366
R59	Resistor, metal film ,axial, 7.5K, 1%, 1/4W	0410 1372
R60	Resistor, metal film ,axial, 2K, 1%, 1/4W	0410 1317
R81, 82	Resistor, fixed composition, 2.2 Ω, 5%, 1/2W	1009 1059
	SEMICONDUCTORS	
CR1, 2, 7, 8	Diode, Zener, 6.8V, 5%, 1W, 1N4736A	29752
CR3	Diode, surmetic, rectifier, 1N4001	38876
CR4	Diode, Zener, 8.2V, 5%, 1W, 1N4738A	29754
CR5, 6	Diode, silicon, 1N914B/1N4448	26482
Q1, 2, 3	Transistor, silicon, PNP, 2N3906	21565
U1-8	IC, linear, OPAMP, EL2044CN	0620 384
U9	IC, analog switch, QUAD, SPST, CMOS	0605 17
	MISCELLANEOUS COMPONENTS	
J1, 3	Connector, header, single, 3 CKT	32802 3
J2	Connector, header, dual, 6/12 CKT	32599 12
L1, 2	Inductor, molded, 56μH, 100ma	32824
P1	Connector, JK male, 64 cont, DIN	98457
SW1-4	DIP switch, 10 position, SPST	101474
TP1-7, 11-12	Test point terminal orange	98441 3
TP8	Test point, black, PC mount	38116 3
TP9	Test point, red, PC mount	38116 2
TP10	Test point, brown, PC mount	38116 4

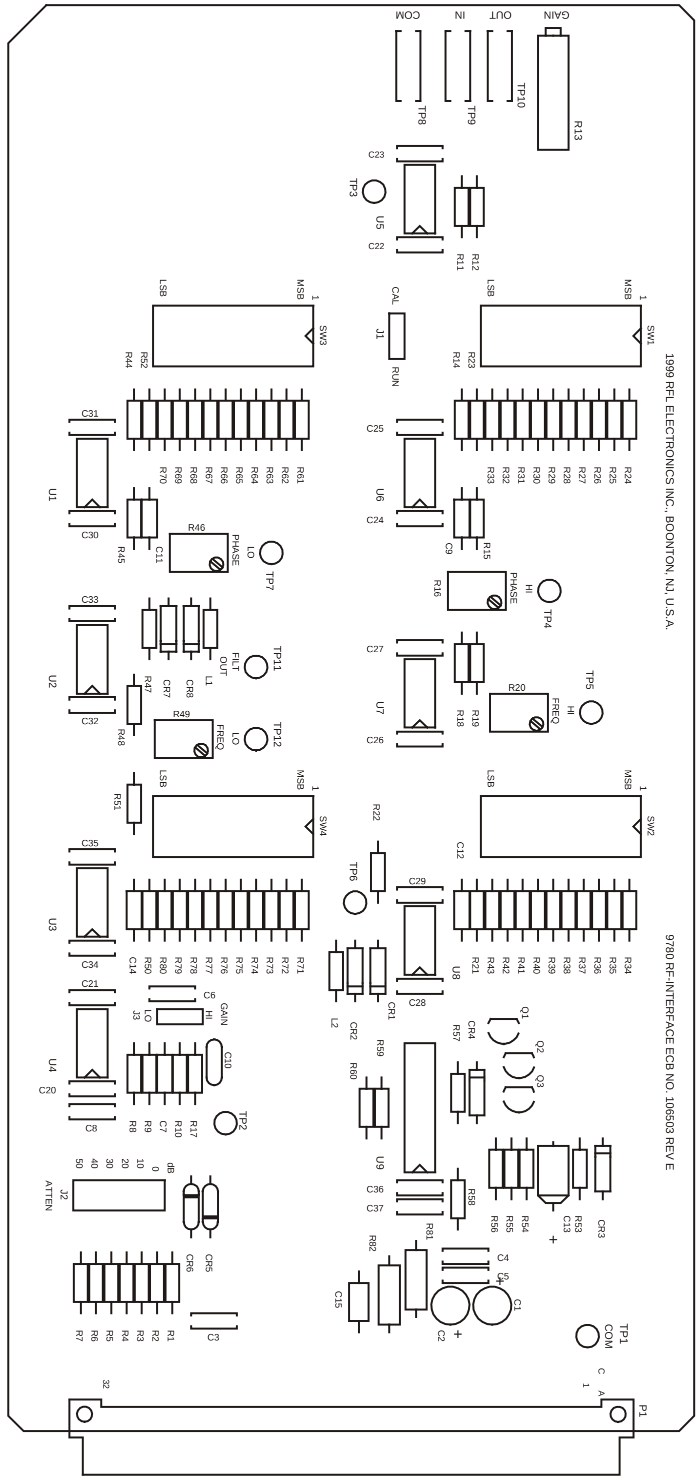

Figure 11-4. Component locator drawing, RFL 9780 RF Interface Module

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Figure 11-5. Schematic, RFL 9780 RF Interface (Dwg. No. D-106504-C)

Please see Figure 11-5 in Section 22

SECTION 12. IF/BF MODULE

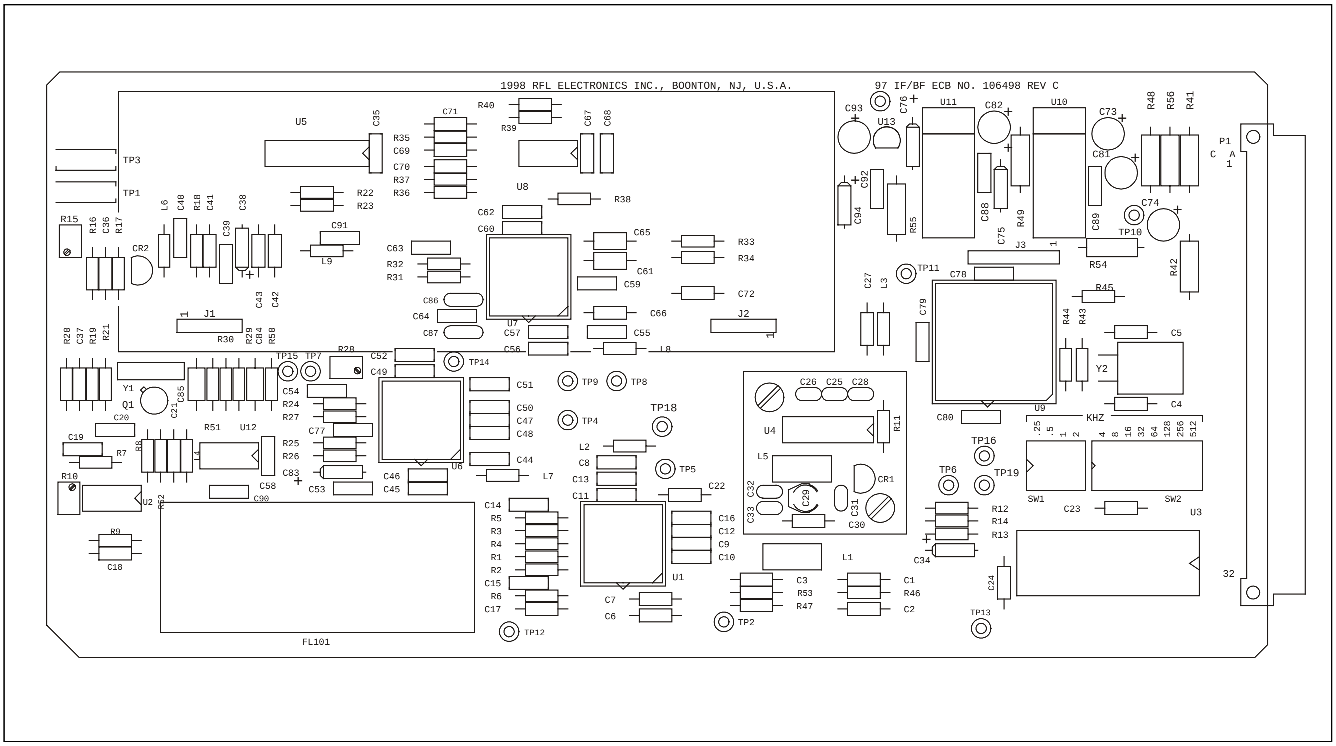

Figure 12-1. RFL 9780 IF/BF Module

12.1 DESCRIPTION

The RFL 9780 IF/BF Module (Figure 12-1) accepts incoming rf signals which are shifted down to 4kHz (the baseband frequency, or bf). Its channel filter is 3700 Hz wide, which will pass FSK signals or voice sidebands of the carrier, if present.

12.2 SPECIFICATIONS

As of the date this manual was published, the following specifications apply to all RFL 9780 IF/BF modules. Because all RFL products undergo constant refinement and improvement, these specifications are subject to change without notice.

Frequency Range: 30 to 535 kHz; frequency is adjustable in 250-Hz steps.

Bandwidth: 3700 Hz.

Input Impedance: 1574 ohms nominal.

Input Level: 63 mVrms when receiving 1/10 full power transmit signal.
200 mVrms when receiving full power transmit signal.

Output Impedance: 100 Ohms.

Output Signal: 4-kHz baseband.

12.3 THEORY OF OPERATION

The main function of the RFL 9780 IF/BF Module is to convert the incoming rf signals to a 4-kHz bf. Basically, the RFL 9780 IF/BF performs the frequency conversion by first up-converting the signal to 5.12 mHz, by using a programmable synthesized local oscillator. The signal is then fed to a crystal filter that passes the lower 3700-Hz wide sideband of the 5.12-mHz signal.

Next, the signal is down-converted to a 2-kHz carrier, and then to the 4-kHz bf. The bf signal is passed on to the RFL 9780 Carrier Level Indicator Module (Section 13) for further processing.

A block diagram of the RFL 9780 IF/BF Module appears in Figure 12-2, controls and indicators appear in Figure 12-3, a component locator drawing appears in Figure 12-4, and a schematic diagram appears in Figure 12-5.

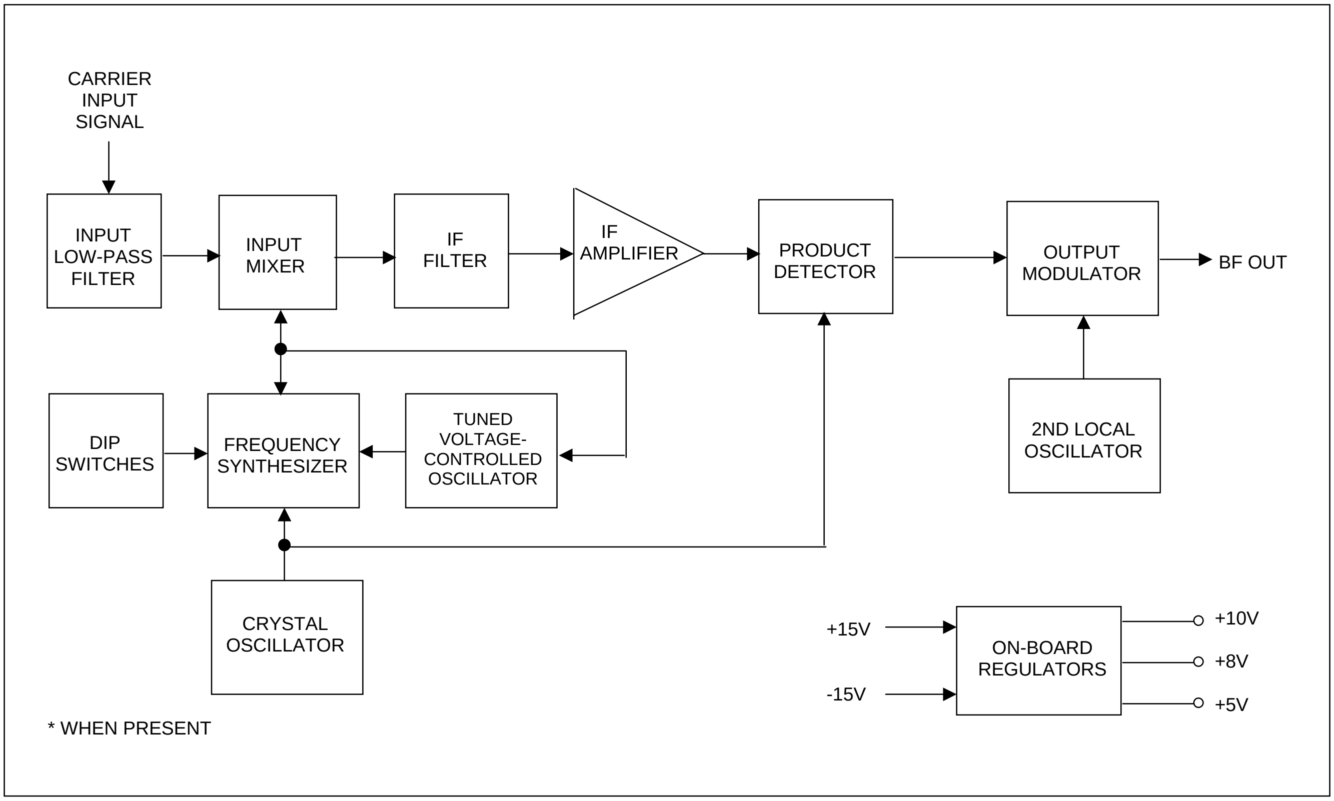

Figure 12-2. Block diagram, RFL 9780 IF/BF Module

a. Crystal Oscillator . Transistor Q1, crystal Y1, varactor CR2, and their associated components form a crystal oscillator. This oscillator serves as the beat frequency oscillator (BFO) for the product detector, as well as the frequency reference for the frequency synthesizer. The voltage applied to the cathode of CR2 determines the output frequency of the crystal oscillator. FREQ ADJ potentiometer R15 is used to adjust this voltage for an output frequency of 5.12 mHz.

b. Synthesizer. Synthesizer U3 sets the frequency at which the demodulator section will receive inputs. DIP switches SW1 and SW2 program U3 for a frequency 2 kHz below the incoming carrier frequency. This frequency difference will produce the 2-kHz if signal. Frequencies are selected by placing sections of SW1 and SW2 in the OFF position and adding up the frequencies each section represents. See paragraph 12.4.1 for more information on setting these switches.

The output of the crystal oscillator is fed to U5-15. U5 is a decade counter whose 512-kHz output (U5-4 and U5-9) is fed to U3-27. U3 divides this signal by 1024, creating a 500-Hz reference frequency. Because of this reference frequency, the synthesizer can only be programmed for frequencies that are 500 Hz apart. 250-kHz increments are accommodated by changing the frequency of the second local oscillator. See paragraph 12.3.i for more information.

Voltage-controlled oscillator U4, varactor CR1, and their associated components form a tunable VCO that is controlled by the signal at U3-4. The VCO output frequency is controlled by varactor CR1, which serves as a tuner. Capacitor C34 and resistors R13 and R14 form a filter, which sets the dynamics of this loop.

The output of the VCO is fed back to the synthesizer through U3-1. When divided by the frequency set by SW1 and SW2, the resultant frequency equals 500 Hz, and the loop is stable. Capacitor C23 attenuates very high-frequency noise, as well as harmonics of the reference frequency. The output of the VCO is also fed to the input mixer.

c. Input Low-Pass Filter. The incoming carrier enters the RFL 97 PLC IF/BF module through edge connector terminals C15 and C16. It then passes through the input low-pass filter formed from capacitors C2 and C3 and inductor L1. This filter has a cutoff frequency of 600 kHz.

d. Input Mixer (First Mixer). Mixer U1 takes the input signal and converts it to the 5.12-mHz if, by combining it with the output of the tunable VCO controlled by the synthesizer.

e. If Filter. FL101 is a ten-pole crystal filter that allows the lower 3.7-kHz sideband of the 5.12-mHz if to pass. It is used to clean up the output of the if mixer before it is fed to the if amplifier.

f. If Amplifier. Operational amplifier U2 is used to boost the output of the if filter and supplies most of the gain in the demodulator section. Its gain is controlled by potentiometer R18.

g. Product Detector (Second Mixer). The output of the if amplifier (U2-6) is fed to U6-6. U6 is the second mixer, which serves as a product detector. U6 combines the if signal with the 5.12-mHz signal generated by the crystal oscillator. The result is an audio signal, consisting of a 2-kHz carrier with upper and lower sidebands. The output of the product detector is fed through low pass filter/amplifier U12.

h. Output Modulator (Third Mixer). The carrier from the product detector is fed through potentiometer R28 to the output modulator or third mixer, formed from modulator/demodulator U7 and its associated components. The output modulator converts the carrier signal to a 4-kHz baseband signal, using the 6.00-kHz or 6.25-kHz signal provided by the second local oscillator. The modulator's output (U7-16) is buffered by operational amplifier U8.

i. Second Local Oscillator. Xilinx programmable logic chip U9, crystal Y2, and their associated components form the second local oscillator. This oscillator produces the 6.00-kHz or 6.25-kHz signal needed by the output modulator. The oscillator frequency is controlled by a selectable divide-by-N binary counter in U9 and is selected by DIP switch SW1-1.

j. Onboard Regulators. Linear voltage regulators U10, U11 and U13 serve as onboard voltage regulators. U13 converts the incoming +15-volt supply voltage to a regulated +8 volts, U11 converts it to a regulated +5 volts, and U10 converts it to a regulated +10 volts.

12.4 CONTROLS AND INDICATORS

Figure 12-3 shows the location of all controls and indicators on the IF/BF module. These controls and indicators are described in Table 12-1. All controls are accessible only when the module is removed from the chassis or is on a card extender.

Table 12-1. Controls and indicators, RFL 9780 IF/BF Module

Component Designator	Name/ Description	Function
J1	Jack	Connects voice filter module to IF/BF module
J2	Jack	Connects voice filter module to IF/BF module
J3	Jack	Test jack for loading and testing XILINX
R10	Potentiometer	Sets signal level into 2nd mixer
R15	Potentiometer	Adjusts frequency of 5.12 mHz crystal oscillator
R28	Potentiometer	Sets signal level into 3rd mixer
SW1	DIP switch	Sets 1st mixer oscillator frequency
SW2	DIP switch	Sets 1st mixer oscillator frequency
TP1	Test point	Ground
TP2	Test point	Input to 1st mixer
TP3	Test point	IF/BF output
TP4	Test point	Input to 2nd mixer
TP5	Test point	Local oscillator for 1st mixer
TP6	Test point	DC control signal for phase locked loop oscillator
TP7	Test point	Unattenuated input to 3rd mixer
TP8	Test point	Input to 3rd mixer
TP9	Test point	Output of 3rd mixer
TP10	Test point	Ground
TP11	Test point	Local oscillator frequency of 3rd mixer (6 or 6.25 kHz)
TP12	Test point	Output of 1st mixer
TP13	Test point	Signal input to IF/BF
TP14	Test point	Output of 2nd mixer
TP15	Test point	26 kHz local oscillator for mixer in voice module
TP16	Test point	+ 8Vdc
TP17	Test point	+ 5Vdc
TP18	Test point	+ 10Vdc

12.4.1 RECEIVE FREQUENCY SELECT

The first mixer stage of the IF/BF Module must be configured for the center frequency of the receive signal. Switches SW1 and SW2 are used to set the receive frequency. The resolution of the switch setting is 250 Hz and is selected by switch SW1-1. The next switch (SW1-2) has twice the value of SW1-1, and so-on. The value of each receive frequency setting switch is given in Table 12-2.

The switches are cumulative (the sum of all of the individual switch values gives the total frequency setting). The frequency selected by SW1 and SW2 must be set for 2 kHz less than the center frequency of the receive signal, rounded down to the nearest 250 Hz.

For example, a receive frequency of 68.5 kHz would be set as follows:

68.5 kHz – 2 kHz = 66.5 kHz

SW2-5	OFF	64.0 kHz
SW1-4	OFF	2.0 kHz
SW1-2	OFF	0.5 kHz
	TOTAL	66.5 kHz

Table 12-2. Receive Frequency Select Switches

Switch	Switch Value (kHz) ON	OFF
SW1-1	0	0.25
SW1-2	0	0.5
SW1-3	0	1.0
SW1-4	0	2
SW2-1	0	4
SW2-2	0	8
SW2-3	0	16
SW2-4	0	32
SW2-5	0	64
SW2-6	0	128
SW2-7	0	256
SW2-8	0	512

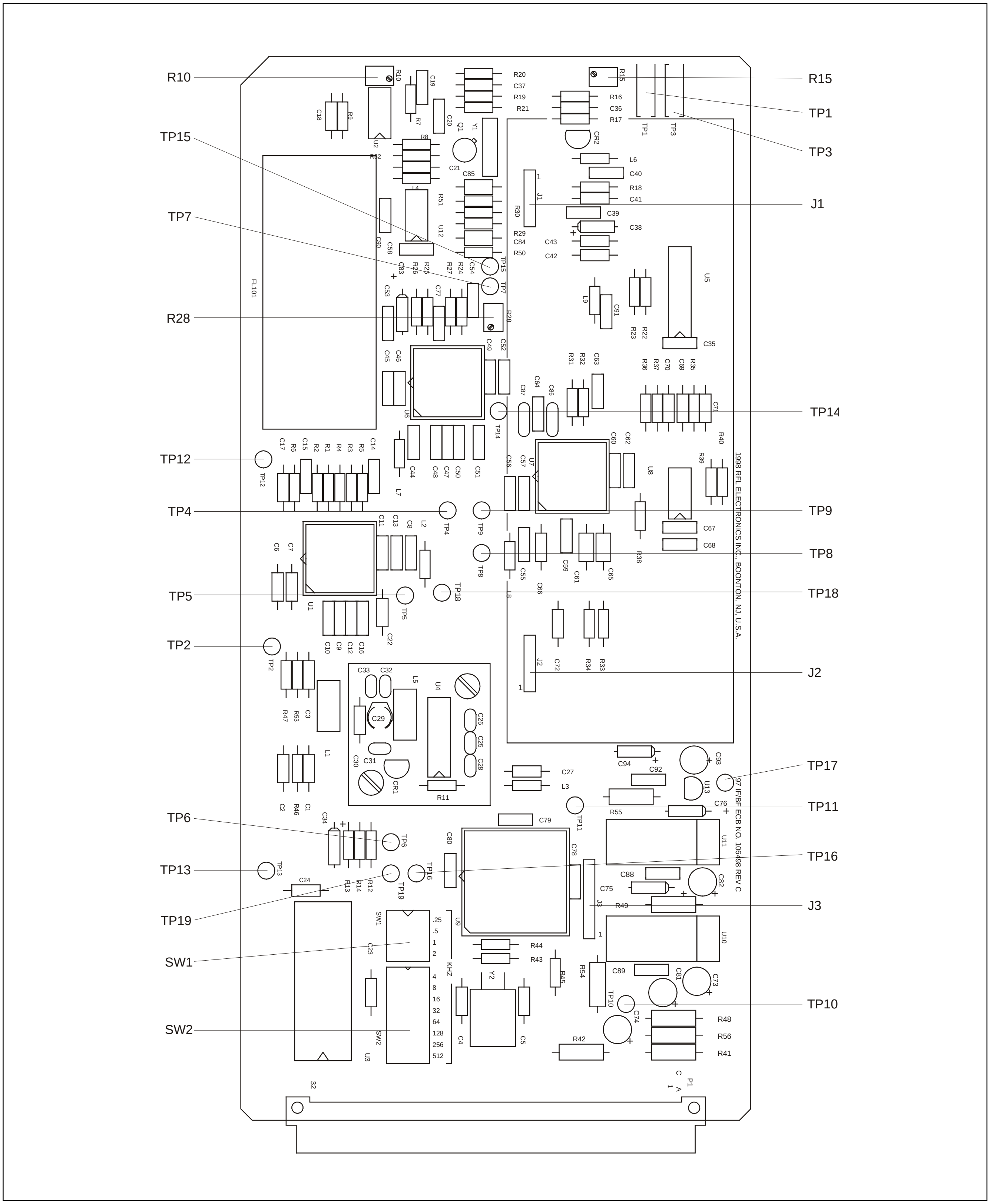

Figure 12-3. Controls and indicators, RFL 9780 IF/BF Module

Table 12-3. Replaceable parts, RFL 9780 IF/BF Module
Assembly No. 106495

Circuit Symbol (Figs. 12-4 & 12-5)	Description	Part Number
	CAPACITORS	
C1, 18, 27	Capacitor, ceramic 0.1µF, 10%, 50V	0130 51041
C2, 3	Capacitor, ceramic 330pF, 10%, 200V	0130 23311
C4, 5	Capacitor, ceramic, 22pF, 5%, 200V	0125 22205
C6, 7, 24, 37	Capacitor, ceramic, 0.001µF, 5%, 100V	0125 11025
C8-16, 19, 20, 35, 39, 40, 44-60, 62-64, 67, 68, 77-80, 88-92	Capacitor, ceramic dip, 0.1µF, 10%, 50V	0120 38
C17, 36, 69	Capacitor, ceramic, 0.01µF, 10%, 100V	0130 11031
C21	Capacitor, ceramic, 82pF, 5%, 100V	0125 18205
C22	Capacitor, ceramic, 100pF, 5%, 200V	0125 21015
C23	Capacitor, ceramic, 220pF, 10%, 200V	0130 22211
C25, 32	Capacitor, ceramic, 0.1µF, 20%, 50V	1007 1366
C26, 28, 31, 33	Capacitor, ceramic dip, 0.001µF, 10%, 50V	1007 1666
C29	Capacitor, variable ceramic, 5-25pF	30129
C30	Capacitor, ceramic, 33pF, 5%, 200V	0125 23305
C34, 38, 75, 76, 94	Capacitor, tantalum, 1µF, 20%, 35V	1007 496
C41, 42	Capacitor, ceramic, 150pF, 5%, 100V	0125 11515
C43	Capacitor, ceramic, 0.0022µF, 5%, 100V	0125 12225
C61, 65	Capacitor, ceramic 0.47µF, 20%, 50V	0135 54742
C66	Capacitor, ceramic, 5pF +1 – 0.5pF, 200V	0125 25R04
C70	Capacitor, ceramic, 100pF, 5%, 100V	0125 21015
C71	Capacitor, ceramic, 10pF, 10%, 200V	0125 21001
C72	Capacitor, ceramic 0.33µF, +80 -20%, 50V	0135 53348
C73, 74, 81, 82, 93	Capacitor, electrolytic, 47µF, 20%, 35V	1007 1578
C83	Capacitor, tantalum, 2.2µF, 10%, 25V	1007 752
C84	Capacitor, ceramic, 0.0018µF, 5%, 100V	0125 11825
C85	Capacitor, ceramic, 0.0039µF, 5%, 100V	0125 13925
C86, 87	Capacitor, ceramic, 1µF, 10%, 50V	0110 6
	RESISTORS	
R1, 2, 25, 26	Resistor, metal film, axial, 4.99K, 1%, 1/4W	0410 1355
R3	Resistor, metal film, axial, 51.1Ω, 1%, 1/4W	0410 1164
R4, 27, 31	Resistor, metal film, axial, 110Ω, 1%, 1/4W	0410 1196
R5, 24, 32	Resistor, metal film, axial, 11Ω, 1%, 1/4W	0410 1100
R6	Resistor, metal film, axial, 1.37K, 1%, 1/4W	0410 1301
R7, 30, 33, 40, 43	Resistor, metal film, axial, 1K, 1%, 1/4W	0410 1288
R8	Resistor, metal film, axial, 887Ω, 1%, 1/4W	0410 1283
R9	Resistor, metal film, axial, 348Ω, 1%, 1/4W	0410 1244
R10	Resistor, variable, ceramic, 1K, 10%, 1/4W	32993
R11	Resistor, metal film, axial, 47.5Ω,, 1%, 1/4W	0410 1161
R12	Resistor, metal film, axial, 53.6K, 1%, 1/4W	0410 1454
R13	Resistor, metal film, axial, 7.15K, 1%, 1/4W	0410 1370
R14	Resistor, metal film, axial, 4.12K, 1%, 1/4W	0410 1347
R15	Resistor, variable, ceramic, 10K, 10%, 1/4W	32996
R16	Resistor, metal film, axial, 221K, 1%, 1/4W	0410 1513

Table 12-3. – continued. Replaceable parts, RFL 9780 IF/BF Module
Assembly No. 106495

Circuit Symbol (Figs. 12-4 & 12-5)	Description	Part Number
	RESISTORS - continued	
R17, 22, 23	Resistor, metal film, axial, 100K, 1%, 1/4W	0410 1480
R18	Resistor, metal film, axial, 27.4K, 1%, 1/4W	0410 1426
R19	Resistor, metal film, axial, 47.5K, 1%, 1/4W	0410 1449
R20	Resistor, metal film, axial, 3.01K, 1%, 1/4W	0410 1334
R21	Resistor, metal film, axial, 221Ω, 1%, 1/4W	0410 1225
R28	Resistor, variable, ceramic, 5K, 10%, 1/4W	32995
R29	Resistor, metal film, axial, 1.58K, 1%, 1/4W	0410 1307
R34	Resistor, metal film, axial, 11K, 1%, 1/4W	0410 1388
R35, 45	Resistor, metal film, axial, 10K, 1%, 1/4W	0410 1384
R36, 38	Resistor, metal film, axial, 100Ω, 1%, 1/4W	0410 1192
R37	Resistor, metal film, axial, 18.7K, 1%, 1/4W	0410 1410
R39	Resistor, metal film, axial, 5.11K, 1%, 1/4W	0410 1356
R41, 42	Resistor, fixed composition, 2.2Ω, 5%, 1/2W	1009 1059
R44	Resistor, metal film, axial, 10.0M, 1%, 1/4W	0410 1672
R46	Resistor, metal film, axial, 787Ω, 1%, 1/4W	0410 1278
R47	Resistor, metal film, axial, 121Ω, 1%, 1/4W	0410 1200
R48	Resistor, metal film, axial, 10Ω, 1%, 1/2W	0410 2096
R49, 54	Resistor, metal film, axial, 47.5Ω, 1%, 1/4W	0410 2161
R50	Resistor, metal film, axial, 2.43K, 1%, 1/4W	0410 1325
R51	Resistor, metal film, axial, 590Ω, 1%, 1/4W	0410 1266
R52	Resistor, metal film, axial, 113Ω, 1%, 1/4W	0410 1197
R53	Resistor, metal film, axial, 665Ω, 1%, 1/4W	0410 1271
R55	Resistor, metal film, precision, 249Ω, 1%, 1/2W	0410 2230
	SEMICONDUCTORS	
CR1, 2	Diode	32509
Q1	Transistor, silicon, NPN, 2N918	46541
U1, 6, 7	IC, linear, mixer, AD831AP	0620 380
U2	IC, linear, opamp, EL2044CN	0620 384
U3	IC, MOS, synthesizer	0615 198
U4	IC, ECL, voltage controlled oscillator	0690 3
U5	IC, MOS, dual 4-bit decade counter	0615 252
U8	IC, linear, opamp, LM318N	0620 126
U9	IC MOS, Xilinx, XC9536	Contact factory
U10	IC, linear, voltage regulator, 5V	0620 341
U11	IC, linear, voltage regulator, 5V	0620 222
U12	IC, linear, JFET, opamp	0620, 227
U13	IC, linear, voltage regulator, 8V, pos	0620 385

Table 12-3. – continued. Replaceable parts, RFL 9780 IF/BF Module Assembly No. 106495

Circuit Symbol (Figs. 12-4 & 12-5)	Description	Part Number
	MISCELLANEOUS COMPONENTS	
FL101	Filter, crystal, 5.12mHz	32523 2
J1,2	Connector, wafer assembly, 5 ckt	42082 5
J3	Connector, header, single, 7 circuit	32802 7
L1	Inductor, molded, 220µH, 5%	46598
L2-4, 7-9	Inductor, molded, 33µH, 130 ma	32868
L5	Shielded inductor assembly	96955
L6	Inductor, molded, 100µH, 10%, 84 madc	32505 1
SW1	DIP switch, SPST, 4 position, 8 pin	98492
SW2	DIP switch, SPST, 8 position, 16 pin	98493
TP1	Test point, black	38116 3
TP2, 4-19	Test point, terminal, orange	98441 3
TP3	Test point, brown	38116 4
Y1	Crystal, 5.12 mHz	93637
Y2	Crystal, 7.8 mHz	99215 17

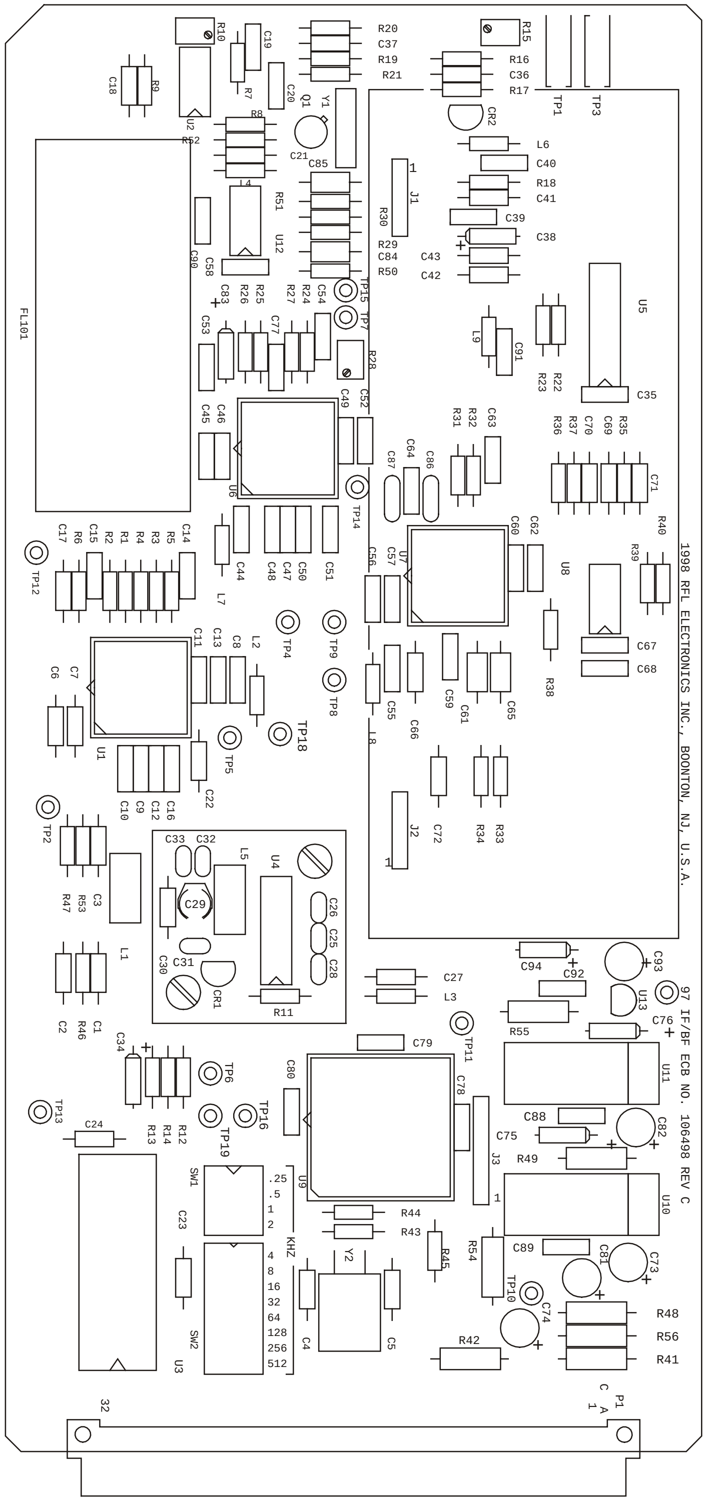

Figure 12-4. Component locator drawing, RFL 9780 IF/BF Module (Assembly No. 106495)

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Figure 12-5. Schematic, RFL 9780 IF/BF (Dwg. No. D-106499-C) Sheet 1 of 2

Please see Figure 12-5 in Section 22

Figure 12-5 Schematic, RFL 9780 IF/BF (Dwg. No. D-106499-C) Sheet 2 of 2

Please see Figure 12-5 in Section 22

SECTION 13. CARRIER LEVEL INDICATOR MODULE

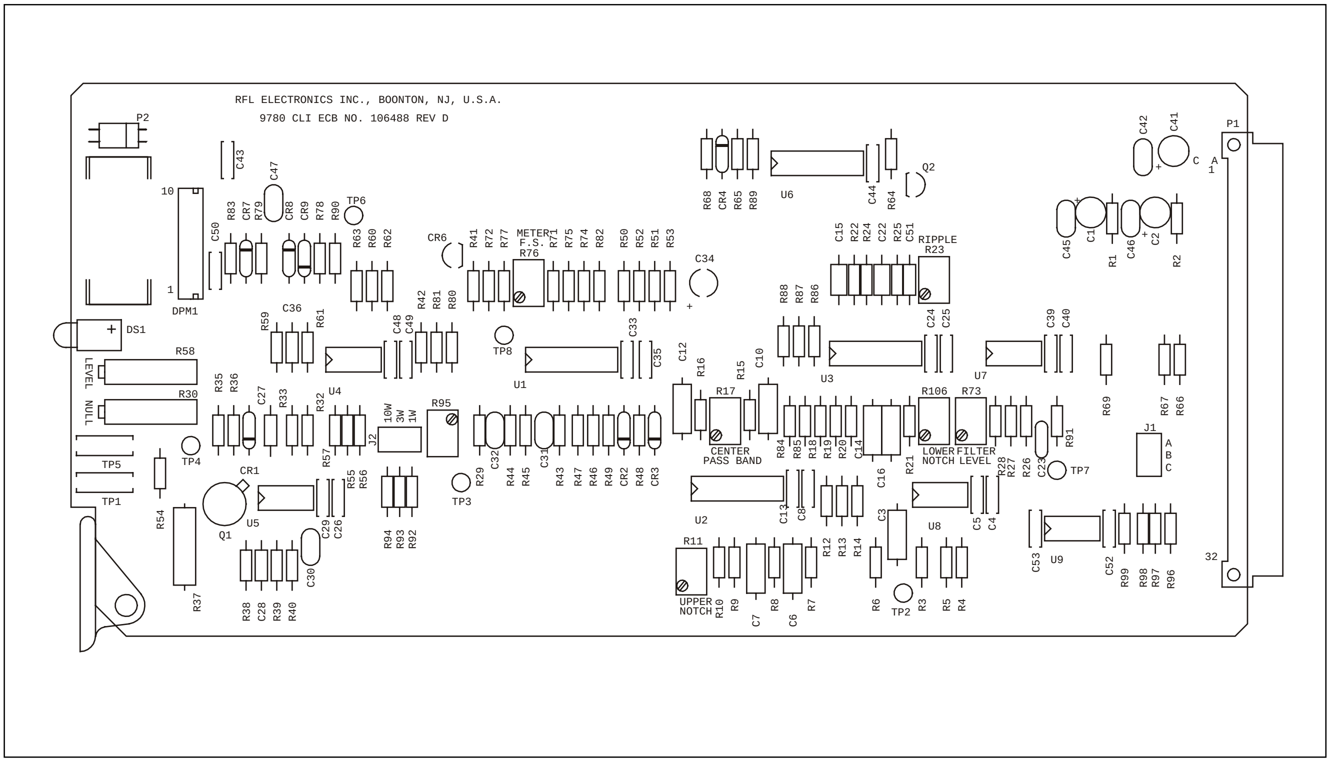

Figure 13-1. RFL 9780 Carrier Level Indicator Module

13.1 DESCRIPTION

The RFL 9780 Carrier Level Indicator Module (Fig. 13-1) contains three elements of the RFL 9780's receiving system:

1. A narrowband active band-pass filter that sets the bandpass limits for the entire receiving section.

2. A signal monitoring circuit that initiates an alarm if the received level falls below a set level.

3. A signal level indicator with a digital meter to indicate deviation of the received signal above or below the specified normal level.

13.2 SPECIFICATIONS

As of the date this manual was published, the following specifications apply to all RFL 9780 Carrier Level Indicator modules, except where indicated. Because all RFL products undergo constant refinement and improvement, these specifications are subject to change without notice.

Narrow-Band Filter:

Center Frequency: 4 kHz
Bandwidth:

106485-4: 200Hz
106485-5: 500Hz
106485-6: 1000Hz

Level Indicator:

Span: ±10 dB
Reference: Typically set to read 0 dB when transmitting a guard signal from the far end.
Accuracy: ± 5% FS nominal

External Meter Output:

Span: ± 10 dB
Reference: Typically set to read 0 dB when transmitting a 1W signal from the far end.
When configured for ±1V: Span mapped from +1.00 to –1.00 Vdc.
When configured for 0 to -100µA: Span mapped from 0 to -100µA.
When configured for 0 to -5V: Span mapped from 0 to -5 Vdc into a 5K Ohm load.

Note: External meter outputs are referenced to logic common.

Low-level alarm:

Threshold: User settable from 5dB to 25 dB below nominal full power carrier receive level.

13.3 THEORY OF OPERATION

The RFL 9780 CLI module contains a narrowband filter, a signal monitoring circuit, and a carrier level indicator. A block diagram of the RFL 9780 CLI module appears in Figure 13-2 and its schematic appears in Figure 13-5.

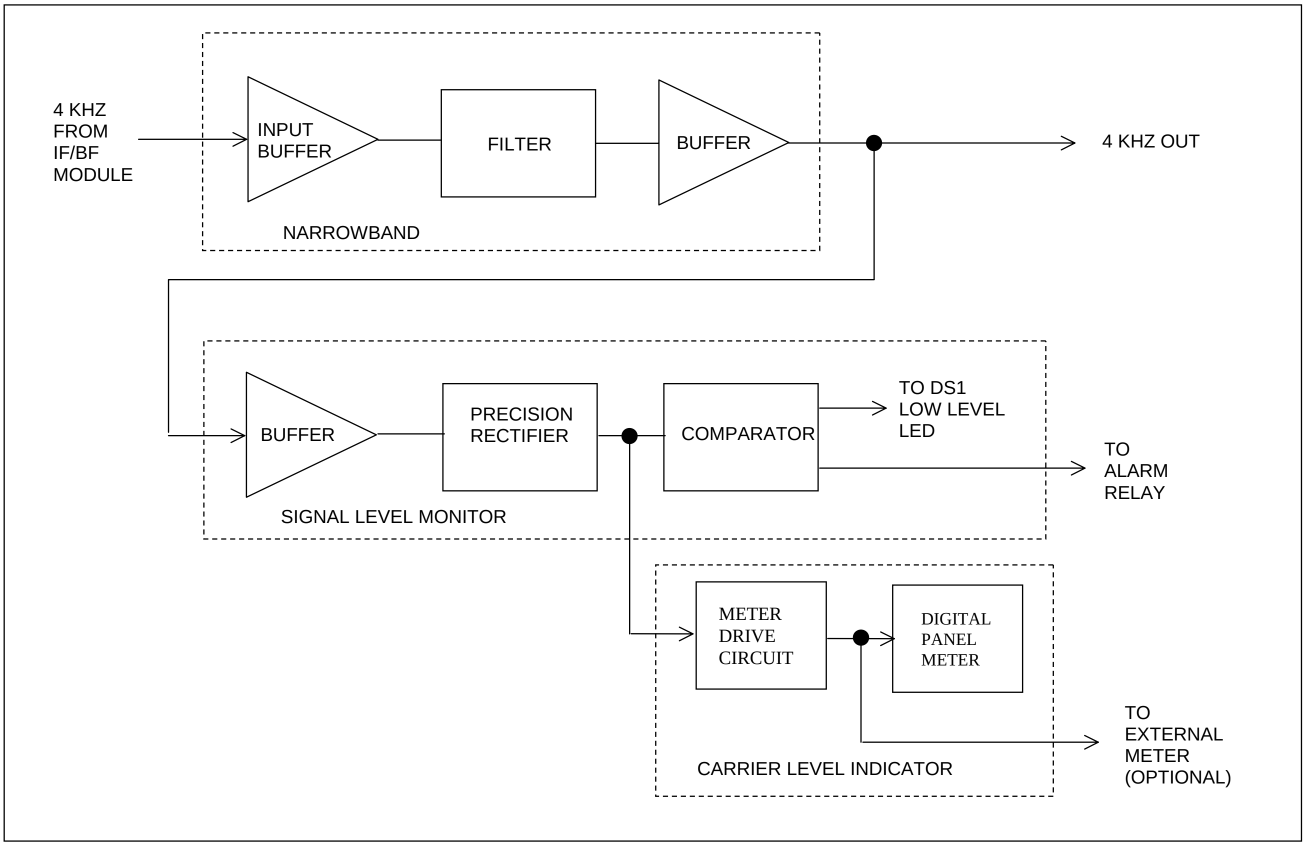

Figure 13-2. Block diagram, RFL 9780 Carrier Level Indicator Module

13.3.1 NARROWBAND FILTER

The output signal from the RFL 9780 IF/BF module (Section 12) enters the RFL 9780 CLI module at edge connector terminal C13. It is then applied to operational amplifier U8A, which serves as an input buffer. From there, it passes to an active narrowband filter, formed from quad operational amplifiers U2 and U3, and their associated components.

The 106485-4 module has a 200Hz bandwidth (BW) filter and is used in ±100 Hz shift systems. The 106485-5 and 106485-6 modules have 500 Hz and 1000Hz BW filters for ±250 and ± 500 Hz shift systems respectively.

The output of the filter is buffered by operational amplifier U7A. FILT LEVEL potentiometer R73 varies the gain of U7A, which controls the amplitude of the 4kHz OUT signal at edge connector terminal A18.

NOTE

THE ACTIVE FILTER FORMED BY U2 AND U3 IS TIGHTLY TUNED AT RFL. NONE OF THE PARTS WITHIN THIS CIRCUIT ARE FIELD REPLACEABLE. ANY COMPONENT CHANGES OR ADJUSTMENTS MADE TO THIS CIRCUIT WILL DEGRADE SYSTEM PERFORMANCE.

13.3.2 SIGNAL LEVEL MONITOR

The signal passed by the narrowband filter is fed to operational amplifier U1A, which serves as a buffer. The output of this buffer is passed through edge connector terminal A13 to the RFL 97 PLC LM/SL module for further processing. It is also fed to a precision rectifier and averager formed from operational amplifiers U1B and U1C, and their associated components.

The output of the rectifier is amplified by operational amplifier U4A, and then applied to operational amplifier U4B, which serves as a comparator. CD potentiometer R58 sets the gain for U4A which is set so that LO LEV indicator DS1 lights when the signal level falls below the desired limit.

Besides driving DS1, U4B also drives FET Q2, an open-drain FET that keeps the station alarm relay energized unless the input signal fails.

13.3.3 CARRIER LEVEL INDICATOR

The digital panel meter (DPM1) is used to provide a visual indication of any signal level deviations from normal, expressed in dB. Dual transistor Q1 and operational amplifiers U5B and U5A form a logarithmic amplifier to convert the received signal strength to dB. R37 is used to temperature compensate the log amp.

Jumper J2 and resistors R92, 93 and 94 are used to scale down the input to the logarithmic amplifier by 0dB, 3dB, or 10dB. This allows for a 0dB reading when receiving:

1. A full power carrier (typically from a 10W transmitter),
2. 30% of full power carrier (systems with a 3.33:1 trip boost, typically a 3W guard transmitter), or
3. 10% of full power carrier (systems with a 10:1 trip boost, typically a 1W guard transmitter).

R95 is an optional potentiometer that allows for differing trip boost levels.

The output of the log amp is a 0 to –5 Vdc signal. Op amp U1D is used to invert, scale, and offset this signal to convert it to a ±1.0 Vdc signal (corresponding to ±10 dB). This signal is scaled down to ±100mVdc to drive the front panel meter DPM1.

When an external ±1.0 Vdc meter is used, jumper J1 must be in the "A" position. The ±1.0 Vdc signal out of U1D will then be buffered by U7B and sent out to pin C16. The external meter is referenced to pin C17. Plus or minus 1.0 Vdc corresponds to ±10.0 dB (0 volts represents 0 dB).

When an external 0 to -100 μA meter is used, jumper J1 must be in the "B" position. This sends the output of the log amplifier through R42 and out on pin C16. The external meter return is connected to pin C17. Zero μA corresponds to –10.0 dB, -50 μA to 0 dB, and -100 μA to +10 dB.

When an external 0 to -5 Vdc meter is used, jumper J1 must be in the “C” position. This sends the output of the log amplifier (U5B) directly to pin C16. The external meter return is connected to pin C17. Zero Vdc corresponds to -10.0 dB, -2.5 Vdc corresponds to 0 dB, and -5 Vdc corresponds to +10 dB.

13.4 CONTROLS AND INDICATORS

Figure 13-3 shows the location of all controls and indicators on the RFL 9780 Carrier Level Indicator module. These controls and indicators are described in Table 13-1. Only DS1, R30 and R58 are accessible with the RFL 9780 Carrier Level Indicator Module installed in the chassis. All others are accessible when the module is removed from the chassis or is on a card extender.

Table 13-1. Controls and indicators, RFL 9780 Carrier Level Indicator

Component Designator	Name/Description	Function
DPM1	Digital Panel Meter	Displays signal level in dB.
DS1	Light Emitting Diode	When lit, indicates that the received level has dropped below a setpoint
J1	Jumper	Position “A” selects ±1 Vdc output. Position “B” selects 0 to -100µA output. Position “C” selects 0 to -5 Vdc output.
J2	3 Position Jumper	Used to scale the digital level meter for 1W, 3W or 10W operation
R11*	Potentiometer	Narrow Band filter adjust
R17*	Potentiometer	Narrow Band filter adjust
R23*	Potentiometer	Narrow Band filter adjust
R30	Potentiometer	Sets the signal level meter to zero dB (meter null)
R58	Potentiometer	Sets the alarm level alarm threshold
R73	Potentiometer	Sets the signal level at the output of the narrow-band filter (output gain)
R76*	Potentiometer	Calibrates the meter signal
R95	Potentiometer	Presently not used
R106*	Potentiometer	Narrow Band filter adjust
TP1	Test Point (black)	Signal ground
TP2	Test Point (orange)	Signal after input buffer
TP3	Test Point (orange)	Scaled signal prior to level detector circuit
TP4	Test Point (orange)	Output of logarithmic amplifier
TP5	Test Point (yellow)	Output of signal level detector and filter
TP6	Test Point (orange)	Signal applied to Digital Panel Meter
TP7	Test Point (orange)	Module output signal
TP8	Test Point (orange)	Signal applied to External Meter

*For factory use only.

NOTE

J2 Jumper Chart on Page 13-19 is used for factory alignment only

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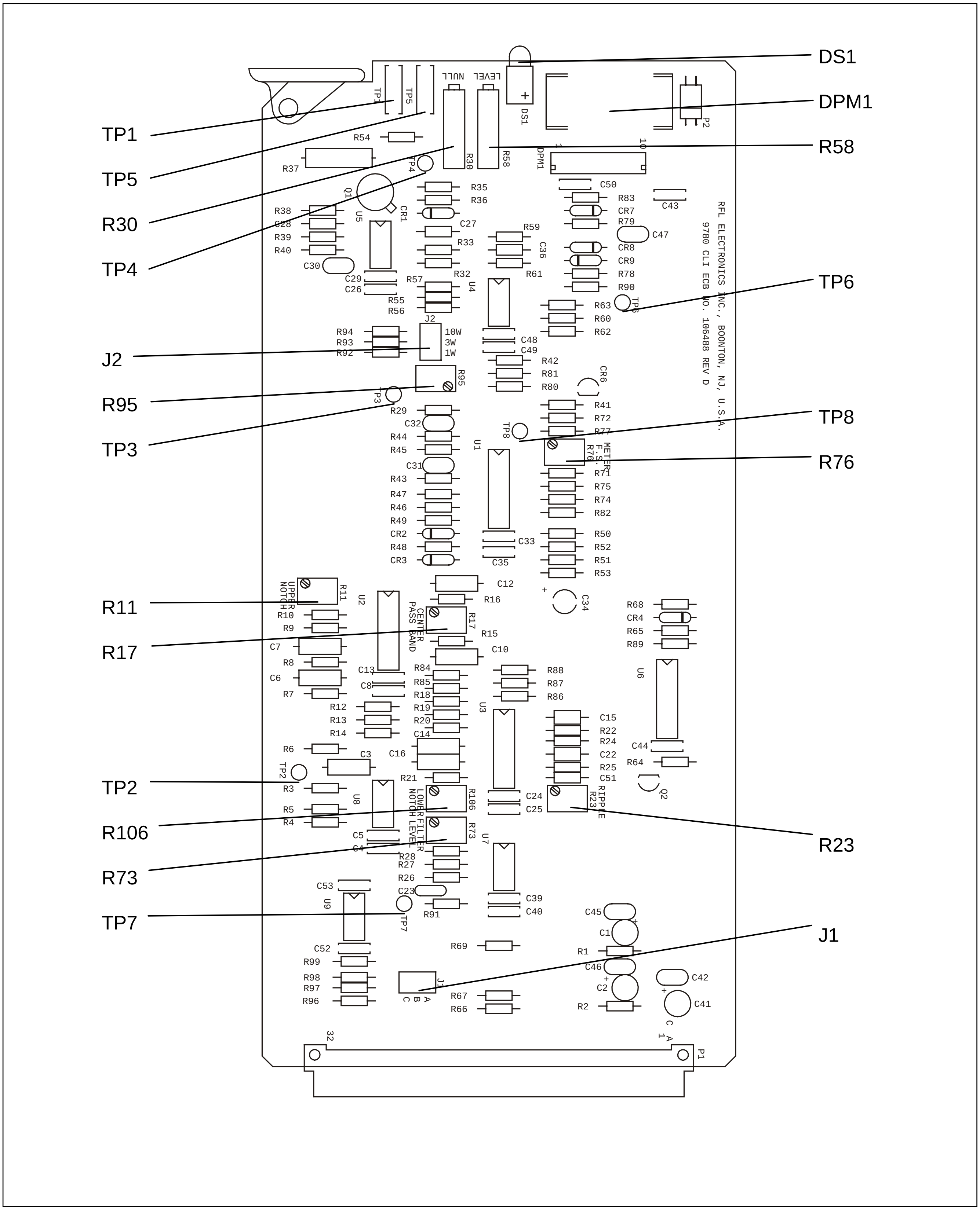

Figure 13-3. Controls and indicators, RFL 9780 Carrier Level Indicator Module

13.4.1 METER SELECT

The module can provide a signal to an external meter. The external meter output can be configured for either a current meter or a voltage meter.

With jumper J1 in the "A" position, the range of the external meter should be from +1 to -1 Vdc. This would correspond to a full-scale range of ± 10 dB, with 0 V indicating 0 dB.

With jumper J1 in the "B" position, the range of the external meter should be from 0 to -100µA. This would correspond to a full-scale range of ± 10 dB, with -50µA indicating 0 dB.

With jumper J1 in the "C" position, the range of the external meter should be from 0 to –5 Vdc. This would correspond to a full-scale range of ± 10 dB, with –2.5 Vdc indicating 0 dB.

13.4.2 METER NULL

R30 is used to null the meter to read 0 dB. This is typically performed with the system installed and the far-end station transmitting a guard signal. Note that a dramatic change in receive level may indicate a problem with the line. Following significant changes (for example, modifications to the line) the system start-up procedure must be performed.

13.4.3 ALARM LEVEL

R58 is used to set the low-level alarm threshold at the desired level. This is normally performed by attenuating a normal receive level to the desired threshold amplitude and adjusting R58 to activate the alarm.

13.4.4. GUARD LEVEL

The position of J2 is related to the desired trip boost level in accordance with the table below.

Trip Boost	J2 Position	Example
None	10W	Display will read 0dB when receiving a 10W level in a 10W/10W system.
3.33:1	3W	Display will read 0dB when receiving a 3W level in a 3W/10W system.
10:1	1W	Display will read 0dB when receiving a 1W level in a 1W/10W system.

Table 13-2. Replaceable parts, RFL 9780 Carrier Level Indicator Module
Assembly No. 106485-4

Circuit Symbol (Fig. 13-4 & 13-5)	**Description**	**Part Number**
	CAPACITORS	
C1, 2, 41	Capacitor, electrolytic, 47µF, 20%, 35V	1007 1578
C3, 6, 7, 10, 12	Capacitor, ceramic, 0.0068µF, 5%, 100V	0125 16825
C4, 5, 8, 13, 24-26, 29, 33, 35, 39, 40, 43, 44, 48-50, 52, 53	Capacitor, ceramic dip, 0.1µF, 10%, 50V	0120 38
C14, 16	Capacitor, ceramic, 0.0056µF, 5%, 100V	0125 15625
C15, 22	Capacitor, ceramic, 0.0047µF, 5%, 50V	0125 54725
C23	Capacitor, ceramic, 1µF, 10%, 50V	0110 6
C27	Capacitor, ceramic, 330pF, 10%, 200V	0130 23311
C28	Capacitor, ceramic, 150pF, 5%, 100V	0125 11515
C30, 42, 45-47	Capacitor, ceramic dip, 0.01µF, 5%, 100V	1007 1645
C31, 32	Capacitor, ceramic, 0.47µF, +80 -20%, 50V	1007 939
C34	Capacitor, tantalum, 15µF, 20%, 35V	1007 539
C36	Capacitor, ceramic, 0.047µF, 10%, 50V	0130 54731
C51	Capacitor, ceramic, 680pF, 5%, 100V	0125 16815
	RESISTORS	
R1, 2	Resistor, fixed composition, 2.7Ω, 5%, 1/4W	1009 900
R3, 28, 29, 35, 54, 66, 67, 69 90, 91, 96	Resistor, metal film, axial, 100Ω, 1%, 1/4W	0410 1192
R4	Resistor, zero ohm	1510 2217
R5	Resistor, metal film, axial, 47.5K, 1%, 1/4W	0410 1449
R6	Resistor, metal film, axial, 4.64K, 1%, 1/4W	0410 1352
R7	Resistor, metal film, axial, 4.42K, 1%, 1/4W	0410 1350
R8, 9, 15, 18	Resistor, metal film, axial, 6.04K, 1%, 1/4W	0410 1363
R10	Resistor, metal film, axial, 5.62K, 1%, 1/4W	0410 1360
R11, 17, 23, 106	Resistor, metal film, variable, 1K, 10%, 1/2W	49995
R12	Resistor, metal film, axial, 1.54K, 1%, 1/4W	0410 1306
R13	Resistor, metal film, axial, 12.1K, 1%, 1/4W	0410 1392
R14	Resistor, metal film, axial, 976Ω, 1%, 1/4W	0410 1287
R16	Resistor, metal film, axial, 5.49K, 1%, 1/4W	0410 1359
R19, R20	Resistor, metal film, axial, 7.5K, 1%, 1/4W	0410 1372
R21	Resistor, metal film, axial, 6.81K, 1%, 1/4W	0410 1368
R22, 24	Resistor, metal film, axial, 8.66K, 1%, 1/4W	0410 1378
R25	Resistor, metal film, axial, 7.87K, 1%, 1/4W	0410 1374
R26, 27	Resistor, metal film, axial, 1.96K, 1%, 1/4W	0410 1316
R30	Resistor, metal film, variable, 10K, 10%, 3/4W	39539
R32, 43, 45-48, 50, 52, 56 64, 79	Resistor, metal film, axial, 10K, 1%, 1/4W	0410 1384
R33	Resistor, metal film, axial, 26.7K, 1%, 1/4W	0410 1425
R36	Resistor, metal film, axial, 82.5K, 1%, 1/4W	0410 1472

Table 13-2. - continued. Replaceable parts, RFL 9780 Carrier Level Indicator Module Assembly No. 106485-4

Circuit Symbol (Fig. 13-4 & 13-5)	Description	Part Number
	RESISTORS – continued	
R37	Thermistor, resistor, 1000Ω, 1%	91529
R38	Resistor, metal film, axial, 2.21K, 1%, 1/4W	0410 1321
R39	Resistor, metal film, axial, 1.5M, 1%, 1/4W	0410 1593
R40	Resistor, metal film, axial, 1.21M, 1%, 1/4W	0410 1584
R41	Resistor, metal film, axial, 4.12K, 1%, 1/4W	0410 1347
R42	Resistor, metal film, axial, 48.7K, 1%, 1/4W	0410 1450
R44	Resistor, metal film, axial, 3.65K, 1%, 1/4W	0410 1342
R49	Resistor, metal film, axial, 4.75K, 1%, 1/4W	0410 1353
R51, 61	Resistor, metal film, axial, 4.99K, 1%, 1/4W	0410 1355
R53	Resistor, metal film, axial, 11.5K, 1%, 1/4W	0410 1390
R55	Resistor, metal film, axial, 2.49K, 1%, 1/4W	0410 1326
R57, 68, 74, 78, 80, 97, 98	Resistor, metal film, axial, 1K, 1%, 1/4W	0410 1288
R58	Resistor, metal film, variable, 25K, 10%, 3/4W	45829
R59, 62	Resistor, metal film, axial, 2K, 1%, 1/4W	0410 1317
R60	Resistor, metal film, axial, 39.2K, 1%, 1/4W	0410 1441
R63	Resistor, metal film, axial, 475K, 1%, 1/4W	0410 1545
R71, 82	Resistor, metal film, axial, 100K, 1%, 1/4W	0410 1480
R65	Resistor, metal film, axial, 5.36K, 1%, 1/4W	0410 1358
R72, 81, 83	Resistor, metal film, axial, 1.5K, 1%, 1/4W	0410 1305
R73	Resistor, metal film, variable, 50K, 10%, 1/2W	93667
R75	Resistor, metal film, axial, 95.3K, 1%, 1/4W	0410 1478
R76	Resistor, metal film, variable, 20K, 10%, 1/2W	44529
R77	Resistor, metal film, axial, 9.09K, 1%, 1/4W	0410 1380
R84	Resistor, metal film, axial, 1.07K, 1%, 1/4W	0410 1291
R85	Resistor, metal film, axial, 12.7K, 1%, 1/4W	0410 1394
R86	Resistor, metal film, axial, 2.43K, 1%, 1/4W	0410 1325
R87	Resistor, metal film, axial, 22.6K, 1%, 1/4W	0410 1418
R88	Resistor, metal film, axial, 13.7K, 1%, 1/4W	0410 1397
R89	Resistor, metal film, axial, 3.01K, 1%, 1/4W	0410 1334
R92	Resistor, metal film, axial, 422Ω, 1%, 1/4W	0410 1252
R93	Resistor, metal film, axial, 261Ω, 1%, 1/4W	0410 1232
R94	Resistor, metal film, axial, 316Ω, 1%, 1/4W	0410 1240
R99	Resistor, metal film, axial, 499Ω, 1%, 1/4W	0410 1259
	SEMICONDUCTORS	
CR1, 2, 3, 8, 9	Diode, silicon, 1N914B/1N4448	26482
CR4	Diode, general purpose, 1N4148	101778
CR6	Integrated circuit, voltage reference diode, 2.5V, 1.5%	0620 218
CR7	Diode, Zener, 5.1V, 500mw, 1N5231B	35027
Q1	Transistor, silicon, NPN, 2N2915	17128
Q2	Transistor, VMOS, FET, VN10KM	0715 13
U1	Integrated circuit, linear, QUAD, op-amp	0620 386
U2, 3	Integrated circuit, linear, JFET, op-amp	0620 182
U4, 5, 7, 8	Integrated circuit, linear, JFET, op-amp	0620 227
U6	Integrated circuit, MOS, HEX inverter	0615 271
U9	Integrated circuit, precision, op-amp	0620 322

Table 13-2. - continued. Replaceable parts, RFL 9780 Carrier Level Indicator Module
Assembly No. 106485-4

Circuit Symbol (Fig. 13-4 & 13-5)	**Description**	**Part Number**
	MISCELLANEOUS COMPONENTS	
DS1	Opto device, single LED, red	98534
DPM1	Meter, panel, LCD display	101466 1
J1, 2	Jumper, connector, programmable	98306
P1	Connector, JK male, 64 contact, DIN	98457
TP1	Test point, black, PC mount	38116 3
TP2, 3, 4, 6, 7, 8	Test point, terminal, orange	98441 3
TP5	Test point, yellow, PC mount	38116 8

Table 13-3. Replaceable parts, RFL 9780 Carrier Level Indicator Module
Assembly No. 106485-5

Circuit Symbol (Fig. 13-4 & 13-5)	Description	Part Number
	CAPACITORS	
C1, 2, 41	Capacitor, electrolytic, 47μF, 20%, 35V	1007 1578
C3, 6, 7, 10, 12	Capacitor, ceramic, 0.0068μF, 5%, 100V	0125 16825
C4, 5, 8, 13, 24-26, 29, 33, 35, 39, 40, 43, 44, 48-50, 52, 53	Capacitor, ceramic dip, 0.1μF, 10%, 50V	0120 38
C14, 16	Capacitor, ceramic, 0.0033μF, 5%, 100V	0125 13325
C15, 22	Capacitor, ceramic, 0.0056μF, 5%, 100V	0125 12225
C23	Capacitor, ceramic, 1μF, 10%, 50V	0110 6
C27	Capacitor, ceramic, 330pF, 10%, 200V	0130 23311
C28	Capacitor, ceramic, 150pF, 5%, 100V	0125 11515
C30, 42, 45-47	Capacitor, ceramic dip, 0.01μF, 5%, 100V	1007 1645
C31, 32	Capacitor, ceramic, 0.47μF, +80 -20%, 50V	1007 939
C34	Capacitor, tantalum, 15μF, 20%, 35V	1007 539
C36	Capacitor, ceramic, 0.047μF, 10%, 50V	0130 54731
C51	Capacitor, ceramic, 680pF, 5%, 100V	0125 16815
	RESISTORS	
R1, 2	Resistor, fixed composition, 2.7Ω, 5%, 1/4W	1009 900
R3, 28, 29, 35, 54, 66, 67, 69, 90, 91, 96	Resistor, metal film, axial, 100Ω, 1%, 1/4W	0410 1192
R4	Resistor, zero ohm	0510 2217
R5	Resistor, metal film, axial, 47.5K, 1%, 1/4W	0410 1449
R6, 8, 9	Resistor, metal film, axial, 4.22K, 1%, 1/4W	0410 1348
R7	Resistor, metal film, axial, 2.1K, 1%, 1/4W	0410 1319
R10	Resistor, metal film, axial, 3.83K, 1%, 1/4W	0410 1344
R11, 17, 106	Resistor, metal film, variable, 1K, 10%, 1/2W	49995
R12, 26, 27	Resistor, metal film, axial, 1.96K, 1%, 1/4W	0410 1316
R13, 19, 20	Resistor, metal film, axial, 13K, 1%, 1/4W	0410 1395
R14, 89	Resistor, metal film, axial, 3.01K, 1%, 1/4W	0410 1334
R15, 18	Resistor, metal film, axial, 6.49K, 1%, 1/4W	0410 1366
R16	Resistor, metal film, axial, 6.04K, 1%, 1/4W	0410 1363
R21	Resistor, metal film, axial, 12.4K, 1%, 1/4W	0410 1393
R22, 24, 25	Resistor, metal film, axial, 20K, 1%, 1/4W	0410 1413
R23	Resistor, metal film, variable, 5K, 10%, 1/2W	94271
R30	Resistor, metal film, variable, 10K, 10%, 3/4W	39539
R32, 43, 45-48, 50, 52, 56 64, 79	Resistor, metal film, axial, 10K, 1%, 1/4W	0410 1384
R33, 85	Resistor, metal film, axial, 26.7K, 1%, 1/4W	0410 1425
R36	Resistor, metal film, axial, 82.5K, 1%, 1/4W	0410 1472
R37	Thermistor, resistor, 1000Ω, 1%	91529
R38	Resistor, metal film, axial, 2.21K, 1%, 1/4W	0410 1321

Table 13-3. – continued. Replaceable parts, RFL 9780 Carrier Level Indicator Module Assembly No. 106485-5

Circuit Symbol (Fig. 13-4 & 13-5)	Description	Part Number
	RESISTORS - continued	
R39	Resistor, metal film, axial, 1.5M, 1%, 1/4W	0410 1593
R40	Resistor, metal film, axial, 1.21M, 1%, 1/4W	0410 1584
R41	Resistor, metal film, axial, 4.12K, 1%, 1/4W	0410 1347
R42	Resistor, metal film, axial, 48.7K, 1%, 1/4W	0410 1450
R44	Resistor, metal film, axial, 3.65K, 1%, 1/4W	0410 1342
R49	Resistor, metal film, axial, 4.75K, 1%, 1/4W	0410 1353
R51, 61	Resistor, metal film, axial, 4.99K, 1%, 1/4W	0410 1355
R53	Resistor, metal film, axial, 11.5K, 1%, 1/4W	0410 1390
R55	Resistor, metal film, axial, 2.49K, 1%, 1/4W	0410 1326
R57, 68, 74, 78, 80, 97, 98	Resistor, metal film, axial, 1K, 1%, 1/4W	0410 1288
R58	Resistor, metal film, variable, 25K, 10%, 3/4W	45829
R59, 62	Resistor, metal film, axial, 2K, 1%, 1/4W	0410 1317
R60	Resistor, metal film, axial, 39.2K, 1%, 1/4W	0410 1441
R63	Resistor, metal film, axial, 475K, 1%, 1/4W	0410 1545
R71, 82	Resistor, metal film, axial, 100K, 1%, 1/4W	0410 1480
R65	Resistor, metal film, axial, 5.36K, 1%, 1/4W	0410 1358
R72, 81, 83	Resistor, metal film, axial, 1.5K, 1%, 1/4W	0410 1305
R73	Resistor, metal film, variable, 50K, 10%, 1/2W	93667
R75	Resistor, metal film, axial, 95.3K, 1%, 1/4W	0410 1478
R76	Resistor, metal film, variable, 20K, 10%, 1/2W	44529
R77	Resistor, metal film, axial, 9.09K, 1%, 1/4W	0410 1380
R84	Resistor, metal film, axial, 3.4K, 1%, 1/4W	0410 1399
R86	Resistor, metal film, axial, 12.8K, 1%, 1/4W	0410 1394
R87, 88	Resistor, metal film, axial, 45.3K, 1%, 1/4W	0410 1447
R92	Resistor, metal film, axial, 422Ω, 1%, 1/4W	0410 1252
R93	Resistor, metal film, axial, 261Ω, 1%, 1/4W	0410 1232
R94	Resistor, metal film, axial, 316Ω, 1%, 1/4W	0410 1240
R99	Resistor, metal film, axial, 499Ω, 1%, 1/4W	0410 1259
	SEMICONDUCTORS	
CR1, 2, 3, 8, 9	Diode, silicon, 1N914B/1N4448	26482
CR4	Diode, general purpose, 1N4148	101778
CR5	Diode, Zener, 3.6V, 5%, 1N5227B	101527
CR6	Integrated circuit, voltage reference diode, 2.5V, 1.5%	0620 218
CR7	Diode, Zener, 5.1V, 500mw, 1N5231B	35027
Q1	Transistor, silicon, NPN, 2N2915	17128
Q2	Transistor, VMOS, FET, VN10KM	0715 13
U1	Integrated circuit, linear, QUAD, op-amp	0620 386
U2, 3	Integrated circuit, linear, JFET, op-amp	0620 182
U4, 5, 7, 8	Integrated circuit, linear, JFET, op-amp	0620 227
U6	Integrated circuit, MOS, HEX inverter	0615 271
U9	Integrated circuit, linear precision op-amp	0620 322

Table 13-3. - continued. Replaceable parts, RFL 9780 Carrier Level Indicator Module Assembly No. 106485-5

Circuit Symbol (Fig. 13-4 & 13-5)	**Description**	**Part Number**
	MISCELLANEOUS COMPONENTS	
DS1	Opto device, single LED, red	98534
DPM1	Meter, panel, LCD display	101466 1
J1, J2	Jumper, connector, programmable	98306
P1	Connector, JK male, 64 contact, DIN	98457
TP1	Test point, black, PC mount	38116 3
TP2, 3, 4, 6, 7, 8	Test point, terminal, orange	98441 3
TP5	Test point, yellow, PC mount	38116 8

Table 13-4. Replaceable parts, RFL 9780 Carrier Level Indicator Module
Assembly No. 106485-6

Circuit Symbol (Fig. 13-4 & 13-5)	Description	Part Number
	CAPACITORS	
C1, 2, 41	Capacitor, electrolytic, 47µF, 20%, 35V	1007 1578
C3, 6, 7, 10, 12	Capacitor, ceramic, 0.0068µF, 5%, 100V	0125 16825
C4, 5, 8, 13, 24-26, 29, 33, 35, 39, 40, 43, 44, 48-50, 52, 53	Capacitor, ceramic dip, 0.1µF, 10%, 50V	0120 38
C14, 16	Capacitor, ceramic, 0.0027µF, 5%, 100V	0125 12725
C15, 22	Capacitor, ceramic, 0.0047µF, 5%, 50V	0125 54725
C23	Capacitor, ceramic, 1µF, 10%, 50V	0110 6
C27	Capacitor, ceramic, 330pF, 10%, 200V	0130 23311
C28	Capacitor, ceramic, 150pF, 5%, 100V	0125 11515
C30, 42, 45-47	Capacitor, ceramic dip, 0.01µF, 5%, 100V	1007 1645
C31, 32	Capacitor, ceramic, 0.47µF, +80 -20%, 50V	1007 939
C34	Capacitor, tantalum, 15µF, 20%, 35V	1007 539
C36	Capacitor, ceramic, 0.047µF, 10%, 50V	0130 54731
C51	Capacitor, ceramic, 680pF, 5%, 100V	0125 16815
	RESISTORS	
R1, 2	Resistor, fixed composition, 2.7Ω, 5%, 1/4W	1009 900
R3, 28, 29, 35, 54, 66, 67, 69 90, 91, 96	Resistor, metal film, axial, 100Ω, 1%, 1/4W	0410 1192
R4	Resistor, zero ohm	1510 2217
R5	Resistor, metal film, axial, 47.5K, 1%, 1/4W	0410 1449
R6, 44	Resistor, metal film, axial, 3.65K, 1%, 1/4W	0410 1342
R7	Resistor, metal film, axial, 2.43K, 1%, 1/4W	0410 1325
R8, 9, 15, 18	Resistor, metal film, axial, 6.65K, 1%, 1/4W	0410 1367
R10, 16, 84	Resistor, metal film, axial, 6.19K, 1%, 1/4W	0410 1364
R11, 17, 23, 106	Resistor, metal film, variable, 1K, 10%, 1/2W	49995
R12	Resistor, metal film, axial, 3.92K, 1%, 1/4W	0410 1345
R13	Resistor, metal film, axial, 13.3K, 1%, 1/4W	0410 1396
R14	Resistor, metal film, axial, 6.34K, 1%, 1/4W	0410 1365
R19, R20	Resistor, metal film, axial, 16.9K, 1%, 1/4W	0410 1406
R21	Resistor, metal film, axial, 16.5K, 1%, 1/4W	0410 1405
R22, 24, 32, 43, 45-48, 50, 52, 56, 64, 79	Resistor, metal film, axial, 10K, 1%, 1/4W	0410 1384
R25	Resistor, metal film, axial, 9.31K, 1%, 1/4W	0410 1381
R26, 27	Resistor, metal film, axial, 15K, 1%, 1/4W	0410 1316
R30	Resistor, metal film, variable, 10K, 10%, 3/4W	39539
R33	Resistor, metal film, axial, 26.7K, 1%, 1/4W	0410 1425
R36	Resistor, metal film, axial, 82.5K, 1%, 1/4W	0410 1472

Table 13-4. - continued. Replaceable parts, RFL 9780 Carrier Level Indicator Module Assembly No. 106485-6

Circuit Symbol (Fig. 13-4 & 13-5)	Description	Part Number
	RESISTORS – continued	
R37	Thermistor, resistor, 1000Ω, 1%	91529
R38	Resistor, metal film, axial, 2.21K, 1%, 1/4W	0410 1321
R39	Resistor, metal film, axial, 1.5M, 1%, 1/4W	0410 1593
R40	Resistor, metal film, axial, 1.21M, 1%, 1/4W	0410 1584
R41	Resistor, metal film, axial, 4.12K, 1%, 1/4W	0410 1347
R42, 85	Resistor, metal film, axial, 48.7K, 1%, 1/4W	0410 1450
R49	Resistor, metal film, axial, 4.75K, 1%, 1/4W	0410 1353
R51, 61	Resistor, metal film, axial, 4.99K, 1%, 1/4W	0410 1355
R53	Resistor, metal film, axial, 11.5K, 1%, 1/4W	0410 1390
R55	Resistor, metal film, axial, 2.49K, 1%, 1/4W	0410 1326
R57, 68, 74, 78, 80, 97, 98	Resistor, metal film, axial, 1K, 1%, 1/4W	0410 1288
R58	Resistor, metal film, variable, 25K, 10%, 3/4W	45829
R59, 62	Resistor, metal film, axial, 2K, 1%, 1/4W	0410 1317
R60	Resistor, metal film, axial, 39.2K, 1%, 1/4W	0410 1441
R63	Resistor, metal film, axial, 475K, 1%, 1/4W	0410 1545
R65	Resistor, metal film, axial, 5.36K, 1%, 1/4W	0410 1358
R71, 82	Resistor, metal film, axial, 100K, 1%, 1/4W	0410 1480
R72, 81, 83	Resistor, metal film, axial, 1.5K, 1%, 1/4W	0410 1305
R73	Resistor, metal film, variable, 50K, 10%, 1/2W	93667
R75	Resistor, metal film, axial, 95.3K, 1%, 1/4W	0410 1478
R76	Resistor, metal film, variable, 20K, 10%, 1/2W	44529
R77	Resistor, metal film, axial, 9.09K, 1%, 1/4W	0410 1380
R86	Resistor, metal film, axial, 29.4K, 1%, 1/4W	0410 1429
R87	Resistor, metal film, axial, 61.9K, 1%, 1/4W	0410 1460
R88	Resistor, metal film, axial, 16.2K, 1%, 1/4W	0410 1404
R89	Resistor, metal film, axial, 3.01K, 1%, 1/4W	0410 1334
R92	Resistor, metal film, axial, 422Ω, 1%, 1/4W	0410 1252
R93	Resistor, metal film, axial, 261Ω, 1%, 1/4W	0410 1232
R94	Resistor, metal film, axial, 316Ω, 1%, 1/4W	0410 1240
R99	Resistor, metal film, axial, 499Ω, 1%, 1/4W	0410 1259
	SEMICONDUCTORS	
CR1, 2, 3, 8, 9	Diode, silicon, 1N914B/1N4448	26482
CR4	Diode, general purpose, 1N4148	101778
CR6	Integrated circuit, voltage reference diode, 2.5V, 1.5%	0620 218
CR7	Diode, Zener, 5.1V, 500mw, 1N5231B	35027
Q1	Transistor, silicon, NPN, 2N2915	17128
Q2	Transistor, VMOS, FET, VN10KM	0715 13
U1	Integrated circuit, linear, QUAD, op-amp	0620 386
U2, 3	Integrated circuit, linear, JFET, op-amp	0620 182
U4, 5, 7, 8	Integrated circuit, linear, JFET, op-amp	0620 227
U6	Integrated circuit, MOS, HEX inverter	0615 271
U9	Integrated circuit, linear, precision op-amp	0620 322

Table 13-4. - continued. Replaceable parts, RFL 9780 Carrier Level Indicator Module
Assembly No. 106485-6

Circuit Symbol (Fig. 13-4 & 13-5)	**Description**	**Part Number**
	MISCELLANEOUS COMPONENTS	
DS1	Opto device, single LED, red	98534
DPM1	Meter, panel, LCD display	101466 1
J1, J2	Jumper, connector, programmable	98306
P1	Connector, JK male, 64 contact, DIN	98457
TP1	Test point, black, PC mount	38116 3
TP2, 3, 4, 6, 7, 8	Test point, terminal, orange	98441 3
TP5	Test point, yellow, PC mount	38116 8

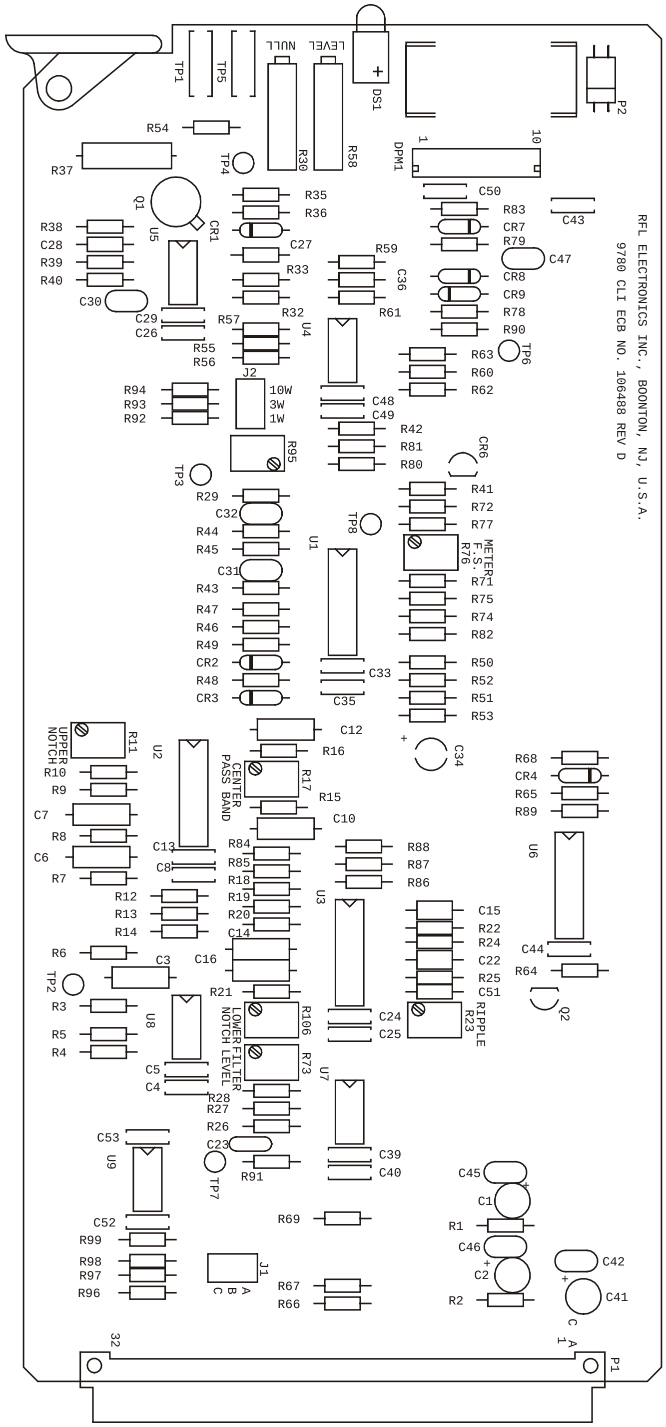

Figure 13-4. Component Locator Drawing, RFL 9780 Carrier Level Indicator Module (Assembly No. 106485)

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Figure 13-5. Schematic, RFL 9780 CLI (Dwg. No. D-106489-E) Sheet 1 of 2

Please see Figure 13-5 in Section 22

Figure 13-5 Schematic, RFL 9780 CLI (Dwg. No. D-106489-E) Sheet 2 of 2

Please see Figure 13-5 in Section 22

SECTION 14. LIMITER/SLICER MODULE

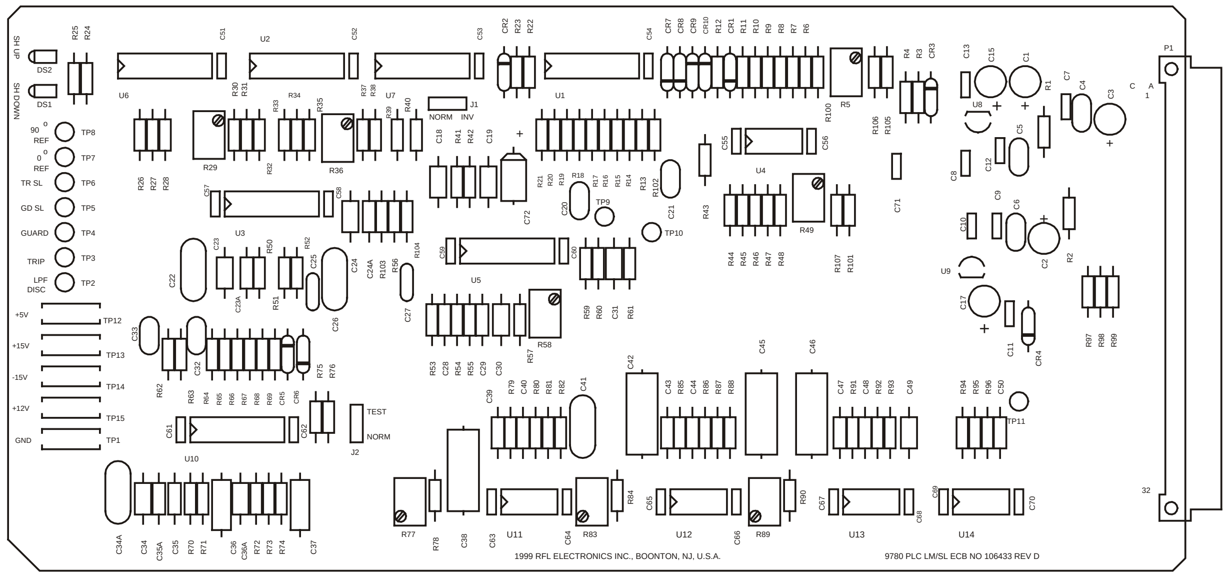

Figure 14-1. RFL 9780 Limiter/Slicer Module

14.1 DESCRIPTION

The RFL 9780 Limiter/Slicer Module (Fig. 14-1) contains two basic functions: a carrier envelope detector and filter, and a frequency discriminator. The envelope signal is sent to the Logic Module to be used in noise and loss of signal detection. The frequency discriminator outputs (Guard and Trip) control LED indicators, and sends signals to the Logic Module (Section 6) for processing. The six basic types of RFL 9780 Limiter/Slicer modules are shown in the table below.

Assembly Number	Bandwidth	Line Frequency
106430-1	200Hz	60Hz
106430-2	500Hz	
106430-3	1000Hz	
106430-11	200Hz	50Hz
106430-12	500Hz	
106430-13	1000Hz	

14.2 SPECIFICATIONS

As of the date this manual was published, the following specifications apply to all RFL 9780 Limiter/Slicer modules, except where indicated. Because all RFL products undergo constant refinement and improvement, these specifications are subject to change without notice.

Discriminator/Slicer detection:

Shift Frequency:

106430-1 & 106430-11: 100 Hz
106430-2 & 106430-12: 250 Hz
106430-3 & 106430-13: 500 Hz

Shift Direction: Selectable using programmable jumper J1 in accordance with Table 14-1.

14.3 THEORY OF OPERATION

For the following discussion of the RFL 9780 LM/SL module, refer to the block diagram in Figure 14-2 and the schematic diagram in Figure 14-5.

14.3.1 OVERVIEW

The 4 kHz signal out of the CLI module is fed into two circuit branches in the Limiter/Slicer Module. One branch performs the Limiter/Slicer functions while the other is an envelope detector. The Limiter/Slicer consists of an input limiter followed by an active discriminator, which shifts the signal by 90 degrees (at 4 kHz). This is followed by another limiter circuit. The two limited signals are then combined using an exclusive-OR which produces a 50% duty cycle 8 kHz squarewave (with 4 kHz in). The signal from the input limiter is passed through another exclusive-OR which may be used to invert the signal. Inverting the signal results in swapping the phase relationship between the two limiter signals. This, in turn results in swapping the subsequent circuitry's response to a shift up versus a shift down in frequency. Note that this feature is rarely used. Receiving a trip-up signal is accommodated by switch SW8-2 on the Logic Module as described in paragraph 6.4.17.

The 8 kHz signal is fed through a low pass filter to extract the dc component (average value) of the signal. This signal is then normalized by an amplifier stage with variable gain and offset adjustments. The resulting signal is fed into two slicer circuits (guard and trip). The guard and trip outputs can be disabled by using the block input.

The envelope detector circuit consists of a precision full-wave bridge rectifier followed by a low pass filter. This converts the amplitude of the input signal to an averaged dc level. The output of the low pass filter is then passed through a corona filter which has three notches to block the effects of corona discharge on the signal.

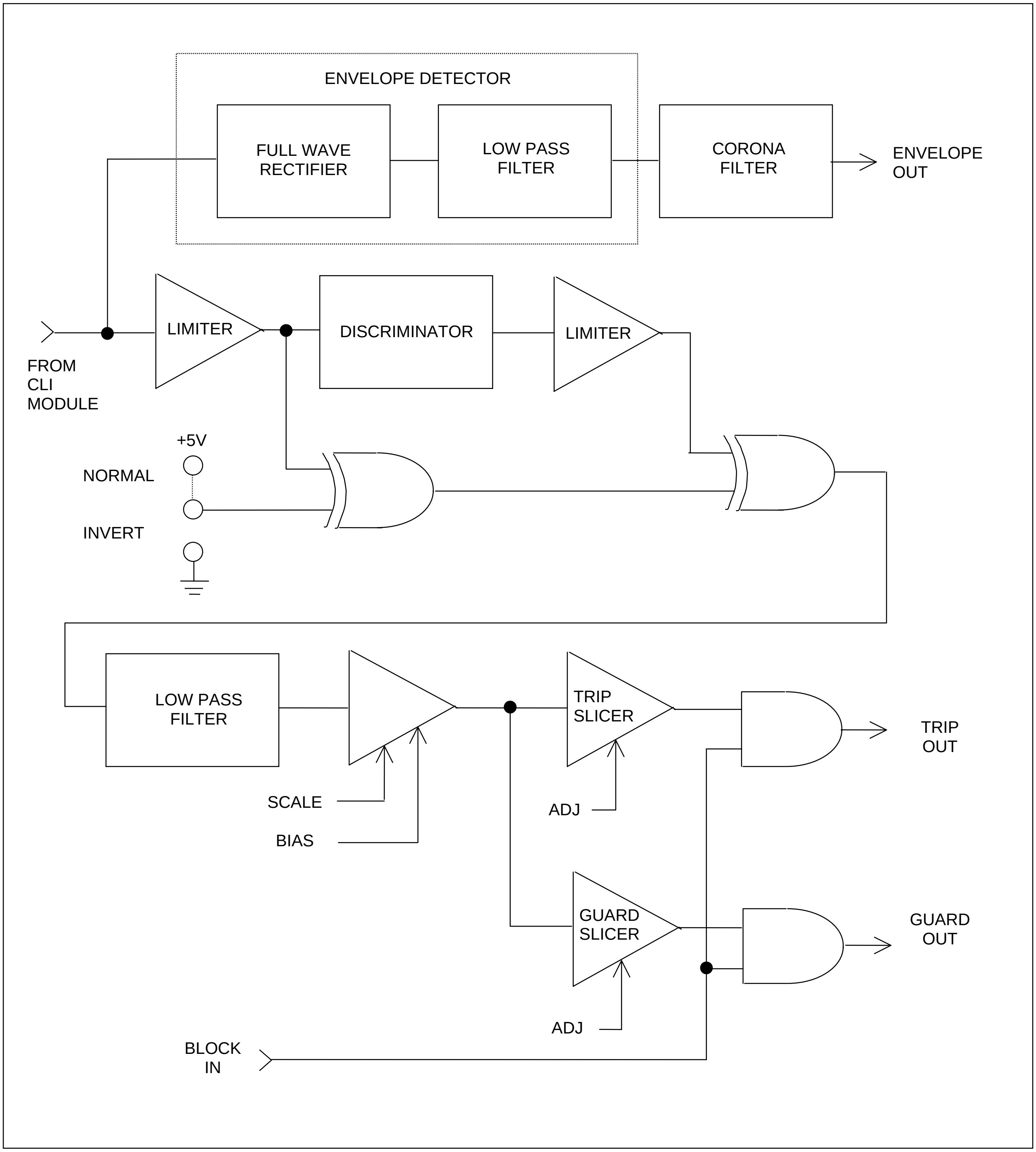

Figure 14-2. Block diagram, RFL 9780 Limiter/Slicer Module

14.3.2 INPUT LIMITER

The 4-kHz signal from the narrowband filter on the RFL 9780 CLI module enters the RFL 9780 LM/SL module at edge connector terminal C13. This signal is passed to the input limiter, which is composed of comparator U1A and is then passed to the discriminator.

NOTE

THE ACTIVE DISCRIMINATOR IS TIGHTLY TUNED AT RFL. NONE OF THE PARTS WITHIN THIS CIRCUIT ARE FIELD REPLACEABLE. ANY COMPONENT CHANGES OR ADJUSTMENTS MADE TO THIS CIRCUIT WILL DEGRADE SYSTEM PERFORMANCE.

14.3.3 ACTIVE DISCRIMINATOR

U5 and its associated components form an active discriminator, which shifts the incoming signal by 90 degrees at 4 kHz.

14.3.4 DISCRIMINATOR LIMITER

The signal produced by the discriminator passes to the discriminator limiter, composed of comparator U1B and associated components.

The output of the discriminator limiter is a square wave at the same frequency as the output of the input limiter. When the center frequency is being received, these signals are 90 degrees out of phase. They are applied to Exclusive-OR gate U7A; the signal produced by U7A is a square wave that is twice the carrier frequency, with a 50-percent duty cycle.

As the input frequency changes, the phase across the resonator U5A and U5D will lag or lead with respect to the input. Depending on the input frequency, the phase difference between the two inputs of U7A will change from -90 degrees to +90 degrees. These phase differences change the duty cycle of U7A's square wave output. The output's dc component is proportional to the pulse width, which is proportional to the input frequency. In this way, the frequency-shifted input creates an output with a dc level that is a function of frequency.

The NORMAL/INVERT jumper J1 should left in the NORM (Normal) position at all times.

14.3.5 LOW-PASS FILTER

Operational amplifiers U3A and U3B and their associated components form an active low-pass filter. This filter averages the mixed limiter signals, thus providing a DC level.

14.3.6 SCALING AND BIAS CIRCUITS

Operational amplifier U3D adds the output of the low pass filter to a bias voltage, and then amplifies the result. The output of the low pass filter is biased at approximately 2.5 volts when receiving a 4 kHz signal. To remove this bias, a negative voltage of the same value is added to the signal. This bias voltage is set using potentiometer R36 and is buffered by U3C. U3D then sums the two signals and provides a gain which is determined by the Scale potentiometer R29.

14.3.7 SLICER CIRCUITS

The slicer circuits determine whether the incoming signal is trip or guard. Comparator U4B and its associated components form the trip slicer. Its slice level is set by TRIP SLICE potentiometer R5. The slice level can be varied from approximately +28 to +4.8 volts, as measured at test point TP6. The output of the trip slicer is buffered by U1C and combined with the block signal before it is passed to edge connector terminal A14. This signal is also used to control the trip LED (DS1).

GUARD SLICE potentiometer R49 sets the slice level for the guard slicer, which is formed from Comparator U4A and its associated components. The slice level can be varied from –2.8 to –4.8 Volts, as measured at test point TP5. U1D buffers the output of the guard slicer before it is combined with the block signal and is passed to edge connector terminal A13. This signal is also used to control the guard LED (DS2).

14.3.8 AM ENVELOPE DETECTOR

The 4-kHz signal from the narrowband filter on the RFL 97 PLC CLI module is also fed to the AM envelope detector, which is comprised of quad operational amplifier U10 and its associated components. U10D serves as an input amplifier, U10C and U10B form a precision rectifier, and U10A is an active low-pass filter. The output of the low-pass filter is sent into a notch filter consisting of U11, U12 and U13. These filters are set to remove frequency components at 60, 120 and 180 Hz. These notch filters reduce the effects of corona discharge on system operation.

NOTE

THESE NOTCH FILTERS ARE TIGHTLY TUNED AT RFL. NONE OF THE PARTS WITHIN THIS CIRCUIT ARE FIELD REPLACEABLE. ANY COMPONENT CHANGES OR ADJUSTMENTS MADE TO THIS CIRCUIT WILL DEGRADE SYSTEM PERFORMANCE.

The output of the notch filter is an envelope which follows the average amplitude of the input signal. It is passed out of connector pin A17 which then goes to the Logic Module for signal analysis.

14.4 CONTROLS AND INDICATORS

Figure 14-3 shows the location of all controls and indicators on the RFL 9780 Limiter/Slicer module. These controls and indicators are described in Table 14-1. Only DS1, DS2 and TP1 through TP8 are accessible with the RFL 9780 Limiter/Slicer Module installed in the chassis. All others are accessible when the module is removed from the chassis or is on a card extender.

Table 14-1. Controls and indicators, RFL 9780 Limiter/Slicer Module

Component Designator	Name/Description	Function
DS1	Shift Down LED	Indicates that the carrier has shifted down from the center frequency
DS2	Shift Up LED	Indicates that the carrier has shifted up from the center frequency
J1	Jumper NORM/INV	Should always be in the NORM (Normal) position
J2*	Jumper TEST/NORM	Bypasses the envelope rectifier and filter
R5*	Potentiometer	Trip slice adjust
R29*	Potentiometer	Slicer scale
R36*	Potentiometer	Bias adjust
R49*	Potentiometer	Guard slice adjust
R58*	Potentiometer	Discriminator adjust
R77*	Potentiometer	60 Hz notch filter adjust
R83*	Potentiometer	120 Hz notch filter adjust
R89*	Potentiometer	180 Hz notch filter adjust
TP1	Test point, black	Signal ground
TP2	Test point terminal	Processed signal prior to entering slicing comparators
TP3	Test point terminal	Logic high indicates trip
TP4	Test point terminal	Logic high indicates guard
TP5	Test point terminal	Guard threshold
TP6	Test point terminal	Trip threshold
TP7	Test point terminal	Shaped input signal (0 Degree reference)
TP8	Test point terminal	90^{o} center frequency
TP9	Test point terminal	4 kHz input
TP10	Test point terminal	Discriminator output
TP11	Test point terminal	Envelope level to 97 PLC Logic (approx 1 Vdc)
TP12	Test point, red	+5Vdc
TP13	Test point, orange	+15Vdc
TP14	Test point, yellow	-15Vdc
TP15	Test point, purple	+12Vdc

* For factory use only.

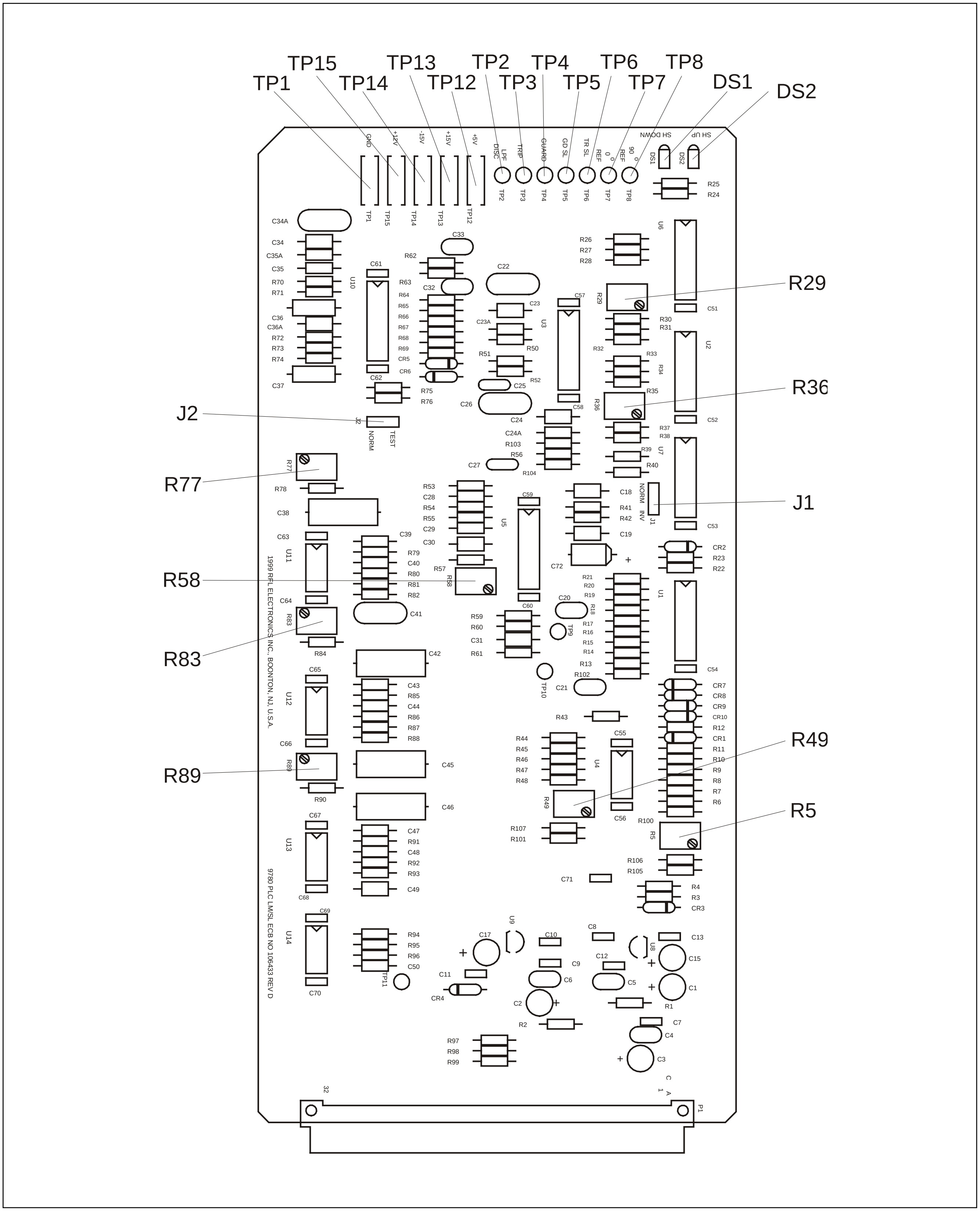

Figure 14-3. Controls and indicators, RFL 9780 Limiter/Slicer Module

Table 14-2. Replaceable parts, RFL 9780 Limiter/Slicer Module.
Assembly No. 106430-1, -2, -3, -11, -12, and –13

Circuit Symbol (Figs. 14-4 & 14-5)	Description	Part Number
	CAPACITORS	
C1, 2, 3, 15, 17	Capacitor, tantalum, 47µF, 20%, 35V	1007 1578
C4, 5, 6	Capacitor, ceramic dip, 0.01µF, 5%, 100V	1007 1645
C7-13, 51-71	Capacitor, ceramic dip, 0.1µF, 10%, 50V	0120 38
C18	Capacitor, tantalum, 0.27µF, 10%, 50V	0130 52741
C19, 30, 31	Capacitor, ceramic, 0.0068µF, 5%, 100V	0125 16825
C20, 21, 32, 33	Capacitor, ceramic, 0.47µF, +80 -20%, 50V	1007 939
C22, 26	Capacitor, ceramic, 0.068µF, 5%, 50V	1007 1831
C23, 24	Capacitor, ceramic, 0.0012µF, 5%, 50V	0125 51225
C23A, 24A, 50	Capacitor, ceramic, 100pF, 5%, 200V	0125 21015
C25, 27	Capacitor, ceramic, 0.018µF, 5%, 50V	1007 1829
C28, 29	Capacitor, ceramic, 33pF, 5%, 200V	0125 23305
C34, 36A	Capacitor, ceramic, 0.0015µF, 5%, 100V	0125 11525
C34A	Capacitor, ceramic, 0.033µF, 5%, 50V	1007 1830
C35	Capacitor, ceramic, 390pF, 5%, 100V	0125 13915
C35A	Capacitor, ceramic, 120pF, 5%, 200V	0125 21215
C36, 37	Capacitor, ceramic, 0.0056µF, 5%, 100V	0125 15625
C38, 42, 45, 46	Capacitor, ceramic	
	106430-1, -2, -3: 0.027µF, 5%, 50V	1007 1834
	106430-11, -12, -13: 0.033µF, 5%, 100V	1007 1830
C39, 40, 43, 44, 47, 48	Capacitor, ceramic, 27pF, 5%, 200V	0125 22705
C41	Capacitor, ceramic	
	106430-1, -2, -3: 0.1µF, 5%, 50V	1007 1832
	106430-11, -12, -13: 0.12µF, 5%, 100V	1007 1867
C49	Capacitor, ceramic	
	106430-1, -2, -3: 0.012µF, 5%, 50V	0125 51235
	106430-11, -12, -13: 0.015µF, 5%, 100V	0125 11535
C72	Capacitor, tantalum, 3.3µF, 20%, 35V	1007 1260

Table 14-2. continued - Replaceable parts, RFL 9780 Limiter/Slicer Module

Circuit Symbol (Figs. 14-4 & 14-5)	Description	Part Number
	RESISTORS	
R1, 2	Resistor, fixed composition, 2.7Ω, 5%, 1/4W	1009 900
R3, 4, 24, 25, 96	Resistor, metal film, axial, 1K, 1%, 1/4W	0410 1288
R5, 36, 49, 77, 83, 89	Resistor, metal film, variable, 10K, 10%, 1/2W	48548
R6, 47	Resistor, metal film, axial, 5.11K, 1%, 1/4W	0410 1356
R7, 14, 19, 46	Resistor, metal film, precision, 1M, 1%, 1/4W	0510 1813
R8, 45	Resistor, metal film, axial, 9.31K, 1%, 1/4W	0410 1381
R9, 11-13, 15-18, 20-23, 33, 39, 40, 44, 59, 60, 63-65, 69, 75, 97, 102	Resistor, metal film, axial, 10K, 1%, 1/4W	0410 1384
R10, 32, 35, 43, 82, 88, 94	Resistor, metal film, axial, 4.99K, 1%, 1/4W	0410 1355
R26-28, 95, 98, 99, 105	Resistor, metal film, axial, 100Ω, 1%, 1/4W	0410 1192
R29	Resistor, metal film, variable, 20K, 10%, 1/2W	44529
R30	Resistor, metal film, axial	
	106430-1, -11: 16.9K, 1%, 1/4W	0410 1406
	106430-2, -3, -12, -13: 14.3K, 1%, 1/4W	0410 1399
R31	Resistor, metal film, axial, 1.05K, 1%, 1/4W	0410 1290
R34, 37, 38, 50-52, 56, 66, 67, 70-72, 74, 76, 103, 104	Resistor, metal film, axial, 20K, 1%, 1/4W	0410 1413
R41	Resistor, metal film, axial, 681K, 1%, 1/4W	0410 1560
R42	Resistor, metal film, axial, 75K, 1%, 1/4W	0410 1410
R48	Resistor, metal film, axial, 3.32K, 1%, 1/4W	0410 1338
R53, 54, 55, 61	Resistor, metal film, axial, 5.9K, 1%, 1/4W	0410 1362
R57	Resistor, metal film, axial, 5.36K, 1%, 1/4W	0410 1358
R58	Resistor, metal film, variable, 1K, 10%, 1/2W	49995
R62	Resistor, metal film, axial, 6.34K, 1%, 1/4W	0410 1365
R68, 73	Resistor, metal film, axial, 4.75K, 1%, 1/4W	0410 1353
R78, 84, 90	Resistor, metal film, axial	
	106430-1, -2, -3: 45.3K, 1%, 1/4W	0410 1447
	106430-11, -12, -13: 47.5K, 1%, 1/4W	0410 1449
R79-81	Resistor, metal film, axial	
	106430-1, -2, -3: 49.9K, 1%, 1/4W	0410 1451
	106430-11, -12, -13: 51.1K, 1%, 1/4W	0410 1452
R85-87, 91-93	Resistor, metal film, axial	
	106430-1, -2, -3: 48.7K, 1%, 1/4W	0410 1450
	106430-11, -12, -13: 51.1K, 1%, 1/4W	0410 1452
R106, 107	Resistor, metal film, axial, 14K, 1%, 1/4W	0410 1398

Table 14-2. continued - Replaceable parts, RFL 9780 Limiter/Slicer Module

Circuit Symbol (Figs. 14-4 & 14-5)	Description	Part Number
	SEMICONDUCTORS	
CR1, 2	Diode, Schottky barrier, 1N6263	93631
CR3	Diode, Schottky, 1A, 20V, 1N5817	30150
CR4-10	Diode, silicon, 1N914B/1N4448	26482
U1	Integrated circuit, linear QUAD comparator	0620 377
U2	Integrated circuit, MOS, QUAD, 2 input AND gate	0615 161
U3, 5, 10	Integrated circuit, linear JFET OP AMP	0620 182
U4	Integrated circuit, linear dual comparator	0620 352
U6	Integrated circuit, MOS HEX inverter	0615 185
U7	Integrated circuit, MOS QUAD 2 input exclusive OR-gate	0615 268
U8	Integrated circuit, linear voltage regulator, 5V, positive	0620 204
U9	Integrated circuit, linear voltage regulator, 5V, negative	0620 210
U11-14	Integrated circuit, linear JFET OP AMP	0620 227
	MISCELLANEOUS COMPONENTS	
DS1	Opto device, LED, red, 5vdc	101761
DS2	Opto device, LED, red, 5vdc	101762
J1, 2	Connector, header, single, 3 circuit	32802 3
TP1	Test point, black	38116 3
TP2-11	Test point, terminal, orange	98441 3
TP12	Test point, red	38116 2
TP13	Test point, orange	38116 6
TP14	Test point, yellow	38116 8
TP15	Test point, purple	38116 10

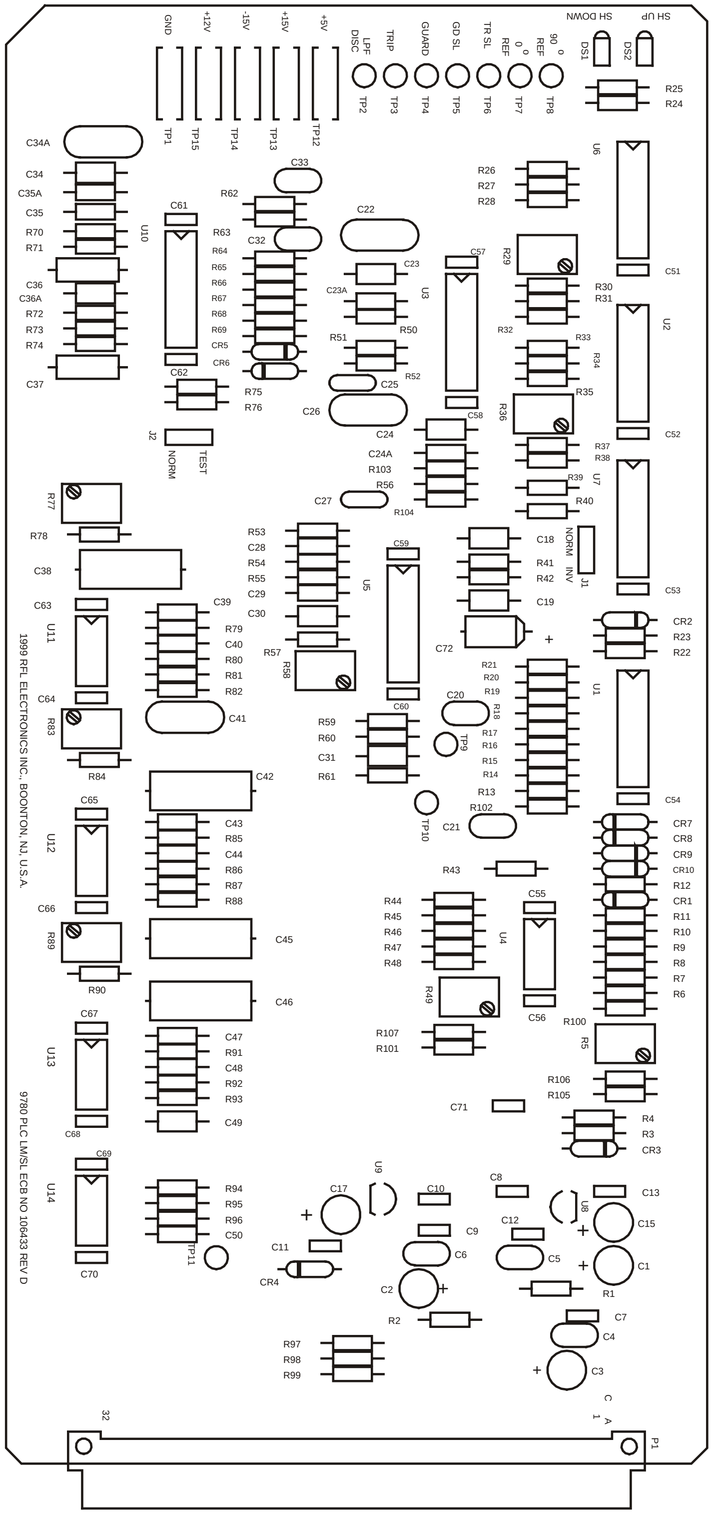

Figure 14-4. Component Locator Drawing, RFL 9780 Limiter/Slicer Module (Assy No. 106430)

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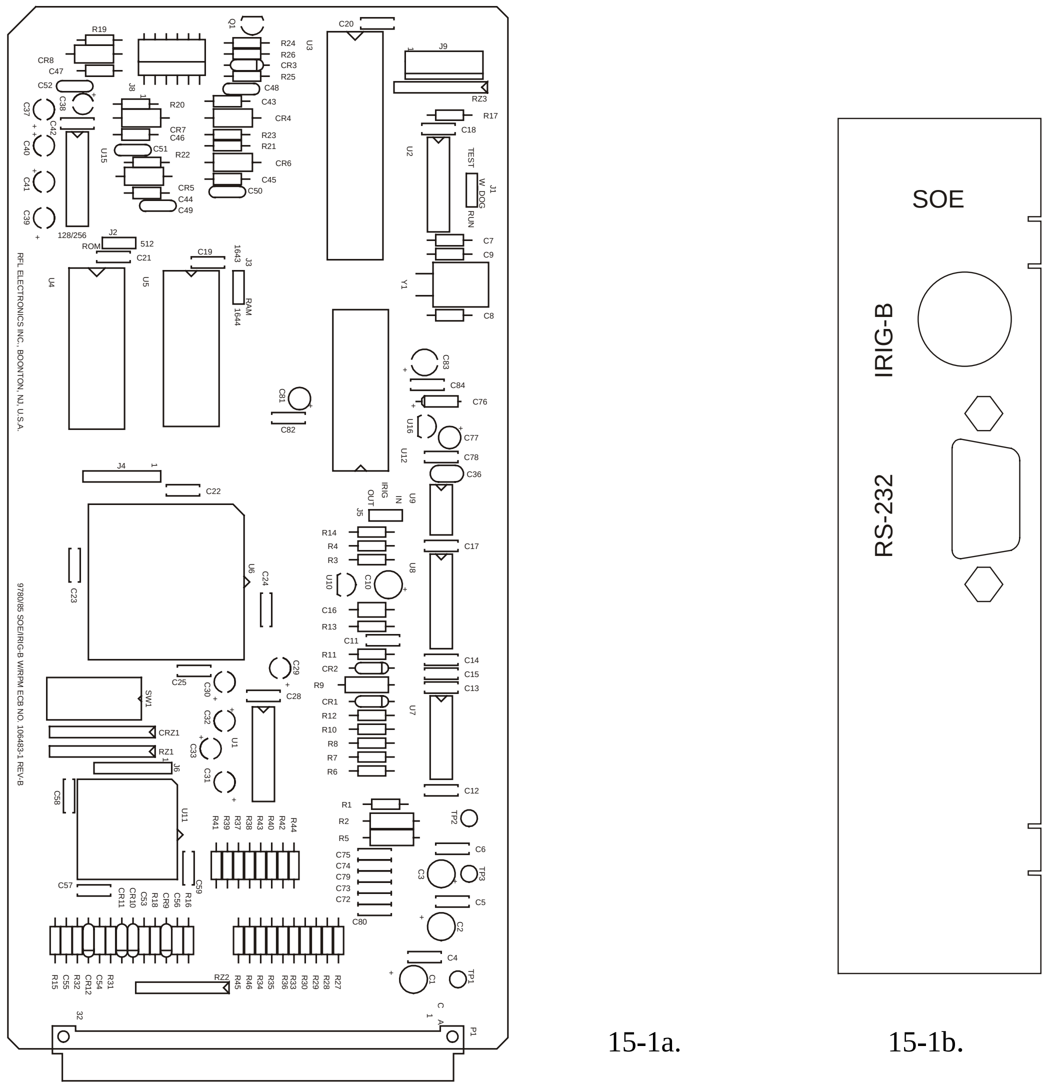
Figure 14-5. Schematic, RFL 9780 Limiter/Slicer (Dwg. No. D-106434-C) Sheet 1 of 2

Please see Figure 14-5 in Section 22.

Figure 14-5 Schematic, RFL 9780 Limiter/Slicer (Dwg. No. D-106434-C) Sheet 2 of 2

Please see Figure 14-5 in Section 22.

SECTION 15. SEQUENCE OF EVENTS/IRIG-B MODULE
And SEQUENCE OF EVENTS/IRIG-B I/O MODULE



15-1a. 15-1b.

Figure 15-1. Views of Sequence of Events/IRIG-B Module and Sequence of Events/IRIG-B I/O Module

15.1 INTRODUCTION

The RFL 9780 SOE/IRIG-B module is shown in Figure 15-1a and the RFL 9780 SOE/IRIG-B I/O module is shown in Figure15-1b. The SOE/IRIG-B module is used to record the status of data points in a log by storing data in a non-volatile memory. The log consists of the state of each data point and the date and time the record was saved. An event is recorded whenever any data point changes state. Refer to paragraph 15.2 for more information on the RFL 9780 SOE/IRIG-B module. Refer to paragraph 15.3 for more information on the RFL 9780 SOE/IRIG-B I/O module.

15.2 SEQUENCE OF EVENTS/IRIG-B MODULE

15.2.1 DESCRIPTION

The SOE/IRIG-B module is a status monitor card for the RFL 9780 which monitors system input status every 1 ms. Events are recorded when any point changes state or if the CPU gets reset. The Sequence Of Events log is a record of the state of each point, the state of CPU reset, and the date and time the record was saved. The system can record up to 40 events. The module has a free running clock, which is synchronized every ten seconds to the IRIG-B clock if IRIG-B is available. The SOE data is retrieved via a 3-wire RS-232 port with a DB9 connector. Refer to Section 16 for information on how to use the RS-232 port to access the RFL 9780 SOE/IRIG-B module.

The SOE/IRIG-B module will record different sets of data points for different RFL 9780 system configurations. For the 9780 TX Only mode, the module will record the status of six data points; for the 9780 RX Only mode, the module will record the status of seven data points; for the 9780 TX/RX mode, the module will record the status of ten data points; for the 9780 TX/TX mode, the module will record the status of nine data points; for the 9780 RX/RX mode, the module will record the status of eleven data points. The sets of data points for each of these modes are listed in Table 15-1.

Table 15-1. RFL 9780 Sequence of Events data points

9780 TX Only	9780 RX Only	9780 TX/RX	9780 TX/TX	9780 RX/RX
CPU Boot Up	CPU Boot Up	CPU Boot Up	CPU Boot Up	CPU Boot Up
Tx Fail	Guard Out	Tx Fail	Tx Fail 1	Guard Out 1
Trip Key #1	Trip Out	Logic Alarm	Trip Key #1	Trip Out 1
Trip Key #2	Logic Alarm	Guard Out	Trip Key #2	Logic Alarm 1
Power Fail #1	Low Level Alarm	Trip Out	Tx Fail 2	Low Level Alarm 1
Power Fail #2	Power Fail #1	Trip Key #1	Trip Key #3	Guard Out 2
	Power Fail #2	Trip Key #2	Trip Key #4	Trip Out 2
		Power Fail #1	Power Fail #1	Power Fail #1
		Power Fail #2	Power Fail #2	Power Fail #2
		Low Level Alarm		Logic Alarm 2
				Low Level Alarm 2

15.2.2 SPECIFICATIONS

As of the date this manual was published, the following specifications apply to all RFL 9780 SOE/IRIG-B modules, except as indicated. Because all RFL products undergo constant refinement and improvement, these specifications are subject to change without notice.

Communications Parameters:
Baud Rate: 9600
Parity: no parity
Data Bits: 8

15.2.3. THEORY OF OPERATION

Refer to the schematic diagram in Figure 15-4 for the following discussion.

The RFL 9780 SOE/IRIG-B module consists of three major sections, the microcontroller section, the IRIG-B section, and the reflected power section. The microcontroller section contains an 80C320 embedded microcontroller, an XILINX - XC9572 and associated support devices. The IRIG-B signal section converts the incoming IRIG-B signal into an appropriate level signal that is fed to the processor.

U3, U4, U5 and U6 form the heart of the processor circuit. U3 is an 80C320 8 bit embedded microcontroller which monitors input status and decodes time information from the IRIG-B signal. U4 is a ROM that stores program code. U5 contains non-volatile RAM for storing SOE data and has a built-in free running real time clock. U2 is a MAX691, which provides a reset pulse on power up and a watchdog timer. U1 is an RS-232 Driver/Receiver. U6 is used to generate chip select signals for U11, and SW1.

The IRIG-B circuits are used to convert the IRIG-B input signal to an appropriate level for the 80C320. It consists of a shunt regulator, a comparator, switches and an ICM7555.

An eight position DIP switch is present to allow the user to set the mode of operation, TX/RX, TX/TX, RX/RX, TX Only or RX Only. The processor reads this switch to set up the SOE/IRIG-B module. U11 is an input buffer for 16 input signals.

In the reflected power section DC input signals are fed into the board through J9, or the corresponding edge connectors. The signals are filtered using a simple RC filter to remove noise picked up on the input lines. The signals are then applied to the analog inputs of A/D converter U12. The inputs represent the eight possible input signal functions, some of which are not used depending on the chassis configuration. The multiplexed input signals at A13 and A19 each appear on two different inputs of U12, one for each of the functions. Only one of these multiplexed functions is possible for any particular chassis configuration. This is done to ease the processing of the signals in the microprocessor.

U16 provides the -5v required by U12. Data is sent to the microprocessor using the standard data bus, along with the normal read and write control signals. The other control signals for U12 are generated by logic in the Actel processor interface chip U6. The A/D converter contains an internal reference.

The Actel circuit U11 is used to control the input digital signals to the microprocessor. Each of the inputs (A21 – A28 and C21 – C28) passes through a debounce circuit which allows the output to change only if the input has been in the same state for three consecutive sampling periods. The signals are then multiplexed onto the DATAIN bus to the microprocessor. J6 is the JTAG input to J11.

15.2.4 CONTROLS AND INDICATORS

Figure 15-2 shows the location of all jumpers, test points and switches on the RFL 9780 SOE/IRIG-B module. The functions of these jumpers, test points and switches are described in Table 15-2. All of these items are accessible only when the module is removed from the chassis or is on a card extender.

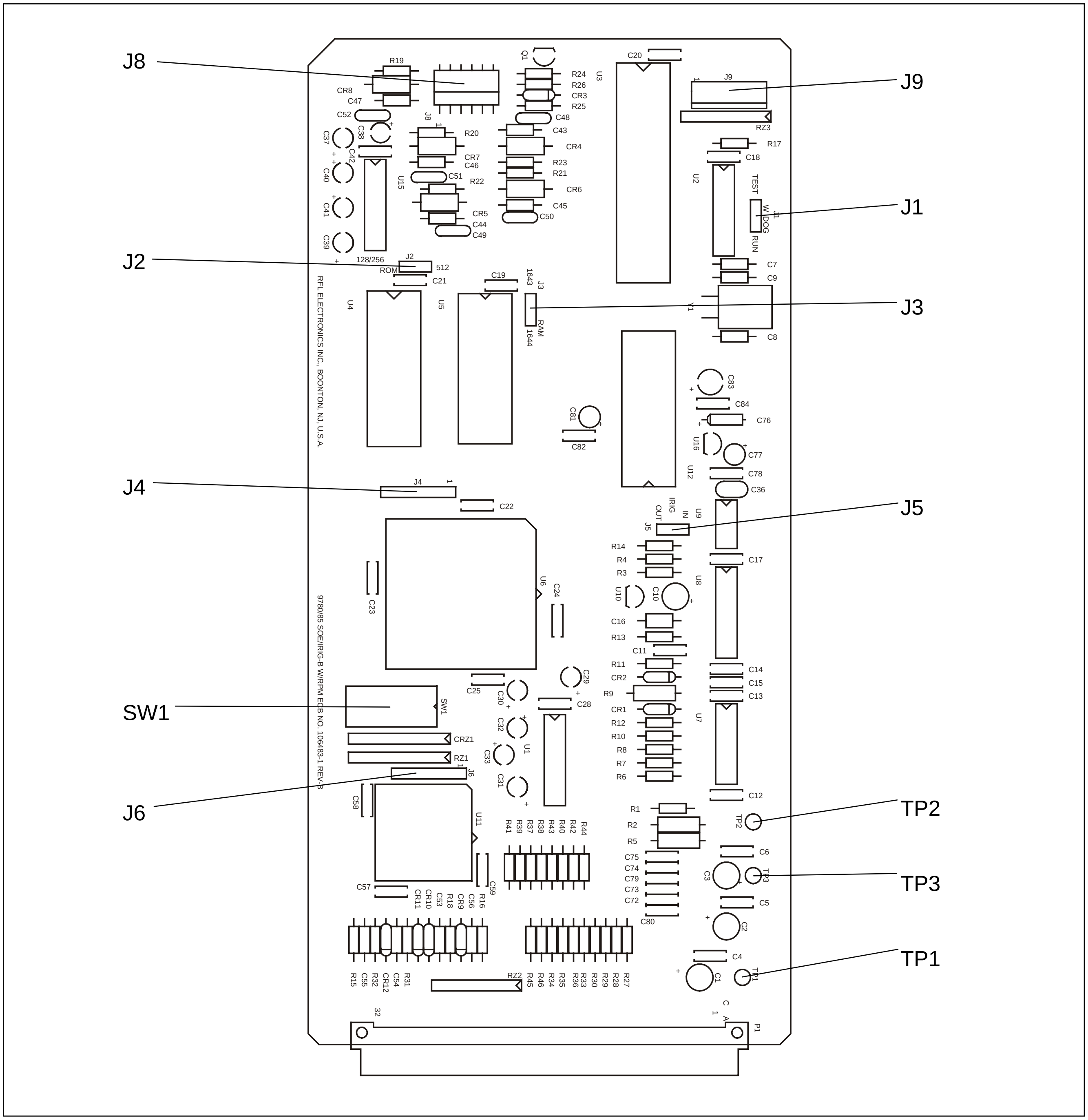


Figure 15-2. Controls and indicators for RFL 9780 SOE/IRIG-B Module

Table 15-2. Controls and indicators for RFL 9780 SOE/IRIG-B Module

<table>
<tr><th>Component Designator</th><th>Name/Description</th><th colspan="6">Function</th></tr>
<tr><td>J1</td><td>Jumper (RUN/TEST)</td><td colspan="6">RUN position selects Normal operation. TEST position selects Test operation.</td></tr>
<tr><td>J2</td><td>Jumper (512 or 128/256)</td><td colspan="6">Header and jumper not installed. For factory use only.</td></tr>
<tr><td>J3</td><td>Jumper (1643/1644)</td><td colspan="6">1643 position selects DS1643 RAM. 1644 position selects DS1644 RAM.</td></tr>
<tr><td>J4</td><td>Connector Header</td><td colspan="6">Used for factory testing</td></tr>
<tr><td>J5</td><td>Jumper (IN/OUT)</td><td colspan="6">IN position selects IRIG-B clock. OUT position selects internal clock.</td></tr>
<tr><td>J6</td><td>Connector Header</td><td colspan="6">For future use</td></tr>
<tr><td>J8</td><td>Connector Header</td><td colspan="6">RS-232 connector</td></tr>
<tr><td rowspan="8">SW1 (Note 1)</td><td rowspan="8">DIP Switch</td><td rowspan="8">Selects Operating Mode:</td><td><u>SW1-1</u></td><td><u>SW1-2</u></td><td><u>SW1-3</u></td><td><u>SW1-6</u></td><td><u>Mode</u></td></tr>
<tr><td>ON</td><td>ON</td><td>ON</td><td>ON</td><td>9785</td></tr>
<tr><td>OFF</td><td>ON</td><td>ON</td><td>ON</td><td>9780TX/RX</td></tr>
<tr><td>ON</td><td>OFF</td><td>ON</td><td>ON</td><td>9780TX/TX</td></tr>
<tr><td>OFF</td><td>OFF</td><td>ON</td><td>ON</td><td>9780RX/RX</td></tr>
<tr><td>ON</td><td>ON</td><td>OFF</td><td>ON</td><td>9780RX</td></tr>
<tr><td>OFF</td><td>ON</td><td>OFF</td><td>ON</td><td>9780TX</td></tr>
<tr><td>ON</td><td>ON</td><td>ON</td><td>OFF</td><td>SP9785 (Note 2)</td></tr>
<tr><td>TP1</td><td>Test Point</td><td colspan="6">Ground Reference</td></tr>
<tr><td>TP2</td><td>Test Point</td><td colspan="6">IRIG-B High</td></tr>
<tr><td>TP3</td><td>Test Point</td><td colspan="6">IRIG-B Low</td></tr>
</table>

NOTE 1: SW1-4, SW1-5, SW1-7 and SW1-8 are for future use. SW1-4, SW1-5 and SW1-7 must be set to ON, and SW1-8 must be set to OFF.

NOTE 2: For RFL use only

Table 15-3. Replaceable parts, RFL 9780 SOE/IRIG-B Module, Assembly No. 106480-1

Circuit Symbol (Figs. 15-3 & 15-4)	Description	Part Number
	CAPACITORS	
C1, 2, 3, 10	Capacitor, electrolytic, 47μF, 20%, 35V	1007 1578
C4-6, 11-15, 17-25, 28, 42, 57-59, 72-75, 78-80, 82, 84	Capacitor, ceramic dip, 0.1μF, 10%, 50V	0120 38
C7	Capacitor, ceramic, 220pF, 5%, 100V	0125 12215
C8, 9	Capacitor, ceramic, 33pF, 10%, 200V	0125 23301
C16	Capacitor, ceramic, 0.0039μF, 5%, 100V	0125 13925
C29-33, 37-41	Capacitor, tantalum, 1μF, 10%, 35V	1007 1768
C36	Capacitor, ceramic, 0.27μF, 10%, 50V	1007 1682
C43-47	Capacitor, ceramic, 0.001μF, 10%, 100V	0130 11021
C48-52	Capacitor, ceramic disc, 0.002μF, 20%, 1000V	1007 942
C53-56	Capacitor, ceramic, 0.01μF, 10%, 50V	0130 51031
C76	Capacitor, tantalum, .033μF, 10%, 35V	1007 1281
	RESISTORS	
R1, 24, 37-44	Resistor, metal film, axial, 1K, 1%, 1/4W	0410 1288
R2, 5	Resistor, metal film, axial, 909Ω, 1%, 1/2W	0410 2284
R3, 4, 14	Resistor, metal film, axial, 10K, 1%, 1/4W	0410 1384
R6, 27-30	Resistor, metal film, axial, 20K, 1%, 1/4W	0410 1413
R7, 12, 33-36, 45, 46	Resistor, metal film, axial, 4.99K, 1%, 1/4W	0410 1355
R8	Resistor, metal film, axial, 4.02K, 1%, 1/4W	0410 1346
R9	Resistor, metal film, axial, 432Ω, 1%, 1/5W	0410 2253
R10	Resistor, metal film, axial, 2.0M, 1%, 1/4W	0410 1605
R11	Resistor, metal film, axial, 8.25K, 1%, 1/4W	0410 1376
R13, 18, 31, 32	Resistor, metal film, axial, 237K, 1%, 1/4W	0410 1516
R15, 16	Resistor, metal film, axial, 24.9K, 1%, 1/4W	0410 1422
R17	Resistor, metal film, axial, 2K, 1%, 1/4W	0410 1317
R19-23	Resistor, metal film, axial, 221Ω, 1%, 1/4W	0410 1225
R25, 26	Resistor, metal film, axial, 316K, 1%, 1/4W	0410 1336
RZ1	Resistor, network, 10K, 8R/PKG, SIP	95571
RZ2	Resistor, network, 22K, 7R/PKG, SIP	101484
RZ3	Resistor, network, 47K, 7R/PKG, SIP	47880
	SEMICONDUCTORS	
U1, 15	Integrated circuit, interface, 5V, RS-232, dual	0680 12
U2	Integrated circuit, peripheral, microprocessor, supervisor	0635 31
U3	Integrated circuit, microprocessor, 8-bit	0640 36
U4	Integrated circuit, EPROM, 64Kx8	0615 452
U5	Integrated circuit, MOS, non-volatile SRAM, RTC, 8Kx8	0615 474
U6	Integrated circuit, MOS, CPLD	0615 472

Table 15-3. continued - Replaceable parts, RFL 9780 SOE/IRIG-B Module

Circuit Symbol (Figs. 15-3 & 15-4)	Description	Part Number
	SEMICONDUCTORS continued	
U7	Integrated circuit, linear, quad, comparator	0620 241
U8	Integrated circuit, analog switch, quad, SPST, CMOS	0605 17
U9	Integrated circuit, MOS, timer	0615 328
U10	Integrated circuit, linear adj precision shunt regulator	0620 320
U11,	Integrated circuit, MOS, CPLD	0615 490
U12	Integrated circuit, A/D converter, high speed	0625 41
U16	Integrated circuit, linear voltage regulator, neg 5V	0620 210
CR1, 2, 3	Diode, silicon, 1N914B/1N4448	26482
CR4, 5, 6	Suppressor, transient voltage, P6KE30CA	100576
CR7, 8	Suppressor, transient voltage, P6KE16CA	100572
CR9, 10, 11, 12	Diode, Schottky barrier, 1N6263	93631
CRZ1	Diode array, 8-diode, common cathode	103444
Q1	Transistor, silicon, NPN, 2N2222A	37445
	MISCELLANEOUS COMPONENTS	
J1, 3, 5	Connector, header, single, 3-circuit	32802 3
J4, 6	Connector, header, single, 7-circuit	32802 7
J8	Connector, wafer assembly, RT angle, 6 ckt	98202 6
J9	Connector, wafer assembly, 7 ckt	97223 7
P1	Connector, JK male, 64 contact, DIN	98457
SW1	Switch, DIP, SPST, 8-position, 16-pin	98493
TP1, 2, 3	Test point, terminal, orange	98441 3
Y1	Crystal, HC-18, 12MHz	30555

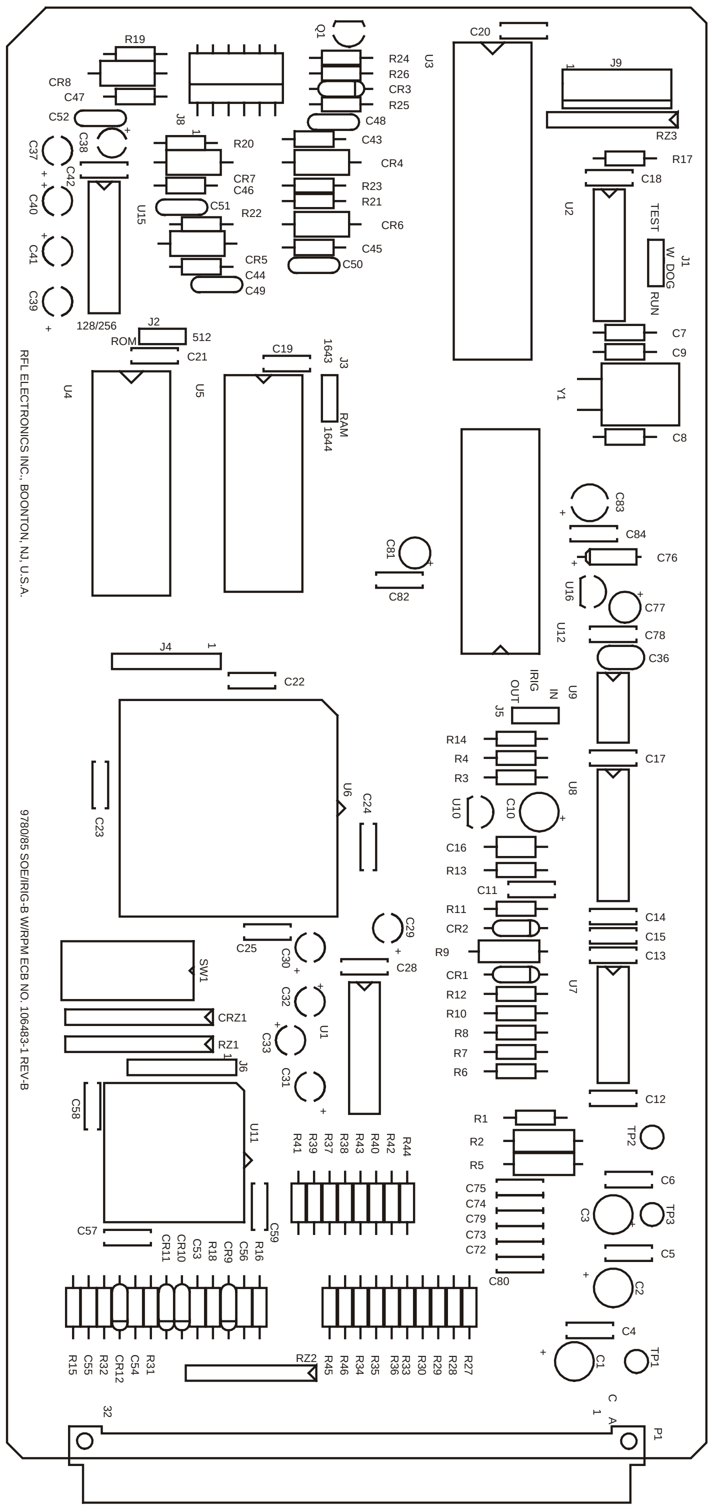


Figure 15-3. Component locator drawing, RFL 9780 SOE/IRIG-B Module

Figure 15-4. Schematic, RFL 9780 SOE/IRIG-B (Dwg. No. D-106484-1-B) Sheet 1 of 2

Please see Figure 15-4 in Section 22

Figure 15-4. Schematic, RFL 9780 SOE/IRIG-B (Dwg. No. D-106484-1-B) Sheet 2 of 2

Please see Figure 15-4 in Section 22

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15.3 SEQUENCE OF EVENTS/IRIG-B I/O MODULE

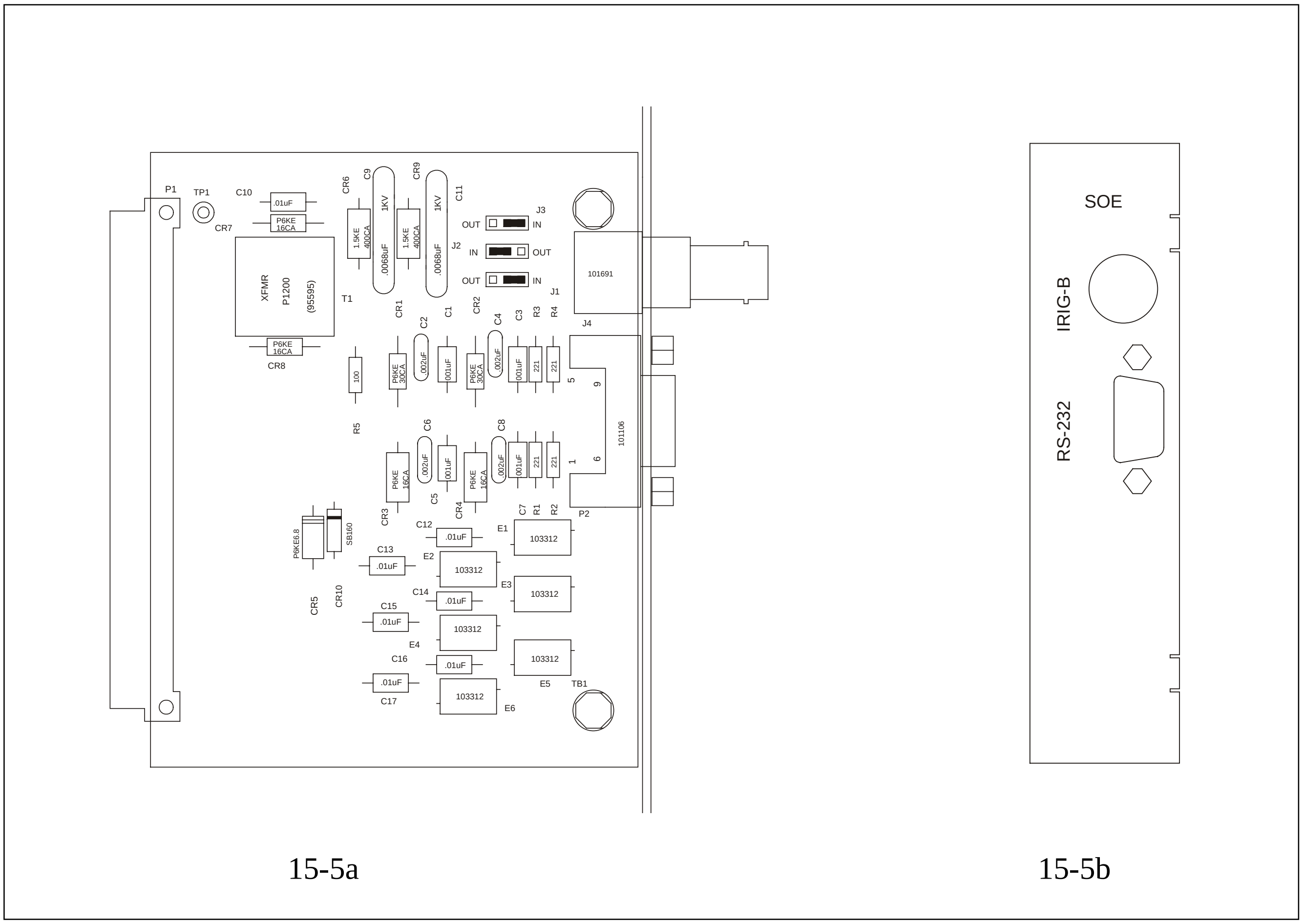


Figure 15-5. Board and panel views of RFL 9780 SOE/IRIG-B I/O Module

15.3.1 DESCRIPTION

The RFL 9780 SOE/IRIG-B I/O module provides an interface between the IRIG-B receiver and the RFL 9780 SOE/IRIG-B module. It has provisions for modulated (bipolar) or demodulated (TTL) IRIG-B inputs, and provides an RS-232 connector to access the sequence of events log. The modulated (bipolar) signal is a 1 kHz amplitude modulated signal (0-3Vp-p) representing seconds, minutes, hours and days. The demodulated (TTL) signal is a 0 to 5Vdc data message representing seconds, minutes, hours and days. A board view of the module is shown in Figure 15-5a, and a rear view of the panel is shown in Figure 15-5b.

15.3.2 CONTROLS AND INDICATORS

Figure 15-6 shows the location of all jumpers, test points and connectors on the RFL 9780 SOE/IRIG-B I/O module. The functions of these jumpers, test points and connectors are described in Table 15-4. All of these items are accessible only when the module is removed from the chassis or is on a card extender.

Table 15-4. Controls and indicators for the RFL 9780 SOE/IRIG-B I/O Module

Component Designator	Name/Description	Function				
J1	Jumper		INPUT	J1	J2	J3
J2	Jumper	Select TTL or bipolar inputs.	Demodulated (TTL)	OUT	OUT	OUT
J3	Jumper		Modulated (bipolar)	IN	IN	IN
J4	Connector	IRIG-B input				
P2	Connector	RS-232 connection				
TP1	Test Point	Signal common				

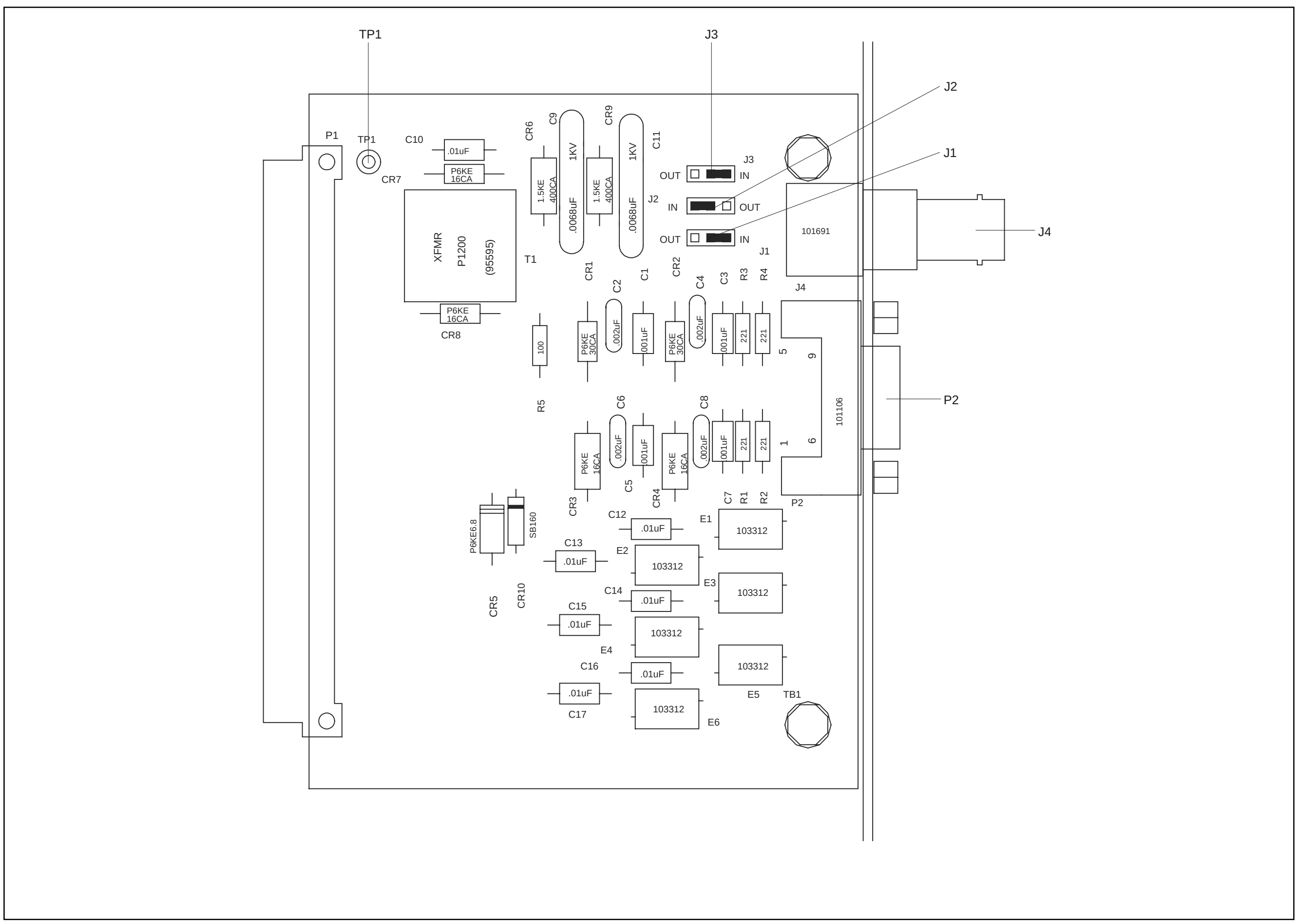


Figure 15-6. Controls and indicators for the RFL 9780 SOE/IRIG-B I/O Module

Table 15-5. Replaceable parts, RFL 9780 SOE/IRIG-B I/O Module Assembly No. 106475-1

Circuit Symbol (Fig. 15-7 and 15-8)	Description	Part Number
	CAPACITORS	
C1, 3, 5, 7	Capacitor, ceramic, 0.001μF, 10%, 100V	0130 11021
C2, 4, 6, 8	Capacitor, ceramic disc, 0.002μF, 20%, 1000V	1007 942
C9, 11	Capacitor, ceramic disc, 0.0068μF, 20%, 1KV	1007 91
C10, 12-17	Capacitor, ceramic, 0.01μF, 10%, 100V	0130 11031
	RESISTORS	
R1-4	Resistor, metal film, axial, 221Ω, 1%, 1/4W	0410 1225
R5	Resistor, metal film, axial, 100Ω, 1%, 1/4W	0410 1192
	SEMICONDUCTORS	
CR1, 2, 7, 8	Suppressor, transient voltage, P6KE16CA	100572
CR3, 4	Suppressor, transient voltage, P6KE30CA	100576
CR5	Suppressor, voltage, DC, 5.8V, 5%, 600W	30694
CR6, 9	Suppressor, transient voltage, 1.5KE400CA	30442
CR10	Diode, Schottkey, barrier, 1N6263	93631
	MISCELLANEOUS COMPONENTS	
E1-6	Bead, ferrite, shield, 2-1/2 turn	103312
J1-3	Connector, header, single, 3 circuit	32802 3
J4	Connector, coaxial, BNC, bulkhead	101691
P1	Connector, plug, female, 64 contact, DIN	99134
P2	Connector, JK male, 9-pin, right angle	101106
T1	Transformer, modem, matching	95595
TP1	Test point, terminal, orange	98441 3

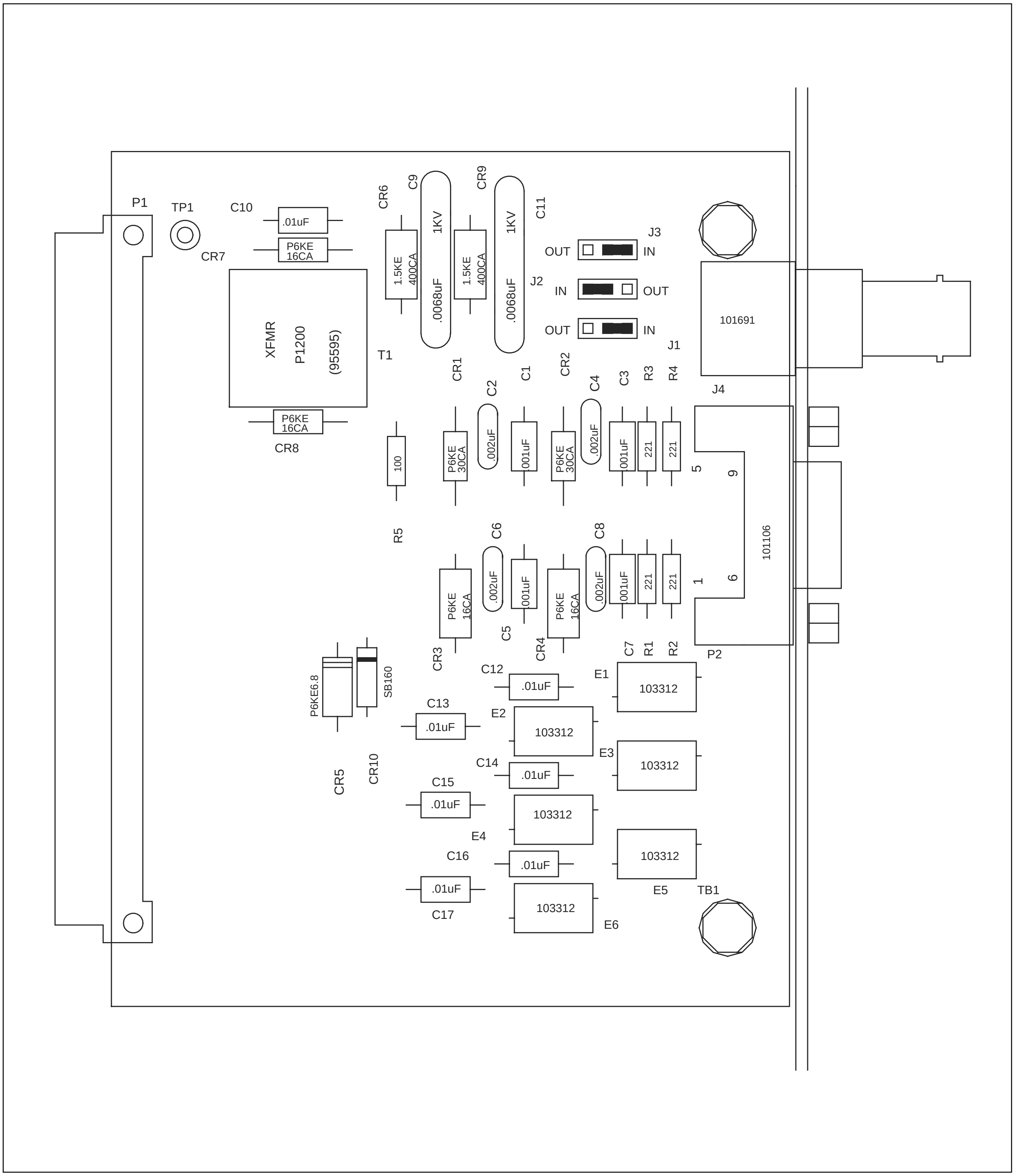


Figure 15-7. Component Locator Drawing, RFL 9780 SOE/IRIG-B I/O Module

Figure 15-8. Schematic, RFL 9780 SOE/IRIG-B I/O (Dwg. No. D-106479-B)

Please see Figure 15-8 in Section 22

SECTION 16. USING RS-232 PORTS TO ACCESS RFL 9780 SOE MODULE

16.1. INTRODUCTION

This section contains information on how to view the RFL 9780 sequence-of-events (SOE) log, and Reflected Power readings using the RS-232 ports. The SOE log can be viewed after a physical connection has been made and communication has been established between the RFL 9780 and a PC.

16.2. ESTABLISHING COMMUNICATIONS

A user can communicate with the RFL 9780 through the RS-232 connector on the front panel (DCE, data communication equipment) or rear panel (DTE, data terminal equipment) of the RFL 9780. Either a dumb terminal or a personal computer equipped with terminal emulation software can be used for communication. The front panel port has priority over the rear port. This allows for a permanent connection to the back of the unit, which will be overridden when the user temporarily connects a terminal to the front of the unit.

Once connected, APRIL (Asynchronous Programming and Remote Interrogation Language) can be used to view the status of the RFL 9780 and review the sequence of events log. Because APRIL is menu based, you do not have to memorize the commands. Help screens can always be displayed by pressing the **[H]** key.

16.2.1. PHYSICAL CONNECTIONS

The front port of the 9780 is typically connected directly to a terminal or PC using a standard (straight-through) connector as shown in Figure 16-1. The rear port of the 9780 is intended for connection to stand-alone modem or multi-port switch (such as the RFL 9660 Digital Switch) using a standard (straight-through) connector as shown in Figure 16-2.

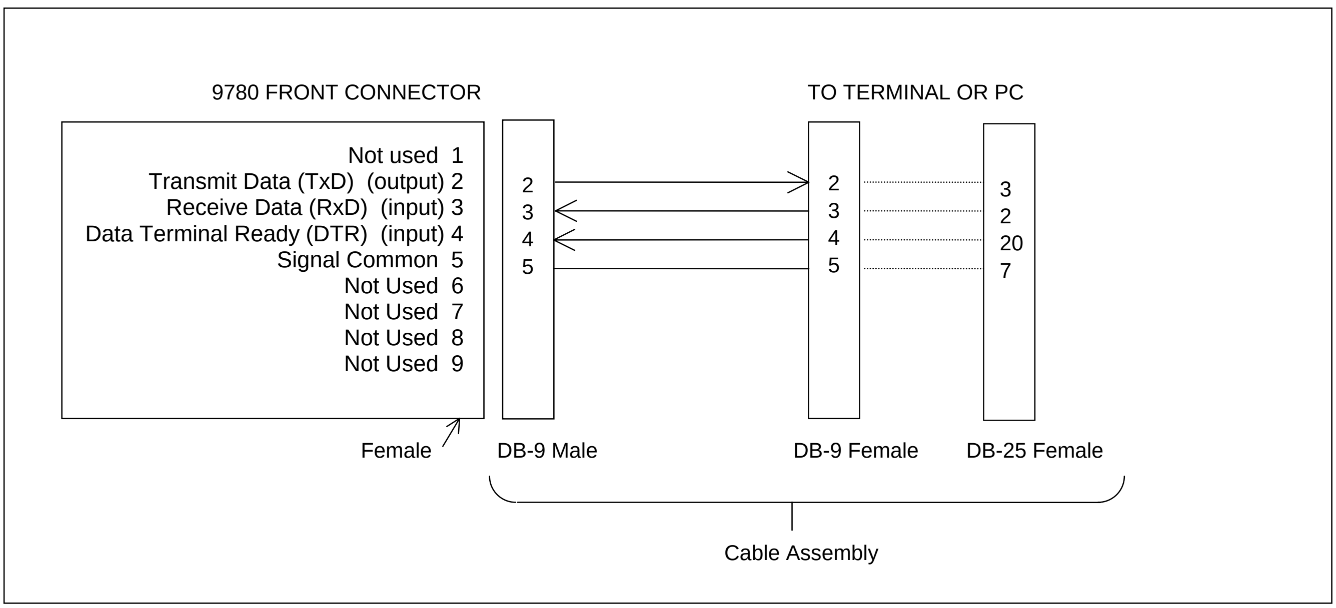


Figure 16-1. Making connections from the PC to the RFL 9780 front connector

> **NOTE**
> Any device connected to the front-panel RS-232 connector must drive the DTR line high. This will disable the rear-panel RS-232 port, eliminating any conflict that may arise from two users attempting to access the RFL 9780 at the same time. Most ports drive the DTR line high.

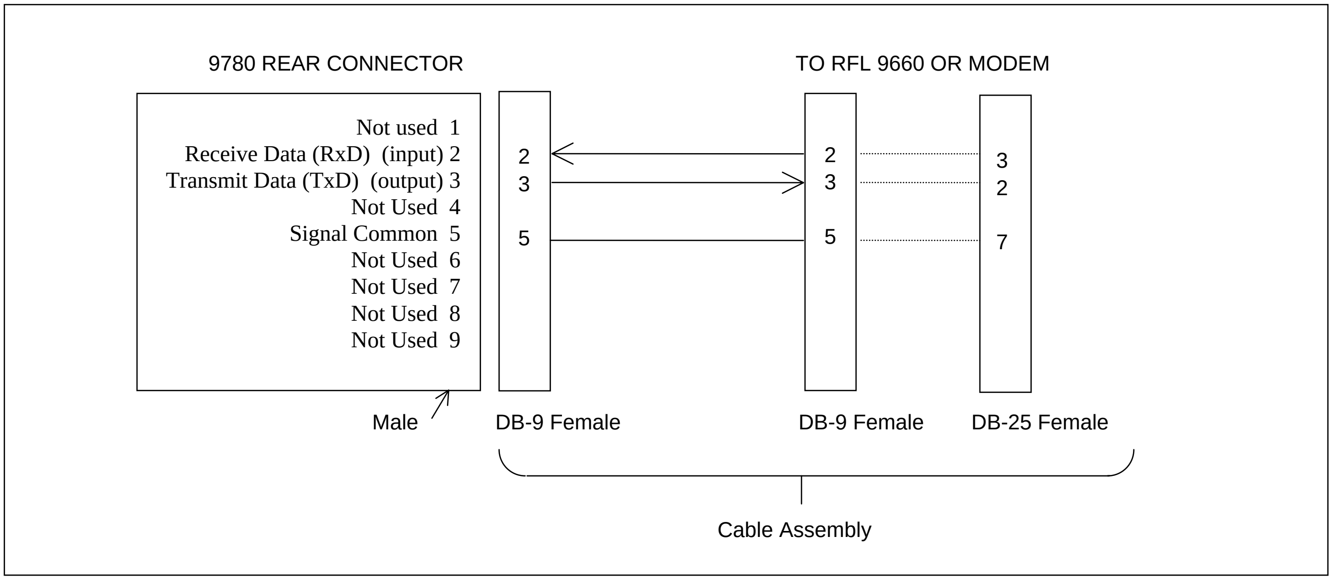


Figure 16-2. Making connections from the PC to the RFL 9780 rear connector

16.2.2 COMMUNICATIONS INFORMATION

The serial communications port on the terminal or PC must be configured to match the 9780:

Data Bits	8
Stop Bits	1
Parity	None
Baud Rate	9600 baud
Handshaking	XON/XOFF

The terminal (or PC terminal emulation mode) must support either ANSI or VT-100 control codes for cleanest visual presentation.

16.3. VIEWING APRIL COMMANDS

Once you have connected a terminal or PC to the RFL 9780 (either directly or through an RFL 9660 Digital Switch) and pressed the **[ENTER]** key the RFL 9780 will send the following prompt to your terminal:

9780TxRx>

This means that you have accessed the RFL 9780, and can now use APRIL commands to view lists of parameter settings, alarm conditions, and other information.

NOTE

The prompt will be **9780TxRx>** for a TxRx chassis, **9780TxTx>** for a TxTx chassis, **9780RxRx>** for an RxRx chassis, **9780Tx>** for a Tx Only chassis, and **9780Rx>** for an Rx Only chassis.

To view a list of the APRIL commands, press the **[H]** and **[ENTER]** keys:

9780 TxRx >H [ENTER]

This tells the RFL 9780 to send a list of APRIL commands called the "main menu" to your terminal. The main menu appears in Figure 16-3.

```
RFL Electronics APRIL(t) Remote Communications, Version 2.1 (c)1993,1999

H - Display the main menu
V - Go to the values display
P - Go to the programming menu (password required)
D - Go to the read settings menu
F - Go to the configuration and software version display
U - Enter the update mode
X - Exit the update mode
S - Go to sequence of events menu
9780TxRx>
```

Figure 16-3. APRIL main menu

For more information on each APRIL command, refer to the paragraph numbers listed below.

Command	Meaning	Paragraph
H	Display the main menu	16.3
V	Go to the values display	16.5
P	Go to the programming menu (password)	16.6
D	Go to the read settings menu	16.7
F	Go to the configure and software version display	16.8
U	Enter the update mode	16.9
X	Exit the update mode	16.9
S	Go to sequence-of-events menu	16.10
W	Window remote April	16.11

16.4 DISPLAYING APRIL HELP

To see a list of APRIL commands while the "9780>" prompt is displayed, use the "H" command.

9780>H [ENTER]

When you invoke the "H" command, the APRIL command main menu shown in Figure 16-3 will re-appear on your screen.

16.5 VIEWING THE VALUES DISPLAY

To view the values display, enter the "V" command.

9780TxRx>V [ENTER]

The "V" command tells the RFL 9780 to send a copy of the most recently measured values to your terminal. This display is for viewing only and cannot be changed by the user. Typical values displays for the five different types of 9780 chassis are shown in Figures 16-4 to 16-8.

```
  #      ALARM                    STATUS
-----------------------------------------
011      Tx Fail #1               Inactive
015      Power Fail #1            Inactive
016      Power Fail #2            Inactive

  #      SIGNAL                   STATUS
-----------------------------------------
035      Trip Key #1              Inactive
036      Trip Key #2              Active
044      IRIG-B Status            Unlocked
102      TxCh1 PWR (50ohm)        0.6 Watts
104      TxCh1 Actual PWR         0.3 Watts
106      TxCh1 REFL_PWR           >40%
9780Tx>
```

Figure 16-4. Typical values display for a Tx Only operating mode

```
 #      ALARM                   STATUS
------------------------------------------
013     Logic Alarm #1          Inactive
015     Power Fail #1           Inactive
016     Power Fail #2           Inactive
017     Low Level #1            Active

 #      SIGNAL                  STATUS
------------------------------------------
031     Guard Out #1            Active
033     Trip Out #1             Active
044     IRIG-B Status           Unlocked
100     RxCh1 Level             <-10dB
9780Rx>
```

Figure 16-5. Typical values display for an Rx Only operating mode

```
 #      ALARM                   STATUS
------------------------------------------
011     Tx Fail #1              Inactive
013     Logic Alarm #1          Inactive
015     Power Fail #1           Inactive
016     Power Fail #2           Inactive
017     Low Level #1            Active

 #      SIGNAL                  STATUS
------------------------------------------
031     Guard Out #1            Active
033     Trip Out #1             Active
035     Trip Key #1             Inactive
036     Trip Key #2             Active
044     IRIG-B Status           Unlocked
100     RxCh1 Level             <-10dB
102     TxCh1 PWR(50ohm)        0.4 Watts
104     TxCh1 Actual PWR        0.4 Watts
106     TxCh1 REFL_PWR          0.6%
9780TxRx>
```

Figure 16-6. Typical values display for a TxRx operating mode

```
 #       ALARM                   STATUS
-----------------------------------------
011      Tx Fail #1              Inactive
012      Tx Fail #2              Inactive
015      Power Fail #1           Inactive
016      Power Fail #2           Inactive

 #       SIGNAL                  STATUS
-----------------------------------------
035      Trip Key #1             Inactive
036      Trip Key #2             Inactive
037      Trip Key #3             Inactive
038      Trip Key #4             Inactive
044      IRIG-B Status           Unlocked
102      TxCh1 PWR(50ohm)        0.4 Watts
103      TxCh2 PWR(50ohm)        0.0 Watts
104      TxCh1 Actual PWR        0.4 Watts
105      TxCh2 Actual PWR        0.0 Watts
106      TxCh1 REFL_PWR          0.6 Watts
107      TxCh1 REFL_PWR          N/A
9780TxTx>
```

Figure 16-7. Typical values display for a TxTx operating mode

```
 #       ALARM                   STATUS
-----------------------------------------
013      Logic Alarm #1          Inactive
014      Logic Alarm #2          Inactive
015      Power Fail #1           Inactive
016      Power Fail #2           Inactive
017      Low Level #1            Active
018      Low Level #2            Active

 #       SIGNAL                  STATUS
-----------------------------------------
031      Guard Out #1            Active
033      Guard Out #2            Active
033      Trip Out #1             Active
034      Trip Out #2             Active
044      IRIG-B Status           Unlocked
100      RxCh1 Level             <-10dB
101      RxCh2 Level             2.5dB
9780RxRx>
```

Figure 16-8. Typical values display for an RxRx operating mode

The values display shows the parameter number for each alarm, a brief description of its meaning, and its status. Full descriptions for each alarm are as follows:

011 – Tx Fail #1 This indicates that transmitter channel #1 has failed (this is the only transmitter in a Tx, or Tx/Rx chassis).

012 – Tx Fail #2 This indicates that transmitter channel #2 has failed (this is the second transmitter in a Tx/Tx chassis).

013 – Logic Alarm #1 This indicates that there is a problem with receive channel #1 (this is the only receive channel in an Rx, or Tx/Rx chassis). The possible causes of a logic alarm are:

- Excessive noise is detected in the received signal.
- The received level is out of normal limits (either too high or too low).
- The system is receiving both guard and trip signals simultaneously.
- The system is not receiving either a guard or a trip signal.
- There has been a failure of the 9780's internal power supply(s).

014 – Logic Alarm #2 This indicates that there is a problem with receive channel #2 (this is the second receive channel in an Rx/Rx chassis). The possible causes of a logic alarm are:

- Excessive noise is detected in the received signal.
- The received level is out of normal limits (either too high or too low).
- The system is receiving both guard and trip signals simultaneously.
- The system is not receiving either a guard or a trip signal.
- There has been a failure of the 9780's internal power supply(s).

015 – Power Fail #1 This indicates that a problem has been detected with power supply #1. In a single supply system, this is the only supply. In a Tx, Rx, Tx/Rx, or Rx/Rx chassis with dual supplies, the system will continue to operate using the backup supply. In a Tx/Tx chassis, as one supply is required for each channel, channel #1 will be disabled.

016 – Power Fail #2 This indicates that a problem has been detected with power supply #2. This is only applicable in dual supply systems. In a Tx, Rx, Tx/Rx, or Rx/Rx chassis with dual supplies, the system will continue to operate using supply #1. In a Tx/Tx chassis, as one supply is required for each channel, channel #2 will be disabled.

017 – Low Level #1 This indicates that the receive level for channel #1 is below acceptable limits (this is the only receive channel in an Rx or Tx/Rx chassis).

018 – Low Level #2 This indicates that the receive level for channel #2 is below acceptable limits (this is the second receive channel in an Rx/Rx chassis).

031 – Guard Out #1 This indicates that the receiver for channel #1 is receiving a valid guard signal (this is the only receiver in an Rx or Tx/Rx chassis).

032 – Guard Out #2 This indicates that the receiver for channel #2 is receiving a valid guard signal (this is the second receiver in an Rx/Rx chassis).

033 – Trip Out #1 This indicates that the receiver for channel #1 is receiving a valid trip signal (this is the only receiver in an Rx or Tx/Rx chassis).

034 – Trip Out #2 This indicates that the receiver for channel #2 is receiving a valid trip signal (this is the second receiver in an Rx/Rx chassis).

035 – Trip Key #1 This indicates that the first key input for transmitter channel #1 is active.

036 – Trip Key #2 This indicates that the second key input for transmitter channel #1 is active.

037 – Trip Key #3 This indicates that the first key input for transmitter channel #2 is active.

038 – Trip Key #4 This indicates that the second key input for transmitter channel #2 is active.

044 – IRIG-B Status This indicates the IRIG-B signal lock status. When locked, the IRIG-B signal is coming into the chassis or is present.

Parameters 053 - 056 are normally pre-set at the factory, or can be set in the field by the user. These parameters must be set, before meaningful Reflected Power readings can be read in the Values Display. For example, in a TxTx chassis with X-Hybrids in the Channel 1 and Channel 2 transmit paths, parameters 054 and 056 must be set to Y (yes). Then set the Channel 1 and Channel 2 frequencies in parameters 053 and 055 as applicable. The settings of these parameters are essential in calculating the Reflected Power readings in the Values Display, as shown in paragraph 16.5.

053 - Freq Ch1 (Hz) This parameter is set to the Channel 1 transmit frequency. This parameter is only used if parameter 054 is set to Y (yes), and is only applicable in a TxRx, TxTx, or Tx only chassis that has an X-hybrid installed in the Tx Channel 1 output path.

054 - X Hybrid Ch1 This parameter is set to:
Y (yes) if an X-Hybrid is installed in the Channel 1 transmit path, or set to
N (no) if an X-Hybrid is not installed in the Channel 1 transmit path.
This parameter is normally set at the factory, or can be set by the user.

055 - Freq Ch2 (Hz)	This parameter is set to the Channel 2 transmit frequency. This parameter is only used if parameter 056 is set to Y (yes), and is only applicable in a TxTx chassis that has an X-hybrid installed in the Tx Channel 2 output path.
056 - X Hybrid Ch2	This parameter is set to: Y (yes) if an X-Hybrid is installed in the Channel 2 transmit path, or set to N (no) if an X-Hybrid is not installed in the Channel 2 transmit path. This parameter is normally set at the factory, or can be set by the user.
100 - RxCh1 Level	Indicates the Channel 1 receive level (+/-10 dB from nominal). This is the same number that is displayed on the RFL 9780 front panel digital meter.
101 - RxCh2 Level	Indicates the Channel 2 receive level (+/-10 dB from nominal). This is the same number that is displayed on the RFL 9780 front panel digital meter.
102 - TxCh1 PWR(50ohm)	Indicates the amount of power that would be transmitted into an ideal, balanced 50Ω load, with zero reflection (with source and load matched), for Channel 1. Typical range is 1W to 10W
103 - TxCh2 PWR(50ohm)	Indicates the amount of power that would be transmitted into an ideal, balanced 50Ω load, with zero reflection (with source and load matched), for Channel 2. Typical range is 1W to 10W
104 - TxCh1 Actual PWR	Indicates the actual power being transmitted into the load for Channel 1. Theoretical range is 0W to 10W.
105 - TxCh2 Actual PWR	Indicates the actual power being transmitted into the load for Channel 2. Theoretical range is 0W to 10W.
106 - TxCh1 REFL PWR	Indicates the Channel 1, percent reflected power. Numerical range is 0% to 40%. Over 40% reflected power will be displayed as >40%. If there is an open or short, “OPEN” or “SHORT” will be displayed.
107 - TxCh2 REFL PWR	Indicates the Channel 2, percent reflected power. Numerical range is 0% to 40%. Over 40% reflected power will be displayed as >40%. If there is an open or short, “OPEN” or “SHORT” will be displayed.

16.6 THE PROGRAMMING MODE

You can use APRIL and your terminal to program the RFL 9780. To use your PC or terminal to program the RFL 9780, use the "P" command.

9780TxRx>P [ENTER]

The "P" command tells the RFL 9780 to send a list of all programming commands to your terminal. The "P" command is password-protected.

If the proper password is entered, a programming menu similar to the one shown in Figure 16-9 will appear.

```
H - Display programming help
Q - Leave programming menu
SV - Save new settings
C - Change password (superuser authorization required)
D - Display present settings and parameter numbers
## - Edit this specific number parameter
9780TxRx-P>
```

Figure 16-9. Typical programming menu

You are now in the programming mode, as indicated by the "9780TxRx-P>" prompt on your screen. You may now use the programming commands to re-program the RFL 9780. For more information on each programming command, refer to the paragraph numbers listed below.

Command	Meaning	Paragraph
H	Display programming help	16.6.1
Q	Leave programming menu	16.6.2
SV	Save new settings	16.6.3
C	Change password	16.12.2
D	Display current settings and parameter numbers	16.6.4
##	Edit the parameter number “##”	16.6.4

16.6.1 DISPLAYING PROGRAMMING HELP

To see a list of all programming commands, use the "H" command.

9780TxRx-P>H [ENTER]

When you invoke the "H" command, the programming menu shown in Figure 16-5 will re-appear on your screen.

16.6.2 LEAVING THE PROGRAMMING MODE

NOTE
Before leaving the Programming Mode, use the “SV” command or your changes will be lost.

Whenever you are finished programming the RFL 9780, use the "Q" command:

9780TxRx-P>Q [ENTER]

The "Q" command tells the RFL 9780 to leave the programming mode and return to the normal "9780TxRx>" prompt. If you changed any setting while in the programming mode, be sure to use the "SV" command described above to save the changes before invoking the "Q" command; otherwise, your changes will be lost.

16.6.3 SAVING NEW PROGRAMMING SETTINGS

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

9780TxRx-P>SV [ENTER]

The "SV" command tells the RFL 9780 to store all the changes in its non-volatile memory. Once the changes are stored, the "9780TxRx-P>" prompt will reappear.

Before you enter the "SV" command, the RFL 9780 operates according to the old parameter settings. Once the "SV" command is entered, the new settings will be in effect.

The new parameter settings can be verified by re-issuing the "D" command to display the parameter settings list. (For more information on the "D" command, go to paragraph 16.7.4.)

16.6.4 DISPLAYING AND EDITING PARAMETER SETTINGS

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

9780TxRx-P>D [ENTER]

When you invoke the "D" command, the RFL 9780 sends a list of all current parameter settings to your terminal. A typical parameter settings display is shown in Figure 16-10.

```
#        PARAMETER          SETTING
999      System Label       PAUL's UNIT
051      Time               16:14:07
052      Date               05/26/1999
053      Freq Ch1 (Hz)      170000
054      X Hybrid Ch1       N
055      Freq Ch2 (Hz)      170000
056      X Hybrid Ch2       Y
9780TxRx-P>
```

Figure 16-10. Typical parameter settings display

To re-program any of the values shown on the parameter settings displays, type in the number in the "#" column, and then press **[ENTER]**. The parameter will be displayed, with information about its setting below it. Type in the new setting, and then press **[ENTER]**.

Example 1: Editing the system time and date parameter settings.

If your RFL 9780 is connected to an IRIG-B generator, its system clock is being automatically synchronized to the IRIG-B time clock, and no manual setting is required except for year. If you are not using an IRIG-B generator, use the following procedure to set the RFL 9780's system clock (note that the time and date values entered will not take effect until stored using the "SV" command):

1. Enter the number for the Date parameter (52) on your terminal or PC keyboard, and then press the **[ENTER]** key.
   The Date parameter will be displayed, with information about its setting below it.
   052 Date 05/24/1999
   [mm/dd/(yy)yy]> _

2. Type in the current date (in "mm/dd/(yy)yy format), and then press the **[ENTER]** key.
   The Year parameter will be re-displayed, set to the new value.
   052 Date 05/25/1999
   IRIG-B values will override entry here
   Note the message that the IRIG-B input can override the manually entered date (other than year, which is not a part of the IRIG-B data).

3. Enter the number for the Time parameter (51) on your terminal or PC keyboard, and then press the **[ENTER]** key.
   The Time parameter will be displayed, with information about its setting below it.
   051 Time 16:21:06
   [hh:mm:ss]> _

4. Type in the current time (in 24-hour “hh:mm:ss format, the seconds are optional), and then press the **[ENTER]** key.

   The Time parameter will be re-displayed, set to the new value.

   051 Time 16:10:00
   IRIG-B values will override entry here

   Again note the message that the IRIG-B input can override the manually entered time.

5. Enter the "SV" command to save your new system label:

   9780TxRx-P>SV

Example 2: Editing the Channel 1 frequency setting.

1. Enter the number for the Channel 1 frequency parameter (53) on your terminal or PC keyboard, and then press the **[ENTER]** key.

   The Channel 1 frequency parameter will be displayed, with information about its setting below it.

   053 Freq Ch1 (Hz) 170000
   [30000 - 537500]> _

2. Type in the desired frequency (for example: 190000), and then press the **[ENTER]** key.

   The Channel 1 frequency will be re-displayed, set to the new value.

   053 Freq Ch1 (Hz) 190000

16.7 READING PARAMETER SETTINGS

The "D" command tells the RFL 9780 to send a list of all parameter settings to your terminal. This list of settings is called the "read settings" menu.

9780TxRx>D [ENTER]

A typical read settings menu for the Audio System appears in Figure 16-11. The settings described in paragraph 16.6.4 are shown, but you can't change the displayed values. To change these values, you will have to enter the programming mode. (See paragraph 16.6 for more information.) The programming mode is password-protected, so only authorized persons can change the RFL 9780's parameter settings.

```
 #       PARAMETER           SETTING
999      System Label        PAUL's UNIT
051      Time                16:14:07
052      Date                05/26/1999
053      Freq Ch1 (Hz)       170000
054      X Hybrid Ch1        N
055      Freq Ch2 (Hz)       170000
056      X Hybrid Ch2        Y
9780TxRx-P>
```

Figure 16-11. Typical read settings menu

16.8 VIEWING CONFIGURATION AND SOFTWARE INFORMATION

The "F" command tells the RFL 9780 to send a configuration and software version display to your terminal. This display tells you how the RFL 9780 is configured, and what software versions are being used. These parameters cannot be changed by the user and are for display only.

9780TxRx>F [ENTER]

Typical configuration and software version display is shown in Figure 16-12.

```
SOE Module Configuration:
001      Type                 9780 Tx/Rx
002      Firmware Version     4.0
003      2nd Power Supply     Yes
9780TxRx>
```

Figure 16-12. Typical configuration and software version display

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

001 – Type This identifies the basic model and configuration of the system (9780 Tx/Rx)

002 – Firmware This gives the version number of the software presently running in the SOE-IRIG-B Module.

figured for single or dual supply operation.

16.9 THE UPDATE MODE

The update mode places a display on your terminal that is updated every few seconds to show up-to-date information about RFL 9780 operation. This mode is entered by using the "U" command.

9780TxRx>U [ENTER]

When the "U" command is entered, the screen on your terminal will be cleared, and replaced by the UPDATE screen shown in Figure 16-13. This is a display of all the measured parameter values. This screen can be used to monitor RFL 9780 operation. The update display shows the parameter numbers for each item, a brief description of its meaning, and its status. To exit the update mode, press the **[X]** key, followed by the **[ENTER]** key. The screen on your terminal will be cleared, and the "9780TxRx>" prompt will re-appear.

```
Value Update - Type 'X<CR>' to Stop
011      Tx Fail #1        Active
013      Logic Alarm #1    Inactive
015      Power Fail #1     Inactive
016      Power Fail #2     Inactive
017      Low Level #1      Inactive
031      Guard Out #1      Active
033      Trip Out #1       Inactive
035      Trip Key #1       Inactive
036      Trip Key #2       Inactive
044      IRIG-B Status     Unlocked
100      RxCh1 Level       <-10dB
102      TxCh1 PWR(50ohm)  0.4 Watts
104      TxCh1 Actual PWR  0.4 Watts
106      TxCh1 REFL_PWR    0.6%
```

Figure 16-13. Typical update display

16.10 THE SEQUENCE-OF-EVENTS MODE

The sequence-of-events log is a data file that keeps track of every time one of the RFL 9780 changes state, and the conditions that existed at that time. The sequence-of-events log is battery backed and can store up to 40 records. To view the sequence-of-events log, use the "S" command:

9780TxRx>S [ENTER]

When you use the "S" command, a sequence-of-events menu similar to the one shown in Figure 16-14 will appear.

```
SEQUENCE OF EVENTS MENU

0 New Events, 3 Events

H - Display sequence of events help
D - Dump All Events to Port
E - See Directory of Events
F - Force Sequence of Event Record
R - Reset All Events
Q - Leave Sequence of Events Menu
## - View this Sequence of Events record
9780TxRx-S>
```

Figure 16-14. Typical sequence-of-events menu

You are now in the sequence-of-events mode, as indicated by the "9780TxRx-S>" prompt on your screen. You may now use the sequence-of-events commands to view the contents of the sequence-of-events log, toggle the event displays and event triggers, or reset the sequence-of-events log. Note that near the top of the screen the total number of events in memory is listed, as well as the number of “new events”. The “new events” counter is cleared once it has been reported and is intended only as a general reference. For more information on each sequence-of-events command, refer to the paragraph numbers listed below.

Command	Meaning	Paragraph
H	Display sequence-of-events help	16.10.1
D	Dump All Events To Port	16.10.2
E	See Directory Of Events	16.10.3
F	Force a Sequence of Events Record	16.10.4
R	Reset All Events	16.10.5
Q	Leave Sequence-of-Events menu	16.10.6
##	View an event record	16.10.7

16.10.1 DISPLAYING SEQUENCE-OF-EVENTS HELP

To see a list of all sequence-of-events menu commands, use the "H" command.

9780TxRx-S>H [ENTER]

When you invoke the "H" command, the sequence-of-events menu shown in Figure 16-15 will re-appear on your screen.

16.10.2 DUMPING THE SEQUENCE-OF-EVENTS LOG TO A PORT

To transfer the event records in the sequence-of-events log from the RFL 9780 to your terminal or PC, use the "D" command:

9780TxRx-S>D [ENTER]

When you invoke the "D" command, each record will appear as ASCII text on your screen as it is being transferred. The records are displayed in reverse chronological order, starting with the most recent event. Each individual log record is displayed as described in paragraph 16.11.3.

Note that the SOE log record number refers to the data’s location in a circular memory buffer. The most recent event may be any record number from 1 through 40.

When all the events have been dumped, the "9780TxRx-S>" prompt will re-appear on your screen.

16.10.3 VIEWING THE DIRECTORY OF EVENTS

To view a list of the events presently stored in the sequence-of-events log, use the "E" command:

9780TxRx-S>E [ENTER]

When you invoke the "E" command, a Directory Of Events display similar to the one shown in Figure 16-15 will appear.

The Directory Of Events lists each record in the sequence-of-events log, along with the date and time it occurred. It also lists which signal changed state to trigger the event. More information about the Directory Of Events can be found in paragraphs 16.13.5 through 16.13.8.

```
003      05/24/1999 05:37:49.068 Tx Fail #1  Active
002      05/24/1999 05:37:48.952 Tx Fail #1  Inactive
001      05/24/1999 15:37:47.000 CPU BOOTS UP
9780TxRx-S>
```

Figure 16-15. Typical Directory Of Events display

16.10.4 FORCING A SEQUENCE-OF-EVENTS RECORD

To force the SOE Module to record an SOE log entry, use the "F" command:

9780TxRx-S>F [ENTER]

The "F" command tells the RFL 9780 SOE Module to create an entry in the log showing the status of all signals, time-stamped to the present time and date.

16.10.5 ERASING THE SEQUENCE-OF-EVENTS LOG

To erase the sequence-of-events log, use the "R" command:

9780TxRx-S>R [ENTER]

When you invoke the "R" command, the following prompt appears:

Are you sure? [Yes,No]

To answer "yes," press the **[Y]** key. The sequence-of-events log will be erased.

If you decide you don't want to erase the sequence-of-events log, press the **[N]** key. The log will remain as it is, and the following message will appear:

Reset Sequence Cancelled

16.10.6 LEAVING THE SEQUENCE-OF-EVENTS MODE

To leave the sequence-of-events mode, use the "Q" command:

9780TxRx-S>Q [ENTER]

The "Q" command tells the RFL 9780 to leave the sequence-of-events mode and return to the normal "9780TxRx>" prompt.

16.10.7 VIEWING AN INDIVIDUAL EVENT RECORD

To view an individual record from the Directory Of Events, enter its record number. For example, to view Record number 1, enter a "1":

9780TxRx-S>1 [ENTER]

An individual record similar to the one shown in Figure 16-16 will appear.

The individual event records shown in Figure 16-16 lists the record number, the name of the input 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 system conditions at the precise instant the event occurred.

```
Record 01                                   Event Trigger:       TX Fail #1 Active
                                            Event Time:          05/26/1999 15:54:53.385

011   Tx Fail #1     Active                 013   Logic Alarm #1 Inactive
015   Power Fail #1  Inactive               016   Power Fail #2  Inactive
017   Low Level #1   Active

031   Guard Out #1   Active                 033   Trip Out #1    Active
035   Trip Key #1    Inactive               036   Trip Key #2    Inactive
044   IRIG-B Status  Unlocked
9780TxRx-S>
```

Figure 16-16. Typical individual event record

16.11 THE WINDOW REMOTE APRIL MODE

The Window Remote APRIL mode is not applicable in the RFL 9780 chassis.

16.12. PASSWORD PROTECTION

> **NOTE**
> This is the only page where the superuser password is discussed
> and can be removed for added security.

Password protection is required to prevent unauthorized personnel from gaining access to the RFL 9780 settings and parameters. The only menu that is password protected is the Programming Menu.

16.12.1 ENTERING THE PROGRAMMING, LOGIC PROGRAMMING OR TEST MENUS

When you invoke the “P” command, the following prompt appears:

enter password:

Enter the password that has been stored in the RFL 9780's memory. The RFL 9780 gives you three chances to enter the correct password. After the third incorrect password is entered, the RFL 9780 enters a lock-out mode. This mode will last for about five minutes, during which you will not be able to enter the programming mode.

16.12.2 CHANGING THE PASSWORD

You can use the "C" command to change the password that can be used to enter the programming, logic programming, or test modes.

9780TxRx-P>C [ENTER]

When you invoke the "C" command, the RFL 9780 sends the following prompt to your terminal:

enter super-user:

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

Current password is (current password)
enter new password:

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

repeat new password:

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

password modified

The new password is now stored in the RFL 9780's non-volatile memory. The password can have a maximum of six alphanumeric characters including spaces. The software only allows one password. If a new password is entered it will write over the old password.

SECTION 17. I/O MODULES

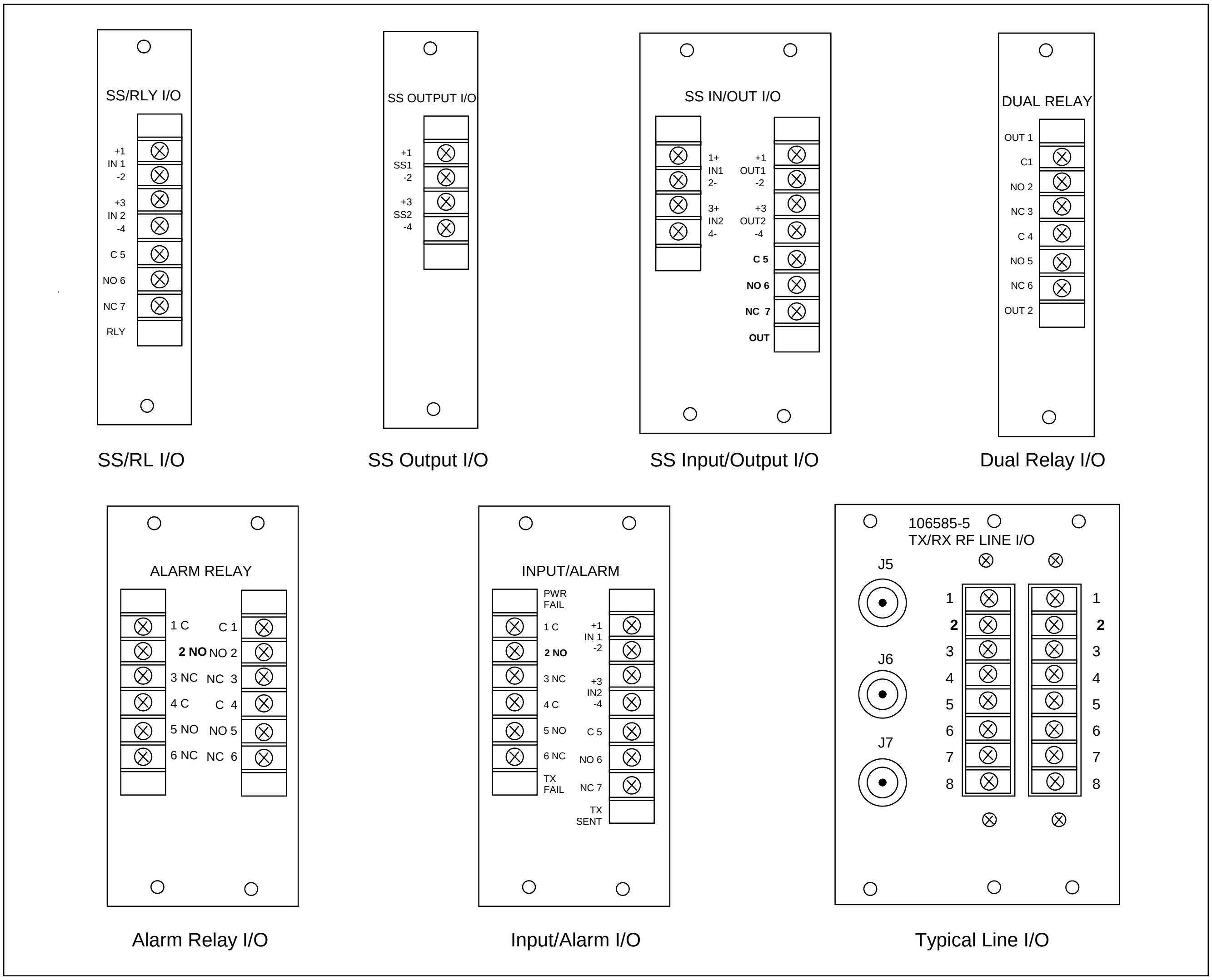


Figure 17-1. Rear panel views of the 7 basic types of I/O modules used in the RFL 9780

17.1 INTRODUCTION

The RFL 9780 I/O modules serve as an interface for input and output signals between the RFL 9780 and the line coupling equipment. There are seven basic types of I/O modules that can be used with the RFL 9780. The rear panel views of these are shown in Figure 17-1.

There are twelve types of Line I/O modules available. The rear panel views of these are shown in Figure 17-2. Table 17-1 shows the various applications of all RFL 9780 I/O modules presently available.

> **NOTE**
> **Chassis power must be turned OFF before removing or installing any RFL 9780 I/O modules.**

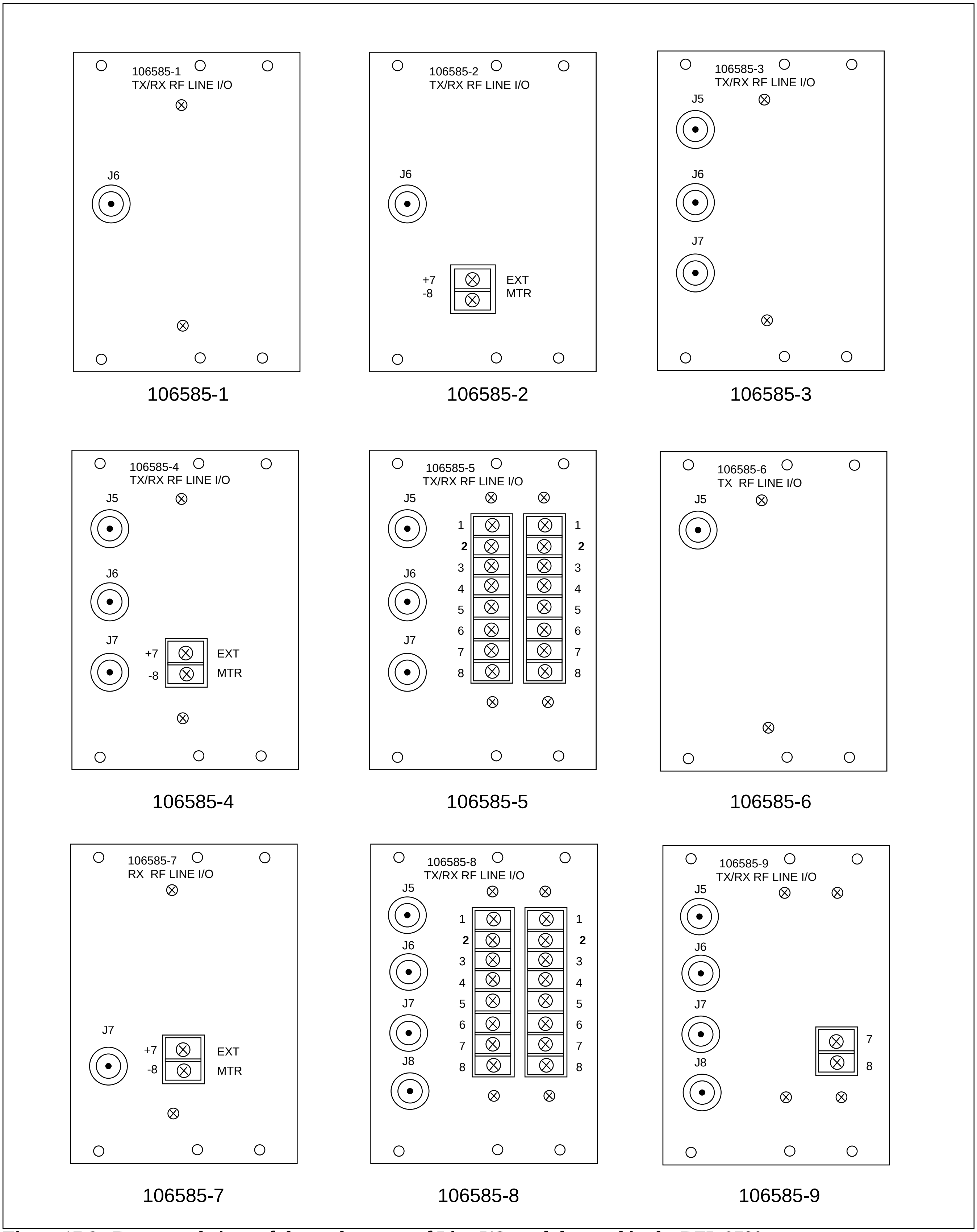


Figure 17-2. Rear panel views of the twelve types of Line I/O modules used in the RFL 9780

>> Figure 17-2 continues on next page <<

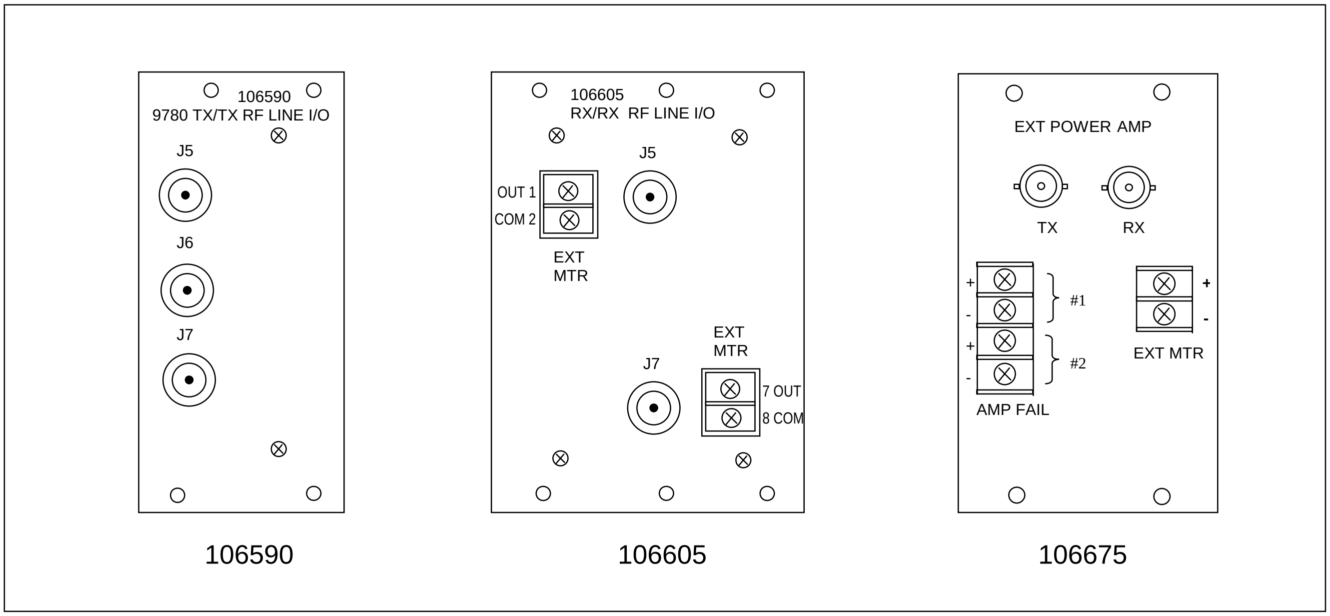


Figure 17-2. continued - Rear panel views of the twelve types of Line I/O modules used in the RFL 9780

Table 17-1. RFL 9780 I/O modules Application Information

<table>
<tr><th colspan="5">9780 Application</th><th rowspan="2">Assembly Number</th><th rowspan="2">I/O Module</th><th rowspan="2">See the following paragraphs for more information</th></tr>
<tr><th>TX ONLY</th><th>RX ONLY</th><th>TX/TX</th><th>RX/RX</th><th>TX/RX</th></tr>
<tr><td>X</td><td></td><td></td><td></td><td></td><td>106435-3
106435-4
106435-5</td><td>Solid-state/Relay I/O</td><td>17.2</td></tr>
<tr><td></td><td>X</td><td></td><td>X</td><td></td><td>106440-3
106440-4
106440-5</td><td>Solid-state Output I/O</td><td>17.3</td></tr>
<tr><td></td><td></td><td></td><td></td><td>X</td><td>106445-3
106445-4
106445-5</td><td>Solid-state In/Out I/O</td><td>17.4</td></tr>
<tr><td></td><td>X</td><td></td><td>X</td><td>X</td><td>106470</td><td>Dual Relay I/O</td><td>17.5</td></tr>
<tr><td>X</td><td>X</td><td></td><td>X</td><td>X</td><td>106465</td><td>Alarm Relay I/O</td><td>17.6</td></tr>
<tr><td></td><td></td><td>X</td><td></td><td></td><td>106600-3
106600-4
106600-5</td><td>Input/Alarm I/O</td><td>17.7</td></tr>
<tr><td></td><td></td><td></td><td></td><td>X</td><td>106585-1</td><td>TX/RX RF Line I/O</td><td>17.8.1.1</td></tr>
<tr><td></td><td></td><td></td><td></td><td>X</td><td>106585-2</td><td>TX/RX RF Line I/O</td><td>17.8.1.1</td></tr>
<tr><td></td><td></td><td></td><td></td><td>X</td><td>106585-3</td><td>TX/RX RF Line I/O</td><td>17.8.1.2</td></tr>
<tr><td></td><td></td><td></td><td></td><td>X</td><td>106585-4</td><td>TX/RX RF Line I/O</td><td>17.8.1.2</td></tr>
<tr><td></td><td></td><td></td><td></td><td>X</td><td>106585-5</td><td>TX/RX RF Line I/O</td><td>17.8.1.2</td></tr>
<tr><td>X</td><td></td><td></td><td></td><td></td><td>106585-6</td><td>TX RF Line I/O</td><td>17.8.1.3</td></tr>
<tr><td></td><td>X</td><td></td><td></td><td></td><td>106585-7</td><td>RX RF Line I/O</td><td>17.8.1.4</td></tr>
<tr><td></td><td></td><td></td><td></td><td>X</td><td>106585-8</td><td>TX/RX RF Line I/O</td><td>17.8.1.5</td></tr>
<tr><td></td><td></td><td></td><td></td><td>X</td><td>106585-9</td><td>TX/RX RF Line I/O</td><td>17.8.1.6</td></tr>
<tr><td></td><td></td><td>X</td><td></td><td></td><td>106590</td><td>TX/TX Line I/O</td><td>17.8.1.7</td></tr>
<tr><td></td><td></td><td></td><td>X</td><td></td><td>106605</td><td>RX/RX Line I/O</td><td>17.8.1.8</td></tr>
<tr><td>X</td><td></td><td>X</td><td></td><td>X</td><td>106675</td><td>External Power Amp I/O Module</td><td>17.9</td></tr>
</table>

17.2 SOLID STATE RELAY I/O MODULE

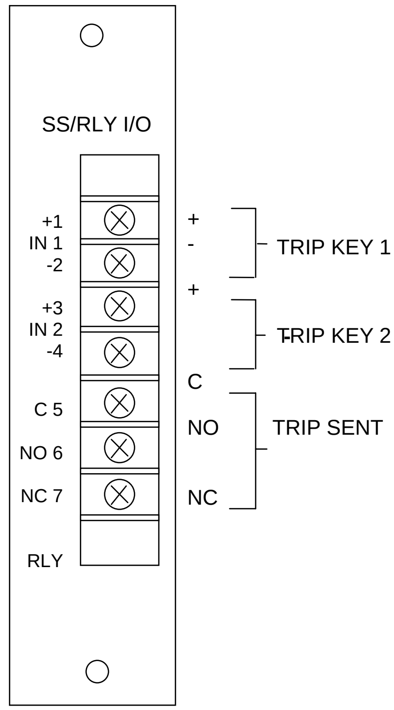


Figure 17-3. Solid State Relay I/O module, rear panel view

17.2.1 DESCRIPTION

The Solid-State Relay I/O module provides two solid state inputs and one electro-mechanical output. This I/O module is available in three versions as follows:

Input Voltage	Assembly No.
48V or 125V	(106435-3)
250V	(106435-4)
5V	(106435-5)

The inputs are used for keying trips, and the output is used as an acknowledgement that a trip was sent (trip sent). The electro-mechanical output has N.O. and N.C. connections at the terminal block. All signals to and from the Solid-State Relay I/O module interface directly with the 9780 Logic Module.

The 48/125V version requires that jumpers J4 and J5 be configured for the input voltage requirement. They are placed in the 48V or 125V position as applicable. The 250V version does not have these jumpers installed.

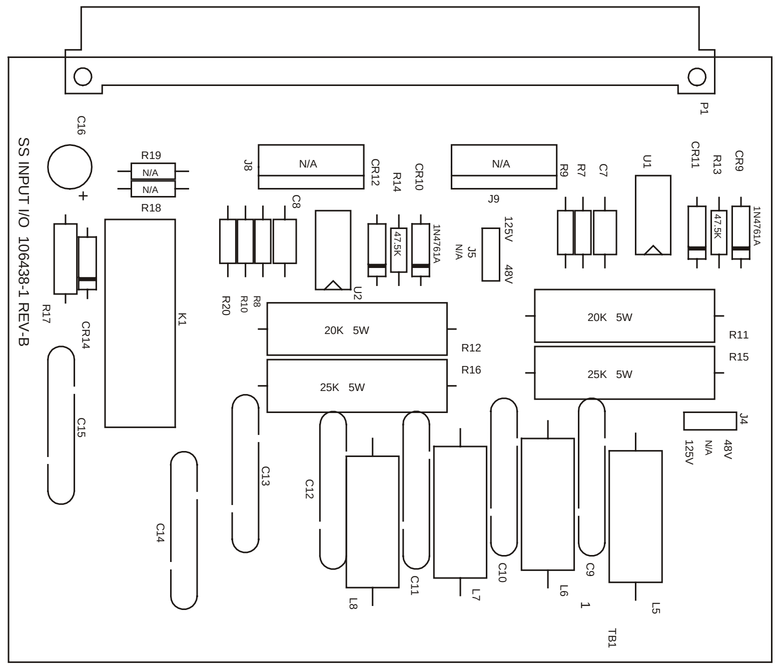
The Solid-State Relay I/O module is primarily used for TX only applications. It can also be used for customer specific applications and can be mounted in a spare I/O slot, if available, or in an expansion chassis.

17.2.2 CONTROLS AND INDICATORS

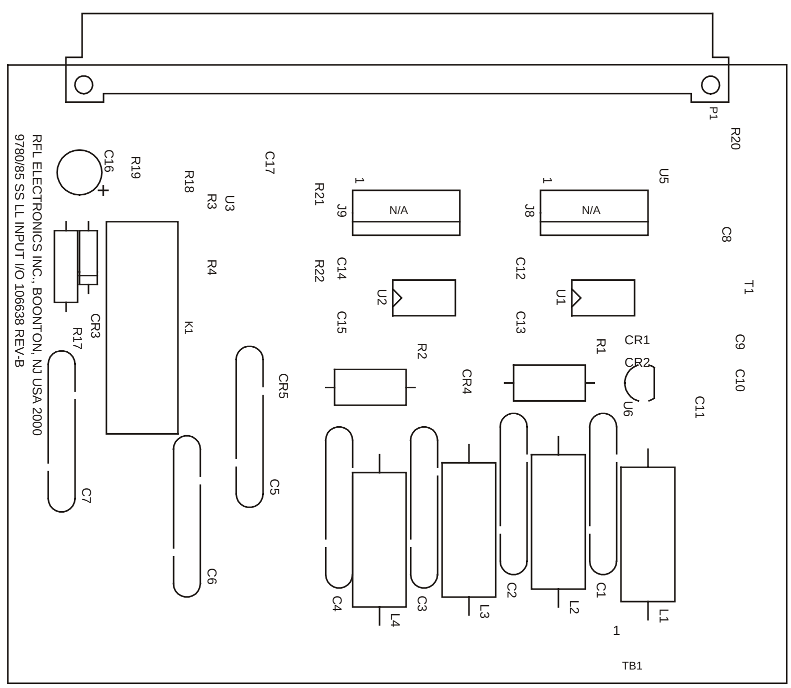
Figure 17-4 shows the location of all controls and indicators on the Solid State Relay I/O module. These controls and indicators are described in Table 17-2. Only TB1 is accessible with the Solid State Relay I/O module installed in the chassis. Jumpers J4 and J5 are accessible only when the module is removed from the chassis or is on a card extender.

Table 17-2. Controls and indicators, Solid State Relay I/O module

Component Designator	Name/ Description	Function
J4	Jumper	Selects 48V or 125V operation (not installed for 250V version)
J5	Jumper	Selects 48V or 125V operation (not installed for 250V version)
TB1	Terminal block	Provides connections to line coupling equipment.



a. 106435-3 and 106435-4



b. 106435-5

Figure 17-4. Controls and indicators, and component locator drawing, Solid State Relay I/O module

Table 17-3. Replaceable Parts, RFL 9780 Solid State Relay I/O module
Assy No. 106435-3 & -4

Circuit Symbol (Figs. 17-4 & 17-5)	**Description**	**Part Number**
C7,8	Capacitor, ceramic, 0.1µF, 10%, 50V	0130 51041
C9-15	Capacitor, ceramic disc, 0.01µF, 20%, 3KV	1007 1811
C16	Capacitor, electrolytic, 100µF, 20%, 25V	1007 1630
CR9, 10	101635-3: Diode, Zener, 20V, 5%, 1W, 1N4747A	20794
	101635-4: Diode, Zener, 75V, 5%, 1W, 1N4761A	101693
CR11, 12, 14	Diode, silicon, rectifier, 1A, 1N4003	30769
J4, 5	Connector, header, single, 3 CKT	32802 3
K1	Relay, SPST, 8A/300V, 6V/0.22W	101461
L5, 6, 7, 8	Inductor, 10µH, 5%, 1.5A max	30285
P1	Connector, plug, female, 64 contact, DIN	99134
R7, 8	Resistor, metal film, axial, 4.75K, 1%, 1/4W	0410 1353
R9, 10	Resistor, metal film, axial, 221Ω, 1%, 1/4W	0410 1225
R11, 12	106435-3: Resistor, wire-wound, 22K, 5%, 5W	1100 800
	106435-4: Resistor, wire-wound, 20K, 5%, 5W	1100 837
R13, 14	106435-3: Resistor, metal film, axial, 11.5K, 1%, 1/4W	0410 1390
	106435-4: Resistor, metal film, axial, 47.5K, 1%, 1/4W	0410 1449
R15, 16	106435-3: Resistor, wire-wound, 5K, 5%, 3.25W	1100 460
	106435-4: Resistor, wire-wound, 25K, 5%, 5W	1100 480
R17	Resistor, metal film, axial, 162Ω, 1%, 1/2W	0410 2212
R20	106435-3: Resistor, metal film, axial, 11Ω, 1%, 1/4W	0410 1100
	106435-4: not used	
TB1	Terminal block, 7 position	101463
U1, 2	Opto device, optical isolator, 6N139	29592
J4, 5	Jumper, connector, programmable, 0.1 inch centers, white	98306

Figure 17-5. Schematic, RFL 9780 Solid-State Input I/O (Dwg. No. D-106439-3-A)

Please see Figure 17-5 in Section 22.

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Table 17-4. Replaceable Parts, RFL 9780 Solid State Relay I/O module
Assembly No. 106435-5

Circuit Symbol (Figs. 17-4 & 17-6)	Description	Part Number
C1-7	Capacitor, ceramic disc, 0.01µF, 20%, 3KV	1007 1811
C8, 11-15, 17	Capacitor, ceramic, 0.1µF, 10%, 50V	151 10104040603
C9, 10	Capacitor, ceramic, 0.47µF, 10%, 16V	151 10474020603
C16	Capacitor, electrolytic, 100µF, 20%, 25V	1007 1630
CR1, 2	Diode, general purpose, 1N4148	340 100
CR3	Diode, silicon, rectifier, 1A, 1N4003	30769
CR4, 5	Suppressor, voltage, 6.8V, 5%, 600W, BIDIR	101497
K1	Relay, SPST, 8A/300V, 6V/0.22W	101461
L1-4	Inductor, 10µH, 5%, 1.5A max	30285
P1	Connector, plug, female, 64 contact, DIN	99134
R1, 2, 21, 22	Resistor, thick film, 1.21K, 1%, 1/8W	700 15121134
R3, 4	Resistor, thick film, 10K, 1%, 1/8W	700 15100234
R17	Resistor, metal film, axial, 162Ω, 1%, 1/2W	0410 2212
R20	Resistor, thick film, 10Ω, 1%, 1/8W	700 1510R034
T1	Transformer, 2:1, 900µH	910 00100
TB1	Terminal block, 7 position	101463
U1, 2	Opto isolator, optical isolator, 74OL6010	101498
U3	Integrated Circuit, 3-St Quad Buffer, 74ABT125	500 101
U5	Integrated Circuit, Linear transformer driver, MAX845	510 107
U6	Integrated Circuit, Linear voltage regulator, 5V, POS	0620 204

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Figure 17-6. Schematic, RFL 9780 Solid-State Logic Level Input I/O (Dwg. No. D-106439-5-B)

Please see Figure 17-6 in Section 22.

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17.3 SOLID STATE OUTPUT I/O MODULE

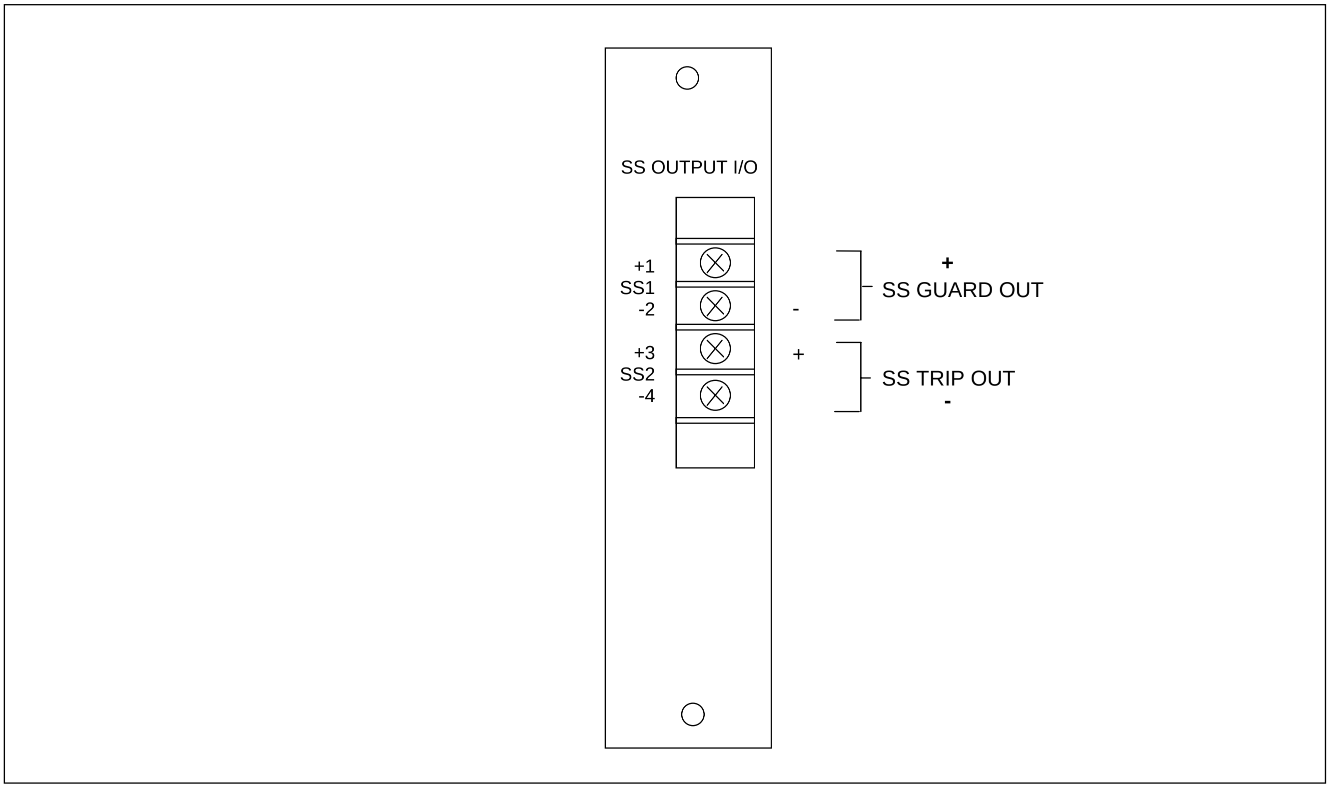


Figure 17-7. Solid State Output I/O module, rear panel view

17.3.1. DESCRIPTION

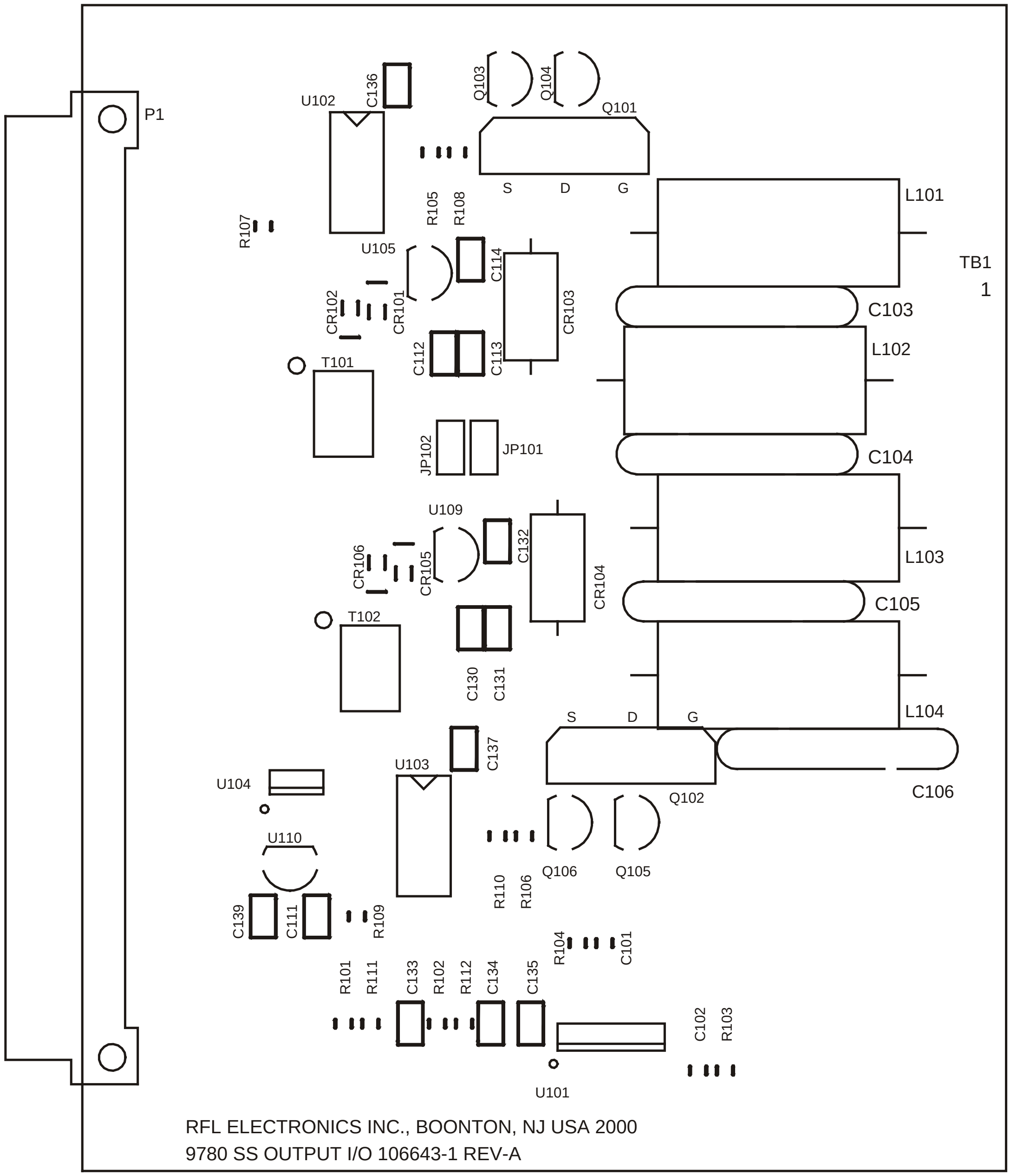
The Solid-State Output I/O module provides two solid state outputs. This I/O module is available in three versions as follows:

Input Voltage	Assembly No.
48V or 125V	(106440-3)
250V	(106440-4)
5V	(106440-5)

The outputs are used for received trip and guard commands. All signals to and from the Solid-State Output I/O module interface directly with the 9780 Logic Module.

The Solid-State Output I/O module is primarily used for RX/RX and RX only applications. It can also be used for customer specific applications and can be mounted in a spare I/O slot, if available, or in an expansion chassis.

User configuration is not required for this module.



(Note: used on 106440-3, -4 and –5)

Figure 17-8. Component locator drawing, Solid State Output I/O module

Table 17-5. Replaceable Parts, RFL 9780 Solid State Output I/O module
Assembly No. 106440-3 &.-4

Circuit Symbol (Figs. 17-8 & 17-)	Description	Part Number
C101, 102	Capacitor, ceramic, 4700pF, 5%, 50V	151 05472040507
C103-106	Capacitor, ceramic disc, 0.01µF, 20%, 3KV	1007 1811
C111, 114, 132, 135-137, 139	Capacitor, ceramic, 0.1µF, 10%, 50V	151 10104040603
C112, 113, 130, 131	Capacitor, ceramic, 0.47µF, 10%, 16V	151 10474020603
C133, 134	Capacitor, ceramic, 0.01µF, 10%, 50V	151 10103040603
CR101, 102, 105, 106	Diode, general purpose, 1N4148	340 100
CR103, 104	106440-3: Suppressor, transient voltage, 1.5KE180CA	42064
	106440-4: Suppressor, transient voltage, 1.5KE350CA	101722
L101-104	Inductor, 12µH, 4.5A, 10%	30436
P1	Connector, plug, female, 64 contact, DIN	99134
Q101, 102	106440-3: Transistor, MOSFET, N-channel	0715 36
	106440-4: Transistor, MOSFET, N-channel	0715 37
R101, 102, 105, 106	Resistor, thick film, 432Ω, 1%, 1/8W	700 15432034
R103, 104	Resistor, thick film, 10K, 1%, 1/8W	700 15100234
R107,109	Resistor, thick film, 2K, 1%, 1/8W	700 15200134
R108, 110-112	Resistor, thick film, 562Ω, 1%, 1/8W	700 15562034
T101, 102	Transformer, 2:1, 900µH	910 00100
TB1	Terminal block, 4 terminal	101126
U101	Integrated Circuit, MOS D RTRG MNST MV, 74HC123	500 104
U102, 103	Opto isolator, 6N139	29592
U104	Integrated Circuit, linear xformer driver, MAX845	510 107
U105, 109, 110	Integrated Circuit, linear voltage regulator, 5V POS	0620 204

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Figure 17-9. Schematic, RFL 9780 Solid-State Output I/O (Dwg. No. D-106444-3-D)

Please see Figure 17-9 in Section 22.

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Table 17-6. Replaceable Parts, RFL 9780 Solid State Output I/O module
Assembly No. 106440-5

Circuit Symbol (Figs. 17-7 & 17-8)	Description	Part Number
C101, 102	Capacitor, ceramic, 4700pF, 5%, 50V	151 05472040507
C103-106	Capacitor, ceramic disc, 0.01µF, 20%, 3KV	1007 1811
C111, 114,135-137, 139	Capacitor, ceramic, 0.1µF, 10%, 50V	151 10104040603
C112, 113	Capacitor, ceramic, 0.47µF, 10%, 16V	151 10474020603
C133, 134	Capacitor, ceramic, 0.01µF, 10%, 50V	151 10103040603
CR101, 102	Diode, general purpose, 1N4148	340 100
CR103, 104	Suppressor, voltage, 6.8V, 5%, 600W BIDIR	101497
JP101, 102	Connector header, single, 2-CKT	32802 2
L101-104	Inductor, 12µH, 4.5A, 10%	30436
P1	Connector, plug, female, 64 contact, DIN	99134
Q103, 105	Transistor, silicon, NPN, medium power	105421
Q104, 106	Transistor, silicon, PNP, medium power	103384
R101, 102, 105, 106	Resistor, thick film, 432Ω, 1%, 1/8W	700 15432034
R103, 104	Resistor, thick film, 10K, 1%, 1/8W	700 15100234
R107,109	Resistor, thick film, 2K, 1%, 1/8W	700 15200134
R108, 110-112	Resistor, thick film, 562Ω, 1%, 1/8W	700 15562034
T101	Transformer, 2:1, 900µH	910 00100
TB1	Terminal block, 4 terminal	101126
U101	Integrated Circuit, MOS D RTRG MNST MV, 74HC123	500 104
U102, 103	Opto isolator, 6N139	29592
U104	Integrated Circuit, linear xformer driver, MAX845	510 107
U105, 110	Integrated Circuit, linear voltage regulator, 5V POS	0620 204

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Figure 17-10. Schematic, RFL 9780 Solid-State Logic Level Output I/O (Dwg. No. D-106444-5-D)

Please see Figure 17-10 in Section 22

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17.4 SOLID STATE INPUT/OUTPUT I/O MODULE

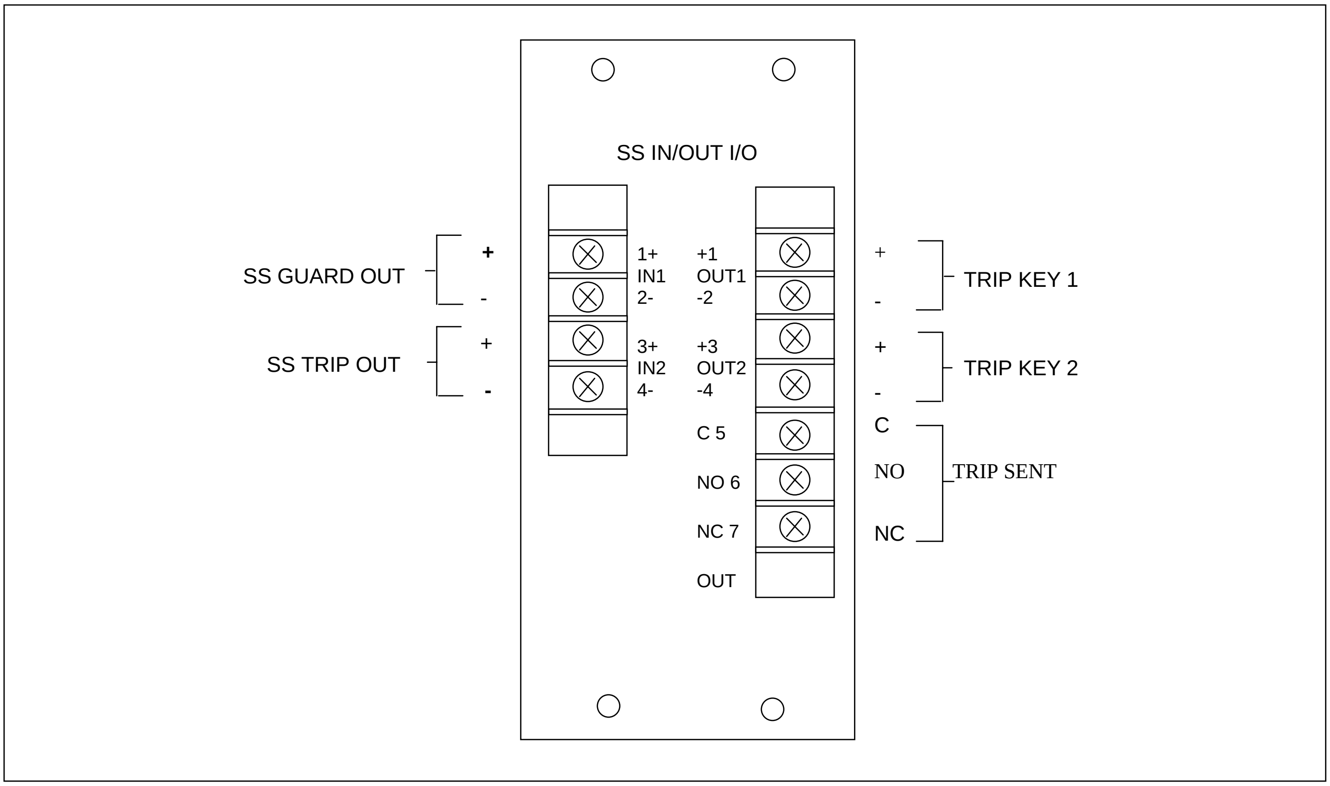


Figure 17-11. Solid State Input/Output I/O module, rear panel view

17.4.1 DESCRIPTION

The Solid-State Input/Output I/O module provides two solid-state inputs, two solid-state outputs, and one electro-mechanical output. This I/O module is available in three versions as follows:

Input Voltage	Assembly No.
48V or 125V	(106445-3)
250V	(106445-4)
5V	(106445-5)

In general, the inputs are used for keying trips, the solid-state outputs are used for receiving trip and guard commands, and the electro-mechanical output is used as an acknowledgement that a trip was sent (trip-sent). The electro-mechanical output has N.O and N.C. connections at the terminal block. All signals to and from the Solid-State Input/Output I/O module interface directly with the 9780 Logic Module.

The 48/125V version requires that jumpers J4 and J5 be configured for the input voltage requirement. They are placed in the 48V or 125V position as applicable. The 250V version does not have these jumpers.

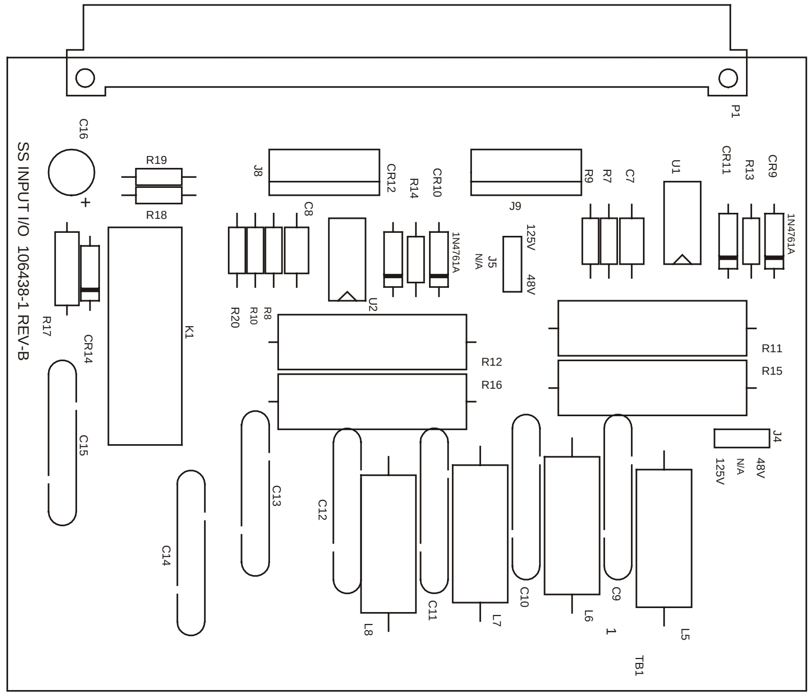
The Solid-State Input/Output I/O module is primarily used for TX/RX applications. It can also be used for customer specific applications and can be mounted in a spare I/O slot, if available, or in an expansion chassis.

17.4.2 CONTROLS AND INDICATORS

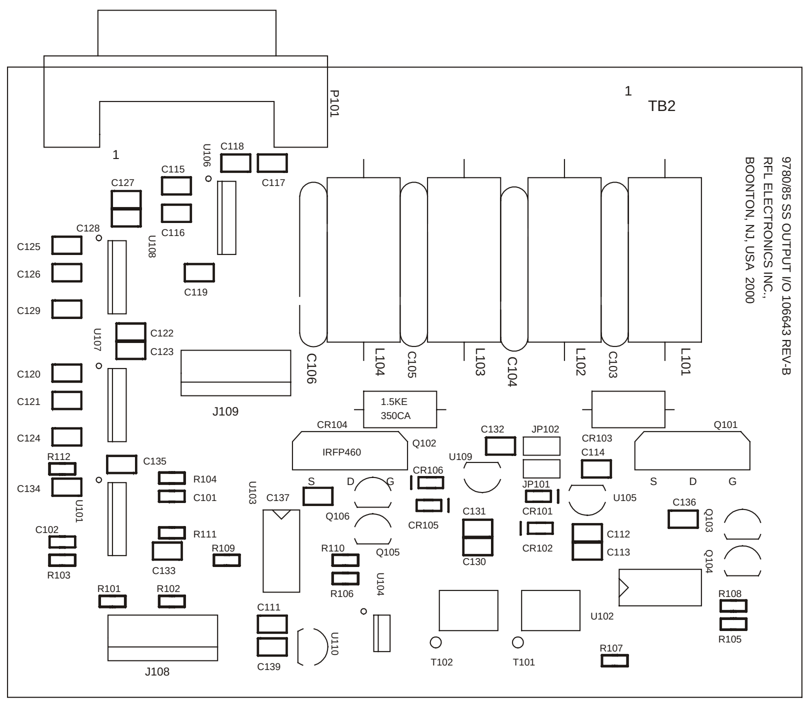
Figure 17-12 shows the location of all controls and indicators on the Solid State Input/Output I/O module. These controls and indicators are described in Table 17-7. Terminal blocks TB1 and TB2 are accessible with the Solid-State Input/Output I/O module installed in the chassis. Jumpers J4 and J5 are only accessible when the module is removed from the chassis or is on a card extender.

Table 17-7. Controls and indicators, Solid-State Input/Output I/O module

Component Designator	Name/ Description	Function
J4	Jumper	Selects 48V or 125V operation
J5	Jumper	Selects 48V or 125V operation
TB1	Terminal block	Provides connections to line coupling equipment.
TB2	Terminal block	Provides connections to line coupling equipment.



a. Input Board for 106445-3 and -4



b. Output Board for 106445-3 and -4

Figure 17-12. Controls and indicators, and component locator drawing, Solid-State Input/Output I/O module

Table 17-8. Replaceable Parts, RFL 9780 Solid-State Input/Output I/O module
Assy No. 106445-3 & -4

Circuit Symbol (Figs. 17-12 & 17-13)	**Description**	**Part Number**
	Input Board Components	
C7,8	Capacitor, ceramic, 0.1µF, 10%, 50V	0130 51041
C9-15	Capacitor, ceramic disc, 0.01µF, 20%, 3KV	1007 1811
C16	Capacitor, electrolytic, 100µF, 20%, 25V	1007 1630
CR9, 10	106445-3; Diode, Zener, 20V, 5%, 1W, 1N4747A	20794
	106445-4; Diode, Zener, 75V, 5%, 1W, 1N4761A	101693
CR11, 12, 14	Diode, silicon, rectifier, 1A, 1N4003	30769
J8	Connector, wafer assembly, 6-CKT	97223 6
K1	Relay, SPST, 8A/300V, 6V/0.22W	101461
L5, 6, 7, 8	Inductor, 10µH, 5%, 1.5A max	30285
P1	Connector, plug, female, 64 contact, DIN	99134
R7, 8	Resistor, metal film, axial, 4.75K, 1%, 1/4W	0410 1353
R9, 10	Resistor, metal film, axial, 221Ω, 1%, 1/4W	0410 1225
R11, 12	106445-3: Resistor, wire-wound, 22K, 5%, 5W	1100 800
	106445-4: Resistor, wire-wound, 20K, 5%, 5W	1100 837
R13, 14	106445-3: Resistor, metal film, axial, 11.5K, 1%, 1/4W	0410 1390
	106445-4: Resistor, metal film, axial, 47.5K, 1%, 1/4W	0410 1449
R15, 16	106445-3: Resistor, wire-wound, 5K, 5%, 3.25W	1100 460
	106445-4: Resistor, wire-wound, 25K, 5%, 5W	1100 480
R17	Resistor, metal film, axial, 162Ω, 1%, 1/2W	0410 2212
R20	Resistor, metal film, axial, 11, 1%, 1/4W	0410 1100
TB1	Terminal block, 7 position	101463
U1, 2	Opto device, optical isolator, 6N139	29592
	Output Board Components	
C101, 102	Capacitor, ceramic, 4700pF, 5%, 50V	151 05472040507
C103-106	Capacitor, ceramic disc, 0.01µF, 20%, 3KV	1007 1811
C111, 114, 132, 135-137, 139	Capacitor, ceramic, 0.1µF, 10%, 50V	151 10104040603
C112, 113, 130, 131	Capacitor, ceramic, 0.47µF, 10%, 16V	151 10474020603
C133, 134	Capacitor, ceramic, 0.01µF, 10%, 50V	151 10103040603
CR101, 102, 105, 106	Diode, general purpose, 1N4148	340 100
CR103, 104	106445-3: Suppressor, transient voltage, 1.5KE180CA	42064
	106445-4: Suppressor, transient voltage, 1.5KE350CA	101722
J108	Connector, wafer assembly, 6-CKT	97223 6
L101-104	Inductor, 12µH, 4.5A, 10%	30436
Q101, 102	106445-3: Transistor, MOSFET, N-channel	0715 36
	106445-4: Transistor, MOSFET, N-channel	0715 37
R101, 102, 105, 106	Resistor, thick film, 432Ω, 1%, 1/8W	700 15432034
R103, 104	Resistor, thick film, 10K, 1%, 1/8W	700 15100234
R107, 109	Resistor, thick film, 2K, 1%, 1/8W	700 15200134
R108, 110-112	Resistor, thick film, 562Ω, 1%, 1/8W	700 15562034
T101,10 2	Transformer, 2:1, 900µH	910 00100
TB2	Terminal block, 4 terminal	101126
U101	Integrated circuit, MOS D RTRG MNST MV, 74HC123	500 104
U102, 103	Opto device, 6N139	29592
U104	Integrated circuit, linear transformer driver, MAX845	510 107
U105, 109, 110	Integrated circuit, linear voltage regulator, 5V POS	0620 204

Figure 17-13. Schematic, RFL 9780 Solid-State Input/Output I/O (Dwg. No. D-106449-3-B) Sheet 1 of 2

Please see Figure 17-13 in Section 22.

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Figure 17-13 Schematic, RFL 9780 Solid-State Input/Output I/O (Dwg. No. D-106449-3-B) Sheet 2 of 2

Please see Figure 17-13 in Section 22.

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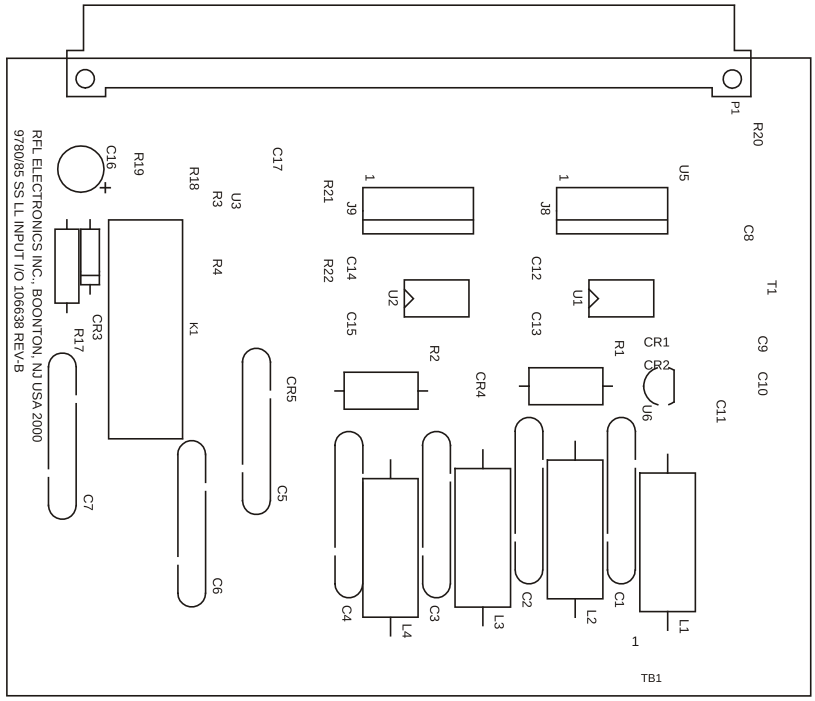
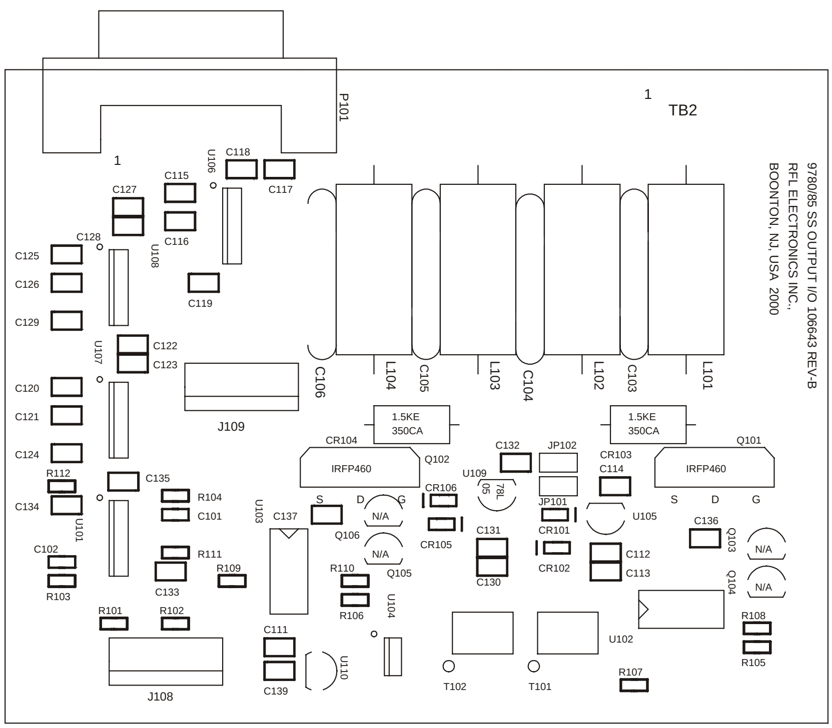


a. Input Board for 106445-5



b. Output Board for 106445-5

Figure 17-14. Controls and indicators, and component locator drawing, Solid-State Input/Output I/O module

Table 17-9. Replaceable Parts, RFL 9780 Solid-State Input/Output I/O module
Assy No. 106445-5

Circuit Symbol (Figs. 17-14 & 17-15)	Description	Part Number
	Input Board Components	
C1-7	Capacitor, ceramic disc, 0.01µF, 20%, 3KV	1007 1811
C8, 11-15, 17	Capacitor, ceramic, 0.1µF, 10%, 50V	151 10104040603
C9, 10	Capacitor, ceramic disc, 0.47µF, 10%, 16V	151 10474020603
C16	Capacitor, electrolytic, 100µF, 20%, 25V	1007 1630
CR1, 2	Diode, general purpose, 1N4148	340 100
CR3	Diode, silicon, rectifier, 1A, 1N4003	30769
CR4, 5	Suppressor, voltage, 6.8V, 5%, 600W, BIDIR	101497
J8	Connector, wafer assembly, 6-CKT	97223 6
K1	Relay, SPST, 8A/300V, 6V/0.22W	101461
L1-4	Inductor, 10µH, 5%, 1.5A max	30285
P1	Connector, plug, female, 64 contact, DIN	99134
R1, 2, 21, 22	Resistor, thick film, 1.21K, 1%, 1/8W	700 15121134
R3, 4	Resistor, thick film, 10K, 1%, 1/8W	700 15100234
R17	Resistor, metal film, axial, 162Ω, 1%, 1/2W	0410 2212
T1	Transformer, 2:1, 900µH	910 00100
TB1	Terminal block, 7 position	101463
TB2	Terminal block, 4 terminal	101126
U1, 2	Opto isolator, 74OL6010	101498
U3	Integrated circuit, MOS 3-ST QUAD BUF, 74ABT125	500 101
U5	Integrated circuit, linear transformer driver, MAX845	510 107
U6	Integrated circuit, linear voltage regulator, 5V POS	0620 204
	Output Board Components	
C101, 102	Capacitor, ceramic, 4700pF, 5%, 50V	151 05472040507
C103-106	Capacitor, ceramic disc, 0.01µF, 20%, 3KV	1007 1811
C111, 114, 135-137, 139	Capacitor, ceramic, 0.1µF, 10%, 50V	151 10104040603
C112, 113	Capacitor, ceramic, 0.47µF, 10%, 16V	151 10474020603
C133, 134	Capacitor, ceramic, 0.01µF, 10%, 50V	151 10103040603
CR101, 102	Diode, general purpose, 1N4148	340 100
CR103, 104	Suppressor, voltage, 6.8v, 5%, 600w, bidir	101497
J108	Connector, wafer assembly, 6-CKT	97223 6
L101-104	Inductor, 12µH, 4.5A, 10%	30436
Q103, 105	Transistor, silicon, NPN, medium power	105421
Q104, 106	Transistor, silicon, PNP, medium power	103384
R101, 102, 105, 106	Resistor, thick film, 432Ω, 1%, 1/8W	700 15432034
R103, 104	Resistor, thick film, 10K, 1%, 1/8W	700 15100234
R107, 109	Resistor, thick film, 2K, 1%, 1/8W	700 15200134
R108, 110-112	Resistor, thick film, 562Ω, 1%, 1/8W	700 15562034
T101	Transformer, 2:1, 900µH	910 00100
U101	Integrated circuit, MOS D RTRG MNST MV, 74HC123	500 104
U102, 103	Opto device, 6N139	29592
U104	Integrated circuit, linear transformer driver, MAX845	510 107
U105, 110	Integrated circuit, linear voltage regulator, 5V POS	0620 204

Figure 17-15. Schematic, RFL 9780 Solid-State Logic Level Input/Output I/O (Dwg. No. D-106449-5-D) Sheet 1 of 2

Please see Figure 17-15 in Section 22.

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Figure 17-15 Schematic, RFL 9780 Solid-State Logic Level Input/Output I/O (Dwg. No. D-106449-5-D) Sheet 2 of 2

Please see Figure 17-15 in Section 22.

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17.5 DUAL RELAY I/O MODULE

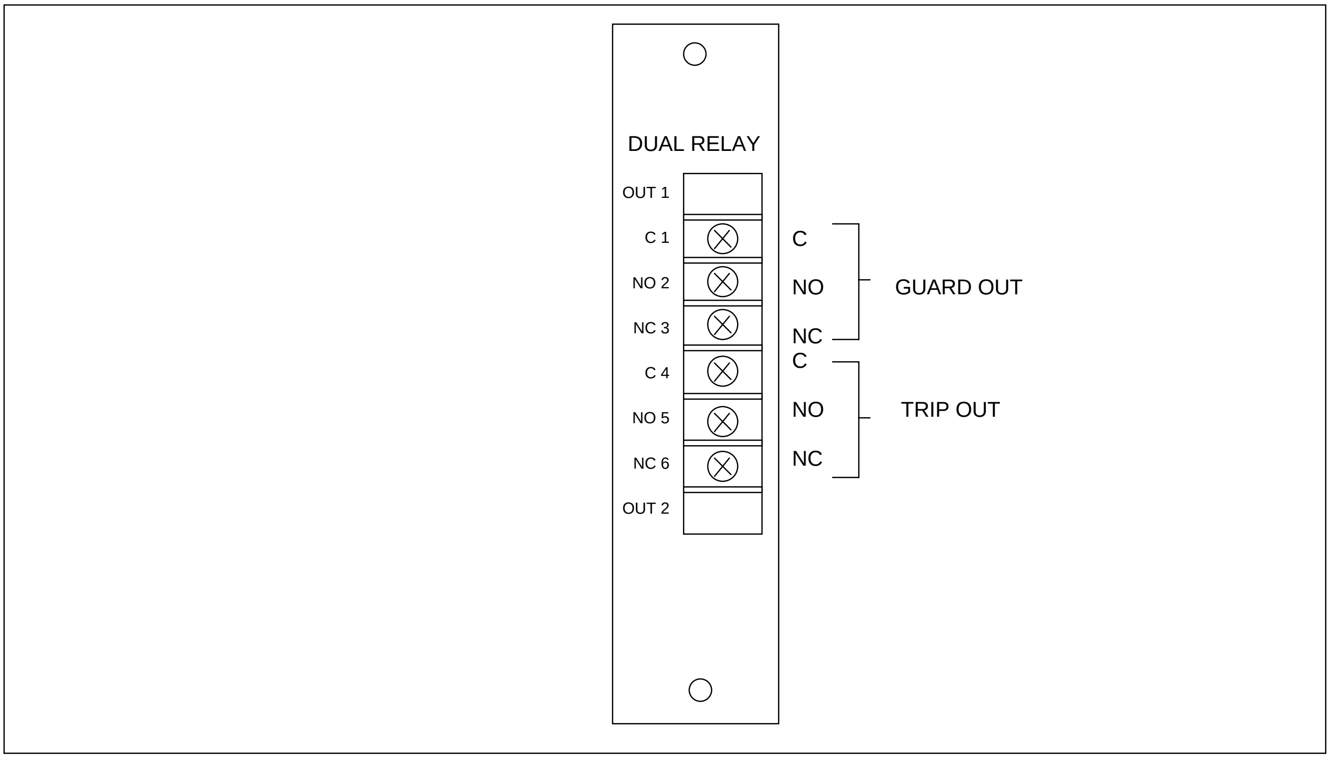

Figure 17-16. Dual Relay I/O module, rear panel view

17.5.1 DESCRIPTION

The Dual Relay I/O module provides two electro-mechanical relay outputs. The outputs are used for receiving trip and guard commands. The electro-mechanical outputs of each have N.O and N.C. connections at the terminal block. All signals to and from the Dual Relay I/O module interface directly with the 9780 Logic Module.

The Dual Relay I/O module requires that jumpers J1, J2 and J3 be configured. Normally J2 and J3 are installed in the “A” position, and J1 is not installed. Other combinations of these jumpers are not presently defined.

The Dual Relay I/O module is primarily used for TX/RX, RX/RX and RX only applications. It can also be used for customer specific applications and can be mounted in a spare I/O slot, if available, or in an expansion chassis.

17.5.2 CONTROLS AND INDICATORS

Figure 17-17 shows the location of all controls and indicators on the Dual Relay I/O module. These controls and indicators are described in Table 17-10 Only TB1 is accessible with the Dual Relay I/O module installed in the chassis. Jumpers J1, J2 and J3 are only accessible when the module is removed from the chassis or is on a card extender.

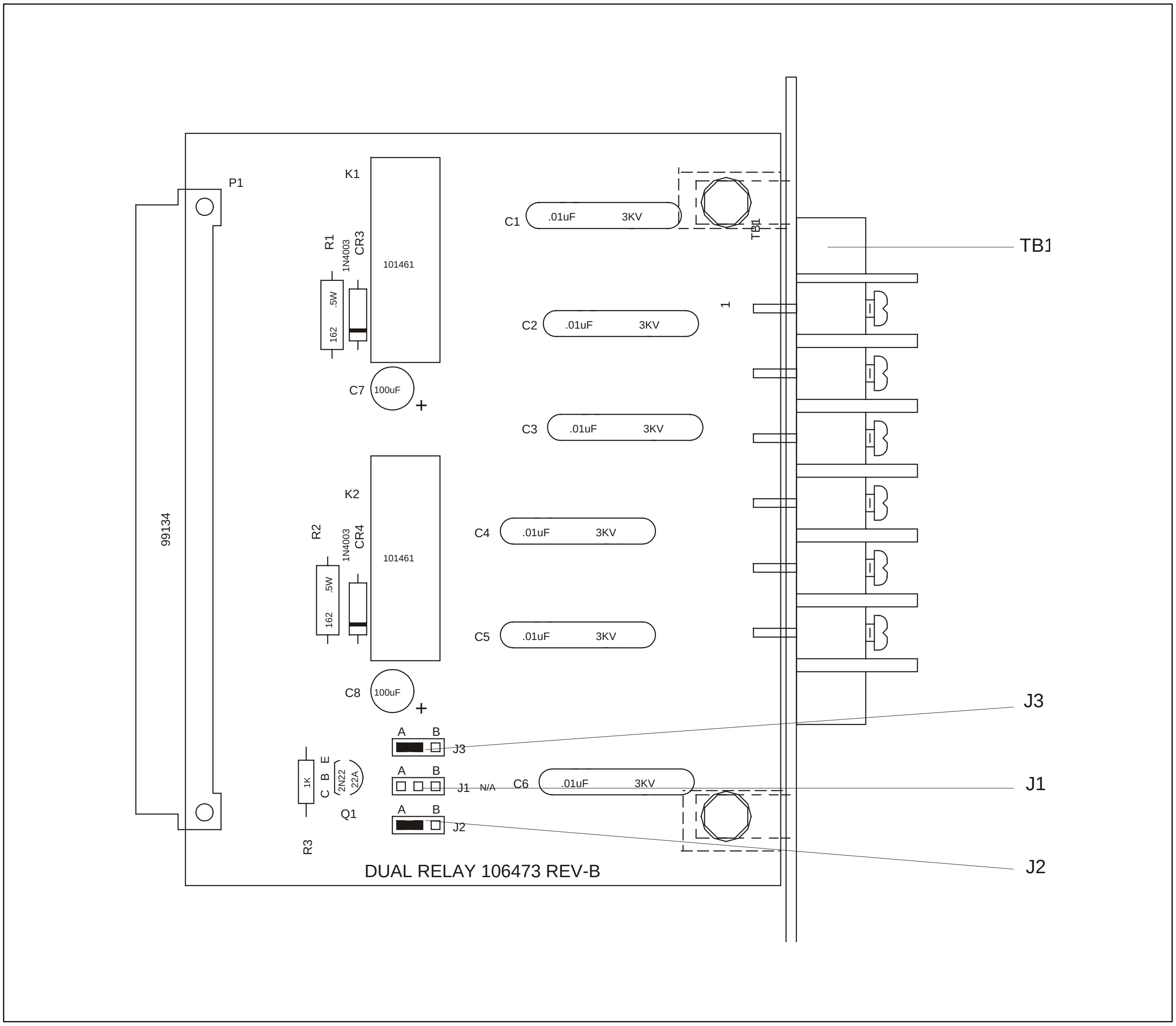

Figure 17-17. Controls and indicators, and component locator drawing, Dual Relay I/O module

Table 17-10. Controls and indicators, Dual Relay I/O module

Component Designator	**Name/Description**	**Function**			
J1		J1	J2	J3	↓
		NC	A	A	one guard output and one trip output (default)
J2	Jumpers	A	B	A	two guard outputs
		A	A	NC	two trip outputs
J3		NC	A	B	one undefined (spare) and one trip output
		B	B	A	one undefined (spare) and one guard output
		A	B	B	two undefined outputs (spares)
TB1	Terminal block	Provides connections to line coupling equipment			

Table 17-11. Replaceable Parts, RFL 9780 Dual Relay I/O module
Assembly No. 106470

Circuit Symbol (Figs. 17-17 & 17-18)	Description	Part Number
C1-6	Capacitor, ceramic disc, 0.01μF, 20%, 3KV	1007 1811
C7, 8	Capacitor, electrolytic, 100μF, 20%, 25V	1007 1630
CR3, 4	Diode, silicon, rectifier, 1A, 1N4003	30769
J1, 2, 3	Connector, header, single, 3 circuit	32802 3
K1, 2	Relay, SPST, 8A/300V, 6V/0.22W	101461
P1	Connector, plug, female, 64 contact, DIN	99134
Q1	Transistor, silicon, NPN, 2N2222A	37445
R1, 2	Resistor, metal film, axial 162Ω, 1%, 1/4W	0410 2212
R3	Resistor, metal film, axial 1K, 1%, 1/4W	0410 1288
TB1	Terminal block, 6-position	101462
J1, 2, 3	Jumper, connector, programmable, 0.1 inch centers, white	98366

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Figure 17-18. Schematic, RFL 9780 Dual Relay I/O (Dwg. No. C-106474-A)

Please see Figure 17-18 in Section 22.

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17.6 ALARM RELAY I/O MODULE

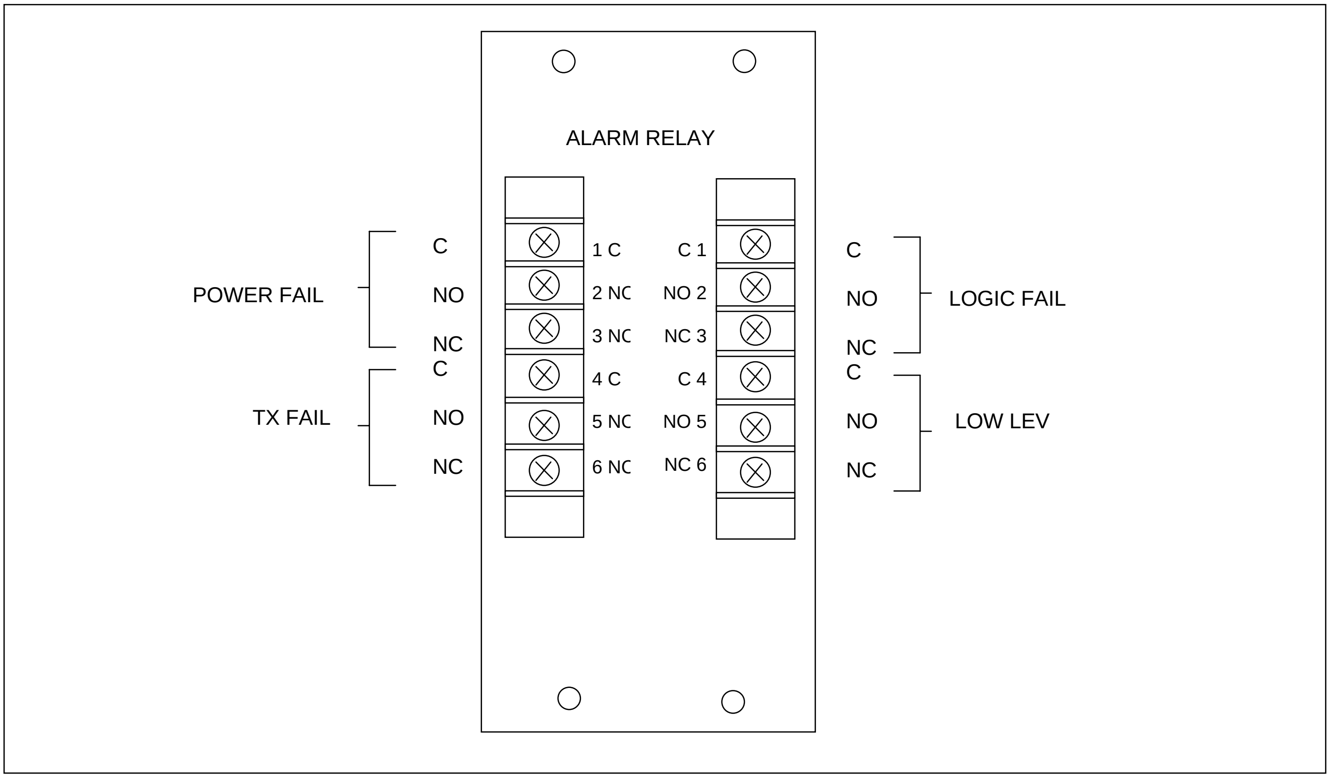

Figure 17-19. Alarm Relay I/O module, rear panel view

17.6.1 DESCRIPTION

The Alarm Relay I/O module (106465) provides four electro-mechanical relay outputs. Each output is used to indicate a factory pre-defined alarm condition. The alarm outputs available depend upon the type of system available (See Table 17-12 below). Each electro-mechanical output has N.O and N.C. connections at the terminal block. All signals to and from the Alarm Relay I/O module interface directly with various modules within the system.

User configuration is not required for this I/O module.

The Alarm Relay I/O is used in all standard TX/RX and RX only applications. It can also be used for customer specific applications and can be mounted in an expansion chassis.

Table 17-12. Alarm Outputs

SYSTEM	ALARM CIRCUIT #1	ALARM CIRCUIT #2	ALARM CIRCUIT #3	ALARM CIRCUIT #4
TX/RX	POWER FAIL	TX FAIL	LOGIC FAIL	LOW LEVEL
RX/RX	POWER FAIL	SPARE	LOGIC FAIL	LOW LEVEL
RX only	POWER FAIL	SPSRE	LOGIC FAIL	LOW LEVEL

Table 17-13. Replaceable Parts, RFL 9780 Alarm Relay I/O module
Assembly No. 106465

Circuit Symbol (Figs. 17-20 & 17-21)	Description	Part Number
C1-12	Capacitor, ceramic disc, 0.01µF, 20%, 3KV	1007 1811
CR1-4	Diode, silicon, rectifier, 1A, 1N4003	30769
J1, 2	Connector, wafer assy, 5 circuit	97223 5
K1-4	Relay, DPDT, 12V, PCB mount	101718
L1-12	Inductor, 10µH, 5%, 1.5A max	30285
P1	Connector, plug. Female, 64 contact, DIN	99134
TB1, 2	Terminal block, 6 position	101462

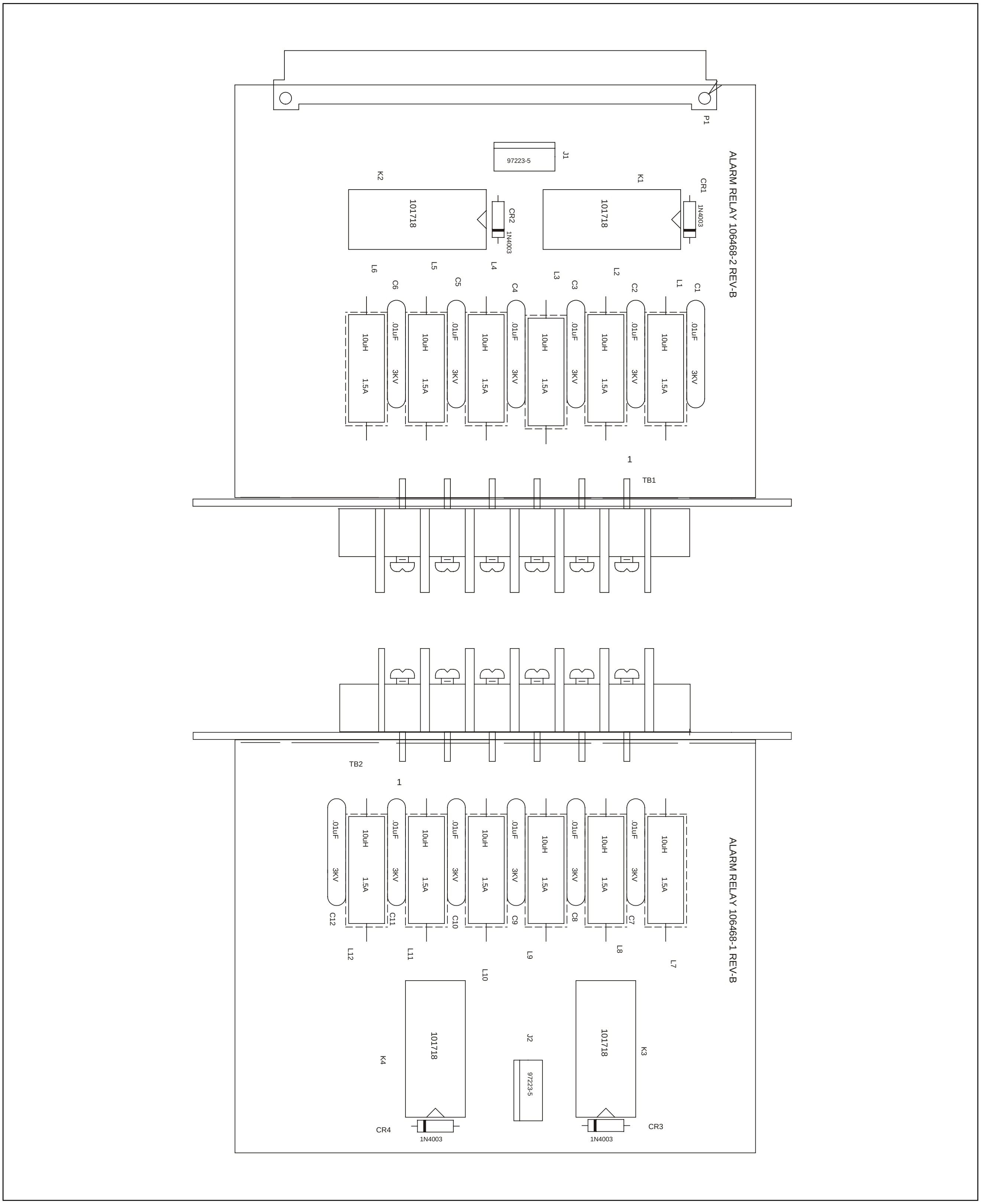

Figure 17-20. Component locator drawing, Alarm Relay I/O module

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Figure 17-21. Schematic, RFL 9780 Alarm Relay I/O (Dwg. No. D-106469-C)

Please see Figure 17-21 in Section 22.

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17.7 INPUT/ALARM I/O MODULE

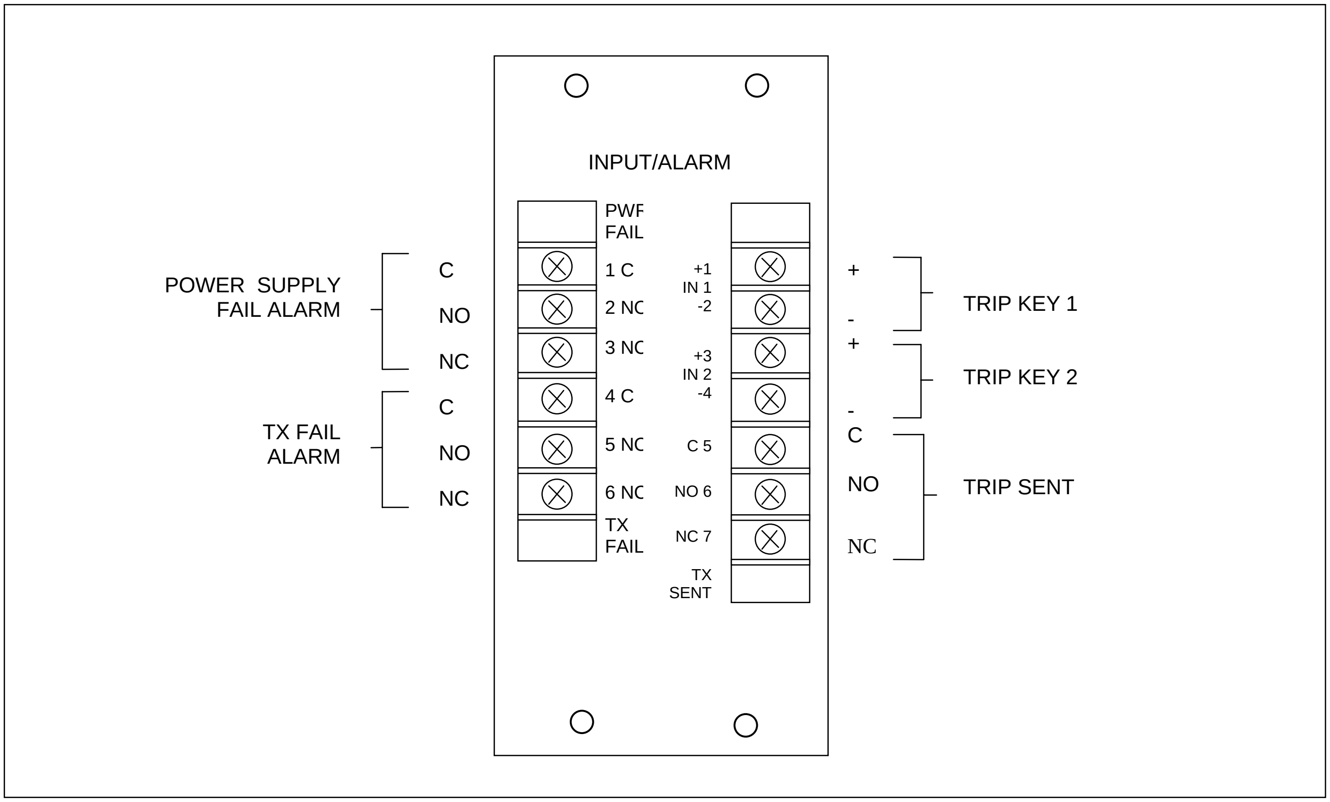

Figure 17-22. Input/Alarm I/O module, rear panel view

17.7.1 DESCRIPTION

The Input/Alarm I/O module (Figure 17-22) is composed of two sections. One section provides solid-state inputs and the other section provides alarm outputs. This I/O module is available in three versions as follows:

Input Voltage	Assembly No.
48V or 125V	(106600-3)
250V	(106600-4)
5V	(106600-5)

The 48/125V version requires that jumpers J4 and J5 be configured for the input voltage requirement. J4 and J5 are placed in the 48V or 125V position as required. Voltage selectors J4 and J5 are not required for 250V operation.

The Input/Alarm I/O module is primarily used for TX/TX applications. It can also be used for customer specific applications and can be mounted in a spare I/O slot or in an expansion chassis.

17.7.1.1 SOLID STATE INPUT SECTION

The solid-state input section of the module provides two solid-state inputs and one electro-mechanical output. The inputs are used for keying trips and the output is used as an acknowledgement that a trip was sent (trip sent). The electro-mechanical output has N.O. and N.C. connections at the terminal block. All signals to and from the solid-state input section of the module interface directly with the 9780 Logic Module.

17.7.1.2 ALARM OUTPUT SECTION

The Alarm output section of the module provides two electro-mechanical relay outputs. Each output is used to indicate a factory pre-defined alarm condition. Each electro-magnetic output has N.O. and N.C. connections at the terminal block. All signals to and from the Alarm output section of the module interface directly with various modules within the RFL 9780 system.

Table 17-14. Replaceable Parts, RFL 9780 Input/Alarm I/O module
Assembly No. 106600-3 and -4

Circuit Symbol (Figs. 17-23 & 17-24)	Description	Part Number
C7, 8	Capacitor, ceramic, 0.1μF, 10%, 50V	0130 51041
C9, 10-15	Capacitor, ceramic disc, 0.01μF, 20%, 3kV	1007 1811
C16	Capacitor, electrolytic, 100μF, 20%, 25V	1007 1630
CR9, 10	106600-3: Diode, Zener, 20V, 5%, 1W, 1N4747A	20794
	106600-4: Diode, Zener, 75V, 5%, 1W, 1N4761A	101693
CR11, 12, 14	Diode, silicon rectifier, 1A, 1N4003	30769
J1	Connector, wafer assembly, 6-CKT	97223 6
J4, 5	106600-3: Connector, header, single, 3-CKT	32802 3
	106600-4: not used	
J8	Connector, wafer assembly, 6-CKT	97223 6
K1	Relay, SPST, 8A/300V, 6V/0.22W	101461
L5-8	Inductor, 10μH, 5%, 1.5A MAX	30285
P1	Connector, plug, female, 64 contact, DIN	99134
R7, 8	Resistor, metal film, axial, 4.75K, 1%, 1/4W	0410 1353
R9, 10	Resistor, metal film, axial, 221Ω, 1%, 1/4W	0410 1225
R11, 12	106600-3: Resistor, wirewound , 22K, 5%, 5W	1100 800
	106600-4: Resistor, wirewound , 20K, 5%, 5W	1100 837
R13, 14	106600-3: Resistor, metal film, axial, 11.5K, 1%, 1/4W	0410 1390
	106600-4: Resistor, metal film, axial, 47.5K, 1%, 1/4W	0410 1449
R15, 16	Resistor, wirewound, 5K, 5%, 3.25W	1100 460
	Resistor, wirewound, 25K, 5%, 5W	1100 480
R17	Resistor, metal film, axial, 162Ω, 1%, 1/2W	0410 2212
R20	Resistor, metal film, axial, 11Ω, 1%, 1/4W	0410 1100
TB1	Terminal block, 7-position	101463
TB2	Terminal block, 6-position	101462
U1, 2	Opto-device, opto-isolator, 6N139	29592
C101-106	Capacitor, ceramic disc, 0.01μF, 20%, 3kV	1007 1811
CR101, 102	Diode, silicon rectifier, 1A, 1N4003	30769
K101, 102	Relay, DPDT, 12V, PCB mount	101718
L101-106	Inductor, 10μH, 5%, 1.5A max	30285

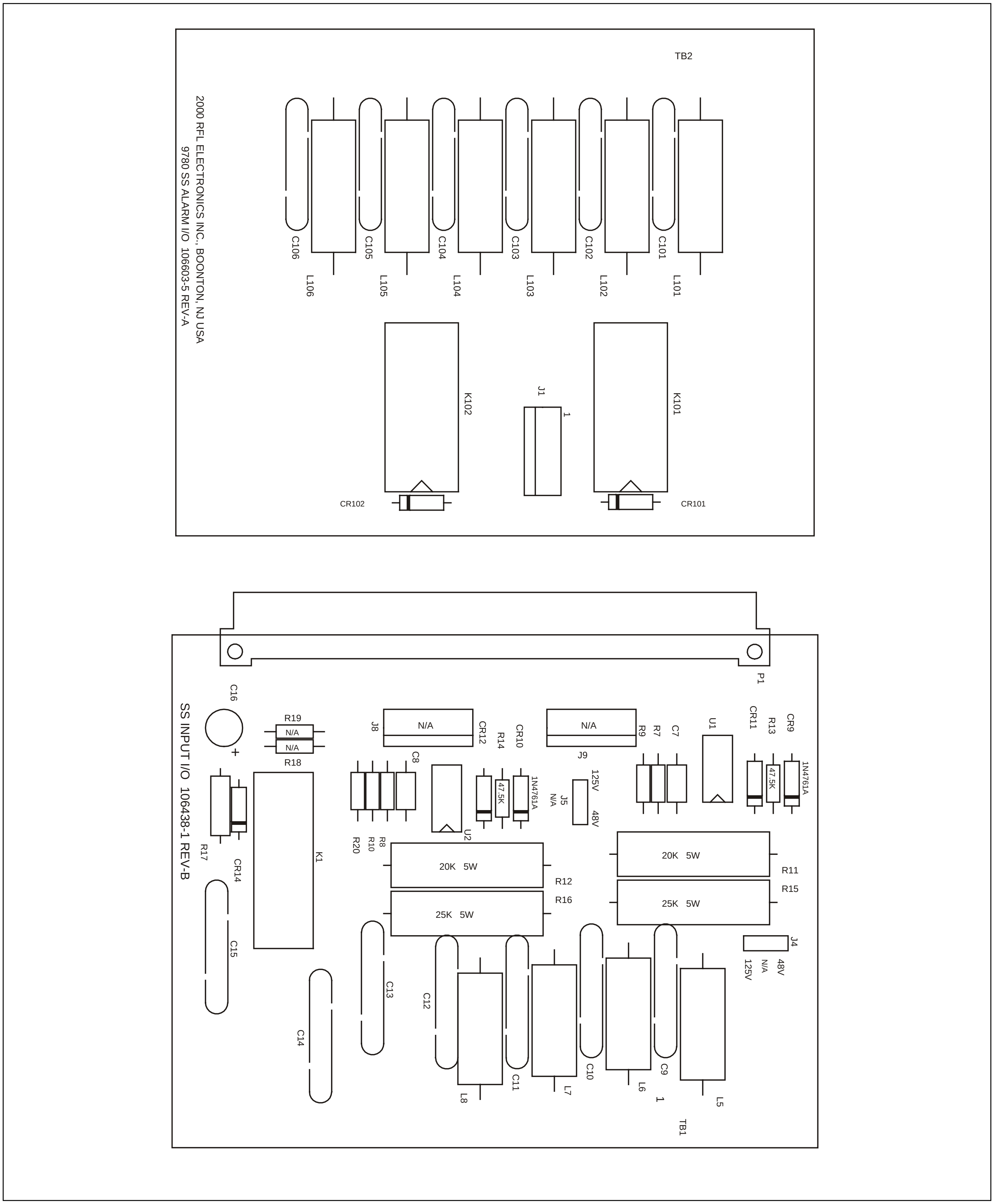

Figure 17-23. Component locator drawing, Input/Alarm I/O module. (Assembly No. D-106600-A)

Figure 17-24. Schematic, RFL 9780 Solid State Input Alarm I/O (Dwg. No. D-106604-3-A) Sheet 1 of 2

Please see Figure 17-24 in Section 22.

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Figure 17-24 Schematic, RFL 9780 Solid State Input Alarm I/O (Dwg. No. D-106604-3-A) Sheet 2 of 2

Please see Figure 17-24 in Section 22

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Table 17-15. Replaceable Parts, RFL 9780 Input/Alarm I/O module
Assembly No. 106600-5

Circuit Symbol (Figs. 17-25 & 17-26)	Description	Part Number
C1-7	Capacitor, ceramic disc, 0.01μF, 20%, 3kV	1007 1811
C8, 11-15, 17	Capacitor, ceramic, 0.1μF, 10%, 50V	151 10104040603
C9, 10	Capacitor, ceramic, 0.47μF, 10%, 16V	151 10474020603
C16	Capacitor, electrolytic, 100μF, 20%, 25V	1007 1630
CR1, 2	Diode, general purpose, 1N4148	340 100
CR3	Diode, silicon rectifier, 1A, 1N4003	30769
CR4, 5	Suppressor, voltage, 6.8V, 5%, 600W, BIDIR	101497
J1	Connector, wafer assembly, 6-CKT	97223 6
J8	Connector, wafer assembly, 6-CKT	97223 6
K1	Relay, SPST, 8A/300V, 6V/0.22W	101461
L1-4	Inductor, 10μH, 5%, 1.5A MAX	30285
P1	Connector, plug, female, 64 contact, DIN	99134
R1, 2, 21, 22	Resistor, thick film, 1.21K, 1%, 1/8W	700 15121134
R3, 4	Resistor, thick film, 10K, 1%, 1/8W	700 15100234
R17	Resistor, metal film, axial, 162Ω, 1%, 1/2W	0410 2212
R20	Resistor, thick film, 10Ω, 1%, 1/8W	700 1510R034
T1	Transformer, 2:1, 900μH	910 00100
TB1	Terminal block, 7-position	101463
TB2	Terminal block, 6-position	101462
U1, 2	Opto-isolator, 74OL6010	101498
U3	Integrated circuit, MOS 3-ST QUAD BUF, 74ABT125	500 101
U5	Integrated circuit, linear transformer driver	510 107
U6	Integrated circuit, linear voltage regulator, 5V POS	0620 204
C101-106	Capacitor, ceramic disc, 0.01μF, 20%, 3kV	1007 1811
CR101, 102	Diode, silicon rectifier, 1A, 1N4003	30769
K101, 102	Relay, DPDT, 12V, PCB mount	101718
L101-106	Inductor, 10μH, 5%, 1.5A max	30285

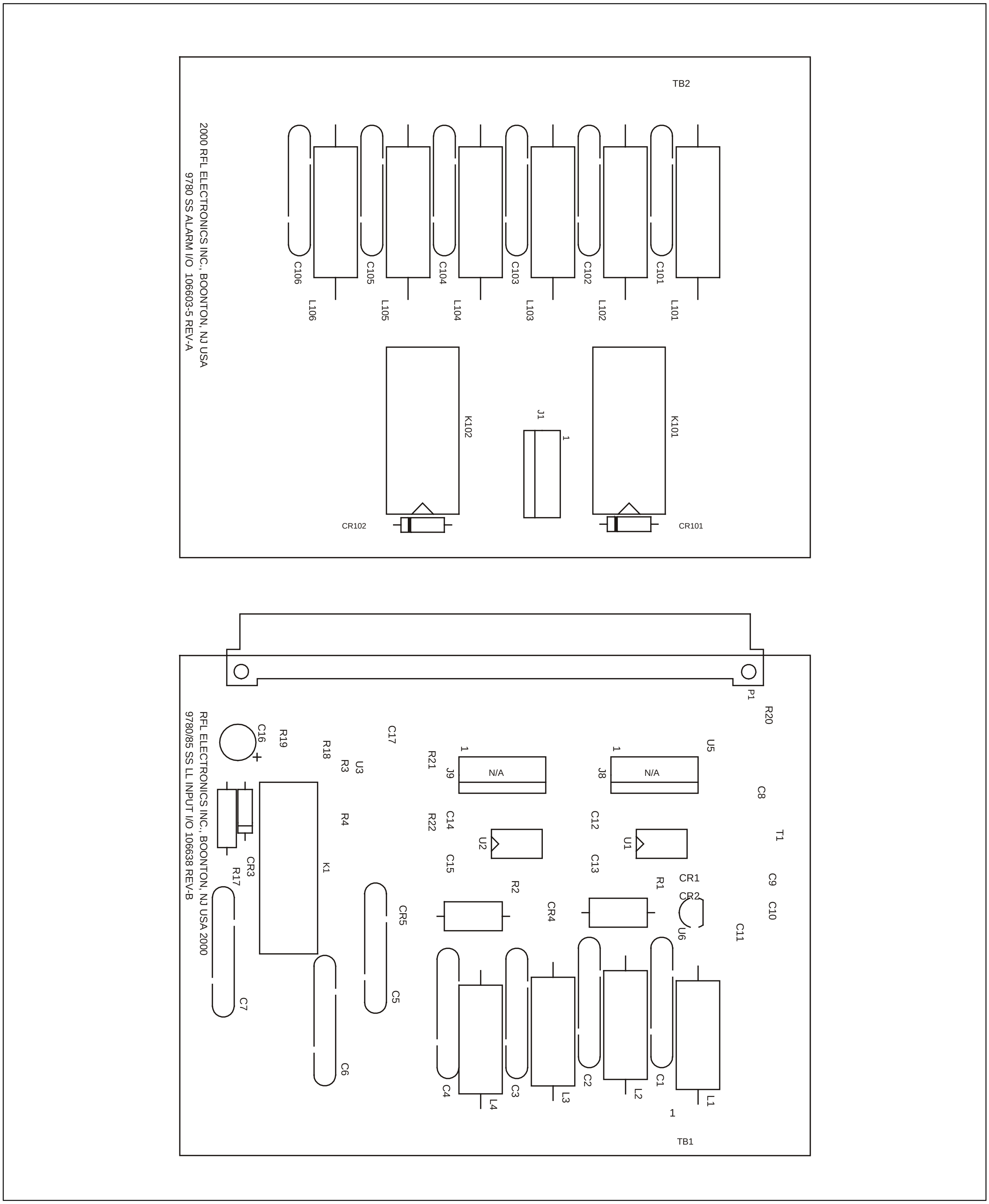

Figure 17-25. Component locator drawing, Input/Alarm I/O module. (Assembly No. 106600-5)

Figure 17-26. Schematic, RFL 9780 Solid-State Logic Level Input Alarm I/O (Dwg. No. D-106604-5-B) Sheet 1 of 2

Please see Figure 17-26 in Section 22.

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Figure 17-26 Schematic, RFL 9780 Solid-State Logic Level input Alarm I/O (Dwg. No. D-106604-5-B) Sheet 2 of 2

Please see Figure 17-26 in Section 22.

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17.8 LINE I/O MODULES

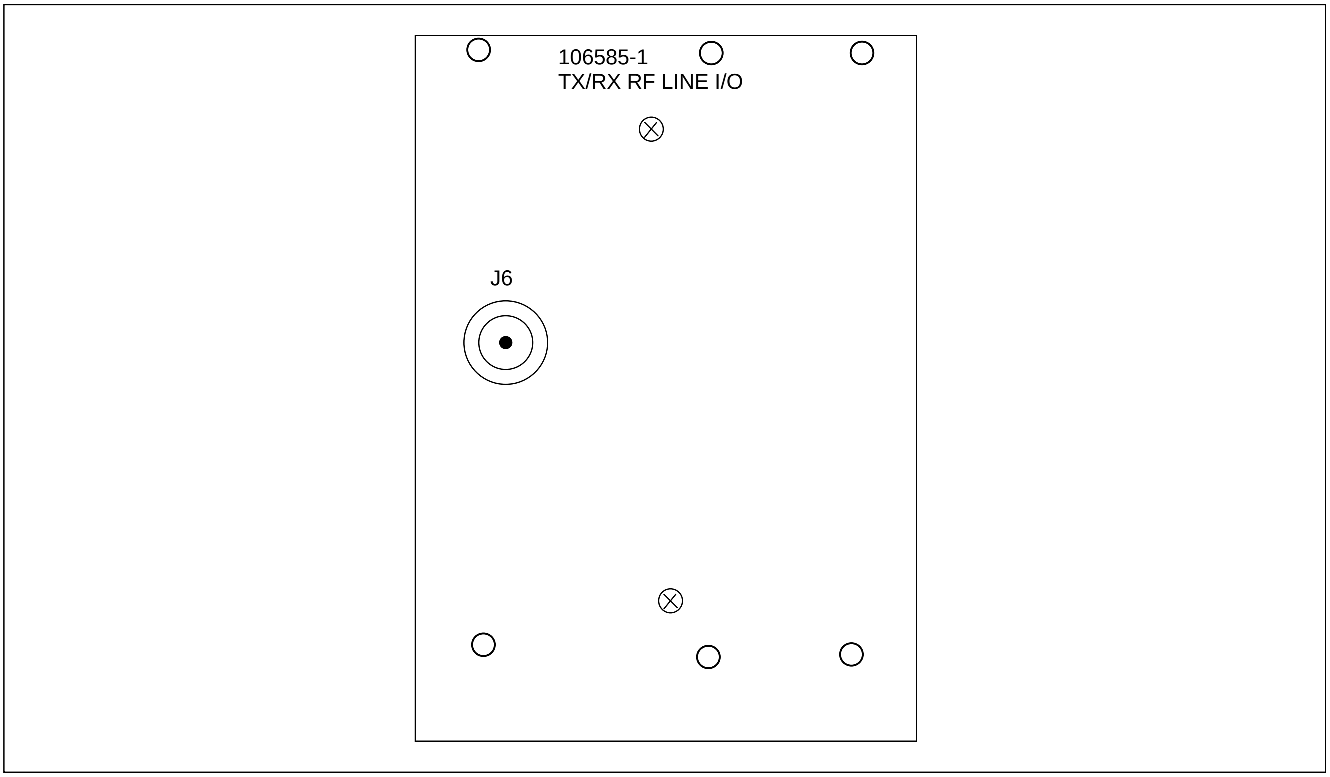

Figure 17-27. Typical Line I/O module (106585-1), rear panel view

17.8.1 DESCRIPTION

There are eleven types of Line I/O modules that can be used in the RFL 9780. The rear panel of the 106585-1 is shown in Figure 17-27. The rear panel views of all eleven types of Line I/O modules can be seen in Figure 17-2. The paragraphs that follow, describe each of these Line I/O modules.

17.8.1.1 TX/RX RF LINE I/O MODULES (106585-1, 106585-2)

The 106585-1 and 106585-2 Line I/O modules provide a single UHF connector for connection to the external line coupling equipment. The signal path is protected with a spark-gap protection device. The 106585-1 is typically used in a TX/RX chassis where a hybrid is used to combine signals to provide a single port for connection to the line coupling equipment.

The 106585-2 is identical to the 106585-1 but adds a two position terminal block for connecting an external receive level meter.

17.8.1.2 TX/RX RF LINE I/O MODULES (106585-3, 106585-4, 106585-5)

The 106585-3 Line I/O module provides three UHF connectors for field connections. All three ports have a spark-gap protection device. The top port is for TX signals, the bottom port is for RX signals, and the middle port is for combined signals. This I/O is normally used in a TX/RX chassis.

In a TX/RX chassis with no internal hybrid, the TX and RX ports are independent, and the middle port is not used. The RX port contains additional input protection circuitry and has a selectable line termination impedance.

In a TX/RX chassis with an internal hybrid the TX and RX ports are combined and fed out through the middle port. The RX port can be used as an output to send the received signal to an additional device if required. The TX signal also appears on the TX connector for alignment and testing purposes.

The 106585-4 is identical to the 106585-3 but has a two position terminal block for connecting an external receive level meter. The 106585-5 is identical to the 106585-4 but has two sets of terminal block connections. The added terminal block connections can be used to isolate the UHF connectors and protection circuitry from the internal connections to the hybrid module.

17.8.1.3 TX RF LINE I/O MODULE (106585-6)

The 106585-6, is a TX RF Line I/O module, which provides one UHF connector with a spark-gap protection device. This I/O can be used in a TX or TX/TX chassis.

17.8.1.4 RX RF LINE I/O MODULE (106585-7)

The 106585-7, is an RX RF Line I/O module, which provides one UHF connector with a spark-gap and additional protection circuits, as well as a selectable termination impedance (50Ω, 75Ω or none). This I/O can be used in an RX or RX/RX chassis.

17.8.1.5 TX/RX RF LINE I/O MODULE (106585-8)

The 106585-8 Line I/O module provides four UHF connectors for field connections. Three of the ports (J5, J6 and J7) have spark gap protection devices and J8 does not since it is only used for local connections. Port J5 is used for Tx signals, port J7 is used for Rx signals, and port J6 is used for combined signals. This I/O is normally used in Tx/Rx chassis.

The 106585-8 is used to tie two Tx/Rx chassis to one single line, where one of the Tx/Rx chassis has an X-hybrid and the other Tx/Rx chassis has a skewed hybrid. TB1 and TB2 are used to gain access to the RF signals, or to insert line test equipment.

17.8.1.6 TX/RX RF LINE I/O MODULE (106585-9)

The 106585-9 Line I/O module provides four UHF connectors for field connections. Three of the ports (J5, J6 and J7) have spark gap protection devices and J8 does not since it is only used for local connections. Port J5 is used for Tx signals, port J7 is used for Rx signals, and port J6 is used for combined signals. This I/O is normally used in Tx/Rx chassis.

The 106585-9 is used to tie two Tx/Rx chassis to one single line, where one of the Tx/Rx chassis has an X-hybrid and the other Tx/Rx chassis has a skewed hybrid. The two position terminal block is used to connect an external receive level meter.

17.8.1.7 TX/TX RF LINE I/O MODULE (106590)

The 106590 is a TX/TX RF Line I/O module. It provides three UHF connectors for field connections. All three ports have a spark gap protection device. The top port (J5) and the bottom port (J7) are for TX signals. The middle port is for combining the two TX signals through a hybrid.

17.8.1.8 RX/RX RF LINE I/O MODULE (106605)

The 106605 is an RX/RX RF Line I/O module. It provides two UHF connectors for field connections. Both ports have spark gap protection devices. The top port (J5) and the bottom port (J7) are for RX signals. The two position terminal blocks next to J5 and J7 are for connecting an external receive level meter.

17.8.2 PROGRAMMABLE JUMPERS

Figures 17-28 through 17-35, and Figures 17-37, 17-39 and 17-41 show the location of all programmable jumpers in addition to component locations on the Line I/O modules. How to set these jumpers is described in Table 17-16. Only terminal blocks and RF connectors are accessible with the Line I/O modules installed in the chassis. All jumpers are accessible only when the modules are removed from the chassis or are on card extenders.

Table 17 16. Setting Programmable Jumpers On Line I/O Modules

I/O Module	Jumper Designator	Function
106585-3	J3	Selects line termination impedance of 50Ω, 75Ω, or OUT (Greater than 30KΩ)
106585-4	J3	Selects line termination impedance of 50Ω, 75Ω, or OUT (Greater than 30KΩ)
106585-5	J3	Selects line termination impedance of 50Ω, 75Ω, or OUT (Greater than 30KΩ)
106585-7	J3	Selects line termination impedance of 50Ω, 75Ω, or OUT (Greater than 30KΩ)
106585-8	J3	Selects line termination impedance of 50Ω, 75Ω, or OUT (Greater than 30KΩ)
106585-9	J3	Selects line termination impedance of 50Ω, 75Ω, or OUT (Greater than 30KΩ)
106605	J3	Selects line termination impedance of 50Ω, 75Ω, or OUT (Greater than 30KΩ)

Table 17-17. Replaceable parts, Line I/O modules 106585-1 thru 106585-9 (See Note 1)

Circuit Symbol (Figs. 17-22 thru 17-29, and 17-31)	Description	Part Number
R1, 2, 3	Resistor, fixed composition, 100Ω, 5%, 1W	1009 182
R4, 5	Resistor, fixed composition, 150Ω, 5%, 1W	1009 183
E1, E2, E3	Arrestor, 2-element gas tube	101472
CR1	Suppressor, transient, bi-directional, 75V	101473
J10, 12, 14, 15, 16, 18, 20, 22, 23	Connector, jack, female, 2-contact, SMB	101485
J3	Connector, header, dual 3/6 circuit	32599 6
J5, 6, 7, 8	Connector, jack, coax, female	101470
J1, 2	Connector wafer assembly, 4 circuit	97223 4
TB1, 2	Terminal block, 8-terminal, modified	101697 8
TB1	Terminal block, 2-terminal, modified	101697 2

Note 1: Refer to the Table in Figure 17-36 (schematic diagram) to determine which components are used in which Line I/O modules. The schematic shown in Figure 17-36 is for Line I/O modules 106585-1 to 106585-8. The schematic shown in Figure 17-38 is for Line I/O module 106585-9.

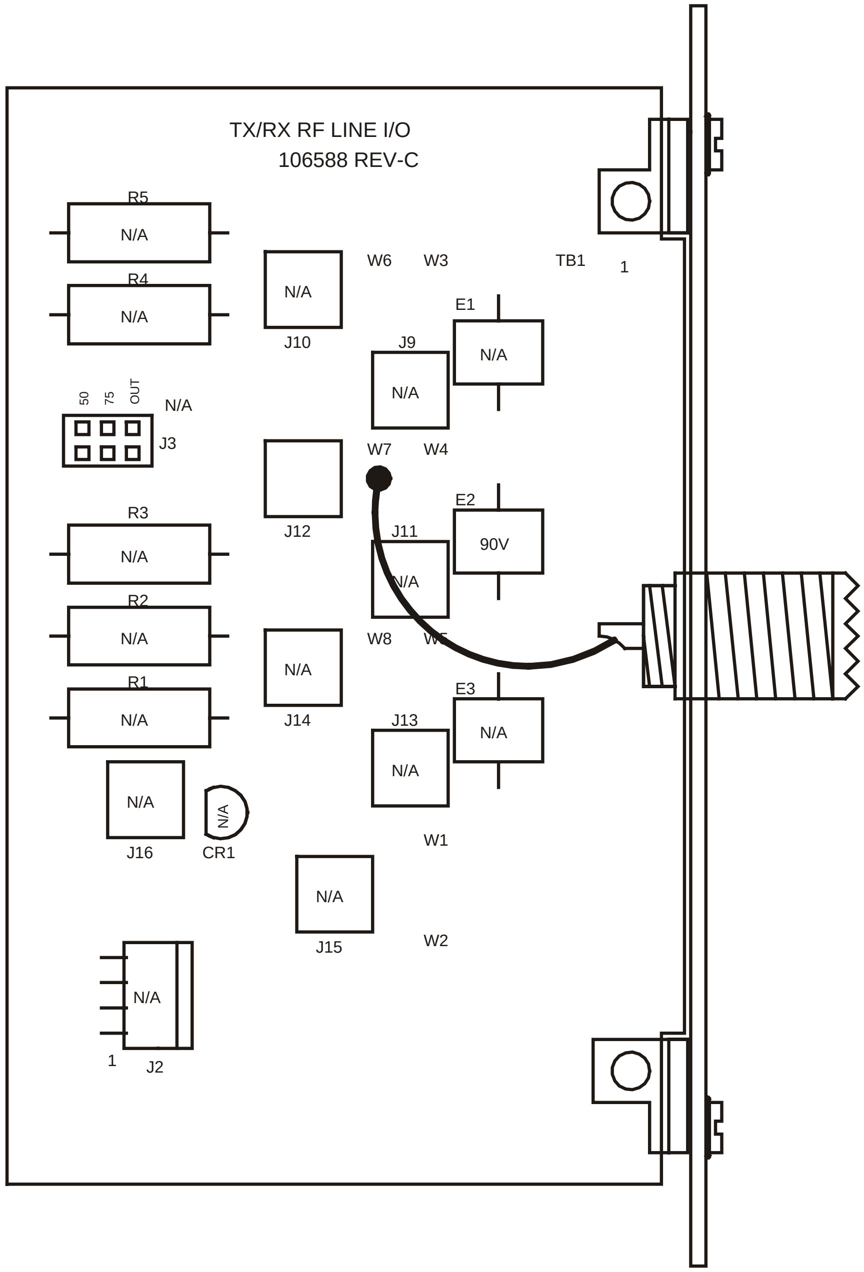

Figure 17-28. Component locator drawing, TX/RX RF Line I/O module (106585-1)

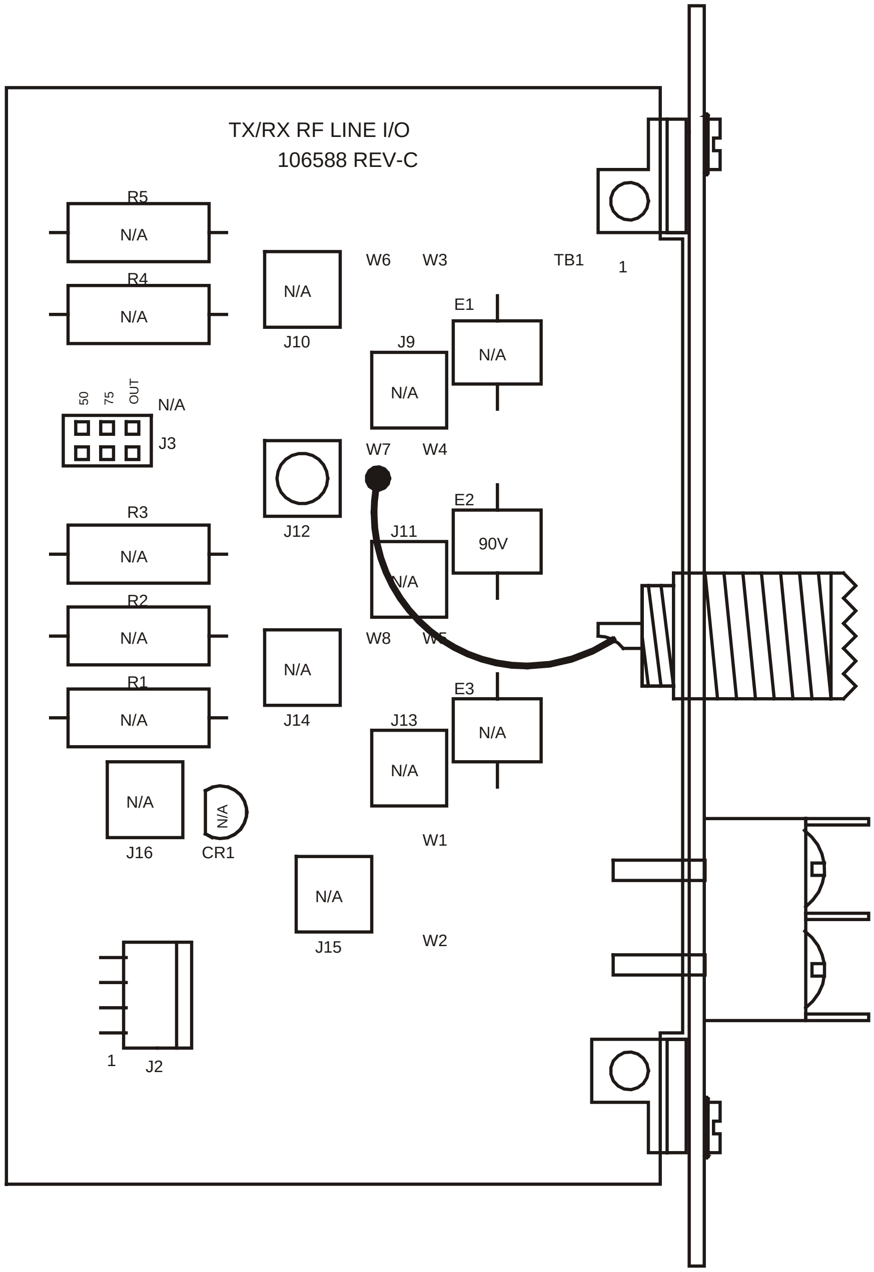

Figure 17-29. Component locator drawing, TX/RX RF Line I/O module (106585-2)

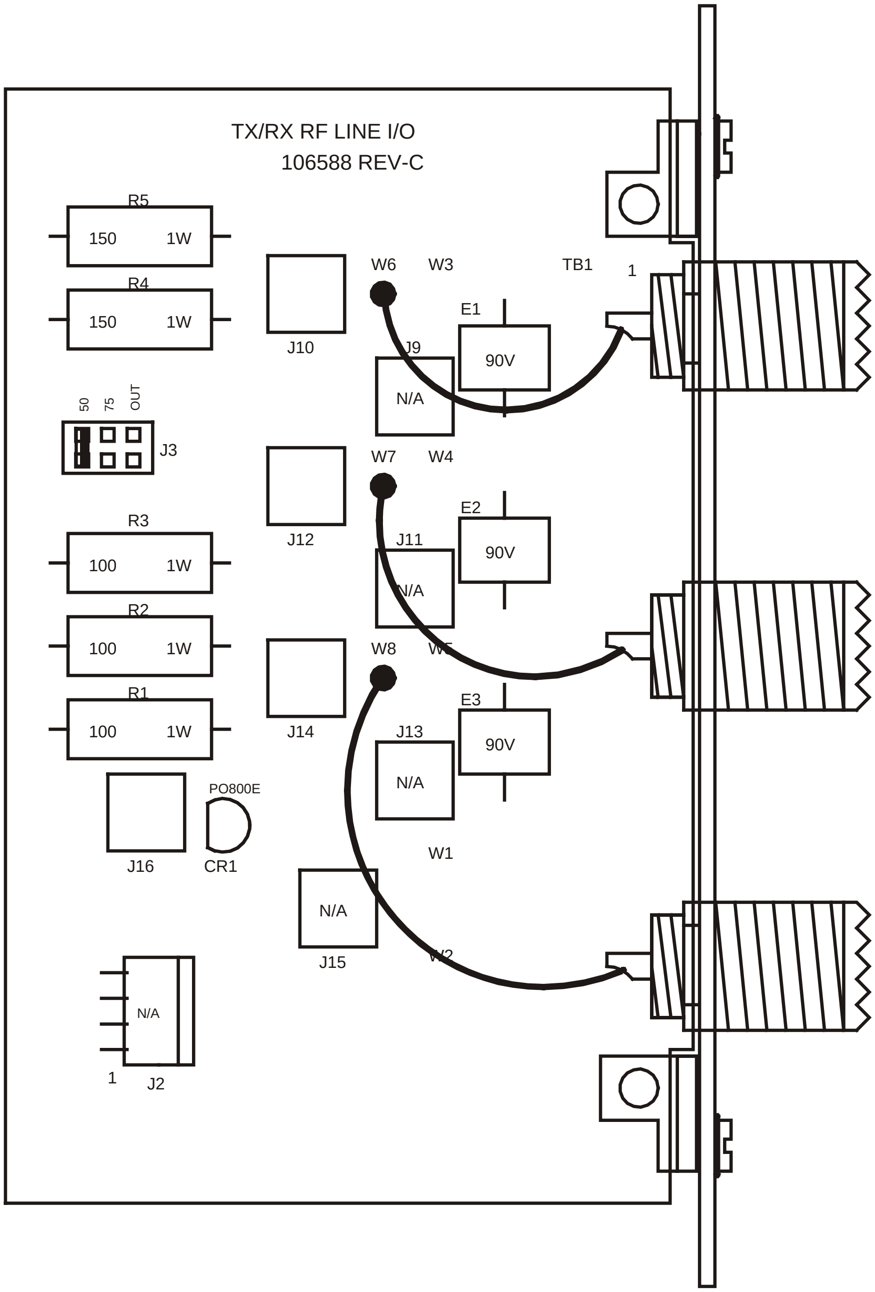

Figure 17-30. Component locator drawing, TX/RX RF Line I/O module (106585-3)

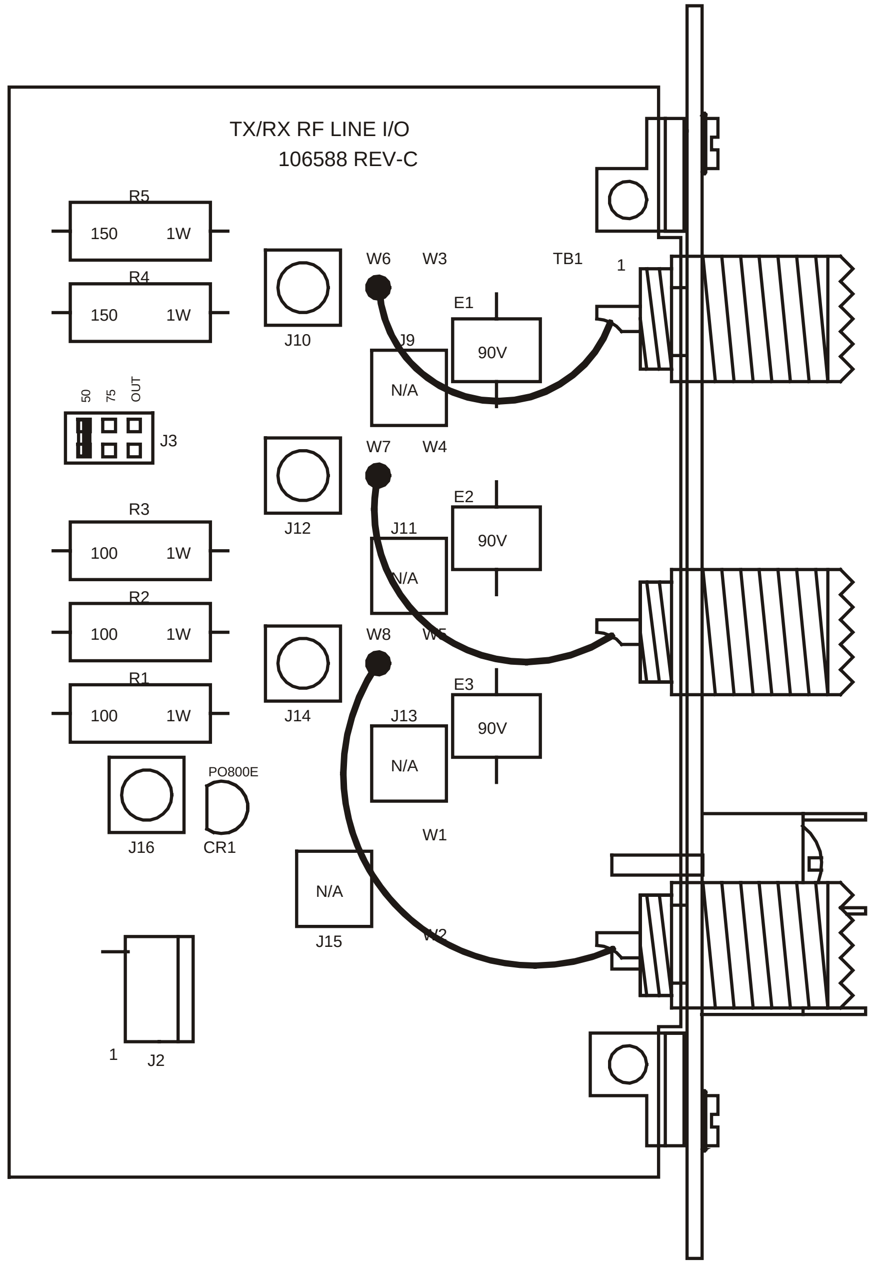

Figure 17-31. Component locator drawing, TX/RX RF Line I/O module (106585-4)

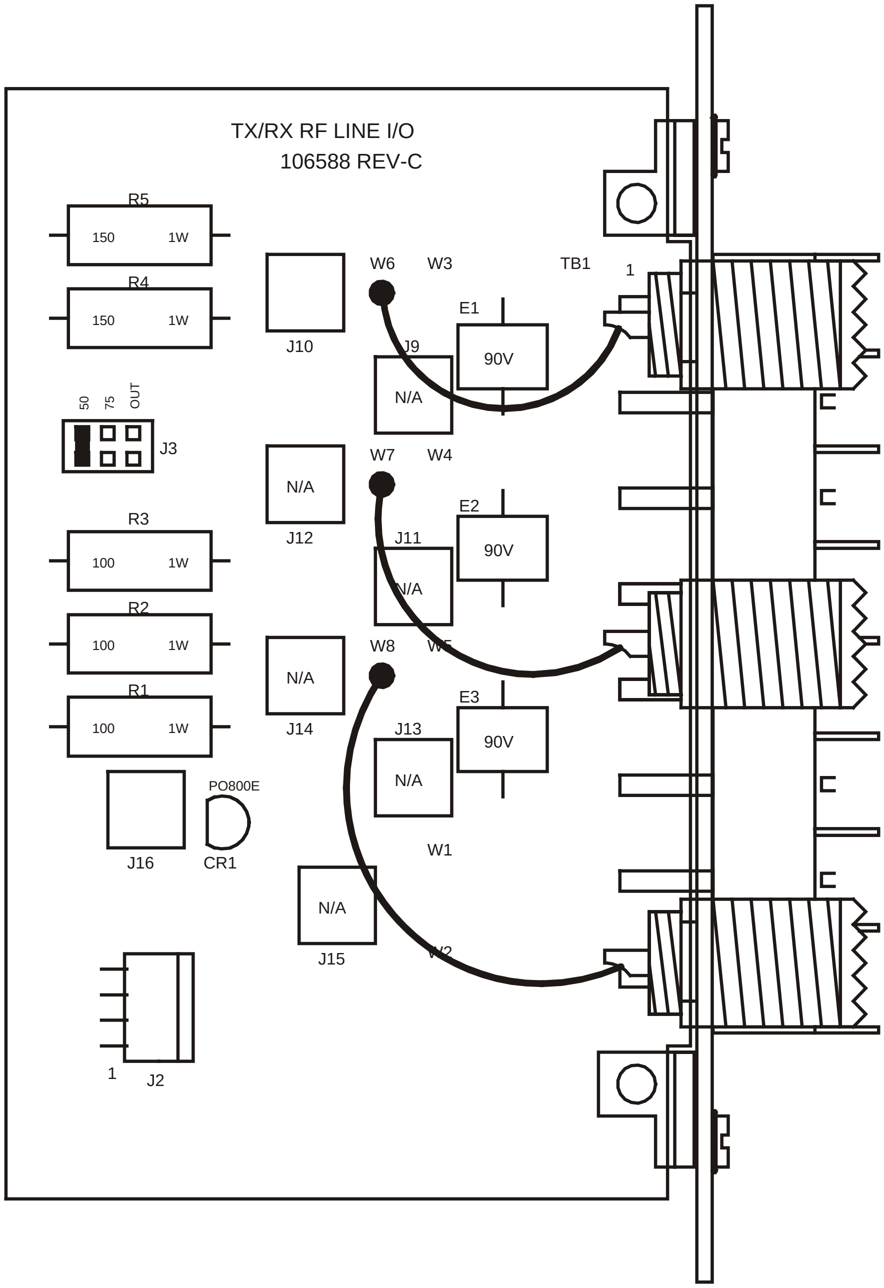

Figure 17-32. Component locator drawing, TX/RX RF Line I/O module (106585-5)

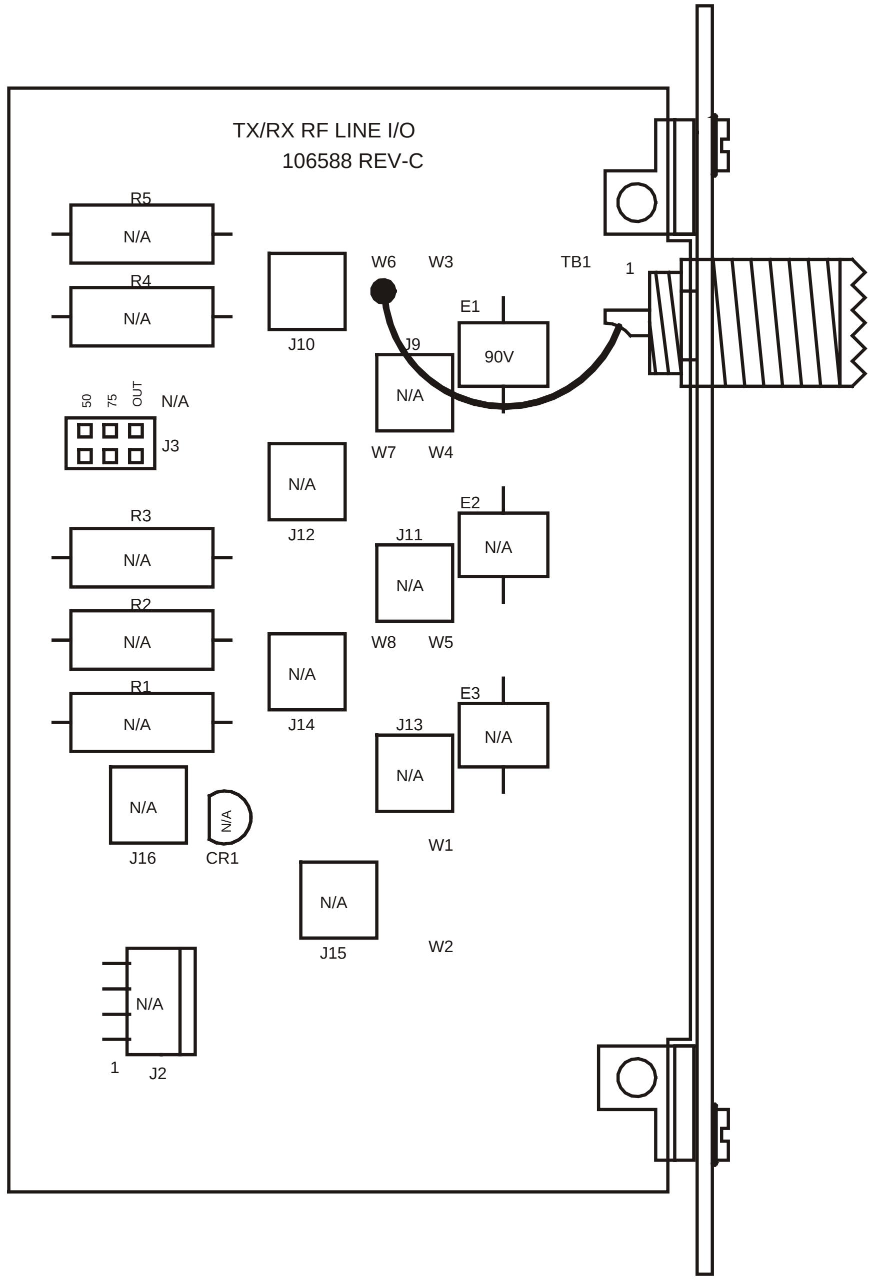

Figure 17-33. Component locator drawing, TX RF Line I/O module (106585-6)

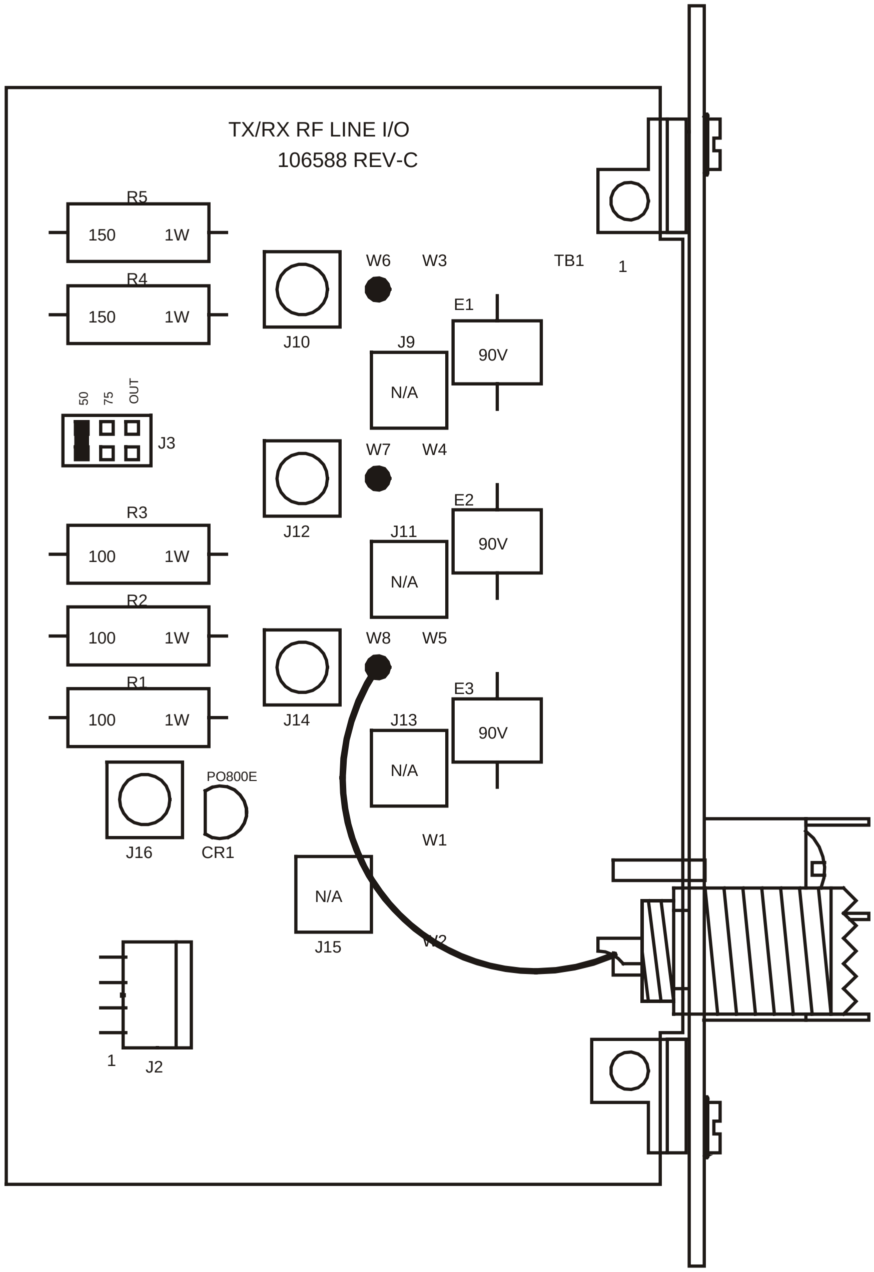

Figure 17-34. Component locator drawing, RX RF Line I/O module (106585-7)

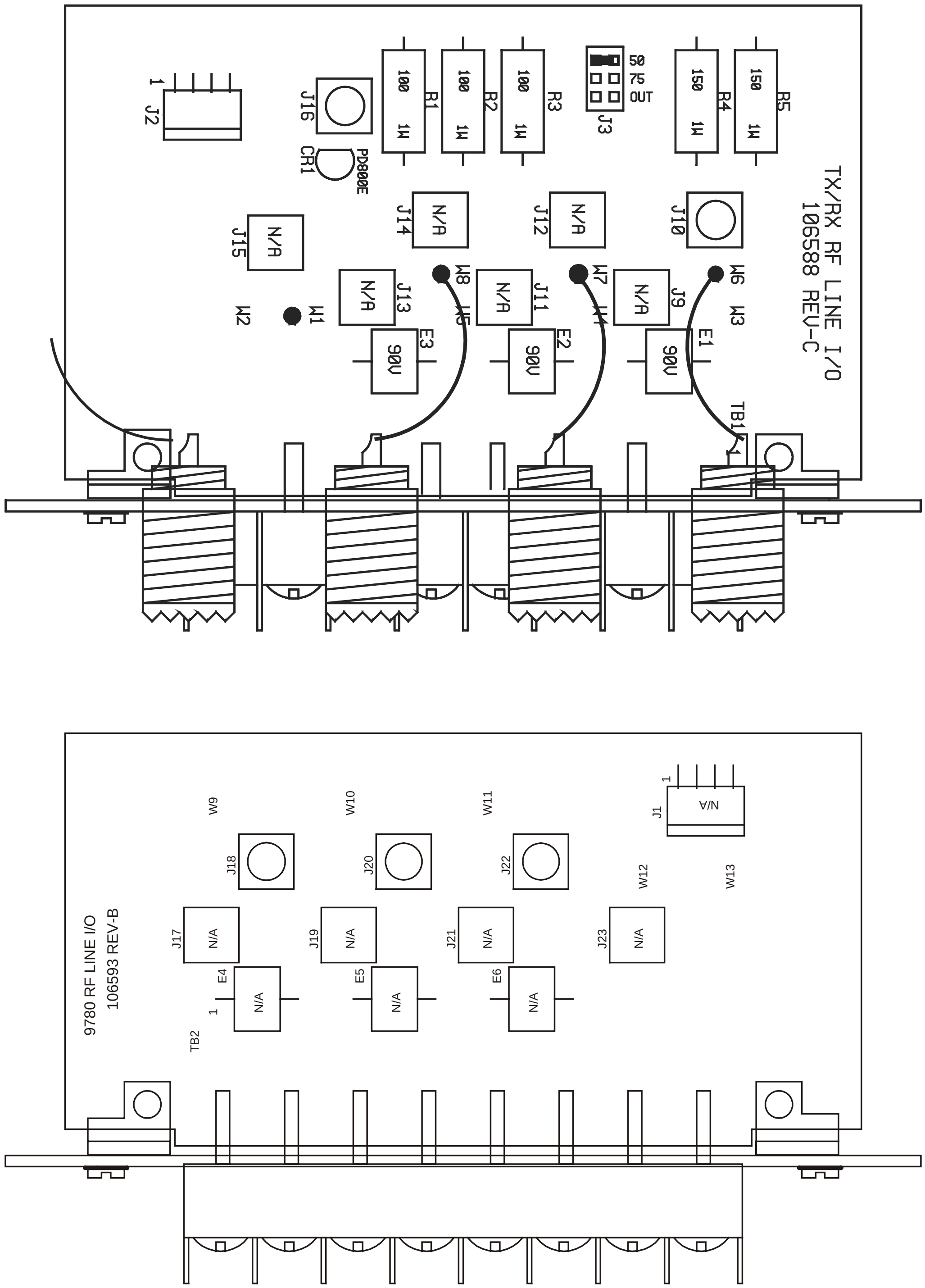

Figure 17-35. Component locator drawing, TX/RX RF Line I/O module (106585-8)

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Figure 17-36. Schematic, RFL 9780 TX/RX RF Line I/O (Dwg. No. C-106589-D)

Please see Figure 17-36 in Section 22.

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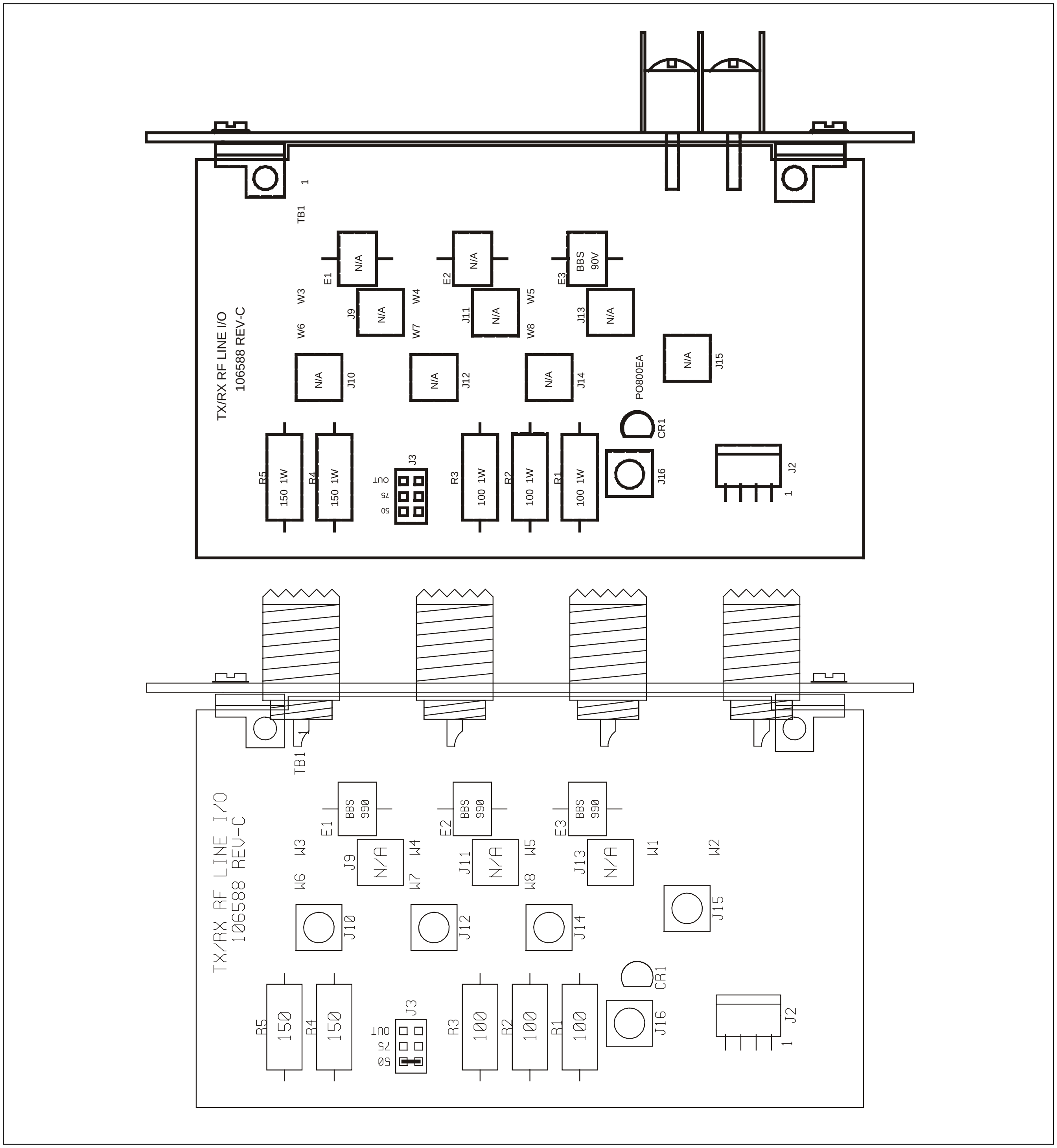

Figure 17-37. Component locator drawing, TX/RX RF Line I/O module (106585-9)

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Figure 17-38. Schematic, RFL 9780 TX/RX RF Line I/O (Dwg. No. D-106609-9-C)

Please see Figure 17-38 in Section 22

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Table 17-18. Replaceable parts, TX/TX RF Line I/O module (106590)

Circuit Symbol (Figs. 17-33 and 17-34)	Description	Part Number
E1-E3	Arrestor, 2-element gas tube	101472
J5-7	Connector, jack, coax, female	101470
J10, 12, 14	Connector, jack, female, 2-contact, SMB	101485
TB1	Terminal block, 8-terminal, modified	101697 8

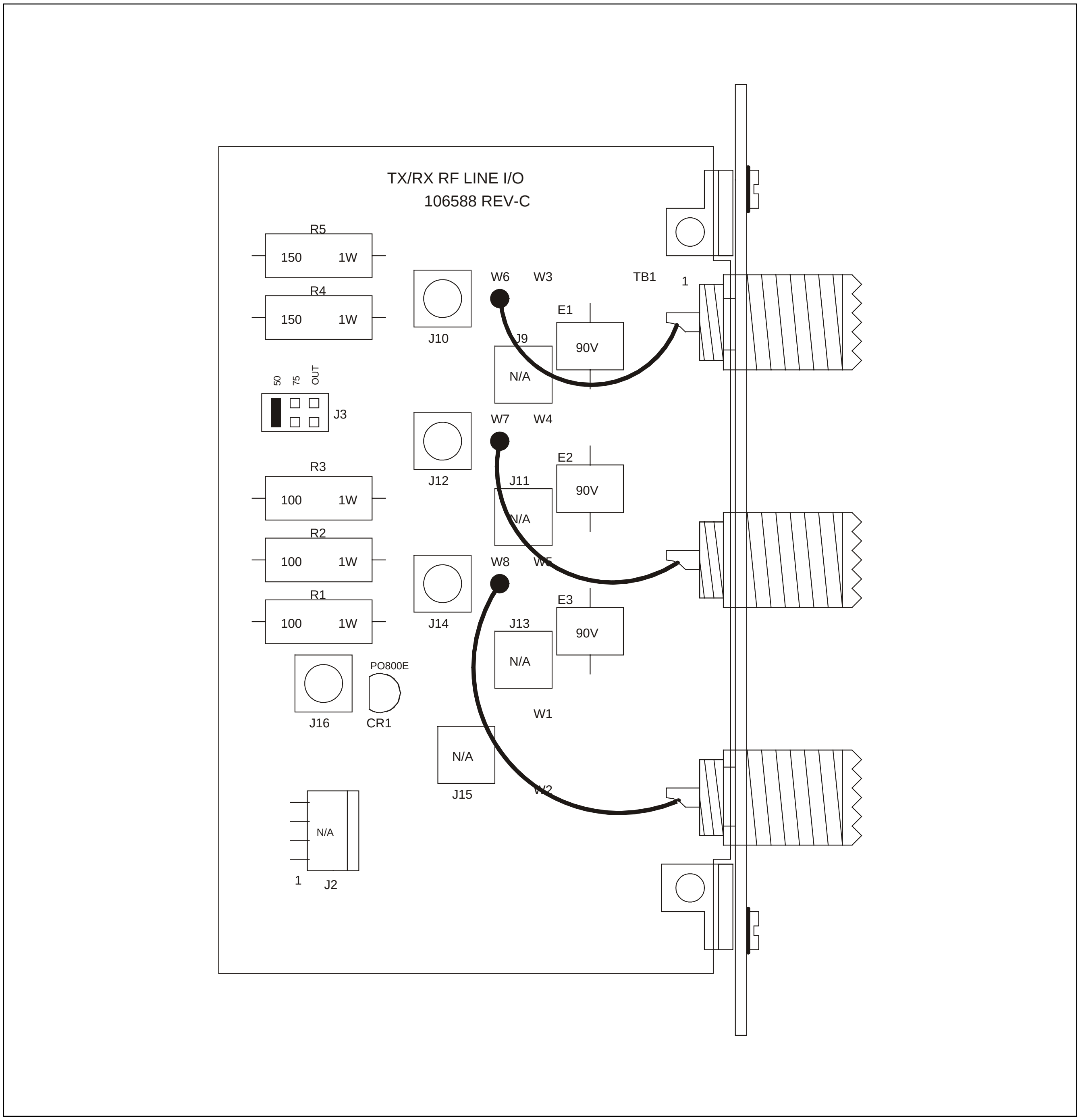

Figure 17-39. Component locator drawing, TX/RX RF Line I/O module (106590)

Figure 17-40. Schematic, RFL 9780 TX/TX RF Line I/O (Dwg. No. C-106594-B)

Please see Figure 17-40 in Section 22.

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Table 17-19. Replaceable parts, RX/RX RF Line I/O module
Assembly Number 106605-1 & -2

Circuit Symbol (Figs. 17-35 and 17-36)	Description	Part Number
R1, 2, 3	Resistor, fixed composition, 100Ω, 5%, 1W	1009 182
R4, 5	Resistor, fixed composition, 150Ω, 5%, 1W	1009 183
E3	Arrestor, 2-element gas tube	101472
CR1	Suppressor, transient, bi-directional, 75V	101473
J16	Connector, jack, female, 2-contact, SMB	101485
J3	Connector, header, dual 3/6 circuit	32599 6
J2	Connector housing, 4-circuit. 0.100 centers	95067 4

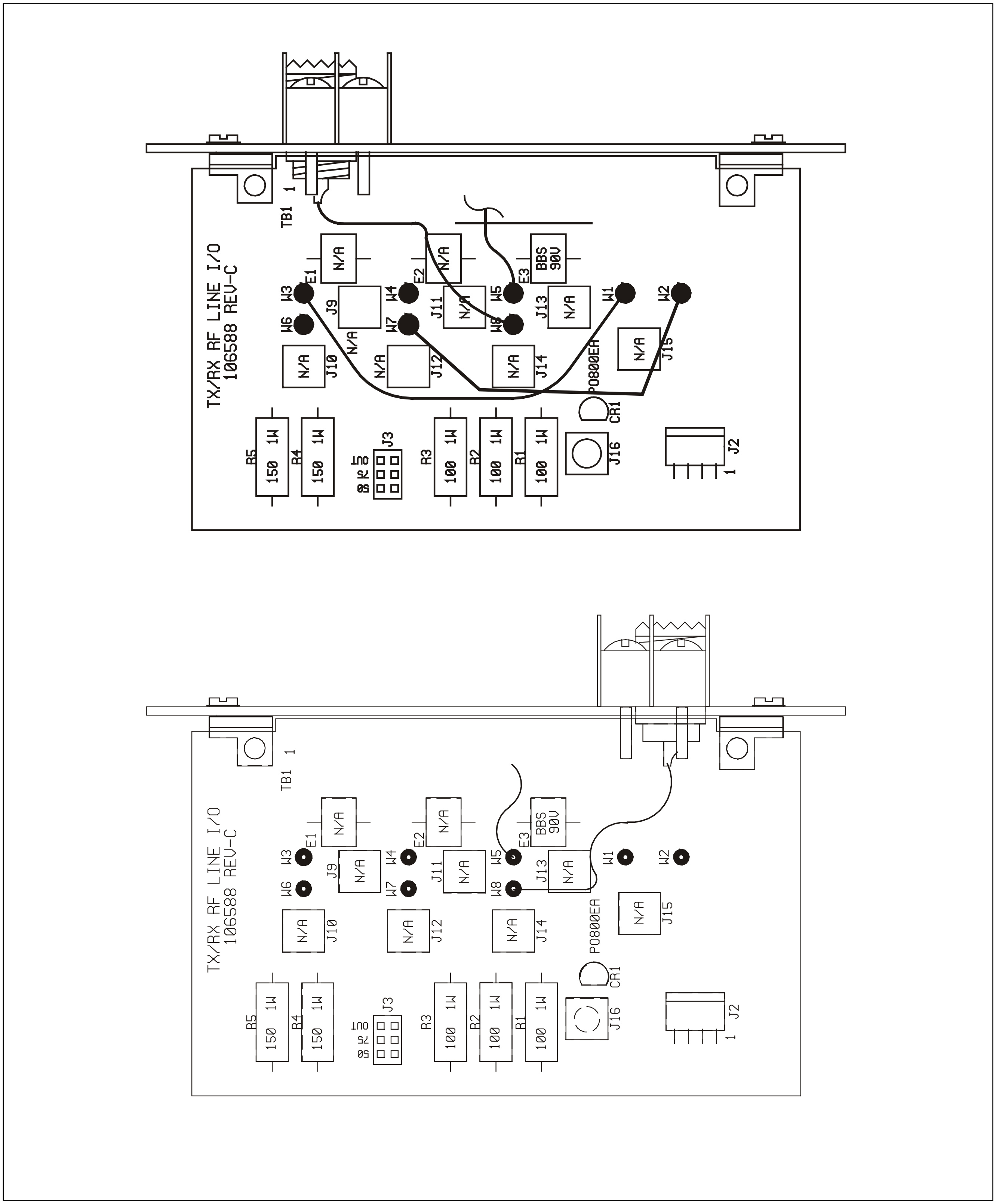

Figure 17-41. Component locator drawing, RX/RX RF Line I/O module (106605-1 and -2)

Figure 17-42. Schematic, RFL 9780 RX/RX RF Line I/O (Dwg. No. D-106609-B)

Please see Figure 17-42 in Section 22.

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17.9 EXTERNAL POWER AMP I/O MODULE

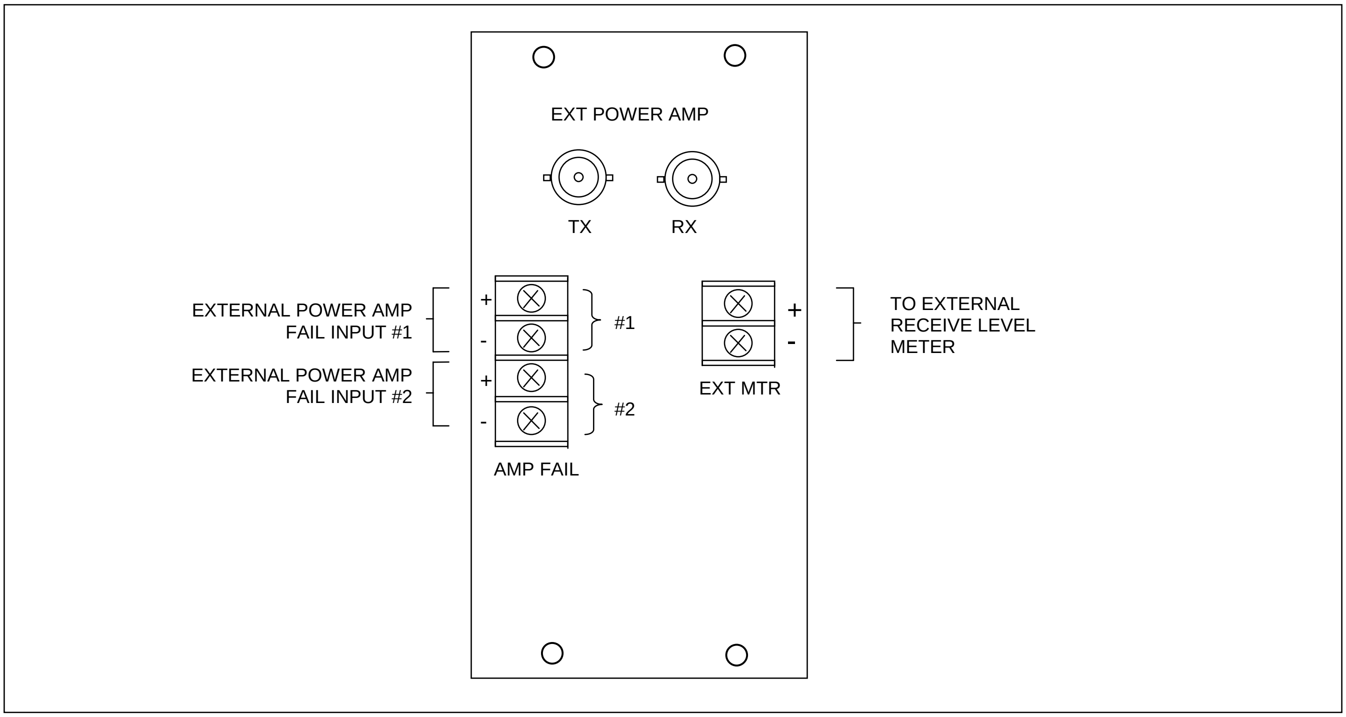

Figure 17-43. External Power Amp I/O module, rear panel view

17.9.1 DESCRIPTION

The external power amp I/O provides an interface when an external high power amplifier is used with the 9780. This module replaces the standard 10W power amplifier for this application. Two panel mounted BNC connectors provide the TX and RX signal interface for the external amplifier and receiver connection.

The External Power Amp I/O module (Figure 17-43) is composed of two sections. One section provides an RX line interface and has provisions for an external power meter, and the other section provides TX scaling and external power amplifier fail inputs. This I/O module is presently available in the following version:

Alarm Input Voltage	Assembly No.
12V	106675

This module has six sets of jumpers that must be configured before the module is placed in service. The B board has jumper JP101 which can select three RX terminations (50Ω, 75Ω, or high impedance). The A board has five sets of jumpers: JP1, JP2, JP3, JP4 and JP5. Jumpers JP3 and JP4 must be set to position C to select 12V alarm inputs. Setting jumpers JP1, JP2 and JP5 are described in Tables 17-20 and 17-21.

The Input/Alarm I/O module is primarily used for TX/TX, TX/RX or TX only applications, which use an external 50W or 100W power amplifier. It can also be used for customer specific applications and can be mounted in a spare I/O slot or in an expansion chassis.

Table 17-20. Logic Straps

Logic with straps in position:		
JP1-A	JP2-A	JP5-B
Input Name	Input Status at TB9	Output Status at C12
Fail#1 (TB9-1&-2)	12V	0V (OK)
Fail#2 (TB9-3&-4)	12V	
Fail#1 (TB9-1&-2)	0V	5V (FAIL)
Fail#2 (TB9-3&-4)	0V	
Fail#1 (TB9-1&-2)	12V	5V (FAIL)
Fail#2 (TB9-3&-4)	0V	
Fail#1 (TB9-1&-2)	0V	5V (FAIL)
Fail#2 (TB9-3&-4)	12V	

Table 17-21. Logic Straps

Logic with straps in position:		
JP1-B	JP2-B	JP5-B
Input Name	Input Status at TB9	Output Status at C12
Fail#1 (TB9-1&-2)	12V	5V (FAIL)
Fail#2 (TB9-3&-4)	12V	
Fail#1 (TB9-1&-2)	0V	0V (OK)
Fail#2 (TB9-3&-4)	0V	
Fail#1 (TB9-1&-2)	12V	5V (FAIL)
Fail#2 (TB9-3&-4)	0V	
Fail#1 (TB9-1&-2)	0V	5V (FAIL)
Fail#2 (TB9-3&-4)	12V	

17.9.2 RECEIVER LINE INTERFACE AND PROIVISION FOR EXTERNAL METER

The RX Line Interface section provides termination and surge protection for the receive signal. Termination is selectable via JP101 for 50 ohm, 75 ohm or high impedance. E101 is a 90 volt high-energy spark gap and along with R105 and CR101 provide maximum surge protection for the 9780 receiver. In addition, connections are provided for an external power meter.

17.9.3 TX SCALING AND EXTERNAL POWER AMP SECTION

This section provides transmitter signal scaling and output buffering via U1 and associated variable and fixed resistors. Additionally, provisions for two external power amplifier alarm signals are located on this module. The standard input level is 12 volts selected via JP3 and JP4 position C. The alarm inputs are capable of handling other voltage levels via components associated with JP3-A&B and JP4-A&B. This can be provided for future applications. Alarm inputs are isolated via U3 and U4 and any combination of logic can be selected via jumpers JP1, JP2 and JP5.

Table 17-22. Replaceable Parts, RFL 9780 External Power Amp I/O module
Assembly No. 106675

Circuit Symbol (Figs. 17-44 & 17-45)	Description	Part Number
	A Board	
C1	Capacitor, 1.0uF, 50V	0135 51052
C2, 5, 7-11	Capacitor, 0.1uF	0120 38
C3	Capacitor, tanatlum 3.3uF	1007 1260
C4, 6	Capacitor, electrolytic 47uF	1007 1578
CR3, 6	Diode, 1N4003	30769
J1	Connector, TX	103731
JP1, 2, 5	Header, 3-pin	32802 3
JP3, 4	Header, dual, 3-position	32599 6
P1	Connector, euro, 64 pin	99134
R1, 4	Resistor, 1K	0410 1288
R7, 11	Resistor, 221Ω	0410 1225
R8, 9, 12, 13, 16, 17	Resistor, 4.75K	0410 1353
TB9	Terminal block, 4-position	101697 4
U1	Integrated circuit, OP AMP	0620 384
U2	Integrated circuit, quad NAND	0615 159
U3, 4	Integrated circuit, 6N139	29592
	B Board	
CR101	PO800EA	101473
E101	Spark gap	101472
J2	Connector, RX	103731
J104	SMB	101485
J105	Molex, 0.001, 4-position	95067 4
JP101	Header, dual, 3-position	32599 6
R101, 102	Resistor, fixed composition, 150Ω, 1W	1009 183
R103, 104, 105	Resistor, fixed composition, 100Ω, 1W	1009 182

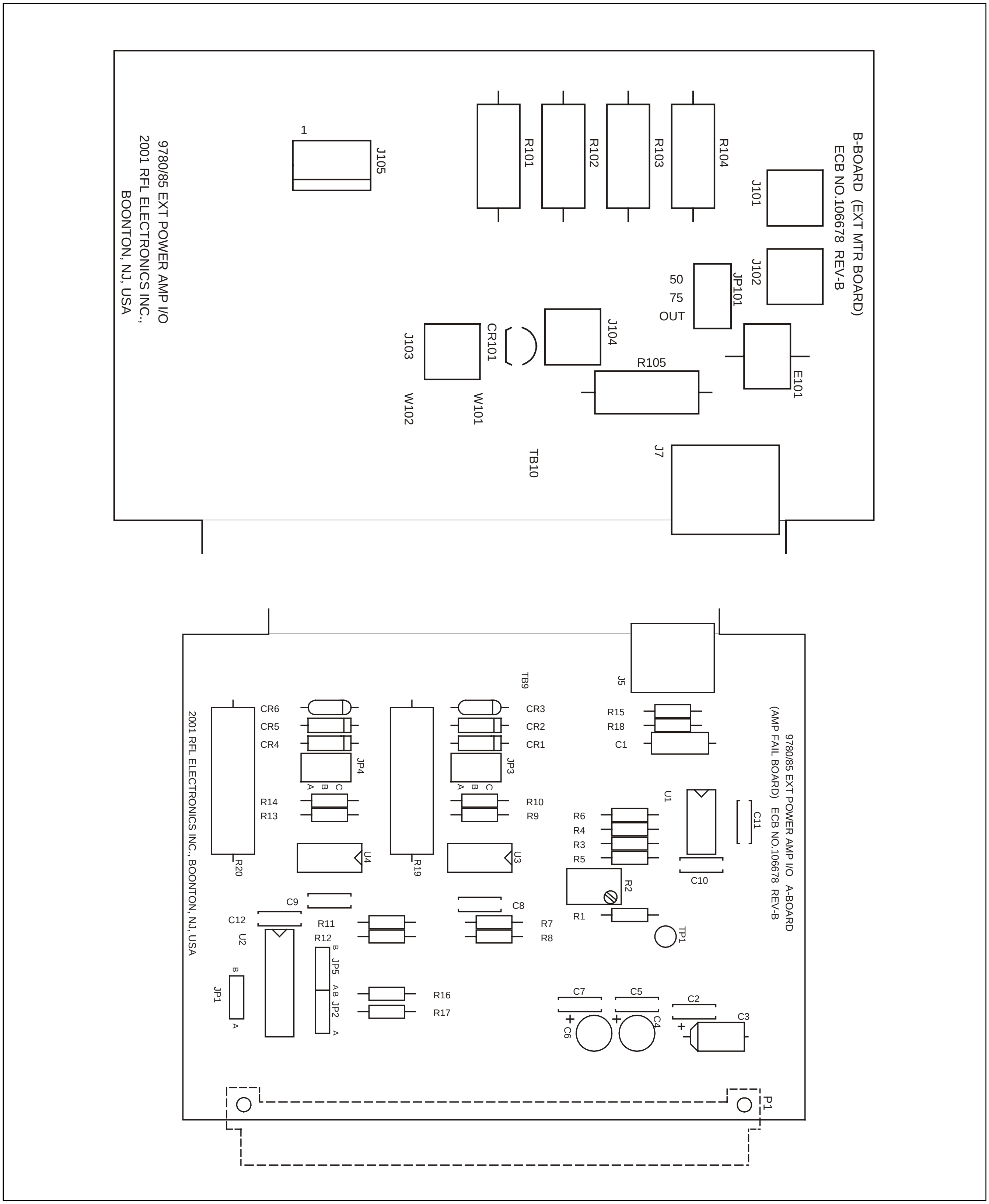

Figure 17-44. Component locator drawing, External Power Amp I/O module (Assy No. 106675)

Figure 17-45. Schematic, RFL 9780 External Power Amp I/O (Dwg. No. 106679-A)

Please see Figure 17-45 in Section 22

SECTION 18. HYBRID MODULES

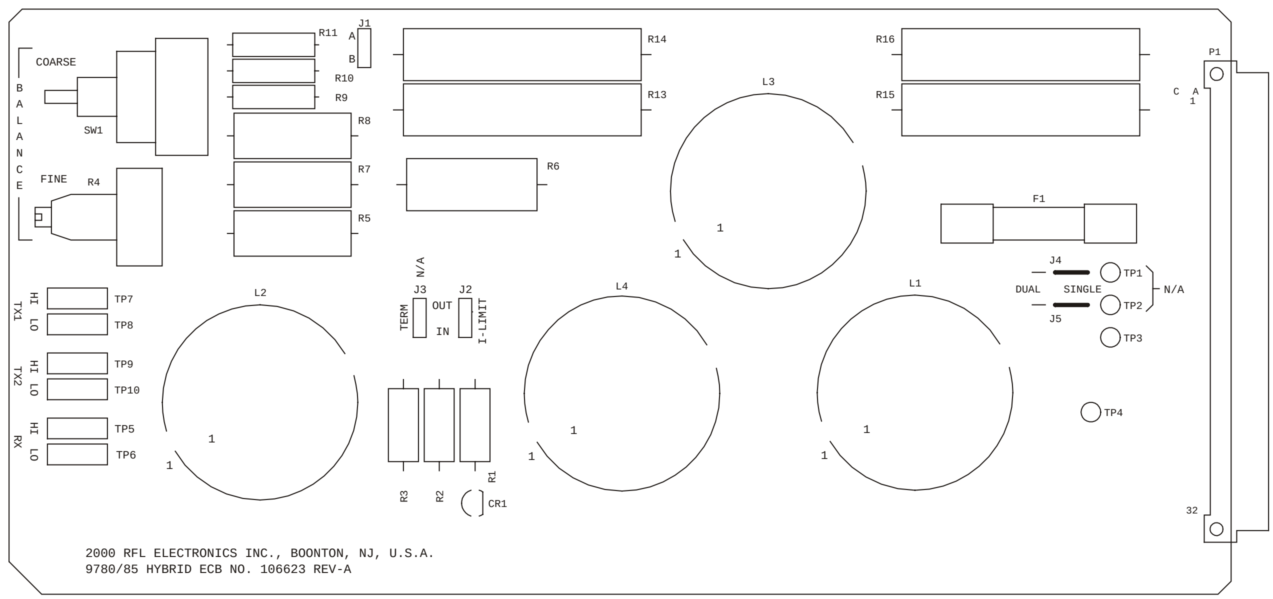

Figure 18-1. Typical layout of RFL 9780 X-Hybrid, Skewed Hybrid and Dual-Hybrid Modules.

18.1 INTRODUCTION

Hybrids are optional modules for the RFL 9780 equipment. They may be used to combine combinations of transmitters and receivers to a single port for connection to line tuning units. There is an X-Hybrid Module, a Skewed Hybrid Module and a Dual Hybrid Module available for the RFL 9780. Each of these modules uses the same basic printed circuit board as shown in Figure 18-1. See paragraph 18.2 for more information on the X-Hybrid Module. See paragraph 18.3 for more information on the Skewed Hybrid Module. See paragraph 18.4 for more information on the Dual Hybrid Module.

18.2 X HYBRID MODULE

The RFL 9780 X-Hybrid Module is a transformer-type hybrid typically used to combine the outputs of two transmitters. The X-Hybrid provides the required impedance matching and signal separation, and prevents mutual loading of the two transmitters. The impedance characteristics of the two types of X-Hybrid modules is shown in the table below.

Assembly Number	Receive	Send	Line
106630-1	50 Ohms	50 Ohms	50 Ohms
106630-2	50 Ohms	50 Ohms	75 Ohms

18.2.1 SPECIFICATIONS

As of the date this manual was published, the following specifications apply to all RFL 9780 X-Hybrid Modules, except where indicated. Because all RFL products undergo constant refinement and improvement, these specifications are subject to change without notice.

Insertion Loss:
Approximately 3.5 dB, either input port to line output port.

Transhybrid Loss:
Greater than 25 dB, from 60 to 500 kHZ, when operating with the specified termination impedances.

Power Capacity:
10 Watts rms.

Two-Wire Line Impedance:
50 Ohms standard; other impedances are available on special order.

Second Harmonic Distortion:
At least 80 dB below the fundamental frequency.

Third Order Intermodulation Products:
At least 60 dB below the fundamental frequency.

18.2.2 THEORY OF OPERATION

For this discussion, refer to the schematic diagram shown in Figure 18-4.

The X-Hybrid module is a transformer-type hybrid used to connect a transmitter and a receiver, or two receivers, to a single line tuning unit. It provides impedance matching and signal separation, and prevents mutual loading and interference. Signals can be accepted from an amplifier with a source impedance of 50 Ohms with up to 10 Watts of output power.

The transmitted signals pass through a transformer hybrid formed from transformers L1 and L2. These transformers each have two secondaries, interconnected so that the first secondary of one transformer is in series with the second secondary of the other. One set of interconnected secondaries is connected to the line tuning unit through edge connector A24/C24 (high) and A25/C25 (low). The other set of secondaries is connected across balancing resistors R13/R14 which determine the amount of isolation between four-wire ports. If additional isolation is required, R13 and R14 can be removed and replaced with an external balancing network connected across edge connector terminals A18/C18 and A19/C19.

The X hybrid can also be used to connect two transmitters to the same line tuning unit, resulting in dual-channel transmission capabilities. In this application, one transmitter is connected across the primary of L1 , and the other transmitter is connected across the primary of L2.

18.2.3 CONTROLS AND INDICATORS

Figure 18-2 shows the location of all controls and indicators on the RFL 9780 X-Hybrid Module. These controls and indicators are described in Table 18-1. Only TP5, TP6, TP7 and TP8 are accessible with the X-Hybrid Module installed in the chassis. All others are accessible when the module is removed from the chassis or is on a card extender.

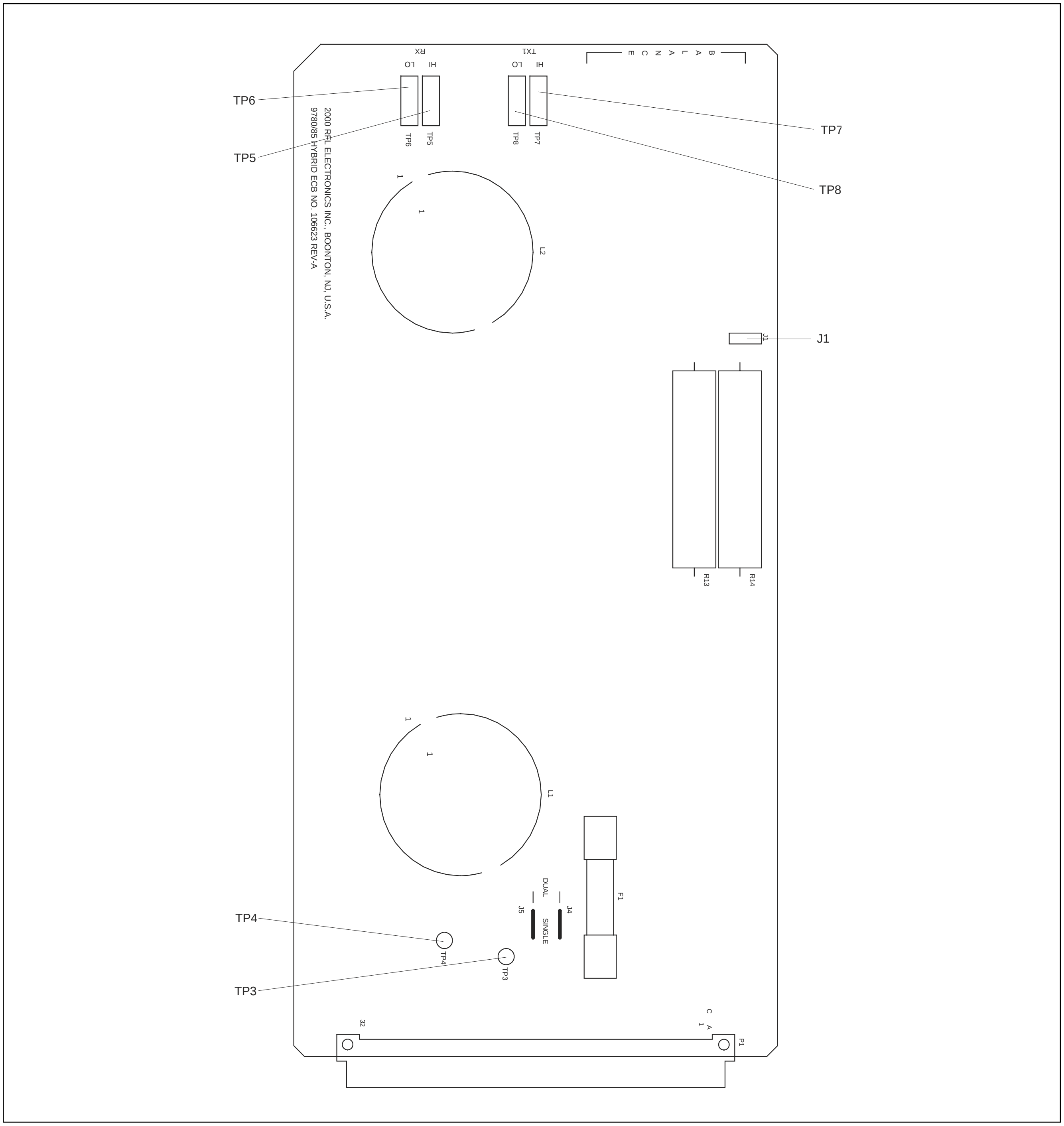

Figure 18-2. Controls and indicators, RFL 9780 X-Hybrid Module

Table 18-1. Replaceable parts, RFL 9780 X-Hybrid module. Assembly No. 106630-1 and -2.

Component Designator	Name/Description	Function
J1	Jumper	Selects internal or external balancing network (A = internal, B = external)
TP3	Test point	Line High (orange)
TP4	Test point	Line Low (orange)
TP5	Test point	Receive High (green)
TP6	Test point	Receive low (yellow)
TP7	Test point	Send High (red)
TP8	Test point	Send Low (white)

18.2.3.1 SELECTING THE BALANCING NETWORK

Jumper J1 is used to select either the internal (50 Ohm resistive) balancing impedance or an external, user supplied, balancing impedance. Placing the jumper in the A position selects the internal impedance. Selecting the B position selects the external impedance.

Table 18-2. Replaceable parts, RFL 9780 X-Hybrid module. Assembly No. 106630-1 and -2.

Circuit Symbol (Figs. 18-3 & 18-4)	Description	Part Number
	MISCELLANEOUS COMPONENTS	
F1	Fuse, SLO-BLO, 10A, 32V, 3AG	10758
J1	Connector, header, single, 3CKT	32802 3
L1	Transformer, hybrid, 50 ohm, XMIT	
	106630-1	55768
	106630-2	55768
L2	Transformer, hybrid, 50 ohm, XMIT	
	106630-1	55768
	106630-2	55769
P1	Connector, JK, male, 64 contact, DIN	98457
R13, 14	Resistor, wirewound, 100Ω, 5%, 10W	100 795
TP3, 4	Test point terminal, orange	98441 3
TP5	Test point, green	38116 5
TP6	Test point, yellow	38116 8
TP7	Test point, red	38116 2
TP8	Test point, white	38116 1

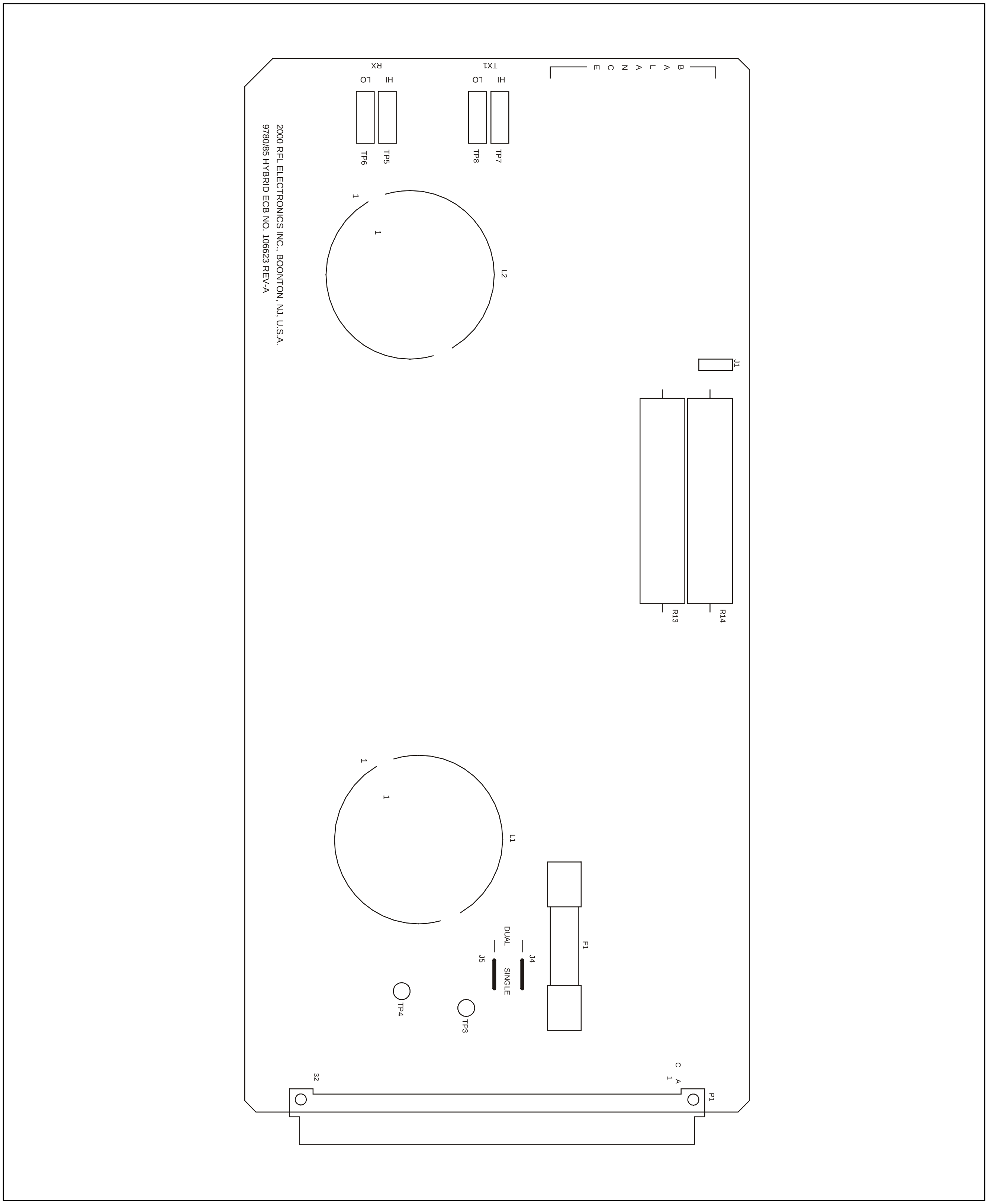

Figure 18-3. Component locator drawing, RFL 9780 X-Hybrid Module

Figure 18-4. Schematic, RFL 9780 X-Hybrid (Dwg. No. D-106634-A)

See Figure 18- 4 in Section 22.

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18.3 SKEWED HYBRID MODULE

The RFL 9780 Skewed Hybrid Module uses two hybrid transformers to connect a transmitter and receiver to a single line tuning port. The Skewed Hybrid provides a high degree of signal separation by isolating the local transmitter signal from the local received signal and preventing the input impedance of the receiver from loading the transmitter. The impedance characteristics of the two types of Skewed-Hybrid modules is shown in the table below.

Assembly Number	Receive	Send	Line
106625-1	50 Ohms	50 Ohms	50 Ohms
106625-2	50 Ohms	50 Ohms	75 Ohms

18.3.1 SPECIFICATIONS

As of the date this manual was published, the following specifications apply to all RFL 9780 Skewed Hybrid Modules, except where indicated. Because all RFL products undergo constant refinement and improvement, these specifications are subject to change without notice.

Insertion Loss (60 to 500 kHz):
Transmitting: Approximately 0.3 dB.
Receiving: Approximately 12.5 dB.

Transhybrid Loss (60 to 500 kHz):
Greater than 40 dB when operating with the specified termination impedance.

Internal Balance Range:
0.5 to 1.95 times the specified two-wire impedance.

Power Capacity:
10 Watts rms.

Two-Wire Line Impedance:
50 Ohms standard; other impedances are available on special order.

Second Harmonic Distortion:
At least 80 dB below the fundamental frequency.

Third Order Intermodulation Products:
At least 60 dB below the fundamental frequency.

18.3.2 THEORY OF OPERATION

For this discussion, refer to the schematic diagram in Figure 18-7.

The RFL 9780 Skewed Hybrid Module uses two hybrid transformers to couple signals between a transmitter, a receiver, and a line tuning unit. It provides impedance matching and signal separation, and prevents mutual loading and interference. Signals can be accepted from an amplifier with a source impedance of 50 Ohms with up to 10 Watts of output power.

The transmitted and received signal passes through a hybrid formed from transformers L1 and L2. These transformers each have two secondaries, interconnected so that the first secondary of one transformer is in series with the second secondary of the other. One set of interconnected secondaries is connected to the line tuning unit through edge connector A24/C24 (high) and A25/C25 (low). This allows both the transmitter and the receiver to be coupled to the line tuning unit. The other set of secondaries is connected across the internal balancing network formed by resistors R4 through R11. The coarse balance switch SW1 and fine balance potentiometer R4 can be adjusted to vary the resistance across the transformer secondaries, which determines the amount of transhybrid loss. If additional transhybrid loss is required, the internal balancing network can be disabled by placing jumper J1 in the “B” position and placing an external network across edge connector terminals A18/C18 and A19/C19.

The transmitter output is connected across the primary of L1, and the receiver input is connected across the primary of L2. Transmitter output signals are coupled through L1 to the line tuning unit, and incoming signals detected by the line tuning unit are coupled through L2 to the receiver. Transmitted signals are attenuated by about 0.3 dB as they pass through the Skewed Hybrid module, and received signals are attenuated by about 12.5 dB. Because both the received signal and its noise content are attenuated equally, signal-to-noise ratios are unaffected.

18.3.3 CONTROLS AND INDICATORS

Figure 18-5 shows the location of all controls and indicators on the Skewed Hybrid module. These controls and indicators are described in Table 18-3. Only TP5, TP6, TP7, TP8, SW1 and R4 are accessible with the Skewed Hybrid Module installed in the chassis. All others are accessible when the module is removed from the chassis or is on a card extender.

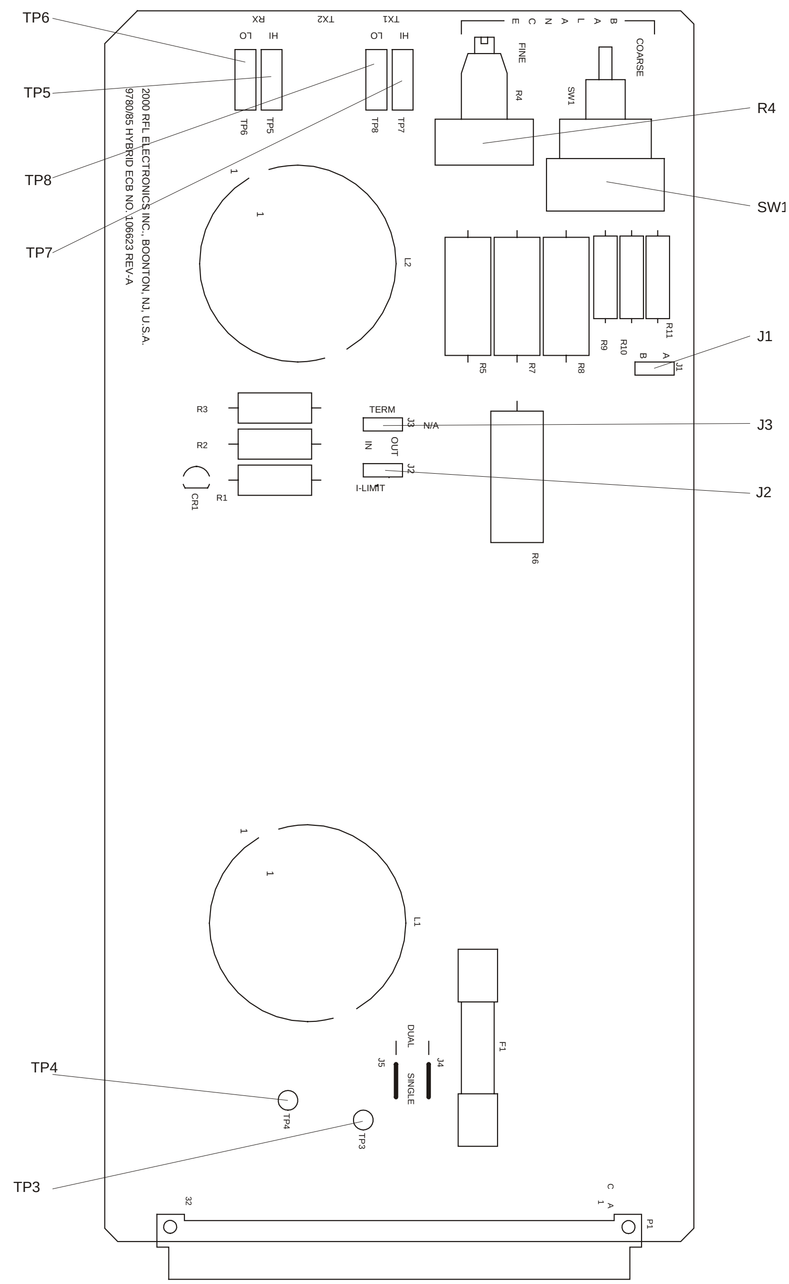

Figure 18-5. Controls and indicators, RFL 9780 Skewed Hybrid Module

Table 18-3. Controls and Indicators, RFL 9780 Skewed Hybrid Model.

Component Designator	Name/Description	Function
J1	Jumper	Selects internal or external balancing network (A = internal, B = external)
J2	Jumper	Enables the protection circuit with current limiting. The “IN” position enables current limiting. The “OUT” position disables current limiting.
J3	Jumper	Enables 50 Ohm termination. The “IN” position enables the termination. The “OUT” position disables the termination.
SW1	Switch	Coarse adjustment for balancing network
R4	Potentiometer	Fine adjustment for balancing network
TP3	Test point	Line High (orange)
TP4	Test point	Line Low (orange)
TP5	Test point	Receive High (green)
TP6	Test point	Receive low (yellow)
TP7	Test point	Send High (red)
TP8	Test point	Send Low (white)

18.3.3.1 SELECTING THE BALANCING NETWORK

Jumper J1 is used to select an internal (resistive) balancing impedance or an external, user supplied, balancing impedance. Placing the jumper in position A selects the internal impedance. Placing the jumper in position B selects the external impedance. The internal impedance has a course adjustment using SW1 and a fine adjustment using potentiometer R4.

18.3.3.2 SELECTING RECEIVE PORT PROTECTION AND TERMINATION

The receive port of the hybrid contains protection circuitry for the receiver’s front-end, and line termination resistance. These features are similar to those used in the RF Line I/O, and may be individually selected by using jumpers J2 and J3 as described in Table 18-3. Transient suppressor CR1 limits the voltage to the receiver and resistor R1 limits the current. Jumper J2 is used to bypass R1 when current limiting is not desired. J3 is used to enable the 50 Ohm termination resistance. The power dissipated by the termination should be limited to 1W.

The protection circuit should be placed as close as possible to the receiver and the termination should be placed at the end of the signal path. In a chassis with a single rear UHF connector, the termination and protection should be enabled (“IN”) on the hybrid. The received signal is then wired directly to the receiver circuits.

If the received signal is sent to a UHF connector on the line I/O (e.g. to go to another receiver), both the termination and protection should be omitted from the hybrid (“OUT”). The received signal out of the hybrid is sent to the line I/O’s UHF connector. Following the connector is the termination resistor. If this is the last, or only receiver using this signal, the termination on the I/O should be enabled. The protection circuit is always enabled on the I/O when connected to the local receiver, to protect the local receiver. This configuration protects the receiver from line disturbances passed through the hybrid and also protects against any transients applied to the UHF connector.

The termination must never follow any current limit resistance. The signal should be wired directly from the protection circuit to the receiver, and each receiver should have protection.

Table 18-4. Replaceable parts, RFL 9780 Skewed Hybrid Module
Assembly No. 106625-1 and -2

Circuit Symbol (Figs. 18-6 & 18-7)	Description	Part Number
	MISCELLANEOUS COMPONENTS	
CR1	Suppressor, transient, bidirectional. 75V	101473
F1	Fuse, SLO-BLO, 10A, 32V, 3AG	10758
J1-J3	Connector, header, single, 3CKT	32802 3
L1	Transformer, hybrid, 50 ohm, XMIT	
	106625-1	55766
	106625-2	55865
L2	Transformer, hybrid, 50 ohm, XMIT	
	106625-1	55766
	106625-2	55865
P1	Connector, JK, male, 64 contact, DIN	98457
R1-3	Resistor, fixed composition, 100Ω, 5%, 1W	1009 182
R4	Resistor, metal film, variable, 100Ω, 10%, 2W	44356
R5	Resistor, wirewound, 50Ω, 5%, 2.5W	1100 747
R6	Resistor, wirewound, 50Ω, 5%, 5W	1100 748
R7, 8	Resistor, wirewound, 12Ω, 5%, 2.5W	1100 745
R9, 10, 11	Resistor, metal film, precision, 12.1Ω, 1%, 1/2W	1510 2109
SW1	Switch, rotary, 1 deck, 6 position	44357
TP3, 4	Test point terminal, orange	98441 3
TP5	Test point, green	38116 5
TP6	Test point, yellow	38116 8
TP7	Test point, red	38116 2
TP8	Test point, white	38116 1

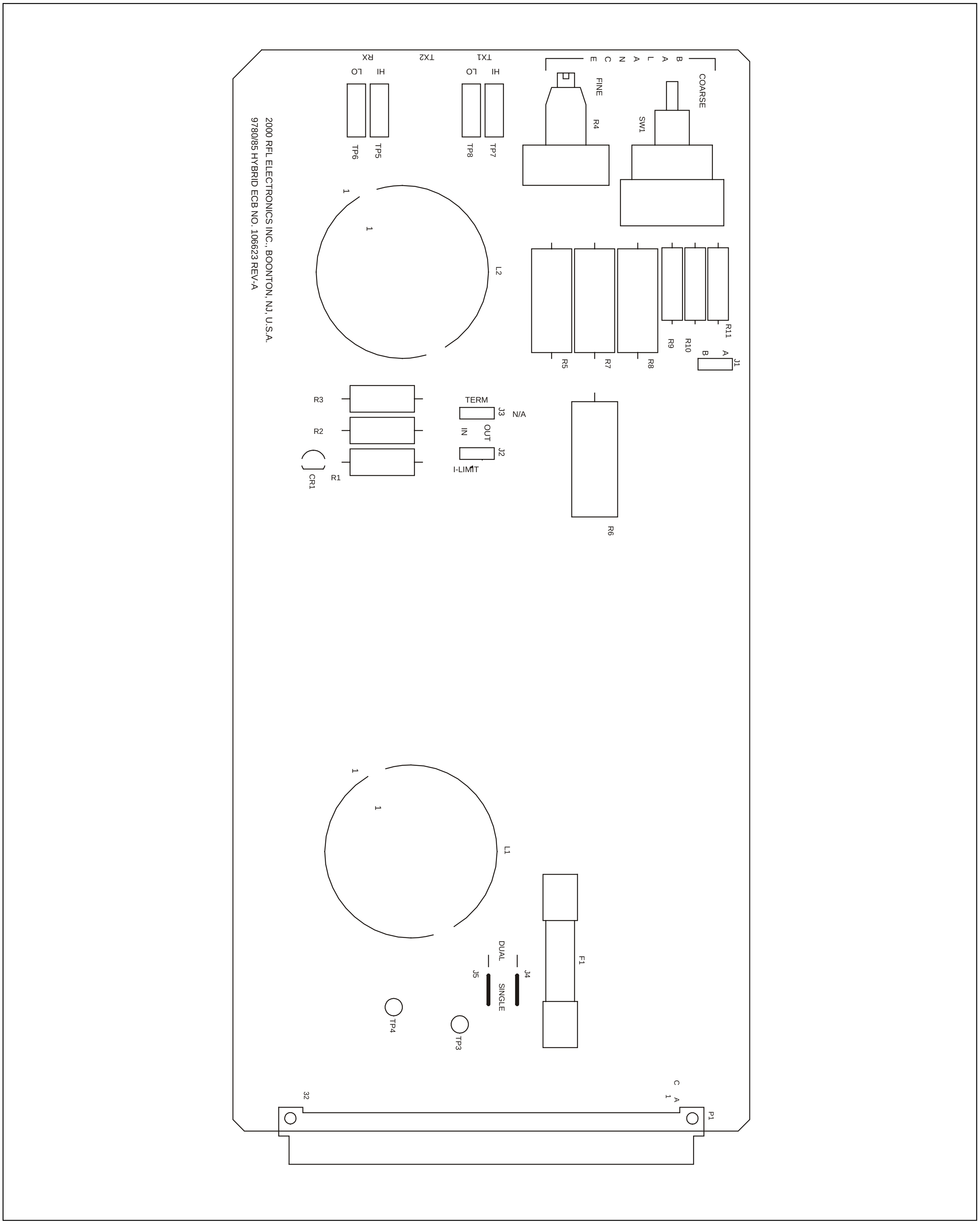

Figure 18-6. Component locator drawing, RFL 9780 Skewed Hybrid Module

Figure 18-7. Schematic, RFL 9780 Skewed Hybrid (Dwg. No. D-106629-A)

Please see Figure 18-7 in Section 22.

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18.4 DUAL HYBRID MODULE

The RFL 9780 Dual Hybrid Module uses four hybrid transformers to connect a transmitter and receiver to a single line tuning port. The Dual Hybrid provides a high degree of signal separation by isolating the local transmitter signal from the local received signal and preventing the input impedance of the receiver from loading the transmitter. The impedance characteristics of the three types of Dual Hybrid modules is shown in the table below.

Assembly Number	Receive Port	Send Port 1	Send Port 2	Line Output Port
106620-1	50 Ohms	50 Ohms	50 Ohms	50 Ohms
106620-2	50 Ohms	50 Ohms	50 Ohms	75 Ohms
106620-3	75 Ohms	50 Ohms	50 Ohms	75 Ohms

18.4.1 SPECIFICATIONS

As of the date this manual was published, the following specifications apply to all RFL 9780 Dual Hybrid Modules, except where indicated. Because all RFL products undergo constant refinement and improvement, these specifications are subject to change without notice.

Insertion Loss (60 to 500 kHz):
Transmitting: Approximately 3.8 dB from either input port to line output port.
Receiving: Approximately 12.5 dB.

Transhybrid Loss (60 to 500 kHz):
Greater than 40 dB when operating with the specified termination impedance.

Internal Balance Range:
0.5 to 1.95 times the specified two-wire impedance.

Power Capacity:
10 Watts rms.

Two-Wire Line Impedance:
106620-1: 50 Ohms.
106620-2: 75 Ohms.
106620-3: 75 Ohms.

Second Harmonic Distortion:
At least 80 dB below the fundamental frequency.

Third Order Intermodulation Products:
At least 60 dB below the fundamental frequency.

18.4.2 THEORY OF OPERATION

For this discussion, refer to the schematic diagram in Figure 18-10.

The RFL 9780 Dual Hybrid Module uses four hybrid transformers to couple signals between a transmitter, a receiver, and a line tuning unit. It provides impedance matching and signal separation, and prevents mutual loading and interference. Signals can be accepted from amplifiers with a source impedance of 50 Ohms with up to 10 Watts of output power.

The combined transmitted and received signal passes through a hybrid formed from transformers L1 and L2. These transformers each have two secondaries, interconnected so that the first secondary of one transformer is in series with the second secondary of the other. One set of interconnected secondaries is connected to the line tuning unit through edge connector A24/C24 (high) and A25/C25 (low). This allows both the transmitters and the receiver to be coupled to the line tuning unit. The other set of secondaries is connected across the internal balancing network formed by resistors R4 through R11. The coarse balance switch SW1 and fine balance potentiometer R4 can be adjusted to vary the resistance across the transformer secondaries, which determines the amount of transhybrid loss. If additional transhybrid loss is required, the internal balancing network can be disabled by placing jumper J1 in the “B” position and placing an external network across edge connector terminals A18/C18 and A19/C19.

The combined transmitter output is connected across the primary of L1, and the receiver input is connected across the primary of L2. Combined output signals are coupled through L1 to the line tuning unit, and incoming signals detected by the line tuning unit are coupled through L2 to the receiver. Transmitted signals are attenuated by about 3.8 dB total as they pass through the Dual Hybrid module, and received signals are attenuated by about 12.5 dB. Because both the received signal and its noise content are attenuated equally, signal-to-noise ratios are unaffected.

The transmitted signals pass through a transformer hybrid formed from transformers L3 and L4. These transformers each have two secondaries, interconnected so that the first secondary of one is in series with the the secondary of the other. One set of interconnected secondaries is the combined transmitted signal. The other set of secondaries is connected across balancing resistors R15/R16 which determine the amount of isolation between four-wire ports.

18.4.3 CONTROLS AND INDICATORS

Figure 18-8 shows the location of all controls and indicators on the Dual Hybrid module. These controls and indicators are described in Table 18-5. Only TP5-10, SW1 and R4 are accessible with the Dual Hybrid Module installed in the chassis. All others are accessible when the module is removed from the chassis or is on a card extender.

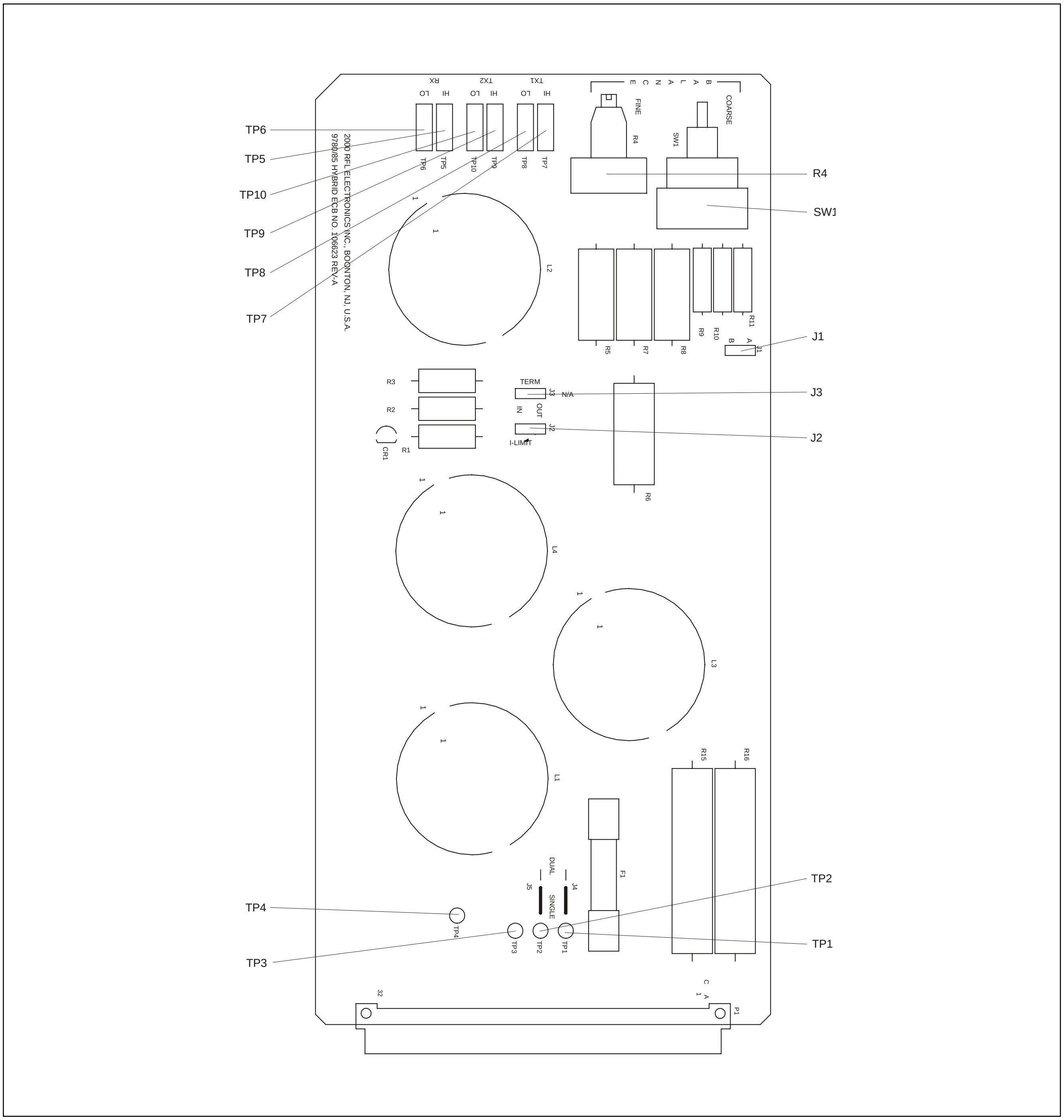

Figure 18-8. Controls and indicators, RFL 9780 Dual Hybrid Module

Table 18-5. Controls and indicators, RFL 9780 Dual Hybrid Module

Component Designator	Name/Description	Function
J1	Jumper	Selects internal or external balancing network (A = internal, B = external)
J2	Jumper	Enables the protection circuit with current limiting. The “IN” position enables current limiting. The “OUT” position disables current limiting.
J3	Jumper	Enables 50 Ohm termination. The “IN” position enables the termination. The “OUT” position disables the termination.
J4	Jumper	Hardwired for dual hybrid
J5	Jumper	Hardwired for dual hybrid
SW1	Switch	Coarse adjustment for balancing network
R4	Potentiometer	Fine adjustment for balancing network
TP1	Test point	Combined Send High (orange)
TP2	Test point	Combined Send Low (orange)
TP3	Test point	Line High (orange)
TP4	Test point	Line Low (orange)
TP5	Test point	Receive High (green)
TP6	Test point	Receive Low (yellow)
TP7	Test point	Transmit CH1 High (red)
TP8	Test point	Transmit CH1 Low (white)
TP9	Test point	Transmit CH2 High (green)
TP10	Test point	Transmit CH2 Low (yellow)

18.4.3.1 SELECTING THE BALANCING NETWORK

Jumper J1 is used to select an internal (resistive) balancing impedance or an external, user supplied, balancing impedance. Placing the jumper in position A selects the internal impedance. Placing the jumper in position B selects the external impedance. The internal impedance has a course adjustment using SW1 and a fine adjustment using potentiometer R4.

18.4.3.2 SELECTING RECEIVE PORT PROTECTION AND TERMINATION

The receive port of the hybrid contains protection circuitry for the receiver's front-end, and line termination resistance. These features are similar to those used in the RF Line I/O, and may be individually selected by using jumpers J2 and J3 as described in Table 18-5. Transient suppressor CR1 limits the voltage to the receiver and resistor R1 limits the current. Jumper J2 is used to bypass R1 when current limiting is not desired. J3 is used to enable the 50 Ohm termination resistance. The power dissipated by the termination should be limited to 1W.

The protection circuit should be placed as close as possible to the receiver and the termination should be placed at the end of the signal path. In a chassis with a single rear UHF connector, the termination and protection should be enabled ("IN") on the hybrid. The received signal is then wired directly to the receiver circuits.

If the received signal is sent to a UHF connector on the line I/O (e.g. to go to another receiver), both the termination and protection should be omitted from the hybrid ("OUT"). The received signal out of the hybrid is sent to the line I/O's UHF connector. Following the connector is the termination resistor. If this is the last, or only receiver using this signal, the termination on the I/O should be enabled. The protection circuit is always enabled on the I/O when connected to the local receiver, to protect the local receiver. This configuration protects the receiver from line disturbances passed through the hybrid and also protects against any transients applied to the UHF connector.

The termination must never follow any current limit resistance. The signal should be wired directly from the protection circuit to the receiver, and each receiver should have protection.

Table 18-6. Replaceable parts, RFL 9780 Dual Hybrid Module
Assembly No. 106620-1-, -2, and -3

Circuit Symbol (Figs. 18-9 & 18-10)	**Description**	**Part Number**
	MISCELLANEOUS COMPONENTS	
CR1	Suppressor, transient, bidirectional, 75V	101473
F1	Fuse, SLO-BLO, 10A, 32V, 3AG	10758
J1-J3	Connector, header, single, 3CKT	32802 3
L1	106620-1: Transformer, hybrid, skewed, 50 ohm, XMIT	55766
	106620-2: Transformer, hybrid, skewed, 50 ohm, XMIT	55865
	106620-3: Transformer, hybrid, skewed, 50 ohm, XMIT	55865
L2	106620-1: Transformer, hybrid, skewed, 50 ohm, XMIT	55766
	106620-2: Transformer, hybrid, skewed, 50 ohm, XMIT	55865
	106620-3: Transformer, hybrid, skewed, 75 ohm, REC	55866
L3, 4	Transformer, hybrid, 50 ohm, XMIT	55768
P1	Connector, JK, male, 64 contact, DIN	98457
R1-3	Resistor, fixed composition, 100Ω, 5%, 1W	1009 182
R4	Resistor, metal film, variable, 100Ω, 10%, 2W	44356
R5	Resistor, wirewound, 50Ω, 5%, 2.5W	1100 747
R6	Resistor, wirewound, 50Ω, 5%, 5W	1100 748
R7, 8	Resistor, wirewound, 12Ω, 5%, 2.5W	1100 745
R9-11	Resistor, metal film, precision, 12.1Ω, 1%, 1/2W	1510 2109
R15, 16	Resistor, wirewound, 100Ω, 5%, 10W	1100 795
SW1	Switch, rotary, 1 deck, 6 position	44357
TP1-4	Test point, orange	38441 3
TP5, 9	Test point, green	38116 5
TP6, 10	Test point terminal, yellow	38116 8
TP7	Test point, red	38116 2
TP8	Test point, white	38116 1

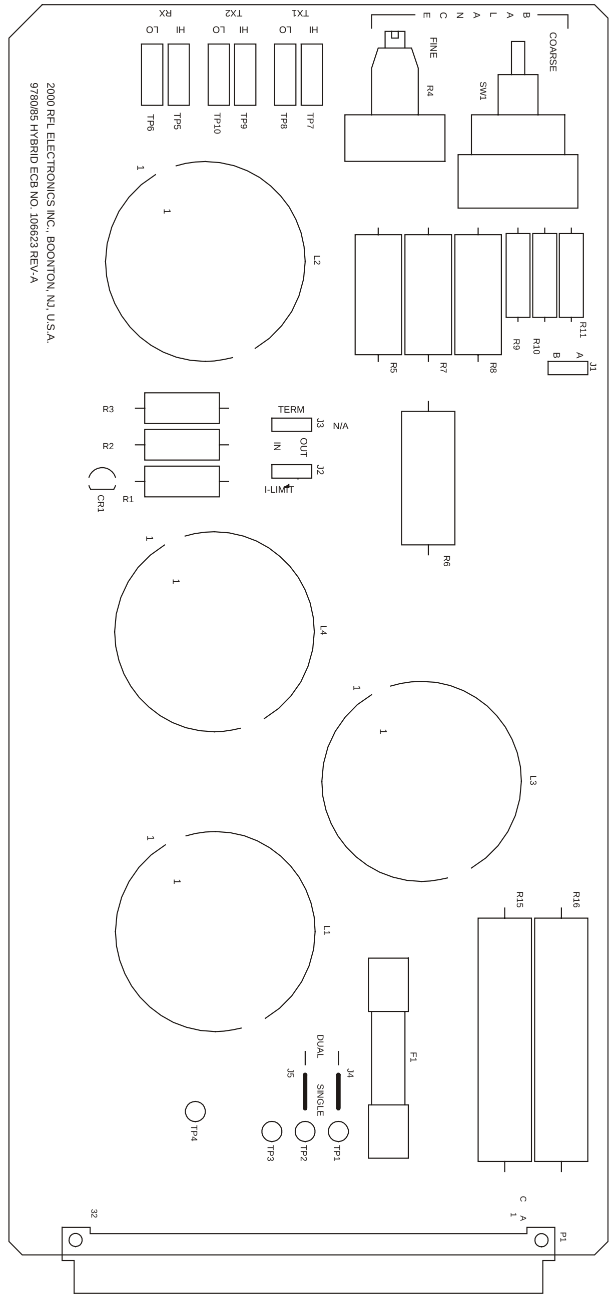

Figure 18-9. Component locator drawing, RFL 9780 Dual Hybrid Module

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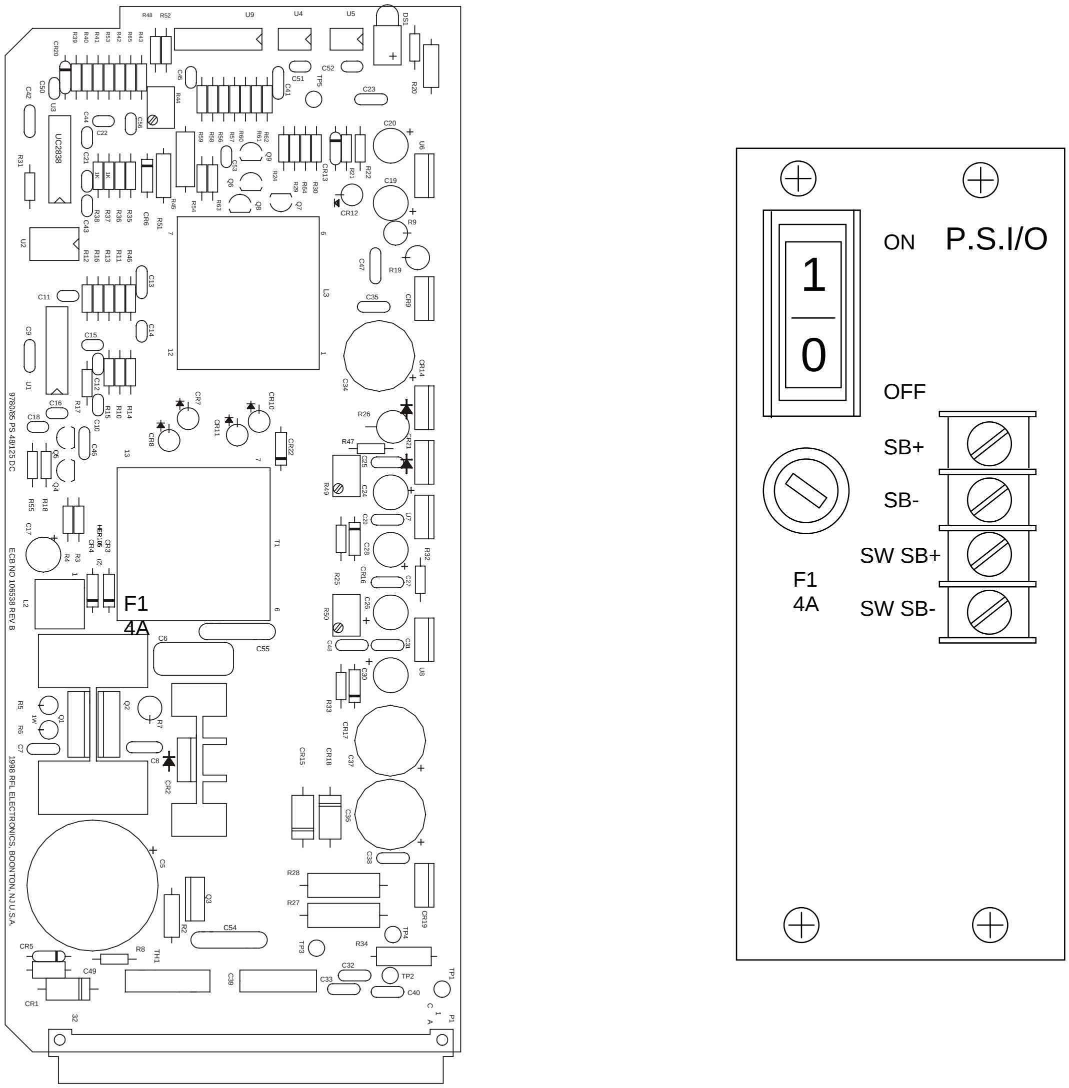
Figure 18-10. Schematic, RFL 9780 Dual Hybrid (Dwg. No. D-106624-A)

Please see Figure 18-10 in Section 22.

SECTION 19. POWER SUPPLY MODULE & POWER SUPPLY I/O MODULE



a. Typical RFL 9780 Power supply module

b. Typical RFL 9780 Power supply I/O module

Figure 19-1. RFL 9780 Power Supply Module

19.1 INTRODUCTION

A 50-Watt Power Supply Module (Figure 19-1a) is used to supply regulated dc power to the RFL 9780 System. The power supply provides four regulated dc outputs: +5, +15, -15 and +12 volts. All outputs have overvoltage protection and short circuit protection. In addition, the entire power supply will shut down if the ambient temperature exceeds a pre-established limit. A Power Supply I/O Module (Figure 19-1b) is used to provide input power connections to the RFL 9780 chassis, and contains the power supply ON/OFF switch and an input fuse. Refer to paragraph 19.2 for more information on the RFL 9780 power supply module. Refer to paragraph 19.3 for more information on the RFL 9780 power supply I/O module.

19.2 POWER SUPPLY MODULE

Two different power supply modules are available for use with the RFL 9780, which provide the following choice of dc input voltages: 38Vdc to 150 Vdc, or 250Vdc. Table 19-1 summarizes the characteristics of the two models. Assembly numbers appear on the power supply circuit board assembly.

Table 19-1. Characteristics of RFL 9780 Power supply module

Assembly Number	Input Voltage Range
106535-1	38Vdc to 150Vdc
106535-2	200Vdc to 300Vdc

19.2.1 SPECIFICATIONS

As of the date this manual was published, the following specifications apply to all RFL 9780 power supply modules, except where indicated. Because RFL products undergo constant refinement and improvement, these specifications are subject to change without notice.

Input Voltage:

106535-1: 38 to 150 Vdc
106535-2: 200 to 300 Vdc

Input Current with 50W Load:

1.50 A @ 48 Vdc Line
0.60 A @ 125 Vdc Line
0.35 A @ 250 Vdc Line

Inrush Current with 50W Load:

20 A@ 48 Vdc Line
40 A @ 125 Vdc Line
35 A @ 250 Vdc Line

Output Voltage Tolerances (Under all line and load conditions)**:**

+5V nominal	4.90V to 5.10V @ +25^{o}C 4.87V to 5.25V @ -20^{o}C to +65^{o}C
+/- 15V nominal	14.75V to 15.25V @ +25^{o}C 14.75V to 15.25V @ -20^{o}C to +65^{o}C
+12 V nominal	11.5V to 12.5V @ -20^{o}C to +65^{o}C

Maximum Output Currents:

+5V Output	500 mA
+15V Output	1.35 A
-15V Output	1.00 A
+12V Output	250 mA

Output Over Current Protection:

+5.00Vdc	1.0 Amp foldback to 50% Max Load Current (500mA)
+/-15Vdc	Internal regulator @ 1.8 Amp foldback/Thermal
+12 Vdc	Internal regulator @ 1.8 Amp foldback/Thermal

Output Ripple Voltage: Measured differentially with full load @ 150Vdc input

+5.00Vdc	<200 mv pp
+15.0 Vdc	<1200 mv pp
-15.0 Vdc	<1200 mv pp
+12.0Vdc	<1200 mv pp

Input Overvoltage Protection: 184 Vdc minimum (38 Vdc to 150 Vdc supply)
388 Vdc minimum (200 Vdc to 300 Vdc supply)

Isolation: As specified in ANSI/IEEE C37.90

3000Vdc	Input to Output
3000Vdc	Input to Chassis

Surge Withstand Requirements: As specified in ANSI/IEEE C37.90.1

The Power Supply input passes Oscillatory and Fast Transient SWC tests with no impact on power supply outputs.

Environmental Specifications:

Temp Range	-20^{o}C to +60^{o}C Still Air
Humidity	95% @ 40^{o}C

Indicators:

DS1 - Normal	Green

19.2.2 THEORY OF OPERATION

The RFL 9780, 50 Watt power supply is a multiple output, forward, dc to dc converter. The 106535-1 power supply operates from a 38 to 150 Vdc input, and the 106535-2 power supply operates from a 200 to 300 Vdc input. Each of these supplies has four outputs: +5 Vdc at 500 mAdc, +15 Vdc at 1.35 Adc, -15 Vdc at –1.00 Adc, and +12 Vdc at 250 mAdc. All of the outputs are connected to a common ground. All DC outputs are constantly monitored. Should any output exceed lower limits Power Fault Monitor (U9), will originate an under voltage signal. This signal will shut down the +12V relay voltage to prevent any possible false operation due to power supply failure. All outputs contain or'ing diodes for paralleling a second supply for redundancy.

Input power is fed through terminals A23-25, C23-25 and A30-32, C30-32. An external alarm and interface board provides fusing and EMI suppression.

Diode CR1 protects the power supply from reversal of input voltage. Under such conditions, a fuse on the power supply I/O board clears. Inrush limiter TH1 allows charging of capacitor C5 from a stiff dc source without excessive input currents.

The forward converter is designed around PWM integrated circuit U1. The device has an internal clock set by resistor R12 and capacitor C11. Power for the device is initially provided by a series regulator consisting of MOSFET Q3, resistors R2 and R8, and diode CR5. With power applied and internal clock set, pin 11 of U1 goes high causing MOSFET's Q1, Q2, and Q5 to conduct. This causes the dc bus voltage to be applied across windings 1 and 2 of transformer T1 and conduction of output diodes CR7, CR9, CR11, and CR14. Upon conduction of these diodes, power flows from the input to the output of the power supply. The dc bus current, which flows through MOSFET's Q1 and Q2 is detected across resistors R5 and R6 and is monitored at pins 3 and 4 of U1. When the peak increases to a level set at pin 7 of U1, pin 11 of U1 is set low causing transistor Q4 to conduct. This drives MOSFET's Q1 and Q2 to an off state. Transformer T1 voltage reverses and diodes CR8, CR9 (opposite device), CR10, CR14 (opposite device) conduct and circulate current stored in inductor L3. Inductor L3 and capacitors C19, C24, C26, and C34 form a low pass filter producing a dc that is the half cycle average voltage produced by transformer T1. Inductor L3 is a multi-winding inductor that is matched to transformer T1.

The auxiliary winding of transformer T1, terminals 5 and 6, provides a source of power for the supply's control circuit. After the first few cycles, the voltage at capacitor C17 increase rendering MOSFET Q3 non-conductive.

The secondary auxiliary winding of transformer T1, terminals 3 and 4, capacitor C6, and diode CR2, is a clamp to limit voltage transients across MOSFET's Q1 and Q2.

The 5 Vdc output is unique because its level is monitored across diode CR6, resistors R42 and R43, and potentiometer R44. The wiper arm of potentiometer R44 is fed to pin 6 of dual error amplifier U3 and is compared against an internal reference set at pin 7 of U3. If the 5Vdc output is greater than the reference, pin 14 of U3 goes high causing optical isolator U2 to conduct. This reduces the voltage applied to pin 5 of integrated circuit U1, reduces the peak current through transformer T1, and lowers the output voltage. The negative feedback path is compensated with resistor R41 and C44.

To protect the 5 Vdc output from excessive output currents, the voltage across shunt R26 is monitored between pins 2 and 3 of U3. Like the voltage feedback path, exceeding limits, established by resistors R35 and R36, causes pin 14 to go high and reduces the output voltage.

Integrated circuits U6, U7, and U8 are series regulators which provide post regulation for the secondary outputs. Post regulation is required to meet the voltage regulation requirements of the supply. Feedback for regulator U7 is provided by resistors R47, R25, potentiometer R49, and CR16. Feedback paths for the other regulators are similarly structured.

All outputs have or'ing diodes. These diodes; CR12, CR15, CR18, CR19, allow two supplies to be connected in parallel. Feedback signals for all outputs are taken before the or'ing diodes. The temperature voltage sensitivities introduced by the or'ing diodes are compensated with diodes CR13, CR16, CR17, and CR6.

19.2.3 CONTROLS AND INDICATORS

Figure 19-2 shows the location of all controls and indicators on the RFL 9780 Power supply module. These controls and indicators are described in Table 19-2. DS1 is visible with the RFL 9780 Power supply module installed in the chassis. All other controls and test points are only accessible when the module is removed from the chassis or is on a card extender.

Table 19-2. Controls and indicators, RFL 9780 power supply module

Component Designator	Name/ Description	Function
DS1	LED indicator (green)	ON/OFF power indicator
R44	Potentiometer	+5 Vdc adjust (for factory use only)
R49	Potentiometer	+15 Vdc adjust (for factory use only)
R50	Potentiometer	-15 Vdc adjust (for factory use only)
TP1	Test point	Power supply common
TP2	Test point	+5 Vdc
TP3	Test point	+15 Vdc
TP4	Test point	-15 Vdc
TP5	Test point	+12 Vdc

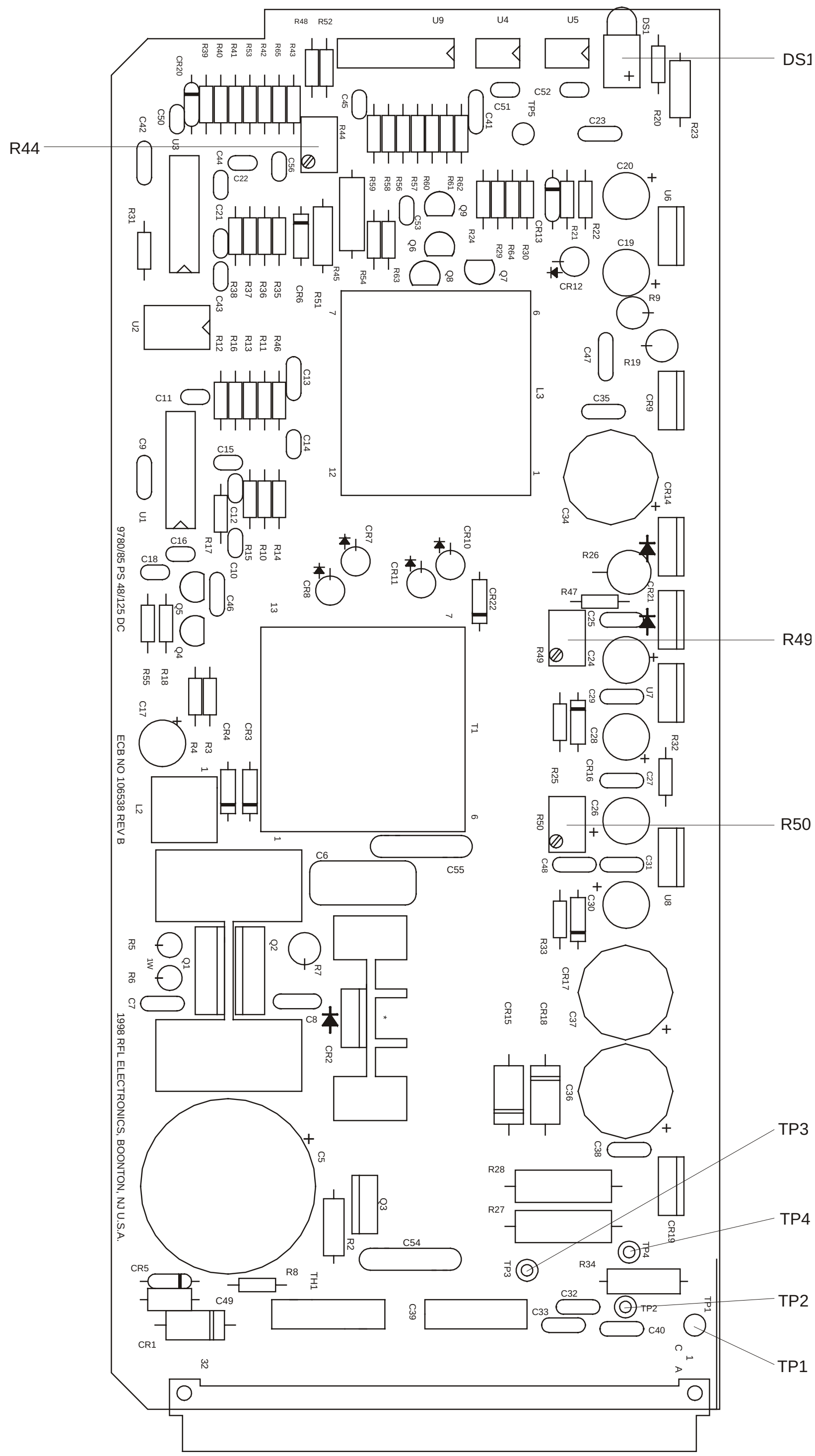


Figure 19-2. Controls and indicators, and component locator drawing, for FL 9780 power supply module (Assembly No. 106535-1)

Table 19-3. Replaceable parts, RFL 9780 Power Supply module
Assembly No. 106535-1

Circuit Symbol (Figs. 19-2 & 19-3)	Description	Part Number
	CAPACITORS	
C5	Capacitor, electrolytic, 680µF, 20%, 200V	1007 1813
C6	Capacitor, metalized polyester, 1.0µF, 10%, 250Vdc	1007 1809
C7, 9, 13, 23, 25, 27, 29, 31, 32, 33, 35, 38, 40, 41, 46, 48	Capacitor, ceramic, 1µF, 10%, 50V	1001 6
C8, 47	Capacitor, ceramic disc, 470pF, 10%, 1000V	1007 378
C10, 16, 44, 45, 50	Capacitor, ceramic dip, 0.01µF, 10%, 50V	1007 1667
C11	Capacitor, ceramic, 0.0047µF, 10%, 50V	1007 1843
C12	Capacitor, ceramic, 0.022µF, 10%, 100V	1007 1840
C14	Capacitor, ceramic, 0.015µF, 10%, 100V	1007 1839
C15	Capacitor, ceramic, 0.047µF, 10%, 100V	1007 1842
C17, 19, 20, 24, 26, 28, 30	Capacitor, electrolytic, 220µF, 20%, 35V	1007 1817
C18	Capacitor, ceramic dip, 0.033µF, 10%, 50V	1007 1453
C21, 22, 51, 52, 53, 56	Capacitor, ceramic dip, 0.01µF, 10%, 100V	1007 1390
C34, 36, 37	Capacitor, electrolytic, 2200µF, 20%, 10V	1007 1815
C39	Capacitor, supr x2, 0.01µF, 20%, 250Vac	1007 1810
C49	Capacitor, ceramic, 0.1µF, 10%, 100V	0130 11041
C54, 55	Capacitor, ceramic disc, 470pF, 20%, 3kV	1007 1849
C58	Capacitor, ceramic, 0.0047µF, 5%, 50V	0125 54725
C59	Capacitor, ceramic, 0.1µF, 20%, 50V	1007 1366
	RESISTORS	
R2	Resistor, metal film, axial, 1K, 1%, 1/2W	0410 2288
R3, 4	Resistor, fixed composition, 10Ω, 5%, 1/4W	1009 823
R5, 6	Resistor, wire wound, 0.10Ω, 1%, 1W	1100 801
R7	Resistor, metal oxide, 10Ω, 5%, 2W	1510 2363
R8	Resistor, metal film, axial, 221K, 1%, 1/4W	0410 1513
R9, 19	Resistor, metal oxide, 100Ω, 5%, 2W	1510 2365
R10	Resistor, metal film, axial, 681Ω, 1%, 1/4W	0410 1272
R11, 13, 14, 16	Resistor, metal film, axial, 10KΩ, 1%, 1/4W	0410 1384
R12	Resistor, metal film, axial, 4.22K, 1%, 1/4W	0410 1348
R15, 37, 39, 42, 46	Resistor, metal film, axial, 1KΩ, 1%, 1/4W	0410 1288
R17, 40	Resistor, metal film, axial, 100Ω, 1%, 1/4W	0410 1192
R18	Resistor, metal film, axial, 82.5Ω, 1%, 1/4W	0410 1184

Table 19-3. Replaceable parts, RFL 9780 Power Supply module (continued)

Circuit Symbol (Figs. 19-2 & 19-3)	Description	Part Number
	RESISTORS - continued	
R20	Resistor, metal film, axial, 332Ω, 1%, 1/4W	0410 1242
R21, 25, 33	Resistor, metal film, axial, 1.4K, 1%, 1/4W	0410 1302
R22	Resistor, metal film, axial, 154Ω, 1%, 1/4W	0410 1210
R23	Resistor, metal film, axial, 449Ω, 1%, 1/4W	0410 2259
R24, 29, 30, 36, 54, 63, 64	Resistor, metal film, axial, 4.99K, 1%, 1/4W	0410 1355
R26	Resistor, wirewound, 0.01Ω, 1%, 3W	1100 840
R27, 28	Resistor, metal oxide, 1K, 5%, 2W	1510 2368
R31, 65	Resistor, metal film, axial, 274Ω, 1%, 1/4W	0410 1234
R32, 47	Resistor, metal film, axial, 118Ω, 1%, 1/4W	0410 1199
R34, 45	Resistor, metal oxide, 56Ω, 5%, 1W	1510 2371
R35	Resistor, metal film, axial, 23.7Ω, 1%, 1/4W	0410 1132
R41	Resistor, metal film, axial, 4.75K, 1%, 1/4W	0410 1353
R43	Resistor, metal film, axial, 1.07K, 1%, 1/4W	0410 1291
R44	Resistor, metal film, variable, 100Ω, 10%, 1/2W	96706
R48	Resistor, metal film, axial, 499Ω, 1%, 1/4W	0410 1259
R49, 50	Resistor, metal film, variable, 20Ω, 20%, 1/2W	105412
R51	Resistor, metal film, axial, 100Ω, 1%, 1/4W	0410 2192
R52	Resistor, metal film, axial, 2.74K, 1%, 1/4W	0410 1330
R53	Resistor, metal film, axial, 475Ω, 1%, 1/4W	0410 1257
R55	Resistor, fixed composition, 22Ω, 5%, 1/4W	1009 613
R56	Resistor, metal film, axial, 7.68K, 1%, 1/4W	0410 1373
R57, 59, 61	Resistor, metal film, axial, 2.49K, 1%, 1/4W	0410 1326
R58	Resistor, metal film, axial, 10.5K, 1%, 1/4W	0410 1386
R60	Resistor, metal film, axial, 13KΩ, 1%, 1/4W	0410 1395
R62	Resistor, metal film, precision, 10Ω, 1%, 1/4W	1510 1015
R66	Resistor, metal film, axial, 2K, 1%, 1/4W	0410 1317
	SEMICONDUCTORS	
CR1	Diode, rectifier, silicon, 3A, 1N5406	101716
CR2	Diode, rectifier, ultrafast, MUR8100E	105011
CR3, 4	Doide, fast recovery, 1A, 400V	103484
CR5	Diode, Zener, 13V, 5%, 1N964B	34652
CR6, 16,17	Diode, Schottky, 1A, 40V, 1N5819	103382
CR7, 8, 10, 11	Diode, rectifier, ultrafast, MUR420	103357

Table 19-3. Replaceable parts, RFL 9780 Power Supply module (continued)

Circuit Symbol (Fig. 19-2 & 19-3)	Description	Part Number
	SEMICONDUCTORS - continued	
CR9	Diode, rectifier, ultrafast	105416
CR13, 20	Diode, general purpose, 1N4148	101778
CR14, 21	Diode, rectifier, ultrafast, 8A, 400V	101464
CR15, 18	Diode, rectifier, Schottky, 5A, 40V	105413
CR19	Diode, rectifier, Schottky, 30A, 45V	105417
CR22	Diode, Schottky barrier, SB160	96365
Q1, 2	Transistor, MOSFET, N-CH, IRFP360	0715 38
Q3	Transistor, FET, N-CH, IRF610	0715 39
Q4, 7	Transistor, silicon, PNP	103384
Q5	Transistor, silicon, NPN	105421
Q6, 9	Transistor, silicon, NPN, 2N2222A	37445
Q8	Transistor, silicon, PNP, 2N2907A	37439
U1	Integrated circuit, linear, current mode, PWM	0620 326
U2	Optocoupler, HCNW136	105041
U3	Assembly, linear mag amp	104530
U4, 5	Optodevice, photo, ISO, 4N35	47104
U6, 7	Integrated circuit, linear voltage regulator, positive, 3-terminal	0620 207
U8	Integrated circuit, linear voltage regulator, negative, 3-terminal	0620 333
U9	Integrated circuit, linear, quad, fault monitor	0620 325
	MISCELLANEOUS COMPONENTS	
DS1	Optodevice, single LED, green	99799
L2	Choke, bias, 20 mH, 50 mAdc	105428
L3	Choke, multi-output, custom	101477
P1	Connector, JK male, 64 contact, DIN	98457
T1	Transformer, FWD, 38-150 Vdc	106537
TH1	Thermistor, NTC, 2.5Ω @ 25°C	103370
TP1-5	Test point terminal, orange	98441 3

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Figure 19-3. Schematic, RFL 9780 Power Supply 48/125V (Dwg. No. D-106539-G)

Please see Figure 19-3 in Section 22.

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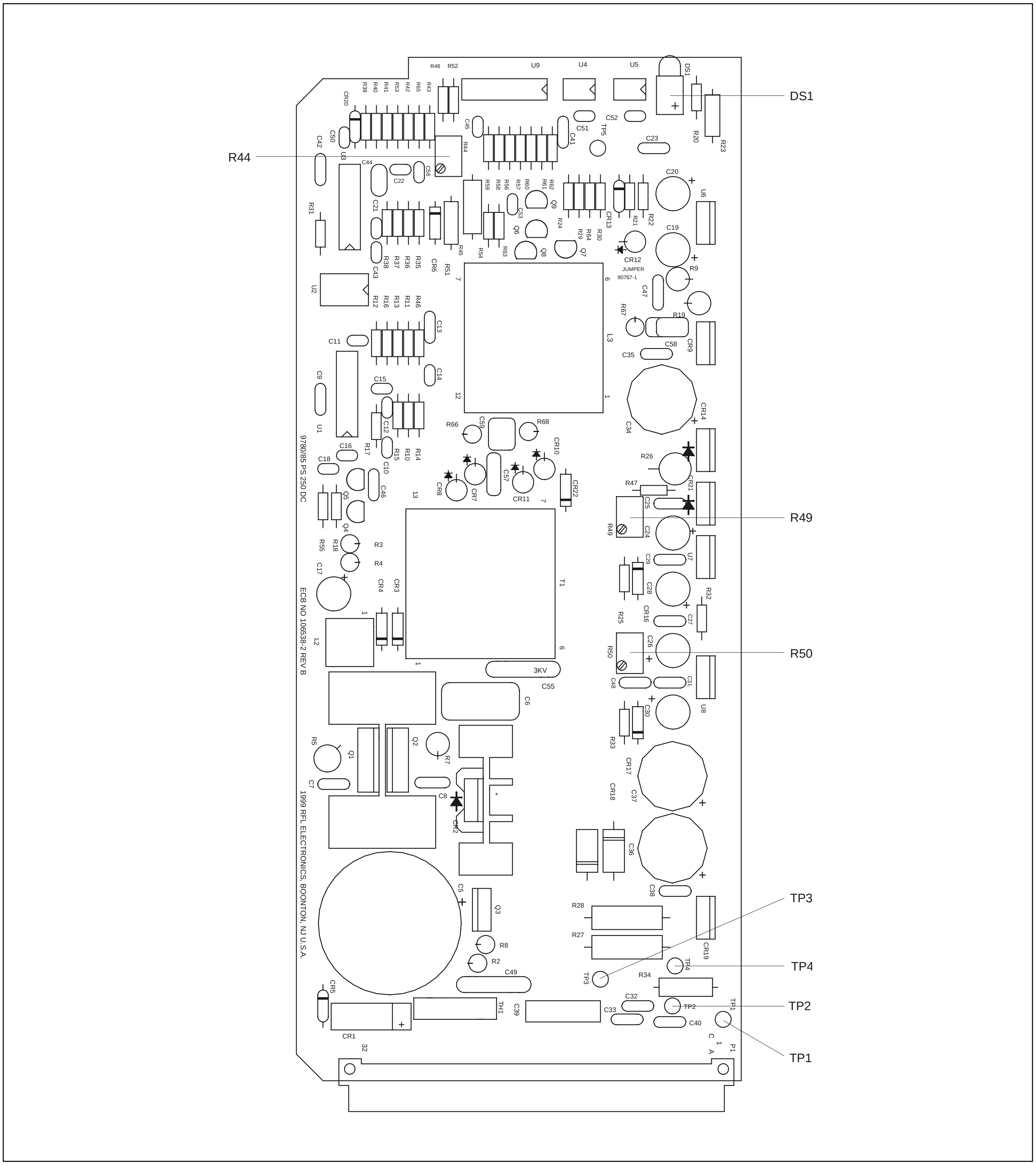

Figure 19-4. Controls and indicators and component locator drawing, RFL 9780 Power Supply Module (Assembly No. 106535-2)

Table 19-4. Replaceable parts, RFL 9780 Power Supply module, Assembly No. 106535-2

Circuit Symbol (Figs. 19-4 & 19-5)	Description	Part Number
	CAPACITORS	
C5	Capacitor, electrolytic, 330μF, 20%, 400V	1007 1846
C6	Capacitor, metalized polyester, 0.22μF, 10%, 630Vdc	1007 1837
C7, 9, 13, 23, 25, 27, 29, 31, 32, 33, 35, 38, 40, 41, 42, 46, 48	Capacitor, ceramic, 1μF, 10%, 50V	1001 6
C8, 47	Capacitor, ceramic disc, 100pF, 10%, 1000V	1007 1845
C10, 16, 43, 45, 50, 60	Capacitor, ceramic dip, 0.01μF, 10%, 50V	1007 1667
C11	Capacitor, ceramic dip, 0.0047μF, 10%, 50V	1007 1843
C12	Capacitor, ceramic, 0.022μF, 10%, 100V	1007 1840
C14	Capacitor, ceramic, 0.015μF, 10%, 100V	1007 1839
C15	Capacitor, ceramic, 0.047μF, 10%, 100V	1007 1842
C17, 19, 20, 24, 26, 28, 30	Capacitor, electrolytic, 220μF, 20%, 35V	1007 1817
C18	Capacitor, ceramic dip, 0.033μF, 10%, 50V	1007 1453
C21, 22, 51, 52, 53, 56	Capacitor, ceramic dip, 0.01μF, 10%, 100V	1007 1390
C34, 36, 37	Capacitor, electrolytic, 2200μF, 20%, 10V	1007 1815
C39	Capacitor, supr x2, 0.01μF, 20%, 250Vac	1007 1810
C44	Capacitor, ceramic, 0.47μF, 10%, 50V	1007 1833
C49, 55	Capacitor, ceramic disc, 470pF, 20%, 3kV	1007 1849
C57	Capacitor, ceramic disc, 56pF, 10%, 1kV	1007 1844
C58	Capacitor, polypropylene, 470pF, 5%, 400V	1007 1847
C59	Capacitor, polypropylene, 0.0047μF, 5%, 400V	1007 1848
C61	Capacitor, ceramic, 0.0047μF, 5%, 50V	0125 54725
C62	Capacitor, ceramic, 0.1μF, 20%, 50V	1007 1366
	RESISTORS	
R2	Resistor, metal film, axial, 1K, 1%, 1/2W	0410 2288
R3, 4	Resistor, fixed composition, 5.1Ω, 5%, 1/2W	1009 712
R5	Resistor, wire wound, 0.4Ω, 5%, 3W	1100 841
R7	Resistor, metal oxide, 47Ω, 5%, 2W	1510 2364
R8	Resistor, metal oxide, 390K, 5%, 1W	0420 7
R9, 19	Resistor, metal oxide, 100Ω, 5%, 2W	1510 2365
R10	Resistor, metal film, axial, 681Ω, 1%, 1/4W	0410 1272
R11, 13, 14, 16	Resistor, metal film, axial, 10KΩ, 1%, 1/4W	0410 1384
R12	Resistor, metal film, axial, 4.22K, 1%, 1/4W	0410 1348
R15, 37, 38, 39, 42, 46	Resistor, metal film, axial, 1KΩ, 1%, 1/4W	0410 1288
R17, 40	Resistor, metal film, axial, 100Ω, 1%, 1/4W	0410 1192
R18	Resistor, metal film, axial, 121Ω, 1%, 1/4W	0410 1200
R20	Resistor, metal film, axial, 332Ω, 1%, 1/4W	0410 1242

Table 19-4. Replaceable parts, RFL 9780 Power Supply module (continued)

Circuit Symbol (Figs. 19-4 & 19-5)	Description	Part Number
	RESISTORS - continued	
R21, 25, 33	Resistor, metal film, axial, 1.4K, 1%, 1/4W	0410 1302
R22	Resistor, metal film, axial, 154Ω, 1%, 1/4W	0410 1210
R23	Resistor, metal film, axial, 449Ω, 1%, 1/4W	0410 2259
R24, 29, 30, 36, 54, 63, 64	Resistor, metal film, axial, 4.99K, 1%, 1/4W	0410 1355
R26	Resistor, wirewound, 0.01Ω, 1%, 3W	1100 840
R27, 28	Resistor, metal oxide, 1K, 5%, 2W	1510 2368
R31, 65	Resistor, metal film, axial, 274Ω, 1%, 1/4W	0410 1234
R32, 47	Resistor, metal film, axial, 118Ω, 1%, 1/4W	0410 1199
R34, 45	Resistor, metal oxide, 56Ω, 5%, 1W	1510 2371
R35	Resistor, metal film, axial, 23.7Ω, 1%, 1/4W	0410 1132
R41	Resistor, metal film, axial, 4.75K, 1%, 1/4W	0410 1353
R43	Resistor, metal film, axial, 1.07K, 1%, 1/4W	0410 1291
R44	Resistor, metal film, variable, 100Ω, 10%, 1/2W	96706
R48	Resistor, metal film, axial, 499Ω, 1%, 1/4W	0410 1259
R49, 50	Resistor, metal film, variable, 20Ω, 20%, 1/2W	105412
R51	Resistor, metal film, axial, 100Ω, 1%, 1/4W	0410 2192
R52	Resistor, metal film, axial, 2.74K, 1%, 1/4W	0410 1330
R53	Resistor, metal film, axial, 475Ω, 1%, 1/4W	0410 1257
R55	Resistor, fixed composition, 22Ω, 5%, 1/4W	1009 613
R56	Resistor, metal film, axial, 7.68K, 1%, 1/4W	0410 1373
R57, 59, 61	Resistor, metal film, axial, 2.49K, 1%, 1/4W	0410 1326
R58	Resistor, metal film, axial, 10.5K, 1%, 1/4W	0410 1386
R60	Resistor, metal film, axial, 13KΩ, 1%, 1/4W	0410 1395
R62	Resistor, metal film, precision, 10Ω, 1%, 1/4W	1510 1015
R66	Resistor, metal oxide, 2K, 5%, 1W	0420 6
R67	Resistor, metal oxide, 27Ω, 5%, 1W	0420 5
R68	Resistor, metal oxide, 10Ω, 5%, 1W	0420 4
R69	Resistor, metal film, axial, 2K, 1%, 1/4W	0410 1317
	SEMICONDUCTORS	
CR1	Rectifier, bridge, 1000V, 4A	105452
CR2	Diode, rectifier, ultrafast, MUR8100E	105011
CR3, 4	Doide, fast recovery, 1A, 400V	103484
CR5	Diode, Zener, 13V, 5%, 1N964B	34652
CR6, 16, 17	Diode, Schottky, 1A, 40V, 1N5819	103382
CR7, 8, 10, 11	Diode, rectifier, ultrafast, MUR420	103357

Table 19-4. Replaceable parts, RFL 9780 Power Supply module (continued)

Circuit Symbol (Fig. 19-4 & 19-5)	Description	Part Number
	SEMICONDUCTORS - continued	
CR9	Diode, rectifier, ultrafast	105416
CR13, 20	Diode, general purpose, 1N4148	101778
CR14, 21	Diode, rectifier, ultrafast, 8A, 400V	101464
CR15, 18	Diode, rectifier, Schottky, 5A, 40V	105413
CR19	Diode, rectifier, Schottky, 30A, 45V	105417
CR22	Diode, Schottky barrier, SB160	96365
Q1, 2	Transistor, MOSFET, N-CH, 1XFH13N90	0715 43
Q3	Transistor, MOSFET, N-CH, MTP6N60E	0715 42
Q4, 7	Transistor, silicon, PNP	103384
Q5	Transistor, silicon, NPN	105421
Q6, 9	Transistor, silicon, NPN, 2N2222A	37445
Q8	Transistor, silicon, PNP, 2N2907A	37439
U1	Integrated circuit, linear, current mode, PWM	0620 326
U2	Optocoupler, HCNW136	105041
U3	Integrated circuit, linear, mag amp controller	0620 370
U4, 5	Optodevice, photo, ISO, 4N35	47104
U6, 7	Integrated circuit, linear voltage regulator, positive, 3-terminal	0620 207
U8	Integrated circuit, linear voltage regulator, negative, 3-terminal	0620 333
U9	Integrated circuit, linear, quad, fault monitor	0620 325
	MISCELLANEOUS COMPONENTS	
DS1	Optodevice, single LED, green	99799
L2	Choke, bias, 20 mH, 50 mAdc	105428
L3	Choke, multi-output, custom	101477
P1	Connector, JK male, 64 contact, DIN	98457
T1	Transformer, FWD, 250 Vdc	101488
TH1	Thermistor, NTC, 10Ω @ 25^{o}C	105021
TP1-5	Test point terminal, orange	98441 3

Figure 19-5. Schematic, RFL 9780 Power Supply 250 Vdc (Dwg. No. D-106539-2-E)

Please see Figure 19-5 in Section 22.

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19.3 POWER SUPPLY I/O MODULES

The RFL 9780 Power supply I/O module is located at the rear of the 9780 chassis directly behind the power supply module. It provides input power connections to the RFL 9780 chassis, contains a power supply ON/OFF switch and has an input fuse. Four types of Power supply I/O modules are available for use with the RFL 9780 system. Table 19-5 summarizes the characteristics of the various models.

Table 19-5. Characteristics of RFL 9780 Power Supply I/O modules

Model Number	Assembly Number	Input Voltage	Application
9780 PSIO 38/150	106455-1	38 Vdc to 150 Vdc	Used with single 38-150 Vdc supply
9780 PSIO 250	106455-2	250 Vdc	Used with single 250 Vdc supply
9780 DUAL PSIO 38/150	106455-3	38 Vdc to 150 Vdc	Used with dual 38-150 Vdc supply
9780 DUAL PSIO 250	106455-4	250 Vdc	Used with dual 250 Vdc supply

19.3.1 CONTROLS AND INDICATORS FOR 106455-1 & -2 P.S. I/Os

Figure 19-6 shows the location of all controls on the RFL 9780 Single Power supply I/O module. These controls are described in Table 19-6.

Table 19-6. Controls and indicators, RFL 9780 single power supply I/O module

Component Designator	Name/ Description	Function
F1	Fuse	Power supply fuse
SW1	Switch	Power supply ON/OFF switch
TB1	Terminal Board	Input power connections

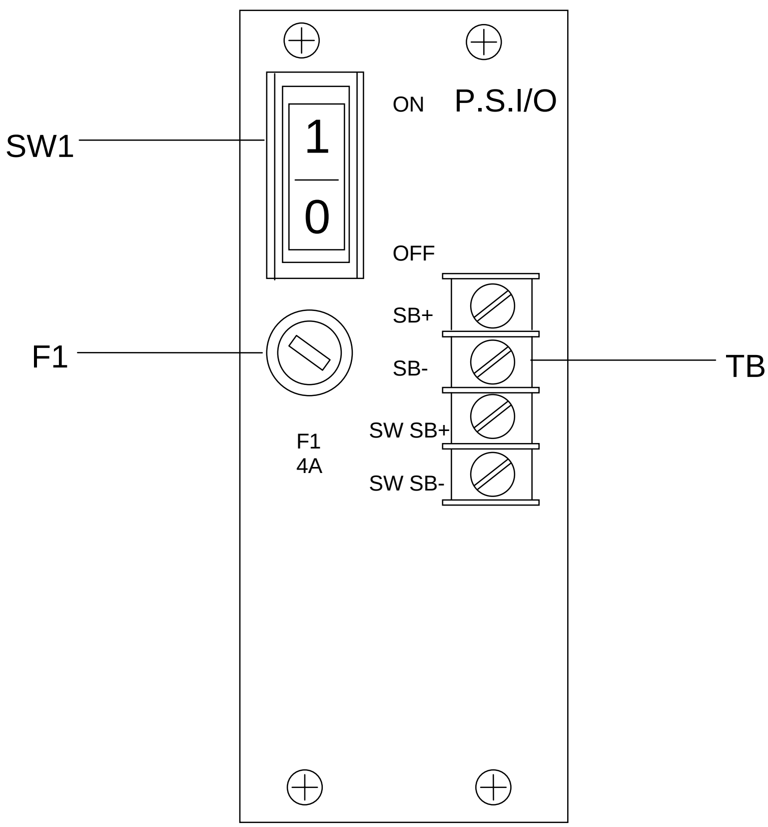

Figure 19-6. Controls and indicators, RFL 9780 single power supply I/O module

Table 19-7. Replaceable parts, RFL 9780 Single Power Supply I/O module
Assembly No. 106455-1 and -2.

Circuit Symbol (Figs. 19-7 & 19-8)	Description	Part Number
C1, 2	Capacitor, metalized polypropylene, 0.22µF, 20%, 275V	1007 1808
C3, 4	Capacitor, ceramic disc, 0.01µF	1007 1788
C5	Capacitor, electrolytic, 0.47µF, 20%, 350V	1007 1854
F1	Fuse, 4A, 250V, slo-blo	301122
L1	Choke, common mode, 3mH, 1.8Adc	105426
L2	Inductor, 120µH, 10%, 2A	101483
P1	Connector, plug, female, 64 cont, DIN	99134
R1	Resistor, carbon film, 330KΩ, 5%, 1/2W	0500 6
S1	Switch, rocker, SPST	30441 1
TB1	Terminal block	101697 4
VR1	Suppressor, varistor	
C1, 2	106455-1: V130LC20B	41079
C3, 4	106455-2: V275LC40B	105447

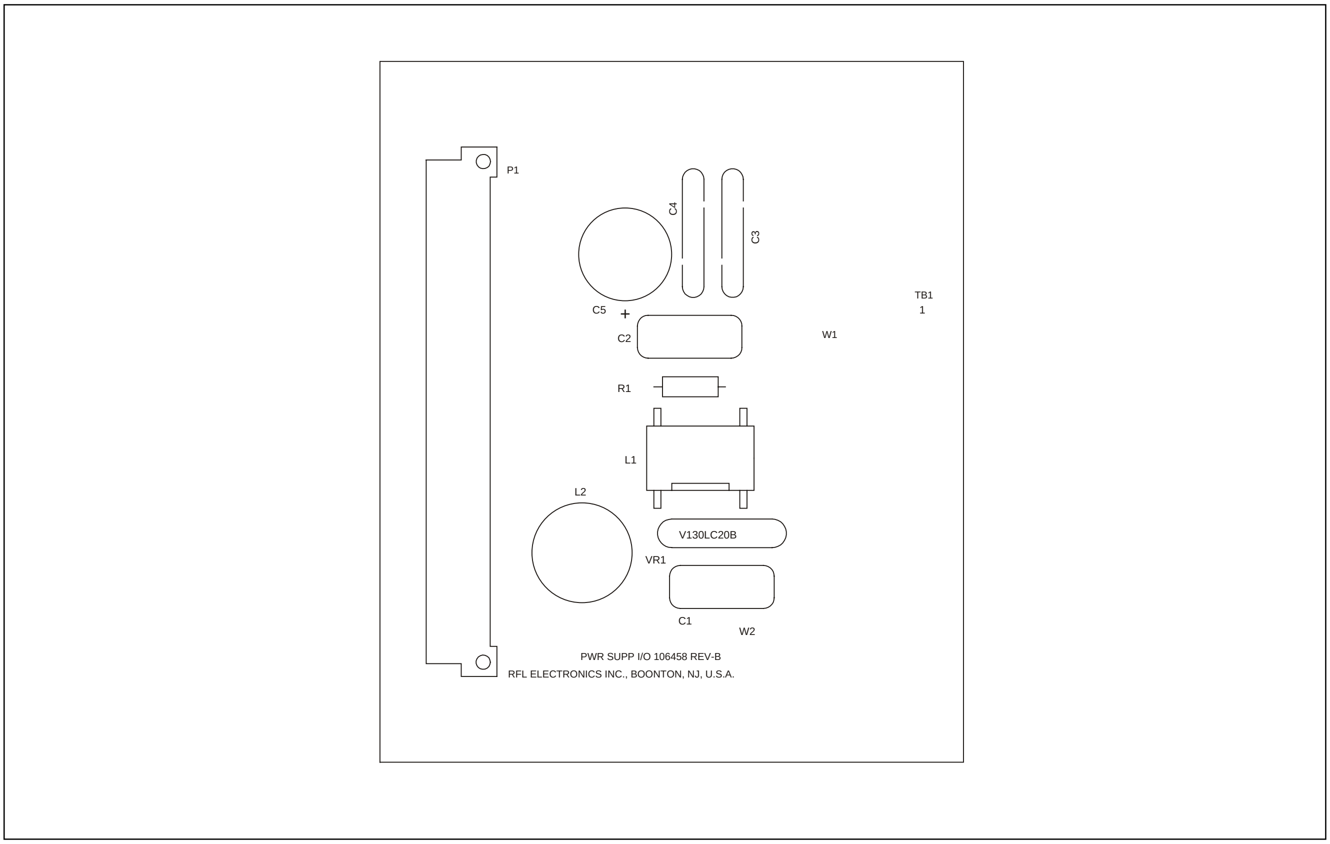

Figure 19-7. Component locator drawing, single power supply I/O module

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Figure 19-8. Schematic, RFL 9780 Power Supply I/O (Dwg. No. B-106459-A)

Please see Figure 19-8 in Section 22.

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19.3.2 CONTROLS AND INDICATORS FOR 106455-3 & -4 P.S. I/Os

Figure 19-9 shows the location of all controls on the RFL 9780 Dual Power supply I/O module. These controls are described in Table 19-8.

Table 19-8. Controls and Indicators, RFL 9780 dual power supply I/O module

Component Designator	Name/ Description	Function
F1	Fuse	Fuse for power supply No. 1
F2	Fuse	Fuse for power supply No. 2
SW1	Switch	ON/OFF switch for power supply No. 1
SW2	Switch	ON/OFF switch for power supply No. 2
TB1	Terminal Board	Input power connections

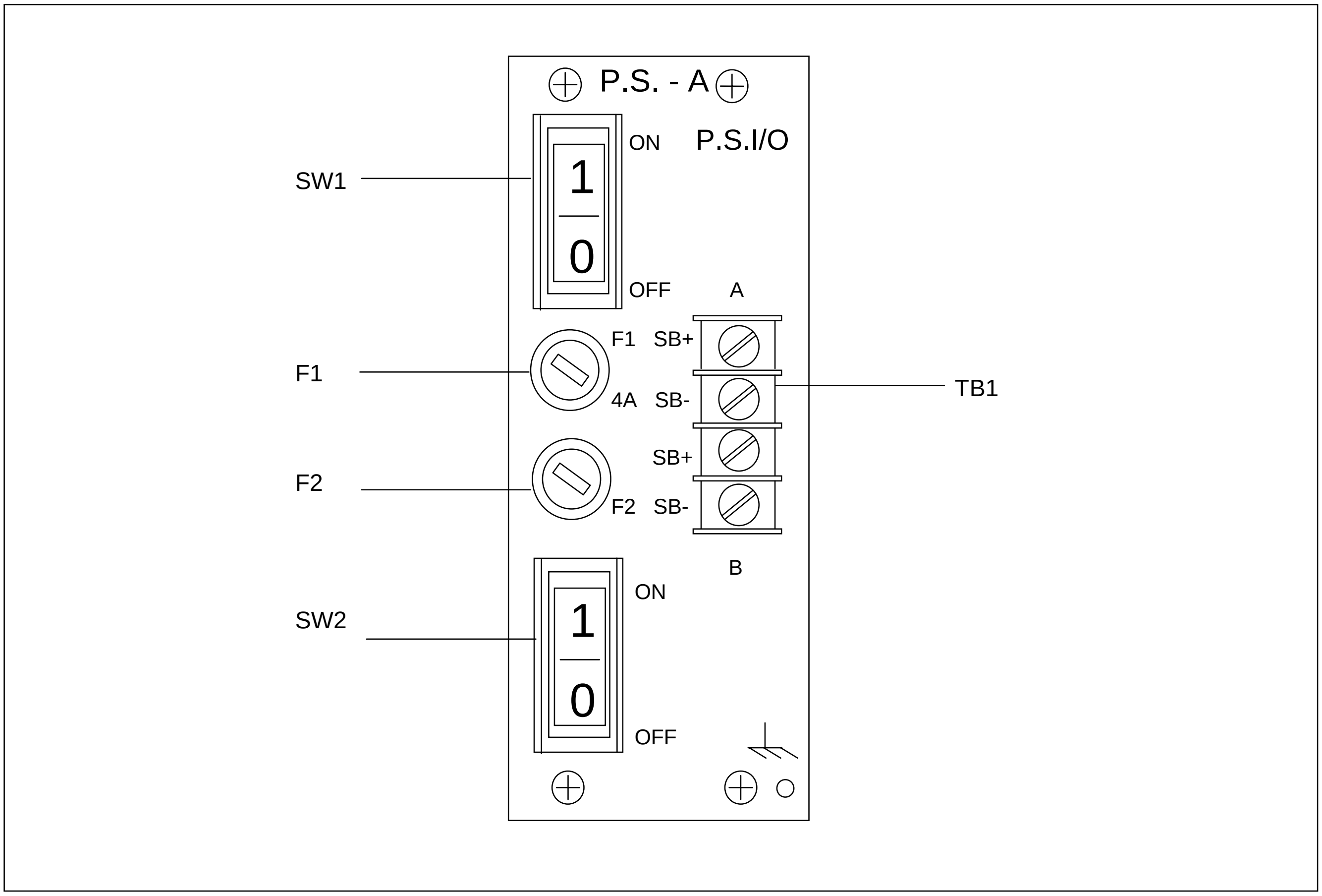

Figure 19-9. Controls and indicators, RFL 9780 dual power supply I/O module

Table 19-9. Replaceable parts, RFL 9780 Dual Power Supply I/O module Assembly No. 106455-3 and -4.

Circuit Symbol (Figs. 19-10 & 19-11)	Description	Part Number
C1, 2, 6 ,7	Capacitor, metalized polypropylene, 0.22µF, 20%, 275V	1007 1808
C3, 4, 8, 9	Capacitor, ceramic disc, 0.01µF	1007 1788
C5, 10	Capacitor, electrolytic, 0.47µF, 20%, 350V	1007 1854
F1, 2	Fuse, carrier international	90278
L1, 3	Choke, common mode, 3mH, 1.8Adc	105426
L2, 4	Inductor, 120µH, 10%, 2A	101483
P1	Connector, plug, female, 64 cont, DIN	99134
R1, 2	Resistor, carbon film, 330KΩ, 5%, 1/2W	0500 6
S1, 2	Switch, rocker, SPST	30441 1
TB1	Terminal block	101697 4
VR1, 2	Suppressor, varistor	

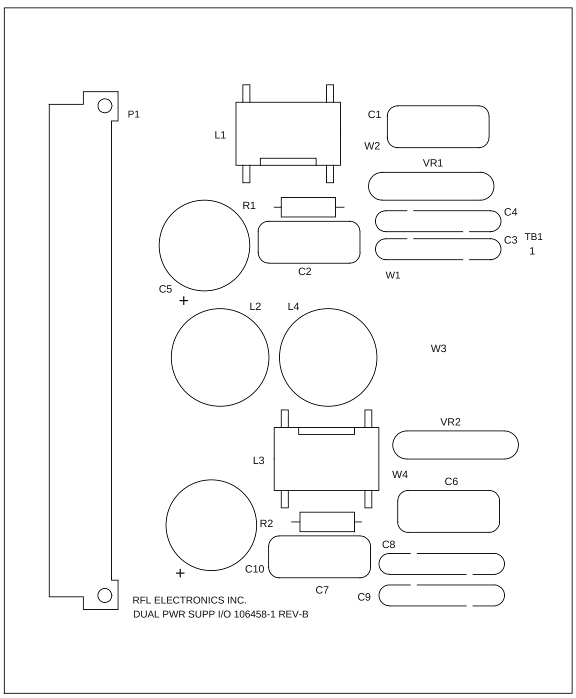

Figure 19-10. Component locator drawing, dual power supply I/O module

Figure 19-11. Schematic, RFL 9780 Power Supply I/O Dual (Dwg. No. B-106459-1-A)

Please see Figure 19-11 in Section 22.

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SECTION 20. CHASSIS ASSEMBLY

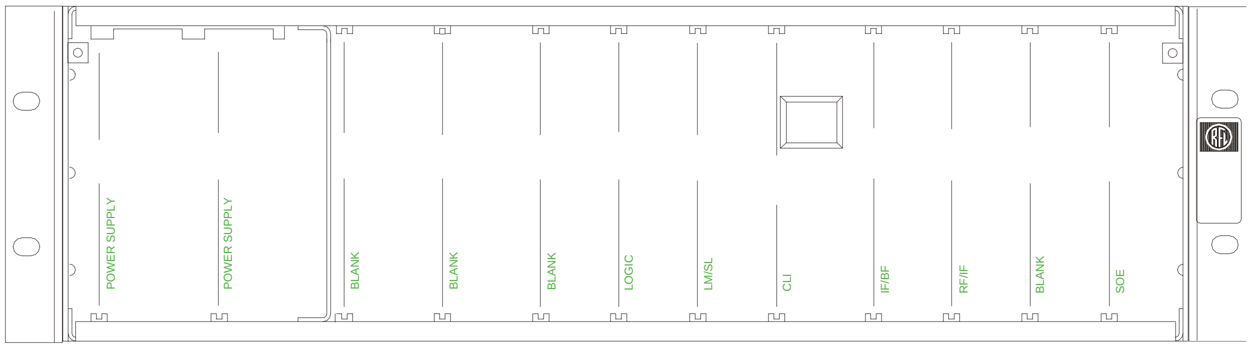

Figure 20-1. RFL 9780 Tx/Rx Chassis Assembly, front view with door opened

20.1 INTRODUCTION

There are five different types of RFL 9780 systems. These are Tx/Rx, Rx/Rx, Tx/Tx, Tx only and Rx only. In addition to this there are five different types of chassis assemblies and three different types of mother board assemblies as shown in Table 20-1. The front view of a typical RFL 9780 Tx/Rx chassis with its door opened is shown in Figure 20-1.

Table 20-1. RFL 9780 Tx/Rx Chassis Assembly, front view with door opened

9780 System	Chassis Assy No.	Mother Board Assy No.		Schematic No.	
Tx/Rx	106400-1	106450-2	(See Fig. 20-2)	D-106454-2-A	(See Fig. 20-6)
Rx/Rx	106410	106560-2	(See Fig. 20-3)	D-106564-2-A	(See Fig. 20-7)
Tx/Tx	106405-1	106555-2	(See Fig. 20-4)	D-106559-2-A	(See Fig. 20-8)
Tx only	106610	106450-2	(See Fig. 20-2)	D-106454-2-A	(See Fig. 20-6)
Rx only	106615	106450-2	(See Fig. 20-2)	D-106454-2-A	(See Fig. 20-6)

Table 20-2. Replaceable parts, RFL 9780 Tx/Rx Motherboard
Assembly No. 106450-2

Circuit Symbol (Figs. 20-2 & 20-8)	Description	Part Number
C1, 2, 3, 14-20	Capacitor, ceramic, 0.1µF, 10%, 100V	0130 11041
C4, 5	Capacitor, electrolytic, 1000µF, 20%, 10V	1007 1746
C7, 8, 10-12	Capacitor, electrolytic, 470µF, 20%, 25V	1007 1856
J1, 3, 8-11	Connector, JK, female, 64 contact, DIN	101280 1
J2, 4, 5, 7	Connector, JK, female, 64 contact, DIN	101281 1
J6	Connector, JK, female, 96 contact, DIN	101679 1
J16	Connector, wafer assembly, 2 circuit	97223 2
J17-22, 24, 26	Connector, jack receptacle, SMB	101485
J23	Connector, header, dual, 3/6 circuit	32599 6

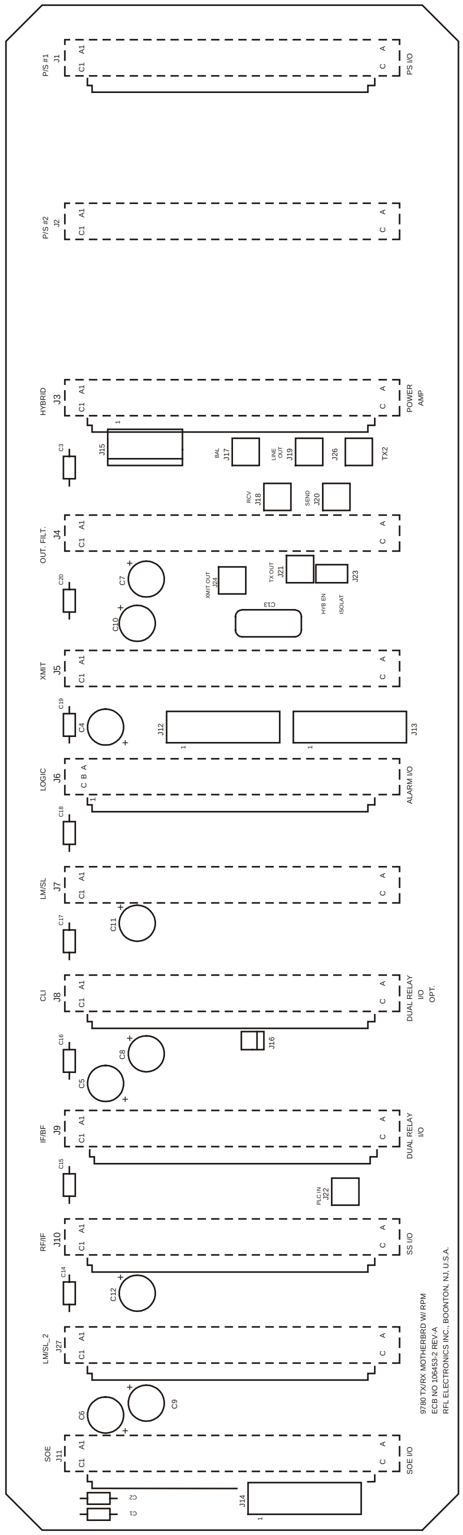

Figure 20-2. Component locator drawing, RFL 9780 Tx/Rx Motherboard (Assembly No. 106450-2)

Table 20-3. Replaceable parts, RFL 9780 Tx/Rx Motherboard
Assembly No. 106560-2

Circuit Symbol (Figs. 20-3 & 20-9)	Description	Part Number
C1, 2, 16-24	Capacitor, ceramic disc, 0.1µF, 10%, 100V	0130 11041
C4-7	Capacitor, electrolytic, 1000µF, 20%, 10V	1007 1746
C8-15	Capacitor, electrolytic, 470µF, 20%, 25V	1007 1856
J1, 5-7, 9-11, 13	Connector, JK, female, 64 contact, DIN	101280 1
J2-4	Connector, JK, female, 64 contact, DIN	101281 1
J8, 12	Connector, JK, female, 96 contact, DIN	101679 1
J15	Connector, header, dual, 3/6 circuit	32599 6
J16, 19, 20, 27	Connector, receptacle, SMB	101485
J17, 18	Connector, wafer assembly, 2 circuit	97223 2
J22, 23, 25, 26	Connector, header, single, 3 circuit	32802 3
J28	Connector, header, single, 2 circuit	32802 2

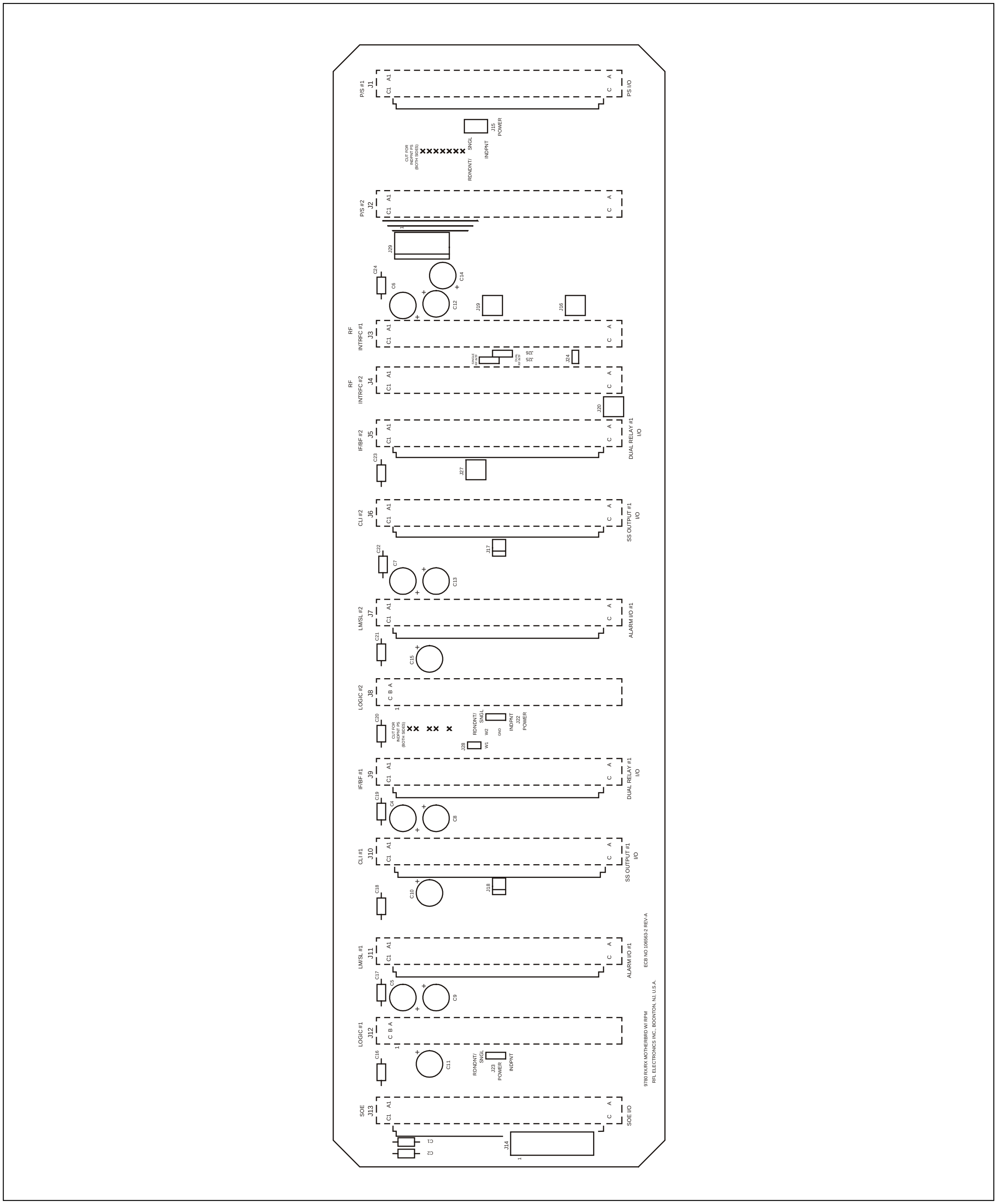

Figure 20-3. Component locator drawing, RFL 9780 Tx/Rx Motherboard (Assembly No. 106560-2)

Table 20-4. Replaceable parts, RFL 9780 Rx/Rx Motherboard
Assembly No. 106555-2

Circuit Symbol (Figs. 20-4 & 20-10)	Description	Part Number
C1-3, 10-16	Capacitor, ceramic disc, 0.1µF, 10%, 100V	0130 11041
C4, 5	Capacitor, electrolytic, 1000µF, 20%, 10V	1007 1746
C6-9	Capacitor, electrolytic, 470µF, 20%, 25V	1007 1856
J1, 3, 5, 8, 9, 11	Connector, JK, female, 64 contact, DIN	101280 1
J2, 4, 7	Connector, JK, female, 64 contact, DIN	101281 1
J6, 10	Connector, wafer assembly, 2 circuit	101679 1
J12, 15-23, 25-27	Connector jack, receptacle, SMB	101485

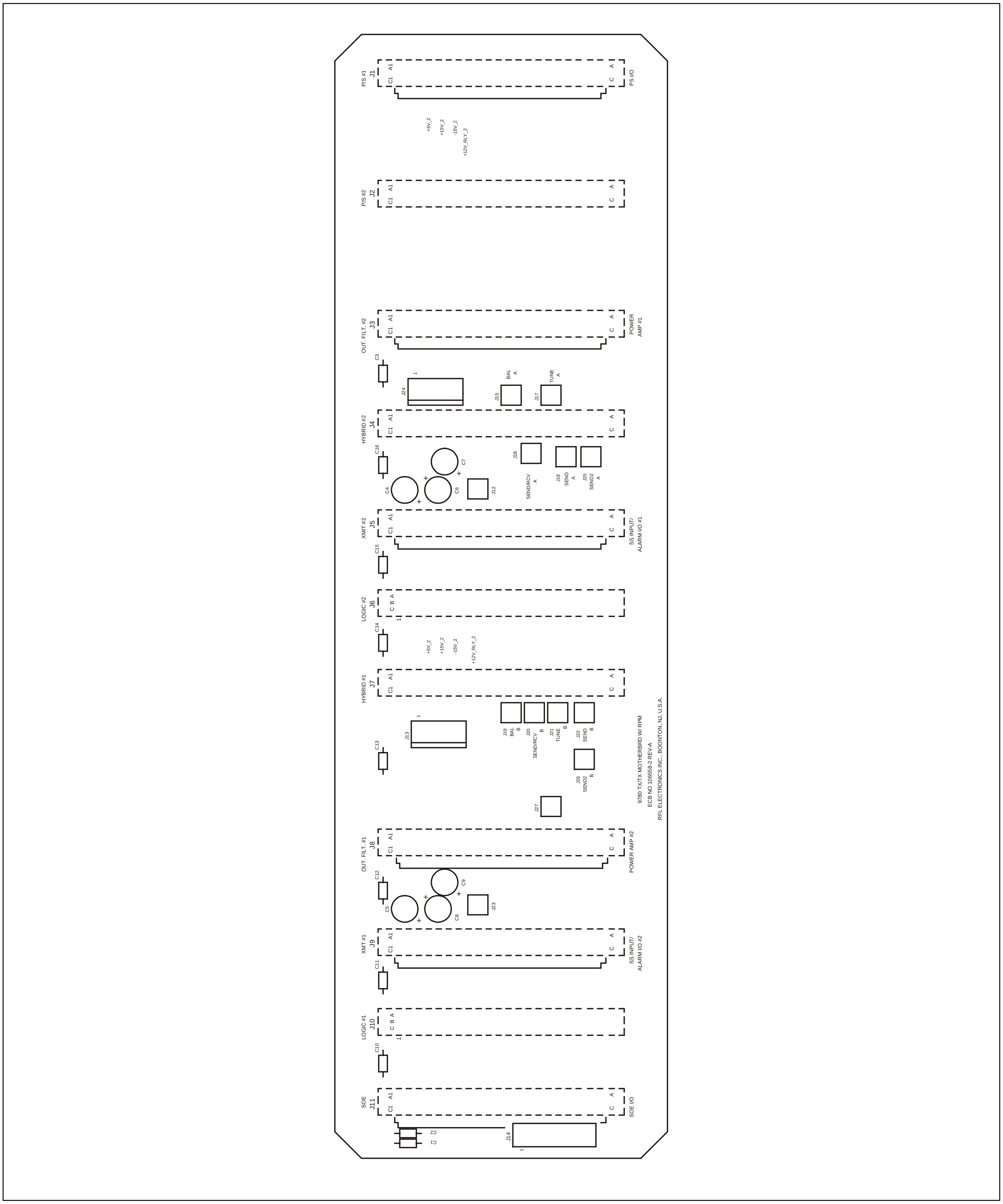

Figure 20-4. Component locator drawing, RFL 9780 Rx/Rx Motherboard (Assembly No. 106555-2)

20.2 SETTING THE J23 PROGRAMMABLE JUMPERS

The J23 programmable jumpers are located on the rear side of the Interconnect Motherboard slightly to the left of the J4 Output Filter Module connector. This can be seen in Figures 20-7, 20-8 and 20-9.

J23 is normally configured at the factory, however in some instances, may have to be reconfigured in the field.

When the J23 jumpers are in the UP position, the output filter module “output” is tied to the “send” input of the hybrid module. This eliminates the need for external wiring in certain RFL 9780 configurations.

When the J23 jumpers are in the DOWN position, the output filter module “output” is isolated from the “send” input of the hybrid module. This would be the case when the RFL 9780 chassis has no hybrid module installed.

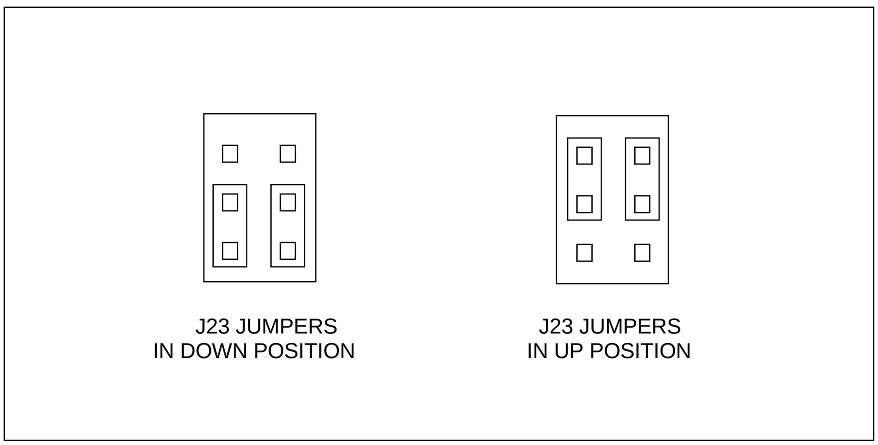

Figure 20-5. J23 jumper position

Figure 20-6. Schematic, RFL 9780 TX/RX Motherboard (Dwg. No. D-106454-2-A)

Please see Figure 20-6 in Section 22.

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Figure 20-7. Schematic, RFL 9780 TX/RX Motherboard (Dwg. No. D-106564-2-A)

Please see Figure 20-7 in Section 22

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Figure 20-8. Schematic, RFL 9780 RX/RX Motherboard (Dwg. No. D-106559-2-A)

Please see Figure 20-8 in Section 22

SECTION 21. ACCESSORY EQUIPMENT

If any accessory equipment was furnished with your RFL 9780 terminal at the time of purchase, information on these accessory items will be found immediately following this page. This may include Instruction Data Sheets, schematics, wiring diagrams, or other documents.

SECTION 22 SCHEMATICS

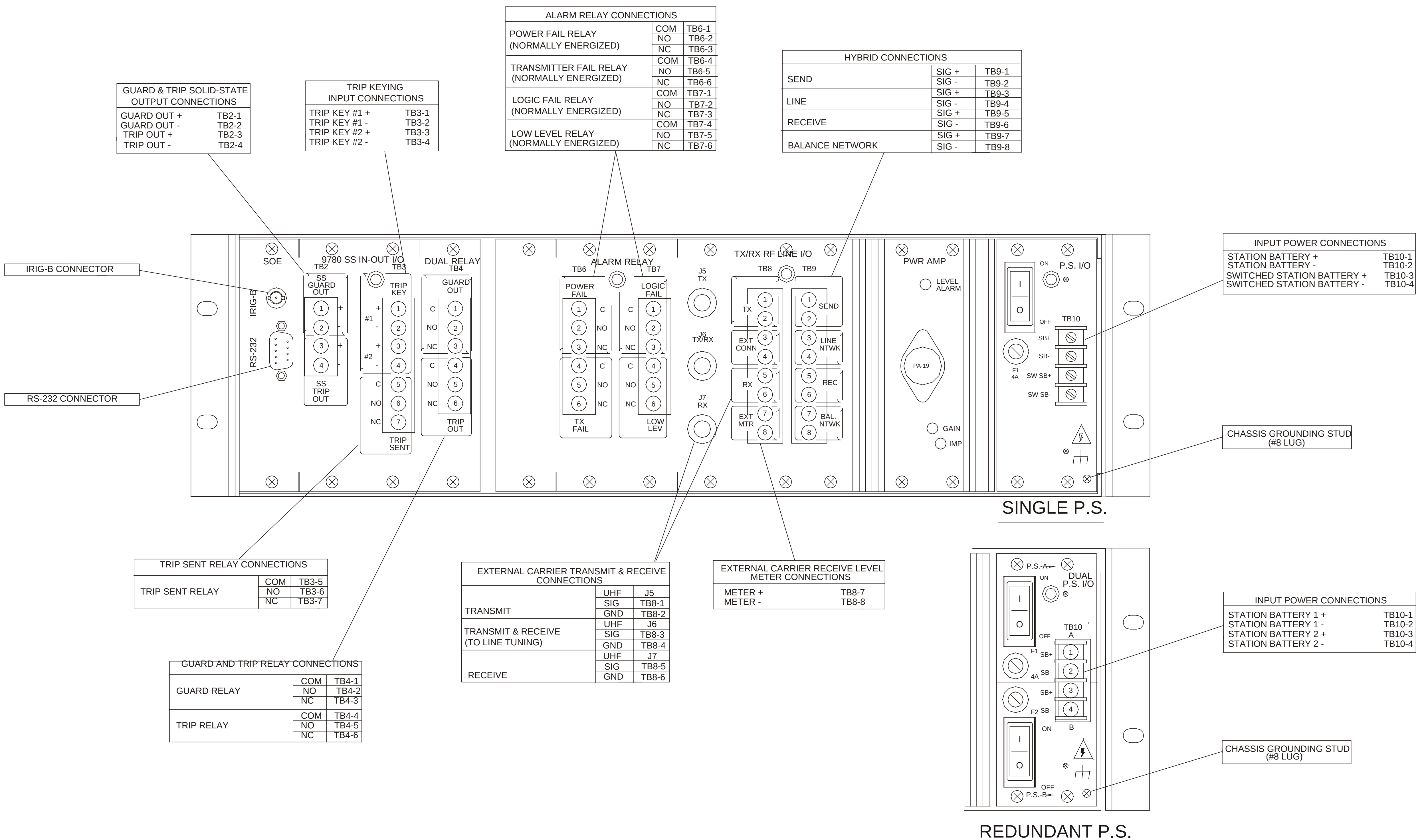
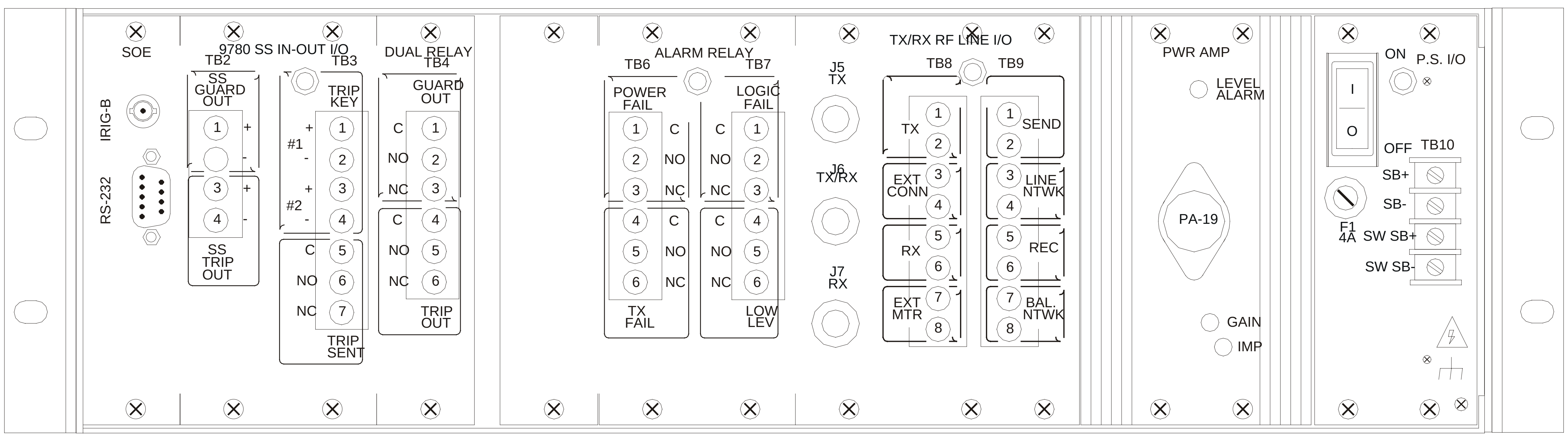


Figure 3-2. Rear Panel View of Typical RFL 9780 TX/RX Chassis (Drawing No. D-106431-A0

FRONT VIEW



REAR VIEW

Figure 4-2. Locations of Circuit Board Modules in a Typical RFL 9780 TX/RX Chassis (Drawing No. D-106431-A)

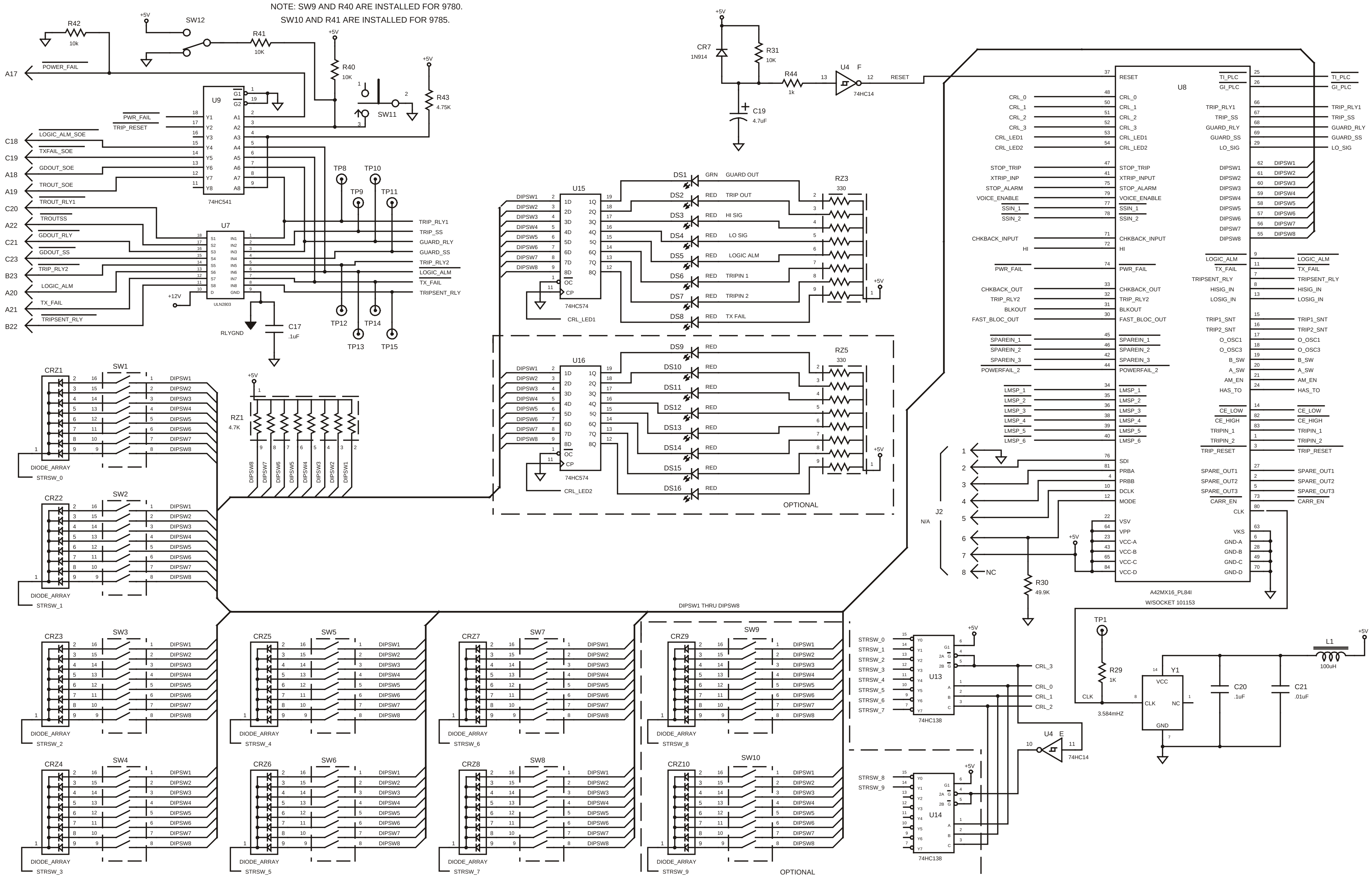


Figure 6-8. Schematic, RFL 9780 Logic Module (Drawing No. D-106494-A) Sheet 1 of 2

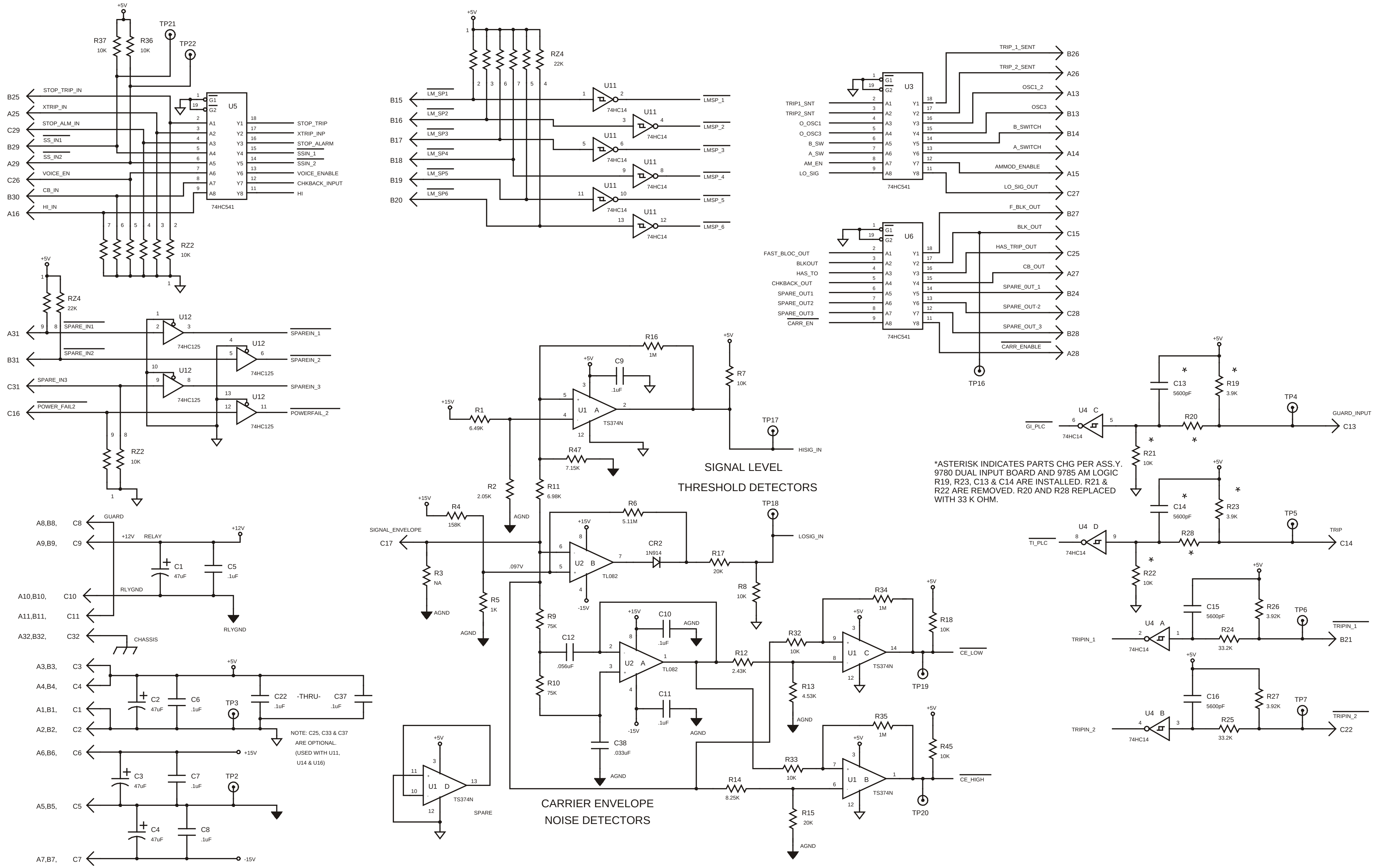


Figure 6-8. Schematic, RFL 9780 Logic Module (Drawing No. D-106494-A) Sheet 2 of 2

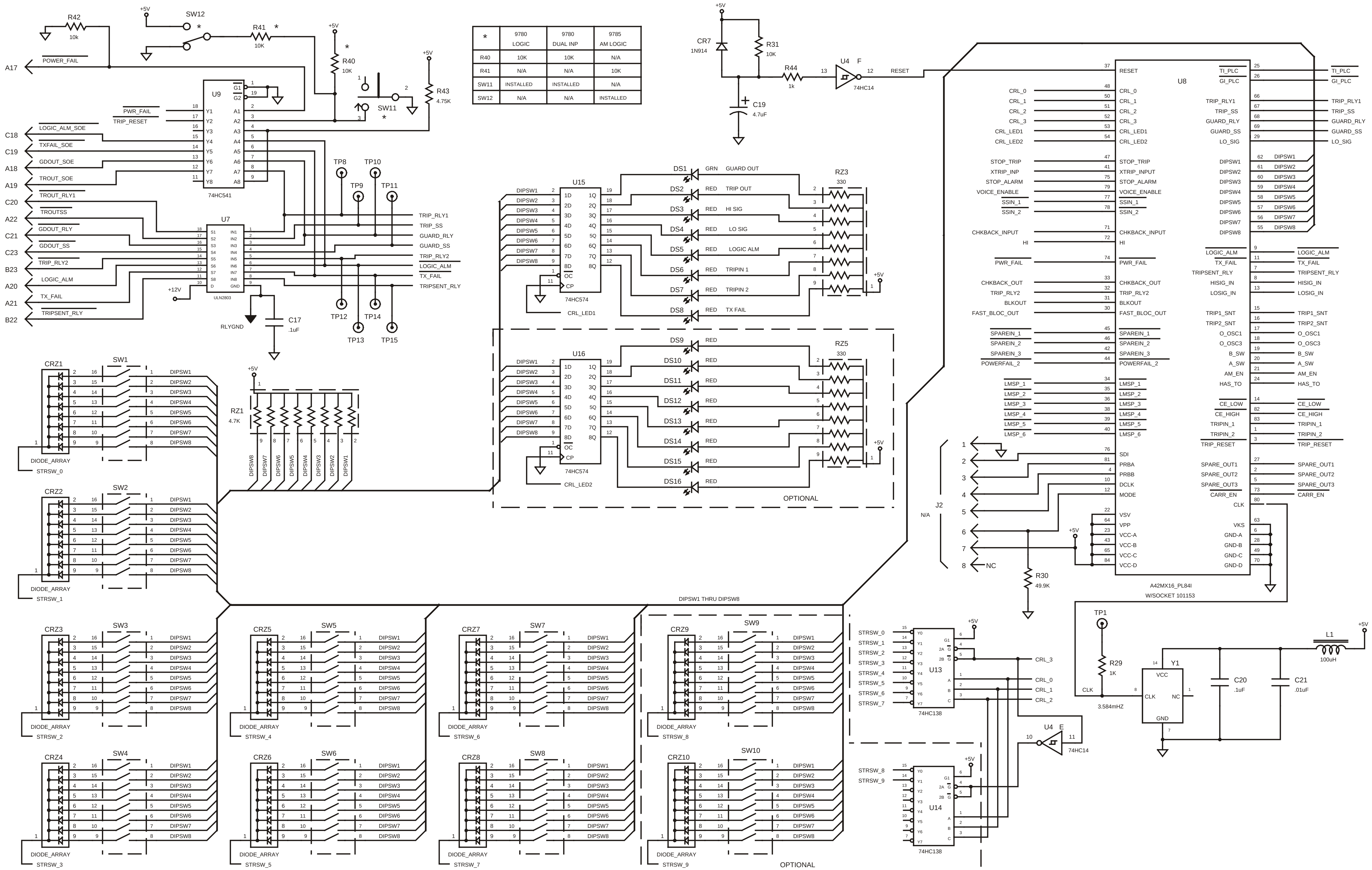
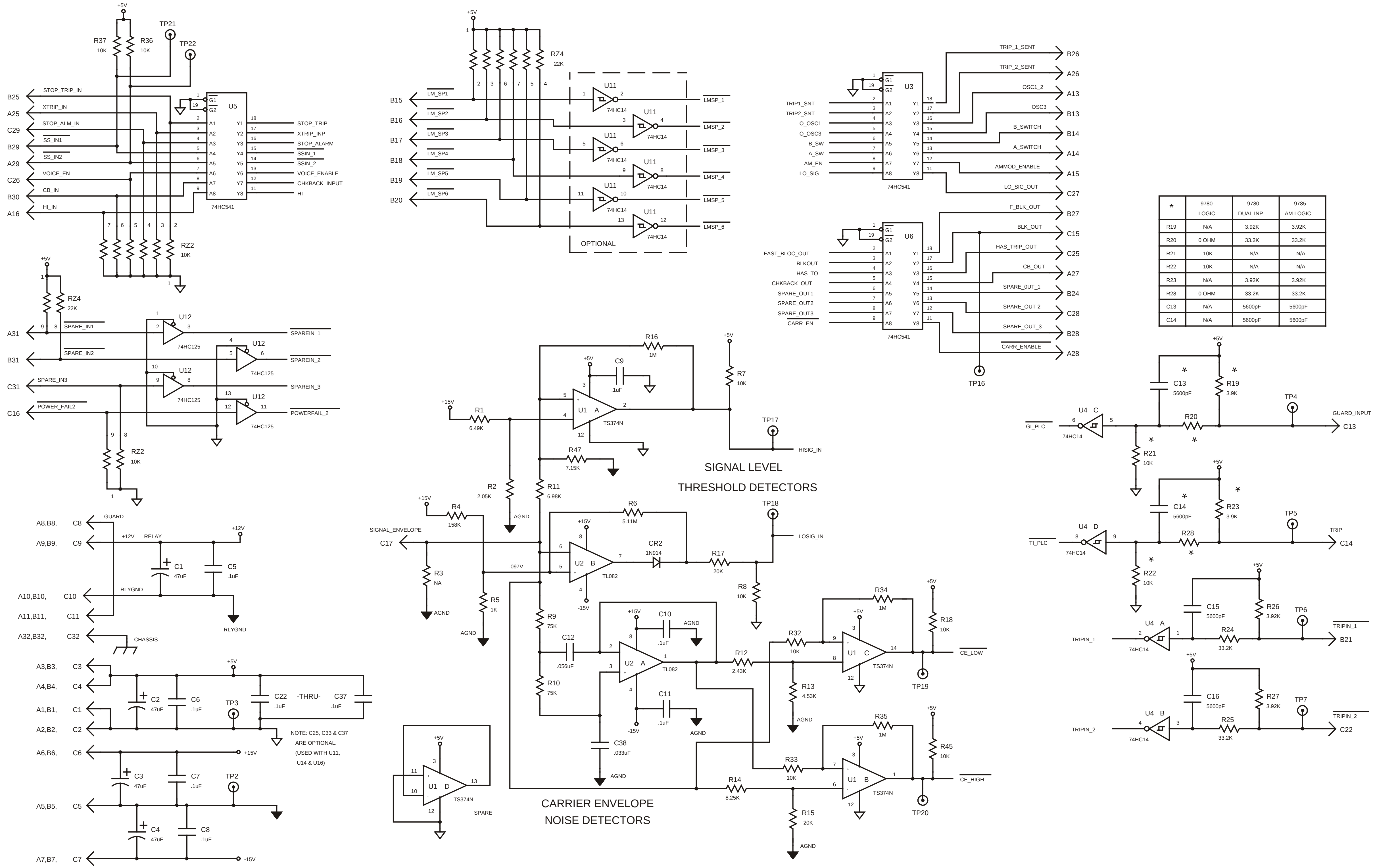


Figure 7-5. Schematic, RFL 9780 Tx Logic Module (Drawing No. D-106494-1-B) Sheet 1 of 2



*	9780 LOGIC	9780 DUAL INP	9785 AM LOGIC
R19	N/A	3.92K	3.92K
R20	0 OHM	33.2K	33.2K
R21	10K	N/A	N/A
R22	10K	N/A	N/A
R23	N/A	3.92K	3.92K
R28	0 OHM	33.2K	33.2K
C13	N/A	5600pF	5600pF
C14	N/A	5600pF	5600pF

Figure 7-5. Schematic, RFL 9780 Tx Logic Module (Drawing No. D-106494-1-B) Sheet 2 of 2

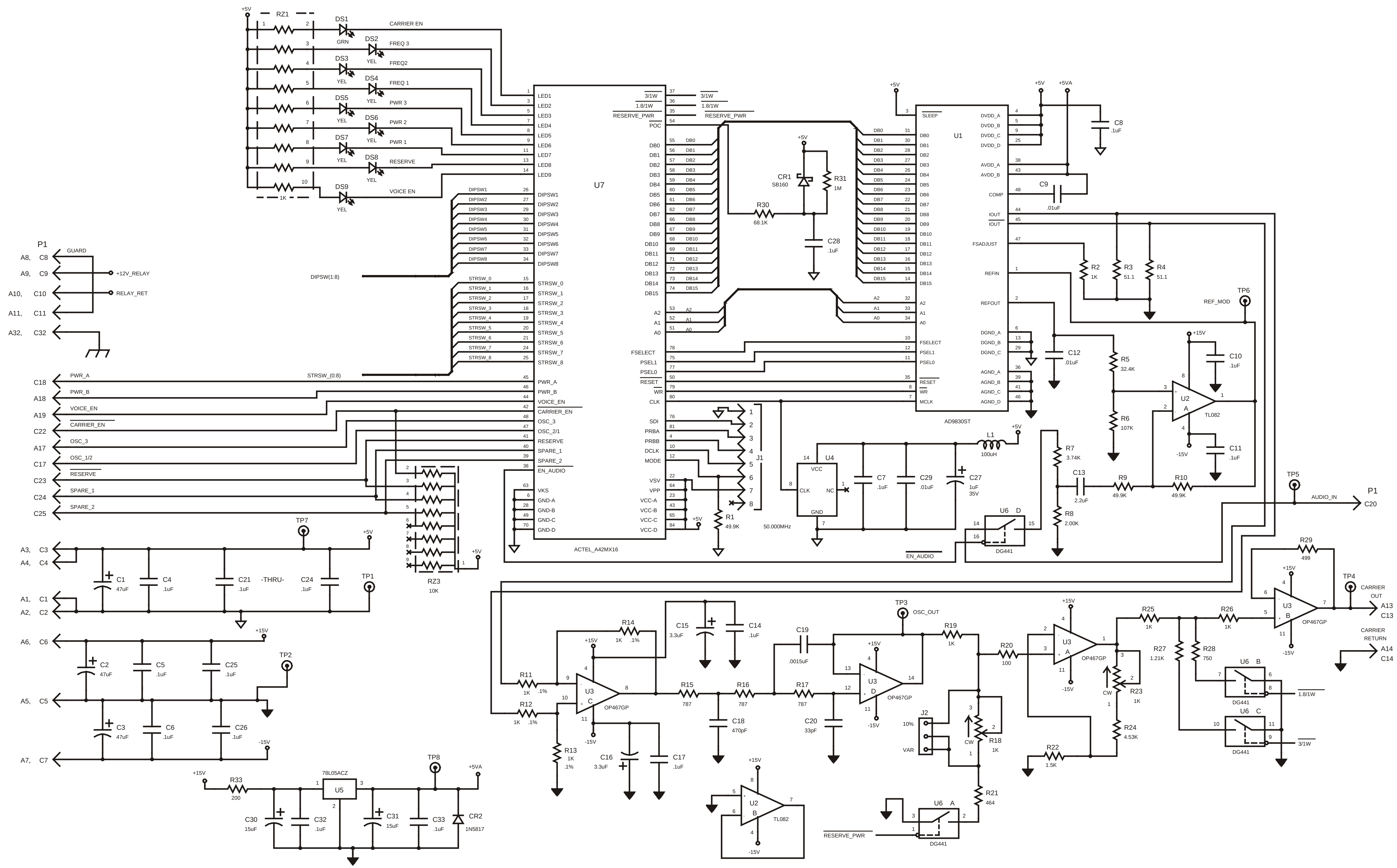


Figure 8-6. Schematic, RFL 9780 Transmitter Module (Drawing No. D-106509-C) Sheet 1 of 2

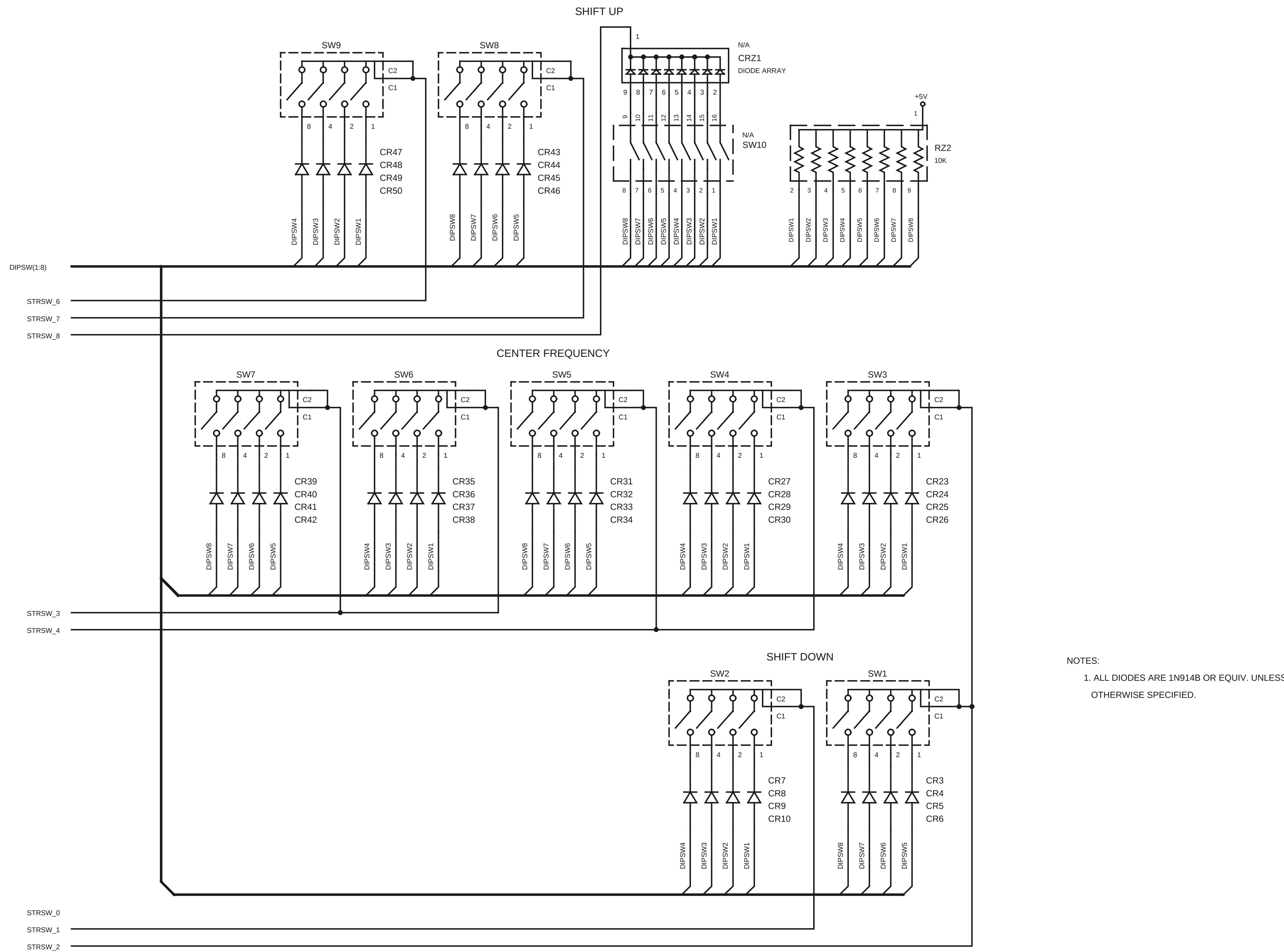


Figure 8-6. Schematic, RFL 9780 Transmitter Module (Drawing No. D-106509-C) Sheet 2 of 2

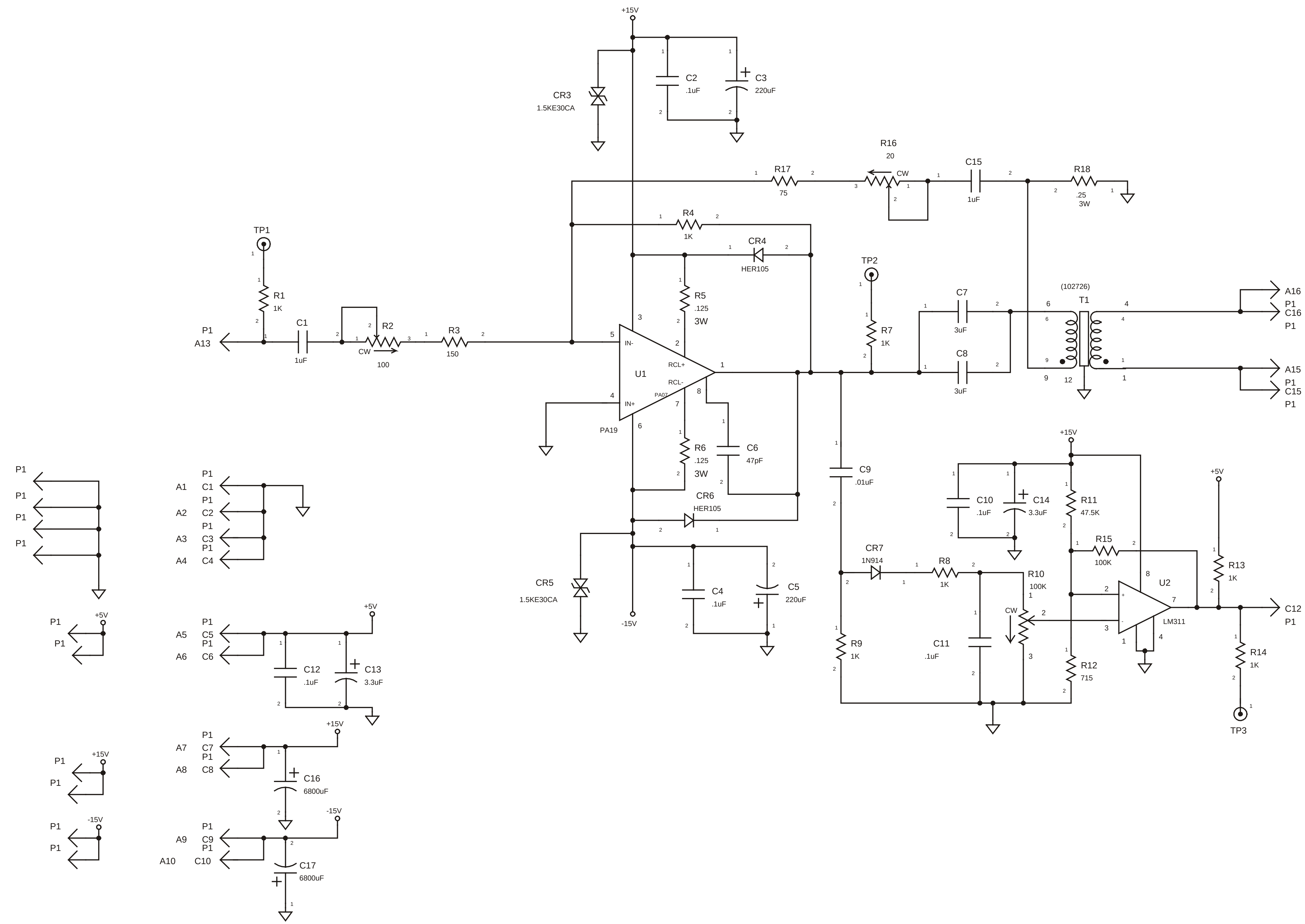
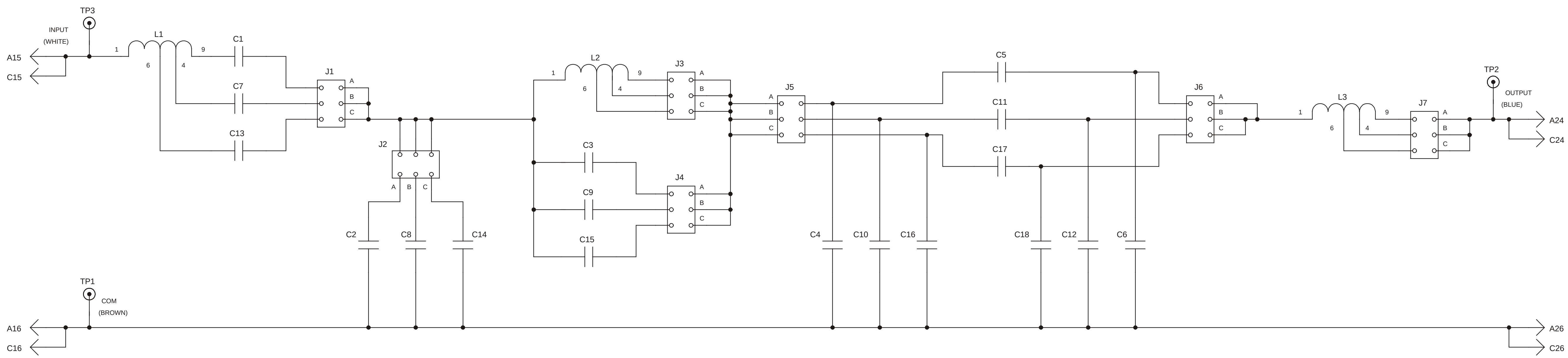
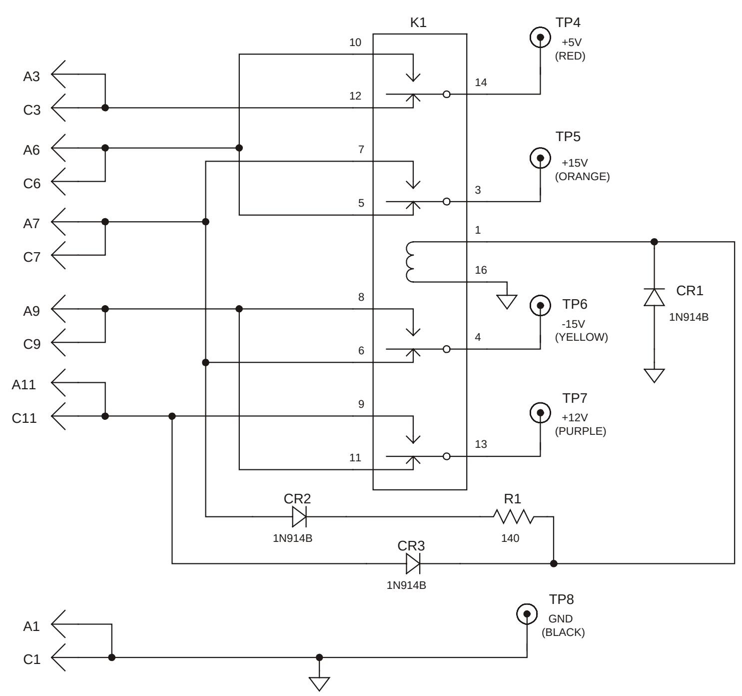


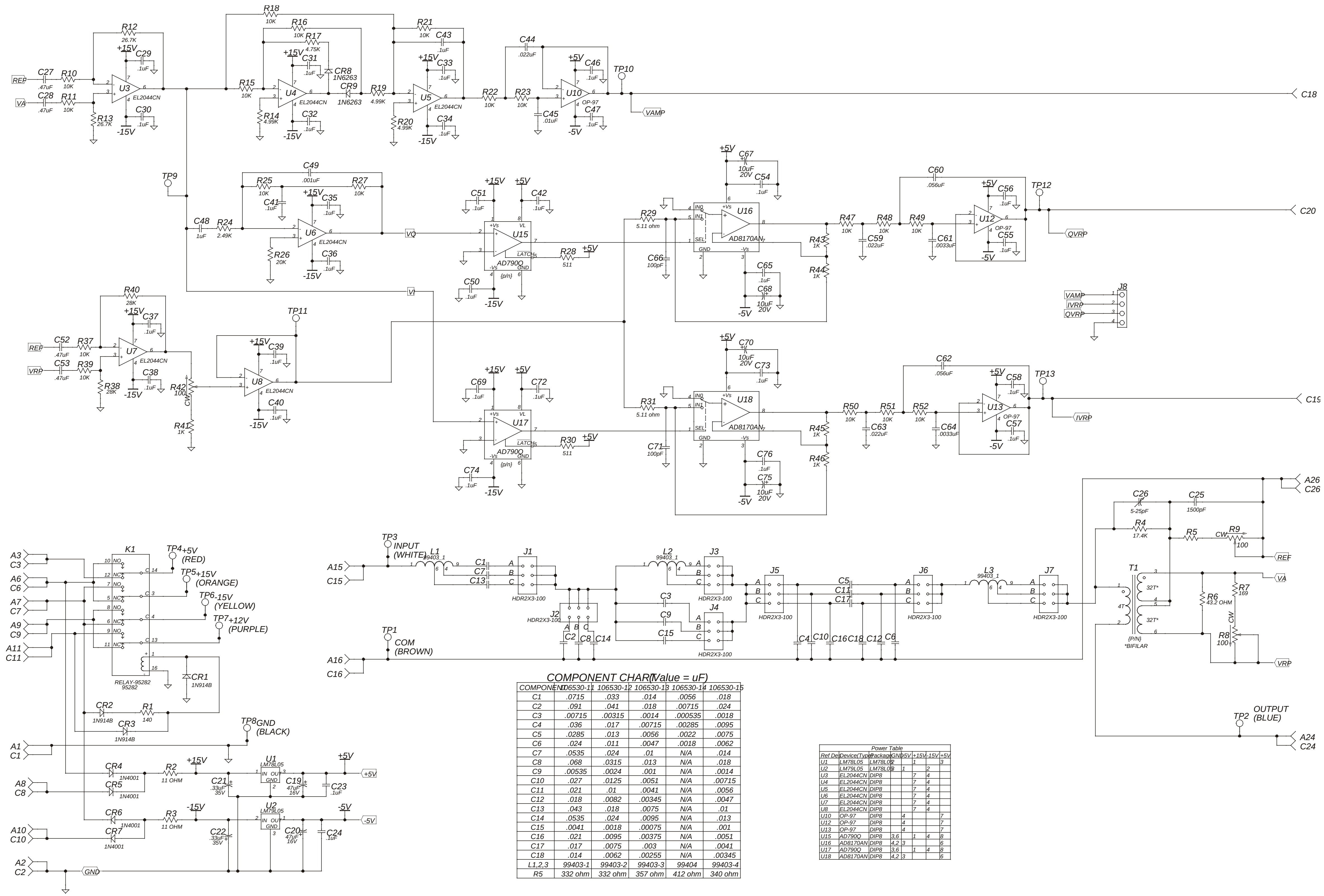
Figure 9-4. Schematic, RFL 9780 Power Amplifier (Drawing No. C-106464-B)





COMPONENT CHART	(VALUE=MICRO-FARAD)				
COMPONENT	106530-1	106530-2	106530-3	106530-4	106530-5
C1	0.0715	0.033	0.014	0.0056	0.018
C2	0.091	0.041	0.018	0.00715	0.024
C3	0.00715	0.00315	0.0014	0.000535	0.0018
C4	0.036	0.017	0.00715	0.00285	0.0095
C5	0.0285	0.013	0.0056	0.0022	0.0075
C6	0.024	0.011	0.0047	0.0018	0.0062
C7	0.0535	0.024	0.01	N/A	0.014
C8	0.068	0.0315	0.013	N/A	0.018
C9	0.00535	0.0024	0.001	N/A	0.0014
C10	0.027	0.0125	0.0051	N/A	0.00715
C11	0.021	0.01	0.0041	N/A	0.0056
C12	0.018	0.0082	0.00345	N/A	0.0047
C13	0.043	0.018	0.0075	N/A	0.01
C14	0.0535	0.024	0.0095	N/A	0.013
C15	0.0041	0.0018	0.00075	N/A	0.001
C16	0.021	0.0095	0.00375	N/A	0.0051
C17	0.017	0.0075	0.003	N/A	0.0041
C18	0.014	0.0062	0.00255	N/A	0.00345
L1,2,3	RFL P/N 99403-1	RFL P/N 99403-2	RFL P/N 99403-3	RFL P/N 99404	RFL P/N 99403-4

Figure 10-6. Schematic, RFL 9780 Output Filters Without Reflected Power Meter, Assy Nos. 106530-1 to –5 (Drawing No. D-106534-D)



COMPONENT CHART (Value = uF)

COMPONENT	106530-11	106530-12	106530-13	106530-14	106530-15
C1	.0715	.033	.014	.0056	.018
C2	.091	.041	.018	.00715	.024
C3	.00715	.00315	.0014	.000535	.0018
C4	.036	.017	.00715	.00285	.0095
C5	.0285	.013	.0056	.0022	.0075
C6	.024	.011	.0047	.0018	.0062
C7	.0535	.024	.01	N/A	.014
C8	.068	.0315	.013	N/A	.018
C9	.00535	.0024	.001	N/A	.0014
C10	.027	.0125	.0051	N/A	.00715
C11	.021	.01	.0041	N/A	.0056
C12	.018	.0082	.00345	N/A	.0047
C13	.043	.018	.0075	N/A	.01
C14	.0535	.024	.0095	N/A	.013
C15	.0041	.0018	.00075	N/A	.001
C16	.021	.0095	.00375	N/A	.0051
C17	.017	.0075	.003	N/A	.0041
C18	.014	.0062	.00255	N/A	.00345
L1,2,3	99403-1	99403-2	99403-3	99404	99403-4
R5	332 ohm	332 ohm	357 ohm	412 ohm	340 ohm

Power Table

Ref Des	Device(Type)	Package	GND	-5V	+15V	-15V	+5V
U1	LM78L05	LM78L05	2		1		3
U2	LM79L05	LM78L05	3	1		2	
U3	EL2044CN	DIP8			7	4	
U4	EL2044CN	DIP8			7	4	
U5	EL2044CN	DIP8			7	4	
U6	EL2044CN	DIP8			7	4	
U7	EL2044CN	DIP8			7	4	
U8	EL2044CN	DIP8			7	4	
U10	OP-97	DIP8		4			7
U12	OP-97	DIP8		4			7
U13	OP-97	DIP8		4			7
U15	AD790Q	DIP8	3,6		1	4	8
U16	AD8170AN	DIP8	4,2	3			6
U17	AD790Q	DIP8	3,6		1	4	8
U18	AD8170AN	DIP8	4,2	3			6

Figure 10-7. Schematic, RFL 9780 Output Filters With Reflected Power Meter, Assy Nos. 106530-11 to -15 (Drawing No. D-106534-1-B)

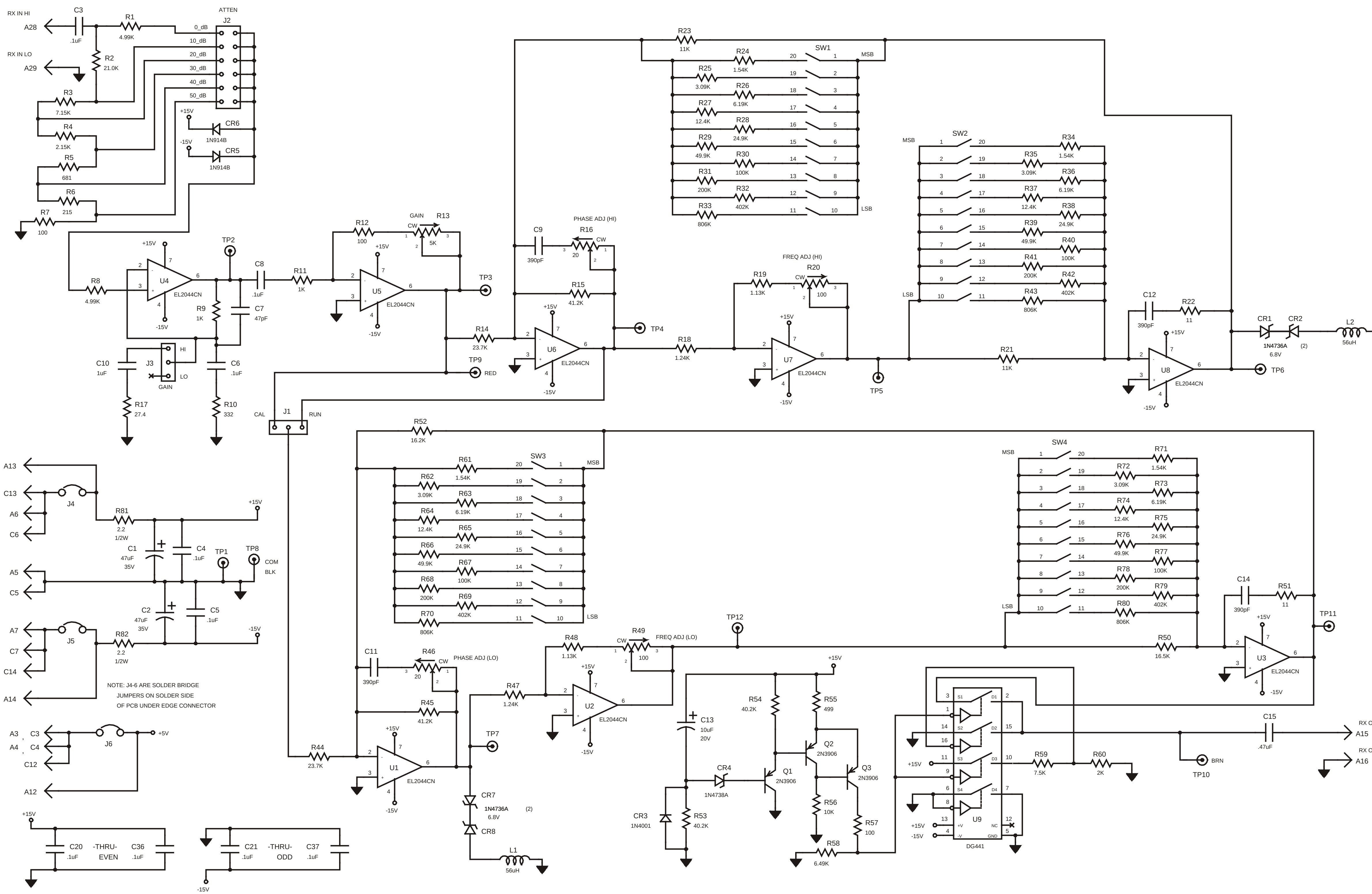


Figure 11-5. Schematic, RFL 9780 RF Interface (Drawing No. D-106504-C)

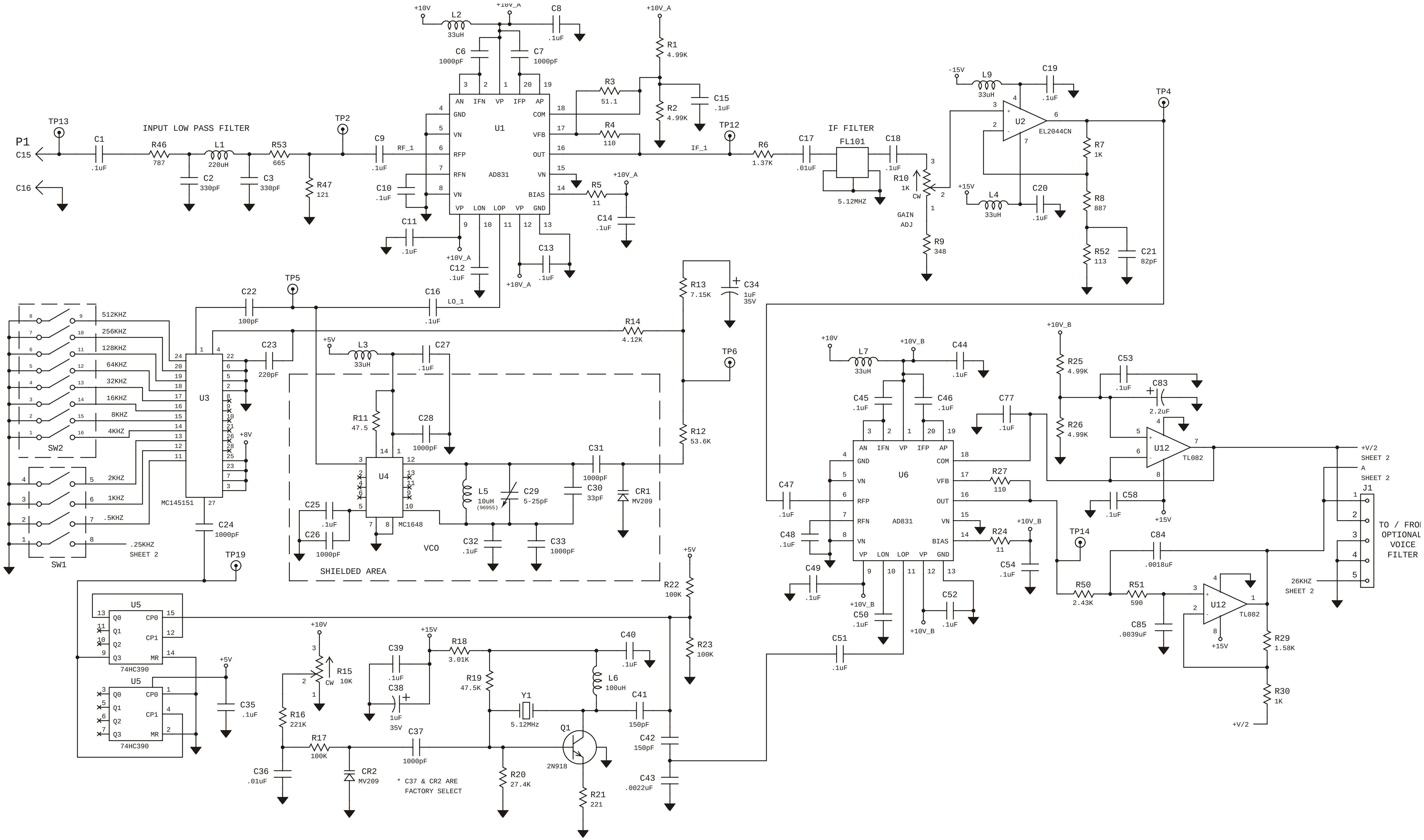


Figure 12-5. Schematic, RFL 9780 IF/BF (Drawing No. D-106499-C) Sheet 1 of 2

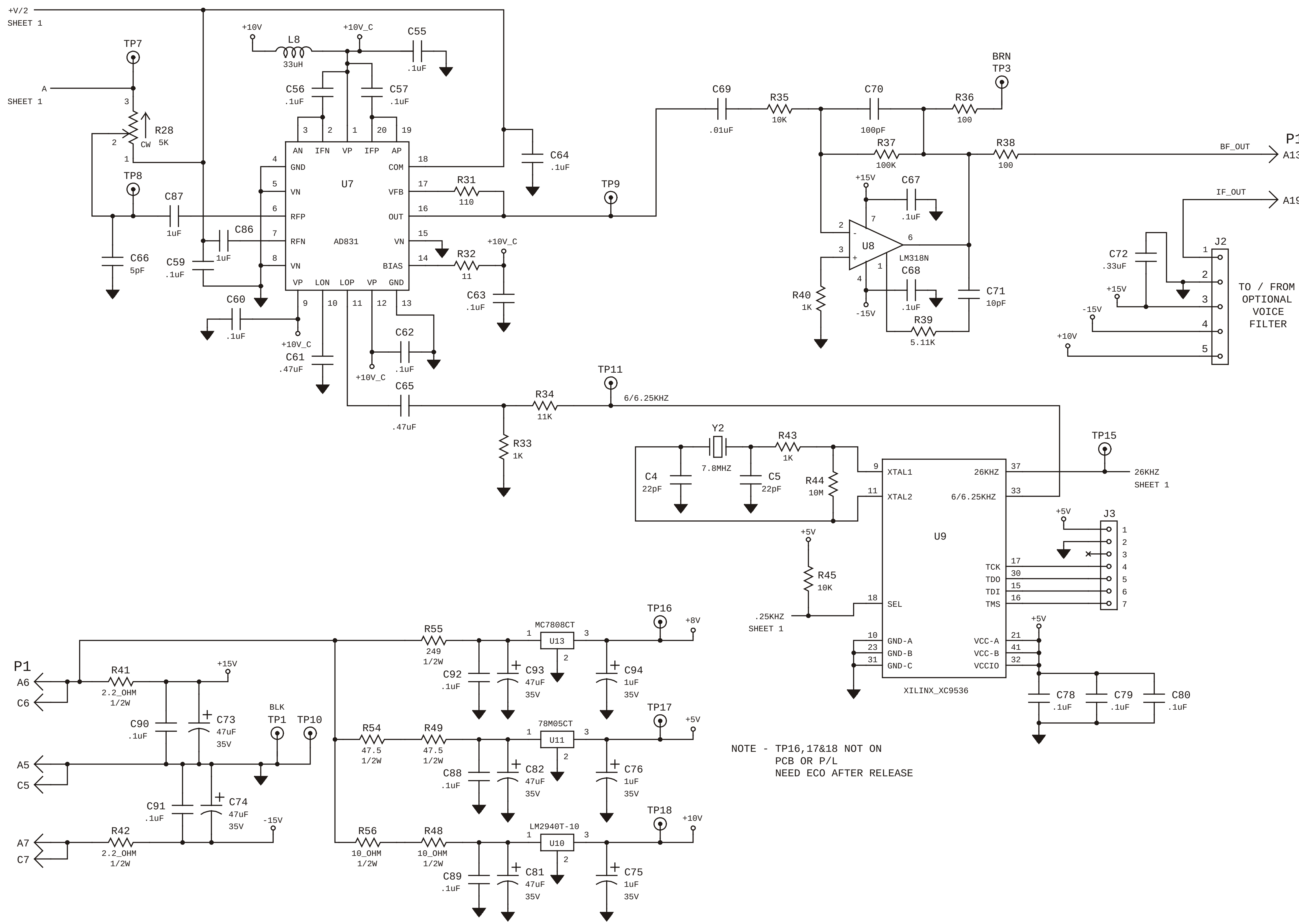
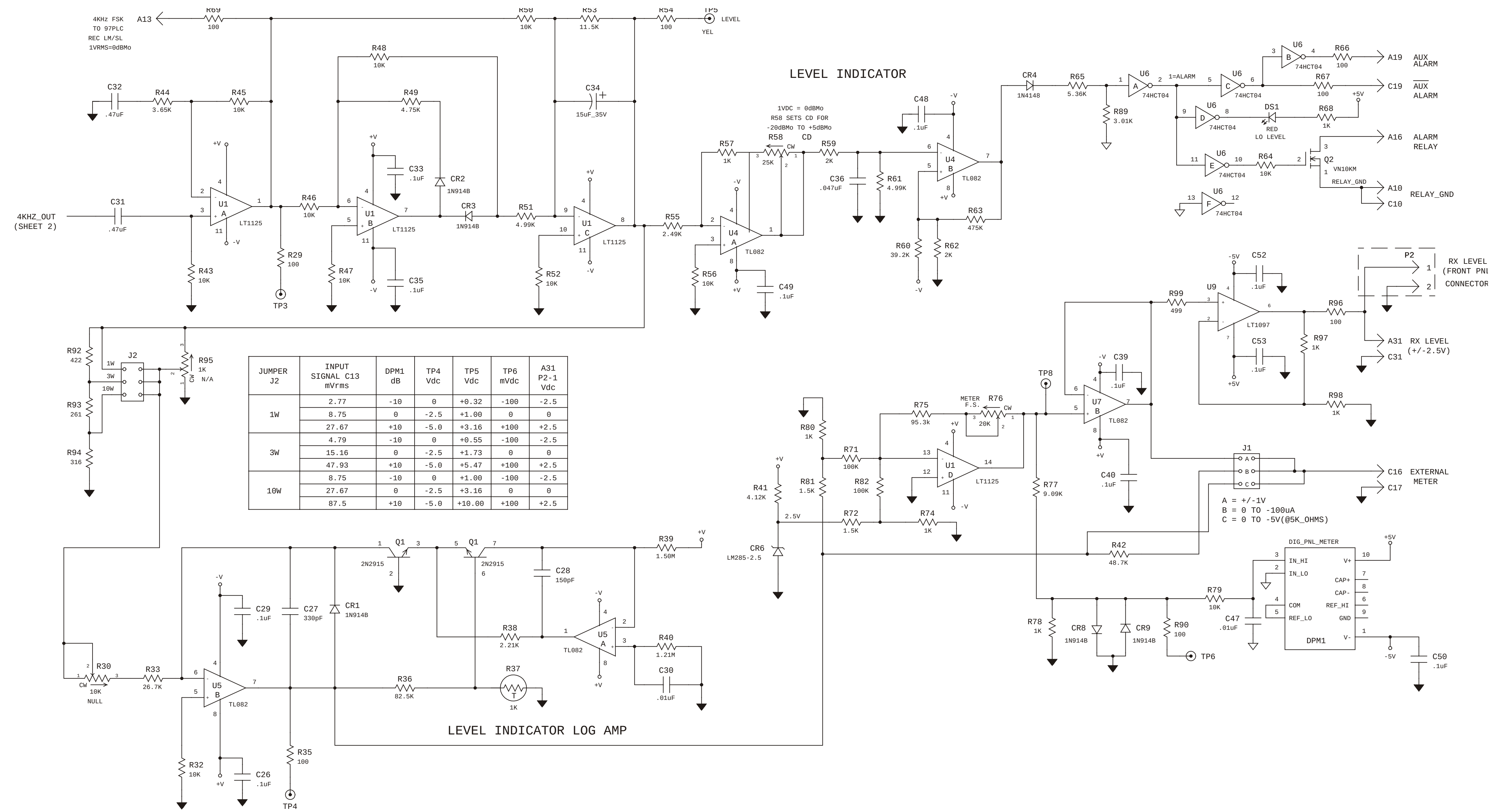
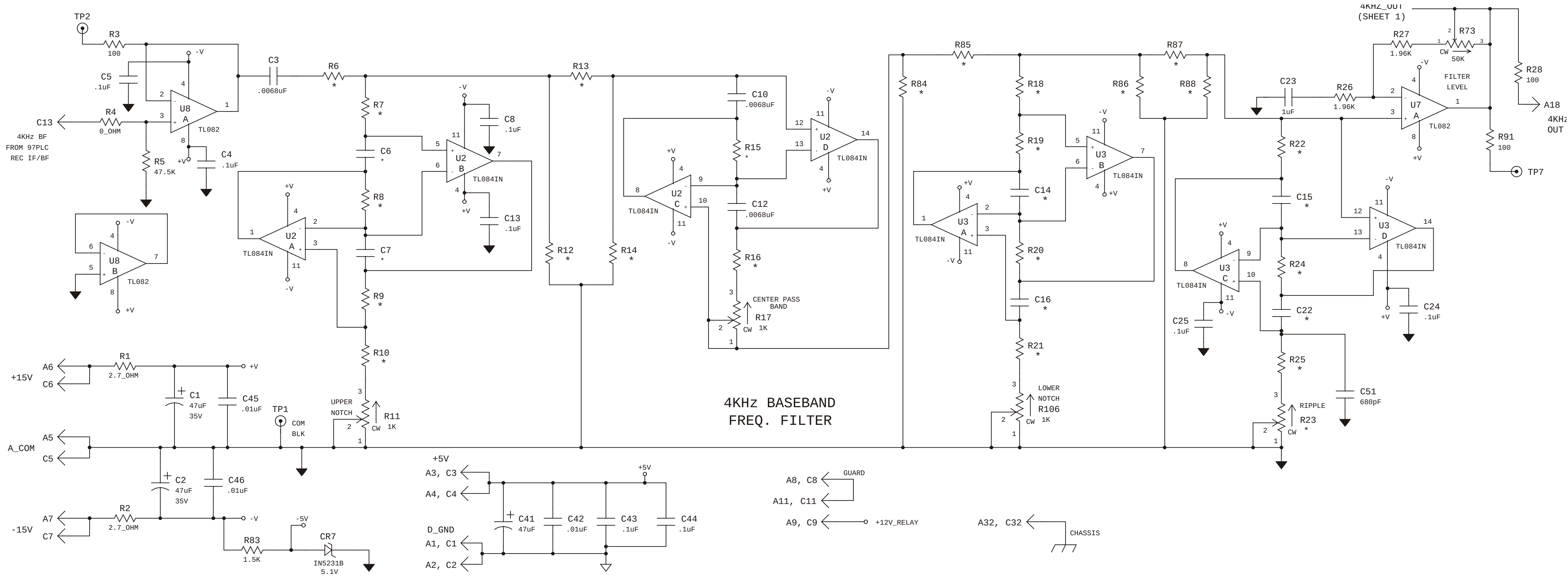


Figure 12-5. Schematic, RFL 9780 IF/BF (Drawing No. D-106499-C) Sheet 2 of 2



JUMPER J2	INPUT SIGNAL C13 mVrms	DPM1 dB	TP4 Vdc	TP5 Vdc	TP6 mVdc	A31 P2-1 Vdc
1W	2.77	-10	0	+0.32	-100	-2.5
	8.75	0	-2.5	+1.00	0	0
	27.67	+10	-5.0	+3.16	+100	+2.5
3W	4.79	-10	0	+0.55	-100	-2.5
	15.16	0	-2.5	+1.73	0	0
	47.93	+10	-5.0	+5.47	+100	+2.5
10W	8.75	-10	0	+1.00	-100	-2.5
	27.67	0	-2.5	+3.16	0	0
	87.5	+10	-5.0	+10.00	+100	+2.5

Figure 13-5. Schematic, RFL 9780 CLI (Drawing No. D-106489-E) Sheet 1 of 2

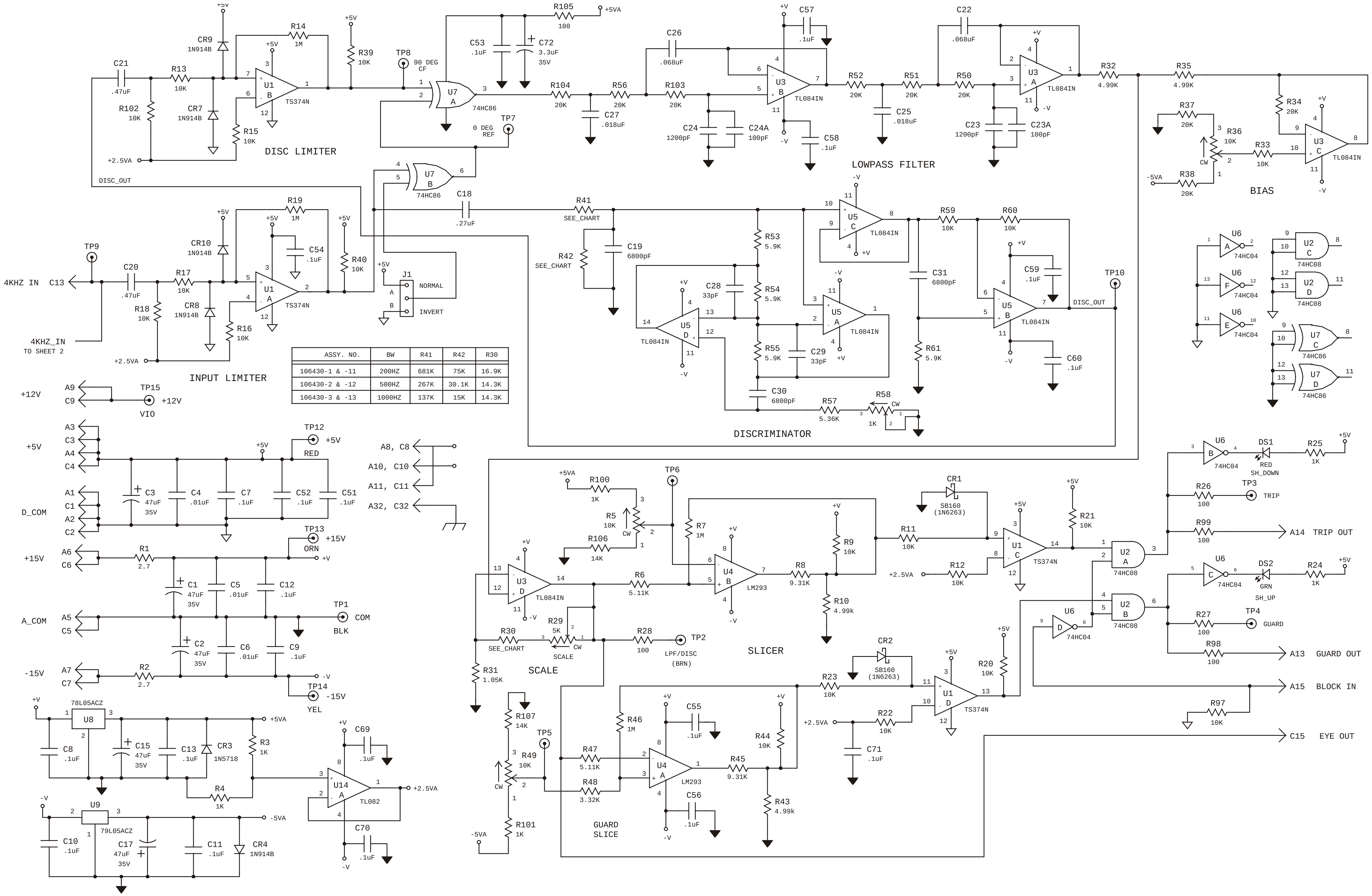


*=SEE CHART FOR COMPONENT VALUE

REF. DESIG.	106485-1 200Hz	106485-2 500Hz	106485-3 1000Hz
R6	4.64K	4.22K	3.65K
R7	4.42K	2.1K	2.43K
R8	6.04K	4.22K	6.65K
R9	6.04K	4.22K	6.65K
R10	5.62K	3.83K	6.19K
R12	1.54K	1.96K	3.92K
R13	12.1K	13K	13.3K
R14	976 OHM	3.01K	6.34K
R15	6.04K	6.49K	6.65K
R16	5.49K	6.04K	6.19K
R18	6.04K	6.49K	6.65K
R19	7.50K	13K	16.9K
R20	7.50K	13K	16.9K
R21	6.81K	12.4K	16.5K
R22	8.66K	20K	10K

REF. DESIG.	106485-1 200Hz	106485-2 500Hz	106485-3 1000Hz
R23	1K	5K	1K
R24	8.66K	20K	10K
R25	7.87K	20K	9.31K
R84	1.07K	3.4K	6.19K
R85	12.7K	26.7K	48.7K
R86	2.43K	12.7K	29.4K
R87	22.6K	45.3K	61.9K
R88	13.7K	45.3K	16.2K
C6	.0068uF	.01uF	.0068uF
C7	.0068uF	.01uF	.0068uF
C14	.0056uF	.0033uF	.0027uF
C15	.0047uF	.0022uF	.0047uF
C16	.0056uF	.0033uF	.0027uF
C22	.0047uF	.0022uF	.0047uF

Figure 13-5. Schematic, RFL 9780 CLI (Drawing No D-106489-E) Sheet 2 of 2



ASSY. NO.	BW	R41	R42	R30
106430-1 & -11	200HZ	681K	75K	16.9K
106430-2 & -12	500HZ	267K	30.1K	14.3K
106430-3 & -13	1000HZ	137K	15K	14.3K

Figure 14-5. Schematic, RFL 9780 Limiter/Slicer (Drawing No. D-106434-F) Sheet 1 of 2

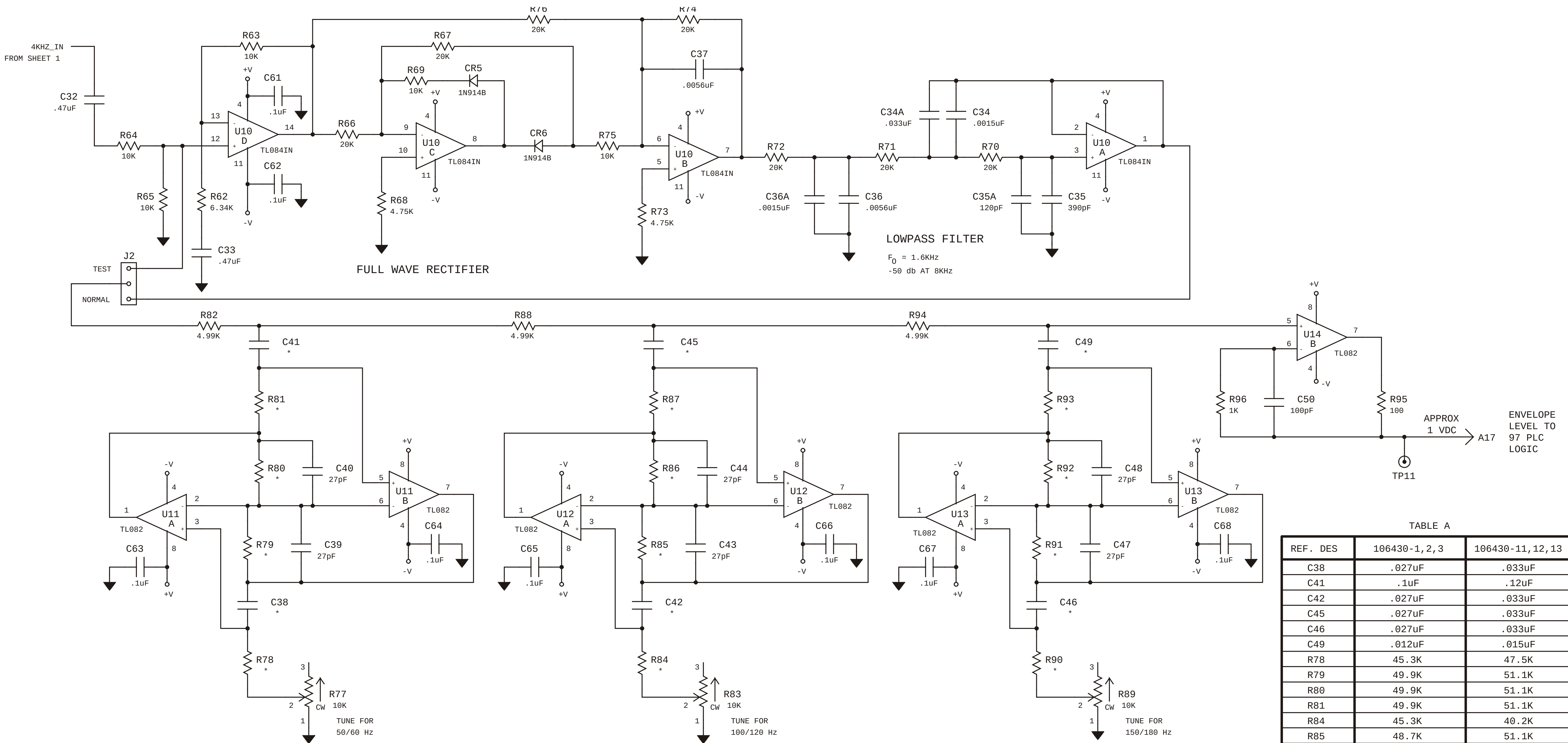
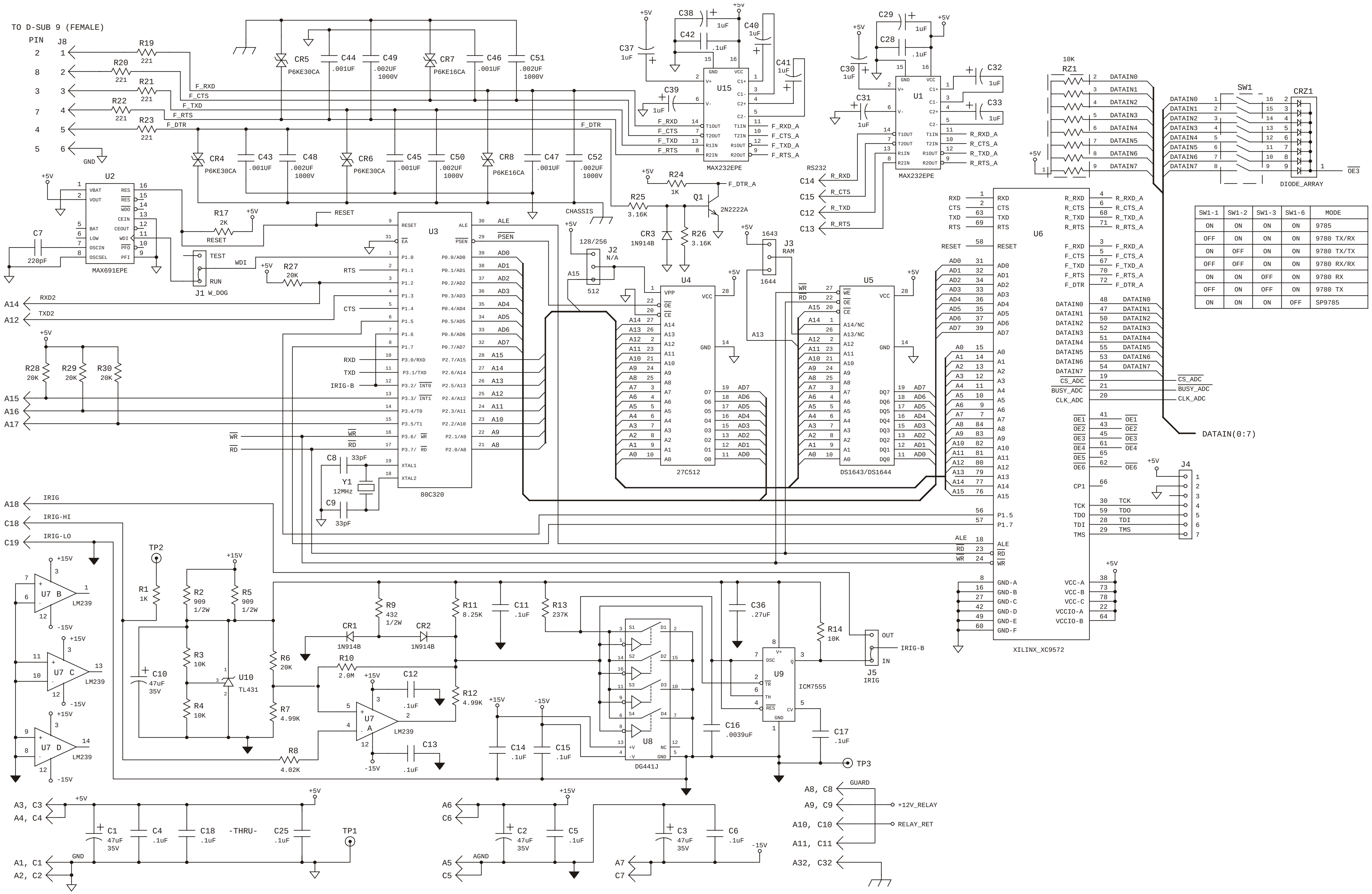


TABLE A

REF. DES	106430-1,2,3	106430-11,12,13
C38	.027uF	.033uF
C41	.1uF	.12uF
C42	.027uF	.033uF
C45	.027uF	.033uF
C46	.027uF	.033uF
C49	.012uF	.015uF
R78	45.3K	47.5K
R79	49.9K	51.1K
R80	49.9K	51.1K
R81	49.9K	51.1K
R84	45.3K	40.2K
R85	48.7K	51.1K
R86	48.7K	51.1K
R87	48.7K	51.1K
R90	45.3K	40.2K
R91	48.7K	51.1K
R92	48.7K	51.1K
R93	48.7K	51.1K

* - SEE TABLE A

Figure 14-5. Schematic, RFL 9780 Limiter/Slicer (Drawing No. D-106434-F) Sheet 2 of 2



SW1-1	SW1-2	SW1-3	SW1-6	MODE
ON	ON	ON	ON	9785
OFF	ON	ON	ON	9780 TX/RX
ON	OFF	ON	ON	9780 TX/TX
OFF	OFF	ON	ON	9780 RX/RX
ON	ON	OFF	ON	9780 RX
OFF	ON	OFF	ON	9780 TX
ON	ON	ON	OFF	SP9785

Figure 15-4. Schematic, RFL 9780 SOE/IRIG-B With Reflected Power Meter (Drawing No. D-106484-1-B) Sheet 1 of 2

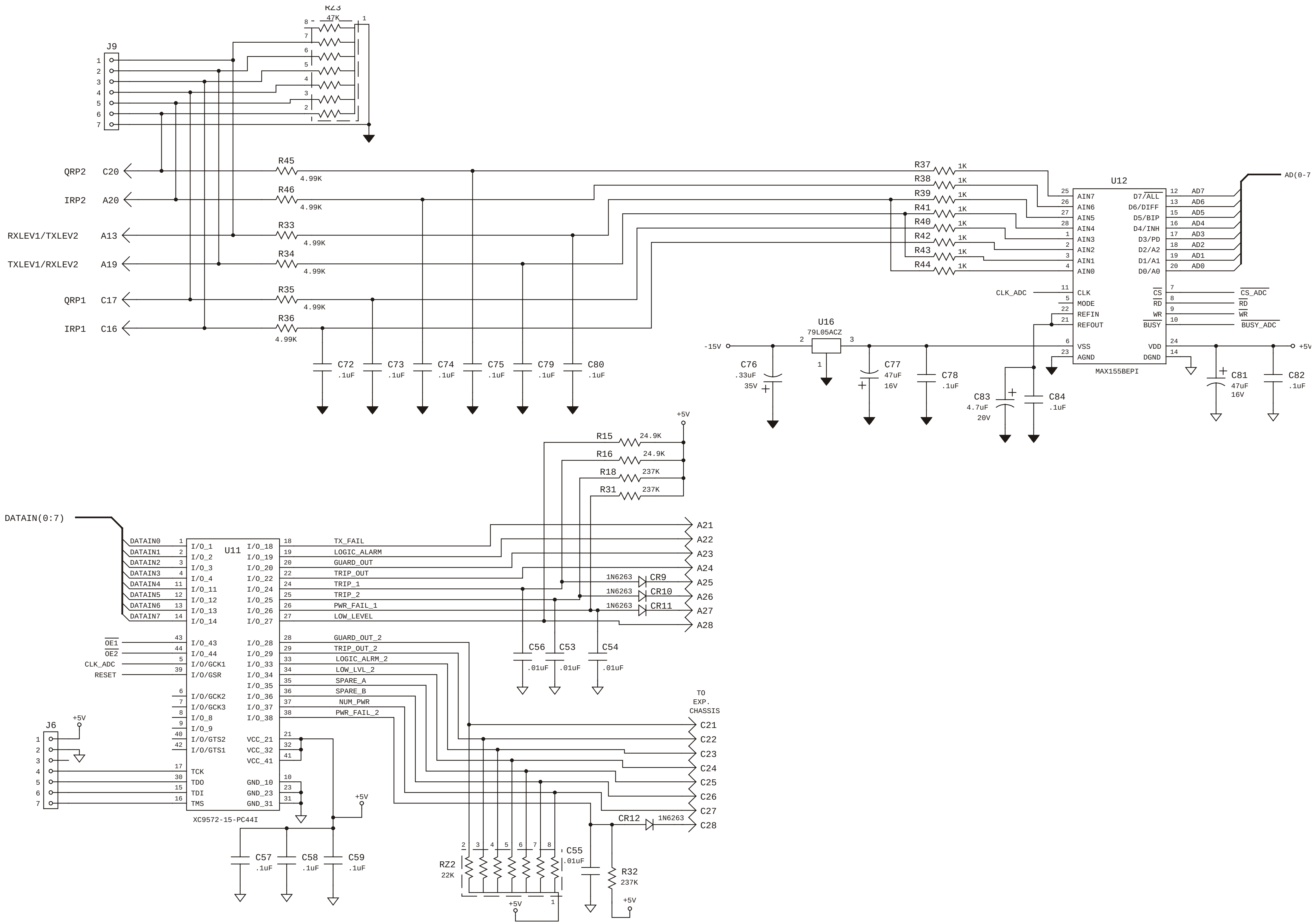


Figure 15-4. Schematic, RFL 9780 SOE/IRIG-B With Reflected Power Meter (Drawing No. D-106484-1-B) Sheet 2 of 2

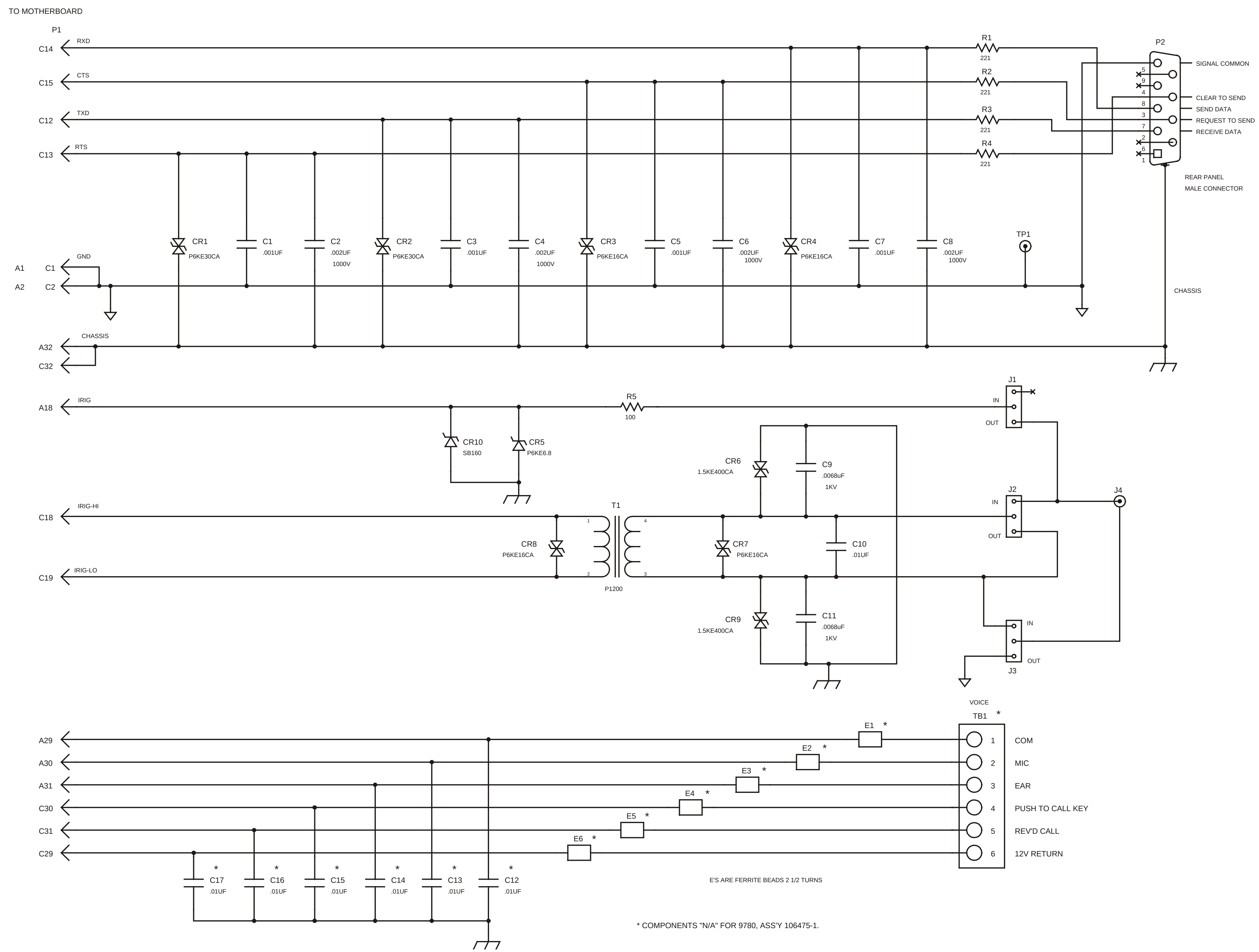
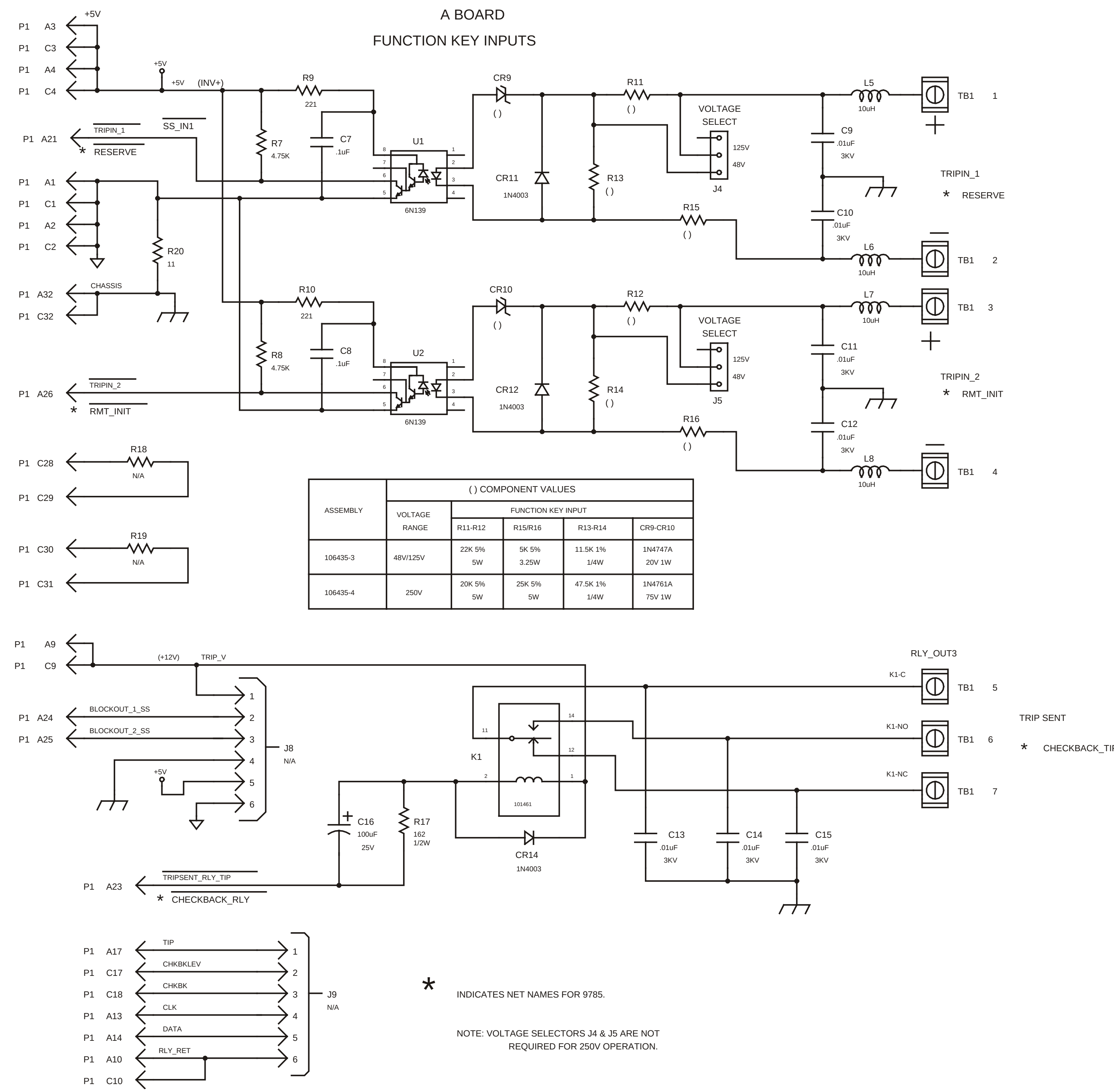


Figure 15-8. Schematic, RFL 9780 SOE/IRIG-B I/O (Drawing No. D-106479-B)



ASSEMBLY	( ) COMPONENT VALUES				
	VOLTAGE RANGE	FUNCTION KEY INPUT			
		R11-R12	R15/R16	R13-R14	CR9-CR10
106435-3	48V/125V	22K 5% 5W	5K 5% 3.25W	11.5K 1% 1/4W	1N4747A 20V 1W
106435-4	250V	20K 5% 5W	25K 5% 5W	47.5K 1% 1/4W	1N4761A 75V 1W

* INDICATES NET NAMES FOR 9785.

NOTE: VOLTAGE SELECTORS J4 & J5 ARE NOT REQUIRED FOR 250V OPERATION.

Figure 17-5. Schematic, RFL 9780 Solid-State Input I/O (Drawing No. D-106439-3-A)

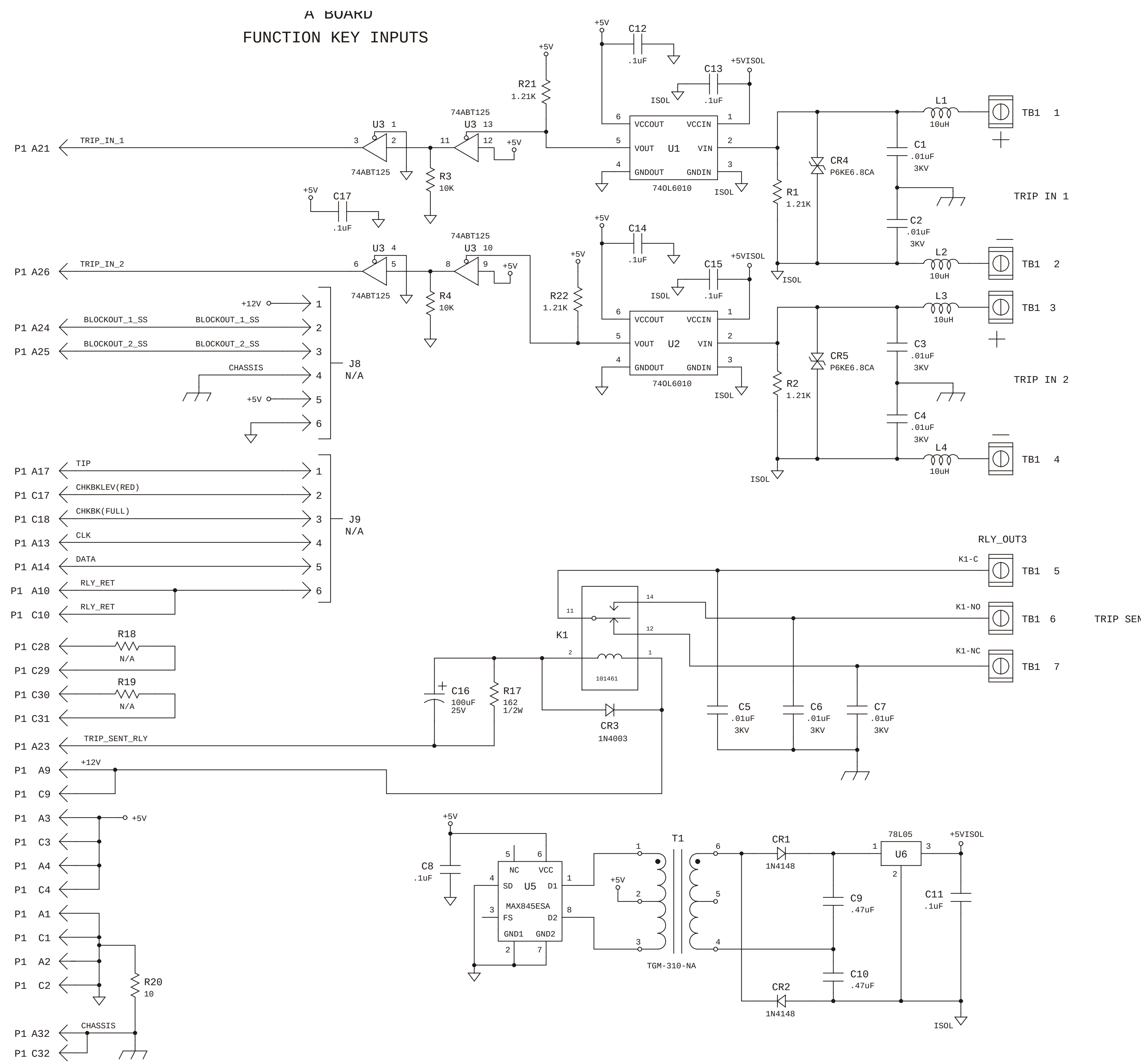
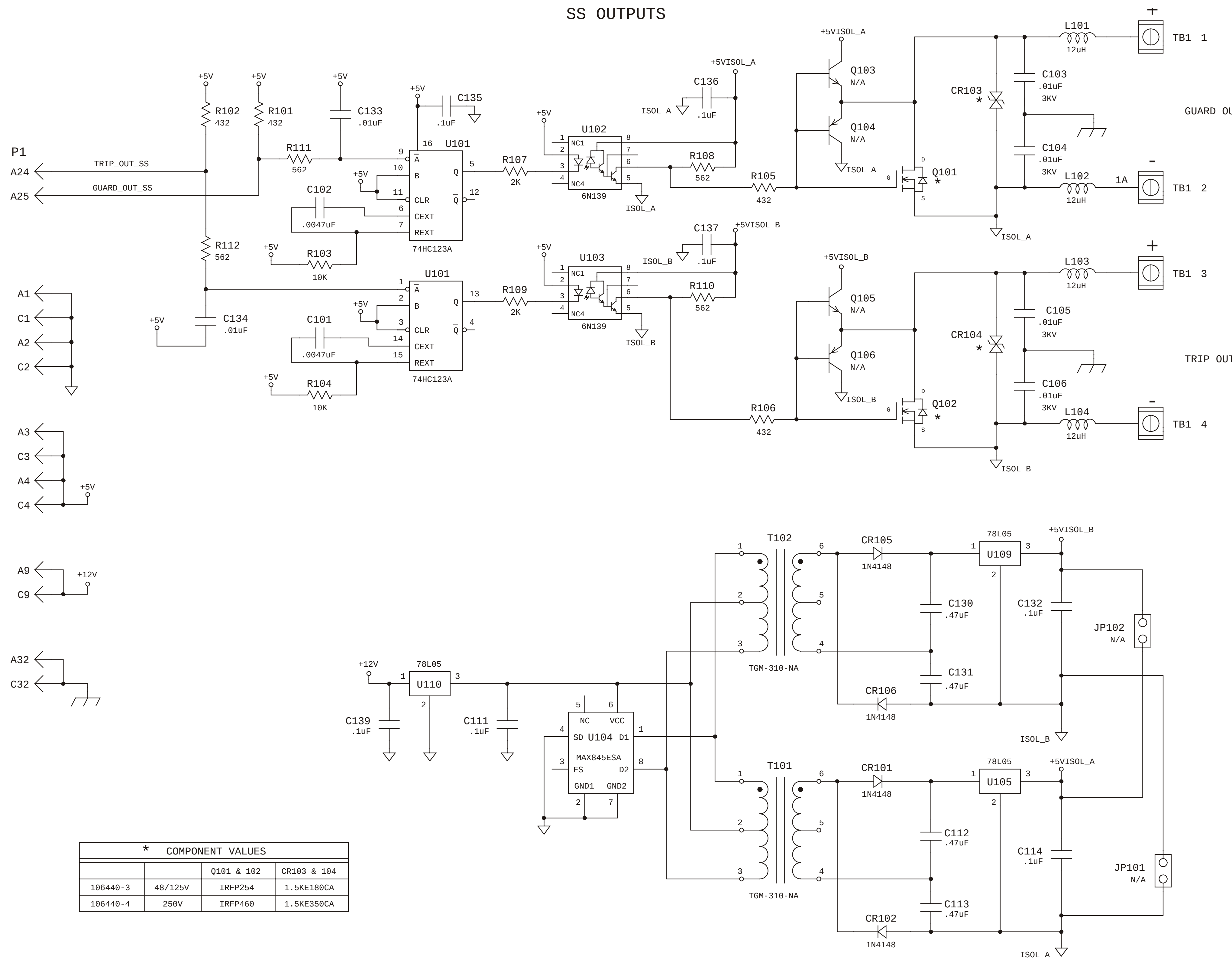


Figure 17-6. Schematic, RFL 9780 Solid-State Logic Level Input I/O (Drawing No. D-106439-5-B)



* COMPONENT VALUES			
		Q101 & 102	CR103 & 104
106440-3	48/125V	IRFP254	1.5KE180CA
106440-4	250V	IRFP460	1.5KE350CA

Figure 17-9. Schematic, RFL 9780 Solid-State Output I/O (Drawing No. D-106444-3-D)

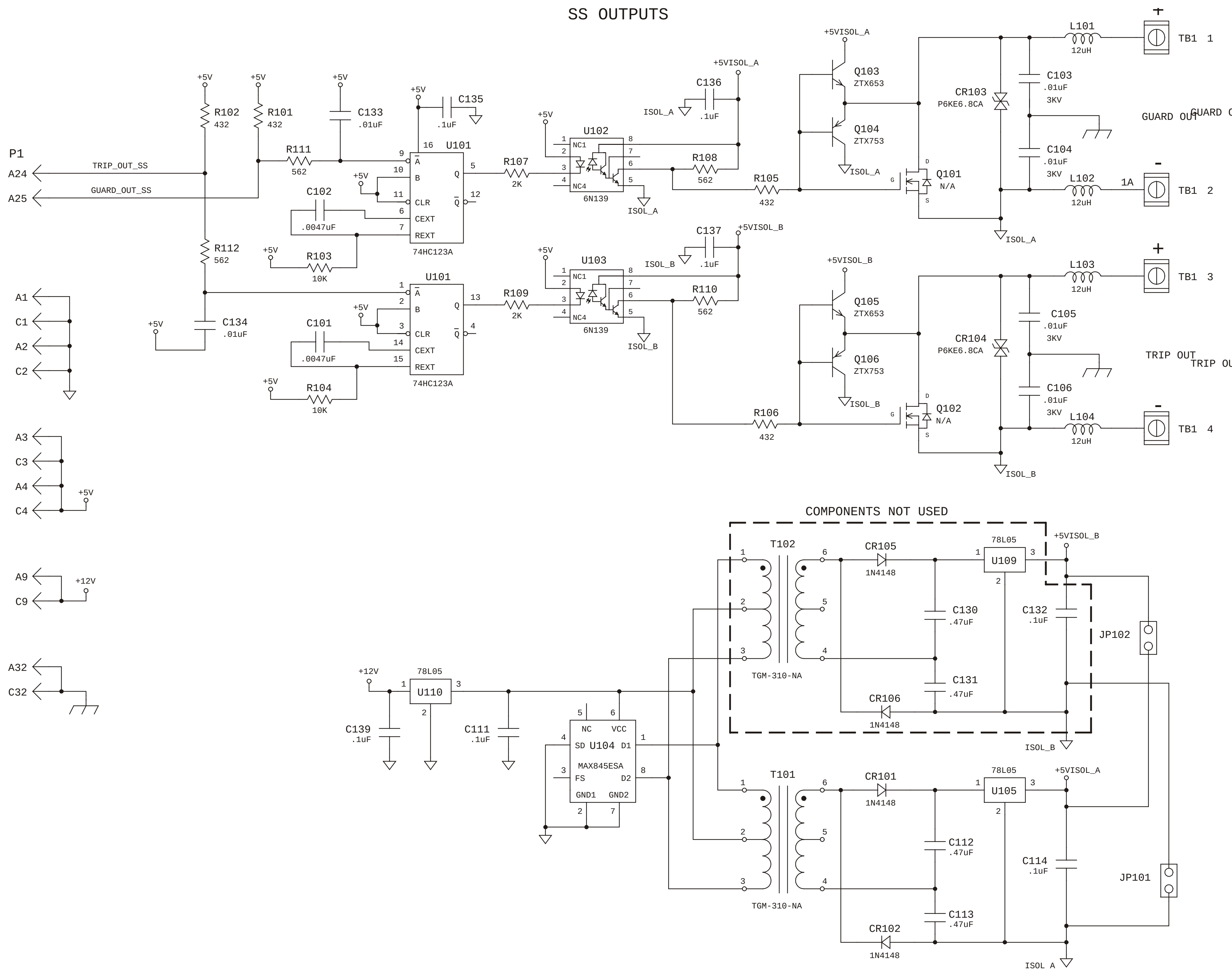
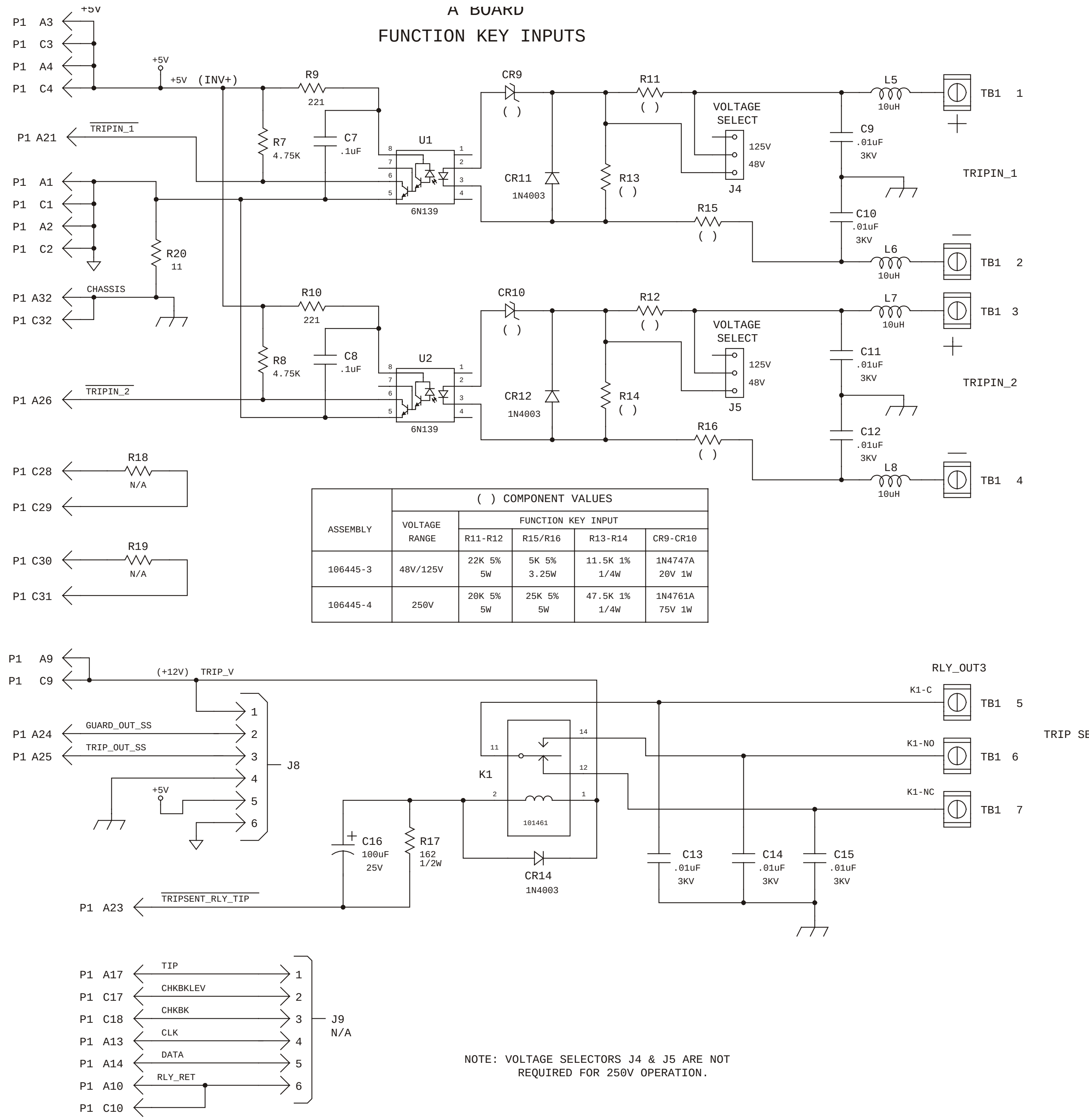
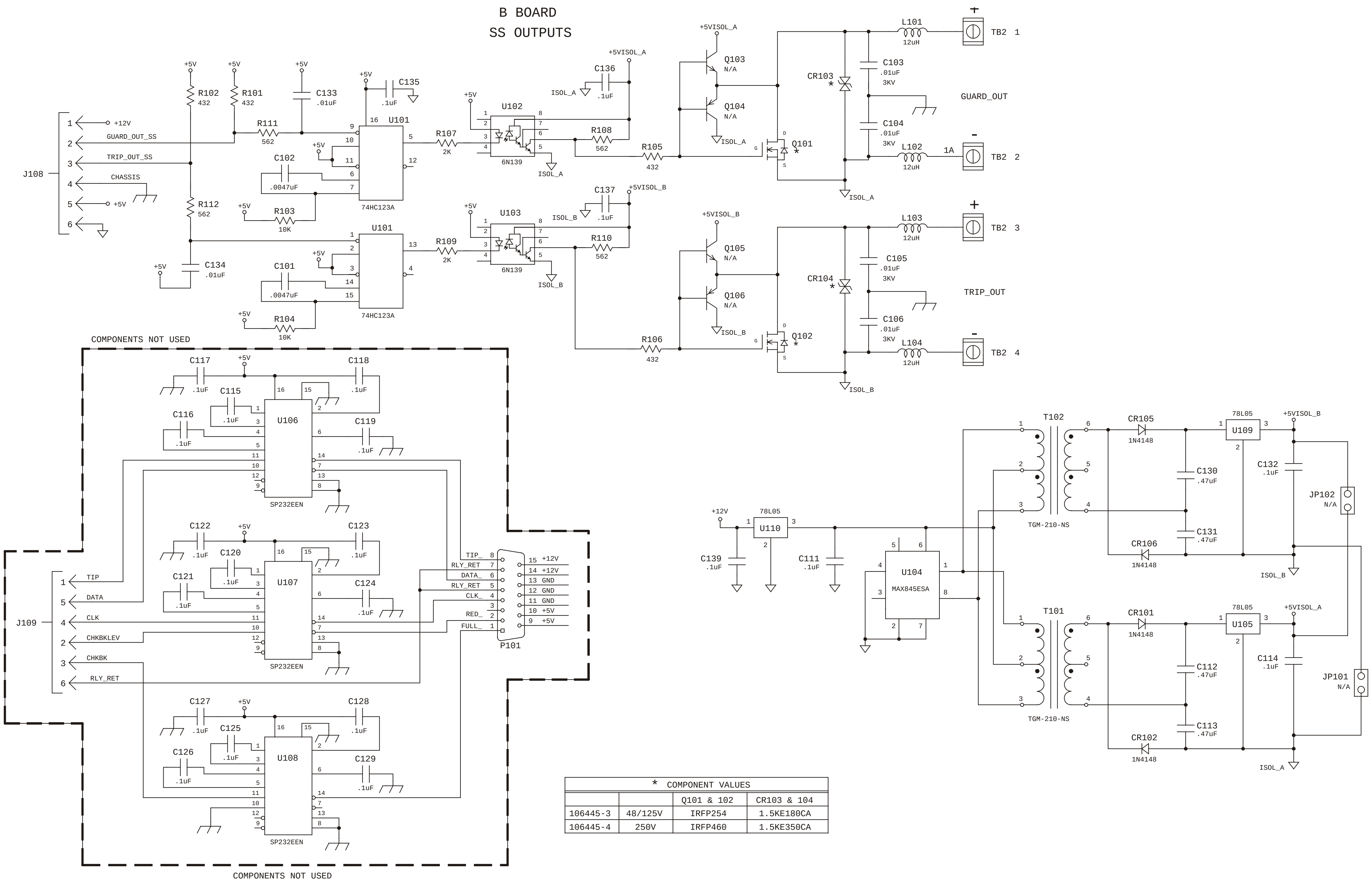


Figure 17-10. Schematic, RFL 9780 Solid-State Logic Level Output I/O (Drawing No. D-106444-5-D)



ASSEMBLY	( ) COMPONENT VALUES				
	VOLTAGE RANGE	FUNCTION KEY INPUT			
		R11-R12	R15/R16	R13-R14	CR9-CR10
106445-3	48V/125V	22K 5% 5W	5K 5% 3.25W	11.5K 1% 1/4W	1N4747A 20V 1W
106445-4	250V	20K 5% 5W	25K 5% 5W	47.5K 1% 1/4W	1N4761A 75V 1W

Figure 17-13. Schematic, RFL 9780 Solid-State Input/Output I/O (Drawing No. D-106449-3-B) Sheet 1 of 2



* COMPONENT VALUES			
		Q101 & 102	CR103 & 104
106445-3	48/125V	IRFP254	1.5KE180CA
106445-4	250V	IRFP460	1.5KE350CA

Figure 17-13. Schematic, RFL 9780 Solid-State Input/Output I/O (Drawing No. D-106449-3-B) Sheet 2 of 2

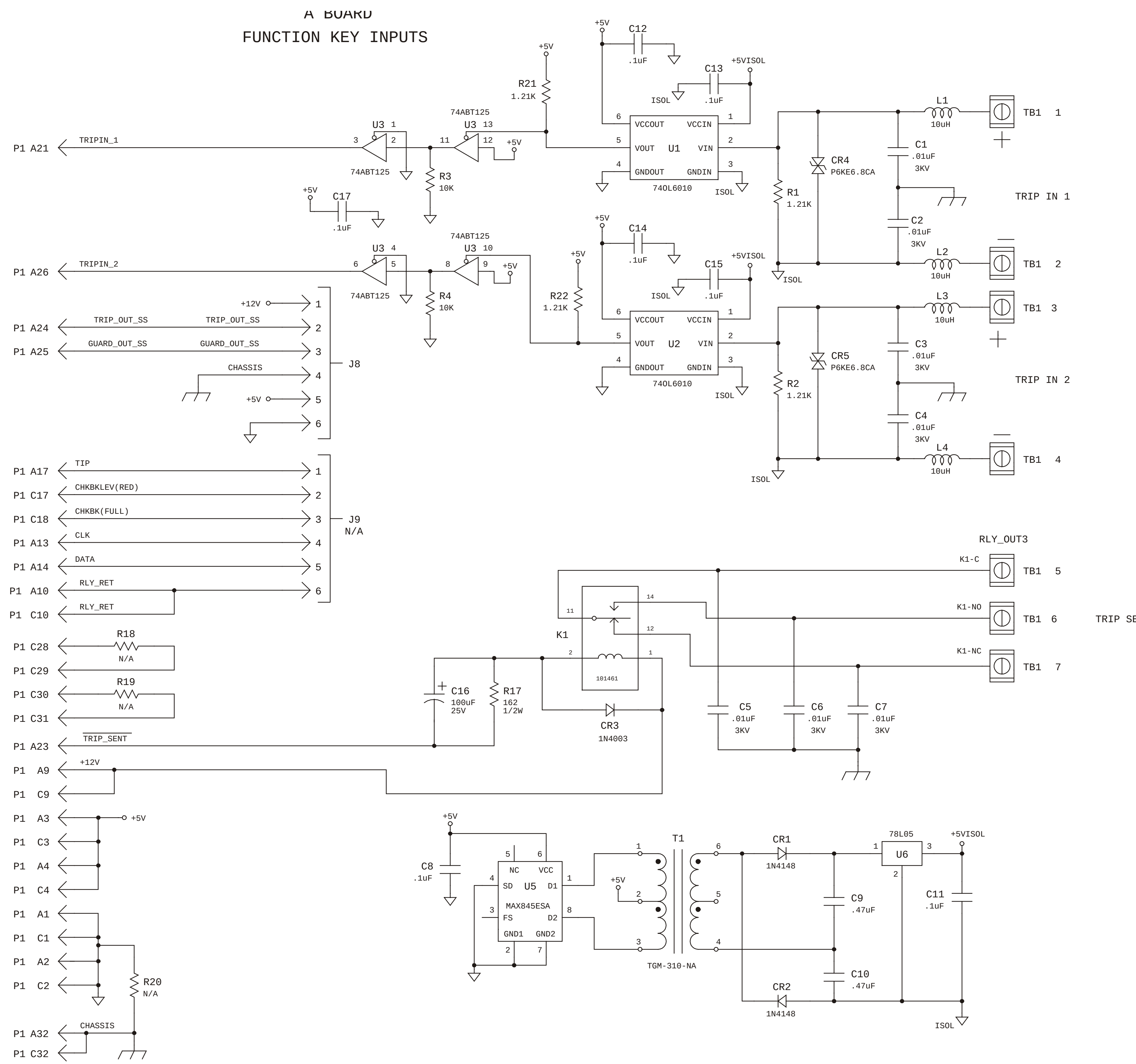


Figure 17-15. Schematic, RFL 9780 Solid-State Logic Level Input/Output I/O (Drawing No. D-106449-5-D) Sheet 1 of 2

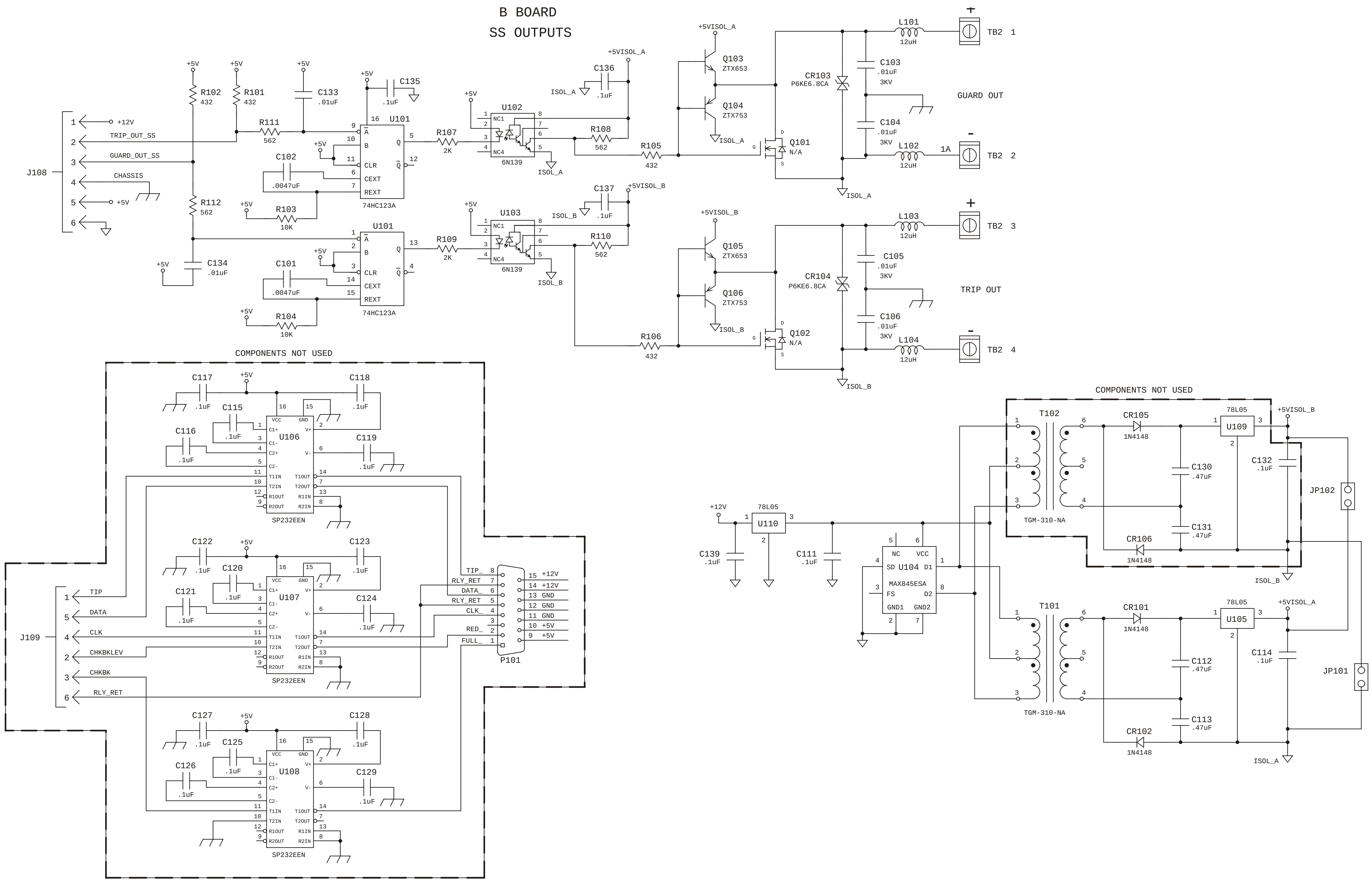
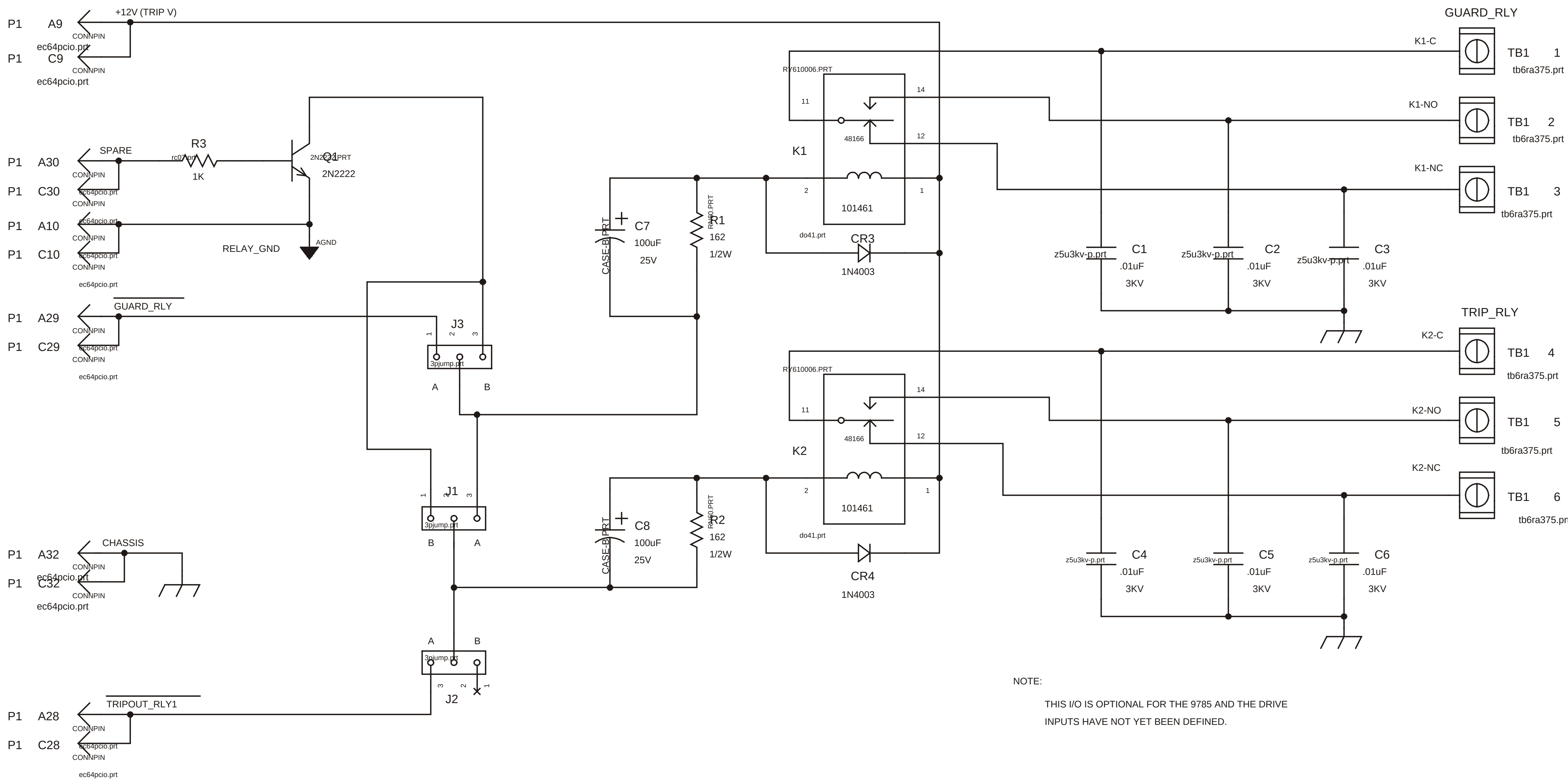


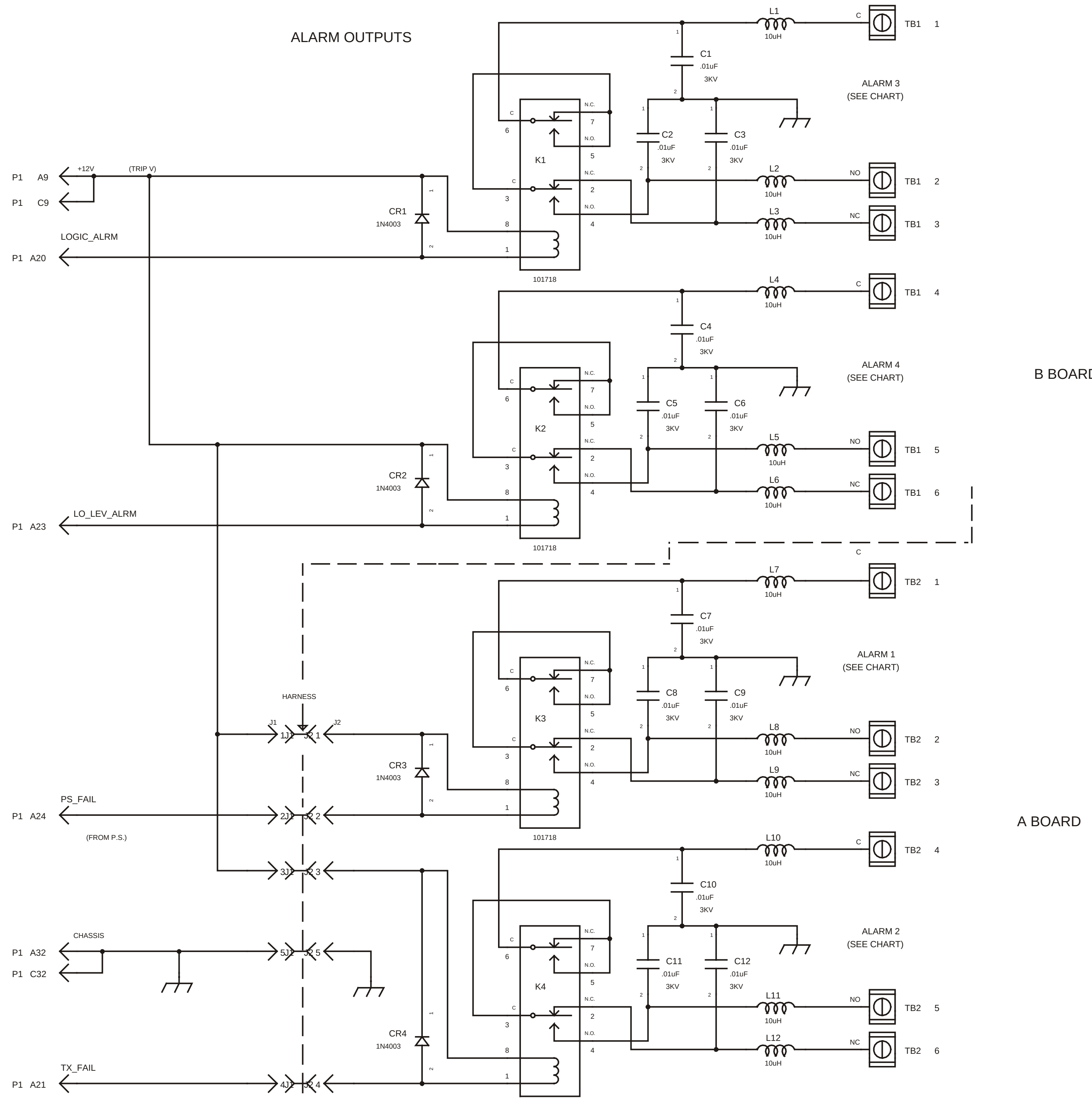
Figure 17-15. Schematic, RFL 9780 Solid-State Logic Level Input/Output I/O (Drawing No. D-106449-5-D) Sheet 2 of 2



NORMAL POSITIONS

J1	NC
J2	A
J3	A

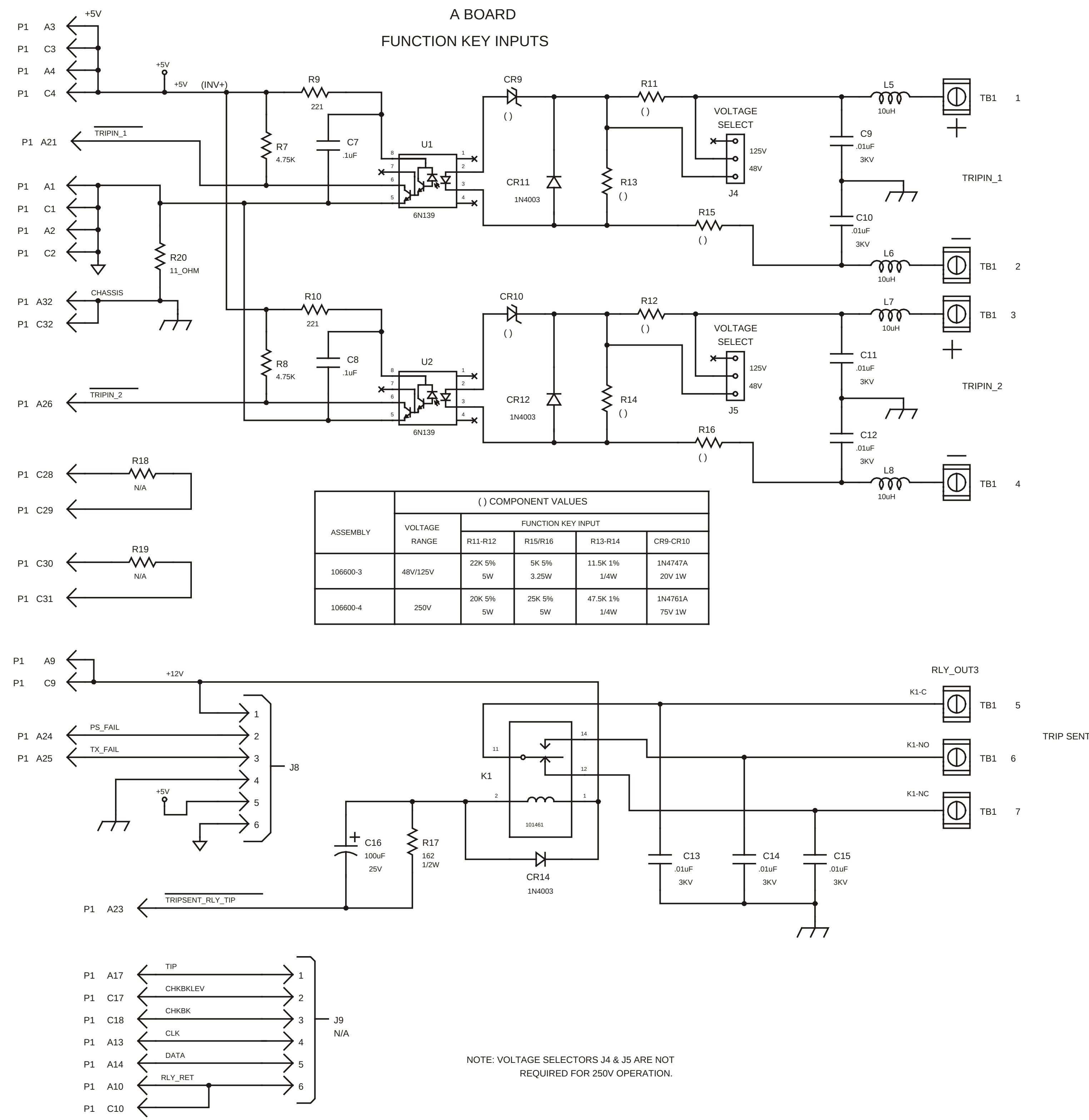
Figure 17-18. Schematic, RFL 9780 Dual Relay I/O (Drawing No. C-106474-A)



ALARM #'S

		1	2	3	4
9780	TX/RX	POWER FAIL	TX FAIL	LOGIC FAIL	LOW LEVEL
	TX/TX	POWER FAIL #1	TX FAIL #1	POWER FAIL #2	TX FAIL #2
	RX/RX	POWER FAIL	SPARE	LOGIC FAIL	LOW LEVEL
	9785	POWER FAIL	TX FAIL	CB TIP	CHECK BACK FAIL

Figure 17-21. Schematic, RFL 9780 Alarm Relay I/O (Drawing No. D-106469-C)



( ) COMPONENT VALUES					
ASSEMBLY	VOLTAGE RANGE	FUNCTION KEY INPUT			
		R11-R12	R15/R16	R13-R14	CR9-CR10
106600-3	48V/125V	22K 5% 5W	5K 5% 3.25W	11.5K 1% 1/4W	1N4747A 20V 1W
106600-4	250V	20K 5% 5W	25K 5% 5W	47.5K 1% 1/4W	1N4761A 75V 1W

Figure 17-24. Schematic, RFL 9780 Solid State Input Alarm I/O (Drawing No. D-106604-3-A) Sheet 1 of 2

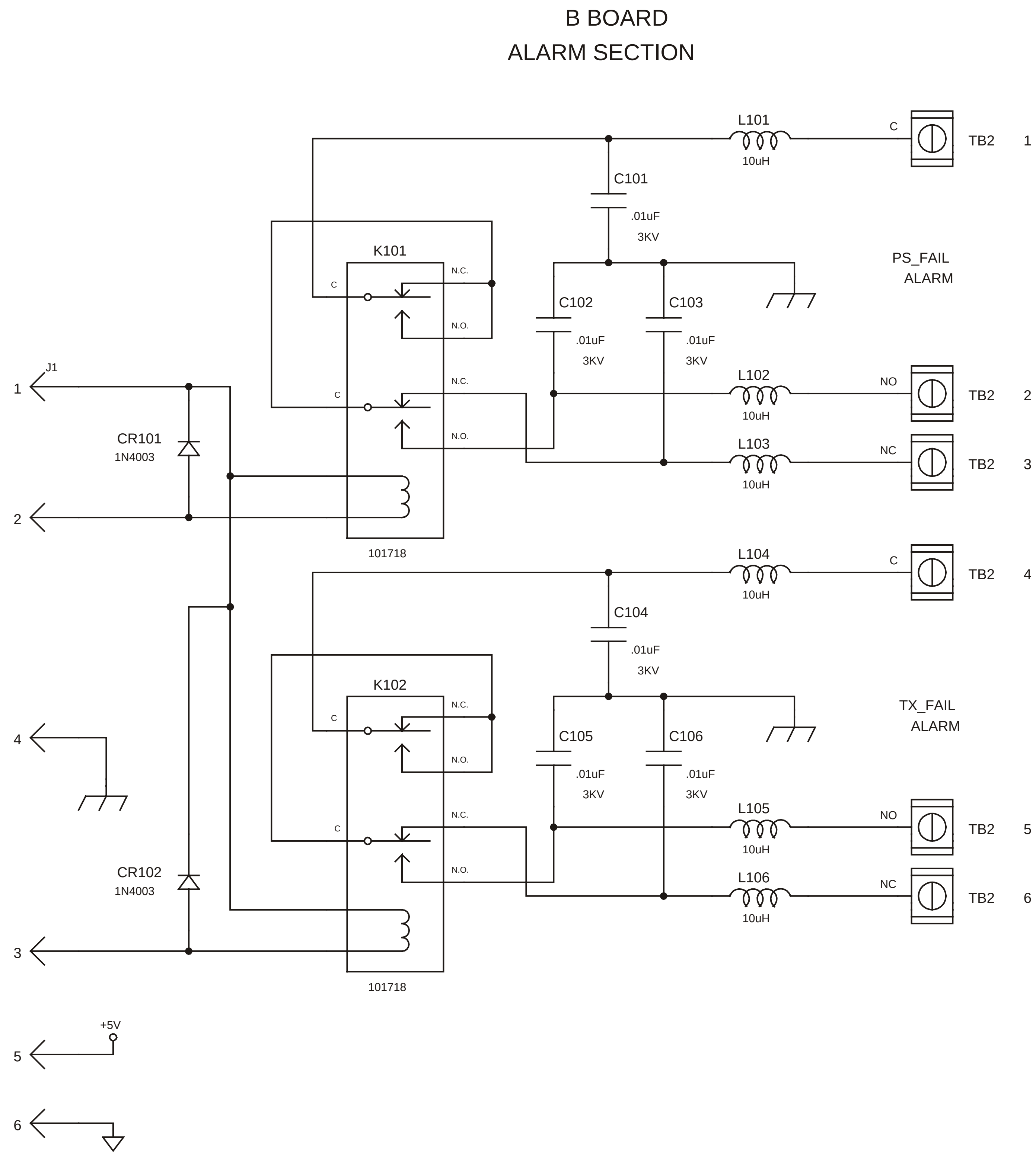


Figure 17-24. Schematic, RFL 9780 Solid State Input Alarm I/O (Drawing No. D-106604-3-A) Sheet 2 of 2

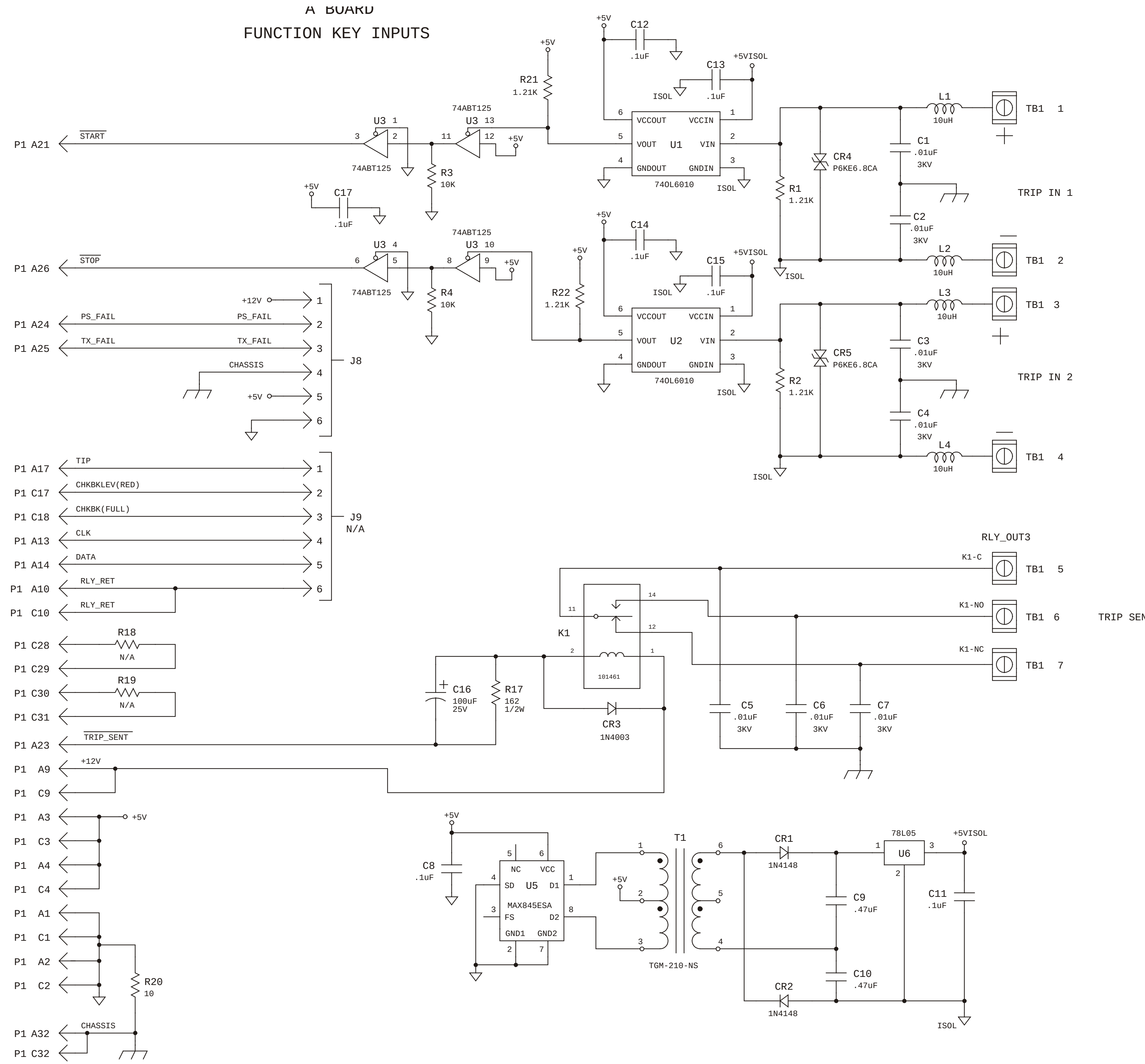


Figure 17-26. Schematic, RFL 9780 Solid-State Logic Level Input Alarm I/O (Drawing No. D-106604-5-B) Sheet 1 of 2

B BOARD
ALARM SECTION

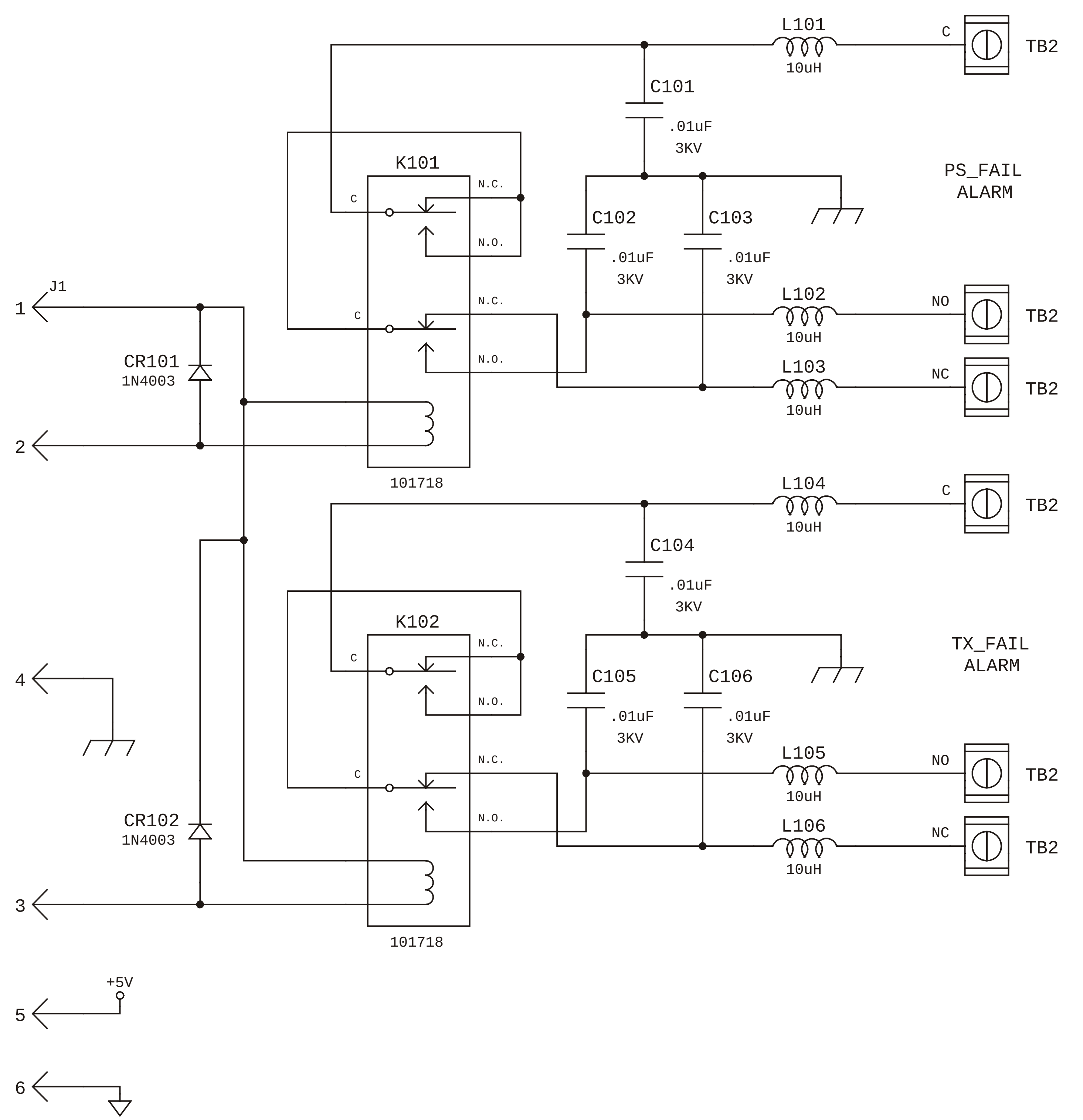
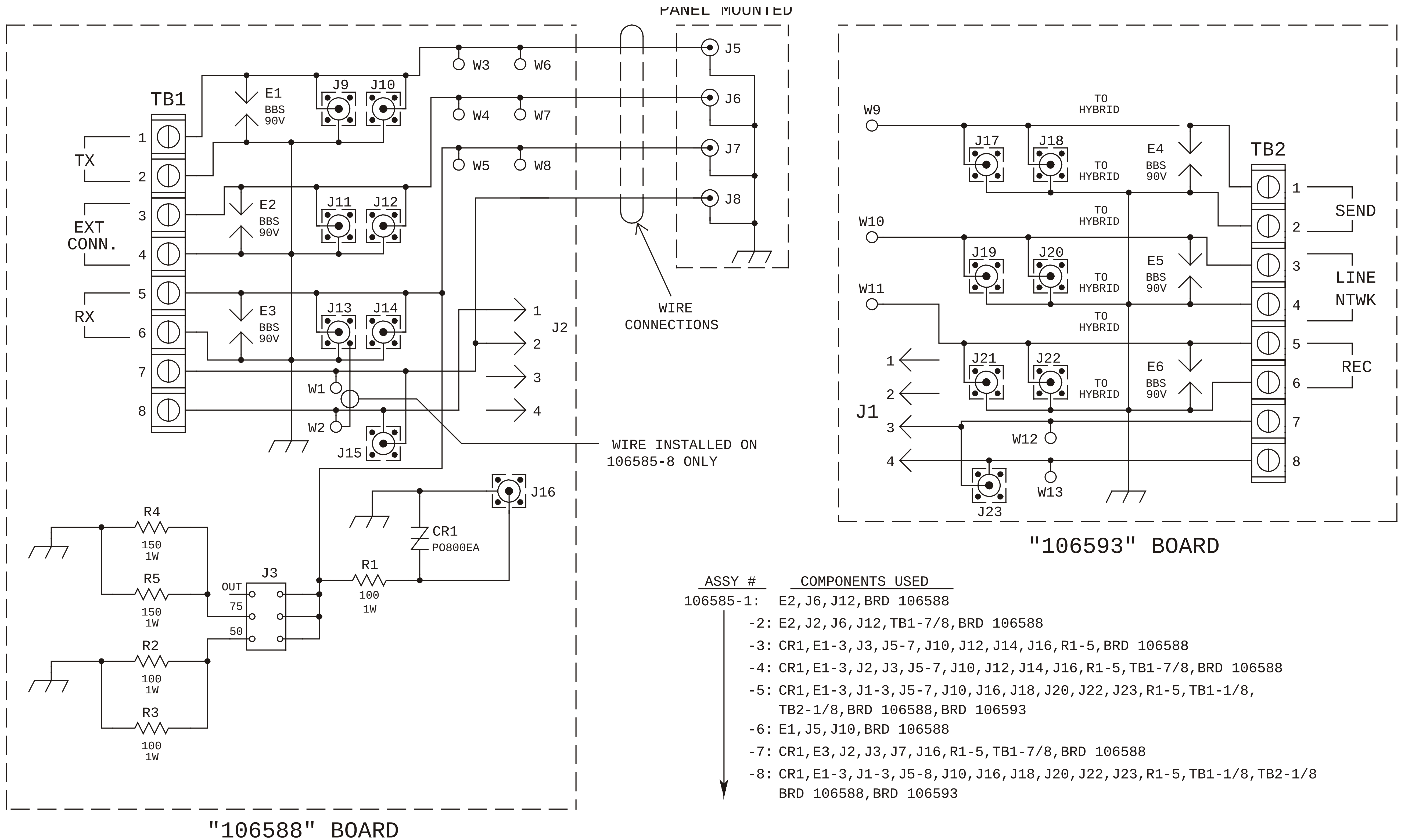


Figure 17-26. Schematic, RFL 9780 Solid-State Logic Level Input Alarm I/O (Drawing No. D-106604-5-B) Sheet 2 of 2



ASSY #	COMPONENTS USED
106585-1:	E2,J6,J12,BRD 106588
-2:	E2,J2,J6,J12,TB1-7/8,BRD 106588
-3:	CR1,E1-3,J3,J5-7,J10,J12,J14,J16,R1-5,BRD 106588
-4:	CR1,E1-3,J2,J3,J5-7,J10,J12,J14,J16,R1-5,TB1-7/8,BRD 106588
-5:	CR1,E1-3,J1-3,J5-7,J10,J16,J18,J20,J22,J23,R1-5,TB1-1/8, TB2-1/8,BRD 106588,BRD 106593
-6:	E1,J5,J10,BRD 106588
-7:	CR1,E3,J2,J3,J7,J16,R1-5,TB1-7/8,BRD 106588
-8:	CR1,E1-3,J1-3,J5-8,J10,J16,J18,J20,J22,J23,R1-5,TB1-1/8,TB2-1/8 BRD 106588,BRD 106593

Figure 17-36. Schematic, RFL 9780 TX/RX RF Line I/O (Drawing No. C-106589-D)

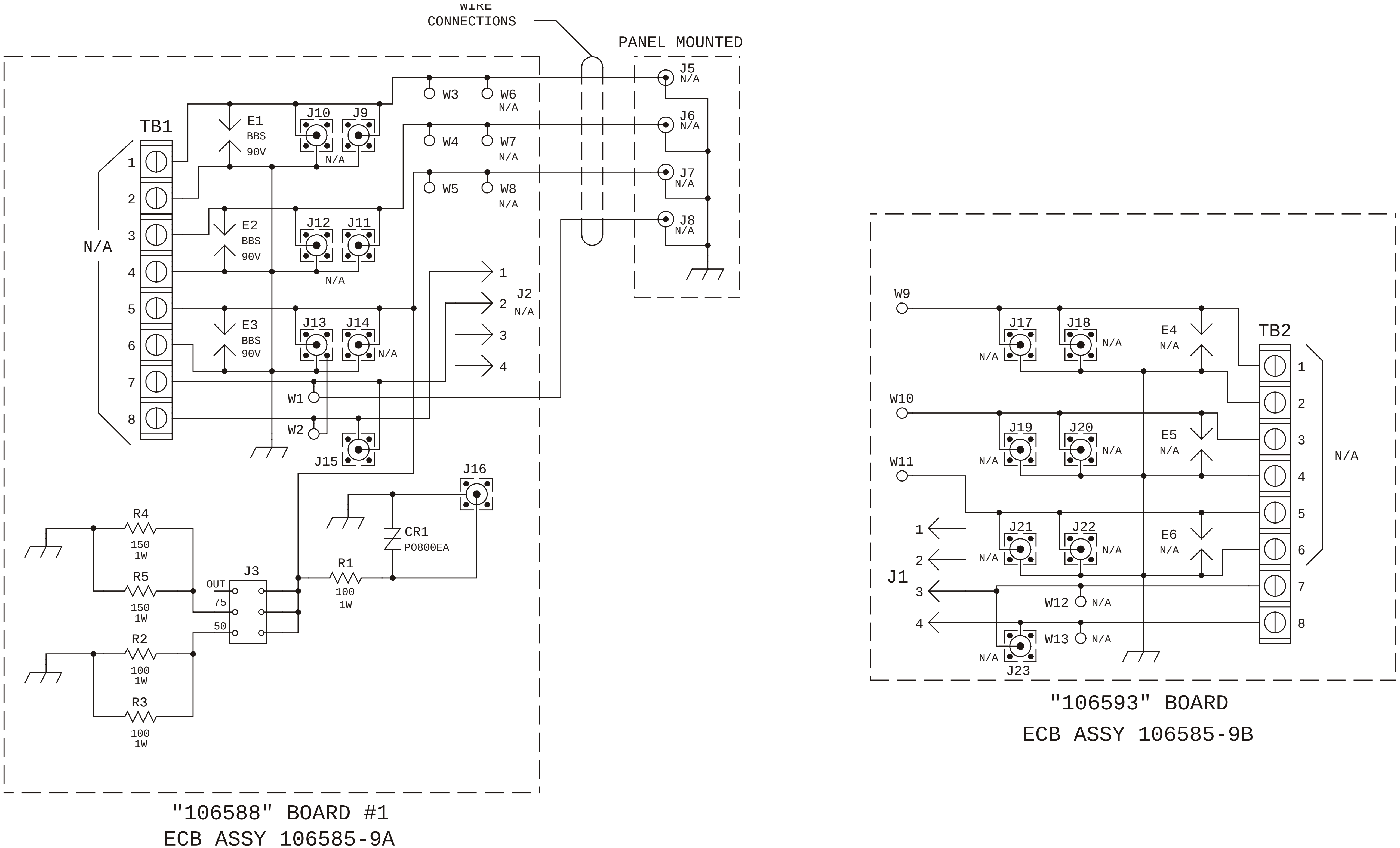


Figure 17-38. Schematic, RFL 9780 TX/RX RF Line I/O (Drawing No. D-106609-9-C)

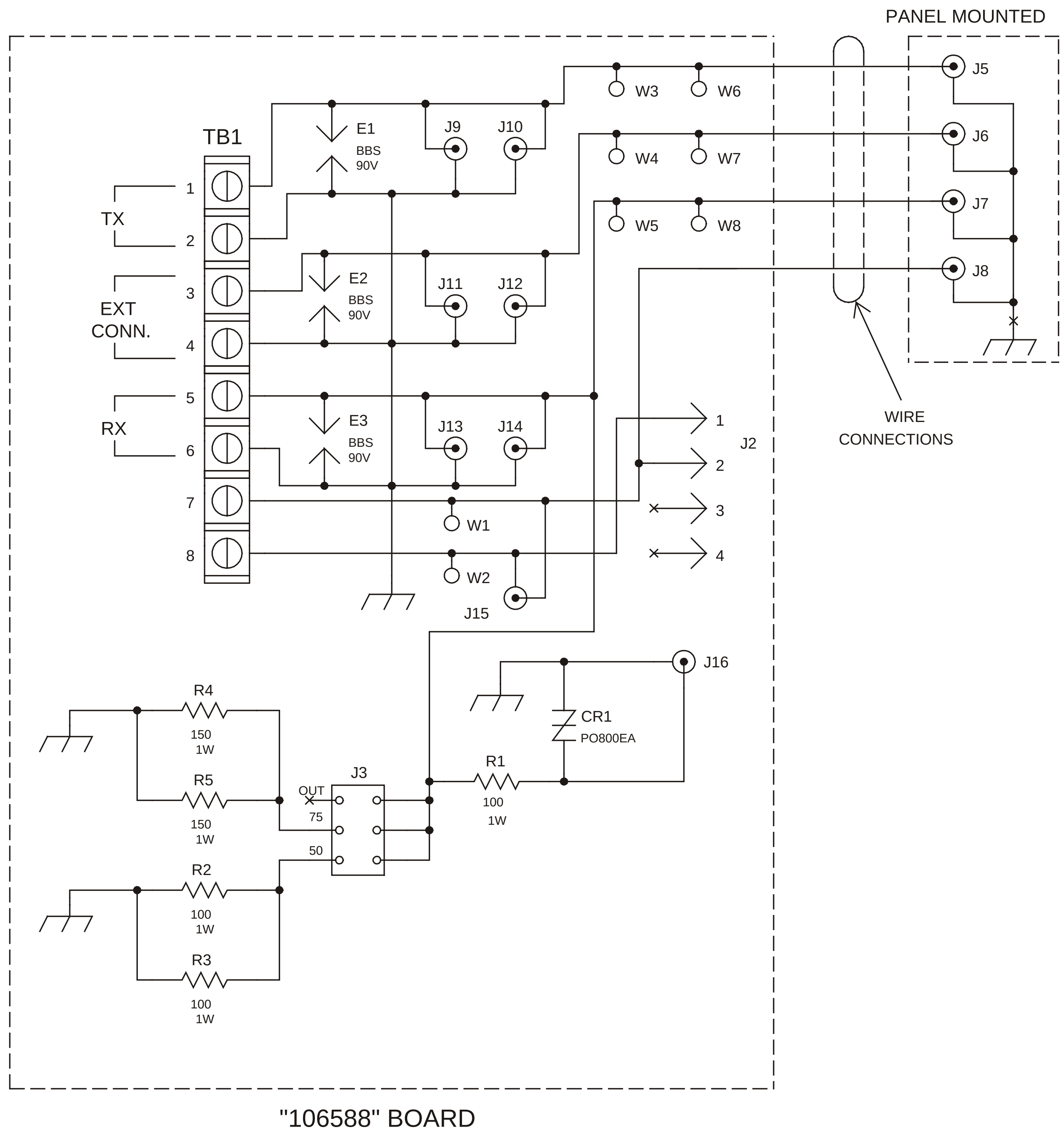


Figure 17-40. Schematic, RFL 9780 TX/TX RF Line I/O (Drawing No. C-106594-B)

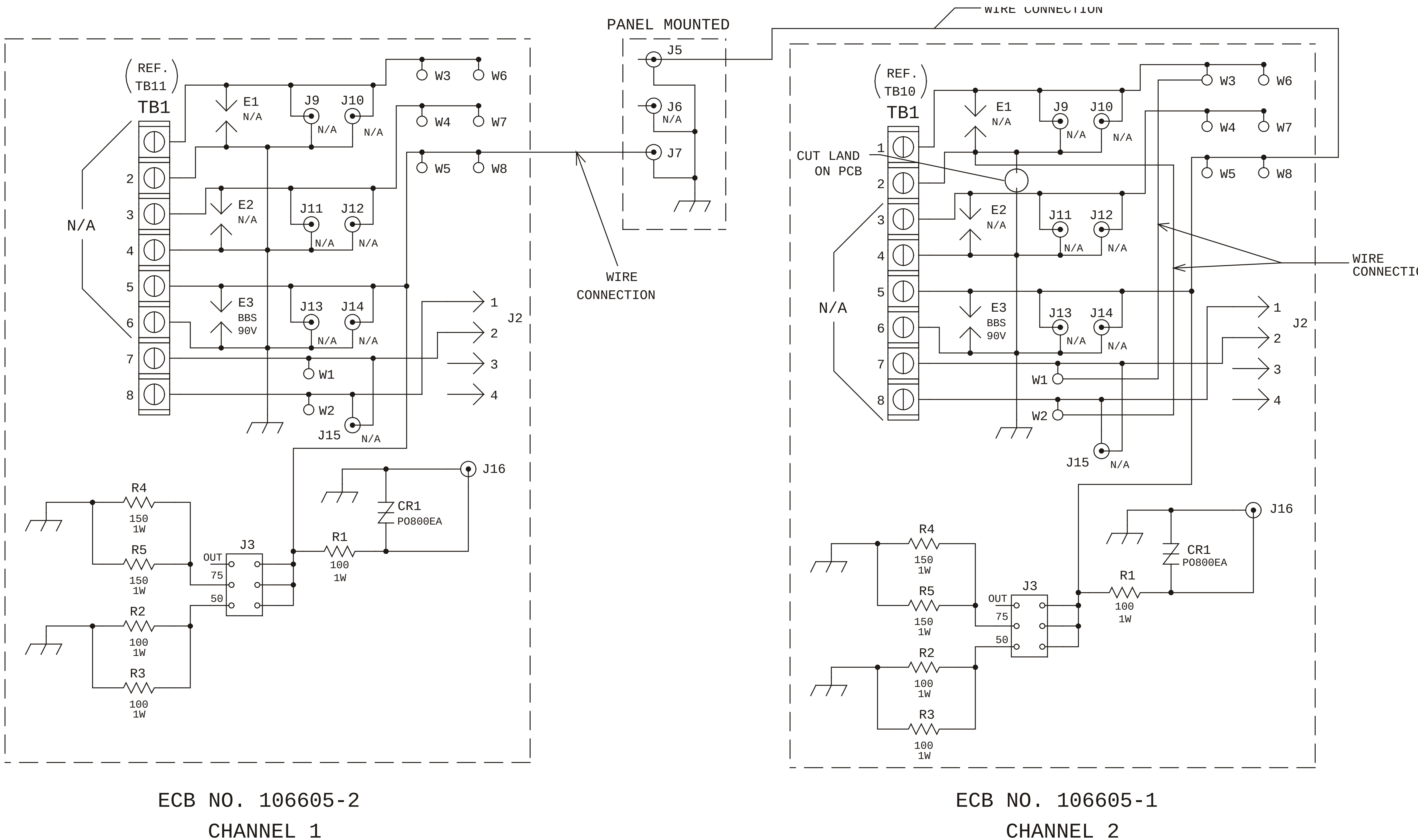


Figure 17-42. Schematic, RFL 9780 RX/RX RF Line I/O (Drawing No. D-106609-B)

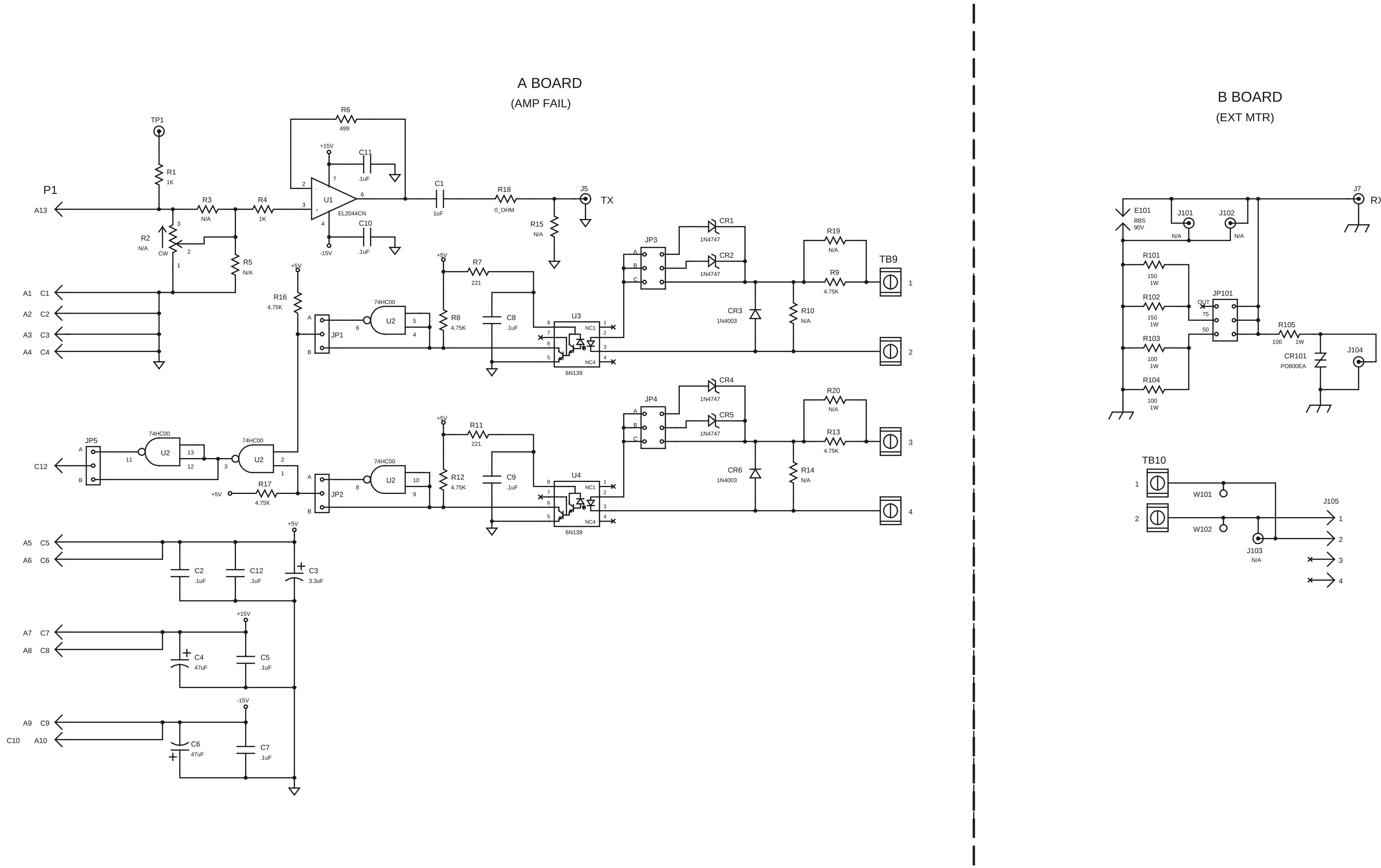
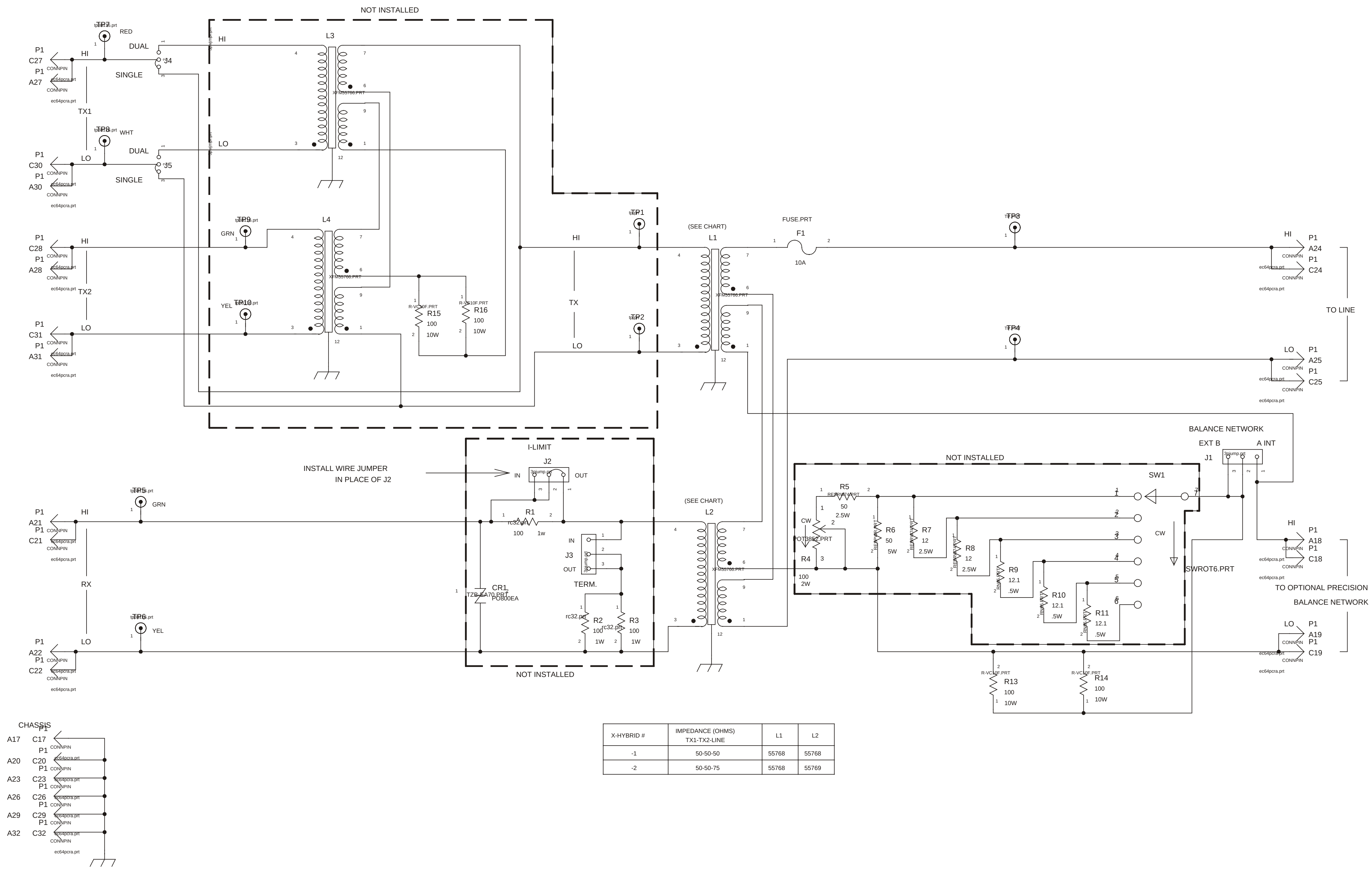
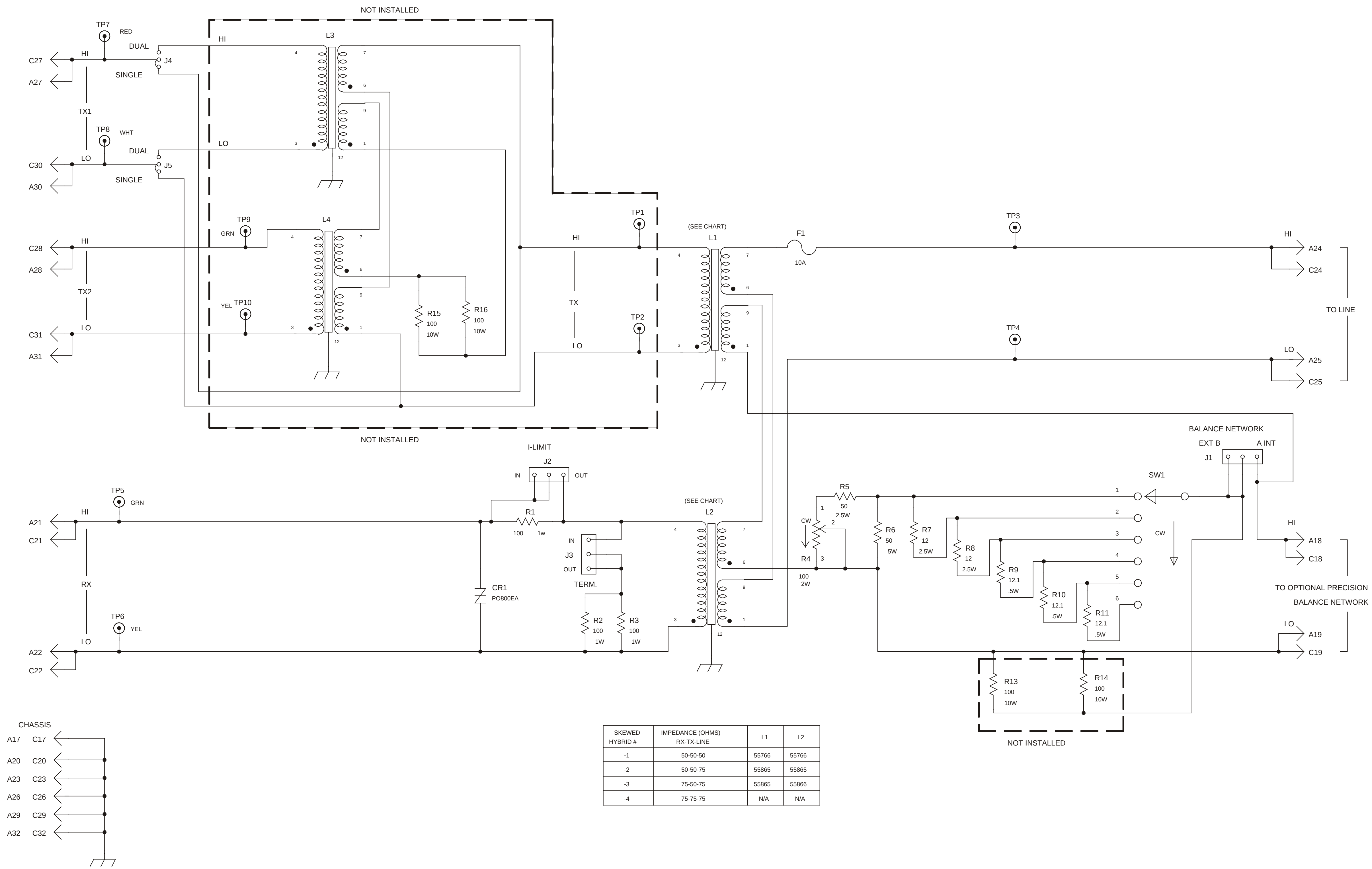


Figure 17-45. Schematic, RFL 9780 External Power Amp I/O (Drawing No. D-106679-A)



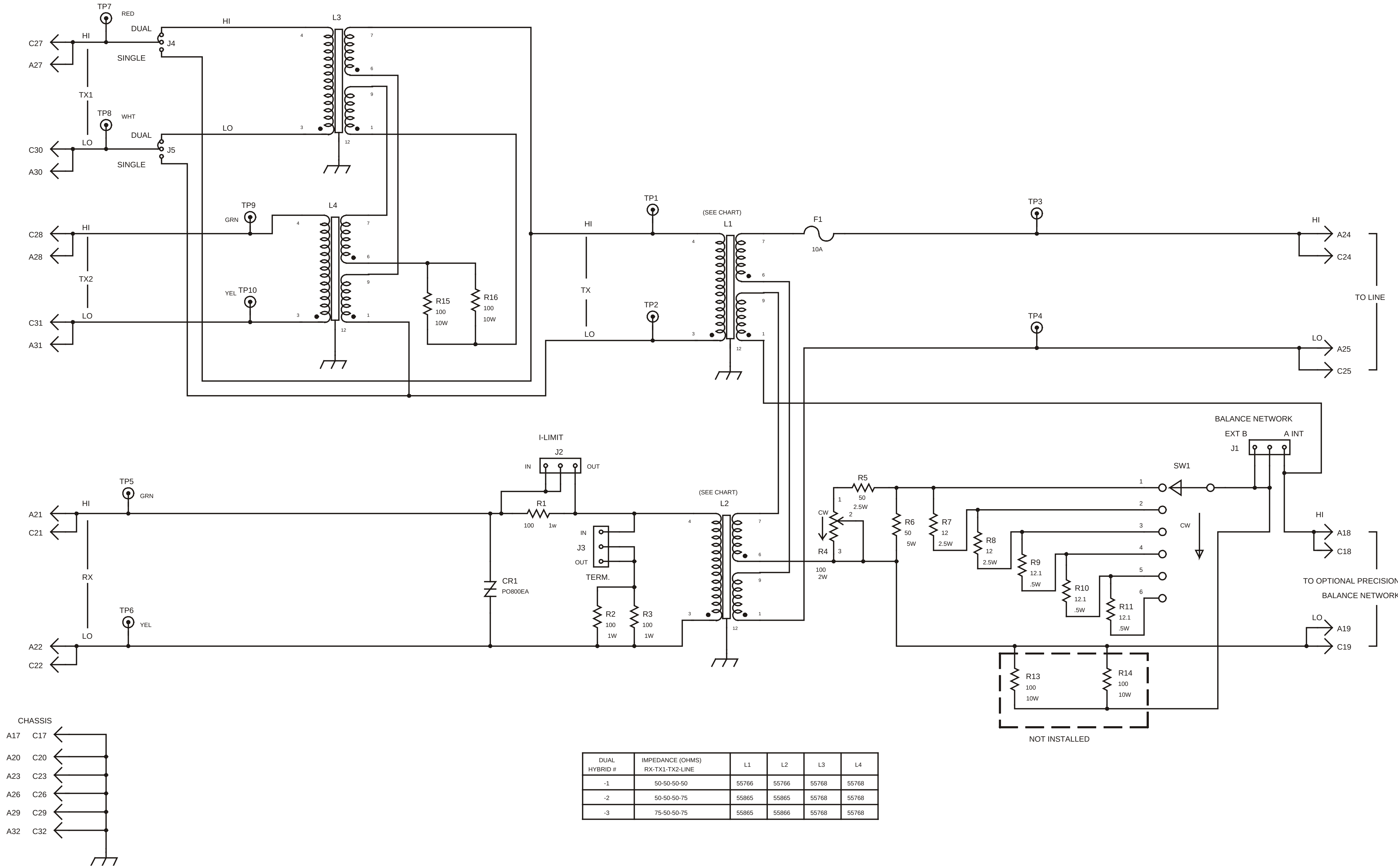
X-HYBRID #	IMPEDANCE (OHMS) TX1-TX2-LINE	L1	L2
-1	50-50-50	55768	55768
-2	50-50-75	55768	55769

Figure 18-4. Schematic, RFL 9780 X-Hybrid (Drawing No. D-106634-A)



SKEWED HYBRID #	IMPEDANCE (OHMS) RX-TX-LINE	L1	L2
-1	50-50-50	55766	55766
-2	50-50-75	55865	55865
-3	75-50-75	55865	55866
-4	75-75-75	N/A	N/A

Figure 18-7. Schematic, RFL 9780 Skewed Hybrid (Drawing No. D-106629-A)



DUAL HYBRID #	IMPEDANCE (OHMS) RX-TX1-TX2-LINE	L1	L2	L3	L4
-1	50-50-50-50	55766	55766	55768	55768
-2	50-50-50-75	55865	55865	55768	55768
-3	75-50-50-75	55865	55866	55768	55768

Figure 18-10. Schematic, RFL 9780 Dual Hybrid (Drawing No. D-106624-A)

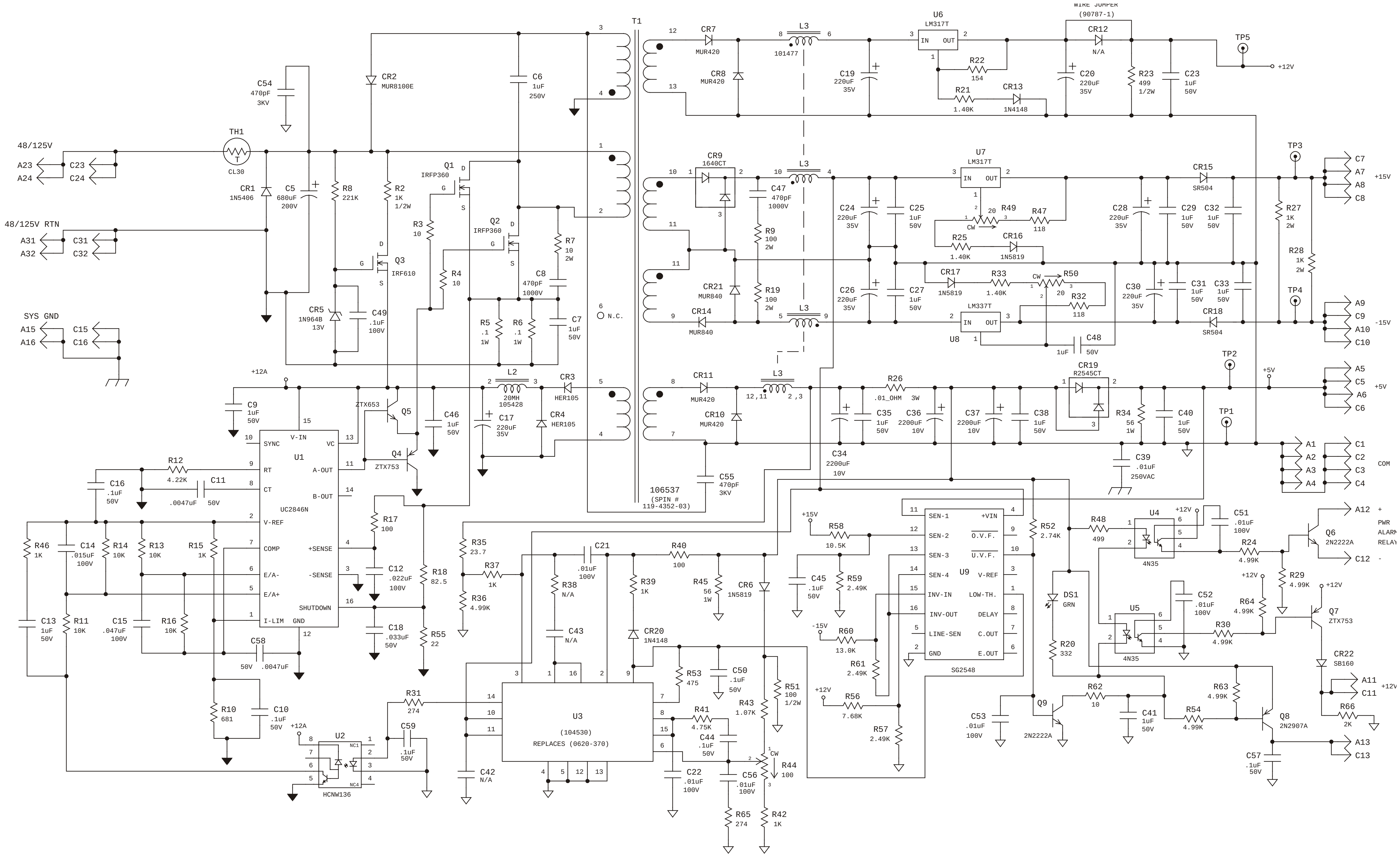


Figure 19-3. Schematic, RFL 9780 Power Supply 48/125V (Drawing No. D-106539-G)

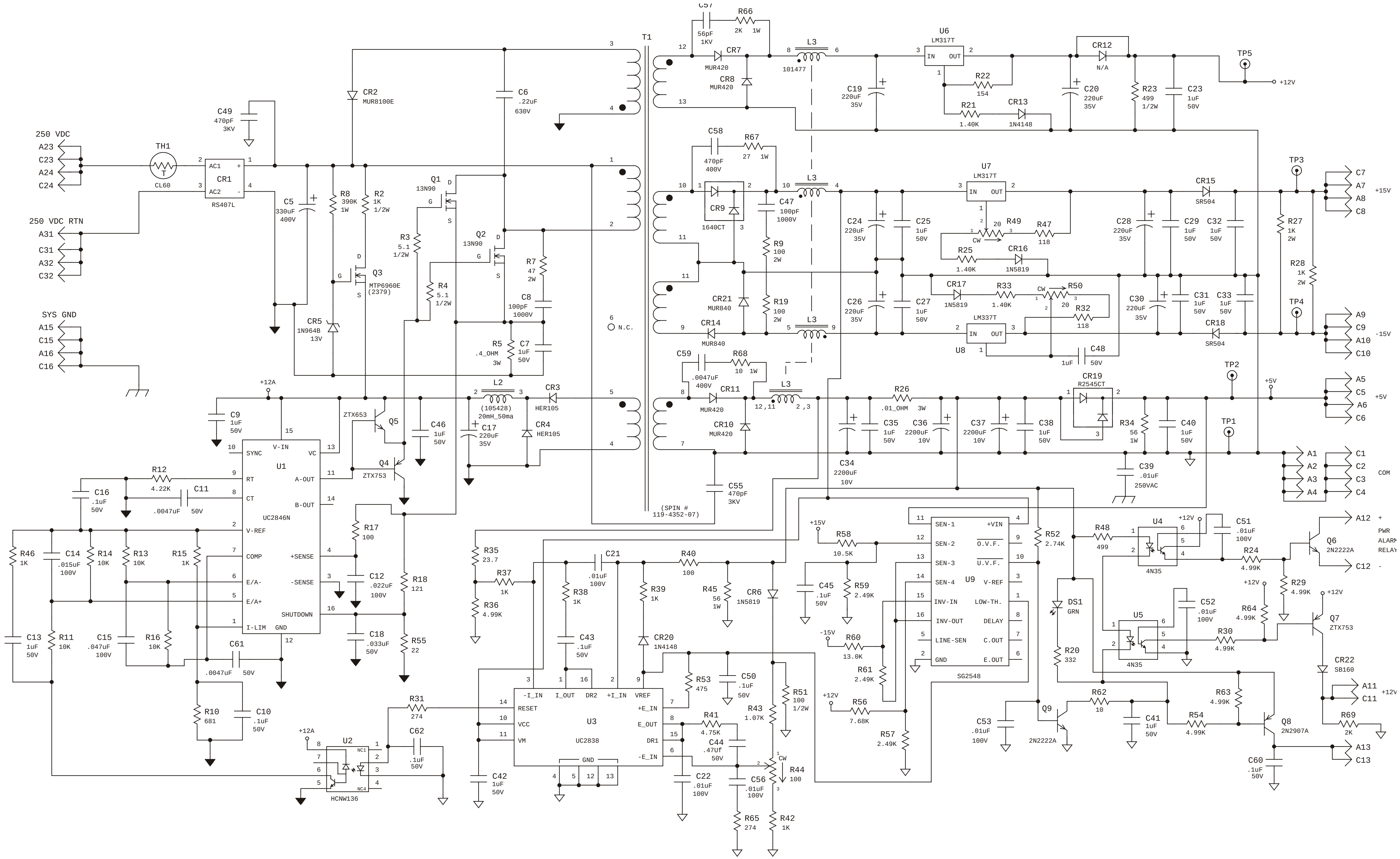
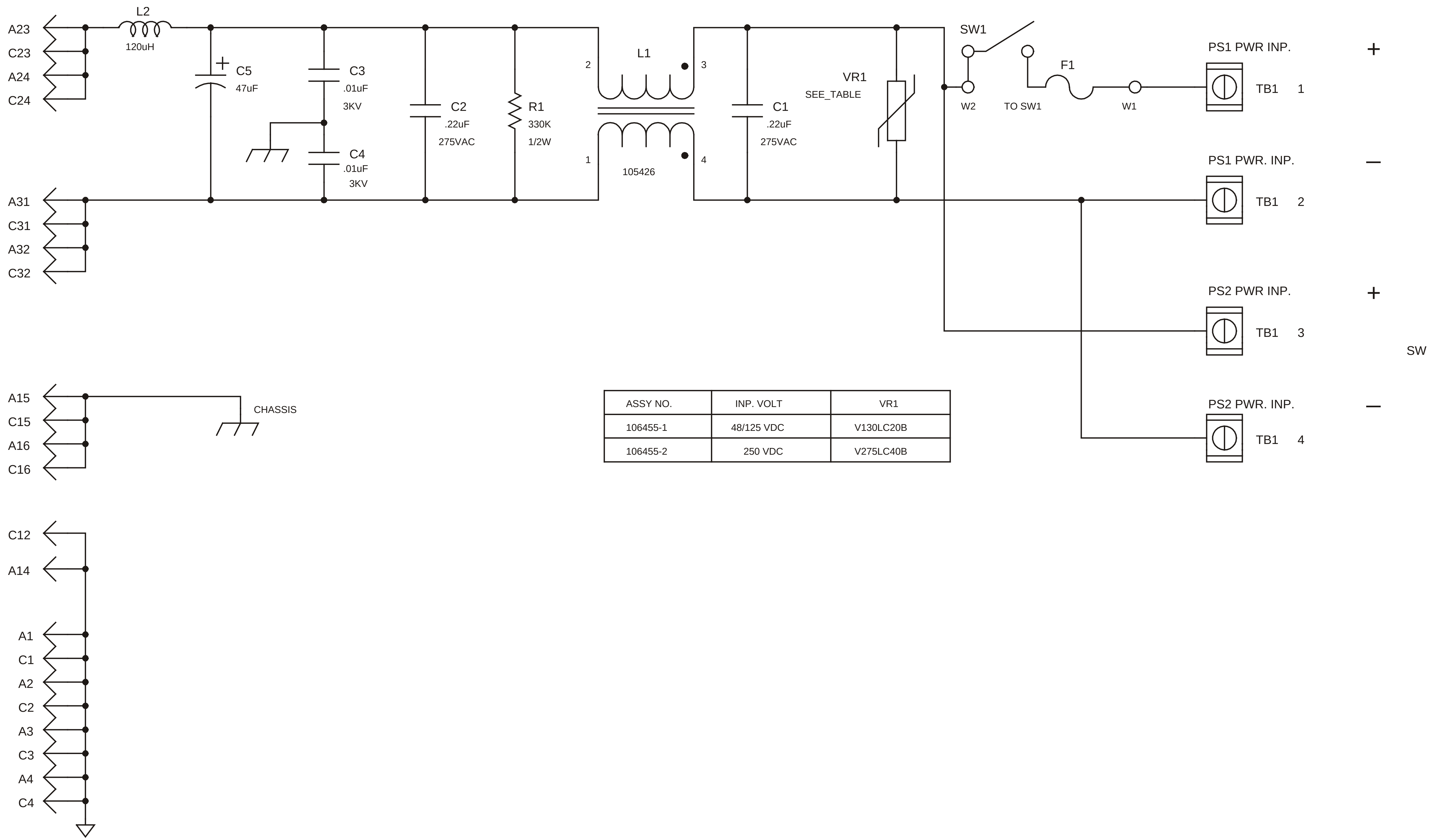
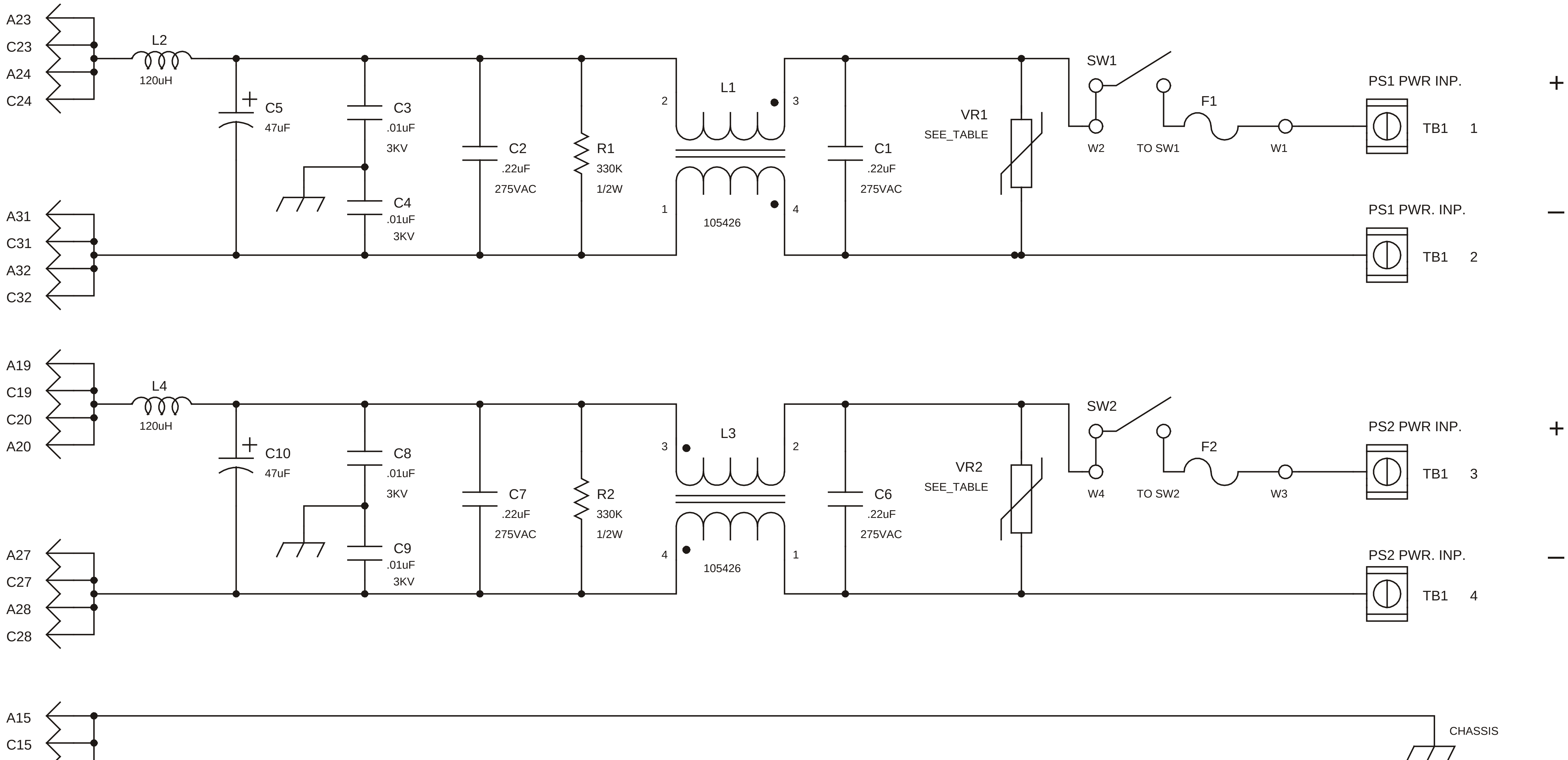


Figure 19-5. Schematic, RFL 9780 Power Supply 250Vdc (Drawing No. D-106539-2-E)



ASSY NO.	INP. VOLT	VR1
106455-1	48/125 VDC	V130LC20B
106455-2	250 VDC	V275LC40B

Figure 19-8. Schematic, RFL 9780 Power Supply I/O (Drawing No. B-106459-A)



ASSY NO.	INP. VOLT.	VR1,VR2
106455-3	48/125 VDC	V130LC20B
106455-4	250 VDC	V275LC40B

Figure 19-11. Schematic, RFL 9780 Power Supply I/O Dual (Drawing No. B-106459-1-A)

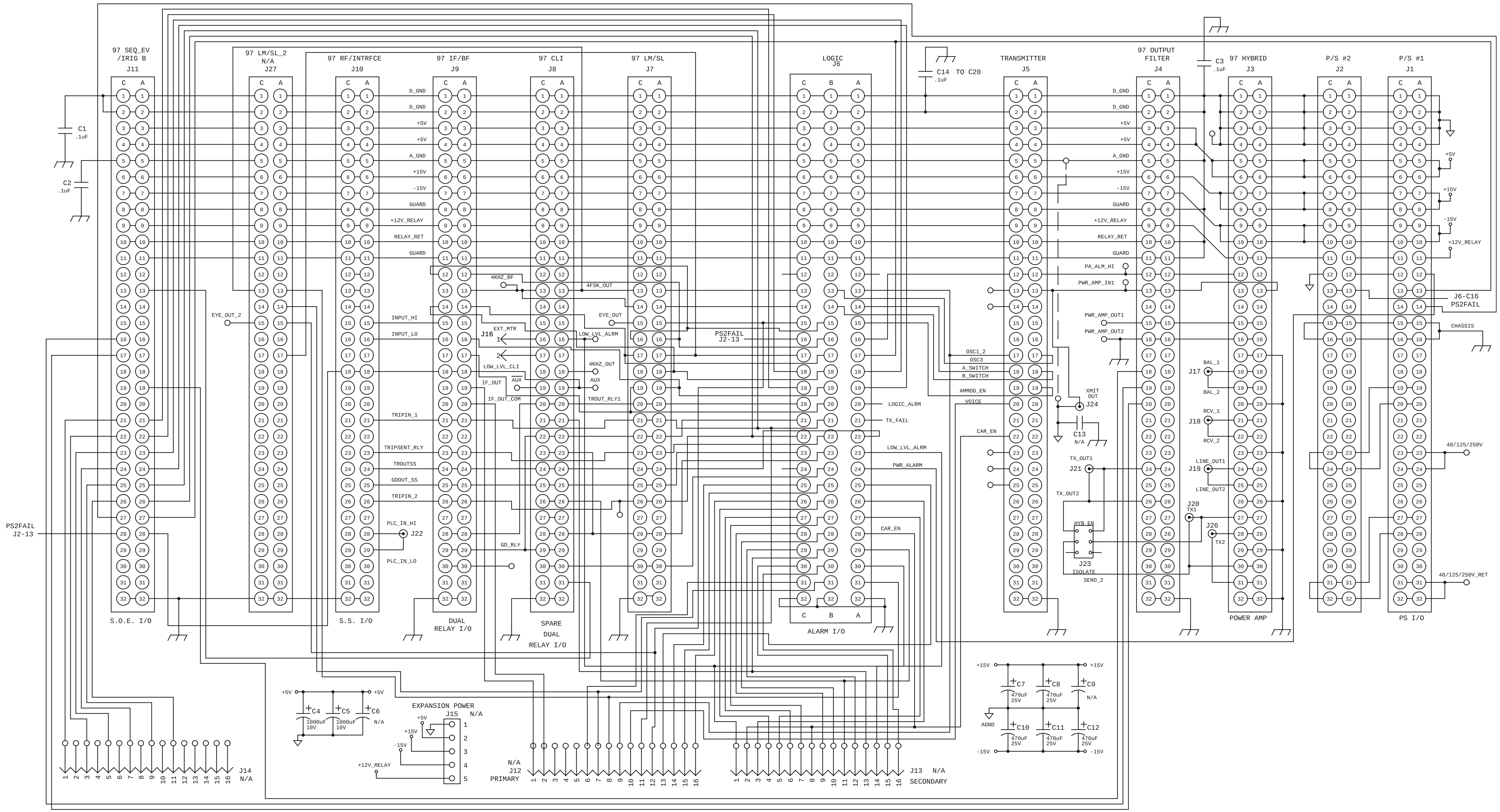


Figure 20-6. Schematic, RFL 9780 TX/RX Motherboard (Drawing No. D-106454-2-A)

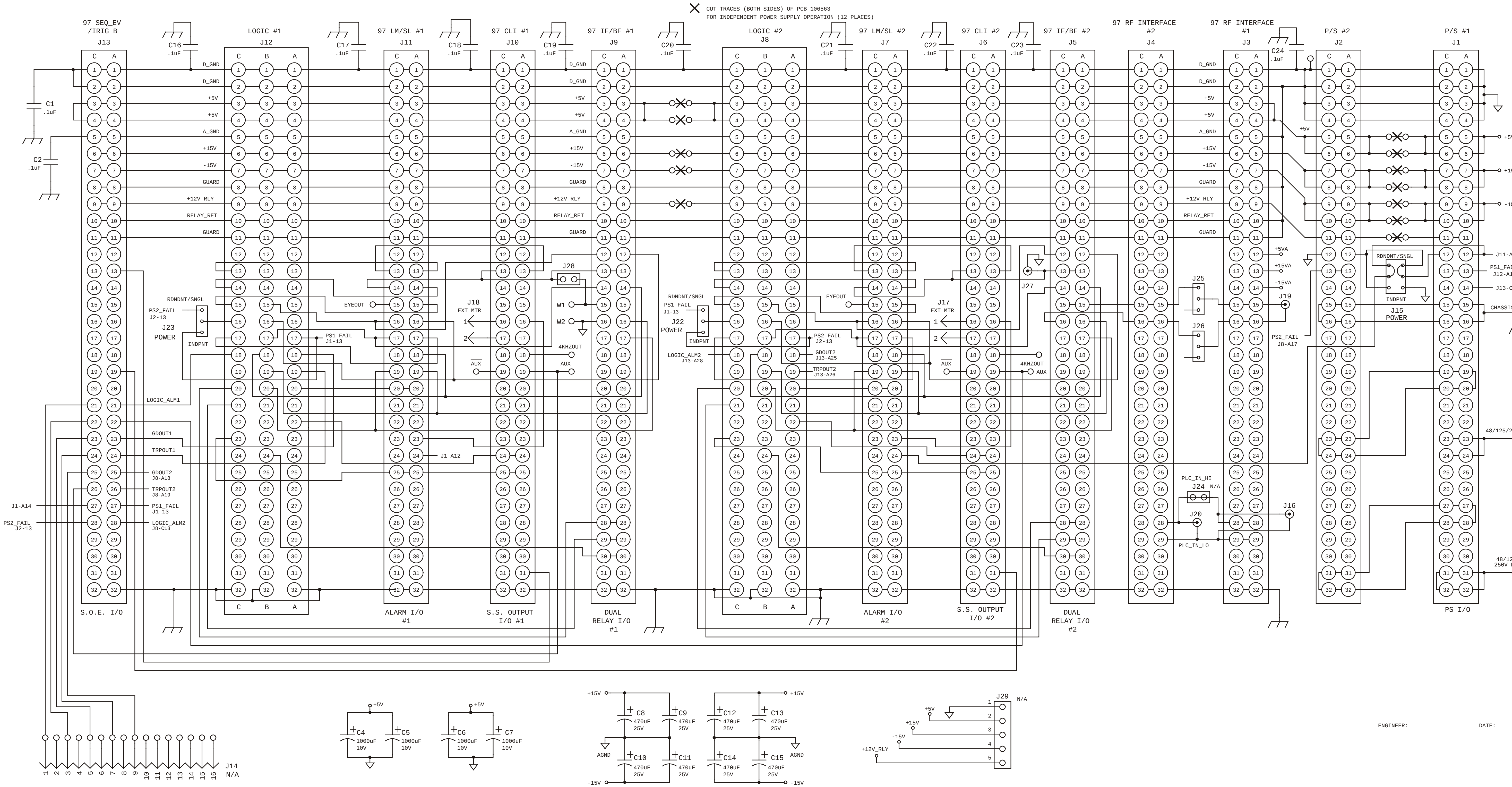


Figure 20-7. Schematic, RFL 9780 RX/RX Motherboard (Drawing No. D-106564-2-A)

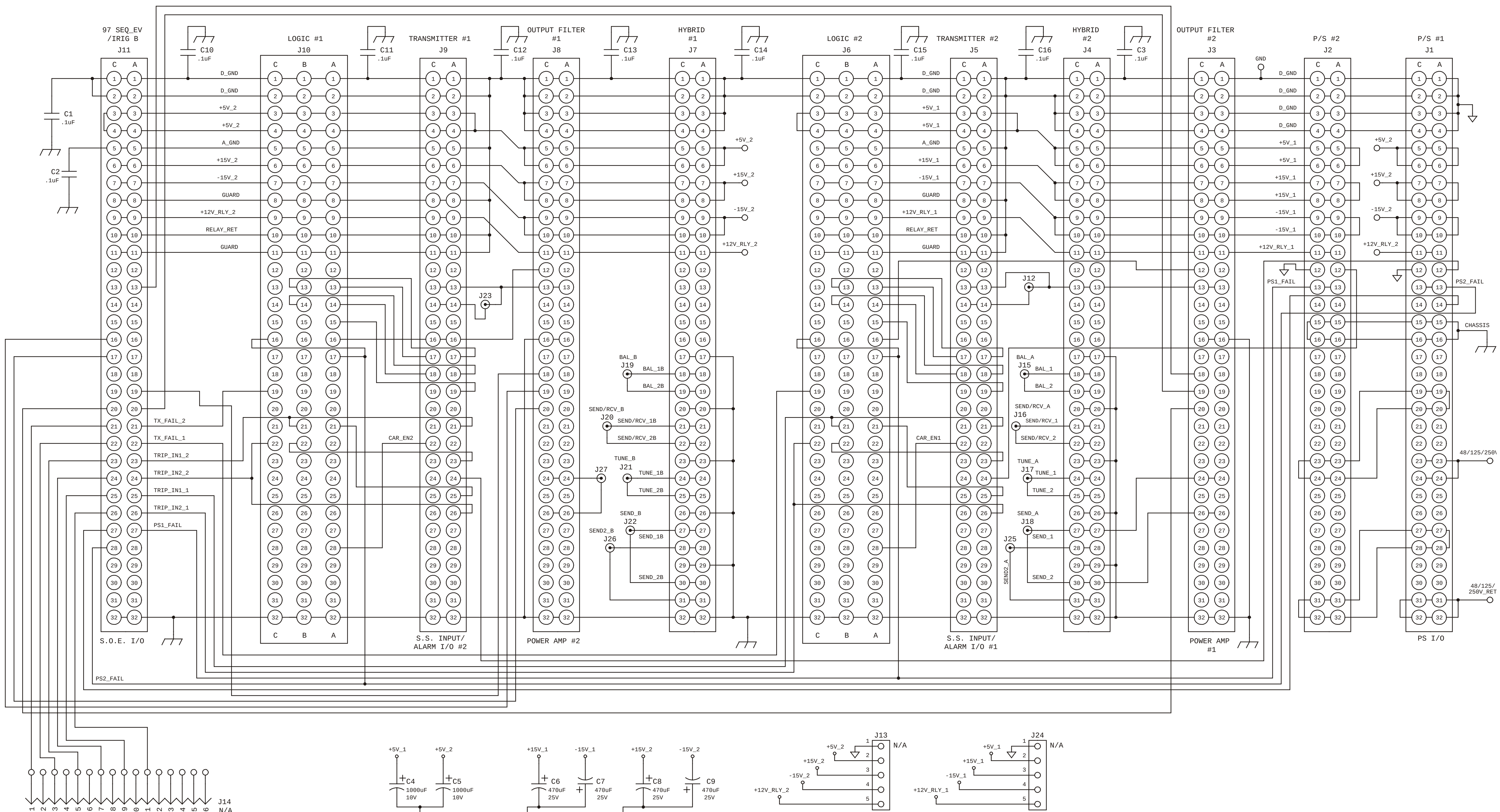


Figure 20-8. Schematic, RFL 9780 TX/TX Motherboard (Drawing No. D-106559-2-A