INSTRUCTION MANUAL

RFL 9785
PROGRAMMABLE ON/OFF
POWERLINE CARRIER SYSTEM

Publication Number MC 9785
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Revised April 10, 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.
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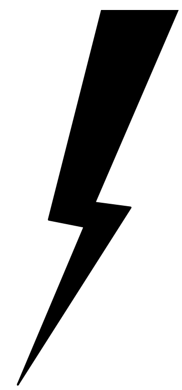
CAUTION

FOR YOUR SAFETY

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



WARNING:

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

SAFETY SUMMARY

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

GROUND THE CHASSIS

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

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

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

KEEP AWAY FROM LIVE CIRCUITS

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

DO NOT SUBSTITUTE PARTS OR MODIFY EQUIPMENT

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

READ THE MANUAL

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

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

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

RFL Electronics Inc.

WARNING!

POWER MUST BE TURNED OFF BEFORE REMOVING OR INSTALLING ANY RFL 9785 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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Front Matter	April 10, 2003
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REVISION RECORD

Rev.	Description	Date	Approval
8-7-99	New Document Release	8-3-99	CS
8-7-99	Revised in accordance with ECO numbers: 9785-004 and -005.	11-3-99	CS
11-5-99	Revised in accordance with latest engineering information	3-14-00	CS
2-29-00	Revised in accordance with ECO numbers: 9785-008, 010, 011, 012, 013, 019, 020 and 023. Revised in accordance with ECO numbers: 9780-005, 014, 016, 017, 021, and 034. Revised in accordance with RFA number: 7005.	6-26-00	CS
7-5-00	Revised in accordance with ECO numbers: 9785-026, 028. Revised in accordance with ECO numbers: 9780-046, 047, 059.	7-28-00	CS
11-8-00	Revised in accordance with ECO number: 9785-033 Added new Section 16: Checkback Comms Module Added new Section 20: Checkback Alarm Chassis Added new SS I/O modules: 106635-1, -2, -3, and –4	12-8-00	CS
3-31-01	Revised in accordance with ECO number: 9785-040: Added External Power Amp I/O 9785-041: Revised AM Logic Module Corrected RCVR Detector Module component designations Updated SOE/IRIG-B schematic and parts list Revised Solid State Input I/O Module (deleted 106435-1, -2 and added 106435-3, -4, -5)	3-31-01	CS
9-10-01	Revised in accordance with ECO number: 9785-030: Added potentiometer to voice module 9785-044: Rx Detector, changed C66A to C66B 9785-046: Rx Detector, changed R89 to 100Ω 9785-047: Added “modules fully seated” warning to page vi	9-17-01	CS

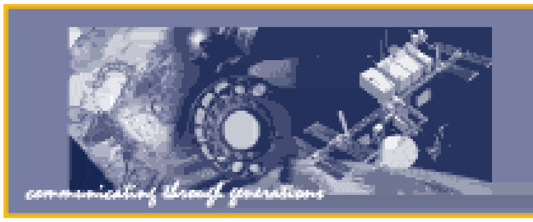
REVISION RECORD - continued.

Rev.	Description	Date	Approval
12-14-01	Revised in accordance with CAR#: C9785-0010 C9785-0012 C9785-0014	12-14-01	CS
1-8-02	Revised in accordance with ECO No. 9780-085: (Replaced SW1 with K1 on Output Filter Module, Section 9)	1-8-02	CS
4-10-03	Revised in accordance with ECO Nos.: MISC-488 (rev C3, C4, C8,&C9 on P.S. I/O) 9785-030 (Voice Module) 9785-041 (AM Logic and Motherboard) 9785-044 (Rx Detector) 9785-046 (Rx Detector) 9785-052 (RF Line I/O) 9785-053 (Voice Filter) 9785-054 (Checkback) 9785-055 (Checkback, revise U7) 9785-056 (Rx Detector) 9780-101 (add C15&C22 to CLI) 9780-109 (9785 I/Os) 9780-116 (CLI: R97 from 1.5K to 1K, R99 from 10K to 499Ω) 9780-129 (Release SOE & Output Filters with RPM) 9780-131 (Add R58&R59 to 48/125, add C61&C62 to 250) Revised in accordance with CAR#s: C9785-0001 (Rx Detector) C9785-0006 (AM Logic) C9785-0010 (AM Logic) C9785-0012 (AM logic) C9785-0014 (Checkback) C9785-0016 (Motherboard) C9785-0018 (Receiver Detector RPM) C9785-0019 (RF Line I/O) C9785-0022 (Voice Filter) C9785-0025 (fix Table 12-4) C9785-0026 (Checkback) C9785-0029 (Checkback) C9785-0032 (Checkback parameter settings&Figs 15-16&15-17) C9780-0041 (CLI RPM) C9780-0049 (add C15&C22 to CLI)	4-10-03	CS

Section 1. PRODUCT INFORMATION

Please see the following page for the following two Product Information Sheets:

1. 9785 Product Information sheet
2. 9785 Reflected Power Measurement Product Information sheet.



LITERATURE

RFL 9785

Programmable ON/OFF Powerline Carrier System

Figure 1. Typical RFL 9785 terminal shown with optional voice module.

The RFL 9785 is an amplitude-modulated ON/OFF powerline carrier transmitter/receiver terminal. It is based on the proven technology of the RFL 6785P, 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) , available redundant power supplies, and increased flexibility through field-programmable frequencies and logic.

The RFL 9785 was designed for directional comparison blocking applications in high-speed protective relaying communications. Its interface circuits are compatible with almost every existing carrier blocking relay. One standard package is all you will need for most schemes. A complete 10 Watt transmitter/receiver is contained in a 19-inch chassis that occupies three rack units of vertical rack space (5.25 inches, or 13.3 cm). An optional voice service channel, Checkback Module, Sequence of Events and redundant power supply can also be added in the same 3U chassis. A functional block diagram of a typical RFL 9785 terminal appears in Figure 3.

The RFL 9785's transmit characteristics are set by rotary switches on the transmitter module. These switches select the operating frequency; it can be set from 30 kHz to 535 kHz, in 10-Hz steps.

The RFL 9785's receive characteristics are set by DIP switches on the receiver module. These switches provide an operating frequency range of 30 kHz to 535 kHz, adjustable in 250-Hz steps,

FEATURES

- *Tested in compliance to the requirements specified in ANSI C93.5-1997 Single Functions powerline Carrier Transmitter/Receiver equipment.*
- *ESD protection (per IEEE PC 37.90.3, draft A, 1/8/99)*
- *RS232 port for remote interrogation of optional checkback and/or SOE log.*

I/O FLEXIBILITY

The RFL 9785's I/O module can be set to match the I/O requirements of your equipment. This means you can interface your equipment directly to the RFL 9785 without special adapter circuits. I/O's are available for 48, 125 and 250 Vdc station battery. Additionally, logic level I/O's (5 Vdc nominal) are available.

- *Transmitter control (start/stop) can be achieved by application or removal of station battery voltage (either positive or negative polarity).*
- *Reserve Signal Carrier keying is provided through application of station battery voltage (either positive or negative polarity).*
- *A current limiter is available to provide 20 mA, 180 mA, 200 mA, or 1 Ampere at station battery voltage (either positive or negative polarity).*

STATION BATTERY OUTPUT

A switched and fused station battery output is available from the RFL 9785's non-redundant power supply. This output can be used to drive external low-current equipment.

RECEIVED CARRIER LEVEL INDICATOR

An LCD display on the CLI Module (visible through the front door) provides a visual indicator of the received carrier level (+/-10 dB from an adjustable nominal value). An analog output is also provided for use with external indicators (+/-1V or 0-100µA, jumper selectable).

NO HYBRID REQUIRED

A hybrid is not required between the transmitter and receiver. However, hybrids can be optionally supplied for applications where the transmitter and receiver ports will be used separately.

OPTIONAL VOICE SERVICE CHANNEL

An optional voice service channel can be added to the RFL 9785. This channel can be used to provide voice communications between substations. A handset and call button are provided on the front panel. Rear connections are provided for remote handsets, call buttons, and call received indications.

OPTIONAL CHECKBACK MODULE

RFL 9785 terminals can be supplied with a Checkback Module. It allows automatic testing of up to four terminal lines. It can be programmed to transmit a particular code, and to respond only when that code is received. This provides greater programming options.

All checkback system programming is done through an RS-232 port on the rear of the RFL 9785. This includes master/remote configuration, number of lines to be tested, full or reduced power and hard carrier response. The RS-232 port can be connected to any computer terminal or personal computer with a terminal emulation mode. Once connected, a non-proprietary software programming language called "APRIL" (Asynchronous Programming and Remote Interrogation Language) can be used to read settings, re-program existing settings, or monitor carrier inputs and outputs.

POWER SUPPLIES

Choice of 48V/125Vdc or 250 Vdc Power Supplies. Chassis may be equipped with single or redundant supplies.

OPTIONAL SOE & IRIG-B

The major status signals within the chassis are constantly monitored by a 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 standard) to provide a time and date stamped record of events. The records are stored in Non Volatile RAM. The unit has a free running clock which will be synchronized to the IRIG-B input every ten minutes if IRIG-B is available.

Sequence Of Events Log for the Tx/Rx provides a record for 40 events for each of the following points	
Point Number	9785
1	Start
2	Stop
3	Reserve Key
4	Remote Initiate
5	Transmitter Fail
6	Checkback Fail
7	Block Output
8	Power Up
9	Power supply #1 fail
10	Power supply #2 fail

Table 1. Signals Monitored

SPECIFICATIONS

GENERAL

The 9785 is a programmable 10 W ON/OFF carrier system which fully complies with ANSI C93.5. The system is packaged in a single 3U high chassis and includes full-feature transmitter and receiver sections. The unit may optionally be equipped with voice capability and checkback functions. 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 85 W)
250 Vdc (200 to 300 Vdc 85 W)

Approximate Weight: 17.5 lbs.

Operating Temperature: -20°C to 60°C

Humidity: 0 to 95% non-condensing

ESD protection (per IEEE PC 37.90.3, draft A, 1/8/99), Dielectric and surge withstand: Per ANSI C93.5

TRANSMITTER

The transmitter is a fully programmable Direct Digital Synthesis (DDS) generator followed by a 10 W power amplifier and filter. If the voice option is installed the audio signal is AM modulated onto the carrier.

Frequency step size: 10 Hz

Frequency setting method: Direct reading rotary switches

Rated output power: 10 Watts

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

Nominal Bandwith	Delay	Channel Spacing w/Voice	Channel Spacing w/o Voice
500 Hz	5 ms	4 kHz	1 kHz
1000 Hz	3 ms	4 kHz	2 kHz
1500 Hz	1.5 ms	4 kHz	3 kHz

Table 2. Minimum permissible channel spacings and delay times.

Carrier Level Indicator:
Display: Front panel 3-½ digit direct reading (in dB)
Range: ±10 dB

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

OPTIONAL SEQUENCE OF EVENTS

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

Signals monitored: See table 1 on page 2.

OUTPUT RATINGS

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

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

Alarm Relay Outputs
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

INPUT RATINGS
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) outputs are available.

RF Input
Input impedance (termination enabled): 50 or 75 Ohms selectable

Maximum continuous termination power dissipation: 1 Watt
Input impedance (termination disabled): >30 K-Ohms

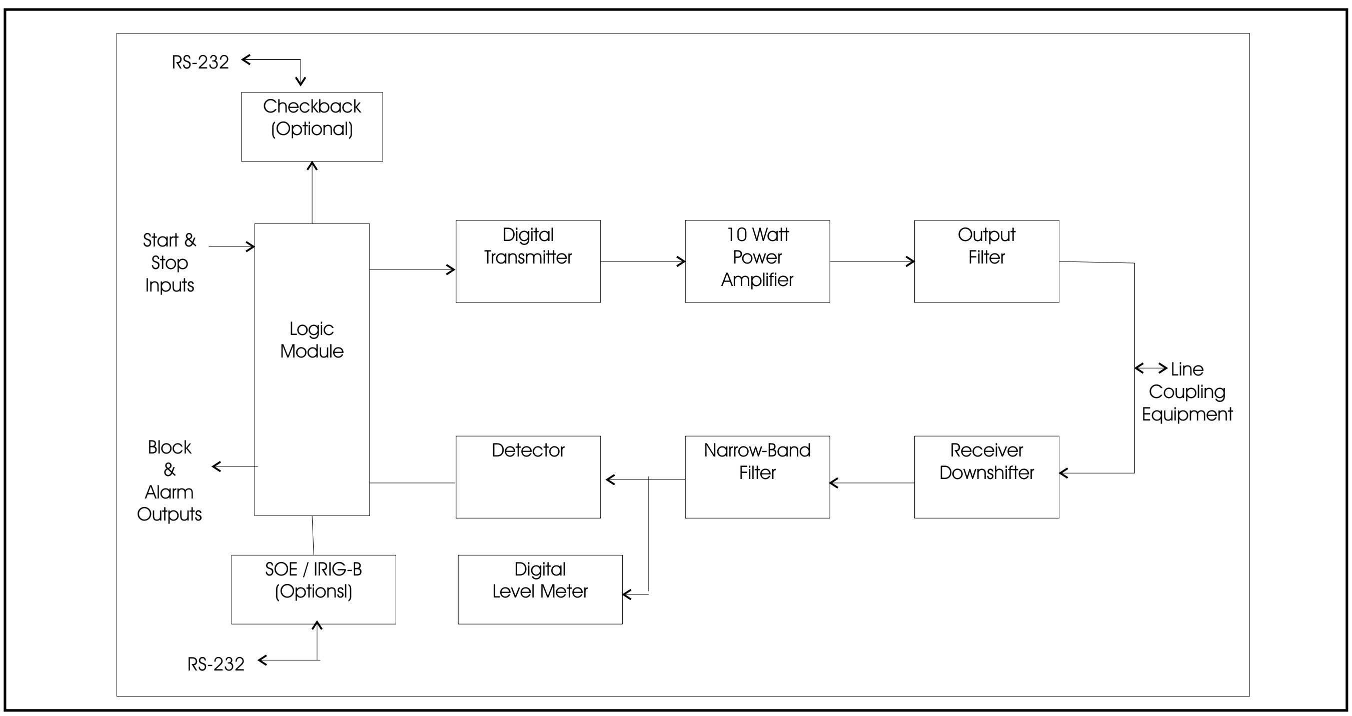


Figure 2. Typical RFL 9785 Programmable ON/OFF Powerline Carrier System Block Diagram.

Specifications subject to change without notice.

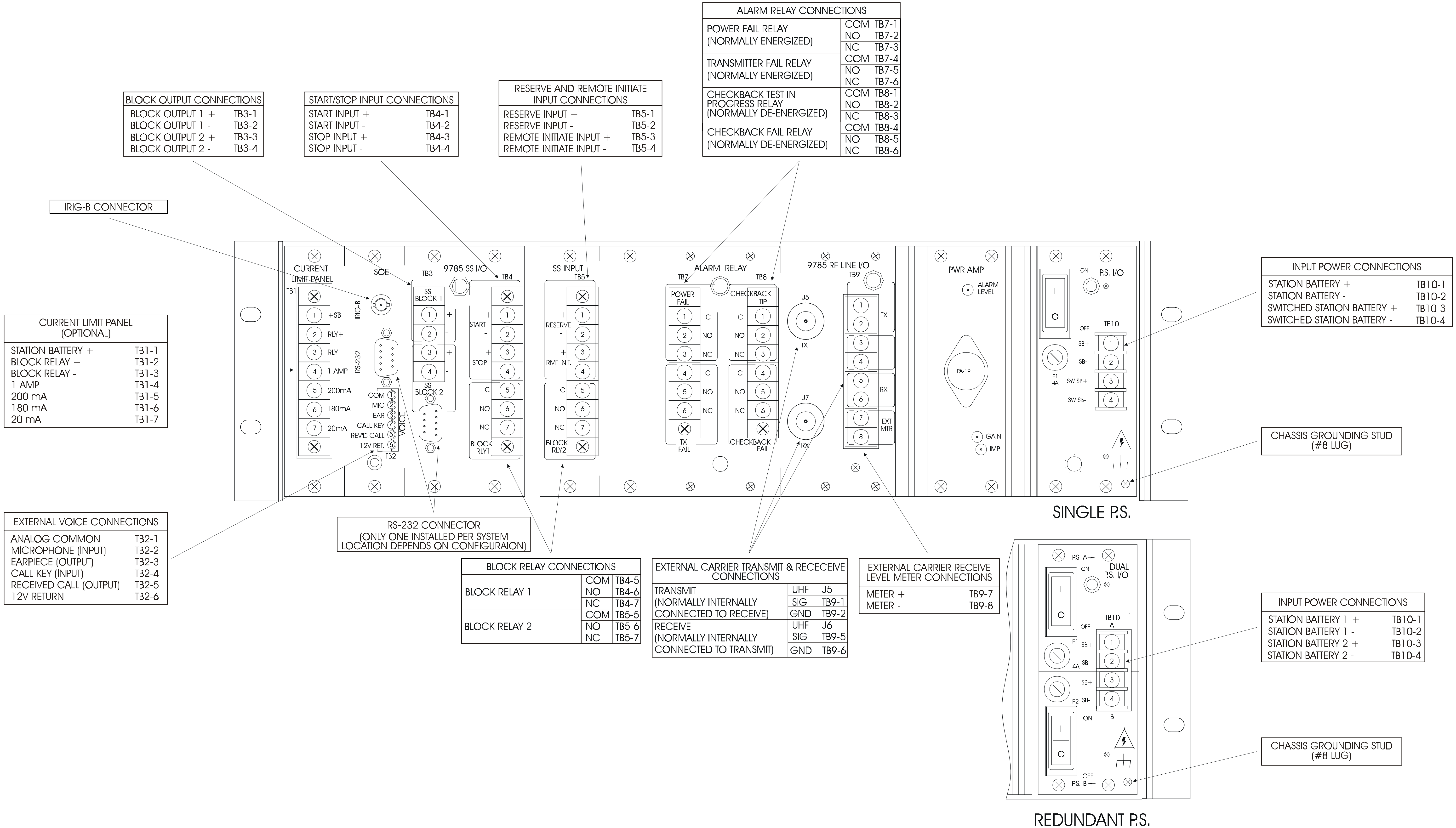


Figure 3. Typical Rear View RFL 9785 Programmable ON/OFF Powerline Carrier System.

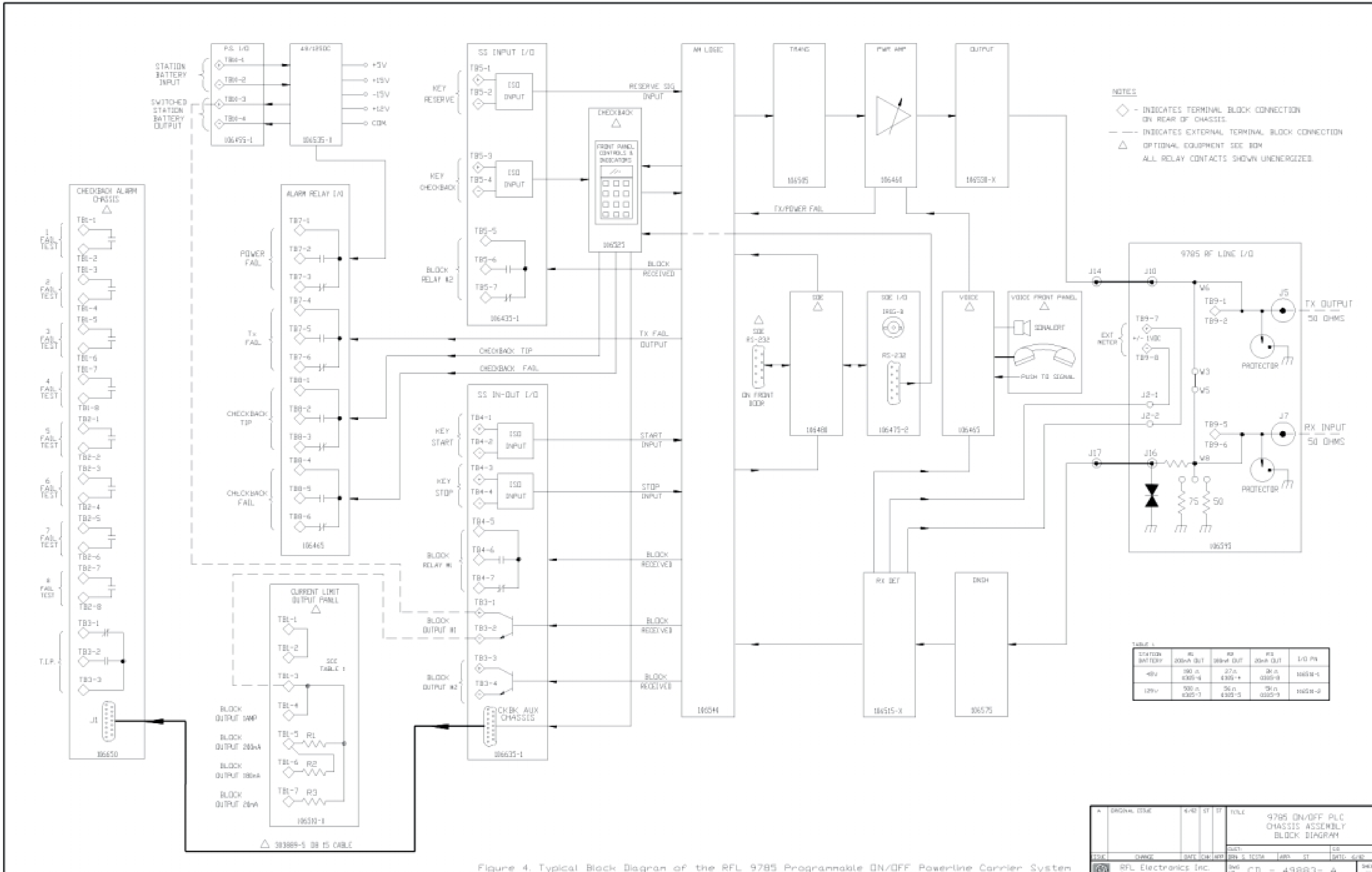


Figure 4. Typical Block Diagram of the RFL 9785 Programmable ON/OFF Powerline Carrier System

9785 Programmable ON/OFF Powerline Carrier System
Smart Number Ordering Infromation

RFL Part Number (fill in blanks): **9785** ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

Basic Transmitter/Receiver		
Chassis, motherboard & standard modules		9785
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, any frequency		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 Relay Control I/O Voltage 48VDC		4
Logic Level Relay Control I/O Voltage 125VDC		5
Logic Level Relay Control I/O Voltage 250VDC		6
Receive Bandwidth		
500 Hz		1
1000 Hz		2
1500 Hz		3
Sequence of Events Option		
No SOE Option		1
SOE Option		2
Checkback Option		
No Checkback Option		1
Checkback Option		2
Checkback with Aux. Alarm Chassis		3
Voice Option		
No Voice Functions		0
With Voice Functions		1
Current Limit / EM Relay Interface		
No Current Limit Module		0
48 Vdc Current Limit Module		1
125 Vdc Current Limit Module		2
Other Custom Configuration		
No user specified customization		A
Additional system details provided by customer		Z

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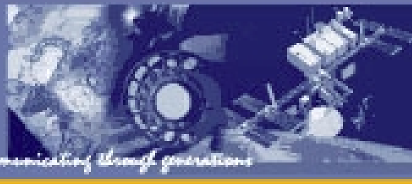


PRODUCT INFORMATION

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 ρ *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* ρ *is 0.*

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

where

ρ *= 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*

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

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:*

$$P_r(\%) = 100\,\rho^2$$

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 (ρ*), 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 %

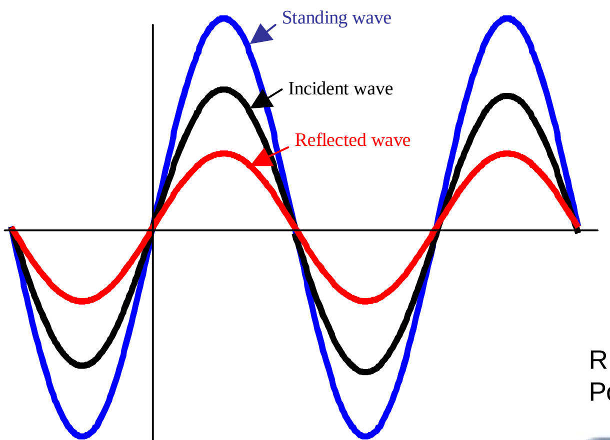
The values of reflected power are "good" if below 1%, "typical" (acceptable) if below 9% and "poor" if above 9%.

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

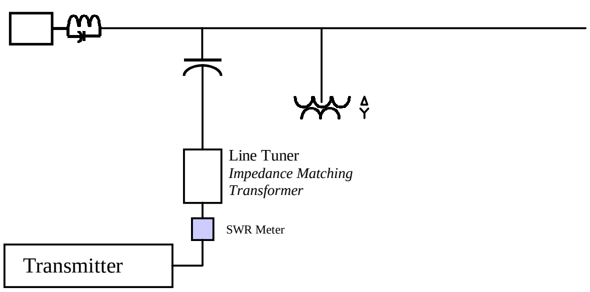
Transmission Line Conductor	Characteristic Impedance Phase to Ground Coupling (Ohms)	Characteristic Impedance Phase to Phase Coupling (Ohms)
Single Wire	350 to 500	650 to 800
Bundled Conductor (2 Wire)	250 to 400	500 to 600
Bundled Conductor (4 Wire)	200 to 350	420 to 500

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.

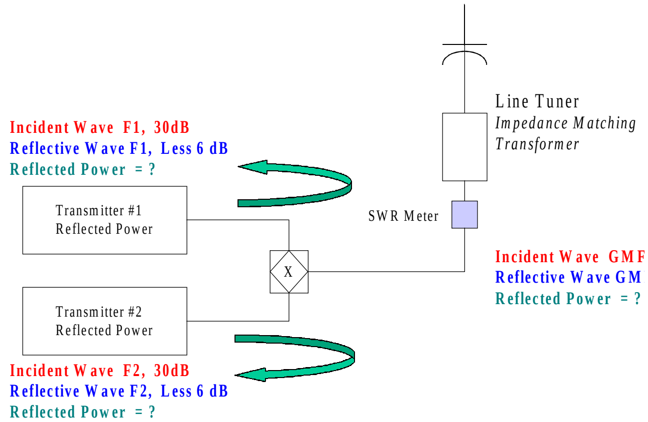
With the RFL 9780/RFL 9785 built-in Reflected Power Meter, reflected power can be measured at any time. The metered value is available remotely as well as locally and the carrier channel performance at all line ends can be evaluated from one location.



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.



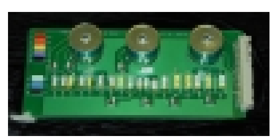
Dual-carrier application

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

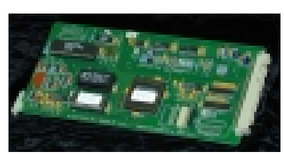
Existing RFL 9780/RFL 9785 carrier sets are field upgradable to provide this feature. Upgrades to the 9780 will require replacing the SOG/IRIG module, RF Power Output Filter and the CLI Level Indicator modules. Upgrading the 9785 involves replacing the SOG/IRIG filter, TRDGT modules.

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

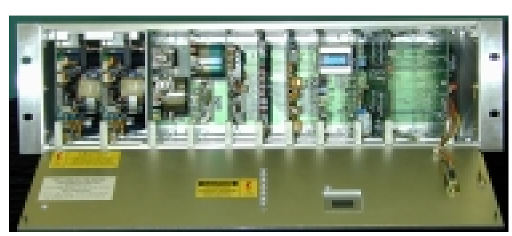


RF Power Output Filter

CLI Level Indicator



Sequence of the Events Module



Please contact RFL Customer Service Department for additional information.

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

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ISO 9001 Registered Company

Section 2. GENERAL INFORMATION

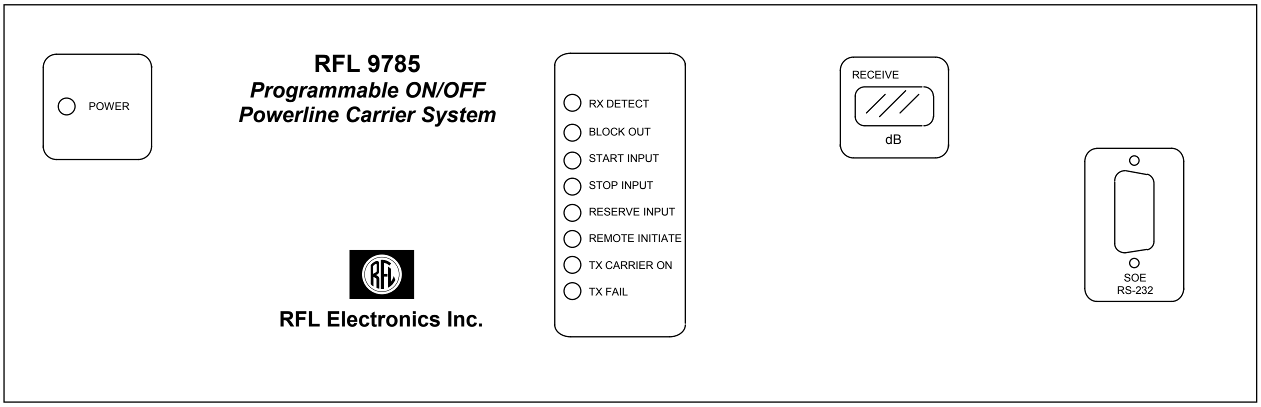

Figure 2-1. RFL 9785 Programmable ON/OFF Powerline Carrier System

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 9785 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 AM 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.

2.1 PURPOSE OF THIS MANUAL

This manual provides operation and maintenance information for the RFL 9785 Programmable ON/OFF Powerline Carrier System. Included are an overall functional description of its purpose, a physical description, specifications, installation instructions, operating procedures, maintenance procedures, theory of operation, and parts information for all circuit card modules. A typical RFL 9785 terminal is shown in Figure 2-1.

WARNING

MANY OF THE CIRCUITS IN THE RFL 9785 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.

2.2 PURPOSE OF EQUIPMENT

The RFL 9785 is an amplitude modulated ON/OFF powerline carrier transmitting and receiving terminal. It is an enhanced version of the field-proven technology used in the RFL 6785P. The RFL 9785 offers fully programmable timers, simplifies the setup process and fully complies with ANSI/IEEE C93.5-1997.

The RFL 9785 was designed for directional comparison blocking applications in high-speed protective relaying communications. It exhibits a high degree of dependability and maintains relatively high security.

2.3 FEATURES

Programmability

The transmit frequencies can be set over a range of 30KHz to 535kHz, adjustable in 10-Hz steps. The receiver frequency range is 30kHZ to 535kHz, adjustable in 250Hz steps.

Output Range

The internal amplifier is rated at 10W. External amplifiers may be used to provide 50W or 100W capability.

Saves Rack Mounting Space

Each RFL 9785 terminal is housed in a single chassis three rack-units high (5.25 inches, or 133mm), including Sequence Of Events, Checkback and Voice options.

Station Battery Isolation

A dc-dc converter supplies regulated voltage to all RFL 9785 modules. All inputs and outputs are made through optically-isolated transistors or electromechanical relays.

Flexible Block Outputs

Block outputs can be made through optically-isolated, high-current transistors, electro-mechanical output relays, or both.

Compatibility With Existing Equipment

The RFL 9785 is backwards compatible with existing RFL 6785P units, as well as almost every other existing directional comparison blocking relay presently in the field.

Carrier Level Indicator

The RFL 9785 continuously monitors incoming carrier level with a digital panel meter providing a visual indication through the front panel. An output is provided for external indicators.

Voice Option

The voice option allows two-way voice communications along the protected line. It includes a telephone handset and a pushbutton-controlled in-band signaling system. During a block, the voice signal may be automatically canceled, so that the full output power of the terminal is dedicated to the block signal.

Automatic Checkback Option

A Checkback Option allows automatic testing of up to four terminal lines. All checkback system programming is done through an RS-232 port.

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.

2.4 PHYSICAL DESCRIPTION

Each RFL 9785 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.

2.5 SYSTEM SPECIFICATIONS

As of the date this manual was published, the following specifications apply to all RFL 9785 terminals, except where indicated. Because all RFL products undergo constant refinement and improvement, these specifications are subject to change without notice.

2.5.1 TRANSMITTER SECTION

Frequency Range: 30 kHZ to 535 kHz, switch-selectable in 10-Hzsteps.

Modulation: ON/OFF amplitude modulated and optional voice modulated.

Frequency Stability: ±10 Hz, crystal-controlled.

Output Power: 10 watts, measured at the amplifier output. Additional power is available when the RFL 9785 is used with one or more external amplifiers.

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

2.5.2 RECEIVER SECTION

Sensitivity: 5 mVrms minimum signal.

Dynamic Range: 30 dB.

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

Response Time: 1.5 to 5 ms, with transmitter and receiver connected back-to-back and using solid-state outputs, depending on bandwidth choice and logic.

Block Outputs:
Two solid-state block outputs
Two electro-mechanical blocking relay outputs

Alarm Outputs:
Two electro-mechanical alarm relay outputs

2.5.3 GENERAL

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

Table 2-1. Minimum permissible channel spacings and delays times, RFL 9785 Programmable ON/OFF Powerline Carrier System

Nominal Bandwidth	Delay	Channel Spacing w/voice	Channel Spacing w/o Voice
500 Hz	5 ms	4 KHz	1 KHz
1000 Hz	3 ms	4 kHz	2 kHz
1500 Hz	1.5 ms	4 kHz	3 kHz

Alarms: There are two standard alarms: transmitter output level and power supply failure.

Checkback Outputs:
Checkback test in progress
Ckeckback test fail

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 9785 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).

2.6 TERMINAL CONFIGURATION

The RFL 9785 is housed in a single 3U high, rack mounted chassis. Table 2-2 shows general information about the available modules for the RFL 9785. Figure 2-2 shows a typical block diagram of an RFL 9785 chassis. A summary of each module is included in paragraphs 2.7.1 through 2.7.12. Detailed descriptions of the modules can be found in Sections 6 through 18.

Table 2-2. RFL 9785 modules, general information

Module Description	Assy. No.	Module Location (Front Or Rear)	Additional Information
AM Logic Module	106540	F	Section 6
Transmitter Module	106505	F	Section 7
Power Amplifier Module	106460	R	Section 8
Output Filter Modules:			Section 9
30 kHz to 67 kHz	106530-1, -11	F	
64 kHz to 157 kHz	106530-2, -12	F	
154 kHz to 393 kHz	106530-3, -13	F	
390 kHz to 537 kHz	106530-4, -14	F	
114 kHz to 288 kHz	106530-5, -15	F	
Receiver Downshifter Module	106575	F	Section 10
Receiver Detector Module	106515-6, -7, -8	F	Section 11
Voice Filter (Plug-On)	106580-2	*	Section 14
Seq Of Events/IRIG-B Module	106480-1	F	Section 12
Seq Of Events/IRIG-B I/O	106475-2	R	
Voice Module	106565	F	Section 14
Checkback Module	106525	F	Section 15
Checkback Communications Module	106645	F	Section 16
Power Supply:			Section 17
48/125 Vdc	106535-1	F	
250 Vdc	106535-2	F	
Power Supply I/O:			
48/125 Vdc	106455-1	R	
250 Vdc	106455-2	R	
Dual Power Supply I/O:			
48/125 Vdc	106455-3	R	
250 Vdc	106455-4	R	
I/O Modules:			Section 18
Solid State Input I/O:			
48/125 Vdc	106435-3	R	
250 Vdc	106435-4	R	
5 Vdc	106435-5	R	
Solid State In/Out I/O:			
48/125 Vdc	106635-1	R	
250 Vdc	106635-2	R	
5/48V or 5/125V	106635-3	R	
5/250V	106635-4	R	
Alarm Relay I/O	106465	R	
RF Line I/O	106595	R	
Current Limit I/O			
48 Vdc	106510-1	R	
125 Vdc	106510-2	R	
External Power Amp I/O	106675	R	
Chassis Assembly:			Section 19
TX/RX	106400		
Motherboard	106545		
Checkback Alarm Chassis	106650		Section 20
Accessory Equipment:			Section 21
Expansion Chassis			

* The voice filter plugs onto the Receiver Detector module only when the RFL 9785 voice option is used.

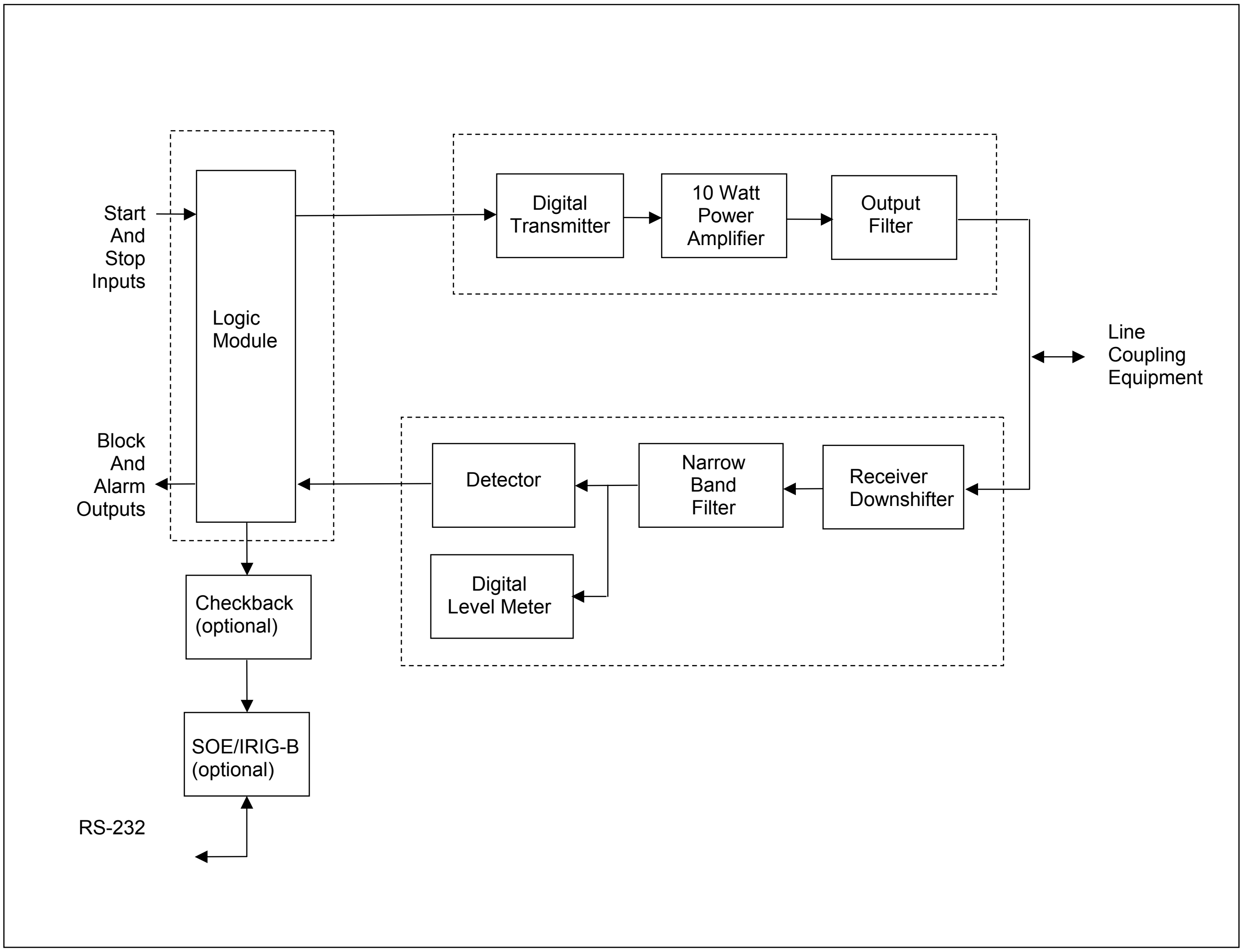

Figure 2-2. Typical block diagram of RFL 9785 chassis

2.7 RFL 9785 SUBASSEMBLIES

Each RFL 9785 terminal contains several circuit board modules and I/O modules. Paragraphs 2.7.1 through 2.7.12 describe the different modules used in the RFL 9785 terminal.

2.7.1 AM LOGIC MODULE

The 9785 AM Logic Module monitors the CARRIER START, CARRIER STOP, and RESERVE KEY keying inputs, as well as signals from other modules of the RFL 9785. It uses this information to generate command signals for the transmitter and receiver detector modules. Switches SW1-1 through SW1-7 on the 9785 AM Logic Module allows the logic to be set according to the requirements of the specific application. The 9785 AM Logic Module also provides status information for the Sequence of Events Module. Additional information on the RFL 9785 AM Logic Module can be found in Section 6 of this manual.

2.7.2 TRANSMITTER MODULE

The 9785 Transmitter Module utilizes Direct Digital Synthesis (DDS) to generate precise carrier signals. The desired frequency is selected by a bank of direct reading switches. There are three banks of switches so that a single Transmitter Module can be used in a three frequency application.

The Transmitter Module can amplitude modulate the carrier to an analog voice signal if the input system is equipped with this option. The output section of the module adjusts the amplitude to provide the desired output power. Additional information on the RFL 9785 Transmitter Module can be found in Section 7 of this manual.

2.7.3 POWER AMPLIFIER MODULE

The RFL 9785 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. Additional information on the RFL 9785 Power Amplifier Module can be found in Section 8 of this manual.

2.7.4 OUTPUT FILTER MODULES

RFL 9785 Output Filter modules are used to reduce the harmonic content of the Power Amplifier's output signal to a level that is at least 55 dB below the carrier level. In order to cover the RFL 9785's entire operating range (30kHz to 535 kHz), there are four different RFL 9785 Output Filters. Three filters are equipped with jumpers for selecting the desired frequency range and the fourth has a fixed range, which covers the top of the RFL 9785's frequency band. All four filters are entirely passive, and require no input power for proper operation. Additional information on the RFL 9785 Output Filter Modules can be found in Section 9 of this manual.

2.7.5 RECEIVER DOWNSHIFTER MODULE

The RFL 9785 Receiver Downshifter Module accepts incoming rf signals which are shifted down to 24 kHz. Its channel filter is 3700 Hz wide, which will pass carrier signals or voice sidebands of the carrier, if present. Additional information on the RFL 9785 Receiver Downshifter Module can be found in Section 10 of this manual.

2.7.6 RECEIVER DETECTOR MODULE

The RFL 9785 Receiver Detector Module contains three elements of the RFL 9785's receiving system: A narrowband active band-pass filter that sets the bandpass limits for the entire receiving section, a carrier detect circuit used to signal the AM Logic Module that a signal is being received, and a digital meter to indicate deviation of the received signal above or below the specified normal level. Additional information on the RFL 9785 Receiver Detector Module can be found in Section 11 of this manual.

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

The IRIG-B Module is a status monitor card for the RFL 9785 which monitors input 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. Additional information on the RFL 9785 SOE/IRIG-B Module can be found in Section 12 of this manual.

2.7.8 VOICE MODULE

The Voice Module is part of the voice option available for the RFL 9785. It contains a microphone amplifier, a signaling tone oscillator for sending signaling tones, a tone detector for receiving tones, a voice demodulator and a speaker amplifier. Additional information on the RFL 9785 Voice Module can be found in Section 14 of this manual.

2.7.9 CHECKBACK MODULE

The RFL 9785 Checkback Module is a microprocessor based checkback system. Control and logic signals are interfaced between the Checkback Module and the RFL 9785 system through the system mother board. The Checkback Module is also connected to the SOE Module through the system motherboard. The user can communicate with the Checkback Module by using the RS-232 connector located on the RFL 9785 front panel, or by using the RS-232 connector located on the SOE I/O Module (RFL 9785 rear panel). Additional information on the RFL 9785 Checkback Module can be found in Section 15 of this manual.

2.7.10 CHECKBACK COMMUNICATIONS MODULE

The RFL 9785 Checkback Communications Module is used in some chassis in place of the SOE Module, but only in chassis that have a Checkback module. Additional information on the RFL 9785 Checkback Communications Module can be found in Section 16 of this manual.

2.7.11 POWER SUPPLY MODULE

The RFL 9785 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 the RFL 9785 Power Supply can be found in Section 17 of this manual.

2.7.12 I/O MODULES

The I/O modules serve as an interface for input and output signals between the RFL 9785 and the line coupling equipment. There are five types of I/O modules that can be used with the RFL 9785. Additional information on the RFL 9785 I/O Modules can be found in Section 18 of this manual.

2.7.13 CHASSIS

The RFL 9785 chassis houses the power supply(s), processing modules, and I/O modules. All interconnections between modules is accomplished using a system motherboard. Some RF signals are routed with coax cables. Additional information on the RFL 9785 Chassis and Motherboard can be found in Section 19 of this manual.

2.7.14 CHECKBACK ALARM CHASSIS

The optional RFL 9785 Checkback Alarm Chassis allows a user to determine the status of each of the eight checkback tests by means of a relay contact closure. Additional information on the RFL 9785 Checkback Alarm Chassis can be found in Section 20 of this manual.

2.7.15 ACCESSORY EQUIPMENT

Other circuit card modules and assemblies are available to enhance the operation of the RFL 9785 terminal, or to adapt it to special applications. If any accessory equipment was furnished with your system, Instruction Data Sheets for each item will appear in Section 19 of this manual.

2.8 SYSTEM THEORY OF OPERATION

The RFL 9785 has four functional blocks: the transmitter section, the receiver section, the logic and control functions, and the sequence of events functions. All of these functions are tied together by the chassis and motherboard and are powered by the power supply. A typical block diagram of the RFL 9785 is shown in Figure 2-2.

2.8.1 TRANSMITTER SECTION

The function of the transmitter section is to provide the desired carrier frequency, at the desired power level at the transmitter port when commanded. The transmitter consists of three basic modules, the Transmitter Module, the Power Amplifier Module, and the Output Filter Module. The Transmitter Module generates a clean, precise, carrier at the desired frequency and at a given power level.

The transmitter may be instructed to generate one of three carrier levels which correspond to 1, 3, and 10 watts of transmitted power after the Power Amplifier. Normally the RFL 9785 is configured to transmit at a nominal 10W power level. See Section 7 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 8 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 9 for more information about the Output Filter Module.

The output of the transmitter circuits must be fed out to the field wiring. This is accomplished using a Line I/O Module. The module provides a UHF connector for Tx and another for Rx. It also contains protection circuitry. See Section 18 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 9785 Output Filter or Hybrid, as these would be required after the external power amplifier.

2.8.2 RECEIVER SECTION

The function of the receiver section is to detect a carrier signal sent by the remote transmitter. The receiver consists of a Line I/O Module, a Downshifter Module, a Receiver Detector Module, and an AM Logic Module.

The received signal enters the 9785 chassis through a Line I/O Module. The Line I/O module has two UHF connectors, screw-type terminal connections, impedance matching circuits, and ANSI C.37.90 compliant protection circuits. See Section 18 for additional information regarding the Line I/O module.

The signal is then fed to the Downshifter Module. This module normalizes the received level and shifts the received carrier from the customer specified center frequency down to the 9785's baseband frequency of 24KHz. Its channel filter has a 3700 Hz bandwidth to pass voice sidebands if the voice option is installed.

The Receiver Detector Module accepts the signal produced by the Downshifter Module, and passes it through a narrow-band filter. A decision whether or not to block is based upon this signal strength. The Receiver Detector Module is equipped with a voice bandpass filter and voice muting circuitry if the voice module is installed. The signal is also sent to a log amplifier circuit to convert the level to a dB measurement.

The block signal is sent to the AM Logic Module. The received block signal drives open-collector transistors, energizing associated solid-state and electro-mechanical relays. Since the received block signal may be a voice transmission from the remote carrier, the local carrier voice is muted until the received block ceases. This is known as simplex communication. A locally keyed block also mutes voice received from the remote carrier. The block signal may also be communication between master and slave Checkback modules. The block ON/OFF pulses are interpreted as messages.

2.8.3 AM LOGIC FUNCTIONS

The AM Logic Module provides features related to both transmit and receive functions. For the transmit path, the user has two keying inputs.

On the receive side, the AM Logic Module is fed information regarding the presence of a received block from the remote carrier.

The AM Logic Module is also responsible for detecting a transmitter fail alarm. See Section 6 for more information on the AM Logic Module.

2.8.4 SEQUENCE OF EVENTS

The Sequence Of Events (SOE) Module provides a computer interface to the RFL 9785. The module monitors the system status at all times and records any changes in a log. There are two RS-232 connectors on the 9785 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 9785 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 12 for more information about the SOE Module.

2.8.5 CHASSIS AND POWER SUPPLY

The 9785 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 9785.

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. See Sections 17 and 19 for more information about the Power Supplies and Chassis.

Section 3. INSTALLATION

WARNING

ALL RFL 9785 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 9785 TERMINAL IN SERVICE.

3.1 INTRODUCTION

This section contains installation instructions for the RFL 9785, including unpacking, mounting, and interconnection wiring.

3.2 UNPACKING

RFL 9785 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 9785 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 9785 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 9785 equipment must be securely mounted, following the instructions in paragraphs 3.3.1 through 3.3.3.

3.3.1 INDIVIDUAL CHASSIS

RFL 9785 terminals housed in individual chassis have two mounting ears (one on each side). Hole sizes and spacings conform with EIA standards, so the RFL 9785 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

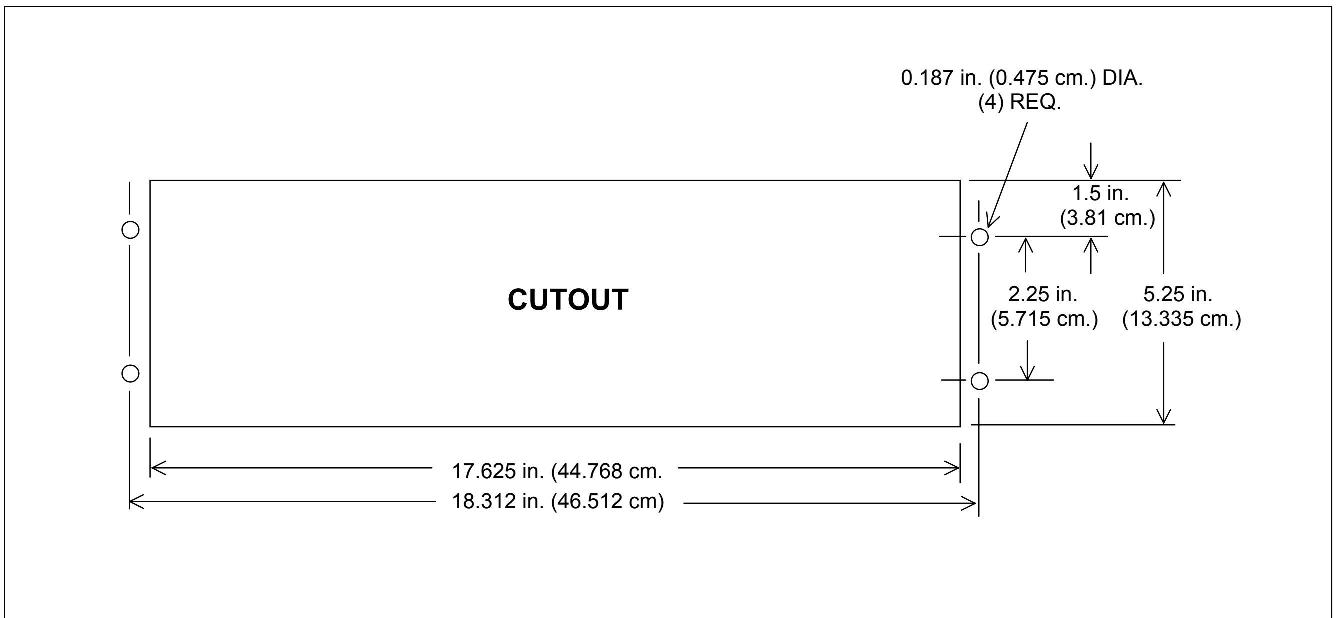

Figure 3-1. Mounting dimensions, RFL 9785 Programmable ON/OFF Powerline Carrier System

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 9785 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.

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 9785 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 9785 chassis through the terminal blocks and connectors on the chassis rear panel. The rear panel of the RFL 9785 terminal is shown in Figure 3-2. Paragraphs 3.5.1 through 3.5.11 provide basic descriptions of all the connections that must be made. Refer to the "as supplied" drawings furnished with your RFL 9785 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 9785 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. Locate the terminal to which the wire is to be connected.

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

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

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

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

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

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

NOTE
All relay contacts are labeled in the de-energized position.

3.5.2 SOLID-STATE INPUT CONNECTIONS

Solid-state input connections are made to terminal blocks TB4 and TB5 on the rear of the RFL 9785 chassis. Terminal assignments are shown below. Be sure to observe proper polarity when making these connections.

Signal Name	Positive	Negative
START	TB4-1	TB4-2
STOP	TB4-3	TB4-4
RESERVE	TB5-1	TB5-2
RMT INIT	TB5-3	TB5-4

3.5.3 SOLID-STATE OUTPUT CONNECTIONS

Solid-state output connections are made to terminal block TB3 on the rear of the RFL 9785 chassis. Terminal assignments are shown below. Be sure to observe proper polarity when making these connections.

Signal Name	Positive	Negative
SS BLOCK 1	TB3-1	TB3-2
SS BLOCK 2	TB3-3	TB3-4

3.5.4 RELAY OUTPUT CONNECTIONS

Relay output connections are made to terminal blocks TB4 and TB5 on the rear of the RFL 9785 chassis. Terminal assignments are as follows:

Signal Name	Contact Type	Terminal Assignments
BLOCK RLY1	COMMON	TB4-5
	NORMALLY OPEN	TB4-6
	NORMALLY CLOSED	TB4-7
BLOCK RLY2	COMMON	TB5-5
	NORMALLY OPEN	TB5-6
	NORMALLY CLOSED	TB5-7

All output relays are normally de-energized when a block is not received. When a block is received, the relay is energized (pulled in).

3.5.5 ALARM OUTPUT CONNECTIONS

Alarm output connections are made to terminal block TB7 on the rear of the RFL 9785 chassis. Terminal assignments are as follows:

Signal Name	Contact Type	Terminal Assignments
POWER FAIL	COMMON	TB7-1
	NORMALLY OPEN	TB7-2
	NORMALLY CLOSED	TB7-3
TX FAIL	COMMON	TB7-4
	NORMALLY OPEN	TB7-5
	NORMALLY CLOSED	TB7-6

All alarm relays are normally energized.

3.5.6 CHECKBACK OUTPUT CONNECTIONS

Checkback output connections are made to terminal block TB8 on the rear of the RFL 9785 chassis. Terminal assignments are as follows:

Signal Name	Contact Type	Terminal Assignments
CHECKBACK TIP	COMMON	TB8-1
	NORMALLY OPEN	TB8-2
	NORMALLY CLOSED	TB8-3
CHECKBACK FAIL	COMMON	TB8-4
	NORMALLY OPEN	TB8-5
	NORMALLY CLOSED	TB8-6

The Checkback TIP (Test In Progress) relay and the Checkback Fail relay are normally de-energized. When a Checkback Test is in progress, the Checkback TIP relay is energized. The Checkback Fail relay is normally de-energized. If the Checkback Test has failed the Checkback Fail relay becomes energized and remains energized until a subsequent Checkback Test is run and passes.

3.5.7 CURRENT LIMIT PANEL CONNECTIONS

Current limit panel connections are made to terminal block TB1 on the rear of the RFL 9785 chassis. Refer to Section 17 for more information.

3.5.8 OTHER CONNECTIONS

TB6 is an unused terminal block on the rear panel of the RFL 9785. This terminal block can be used for making connections to any accessory equipment supplied with your RFL 9785 terminal. Refer to the "as supplied" drawings furnished with your terminal for further information.

3.5.9 RF INPUT/OUTPUT CONNECTIONS

There are two rf connectors on the rear of the RFL 9785 chassis which are marked "TX" and "RX". These connectors are normally connected together with an internal jumper. When external hybrids are used, the outgoing coaxial cable is connected to the TX connector, and the incoming coaxial cable is connected to the RX connector.

WARNING

THE RFL 9785 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.

3.5.10 CHASSIS GROUND CONNECTIONS

TB1-1 at the rear of the RFL 9785 chassis is the main ground for the RFL 9785 terminal. Grounding is accomplished by connecting a wire 6AWG or larger between TB1-1 and rack ground. The grounding wire should be kept as short and straight as possible, to keep its resistance and inductance to a minimum.

TB1-3 is tied to circuit common. This terminal can be allowed to float, or it can be tied to RACK GROUND (TB1-1) if local practice requires this.

Before attempting to make power connections, make sure the RFL 9785 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.

3.5.11 POWER CONNECTIONS

After all other connections have been made to the RFL 9785, 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 dc-dc converter power supply installed in the terminal, either 48-volt or 125-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 9785 is shut down for any reason.

Figure 3-2. Rear panel View of Typical RFL 9785 TX/RX Chassis (Dwg. No. D-106577-A)

Please see Figure 3-2 in Section 22: Schematics.

Section 4. OPERATING INSTRUCTIONS

WARNING

ALL RFL 9785 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 9785 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 9785. All front panel controls and indicators are shown and described, and an initial startup procedure is included for verifying operation before placing the RFL 9785 into continuous service.

4.2 FRONT PANEL CONTROLS AND INDICATORS

The front panel of the RFL 9785 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 9785 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 9785 was equipped with any accessory equipment containing controls and indicators, refer to Section 21 of this manual for further information.

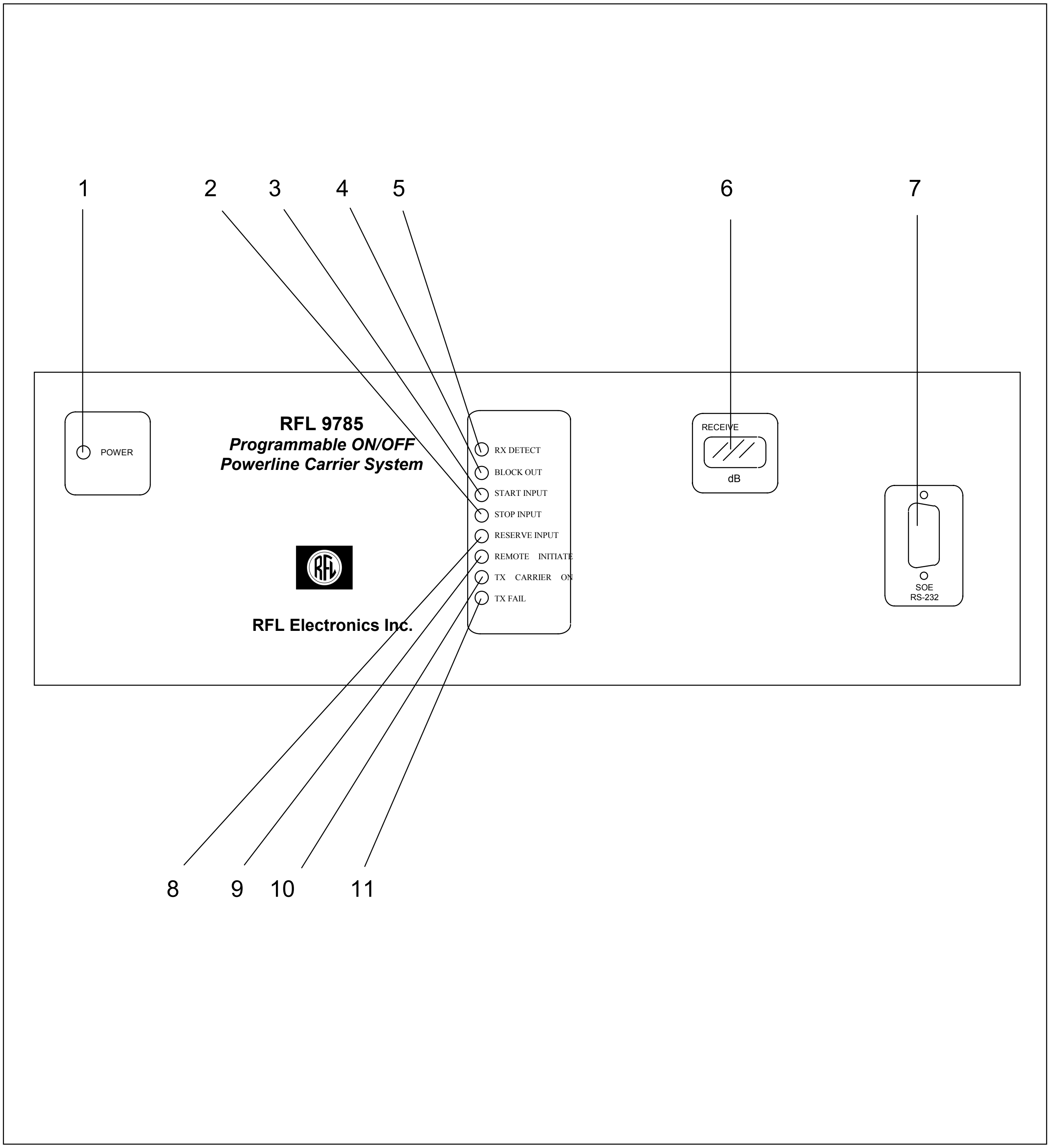

Figure 4-1. Controls and indicators, RFL 9785 front panel

Table 4-1. Controls and indicators, RFL 9785 Front Panel

Item Number	Name/Description	Function
1	POWER ON indicator	Lights green when system power is ON
2	STOP INPUT indicator	Lights red when CARRIER STOP input is active
3	START INPUT indicator	Lights red when CARRIER START input is active
4	BLOCK OUT indicator	Lights red when a block condition has been detected
5	RX DETECT indicator	Lights red when a received signal has been detected
6	RECEIVE LEVEL display	Displays the power level of the received carrier signal in dB. The range is –10 dB to +10 dB.
7	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)
8	RESERVE INPUT indicator	Lights red when RESERVE INPUT is active
9	REMOTE INITIATE indicator	Lights red when REMOTE INITIATE is active
10	TX CARRIER ON indicator	Lights red when TX CARRIER is active
11	TX FAIL indicator	Lights red when the transmitter has failed.

Table 4-2. Controls and indicator information for RFL 9785 system modules

Module Description	Controls and Indicators Information	Refer to Section:
AM Logic module	Table 6-1 & Figure 6-3	6
Transmitter module	Table 7-1 & Figure 7-4	7
Power amplifier module	Table 8-1 & Figure 8-2	8
Output filter modules	Table 9-1 & Figure 9-2	9
Receiver Downshifter module	Table 10-1 & Figure 10-3	10
Receiver Detector module	Table 11-1 & Figure 11-3	11
SOE/IRIG-B module	Table 12-1 & Figure 12-2	12
SOE/IRIG-B I/O module	Table 12-4 & Figure 12-6	12
Voice module	Table 14-1 & Figure 14-3	14
Checkback module	Tables 15-1 & 15-2, & Figures 15-8 & 15-9	15
Checkback communications module	Figure 16-2	16
Power supply module	Table 17-2 & Figure 17-2	17
Power supply I/O module	Tables 17-6 & 17-8, & Figures 17-6 & 17-19	17
Solid State Input I/O	Table 18-2 & Figure 18-3	18
Solid State Input/Output I/O	Table 18-5 & Figures 18-6 & 18-7	18
Alarm Relay I/O	Figures 18-10 & 18-11	18
RF Line I/O	Table 18-10 & Figures 18-13 & 18-14	18
Current Limit module	Figures 18-16 & 18-17	18
Chassis Assembly	Paragraph 19.2	19
Checkback alarm chassis	Figures 20-1 & 20-2	20

Figure 4-2. Locations of Circuit Board Modules in a Typical RFL 9785 Chassis (Dwg. No. D-106577-A)

Please see Figure 4-2 in Section 22: Schematics.

4.4 POWER SUPPLY CONSIDERATIONS

There are three standard station battery voltages which can be used to power the 9785 chassis: 48 Vdc, 125 Vdc, or 250 Vdc. Both the 48 V and 125 V station battery voltages require the use of a single, wide-range power supply. The 250 V station battery requires the use of a different chassis power supply. In addition to this, the chassis can be equipped with single or dual power supplies.

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

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

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

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

See section 16 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 9785 chassis.

4.5 INPUT AND OUTPUT VOLTAGES

The input and output voltages of the 9785 (other than the carrier signals) are typically either 48, 125, or 250 Vdc nominal. The 48 and 125 Vdc systems utilize the same power supply and I/O modules, while the 250 Vdc system requires that a different power supply and 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 9785 chassis. A single I/O Module accommodates both 48 and 125 V systems, and a jumper is used to select the desired configuration. The I/O Module must be removed from the chassis to change the jumper setting. See Section 18 for more information on the I/O modules. Refer to Section 1, page 5 for input and output, voltage and current specifications.

4.6 TRANSMIT FUNCTIONS

This section covers the configuration requirements related to the transmit functions of the 9785. The user must select the transmit frequency, the transmit power level, and how to combine the two keying input signals.

4.6.1 TRANSMIT FREQUENCIES

The user must know what transmit frequency is 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 range. 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 9 for details on selecting and configuring the Output Filter. The Transmitter Module must be set to generate the required carrier frequency. 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 other two banks of switches are used only in FSK systems. See Section 7 for more information on the Transmitter Module.

4.6.2 TRANSMIT POWER

The system can be configured for a 1W, 3W, or 10W transmit level. The output level is configured using switches SW1-3 and SW1-4 on the AM Logic Module. See paragraph 6.3.2 for more information. Note that for systems with external power amplifiers, these settings will be scaled by the external amplifier.

NOTE **The 1W and 3W configurations are for special applications only and are not compatible with the voice option.**

4.6.3 KEYING MODES

The 9785 can be configured for normally energized or normally de-energized start and stop inputs. This is configured using switches SW1-1 and SW1-2 on the AM Logic Module. See Paragraph 6.3.1 for more information.

4.6.4 TX VOICE

If the system is configured with the voice option, the transmission of voice signals can be enabled or disabled using switch SW1-5. See paragraph 6.3.3 for more information.

4.7 RECEIVER FUNCTIONS

There are several user configurable features in the 9785. 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. Consult RFL if you have any questions regarding the proper configuration of the 9785.

4.7.1 LINE TERMINATION

The 9785 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 on the Line I/O assembly at 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 18 for more information.

> **NOTE**
>
> **In two-wire operation, Rx tied to Tx (W3 and W5 shorted on I/O), the local transmitter terminates the receiver and the Line I/O terminal jumper must be set to “OUT”.**

4.7.2 RECEIVE FREQUENCIES

The receive center frequency must be programmed into the Receiver Downshifter 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 10.4.1 for more information.

The bandwidth of the received signal determines which Receiver Detector module is required in the system:

A 500 Hz bandwidth system requires one 500 Hz BW Receiver Detector module (assembly no. 106515-1).

A 1000 Hz bandwidth system requires one 1000 Hz BW Receiver Detector module (assembly no. 106515-2).

A 1500 Hz bandwidth system requires one 1500 Hz BW Receiver Detector module (assembly no. 106515-3).

4.7.3 EXTERNAL METER TYPE

Two types of external carrier level meters are supported by the 9785. 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 J3 on the Receiver Detector module. See paragraph 11.4.1 for more information.

4.7.4 TRANSMITTER FAIL ALARM, PICK-UP AND DROP-OUT

The transmitter fail detector (located on the Power Amplifier module) is designed to detect gross failure of the transmitter, and therefore has a fairly slow response time. Depending on the dynamics of the installed system, the actual settling time of the detector varies. For an ON/OFF carrier system, the carrier is normally off, which is not a fail condition.

When the carrier is enabled, there is a delay before the detector signal becomes reliable. The AM logic module allows for a delay between the carrier being enabled, and a transmitter fail alarm being issued. This pick-up delay may be set for 3ms, 50ms, 100ms or 150ms using switches SW1-6 and SW1-7 on the AM Logic module. See paragraph 6.3.4 for more information.

4.7.5 FORCE LOCAL BLOCK

The system can be configured to automatically enable the Block output when it is transmitting a block to the remote end. This can be enabled or disabled using switch SW2-1 on the AM Logic module. See paragraph 6.3.3 for more information. It should also be noted that the same function is often accomplished by connecting the Tx and Rx ports of the unit by installing a jumper on the line I/O module.

4.7.6 RX VOICE LEVEL

The system can be configured for high or low voice levels using switch SW2-2 on the AM Logic module. Systems are normally configured for high voice level. See paragraph 6.3.7 for more information.

4.8 INITIAL START-UP PROCEDURE

NOTE

DURING SHIPPING, THE MODULES IN THE CHASSIS MAY BACK OUT OF THEIR CONNECTORS. PRIOR TO BEGINNING THE STARTUP PROCEDURE, OPEN THE FRONT DOOR, AND REMOVE AND RE-SEAT ALL FRONT PANEL MODULES.

After the 9785 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 9785 are not hot pluggable. The power to the chassis must be turned off prior to removing in or installing 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)

4.8.1 TRANSMITTER

It is advisable to verify the operation of the transmitter after installation into the system. This allows checking the 9785 and line tuning equipment.

4.8.2.1 Output Power

The 9785 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 Tx port.
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. Verify that the “PWR 3” LED on the Transmitter Module is lit.
4. Adjust the Power Amplifiers Gain control (R2 on the rear of the chassis) to achieve 22.36 Vrms (40 dBm).
5. Disconnect the dummy load and restore the line connection.

4.8.2.2 Output Impedance

Once the 9785 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 9785 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 9785 and the output compliance voltage is limited.) For this reason, the adjustment must be made at less than 10 W output power.

1. Disconnect all loads from the amplifier. To do this, remove the Output Filter Module from the 9785 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.
2. Key the transmitter using the reserve input (terminals 1 and 2 on terminal block TB5 on the rear of the chassis). The “PWR3” and “RESV” LEDs should be lit.
3. Measure the amplifiers output voltage using a FSVM across TP3 (white) and TP1(brown) on the Output Filter Module and record.
4. Connect the 9785 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 9785 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 9785 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 (J1 on the Receiver Downshifter) to "50 dB".

2. With the system in place and the far end transmitting a 10W block signal, measure the receive level using a FSVM. The FSVM must be set to the frequency being transmitted by the far end . The level should be measured at the receive test point TP20 (white), with the reference common at TP1 (black) on the Receiver Downshifter.

3. Using Table 4-3, determine the appropriate input attenuator setting (J1) and gain setting (J2) and configure the Receiver Downshifter Module accordingly.

Table 4-3. Input Attenuator Settings

Measured Receive Level	Jumper J1 (Attenuation)	Jumper J2 (Gain-Hi/Lo)
5 - 15 mVrms	0 dB	HI
15 - 75 mVrms	0 dB	LO
75 - 150 mVrms	10 dB	LO
150 - 500 mVrms	20 dB	LO
0.5 - 1.5 Vrms	30 dB	LO
1.5 - 5 Vrms	40 dB	LO
Above 5 Vrms	50 dB	LO

4.8.3.2 Input Level Adjust

Adjust the GAIN potentiometer (R69) on the front of the Receiver Downshifter Module to achieve a 0 dB reading on the carrier level indicator.

Schematic, Locations Of Ckt Board Modules In A Typical RFL 9785 Chassis (Dwg No. D-106577-A)

Please see Figure 4-2 in Section 22: Schematics.

Section 5. MAINTENANCE

WARNING

HAZARDOUS VOLTAGES CAN BE PRESENT INSIDE RFL 9785 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 9785 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 9785. 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 9785 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 9785'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 9785 circuit board modules and I/O modules.

5.2.1 CIRCUIT BOARD MODULES

All RFL 9785 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 9785 front panel module, with the exception of the power supply module, proceed as follows:

1. Lower the front cover of the RFL 9785.

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 9785 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 9785 power supply module proceed as follows:

1. Lower the front cover of the RFL 9785.

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 9785 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 9785 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 9785 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 9785 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 9785 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 pushing in on the fuseholder cap and turning it counter clockwise about 1/4 turn. Some fuseholders require a screwdriver to remove the fuse, while others can be turned with the fingers.

3. Remove the fuse from the fuseholder cap and inspect it for damage. If the fuse is bad, it must be replaced. If the fuse is good, check for 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 17 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 9785 Power Supply I/O Modules

Model	Assembly Number	Fuse Rating	Manufacturers type	RFL Part Number
48/125Vdc	106455-1	5x20mm, slo-blow, 250V, 4A	Littlefuse 218004 or equiv.	301122
250Vdc	106455-2	5x20mm, slo-blow, 250V, 4A	Littlefuse 218004 or equiv.	301122
48/125Vdc, dual	106455-3	5x20mm, slo-blow, 250V, 4A	Littlefuse 218004 or equiv.	301122
250Vdc, dual	106455-4	5x20mm, slo-blow, 250V, 4A	Littlefuse 218004 or equiv.	301122

5.4 CORRECTIVE MAINTENANCE

The RFL 9785 Programmable ON/OFF Powerline Carrier System has been designed for years of trouble-free service. Should a malfunction occur involving the RFL 9785, use standard troubleshooting techniques to determine if the problem is in the RFL 9785, or in some other connected equipment. If the problem lies within the RFL 9785, use the schematics at the end of Sections 6 through 20 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 EXTENDER CARD

Most RFL 9785 modules have test points which can be monitored when the module is mounted on an extender card. The RFL part number of the extender card is 9547 1870.

5.6 HOW TO ARRANGE FOR SERVICING

If necessary, RFL 9785 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. AM LOGIC MODULE

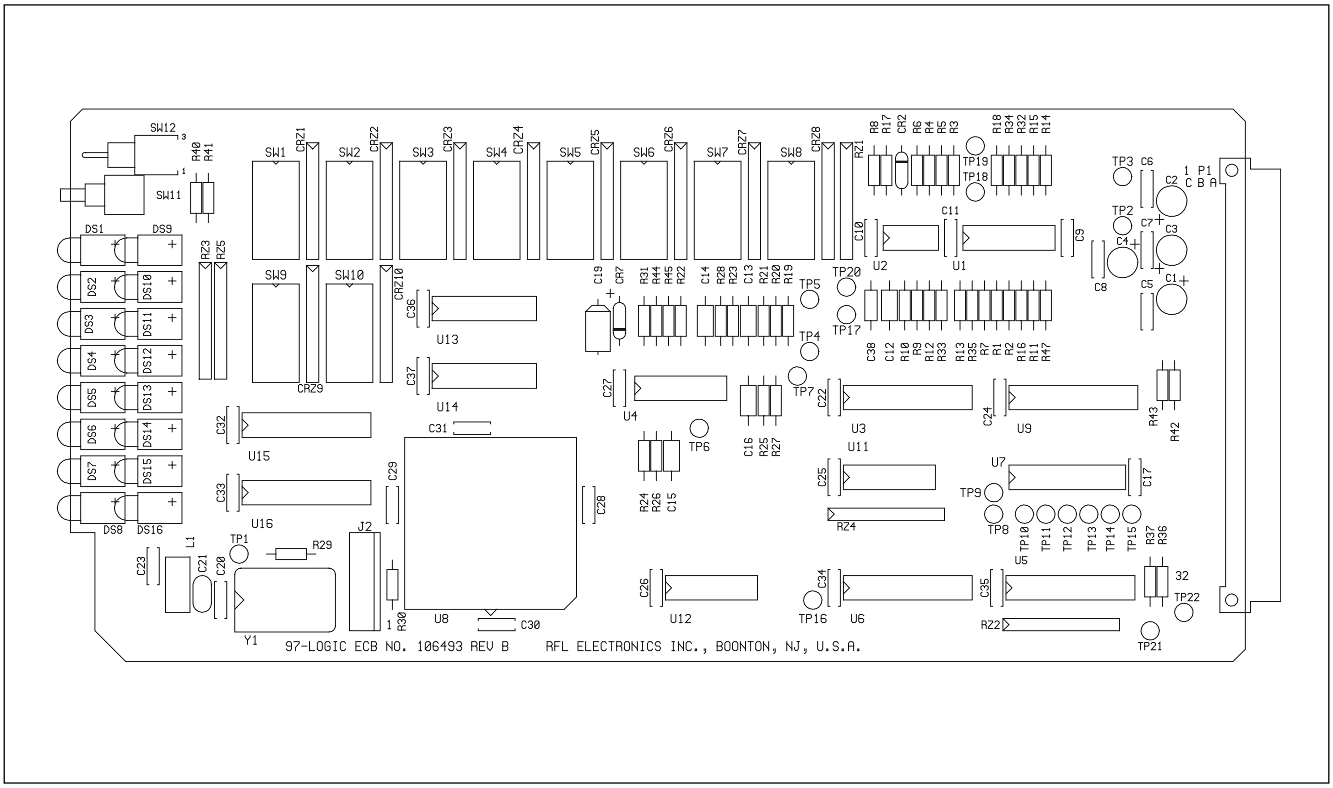

Figure 6-1. RFL 9785 AM Logic Module

6.1 DESCRIPTION

The 9785 AM Logic Module (Figure 6-1) monitors the CARRIER START, CARRIER STOP, and RESERVE KEY keying inputs, as well as signals from other modules of the RFL 9785. It uses this information to generate command signals for the transmitter and receiver detector modules. Switches SW1 and SW2 on the 9785 AM Logic Module allows the logic to be set according to the requirements of the specific application. The 9785 AM Logic Module also provides status information for the Sequence of Events Module (SOE).

The 9785 AM Logic Module has eight red indicator lamps (DS1 through DS-8) on the front edge of the module, which protrude through the front panel of a closed chassis for ease of visibility. These include RX DETECT (DS1), BLOCK OUT (DS2), START (DS3), STOP (DS4), RESERVE (DS5), REMOTE INIT (DS6), TX CARRIER (DS7), and TX FAIL (DS8).

Open-collector transistors are provided on the 9785 AM Logic Module to drive relays with block, logic alarm, and transmitter fail alarm output signals.

6.2 SPECIFICATIONS

Crystal Frequency:

The frequency of crystal clock oscillator Y1 is 3.584 MHz ± 50 ppm.

6.3 THEORY OF OPERATION

The 9785 AM Logic module circuitry is described in the following paragraphs. Refer to the block diagram shown in Figure 6-2 and the schematic diagram shown in Figure 6-5.

6.3.1 INPUT KEYING CONTROL LOGIC

The 9785 AM Logic Module receives its input from the rear panel I/O and modules in the RFL 9785 terminal. It generates output for the transmitter and receiver detector modules based on switch settings and input signals.

The START and STOP signals are present at edge connector pins B21 and C22 respectively where they are buffered and filtered. Both of these signals are polarized by Switch SW1-1 depending on whether normally energized or de-energized input relays are required for the application. An active START input will generate a logic high output signal unless the STOP is active. A STOP command has priority over a START command. The resulting logic high output is combined with other possible sources of carrier start. These include DIRECT KEY, TEST-SWITCH (SW12), RESERVE KEY, and CHECKBACK KEY. Any of these will generate a logic low SEND signal initiating carrier start.

START indicator DS3 and STOP indicator DS4 provide a visual indication when their corresponding inputs are active. An active START input will generate a logic high START-OUT output signal at edge connector pin B26. An active STOP input will generate a logic high STOP-OUT output signal at edge connector pin A26.

The logic low SEND signal is inverted and available on edge connector pin B27 as a logic high UTILITY-OUT output signal.

The logic low RESERVE KEY input starts the carrier as noted above, and also sends a logic low RESERVE-OUT signal to the transmitter module to set the reserve signal level. A logic high CHECKBACK-LEVEL input can also set the reserve signal level. A START command has priority over RESERVE KEY and CHECKBACK-LEVEL inputs. The reserve signal level is overridden.

6.3.2 POWER LEVEL AND FREQUENCY CONTROL LOGIC

Switches SW1-3 and SW1-4 determine the power level used to transmit a BLOCK if the SEND signal is active. The power level can be programmed for 1W, 3W, or 10W. The power level is always set for 3W whenever SEND is not active. This will guarantee a 3W level when voice is active. The power output signals are A-SWITCH and B-SWITCH. These are located at edge connector pins A14 and B14 respectively.

As this is not a frequency-shift-keying system, the OSC1-2 at edge connector pin A13 is held to a logic-high and OSC-3 at edge connector pin B13 is held to a logic-low. Therefore, the transmit frequency is always programmed with the "Center Frequency" rotary switches on the transmitter module. The "Shift Up" and "Shift Down" rotary switches are not used.

6.3.3 LOCAL CARRIER AND TRANSMIT VOICE CONTROL LOGIC

Local carrier is active when either a logic-high is applied to the VOICE-REQUEST input at edge connector pin A16 (indicating that voice is active), or when SEND is active and STOP is not active. The CARRIER-SWITCH signal at edge connector pin C15 will be a logic-high when the local carrier is active.

Voice is enabled by switch SW1-5 if the voice option is installed. Voice will only be transmitted when SEND is <u>not</u> active. The AM-ENABLE signal at edge connector pin B24 will be a logic-high when voice is being modulated over the carrier frequency.

6.3.4 TRANSMITTER FAIL CIRCUIT

The Transmitter Fail Circuit can be configured by switches SW1-6, SW1-7 and SW1-8 for 3ms, 50ms, 100ms or 150ms alarm pickup delay. The CARRIER-DETECT input applied to edge connector pin C13 must be a logic low within the allotted time after SEND initially goes to a logic low. If it does not, TX FAIL LED DS8 will light and TX FAIL alarm relay will de-energize, indicating a power amplifier failure. The condition will be logged by the sequence of events module (SOE).

When the CARRIER-DETECT input is a logic low, DS3 will be lit.

6.3.5 BLOCK CONTROL LOGIC

The receiver detector monitors the receive carrier signal strength, and generates a logic signal which is applied to edge connector pin A29 (SIG-COMP-IN) of the 9785 AM Logic Module. A logic-high SIG-COMP-IN or a logic-high CARRIER-SWITCH (indicating local carrier is active) will generate a block. The local carrier blocking function can be disabled with switch SW2-1 if desired. A block received from the local carrier will be held for an additional 3 ms after blocking inputs go inactive. A block received from the remote carrier is not held. DS1 will light when SIG-COMP-IN is active. This indicates that a received signal is detected.

6.3.6 BLOCK OUTPUT CIRCUIT

A block generated by the Block Control Logic will turn-on transistors which drive BLOCK-OUT-RLY1, BLOCK-OUT-RLY2(optional), BLOCK-OUT-SS1, and BLOCK-OUT-SS2 outputs at edge connector pins C20, B23, A22, and C23 respectively. These signals will energize solid-state and electro-mechanical relays for the period of the block plus an additional 3ms hold time. The active BLOCK-OUT-SS1 and BLOCK-OUT-SS2 outputs are 32Khz 50% duty-cycle signals. A BLOCK indicator DS2 will illuminate to show that a block has been generated.

If an under-voltage condition is detected by the power supply, the POWER-FAIL (A17) and/or POWERFAIL2 (C16) inputs to the 9785 AM Logic Module will be logic-low. Both signals in the logic-low state will generate a logic-low POWER signal to prevent a BLOCK function for the period of the under-voltage condition plus an additional 320ms.

The status of the block output circuit is monitored by the optional sequence of events module (SOE).

6.3.7 RECEIVE VOICE CONTROL LOGIC

If the voice option is installed, voice can be received when the receive carrier is detected from the remote unit and the local carrier is not keyed. This implies that the SIG-COMP-IN signal is active and the CARRIER-SWITCH signal is inactive. The voice will be muted if either of these conditions is not met. The logic low VOICE-MUTE signal is applied to edge connector pin A27.

High or low voice level is selected with Switch SW2-2. Either a logic low VOICE-HIGH or VOICE-LOW signal is produced depending on SW2-2. These outputs are applied to edge connector pins C27 and C25 respectively. A logic low VOICE-MUTE overrides VOICE-HIGH and VOICE-LOW signals.

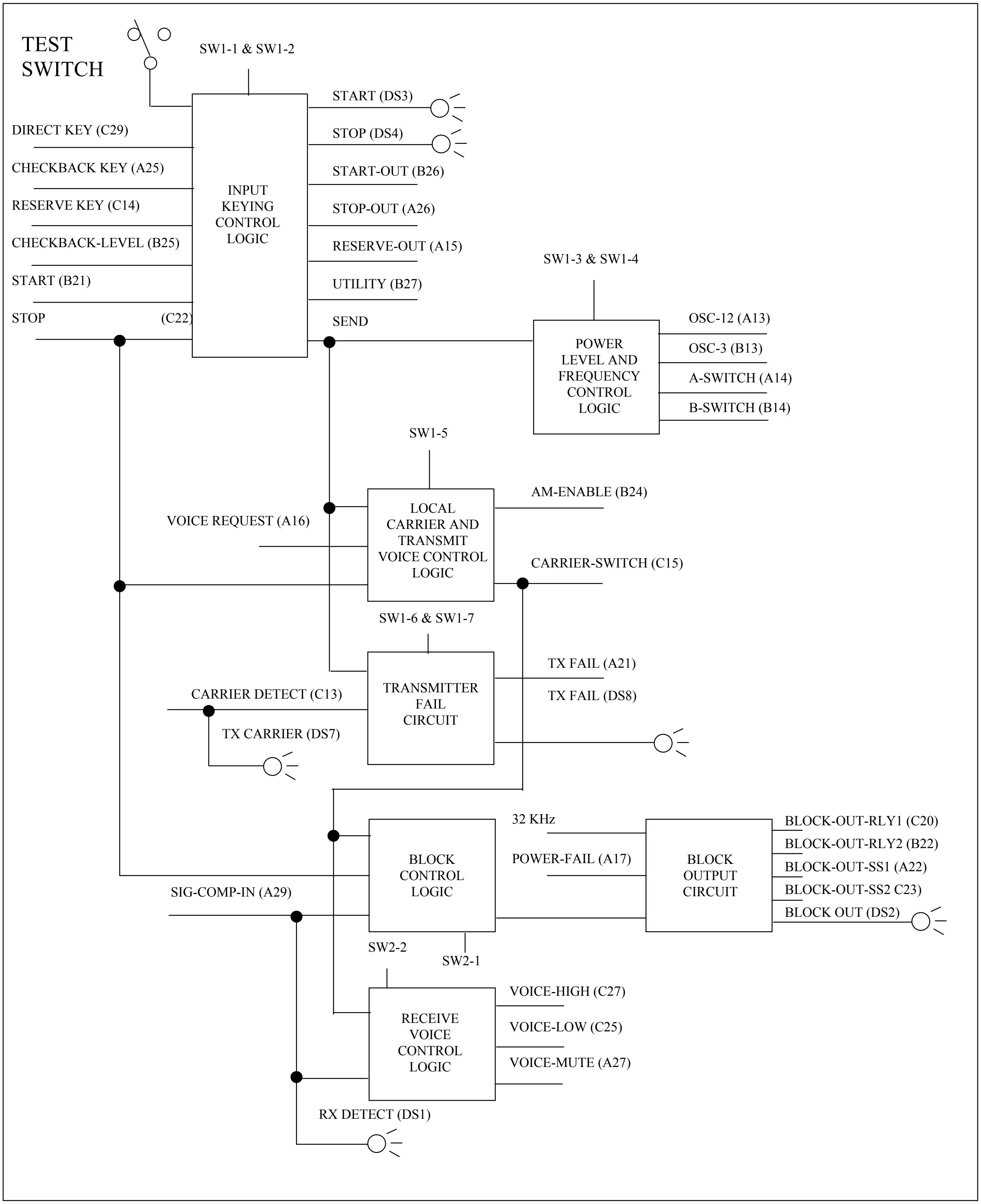

Figure 6-2. Block diagram, AM Logic Module

6.4 CONTROLS AND INDICATORS

Figure 6-3 shows the locations of all controls and indicators on the AM Logic module. These controls and indicators are described in Table 6-1. LEDs DS1, DS2 and DS4 through DS7 are visible with the module installed in the chassis. All other controls and indicators are only accessible when the module is removed from the chassis or is on a card extender.

Table 6-1. Controls and indicators, RFL 9785 AM Logic Module

Component Designator	Name/ Description	Function
DS1	LED Indicator, red	Lights when a received signal has been detected
DS2	LED Indicator, red	Lights when a block condition has been detected
DS3	LED Indicator, red	Lights when the CARRIER START input is active
DS4	LED Indicator, red	Lights when the CARRIER STOP input is active
DS5	LED Indicator, red	Lights when the RESERVE input is active
DS6	LED Indicator, red	Lights when the REMOTE INIT input is active
DS7	LED Indicator, red	Lights when the TX CARRIER is active
DS8	LED Indicator, red	Lights when the power amplifier has failed
DS9 to DS16	LED indicators	Not installed
SW1	DIP Switch	See Table 6-2.
SW2	DIP Switch	See Table 6-4.
SW3 to SW10	DIP Switch	Not installed
SW11	Push button switch	Not installed
SW12	Toggle Switch	Test switch used to manually key the transmitter module during setup and alignment as follows: <u>SW12</u> UP Enabled (initiates local carrier) DOWN Disabled
TP1	Test point	Monitoring point for 3.584 MHz master clock for ACTEL
TP3	Test point	Ground
TP4	Test point	Monitoring point for carrier detect signal
TP5	Test point	Monitoring point for reserve keying input signal
TP6	Test point	Monitoring point for carrier start input signal
TP7	Test point	Monitoring point for carrier stop input signal
TP8	Test point	Monitoring point for BLK OUT RLY1 logic control signal
TP9	Test point	Monitoring point for BLK OUT SS1 logic control signal
TP10	Test point	Monitoring point for SPARE DRIVER1 logic control signal
TP11	Test point	Monitoring point for BLK OUT SS2 logic control signal
TP12	Test point	Monitoring point for SPARE DRIVER2 logic control signal
TP13	Test point	Monitoring point for CB (checkback) RELAY logic control signal
TP14	Test point	Monitoring point for TX FAIL logic control signal
TP15	Test point	Monitoring point for BLK OUT RLY2 logic control signal
TP16	Test point	Monitoring point for CARRIER SW OUT logic control signal

Table 6-2. Switch Settings, DIP Switch SW1

Switch Section(s)	Function	Setting
SW1-1	Start Input Polarity	ON (UP) Normally Energized OFF(DOWN) Normally De-energized
SW1-2	Stop Input Polarity	ON (UP) Normally Energized OFF(DOWN) Normally De-energized
SW1-3 and SW1-4	Sets TX Power Levels	SW1-3 / SW1-4 / Power Level OFF(DOWN) OFF(DOWN) 1W OFF(DOWN) ON(UP) 3W ON(UP) OFF(DOWN) 10W ON(UP) ON(UP) 10W
SW1-5	TX Voice	ON(UP) TX Voice Enabled OFF(DOWN) TX Voice Disabled
SW1-6, SW1-7 & SW1-8	TX Fail	See Table 6-3.

Table 6-3. Switch Settings, DIP Switch SW1-6, -7, -8

SW1-6	SW1-7	SW1-8	Normal Delay*	X4 Delay*
OFF(DOWN)	OFF(DOWN)	OFF(DOWN)	3mspu/2.5msdo	- - -
OFF(DOWN)	ON(UP)	OFF(DOWN)	50mspu/2.5msdo	- - -
ON(UP)	OFF(DOWN)	OFF(DOWN)	100mspu/2.5msdo	- - -
ON(UP)	ON(UP)	OFF(DOWN)	150mspu/2.5msdo	- - -
OFF(DOWN)	OFF(DOWN)	ON(UP)**	- - -	12mspu/2.5msdo
OFF(DOWN)	ON(UP)	ON(UP)**	- - -	200mspu/2.5msdo
ON(UP)	OFF(DOWN)	ON(UP)**	- - -	400mspu/2.5msdo
ON(UP)	ON(UP)	ON(UP)**	- - -	600mspu/2.5msdo

* mspu = millisecond pick-up
* msdo = millisecond drop-out delay
** ON for applications using 9505 amplifier

Table 6-4. Switch Settings, DIP Switch SW2

Switch Section(s)	Function	Setting
SW2-1	Force Local RX Block	ON(UP) Enabled OFF(DOWN) Disabled
SW2-2	RX Voice Level	ON(UP) High level voice OFF(DOWN) Low level voice
SW2-3	SS Block Out #1 Polarity	ON(UP) Normally energized OFF(DOWN) Normally de-energized
SW2-4	SS Block Out #2 Polarity	ON(UP) Normally energized OFF(DOWN) Normally de-energized
SW2-5 thru SW2-8	N/A	N/A

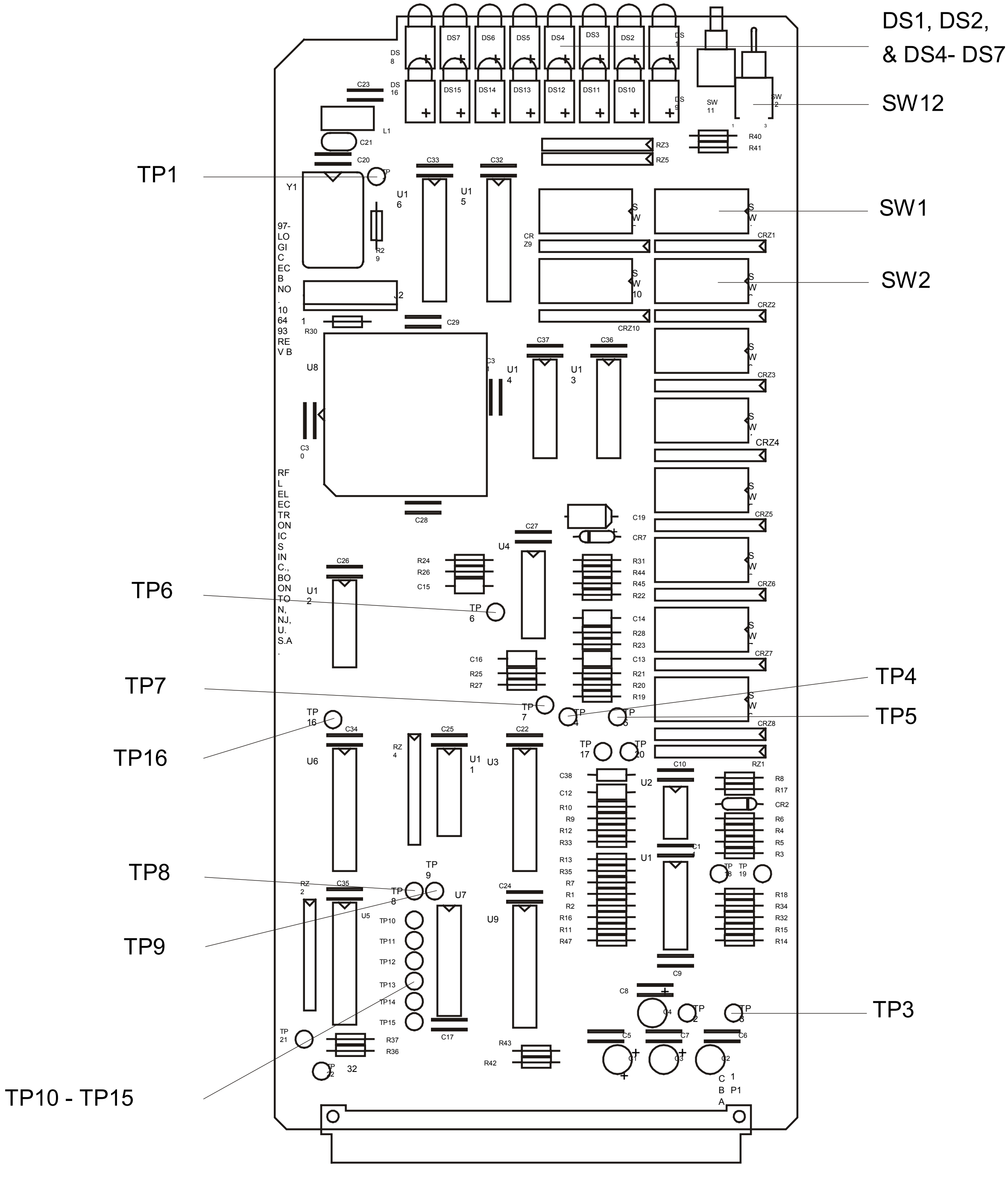

Figure 6-3. Controls and indicators, RFL 9785 AM Logic Module

Table 6-5. Replaceable parts, RFL 9785 AM Logic Module. Assembly No. 106540

Circuit Symbol (Figs 6-3 & 6-4)	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
C13, 14, 15, 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	
R19, 23, 26, 27	Resistor, metal film axial, 3.92K, 1%, 1/4W	0410 1345
R20, 24, 25, 28	Resistor, metal film axial, 33.2K, 1%, 1/4W	0410 1434
R29, 44	Resistor, metal film axial, 1K, 1%, 1/4W	0410 1288
R30	Resistor, metal film axial, 49.9K, 1%, 1/4W	0410 1451
R31, 36, 37, 41, 42	Resistor, metal film axial, 10K, 1%, 1/4W	0410 1384
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	302557
RZ4	Resistor network, 22K, 8R/PKG, SIP	32876
	SEMICONDUCTORS	
CR7	Diode, silicon, 1N914B/1N4448	26482
CRZ1	Diode array, 8 diode, common cathode	103444
U3, 5, 6, 9	Integrated circuit, MOS, octal, tri-state, non-inverting, buffer/line driver	0615 297
U4	Integrated circuit, MOS, HEX inverter, Schmitt trigger	0615 242
U7	Transistor array, ULN2803A	0720 7
U8	Integrated circuit, MOS, FPGA, A42MX09-PL84I	0615 473
U12	Integrated circuit, MOS, QUAD Buffer/Line driver	0615 292
U13	Integrated circuit, MOS, 3 to 8 line decoder	0615 168
U15	Integrated circuit, MOS, octal, 3-state, D Flip-Flop	0615 298
	MISCELLANEOUS COMPONENTS	
DS1, 2, 4, 5, 6, 7	Opto device, single, LED, red	98534
L1	Inductor, coated, 100µH, 10%	103472
P1	Connector plug, male, 96 contact, DIN	101681
SW1, 2	Switch, DIP, SPST, 8-position, 16 pin	98493
SW12	Switch, toggle, SPDT, ON-NONE-ON	32322
TP1, 3-16	Test point, terminal, orange	98441 3
Y1	Crystal, hybrid, clock oscillator, 3.584 MHz	103347

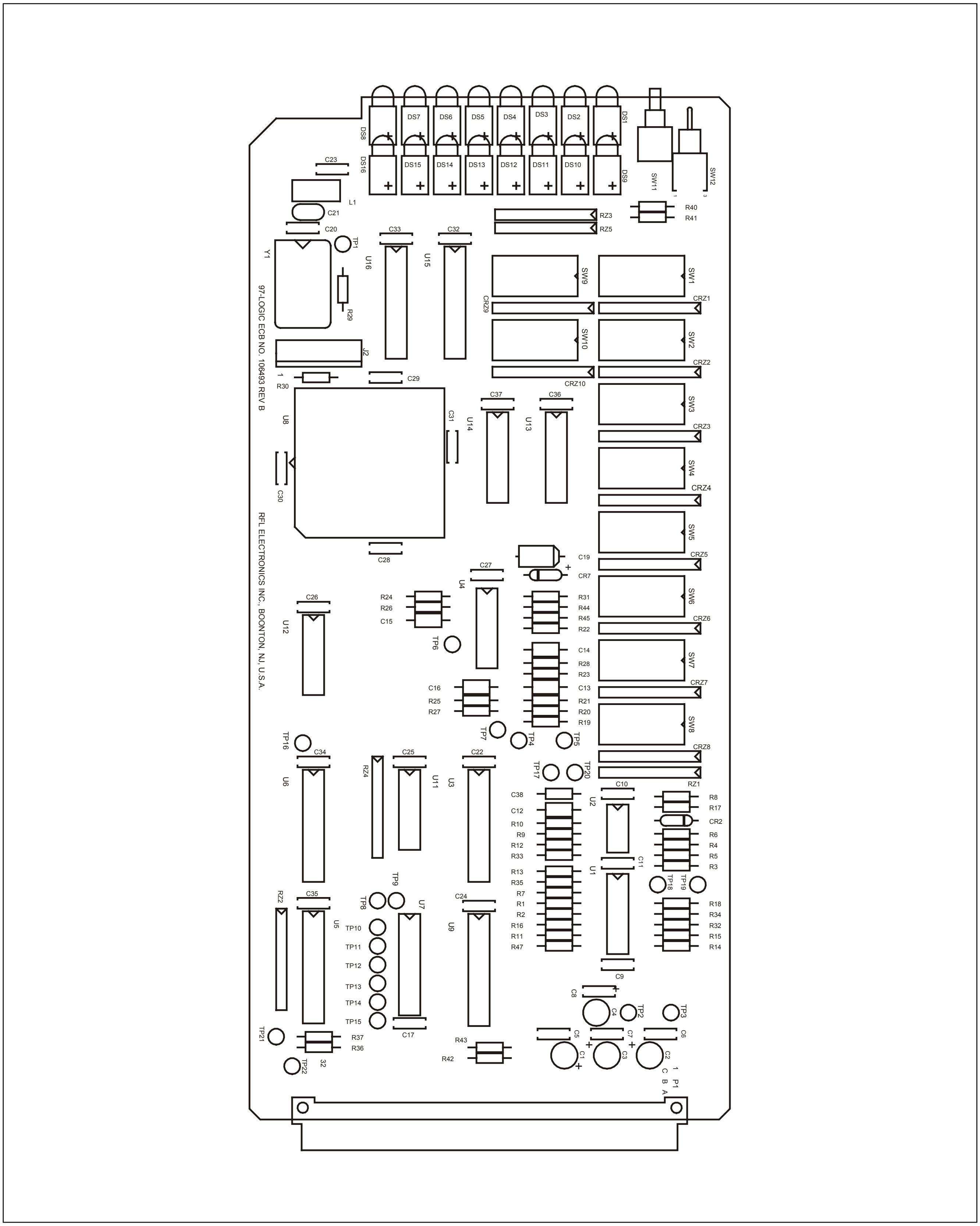

Figure 6-4. Component locator drawing, RFL 9785 AM Logic Module (Assembly No. 106540)

Figure 6-5. Schematic, RFL 9785 AM Logic (Dwg. No. D-106544-C) Sheet 1 of 2

Figure 6-5. Schematic, RFL 9785 AM Logic (Dwg. No. D-106544-C) Sheet 2 of 2

Please see Figure 6-5 in Section 22: Schematics.

Section 7. TRANSMITTER MODULE

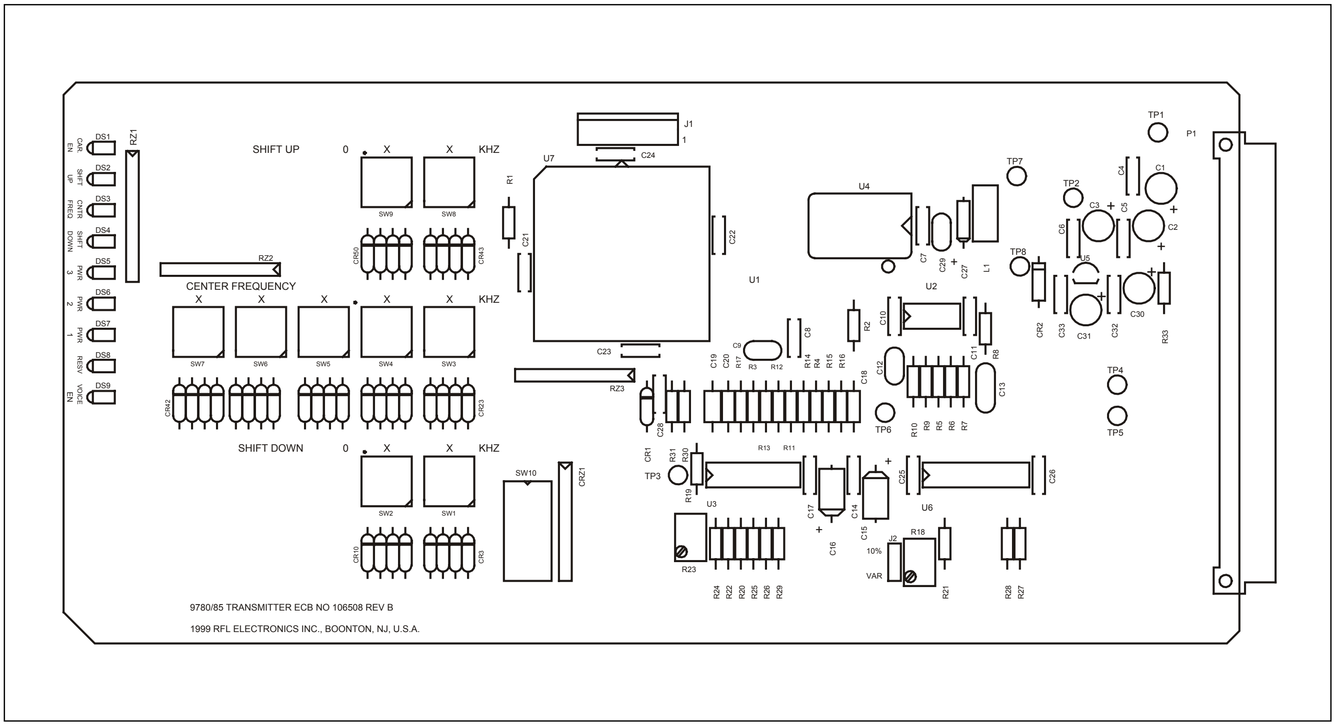

Figure 7-1. RFL 9785 Transmitter Module

7.1 DESCRIPTION

The RFL 9785 Transmitter Module (Figure 7-1) 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. If the voice option is installed in the system, the output of the DDS is amplitude modulated to the audio signal input. 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. The module can provide amplitude modulation in systems equipped with the voice option, and an input signal can be used to disable the voice signal when desired. 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, voice or reserve is enabled.

7.2 SPECIFICATIONS

As of the date this manual was published, the following specifications apply to all RFL 9785 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 9785 Power Amplifier Module):
10-Watt Output: 6.0 Vp-p
3-Watt Output: 3.4 Vp-p
1-Watt Output: 2.0 Vp-p

Voice Input: 1.6 Vp-p nominal; a 1000-Hz test tone at this level will produce 20 to 30 percent modulation. Voice input level is adjusted on the optional RFL 9785 Voice Module (Section 14).

7.3 THEORY OF OPERATION

The RFL 9785 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 7-2, a block diagram of the DDS is shown in Figure 7-3, and a schematic diagram of the transmitter module is shown in figure 7-5.

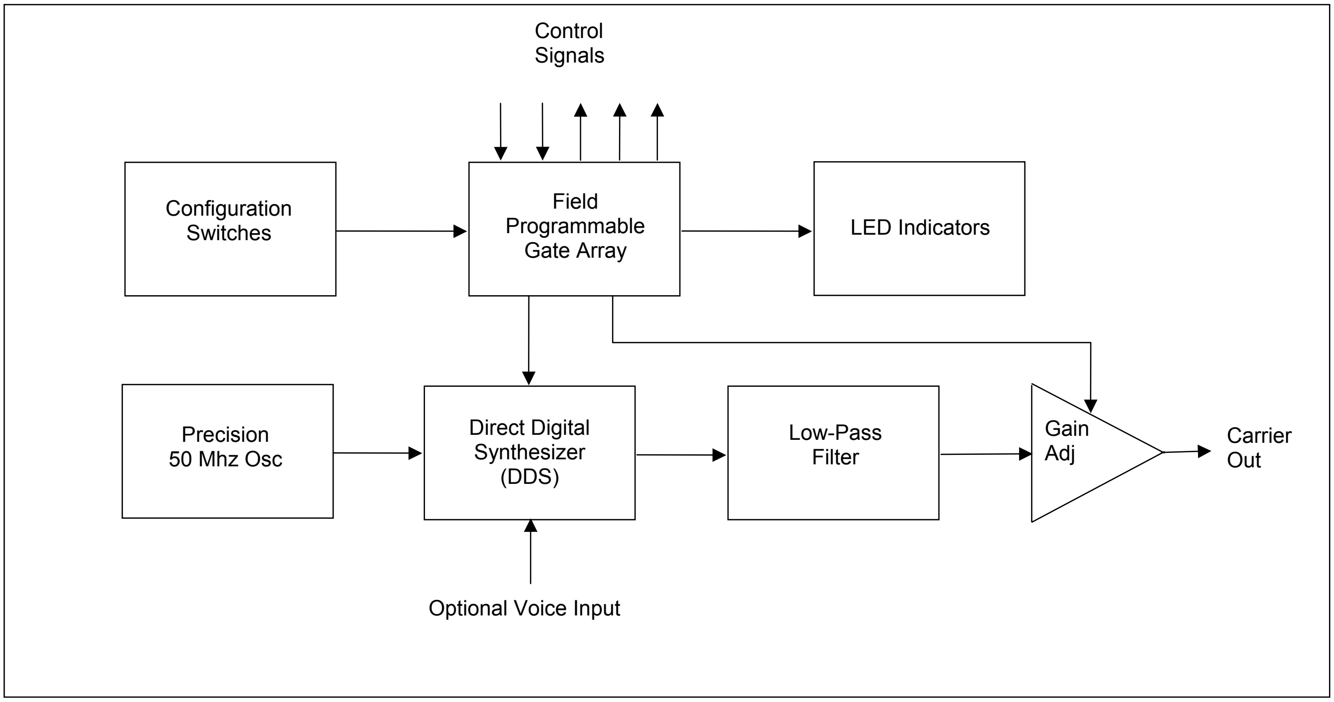

Figure 7-2. Transmitter module block diagram

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.

7.3.1 DIRECT DIGITAL SYNTHESIZER FUNDAMENTALS

A simplified block diagram for a basic DDS is shown in Figure 7-3. 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.

7.3.2 9785 DIRECT DIGITAL SYNTHESIZER

In the RFL 9785, 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.

7.3.3 VOICE AMPLITUDE MODULATION

When the voice option is installed, U2A is used to modulate the reference input to the D/A portion of the DDS based upon the voice input. This varies the full-scale setting of the D/A, thus providing the desired modulation. The modulation can be disabled, by opening the analog switch U6D.

7.3.4 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.

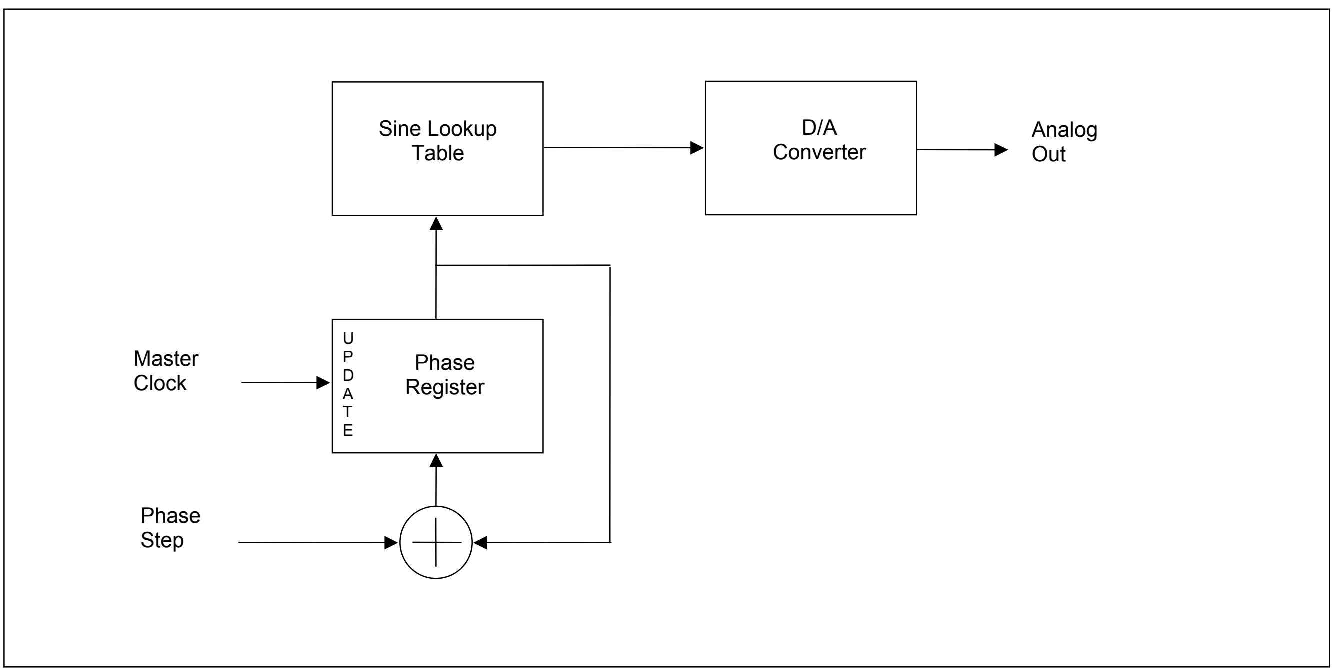

Figure 7-3. Block diagram of a basic DDS

7.3.5 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.

7.4 CONTROLS AND INDICATORS

Figure 7-4 shows the locations of all controls and indicators on the transmitter module. These controls and indicators are described in Table 7-1. 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 (RFL Part No. 9547-1870).

Table 7-1. Controls and indicators, RFL 9785 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 shift up frequency
DS3	Frequency 2 LED	The carrier is set for center frequency
DS4	Frequency 1 LED	The carrier is set for 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 10%
R18	Potentiometer	Used to vary the reserve level
R23	Potentiometer	Sets the module's nominal output level
SW1-SW2	Switch bank for shift up freq.	Sets the desired shift up frequency
SW3-SW7	Switch bank for center frequency	Sets the desired center frequency
SW8-SW9	Switch bank for shift down freq.	Sets the desired shift down 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)

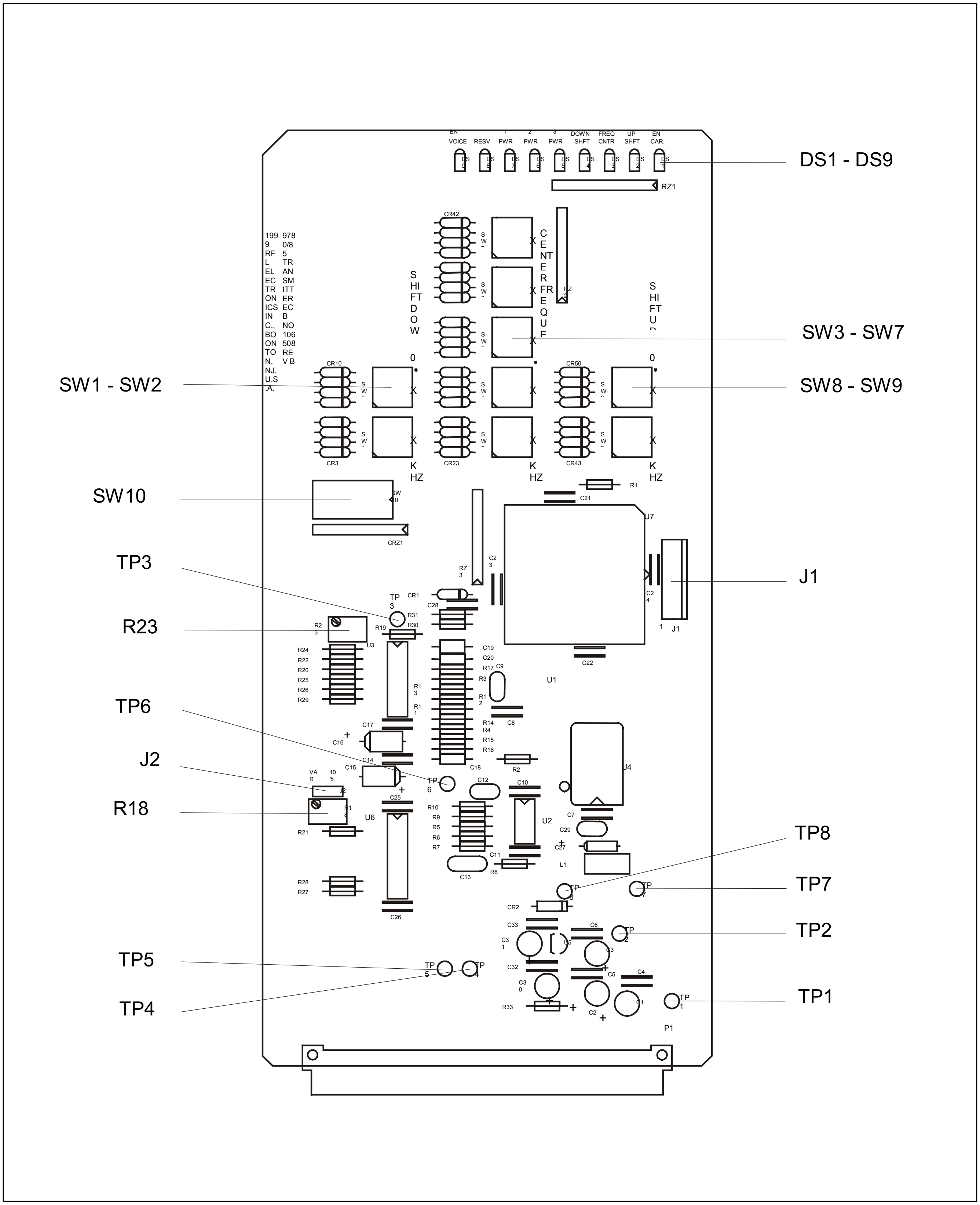

Figure 7-4. Controls and indicators, RFL 9785 Transmitter Module

7.4.1 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.

7.4.2 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.

7.4.3 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 7-2. Replaceable parts, RFL 9785 Transmitter Module. Assembly No. 106505

Circuit Symbol (Figs. 7-3 & 7-4)	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 7 2 - continued. Replaceable parts, RFL 9785 Transmitter Module

Circuit Symbol (Figs. 7-3 & 7-4)	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

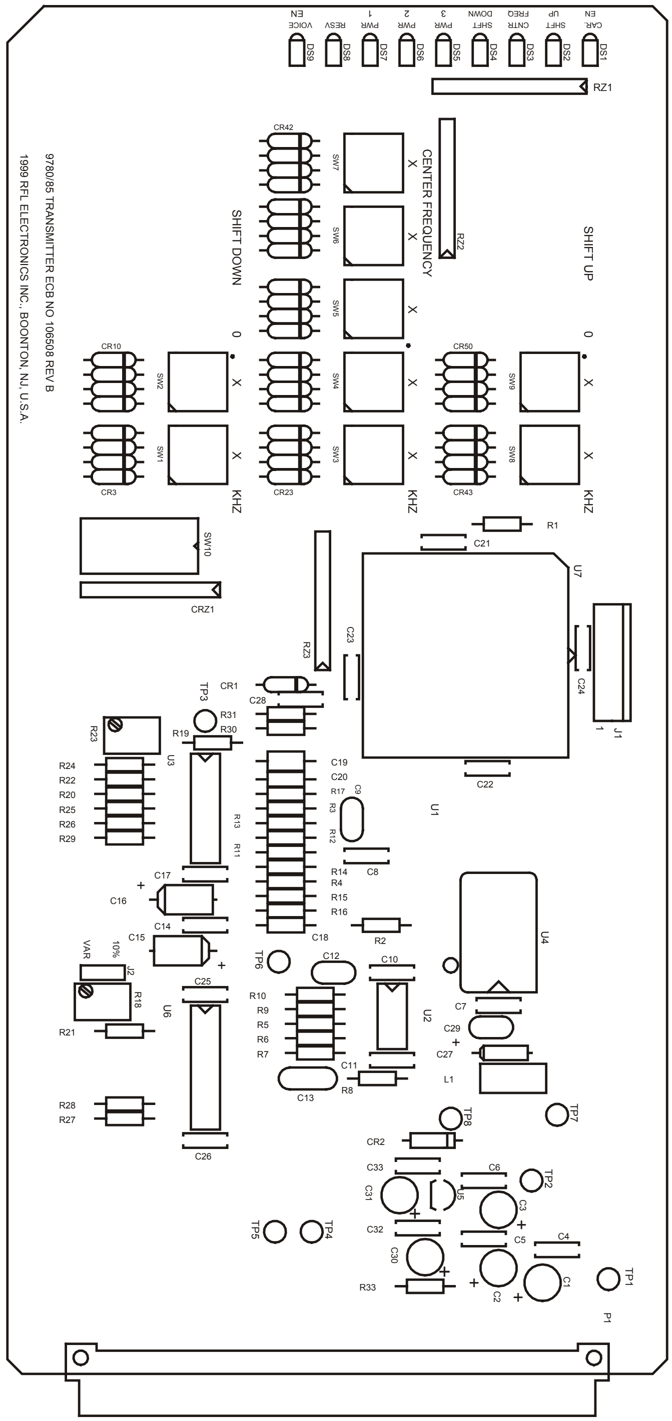

Figure 7-5. Component locator dwg, RFL 9785 Transmitter Module (Assy No. 106505, Circuit Board No. D-106508, Rev. B)

Figure 7-6. Schematic, RFL 9785 Transmitter (Drawing No. D-106509-C) Sheet 1 of 2

Figure 7-6. Schematic, RFL 9785 Transmitter (Drawing No. D-106509-C) Sheet 2 of 2

Please see Figure 7-6 in Section 22: Schematics.

Section 8. POWER AMPLIFIER MODULE

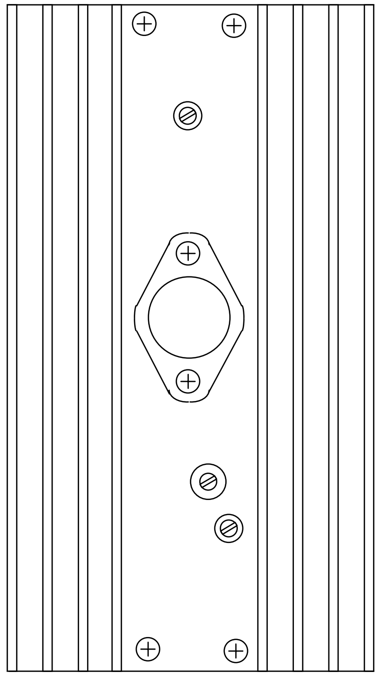

Figure 8-1. RFL 9785 Power Amplifier Module

8.1 DESCRIPTION

The RFL Power Amplifier module provides both voltage and current gain to the signal coming from the Transmitter module (Section 7). 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.

8.2 SPECIFICATIONS

As of the date this manual was published, the following specifications apply to all RFL 9785 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: See table below.
(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

8.3 THEORY OF OPERATION

Refer to the schematic diagram in Figure 8-4 for the following discussion.

The design of the RFL 9785 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.

8.4 CONTROLS AND INDICATORS

Figure 8-2 shows the location of all controls and indicators on the RFL 9785 Power Amplifier module. These controls and indicators are described in Table 8-1. Potentiometers R2, R10 and R16 are accessible with the RFL 9785 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.

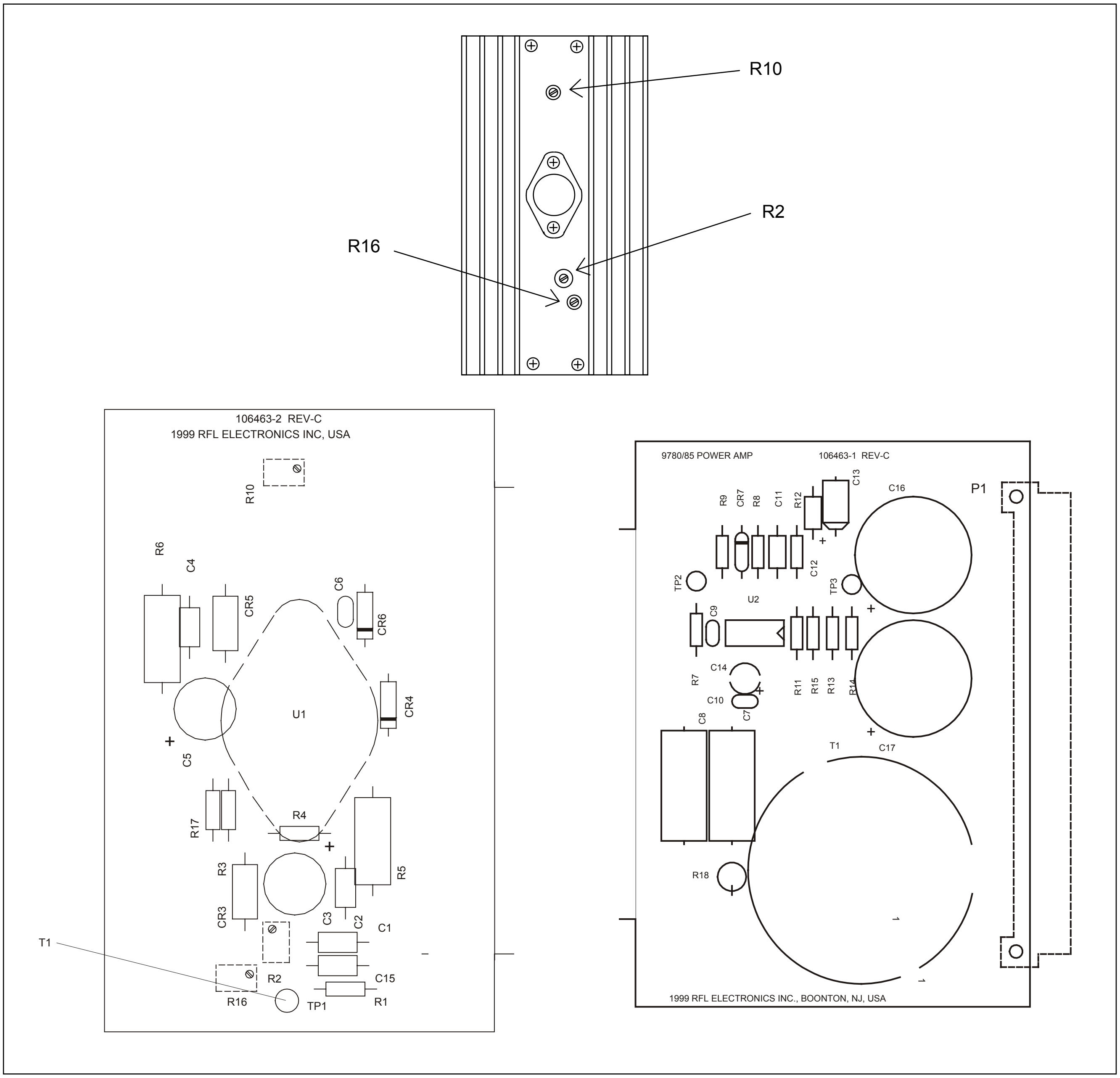

Figure 8-2. Controls and indicators, RFL 9785 Power Amplifier module

Table 8-1. Controls and indicators, RFL 9785 Power Amplifier module

Component Designator	Name/Description	Function
R2	Potentiometer	Gain adjustment
R10	Potentiometer	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

8.4.1 AMPLIFIER GAIN

The amplifier gain can be adjusted with Potentiometer R2. This adjustment 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.

8.4.2 OUTPUT IMPEDANCE

The Power Amplifier Module has provisions for adjusting the unit's output impedance to compensate for variations in actual field installations. This should only require setting upon initial installation, or following system changes that impact the impedance the 9785 is driving.
To match the impedance proceed as follows (with the system off-line):

1. Set the unit to transmit a 3 W signal (1 W would also work). *Do not set the unit for a 10 W transmit level.*

2. Remove the load from the output of the 9785 and measure the output signal voltage.

3. Connect the (actual) load to the 9785 and adjust potentiometer R16 (IMP ADJ) to obtain one-half of the unloaded output signal level.

8.4.3 LOW-LEVEL ALARM THRESHOLD

The low-level alarm threshold is set using potentiometer R10.

Table 8-2. Replacement parts, RFL 9785 Power Amplifier. Assembly No. 106460

Circuit Symbol (Figs. 8-3 & 8-4)	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	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

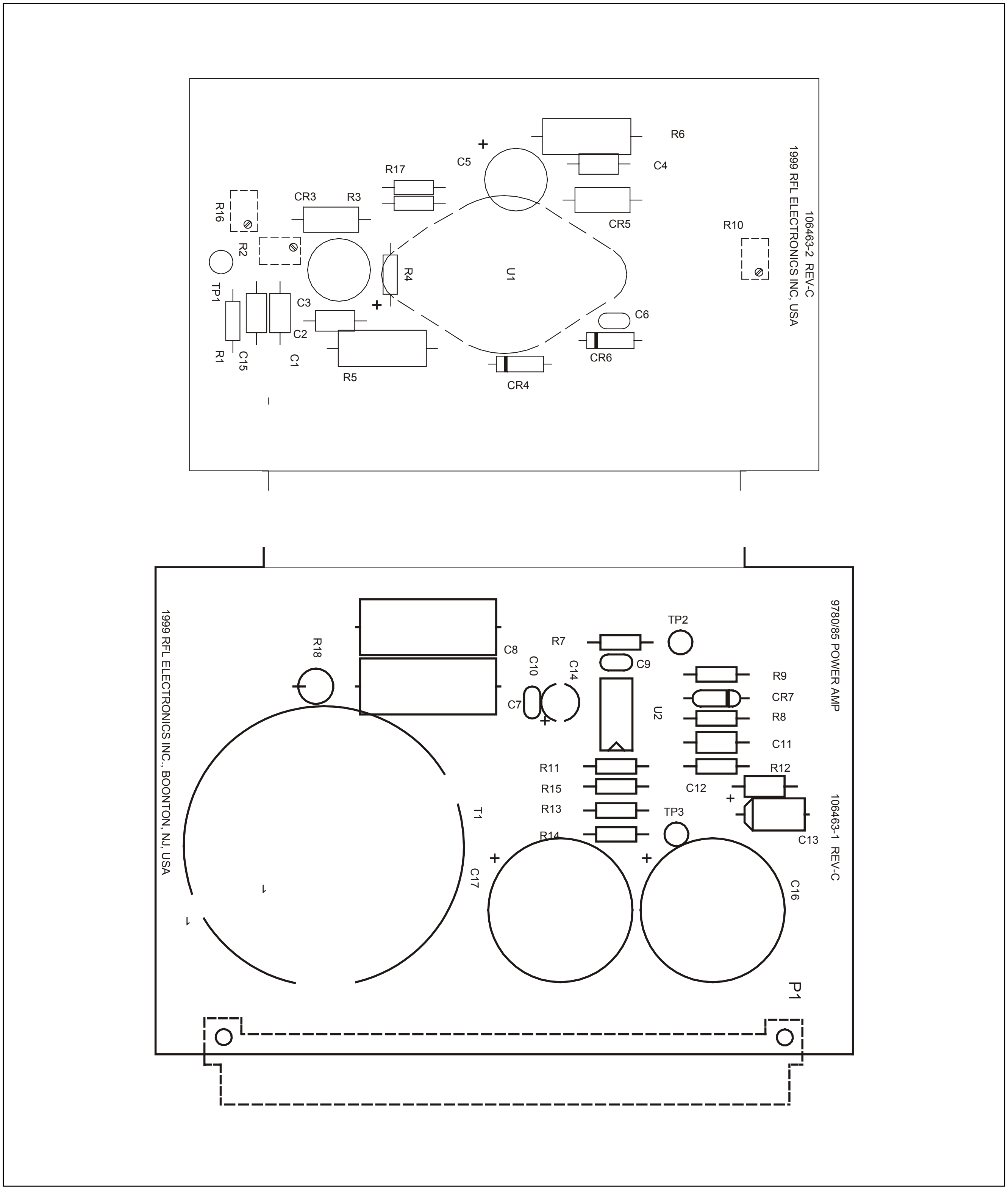

Figure 8-3. Component locator drawing, RFL 9785 Power Amplifier module

Figure 8-4. Schematic, RFL 9785 Power Amp (Dwg. No. C-106464-B)

Please see Figure 8-4 in Section 22: Schematics.

Section 9. OUTPUT FILTER MODULES

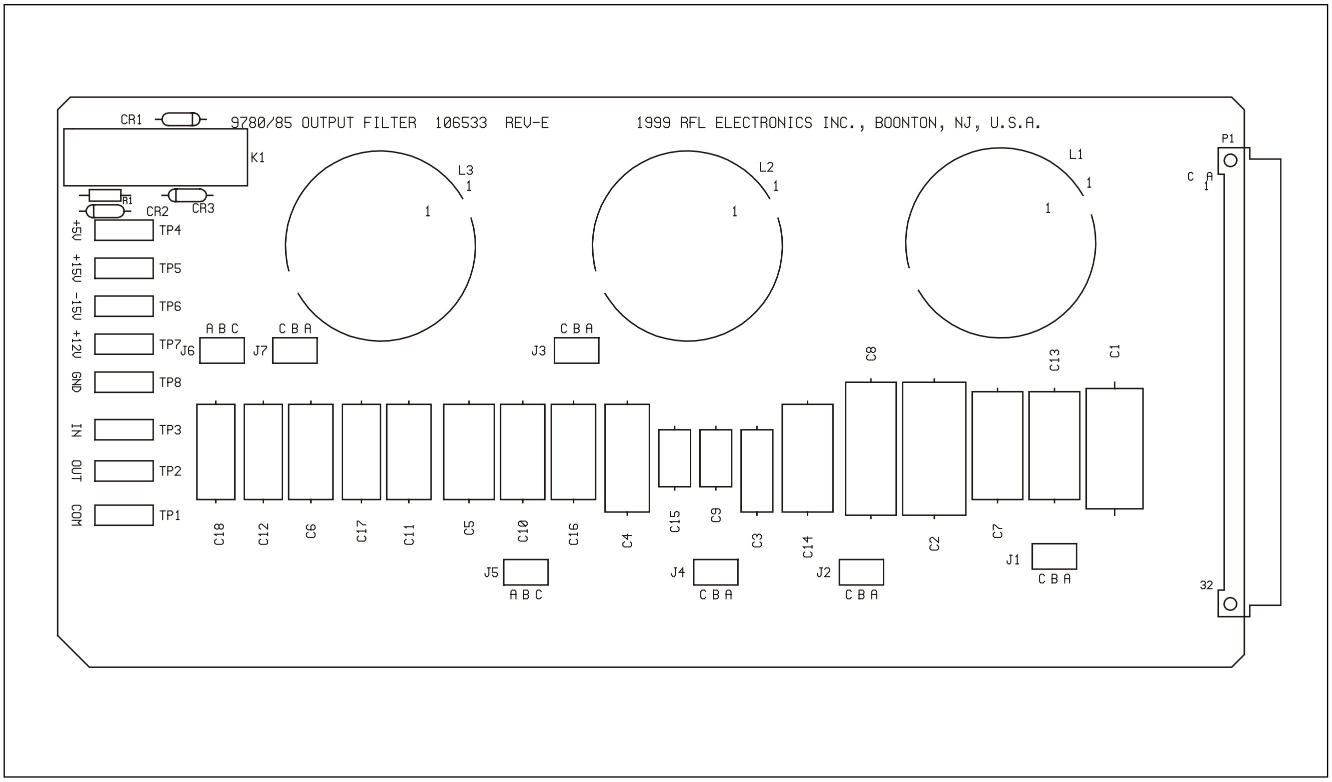

Figure 9-1. Typical RFL 9785 Output Filter Module (without reflected power meter option)

9.1 DESCRIPTION

RFL 9785 Output Filter Modules are used to reduce the harmonic content of the RFL 9785's output signal to a level that is at least 55 dB below the carrier level. A typical RFL 9785 Output Filter module appears in Figure 9-1.

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 9785, 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.

9.2 SPECIFICATIONS

As of the date this manual was published, the following specifications apply to all RFL 9785 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	30 kHz to 67.5 kHz	Without reflected power measurement option
106530-2	64 kHz to157.5 kHz	
106530-3	154 kHz to 393.5 kHz	
106530-4	390 kHz to 537.5 kHz	
106530-5	114 kHz to 288.5 kHz	
106530-11	30 kHz to 67.5 kHz	With reflected power measurement option
106530-12	64 kHz to157.5 kHz	
106530-13	154 kHz to 393.5 kHz	
106530-14	390 kHz to 537.5 kHz	
106530-15	114 kHz to 288.5 kHz	

Attenuation Notch:

Magnitude: Greater than 55 dB below passband level.
Approximate Frequency: See Table 9-2

Stopband:

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

106530-1: 90 kHz to 2 mHz
106530-2: 192 kHz to 2 mHz
106530-3: 462 kHz to 2 mHz
106530-4: 1.17 mHz to 2 mHz
106530-5: 342 kHz to 2mHz

Passband: 0.75 dB deviation.

Signal Power: 10 watts maximum.

Impedance: 50 ohms.

9.3 THEORY OF OPERATION

RFL 9785 Output Filters are elliptical six-pole passive L-C filters, that present less than 0.075 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 9-2 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 9785 and a PC using the front or rear RS-232 ports. Refer to Section 16 for additional information.

9.4 CONTROLS AND INDICATORS

The RFL 9785 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 9-1. Controls and indicators, RFL 9785 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.

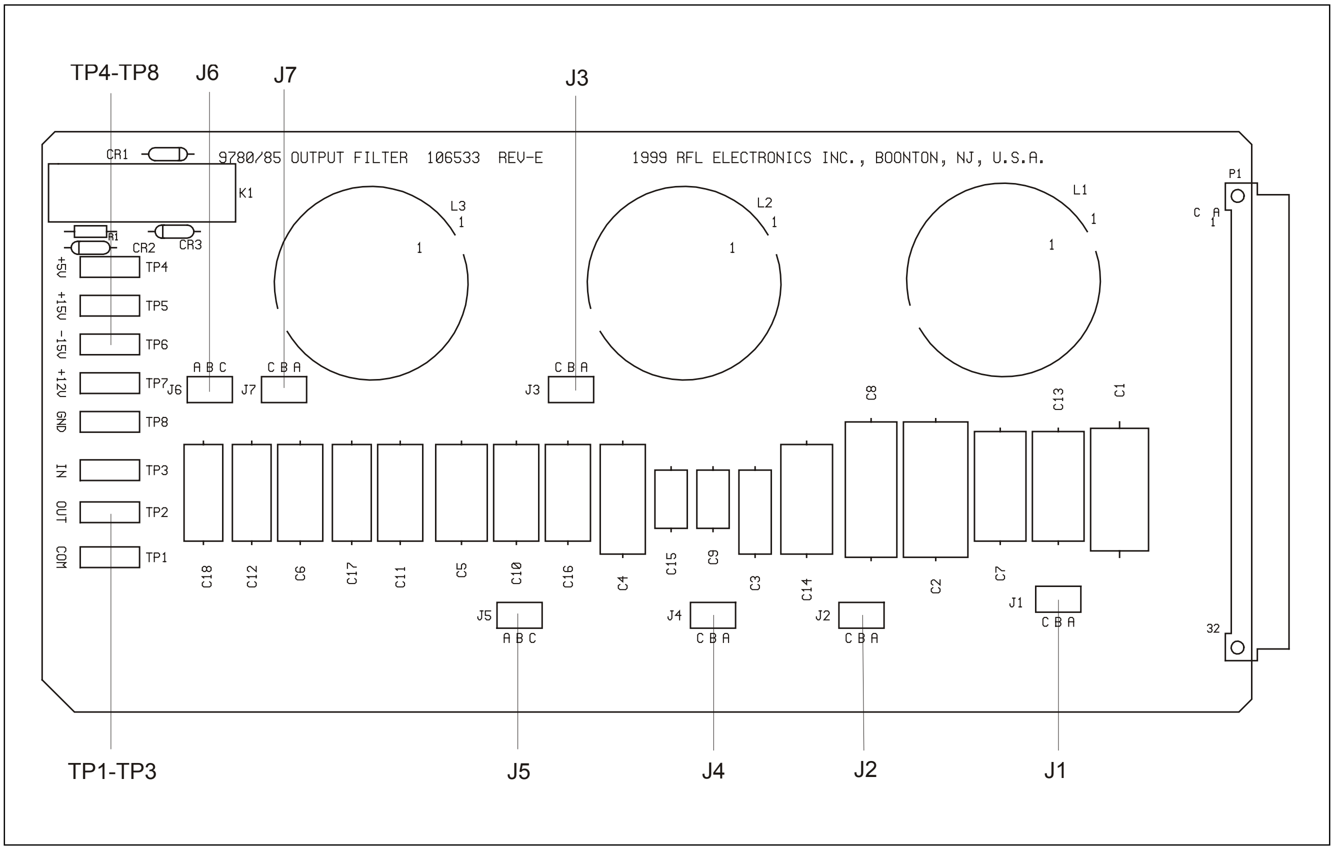

Figure 9-2. Controls and indicators, RFL 9785 Output Filter modules (106530-1 to 106530-5)

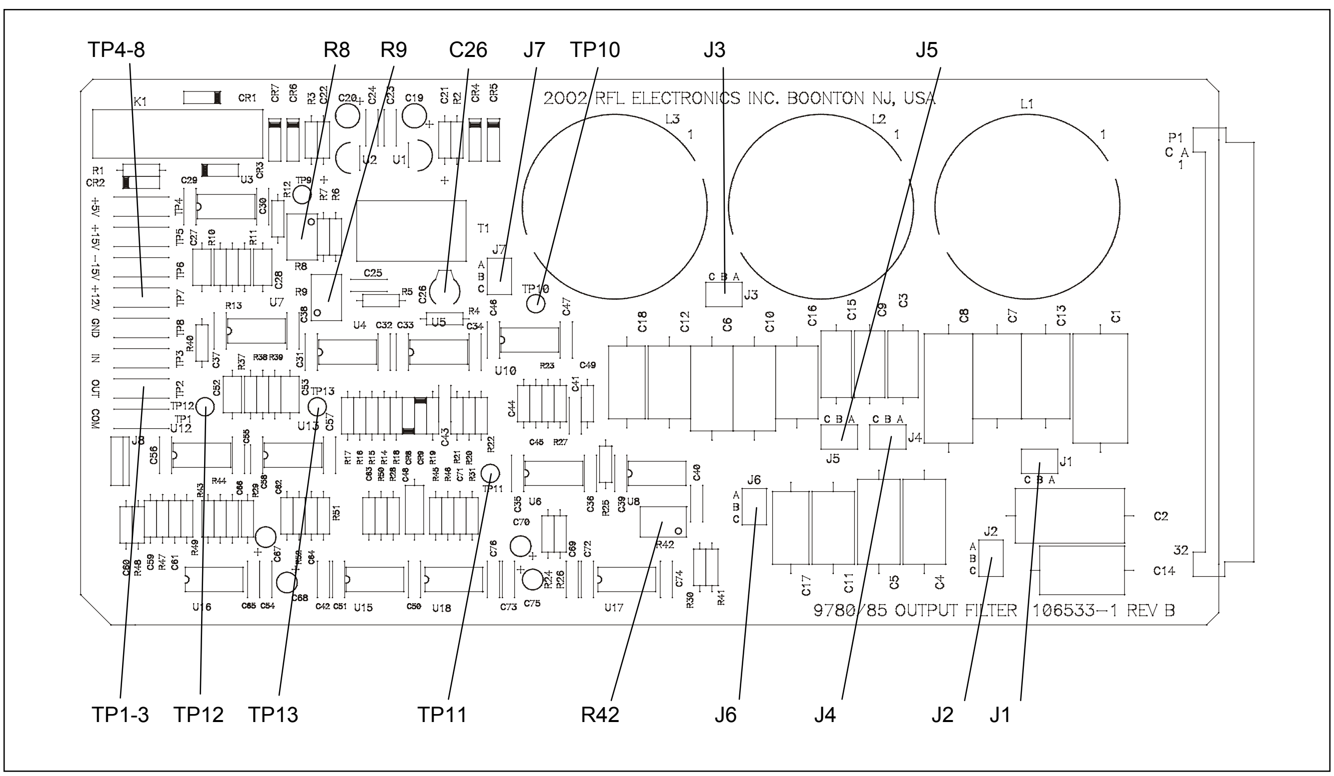

Figure 9-3. Controls and indicators, RFL 9785 Output Filter Modules (106530-11 to 106530-15)

Table 9-2. RFL 9785 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 9-3. Replaceable parts, RFL 9785 Output Filter modules
30 to 65 kHz – Assembly No. 106530-1, -11
65 to 156 kH – Assembly No. 106530-2, -12
156 to 392 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. 9-3 & 9-4)	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	
	106530-1, -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: 0.018µF	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 9-3. continued - Replaceable parts, RFL 9785 Output Filter modules

Circuit Symbol (Figs. 9-3 & 9-4)	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	019 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 9-3. continued - Replaceable parts, RFL 9785 Output Filter modules

Circuit Symbol (Figs. 9-3 & 9-4)	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 9-3. continued - Replaceable parts, RFL 9785 Output Filter modules

Circuit Symbol (Figs. 9-3 & 9-4)	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 9-3. continued - Replaceable parts, RFL 9785 Output Filter modules

Circuit Symbol (Figs. 9-3 & 9-4)	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

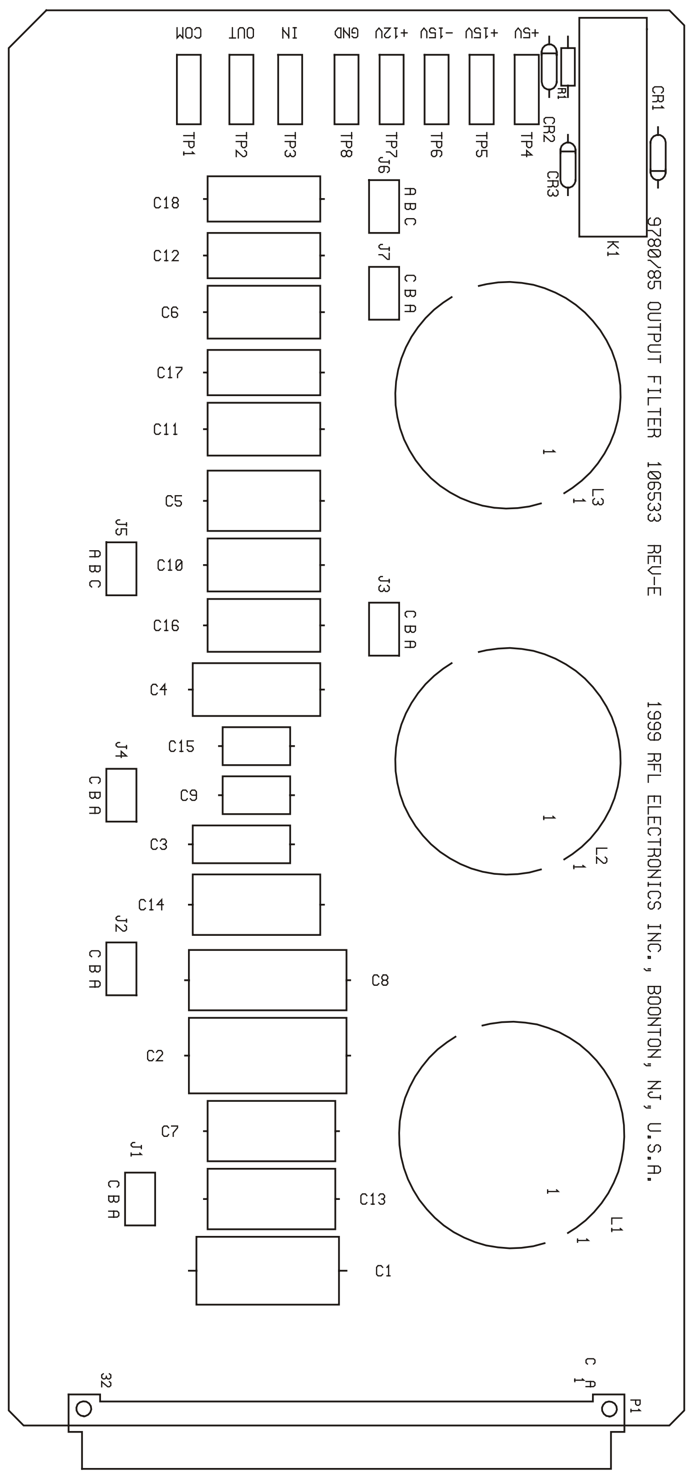

Figure 9-4. Component locator drawing, RFL9785 Output Filter Module (Assembly No. 106530-1 to -5)

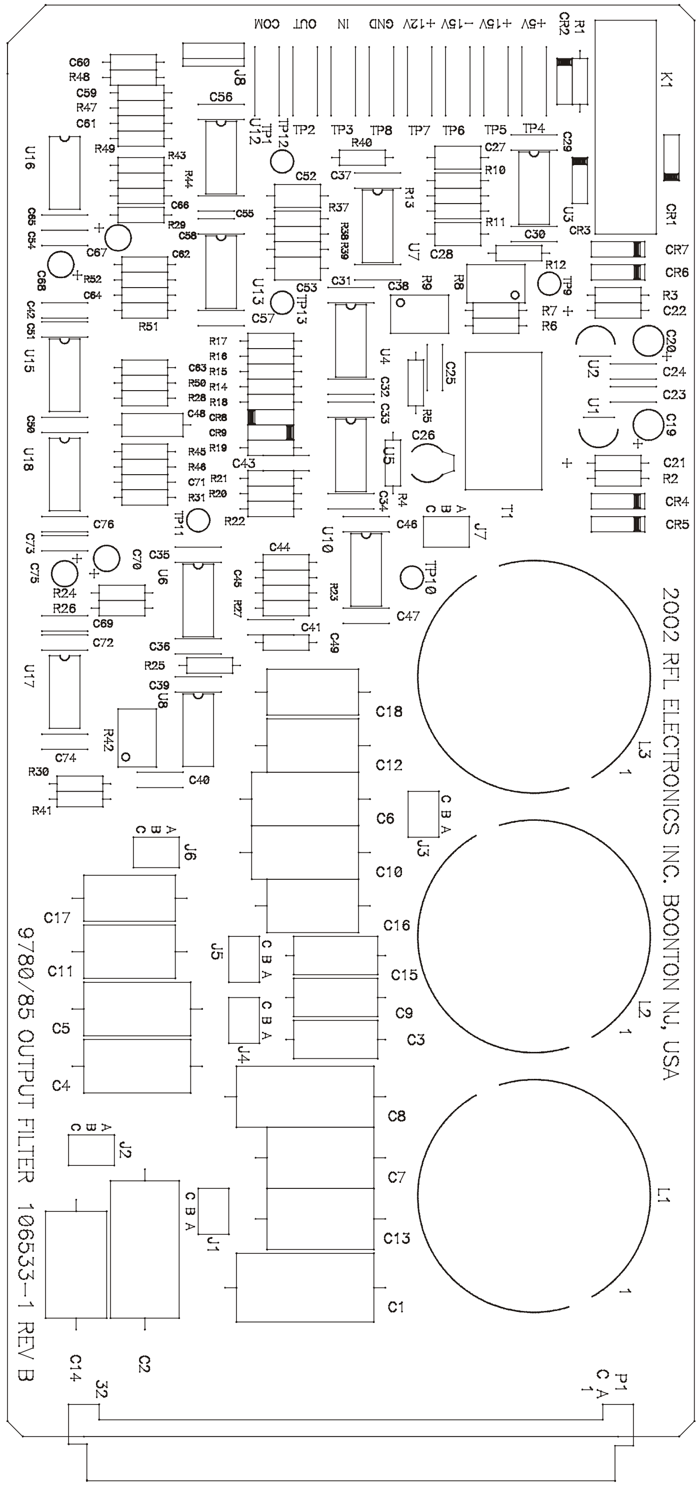

Figure 9-5. Component Locator Drawing, RFL 9785 Output Filter Module (Assy No. 106530-11 to -15)

Figure 9-6. Schematic, RFL 9785 Output Filters (Dwg. No. D-106534-D)

Figure 9-7. Schematic, RFL 9785 Output Filters (Dwg. No. D-106434-1-B)

Please see Figure 9-6 and Figure 9-7 in Section 22

Section 10. RECEIVER DOWNSHIFTER MODULE

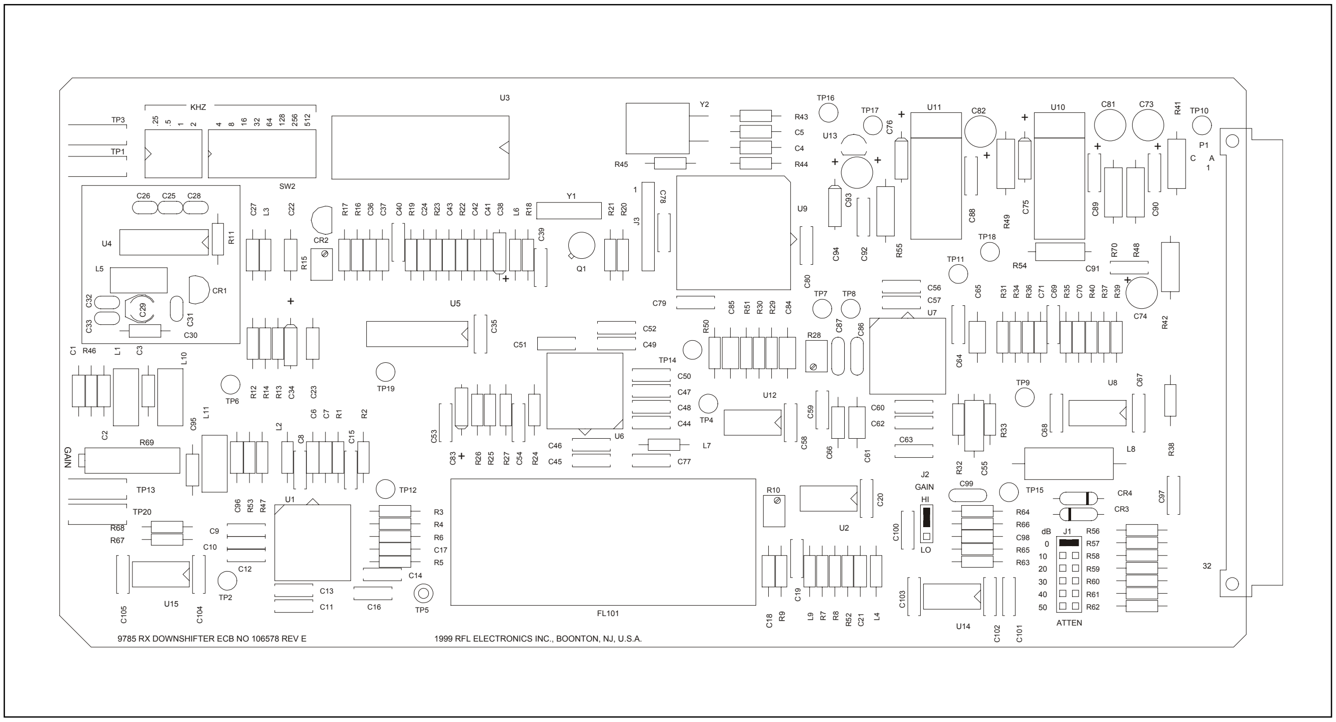

Figure 10-1. RFL 9785 Receiver Downshifter Module

10.1 DESCRIPTION

The RFL 9785 Receiver Downshifter Module (Figure 10-1) is used to shift the desired set of incoming rf signals down to a lower range, around 24 kHz, to be further processed by the receiver detector module (Section 11). Its channel filter, which is 3700 Hz wide, will pass carrier signals or voice sidebands of the carrier, if present. The Downshifter Module contains a set of DIP switches which allow a user to program the desired receive frequency.

10.2 SPECIFICATIONS

As of the date this manual was published, the following specifications apply to all RFL 9785 Receiver Downshifter modules. Because all RFL products undergo constant refinement and improvement, these specifications are subject to change without notice.

Frequency Range:	30 kHz to 535 kHz, frequency is adjustable in 250 Hz steps.
Modulation:	AM.
Bandwidth:	3700 Hz.
Input Attenuation:	0dB to 50dB in 10dB steps.
Gain Adjust:	4dB to 40dB.
Output Impedance:	100 ohms.
Output Signal:	24 kHz baseband.

10.3 THEORY OF OPERATION

The main function of the RFL 9785 Receiver Downshifter Module is to convert the incoming signals to a 24 kHz base frequency (bf). Basically, the RFL 9785 Receiver Downshifter 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 24 kHz bf. The bf signal is passed on to the RFL 9785 Filter Module (Section 9) for further processing.

A block diagram of the RFL 9785 Receiver Downshifter appears in Figure 10-2, controls and indicators appear in Figure 10-3, a component locator drawing appears in Figure 10-4, and a schematic diagram appears in Figure 10-5.

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.

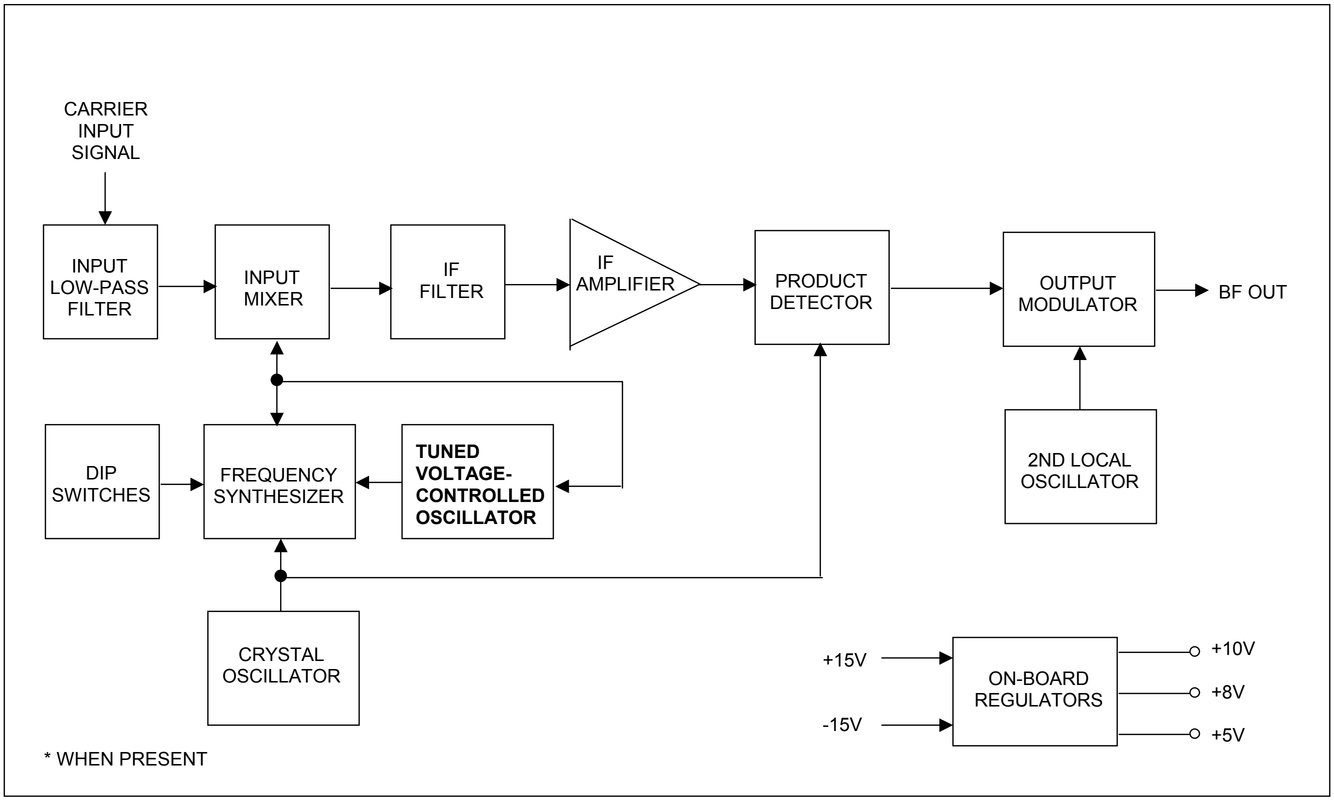

Figure 10-2. Block diagram, RFL 9785 Receiver Downshifter Module

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 10.4.1 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 Hz increments are accommodated by changing the frequency of the second local oscillator. See paragraph 10.3.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.

Input Normalizer. The input signal at pin C15 is first attenuated by 0 to 50 dB in 10 dB steps, as selected by J1. Diodes CR3 and CR4 provide high voltage transient protection. The signal is then amplified by U14 and U15. The gain of the first amplifier (U14) is either 4 or 40, depending on the selection of J2. The gain of amplifier U15 is variable between 0.1 and 5.1, as determined by the setting of GAIN potentiometer R69.

Input Low-Pass Filter. The incoming carrier enters the RFL 9785 Receiver Downshifter module through edge connector terminals C15 and C16. It then passes through the input low-pass filter formed from capacitors C2, C3, C95 and C96 and inductors L1, L10 and L11. This filter has a cutoff frequency of approximately 600 kHz.

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.

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.

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 R10.

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.

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 24 kHz baseband signal, using the 26.00 kHz or 26.25 kHz signal provided by the second local oscillator. The modulator's output (U7-16) is buffered by operational amplifier U8.

Second Local Oscillator. Xilinx programmable logic chip U9, crystal Y2, and their associated components form the second local oscillator. This oscillator produces the 26.00 kHz or 26.25 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.

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.

10.4 CONTROLS AND INDICATORS

Figure 10-3 shows the location of all controls and indicators on the Receiver Downshifter module. These controls and indicators are described in Table 10-1. TP1, TP3, TP13, TP20 and R69 are accessible with the module installed in the chassis. All all other controls are accessible only when the module is removed from the chassis or is on a card extender.

Table 10-1. Controls and indicators, RFL9785 Receiver Downshifter Module

Component Designator	Name/ Description	Function
J1	Jack	Input signal attenuation adjustment in 10dB steps
J2	Jack	High or low gain select for input signal
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
R69	Potentiometer	Input signal gain adjust
SW1	DIP switch	Sets 1st mixer oscillator frequency (selects channel frequency)
SW2	DIP switch	Sets 1st mixer oscillator frequency (selects channel frequency)
TP1	Test point (black)	Ground
TP2	Test point	Input to 1st mixer
TP3	Test point (brown)	Receiver Downshifter 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 (26 or 26.25 kHz)
TP12	Test point	Output of 1st mixer
TP13	Test point (yellow)	Gain adjusted input to downshifter
TP14	Test point	Output of 2nd mixer
TP15	Test point	Output of first input amplifier
TP16	Test point	+ 8Vdc
TP17	Test point	+ 5Vdc
TP18	Test point	+ 10Vdc
TP19	Test point	Reference frequency for phase locked loop
TP20	Test point (white)	Rx input high

10.4.1 RECEIVE FREQUENCY SELECT

The first mixer stage of the Receiver Downshifter 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 10-2.

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 10-2. 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

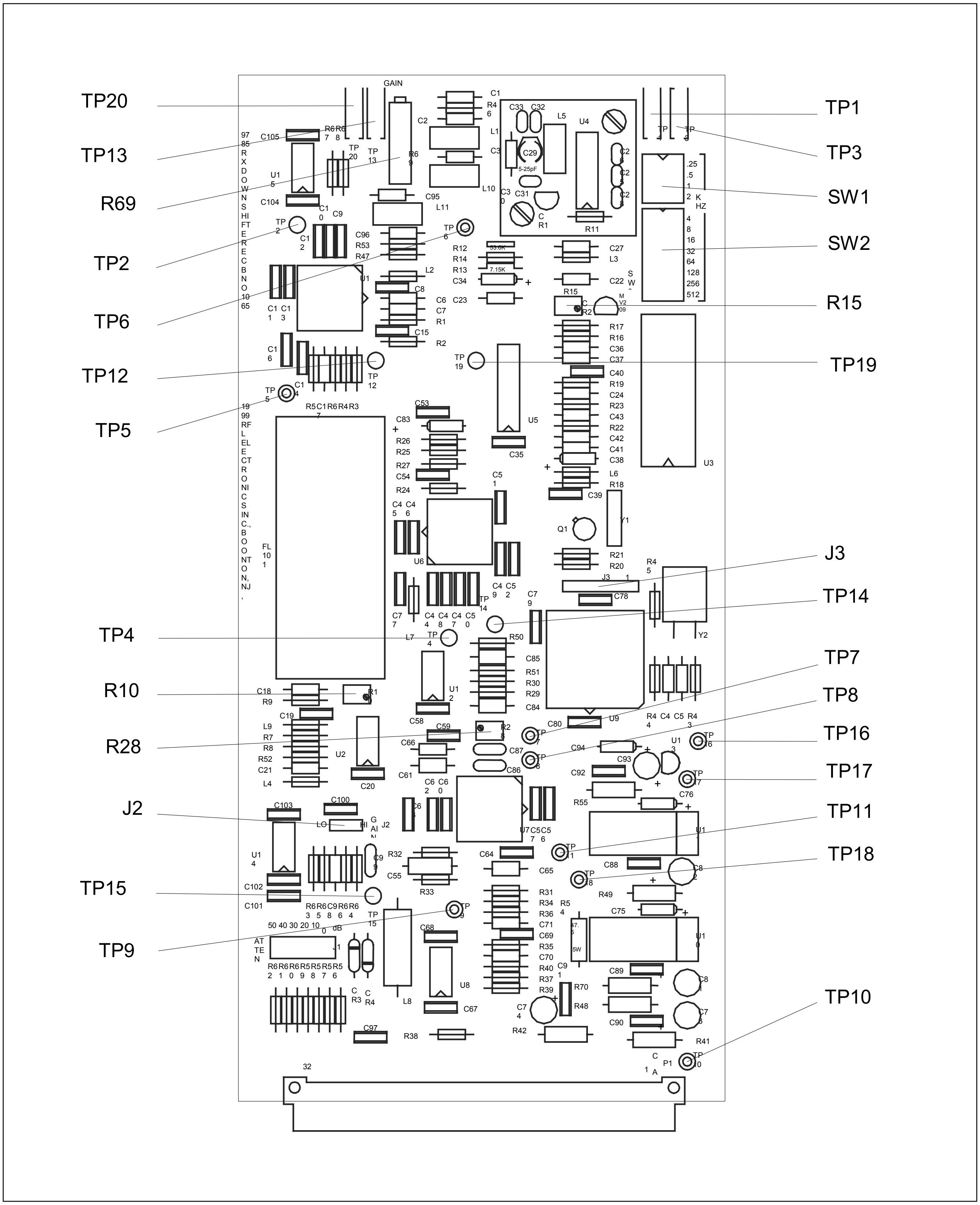

Figure 10-3. Controls and indicators, RFL 9785 Receiver Downshifter Module

Table 10-3. Replaceable parts, RFL 9785 Receiver Downshifter Module
Assembly No. 106575

Circuit Symbol (Figs. 10-4 & 10-5)	Description	Part Number
	CAPACITORS	
C1, 18, 27	Capacitor, ceramic, 0.1μF, 10%, 50V	0130 51041
C2, 23, 96	Capacitor, ceramic, 220pF, 10%, 200V	0130 22211
C3, 70, 95	Capacitor, ceramic, 560pF, 5%, 100V	0125 15615
C4, 5, 70	Capacitor, ceramic, 22pF, 5%, 200V	0125 22205
C6, 7, 24	Capacitor, ceramic, 0.001μF, 5%, 100V	0125 11025
C8-16, 19, 20, 35, 39, 40, 44-54, 56-60, 62-64, 67, 68, 69, 77- 80, 88-92, 97, 100-105	Capacitor, ceramic dip, 0.1μF, 10%, 50V	0120 38
C17, 36	Capacitor, ceramic, 0.01μF, 10%, 100V	0130 11031
C21	Capacitor, ceramic, 82pF, 5%, 100V	0125 18205
C22, 37	Capacitor, ceramic, 100pF, 5%, 200V	0125 21015
C25, 32	Capacitor, ceramic, 0.1μF, 20%, 50V	1007 1366
C26, 28, 31, 33	Capacitor, ceramic, 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
C55	Capacitor, ceramic, 1μF	0135 51052
C61, 65	Capacitor, ceramic 0.47μF, 20%, 50V	0135 54742
C66	Capacitor, ceramic, 5pF +1 – 0.5pF, 200V	0125 25R04
C71	Capacitor, ceramic, 10pF, 10%, 200V	0125 21001
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, 99	Capacitor, ceramic, 1μF, 10%, 50V	0110 6
C98	Capacitor, ceramic, 47pF, 5%, 200V	0125 24705
	RESISTORS	
R1, 2, 25, 26, 56, 63	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, 65, 67	Resistor, metal film, axial, 1K, 1%, 1/4W	0410 1288

Table 10-3 - continued. Replaceable parts, RFL 9785 Receiver Downshifter Module

Circuit Symbol (Figs. 10-4 & 10-5)	Description	Part Number
	RESISTORS (continued)	
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, 58	Resistor, metal film, axial, 7.15K, 1%, 1/4W	0410 1370
R14	Resistor, metal film, axial, 4.12K, 1%, 1/4W	0410 1347
R15, 28	Resistor, variable, ceramic, 10K, 10%, 1/4W	32996
R16	Resistor, metal film, axial, 221K, 1%, 1/4W	0410 1513
R17, 22, 23, 37	Resistor, metal film, axial, 100K, 1%, 1/4W	0410 1480
R18	Resistor, metal film, axial, 3.01K, 1%, 1/4W	0410 1334
R19	Resistor, metal film, axial, 47.5K, 1%, 1/4W	0410 1449
R20	Resistor, metal film, axial, 27.4K, 1%, 1/4W	0410 1426
R21	Resistor, metal film, axial, 221Ω, 1%, 1/4W	0410 1225
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, 62, 68	Resistor, metal film, axial, 100Ω, 1%, 1/4W	0410 1192
R39	Resistor, metal film, axial, 5.11K, 1%, 1/4W	0410 1356
R41, 42, 48	Resistor, fixed composition, 2.2Ω, 5%, 1/2W	1009 1059
R44	Resistor, metal film, axial, 10.0M, 1%, 1/4W	0410 1672
R46, 60	Resistor, metal film, axial, 681Ω, 1%, 1/4W	0410 1272
R47	Resistor, metal film, axial, 102Ω, 1%, 1/4W	0410 1193
R48, 70	Resistor, metal film, axial, 10Ω, 1%, 1/2W	0410 2096
R49, 54	Resistor, metal film, axial, 47.5Ω, 1%, 1/2W	0410 2161
R50	Resistor, metal film, axial, 2.43K, 1%, 1/4W	0410 1325
R51, 53	Resistor, metal film, axial, 590Ω, 1%, 1/4W	0410 1266
R52	Resistor, metal film, axial, 113Ω, 1%, 1/4W	0410 1197
R55	Resistor, metal film, axial, 249Ω, 1%, 1/2W	0410 2230
R57	Resistor, metal film, axial, 21K, 1%, 1/4W	0410 1415
R59	Resistor, metal film, axial, 2.15K, 1%, 1/4W	0410 1320
R61	Resistor, metal film, axial, 215Ω, 1%, 1/4W	0410 1224
R64	Resistor, metal film, precision, 27.4Ω, 1%, 1/8W	1510 1425
R66	Resistor, metal film, axial, 322Ω, 1%, 1/4W	0410 1242
R69	Resistor, metal film, variable, 5K, 10%, 3/4W	39538

Table 10- 3 - continued. Replaceable parts, RFL 9785 Receiver Downshifter Module

Circuit Symbol (Figs. 10-4 & 10-5)	Description	Part Number
	SEMICONDUCTORS	
CR1, 2	Diode, varactor, MV209	32509
CR3, 4	Diode, silicon, 1N914B/1N4448	26482
Q1	Transistor, silicon, NPN, 2N918	46541
U1, 6, 7	IC, linear, mixer, AD831AP	0620 380
U2, 14, 15	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	0620 126
U9	IC MOS, CPLD, Xilinx, XC9536-15PC44I	0615 483
U10	IC, linear, voltage regulator, 10V, 1A	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
	MISCELLANEOUS COMPONENTS	
F1-3	Inductor, molded, 10μH, 220mA	30128
F1-4	Sleeve, ferrite, shielded	96956
FL101	Filter, crystal, 5.12Mhz	32523 2
J1	Connector, header, dual, 6/12 CKT	32599 12
J2	Connector, header, single, 3 circuit	32802 3
J3	Connector, header, single, 7 circuit	32802 7
L1, 11	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
L8	Inductor, molded, 1mH	101489
L10	Inductor, molded, 270μH, 5%	101481
P1	Connector, JK male, 64 contact, DIN	98457
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, 4-12, 14-19	Test point, terminal, orange	98441 3
TP3	Test point, brown	38116 4
TP13	Test point, yellow	38116 8
TP20	Test point, white	38116 1
Y1	Crystal, 5.12 mHz	93637
Y2	Crystal, 5.46 mHz	101482

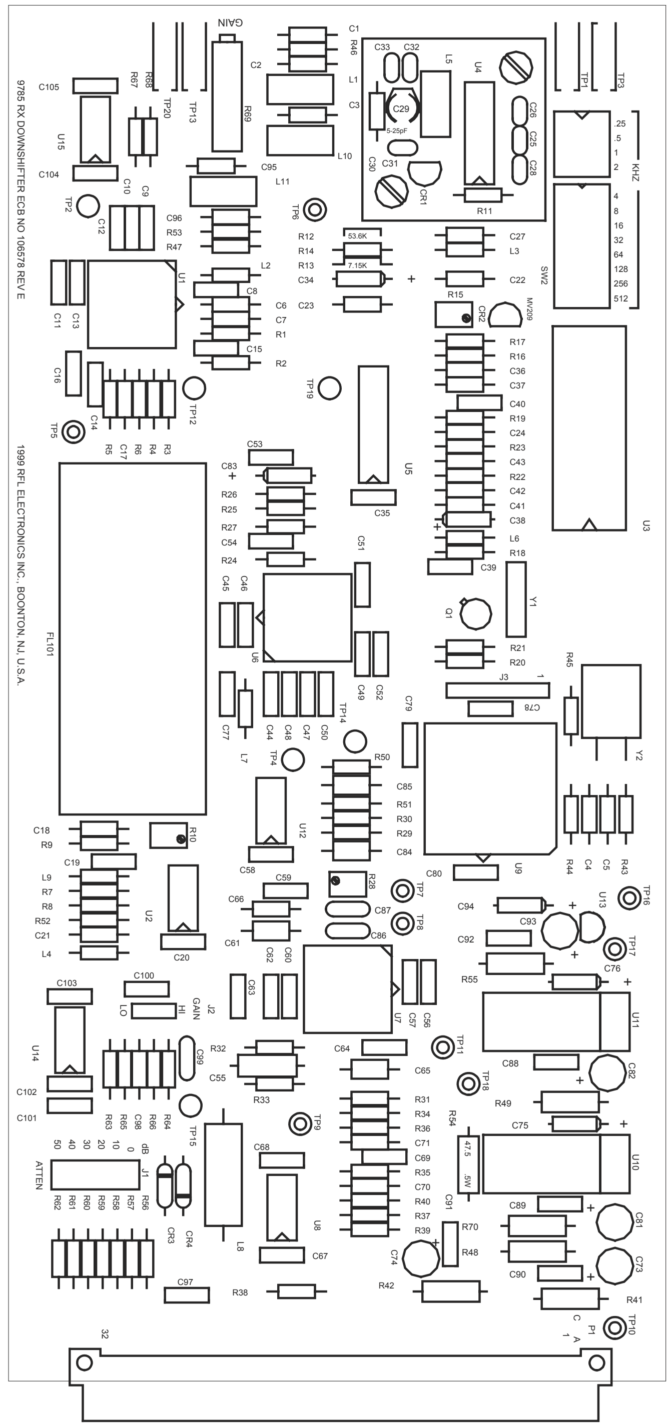

Figure 10-4. Component locator dwg, RFL 9785 Receiver Downshifter Module (Assy No. 106575)

Figure 10-5. Schematic, RFL 9785 RX Downshifter (Dwg. No. D-106579-D) Sheet 1 of 2

Figure 10-5. Schematic, RFL 9785 RX Downshifter (Dwg. No. D-106579-D) Sheet 2 of 2

Please see Figure 10-5 in Section 22: Schematics.

Section 11. RECEIVER DETECTOR MODULE

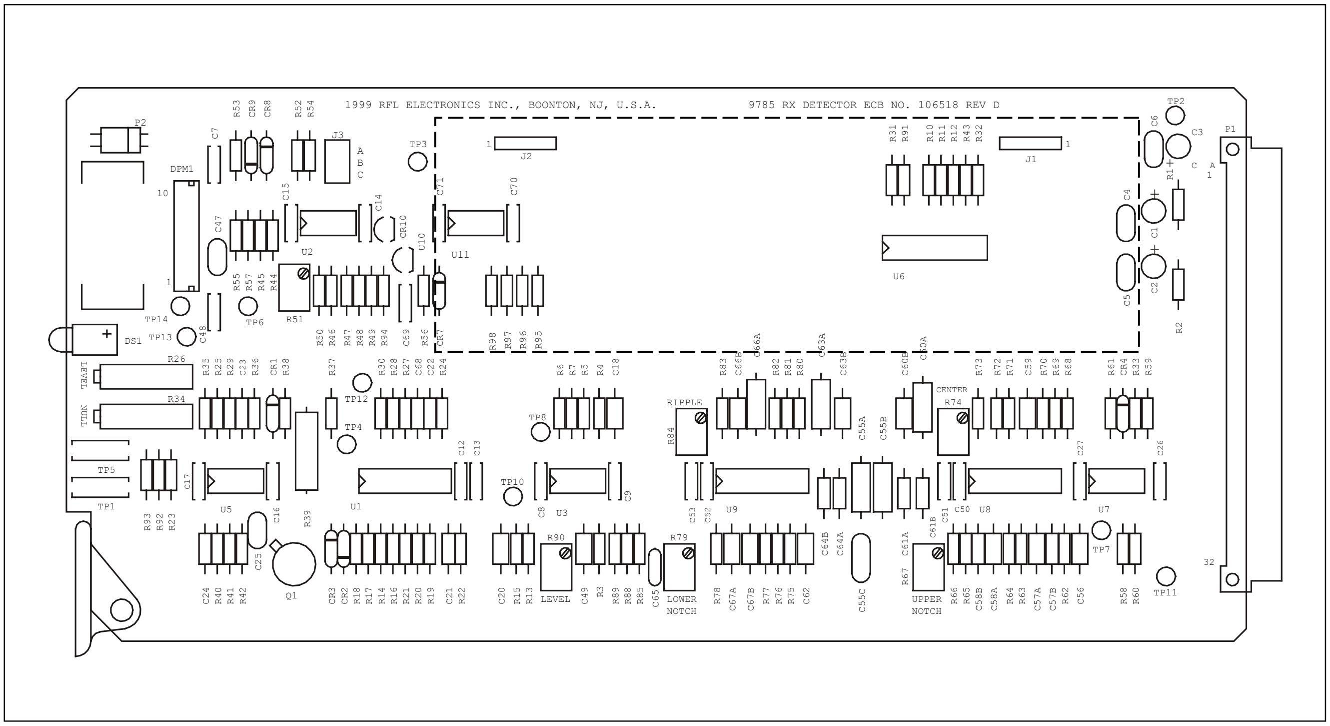

Figure 11-1. RFL 9785 Receiver Detector Module

11.1 DESCRIPTION

The RFL 9785 Receiver Detector Module (Fig. 11-1) contains three elements of the RFL 9785's receiving system:

1. A narrowband active band-pass filter that sets the bandpass limits for the entire receiving section.
2. A carrier detect circuit used to signal the AM Logic module that a signal is being received.
3. A signal level indicator with a digital meter to indicate deviation of the received signal above or below the specified normal level.
4. An optional voice filter when the RFL 9785 voice option is used.

NOTE

The dotted area in Figure 11-1 indicates the location of the Voice Filter when the RFL 9785 voice option is used. The Voice Filter plugs into connectors J1 and J2 within the dotted area of Figure 11-1. Refer to Section 14 for information on the Voice Module and the voice filter.

11.2 SPECIFICATIONS

As of the date this manual was published, the following specifications apply to all RFL 9785 Receiver Detector 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: 24 Khz

Bandwidth:

106515-6:	500Hz
106515-7:	1000Hz
106515-8	1500Hz

Level Indicator:

Span: ±10 dB

Reference: Typically set to read 0 dB when transmitting a 1W 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.

Carrier Detect:

Threshold: -15 dB to +5 dB.

11.3 THEORY OF OPERATION

The RFL 9785 Receiver Detector module contains a narrowband filter, a signal monitoring circuit, a carrier level indicator, and an optional voice filter. A block diagram of the Receiver Detector module appears in Figure 11-2 and its schematic appears in Figure 11-5.

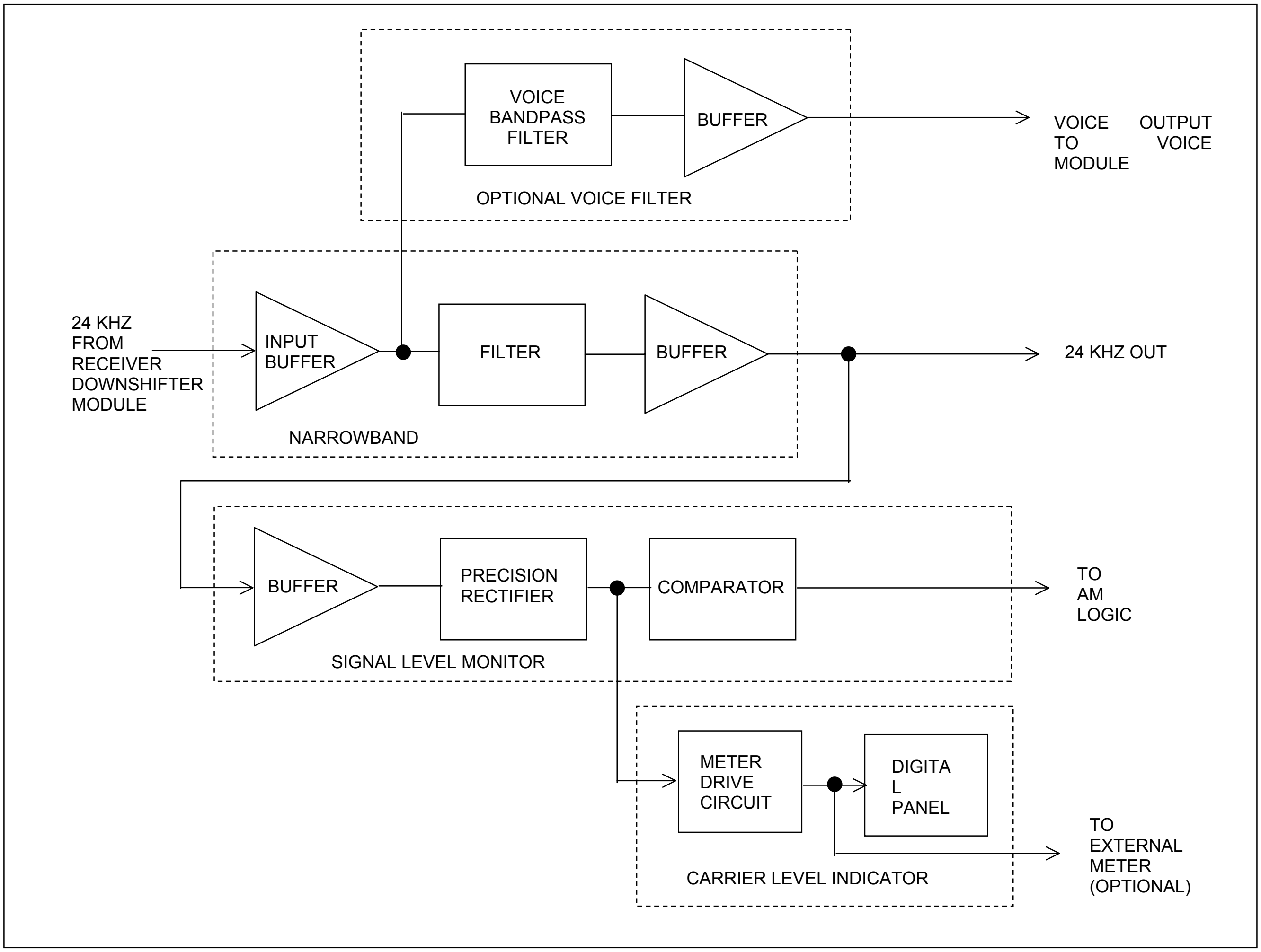

Figure 11-2. Block diagram, RFL 9785 Receiver Detector Module

11.3.1 NARROWBAND FILTER

The output signal from the Receiver Downshifter module (Section 10) enters the Receiver Detector module at edge connector terminal C13. It is then applied to operational amplifier U7A, which serves as an input buffer. From there, it passes to an active narrowband filter, formed from quad operational amplifiers U8 and U9, and their associated components.

The output of the filter is buffered by operational amplifier U3A. FILT LEVEL potentiometer R90 varies the gain of U3A, which controls the amplitude of the 24KHZ OUT signal at edge connector terminal A13.

There are three types of Receiver Detector modules. The 106515-6 has a 500Hz bandwidth (BW) filter, the 106515-7 has a 1000Hz bandwidth (BW) filter and the 106515-8 has a 1500Hz bandwidth (BW) filter.

NOTE

THE ACTIVE FILTER FORMED BY U8 AND U9 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.

11.3.2 SIGNAL LEVEL MONITOR

The signal passed by the narrowband filter is fed to operational amplifier U3B, which serves as a buffer. The output of this buffer is passed through edge connector terminal C16 to the RFL 9785 Limiter Slicer module for further processing. It is also fed to a precision rectifier and averager formed from operational amplifiers U1A and U1B, and their associated components.

The output of the rectifier is amplified by operational amplifier U1C, and is then applied to operational amplifier U1D, which serves as a comparator. Potentiometer R26 sets the gain for U1D.

11.3.3 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 U5A and U5B form a logarithmic amplifier to convert the received signal strength to dB. R37 is used to temperature compensate the log amp.

The output of the log amp is a 0 to -5 Vdc signal. Op amp U2A 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 U2A will then be buffered by U2B and sent out to pin A19. The external meter return is connected to pin C19. 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 R54 and out on pin A19. The external meter return is connected to pin C19. 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 A19. The external meter return is connected to pin C19. Zero Vdc corresponds to -10.0 dB, -2.5 Vdc corresponds to 0 dB, and -5 Vdc corresponds to +10 dB.

11.4 CONTROLS AND INDICATORS

Figure 11-3 shows the location of all controls and indicators on the RFL 9785 Receiver Detector module. These controls and indicators are described in Table 11-1. Only R26 and R34 are accessible with the RFL 9785 Receiver Detector module installed in the chassis. All others are accessible when the module is removed from the chassis or is on a card extender.

Table 11-1. Controls and indicators, RFL 9785 Receiver Detector Module

Component Designator	Name/Description	Function
DPM1	Digital Panel Meter	Displays signal level in dB.
J1	Connector	Input to voice bandpass filter (when voice filter is plugged in)
J2	Connector	Output of voice bandpass filter (when voice filter is plugged in)
J3	Jumper	Position “A” selects ±1 Vdc output. Position “B” selects 0 to -100µA output. Position “C” selects 0 to -5 Vdc output.
R26	Potentiometer	Sets the signal level threshold
R34	Potentiometer	Sets the signal level meter to zero dB (meter null)
R51	Potentiometer	Calibrates the meter signal
R67	Potentiometer	Narrow Band filter adjust
R74	Potentiometer	Narrow Band filter adjust
R79	Potentiometer	Narrow Band filter adjust
R84	Potentiometer	Ripple adjust
R90	Potentiometer	Sets the signal level at the output of the narrow-band filter (output gain)
TP1	Test Point	Signal ground
TP2	Test Point	Input to voice filter
TP3	Test Point	Output of voice filter
TP4	Test Point	Output of logarithmic amplifier
TP5	Test Point	Output of signal level detector and filter
TP6	Test Point	Signal applied to Digital Panel Meter
TP7	Test Point	Input to bandpass filter
TP8	Test Point	Output of bandpass filter
TP10	Test Point	Level out
TP11	Test Point	Signal ground
TP12	Test Point	Used to monitor the threshold for carrier detect (for factory use only)
TP13	Test Point	+5VDC reference
TP14	Test Point	-5VDC

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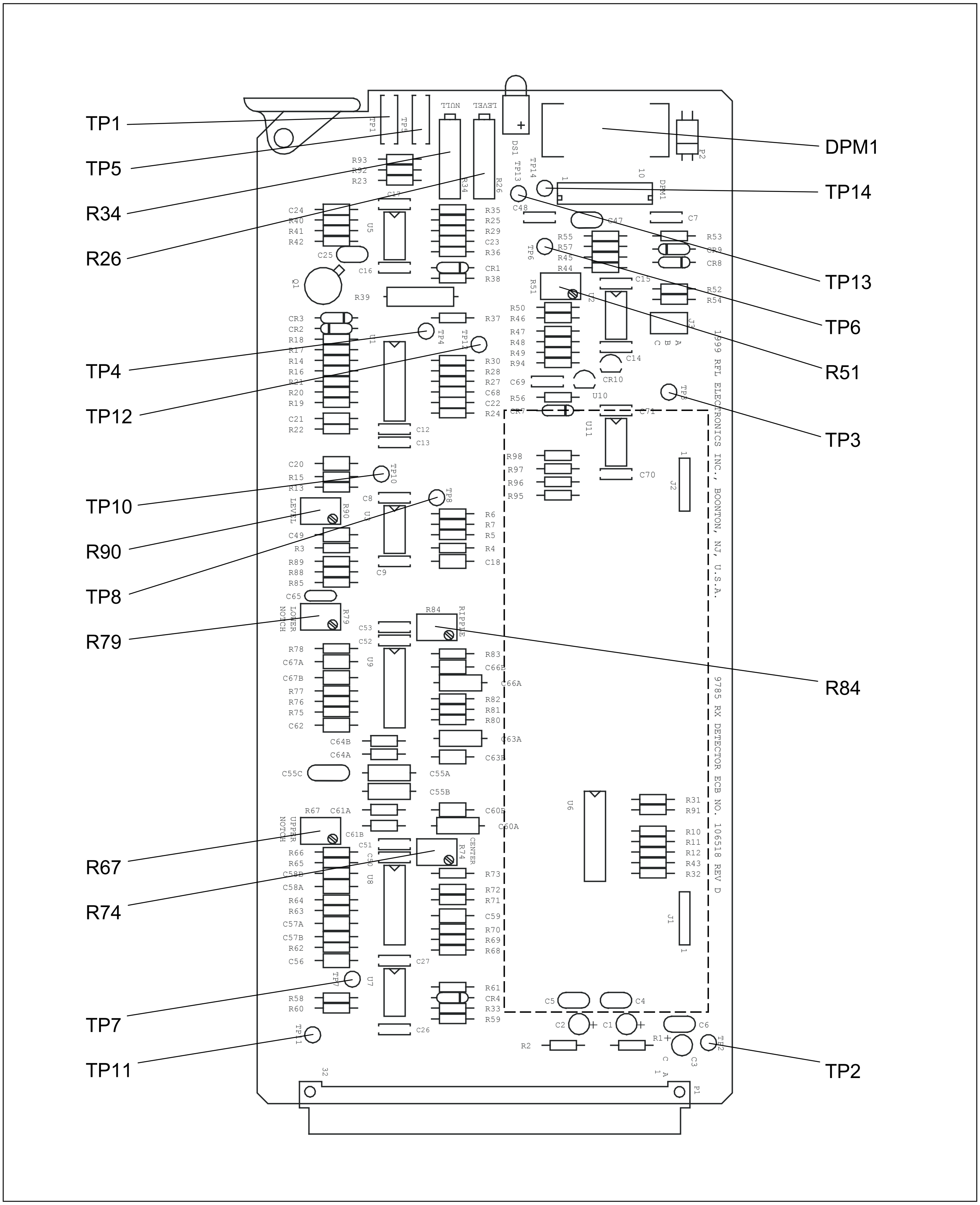


Figure 11-3. Controls and indicators, RFL 9785 Receiver Detector module

11.4.1 METER SELECT

The module can provide a signal to an external meter. The external meter output can be configured for either a current or 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.

11.4.2 METER NULL

R34 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 1 W signal.

11.4.3 CARRIER DETECT LEVEL

R26 is used to set the carrier detect threshold at the desired level. This is normally performed by attenuating a normal receive level to the desired threshold amplitude and adjusting R26 to activate the alarm.

11.4.4 VOICE FILTER OPTION (J1 and J2)

Connectors J1 and J2 are used when the voice filter is installed. The voice filter plugs into these connectors and is secured to the board with four standoffs and screws. Refer to Section 14 for more information on the Voice Module and the voice filter.

Table 11-2. Replaceable parts, RFL 9785 Receiver Detector Module
Assembly No. 106515-6

Circuit Symbol (Fig. 11-4 & 11-5)	Description	Part Number
	CAPACITORS	
C1, 2, 3	Capacitor, electrolytic, 47μF, 20%, 35V	1007 1578
C4, 5, 6, 25, 47	Capacitor, ceramic dip, 0.01μF, 5%, 100V	1007 1645
C7, 8, 9, 12, 13, 14, 15, 16, 17, 26, 27, 48, 50, 51, 52, 53, 69	Capacitor, ceramic dip, 0.1μF, 10%, 50V	0120 38
C18, 20, 49	Capacitor, ceramic, 0.47μF, 20%, 50V	0135 54742
C21	Capacitor, ceramic, 0.0015μF, 5%, 100V	0125 11525
C22	Capacitor, ceramic, 0.0022μF, 5%, 100V	0125 12225
C23	Capacitor, ceramic, 330pF, 5%, 200V	0125 23315
C24	Capacitor, ceramic, 150pF, 5%, 100V	0125 11515
C55C	Capacitor, ceramic, 0.047μF, 10%, 100V	1007 1842
C56, 59, 62, 67A	Capacitor, ceramic, 0.0039μF, 5%, 100V	0125 13925
C57B, 58B	Capacitor, ceramic, 120pF, 5%, 200V	0125 21215
C57A, 58A, 61A	Capacitor, ceramic, 820pF, 5%, 100V	0125 58215
C60A	Capacitor, ceramic, 0.0056μF, 5%, 100V	0125 15625
C60B	Capacitor, ceramic, 0.0018μF, 5%, 100V	0125 11825
C61B, 64B	Capacitor, ceramic, 100pF, 5%, 200V	0125 21015
C63A	Capacitor, ceramic, 0.01μF, 5%, 50V	0125 51035
C63B	Capacitor, ceramic, 560pF, 5%, 100V	0125 15615
C64A	Capacitor, ceramic, 0.0012μF, 5%, 50V	0125 51225
C65	Capacitor, ceramic, 1μF, 10%, 50V	0110 6
C66B	Capacitor, ceramic, 0.012μF, 5%, 50V	0125 51235
C68	Capacitor, ceramic, 0.0012μF, 5%,50V	0125 51225
	RESISTORS	
R1, 2	Resistor, fixed composition, 2.7Ω, 5%, 1/4W	1009 900
R3, 5, 14, 16, 17, 20, 21, 24, 27, 31, 32, 36, 43, 55, 60, 91	Resistor, metal film, axial, 10K, 1%, 1/4W	0410 1384
R4	Resistor, metal film, axial, 3.65K, 1%, 1/4W	0410 1342
R6, 7, 13, 23, 37, 57, 89, 95	Resistor, metal film, axial, 100Ω, 1%, 1/4W	0410 1192
R10	Resistor, metal film, axial, 383Ω, 1%, 1/4W	0410 1248
R11	Resistor, metal film, axial, 93.1Ω, 1%, 1/4W	0410 1189
R12	Resistor, metal film, axial, 121Ω, 1%, 1/4W	0410 1200
R15	Resistor, metal film, axial, 20K, 1%, 1/4W	0410 1413
R18	Resistor, metal film, axial, 4.75K, 1%, 1/4W	0410 1353
R19	Resistor, metal film, axial, 4.99K, 1%, 1/4W	0410 1355
R22	Resistor, metal film, axial, 11.5K, 1%, 1/4W	0410 1390
R25	Resistor, metal film, axial, 1.4K, 1%, 1/4W	0410 1302
R26	Resistor, metal film, variable, 500Ω, 10%, 3/4W	39544
R28	Resistor, metal film, axial, 2K, 1%, 1/4W	0410 1317
R29	Resistor, metal film, axial, 68.1Ω, 1%, 1/4W	0410 1176
R30	Resistor, metal film, axial, 1.0M, 1%, 1/4W	0410 1576
R33	Resistor, metal film, axial, 5.36K, 1%, 1/4W	0410 1358

Table 11-2. - continued. Replaceable parts, RFL 9785 Receiver Detector Module Assembly No. 106515-6

Circuit Symbol (Fig. 11-4 & 11-5)	Description	Part Number
	RESISTORS – continued	
R34	Resistor, metal film, variable, 10K, 10%, 3/4W	39539
R35	Resistor, metal film, axial, 26.7K, 1%, 1/4W	0410 1425
R38	Resistor, metal film, axial, 82.5K, 1%, 1/4W	0410 1472
R39	Thermistor, resistor, 1000Ω, 1%	91529
R40	Resistor, metal film, axial, 2.21K, 1%, 1/4W	0410 1321
R41	Resistor, metal film, axial, 1.5M, 1%, 1/4W	0410 1593
R42	Resistor, metal film, axial, 1.21M, 1%, 1/4W	0410 1584
R44, 49, 53, 96, 97	Resistor, metal film, axial, 1K, 1%, 1/4W	0410 1288
R45, 48, 56	Resistor, metal film, axial, 1.5K, 1%, 1/4W	0410 1305
R46, 47	Resistor, metal film, axial, 100K, 10%, 1/4W	0410 1480
R50	Resistor, metal film, axial, 95.3K, 1%, 1/4W	0410 1478
R51	Resistor, metal film, variable, 20K, 10%, 1/2W	44529
R52	Resistor, metal film, axial, 9.09K, 1%, 1/4W	0410 1380
R54	Resistor, metal film, axial, 48.7K, 1%, 1/4W	0410 1450
R58	Resistor, metal film, zero ohm, 1/4 watt size	1510 2217
R59	Resistor, metal film, axial, 3.01K, 1%, 1/4W	0410 1334
R62	Resistor, metal film, axial, 511Ω, 1%, 1/4W	0410 1260
R63	Resistor, metal film, axial, 6.49K, 1%, 1/4W	0410 1366
R64, 65	Resistor, metal film, axial, 6.98K, 1%, 1/4W	0410 1369
R66	Resistor, metal film, axial, 6.04K, 1%, 1/4W	0410 1363
R67	Resistor, metal film, variable, 2K, 10%, 1/2W	90392
R68	Resistor, metal film, axial, 649Ω, 1%, 1/4W	0410 1270
R69	Resistor, metal film, axial, 11K, 1%, 1/4W	0410 1388
R70	Resistor, metal film, axial, 845Ω, 1%, 1/4W	0410 1281
R71, 72	Resistor, metal film, axial, 1.74K, 1%, 1/4W	0410 1311
R73	Resistor, metal film, axial, 1.43K, 1%, 1/4W	0410 1303
R74, 79	Resistor, metal film, variable, 500Ω, 10%, 1/2W	94296
R75, 76, 77	Resistor, metal film, axial, 1.78K, 1%, 1/4W	0410 1312
R78	Resistor, metal film, axial, 1.58K, 1%, 1/4W	0410 1307
R80-82	Resistor, metal film, axial, 562Ω, 1%, 1/4W	0410 1264
R83	Resistor, metal film, axial, 499Ω, 1%, 1/4W	0410 1259
R84	Resistor, metal film, variable, 100Ω, 10%, 1/2W	96706
R85	Resistor, metal film, axial, 34K, 1%, 1/4W	0410 1435
R88	Resistor, metal film, axial, 1.96K, 1%, 1/4W	0410 1316
R90	Resistor, metal film, variable, 50K, 10%, 1/2W	93667

Table 11-2. - continued. Replaceable parts, RFL 9785 Receiver Detector Module Assembly No. 106515-6

Circuit Symbol (Fig. 11-4 & 11-5)	Description	Part Number
	RESISTORS – continued	
R92	Resistor, metal film, axial, 681Ω, 1%, 1/4W	0410 1272
R93	Resistor, metal film, axial, 316Ω, 1%, 1/4W	0410 1240
R94	Resistor, metal film, axial, 4.12K, 1%, 1/4W	0410 1347
	SEMICONDUCTOR	
CR1, 2, 3, 8, 9	Diode, silicon, 1N914B/1N4448	26482
CR4	Diode, general purpose, 1N4148	101778
CR7	Diode, Zener, 5.1V, 500MW, 1N5231B	35027
CR10	Integrated circuit, voltage reference, diode	0620 218
Q1	Transistor, silicon, NPN, 2N2915	17128
U1	Integrated circuit, linear, QUAD, OP AMP	0620 386
U2, 3, 5, 7	Integrated circuit, linear, JFET, OP AMP	0620 227
U6	Integrated circuit, analog switch, QUAD, SPST, CMOS	0605 17
U8, 9	Integrated circuit, linear, JFET, OP AMP	0620 182
U10	Integrated circuit, linear, voltage regulator, 5V positive	0620 387
U11	Integrated circuit, linear, precision OPAMP	0620 322
	MISCELLANEOUS COMPONENTS	
DPM1	Meter, panel, LCD display	101466
J1, 2	Connector, wafer assembly, 5 circuit	42082 5
J3	Connector header, dual, 3/6 circuit	32802 3
P1	Connector, JK male, 64 contact, DIN	98457
TP1	Test point, black	38116 3
TP2, 3, 4, 6, 7, 8, 10, 11, 12, 13, 14	Test point, terminal, orange	98441 3
TP5	Test point, yellow	38116 8

Table 11-3. Replaceable parts, RFL 9785 Receiver Detector Module
Assembly No. 106515-7

Circuit Symbol (Fig. 11-4 & 11-5)	**Description**	**Part Number**
	CAPACITORS	
C1, 2, 3	Capacitor, electrolytic, 47µF, 20%, 35V	1007 1578
C4, 5, 6, 25, 47	Capacitor, ceramic dip, 0.01µF, 5%, 100V	1007 1645
C7, 8, 9, 12, 13, 14, 15, 16, 17, 26, 27, 48, 50, 51, 52, 53, 69, 70, 71	Capacitor, ceramic dip, 0.1µF, 10%, 50V	0120 38
C18, 20, 49	Capacitor, ceramic, 0.47µF, 20%, 50V	0135 54742
C21	Capacitor, ceramic, 0.0015µF, 5%, 100V	0125 11525
C22, 67A	Capacitor, ceramic, 0.0022µF, 5%, 100V	0125 12225
C23	Capacitor, ceramic, 330pF, 5%, 200V	0125 23315
C24	Capacitor, ceramic, 150pF, 5%, 100V	0125 11515
C55A, 55B	Capacitor, ceramic, 0.01µF, 5%, 50V	0125 51035
C56, 59, 62	Capacitor, ceramic, 0.0039µF, 5%, 100V	0125 13925
C57B, 58B, 61A, 66B	Capacitor, ceramic, 560pF, 5%, 100V	0125 15615
C57A, 58A, 67B, 68	Capacitor, ceramic, 0.0012µF, 5%, 50V	0125 51225
C60A	Capacitor, ceramic, 0.0022µF, 5%, 100V	0125 12225
C60B	Capacitor, ceramic, 0.0012µF, 5%, 50V	0125 51225
C61B	Capacitor, ceramic, 56pF, 5%, 200V	0125 25605
C63A	Capacitor, ceramic, 0.0039µF, 5%, 100V	0125 13925
C63B	Capacitor, ceramic, 0.001µF, 5%, 100V	0125 11025
C64A	Capacitor, ceramic, 820pF, 5%, 100V	0125 58215
C64B	Capacitor, ceramic, 100pF, 5%, 200V	0125 21015
C65	Capacitor, ceramic, 1µF, 10%, 50V	0110 6
C66A	Capacitor, ceramic,0.0056µF, 5%, 100V	0125 15625
	RESISTORS	
R1, 2	Resistor, fixed composition, 2.7Ω, 5%, 1/4W	1009 900
R3, 5, 14, 16, 17, 20, 21, 24, 27, 31, 32, 36, 43, 55, 60, 91	Resistor, metal film, axial, 10K, 1%, 1/4W	0410 1384
R4	Resistor, metal film, axial, 3.65K, 1%, 1/4W	0410 1342
R6, 7, 13, 23, 37, 57, 89, 95	Resistor, metal film, axial, 100Ω, 1%, 1/4W	0410 1192
R10	Resistor, metal film, axial, 383Ω, 1%, 1/4W	0410 1248
R11	Resistor, metal film, axial, 93.1Ω, 1%, 1/4W	0410 1189
R12	Resistor, metal film, axial, 121Ω, 1%, 1/4W	0410 1200
R15	Resistor, metal film, axial, 20K, 1%, 1/4W	0410 1413
R18	Resistor, metal film, axial, 4.75K, 1%, 1/4W	0410 1353
R19	Resistor, metal film, axial, 4.99K, 1%, 1/4W	0410 1355
R22	Resistor, metal film, axial, 11.5K, 1%, 1/4W	0410 1390
R25	Resistor, metal film, axial, 1.4K, 1%, 1/4W	0410 1302

Table 11-3. - continued. Replaceable parts, RFL 9785 Receiver Detector Module Assembly No. 106515-7

Circuit Symbol (Fig. 11-4 & 11-5)	Description	Part Number
	RESISTORS – continued	
R26	Resistor, metal film, variable, 500Ω, 10%, 3/4W	39544
R28	Resistor, metal film, axial, 2K, 1%, 1/4W	0410 1317
R29	Resistor, metal film, axial, 68.1Ω, 1%, 1/4W	0410 1176
R30	Resistor, metal film, axial, 1.0M, 1%, 1/4W	0410 1576
R33	Resistor, metal film, axial, 5.36K, 1%, 1/4W	0410 1358
R34	Resistor, metal film, variable, 10K, 10%, 3/4W	39539
R35	Resistor, metal film, axial, 26.7K, 1%, 1/4W	0410 1425
R38	Resistor, metal film, axial, 82.5K, 1%, 1/4W	0410 1472
R39	Thermistor, resistor, 1000Ω, 1%	91529
R40	Resistor, metal film, axial, 2.21K, 1%, 1/4W	0410 1321
R41	Resistor, metal film, axial, 1.5M, 1%, 1/4W	0410 1593
R42	Resistor, metal film, axial, 1.21M, 1%, 1/4W	0410 1584
R44, 49, 53, 83, 96, 97	Resistor, metal film, axial, 1K, 1%, 1/4W	0410 1288
R45, 48, 56	Resistor, metal film, axial, 1.5K, 1%, 1/4W	0410 1305
R46, 47	Resistor, metal film, axial, 100K, 10%, 1/4W	0410 1480
R50	Resistor, metal film, axial, 95.3K, 1%, 1/4W	0410 1478
R51	Resistor, metal film, variable, 20K, 10%, 1/2W	44529
R52	Resistor, metal film, axial, 9.09K, 1%, 1/4W	0410 1380
R54	Resistor, metal film, axial, 48.7K, 1%, 1/4W	0410 1450
R58	Resistor, metal film, zero ohm, 1/4 watt size	1510 2217
R59	Resistor, metal film, axial, 3.01K, 1%, 1/4W	0410 1334
R62	Resistor, metal film, axial, 511Ω, 1%, 1/4W	0410 1260
R63	Resistor, metal film, axial, 3.32K, 1%, 1/4W	0410 1338
R64, 65	Resistor, metal film, axial, 3.92K, 1%, 1/4W	0410 1345
R66	Resistor, metal film, axial, 2.94K, 1%, 1/4W	0410 1333
R67	Resistor, metal film, variable, 2K, 10%, 1/2W	90392
R68, 92	Resistor, metal film, axial, 681Ω, 1%, 1/4W	0410 1272
R69	Resistor, metal film, axial, 11K, 1%, 1/4W	0410 1388
R70	Resistor, metal film, axial, 1.87K, 1%, 1/4W	0410 1314
R71, 72, 78	Resistor, metal film, axial, 1.74K, 1%, 1/4W	0410 1311
R73	Resistor, metal film, axial, 1.47K, 1%, 1/4W	0410 1304
R74, 79	Resistor, metal film, variable, 500Ω, 10%, 1/2W	94296
R75, 76, 77, 88	Resistor, metal film, axial, 1.96K, 1%, 1/4W	0410 1316

Table 11-3 continued. Replaceable parts, RFL 9785 Receiver Detector Module
Assembly No. 106515-7

Circuit Symbol (Fig. 11-4 & 11-5)	Description	Part Number
	RESISTORS – continued	
R80, 81, 82	Resistor, metal film, axial, 1.1K, 1%, 1/4W	0410 1292
R84	Resistor, metal film, variable, 200Ω, 10%, 1/2W	96318
R85	Resistor, metal film, axial, 34.8K, 1%, 1/4W	0410 1436
R90	Resistor, metal film, variable, 50K, 10%, 1/2W	93667
R93	Resistor, metal film, axial, 316Ω, 1%, 1/4W	0410 1240
R94	Resistor, metal film, axial, 4.12K, 1%, 1/4W	0410 1347
R98	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
CR7	Diode, Zener, 5.1V, 500MW, 1N5231B	35027
CR10	Integrated circuit, voltage reference, diode	0620 218
Q1	Transistor, silicon, NPN, 2N2915	17128
U1	Integrated circuit, linear, QUAD, OP AMP	0620 386
U2, 3, 5, 7	Integrated circuit, linear, JFET, OP AMP	0620 227
U6	Integrated circuit, analog switch, QUAD, SPST, CMOS	0605 17
U8, 9	Integrated circuit, linear, JFET, OP AMP	0620 182
U10	Integrated circuit, linear, voltage regulator, 5V positive	0620 387
U11	Integrated circuit, linear precision OPAMP	0620 322
	MISCELLANEOUS COMPONENTS	
DPM1	Meter, panel, LCD display	101466
J1, 2	Connector, wafer assembly, 5 circuit	42082 5
J3	Connector header, dual, 3/6 circuit	32599 6
P1	Connector, JK male, 64 contact, DIN	98457
TP1	Test point, black	38116 3
TP2, 3, 4, 6, 7, 8, 10, 11, 12, 13, 14	Test point, terminal, orange	98441 3
TP5	Test point, yellow	38116 8

Table 11-4. Replaceable parts, RFL 9785 Receiver Detector Module
Assembly No. 106515-8

Circuit Symbol (Fig. 11-4 & 11-5)	**Description**	**Part Number**
	CAPACITORS	
C1, 2, 3	Capacitor, electrolytic, 47µF, 20%, 35V	1007 1578
C4, 5, 6, 25, 47	Capacitor, ceramic dip, 0.01µF, 5%, 100V	1007 1645
C7, 8, 9, 12, 13, 14, 15, 16, 17, 26, 27, 48, 50, 51, 52, 53, 69, 70, 71	Capacitor, ceramic dip, 0.1µF, 10%, 50V	0120 38
C18, 20, 49	Capacitor, ceramic, 0.47µF, 20%, 50V	0135 54742
C21	Capacitor, ceramic, 0.0015µF, 5%, 100V	0125 11525
C22, 57A, 58A, 60B, 67A	Capacitor, ceramic, 0.0022µF, 5%, 100V	0125 12225
C23	Capacitor, ceramic, 330pF, 5%, 200V	0125 23315
C24	Capacitor, ceramic, 150pF, 5%, 100V	0125 11515
C55A	Capacitor, ceramic, 0.012µF, 5%, 50V	0125 51235
C55B	Capacitor, ceramic, 560pF, 5%, 100V	0125 15615
C56, 59, 62	Capacitor, ceramic, 0.0039µF, 5%, 100V	0125 13925
C68	Capacitor, ceramic, 0.0012µF, 5%, 50V	0125 51225
C61A	Capacitor, ceramic, 390pF, 5%, 100V	0125 13915
C61B	Capacitor, ceramic, 100pF, 5%, 200V	0125 21015
C63A	Capacitor, ceramic, 0.0022µF, 5%, 100V	0125 12225
C63B, 67B	Capacitor, ceramic, 0.001µF, 5%, 100V	0125 11025
C64A	Capacitor, ceramic, 560pF, 5%, 100V	0125 15615
C64B	Capacitor, ceramic, 180pF, 5%, 100V	0125 11815
C65	Capacitor, ceramic, 1µF, 10%, 50V	0110 6
C66A	Capacitor, ceramic,0.0039µF, 5%, 100V	0125 13925
C66B	Capacitor, ceramic, 220pF, 5%, 100V	0125 12215
C68	Capacitor, ceramic,0.0012µF, 5%, 50V	0125 51225
	RESISTORS	
R1, 2	Resistor, fixed composition, 2.7Ω, 5%, 1/4W	1009 900
R3, 5, 14, 16, 17, 20, 21, 24, 27, 31, 32, 36, 43, 55, 60, 91	Resistor, metal film, axial, 10K, 1%, 1/4W	0410 1384
R4	Resistor, metal film, axial, 3.65K, 1%, 1/4W	0410 1342
R6, 7, 13, 23, 37, 57, 89, 95	Resistor, metal film, axial, 100Ω, 1%, 1/4W	0410 1192
R10	Resistor, metal film, axial, 383Ω, 1%, 1/4W	0410 1248
R11	Resistor, metal film, axial, 93.1Ω, 1%, 1/4W	0410 1189
R12	Resistor, metal film, axial, 121Ω, 1%, 1/4W	0410 1200
R15	Resistor, metal film, axial, 20K, 1%, 1/4W	0410 1413
R18	Resistor, metal film, axial, 4.75K, 1%, 1/4W	0410 1353
R19	Resistor, metal film, axial, 4.99K, 1%, 1/4W	0410 1355
R22	Resistor, metal film, axial, 11.5K, 1%, 1/4W	0410 1390
R25	Resistor, metal film, axial, 1.4K, 1%, 1/4W	0410 1302

Table 11-4. - continued. Replaceable parts, RFL 9785 Receiver Detector Module
Assembly No. 106515-8

Circuit Symbol (Fig. 11-4 & 11-5)	**Description**	**Part Number**
	RESISTORS – continued	
R26	Resistor, metal film, variable, 500Ω, 10%, 3/4W	39544
R28	Resistor, metal film, axial, 2K, 1%, 1/4W	0410 1317
R29	Resistor, metal film, axial, 68.1Ω, 1%, 1/4W	0410 1176
R30	Resistor, metal film, axial, 1.0M, 1%, 1/4W	0410 1576
R33	Resistor, metal film, axial, 5.36K, 1%, 1/4W	0410 1358
R34	Resistor, metal film, variable, 10K, 10%, 3/4W	39539
R35	Resistor, metal film, axial, 26.7K, 1%, 1/4W	0410 1425
R38	Resistor, metal film, axial, 82.5K, 1%, 1/4W	0410 1472
R39	Thermistor, resistor, 1000Ω, 1%	91529
R40	Resistor, metal film, axial, 2.21K, 1%, 1/4W	0410 1321
R41	Resistor, metal film, axial, 1.5M, 1%, 1/4W	0410 1593
R42	Resistor, metal film, axial, 1.21M, 1%, 1/4W	0410 1584
R44, 49, 53, 96, 97	Resistor, metal film, axial, 1K, 1%, 1/4W	0410 1288
R45, 48, 56, 73	Resistor, metal film, axial, 1.5K, 1%, 1/4W	0410 1305
R46, 47	Resistor, metal film, axial, 100K, 10%, 1/4W	0410 1480
R50	Resistor, metal film, axial, 95.3K, 1%, 1/4W	0410 1478
R51	Resistor, metal film, variable, 20K, 10%, 1/2W	44529
R52	Resistor, metal film, axial, 9.09K, 1%, 1/4W	0410 1380
R54	Resistor, metal film, axial, 48.7K, 1%, 1/4W	0410 1450
R58	Resistor, metal film, zero ohm, 1/4 watt size	1510 2217
R59	Resistor, metal film, axial, 3.01K, 1%, 1/4W	0410 1334
R62, 98	Resistor, metal film, axial, 499Ω, 1%, 1/4W	0410 1259
R63	Resistor, metal film, axial, 2.26K, 1%, 1/4W	0410 1322
R64, 65	Resistor, metal film, axial, 3.16K, 1%, 1/4W	0410 1336
R66, 75, 76, 77	Resistor, metal film, axial, 2.15K, 1%, 1/4W	0410 1320
R67	Resistor, metal film, variable, 2K, 10%, 1/2W	90392
R68	Resistor, metal film, axial, 715Ω, 1%, 1/4W	0410 1274
R69	Resistor, metal film, axial, 11K, 1%, 1/4W	0410 1388
R70	Resistor, metal film, axial, 3.09K, 1%, 1/4W	0410 1335
R71, 72	Resistor, metal film, axial, 1.74K, 1%, 1/4W	0410 1311
R74, 79	Resistor, metal film, variable, 500Ω, 10%, 1/2W	94296
R78	Resistor, metal film, axial, 1.91K, 1%, 1/4W	0410 1315
R80, 81, 82	Resistor, metal film, axial, 1.65K, 1%, 1/4W	0410 1309
R83	Resistor, metal film, axial, 1.58K, 1%, 1/4W	0410 1307

Table 11-4. - continued. Replaceable parts, RFL 9785 Receiver Detector Module
Assembly No. 106515-8

Circuit Symbol (Fig. 11-4 & 11-5)	**Description**	**Part Number**
	RESISTORS – continued	
R84	Resistor, metal film, variable, 200Ω, 10%, 1/2W	96318
R85	Resistor, metal film, axial, 34.8K, 1%, 1/4W	0410 1436
R88	Resistor, metal film, axial, 1.96K, 1%, 1/4W	0410 1316
R90	Resistor, metal film, variable, 50K, 10%, 1/2W	93667
R92	Resistor, metal film, axial, 681Ω, 1%, 1/4W	0410 1272
R93	Resistor, metal film, axial, 316Ω, 1%, 1/4W	0410 1240
R94	Resistor, metal film, axial, 4.12K, 1%, 1/4W	0410 1347
	SEMICONDUCTORS	
CR1, 2, 3, 8, 9	Diode, silicon, 1N914B/1N4448	26482
CR4	Diode, general purpose, 1N4148	101778
CR7	Diode, Zener, 5.1V, 500MW, 1N5231B	35027
CR10	Integrated circuit, voltage reference, diode	0620 218
Q1	Transistor, silicon, NPN, 2N2915	17128
U1	Integrated circuit, linear, QUAD, OP AMP	0620 386
U2, 3, 5, 7	Integrated circuit, linear, JFET, OP AMP	0620 227
U6	Integrated circuit, analog switch, QUAD, SPST, CMOS	0605 17
U8, 9	Integrated circuit, linear, JFET, OP AMP	0620 182
U10	Integrated circuit, linear, voltage regulator, 5V positive	0620 387
U11	Integrated circuit, linear precision OPAMP	0620 322
	MISCELLANEOUS COMPONENTS	
DPM1	Meter, panel, LCD display	101466
J1, 2	Connector, wafer assembly, 5 circuit	42082 5
J3	Connector header, dual, 3/6 circuit	32599 6
P1	Connector, JK male, 64 contact, DIN	98457
TP1	Test point, black	38116 3
TP2, 3, 4, 6, 7, 8, 10, 11, 12, 13, 14	Test point, terminal, orange	98441 3
TP5	Test point, yellow	38116 8

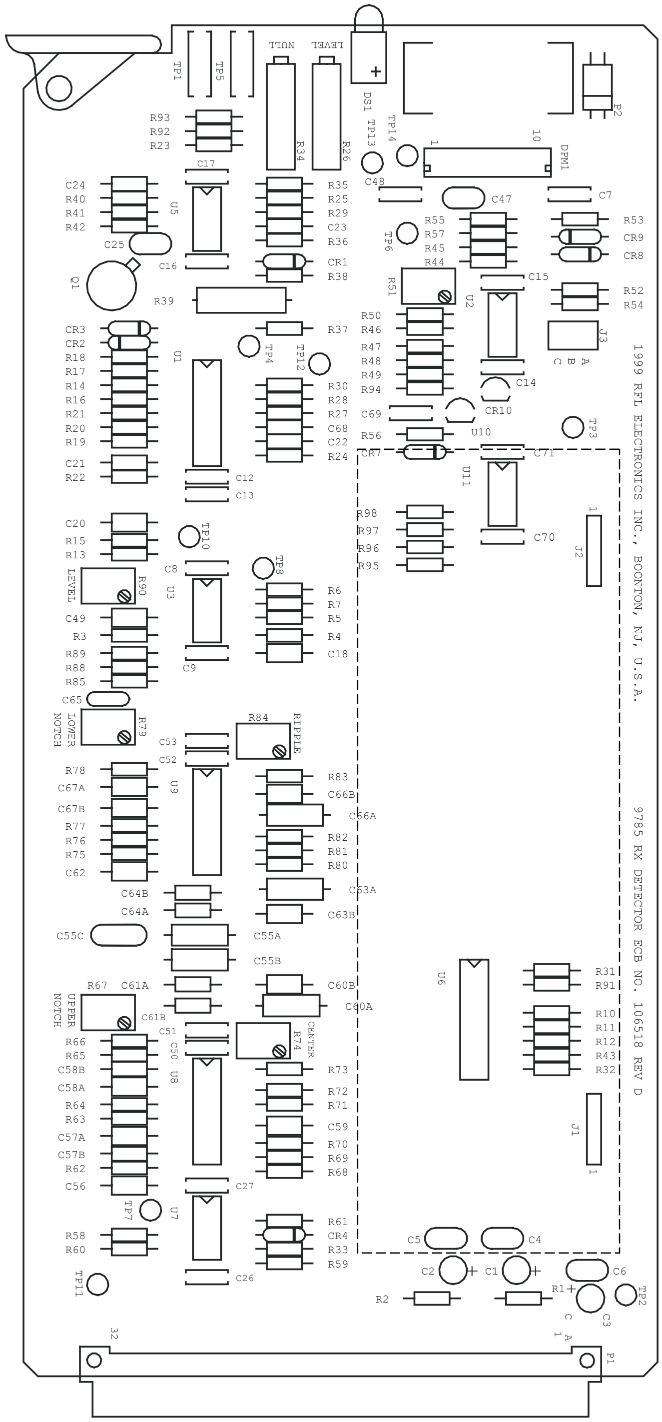


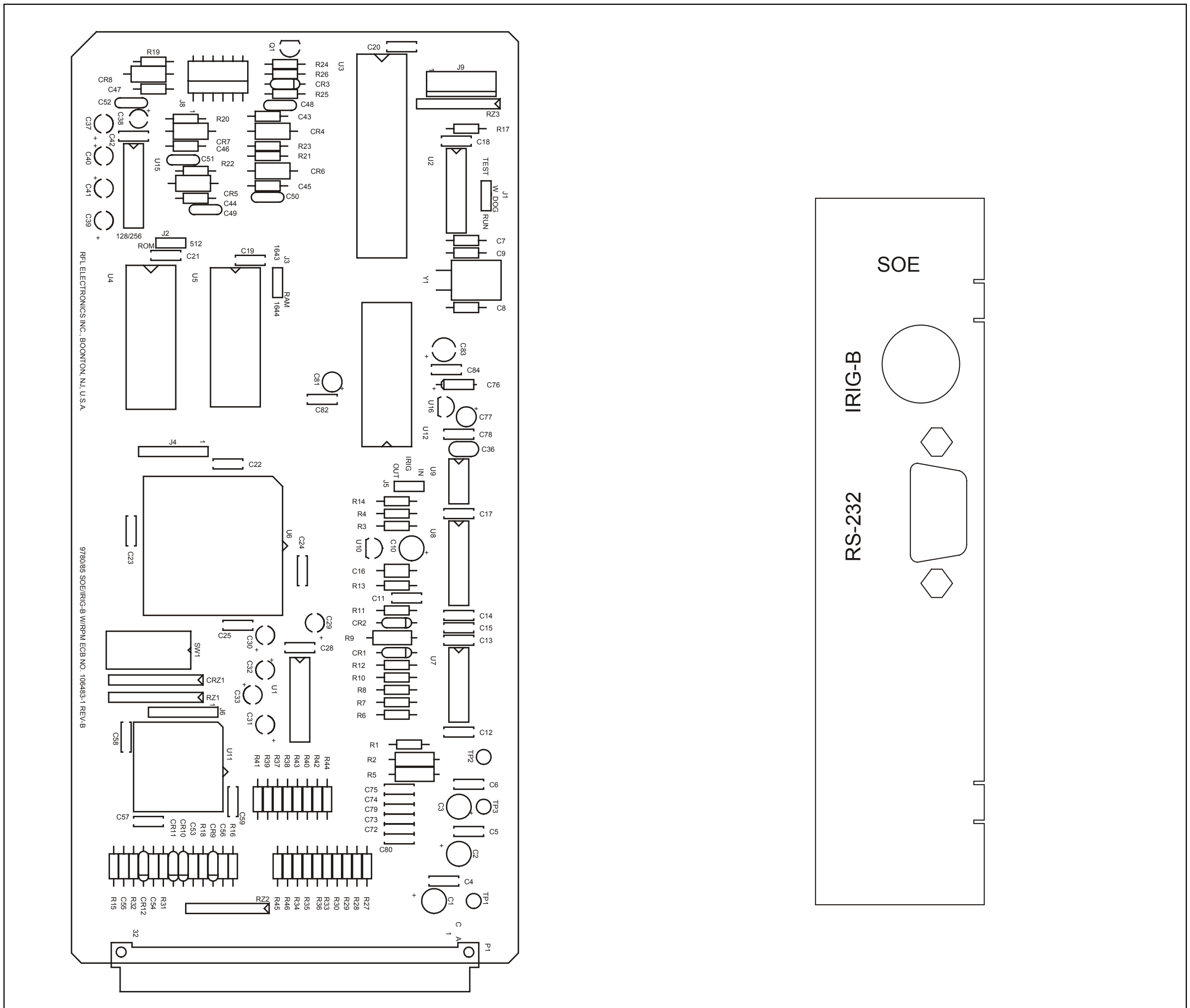
Figure 11-4. Component locator dwg, RFL 9785 Receiver Detector Module (Assy No. 106555)

Figure 11-5. Schematic, RFL 9785 RX Detector (Dwg. No. D-106519-E) Sheet 1 of 2

Figure 11-5. Schematic, RFL 9785 RX Detector (Dwg. No. D-106519-E) Sheet 2 of 2

Please see Figure 11-5 in Section 22: Schematics.

Section 12. SEQUENCE OF EVENTS/IRIG-B MODULE And SEQUENCE OF EVENTS/IRIG-B I/O MODULE



12-1a 12-1b

Figure 12-1. Views of Sequence of Events/IRIG-B Module and SOE/IRIG-B I/O Module

12.1 INTRODUCTION

The RFL 9785 SOE/IRIG-B module is shown in Figure 12-1a, and the RFL 9785 SOE/IRIG-B I/O module is shown in Figure 12-1b. 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 9785 SOE/IRIG-B module. Refer to paragraph 15.3 for more information on the RFL 9785 SOE/IRIG-B I/O module.

12.2 SEQUENCE OF EVENTS/IRIG-B MODULE

12.2.1 DESCRIPTION

The RFL 9785 SOE/IRIG-B module is a status monitor card for the RFL 9785 which monitors 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 13 for information on how to use the RS-232 port to access the RFL 9785 SOE/IRIG-B module.

The SOE/IRIG-B module will record ten events for the RFL 9785 system. These events are listed in Table 12-1.

Table 12-1. Events recorded by the RFL 9785 Sequence of Events Module

RFL 9785 SOE Module, recorded events
CPU Boot Up
Tx Fail
Checkback Fail
Reserve Key
Remote Initiate
Start
Stop
Power Fail #1
Power Fail #2
Block Output

12.2.2 SPECIFICATIONS

As of the date this manual was published, the following specifications apply to all RFL 9785 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

12.2.3 THEORY OF OPERATION

Refer to the schematic diagram in Figure 12-4 for the following discussion.

The RFL 9785 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.

SW1 is an eight position DIP switch which allows the user to set the mode of operation. For the RFL 9785 application, SW1-1, -2 and -3 should be in the ON position, and SW-5 should be in the OFF position. 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.

12.2.4 CONTROLS AND INDICATORS

Figure 12-2 shows the location of all jumpers, test points and switches on the RFL 9785 SOE/IRIG-B module. The functions of these jumpers, test points and switches are described in Table 12-2. All of these items are accessible only when the module is removed from the chassis or is on a card extender.

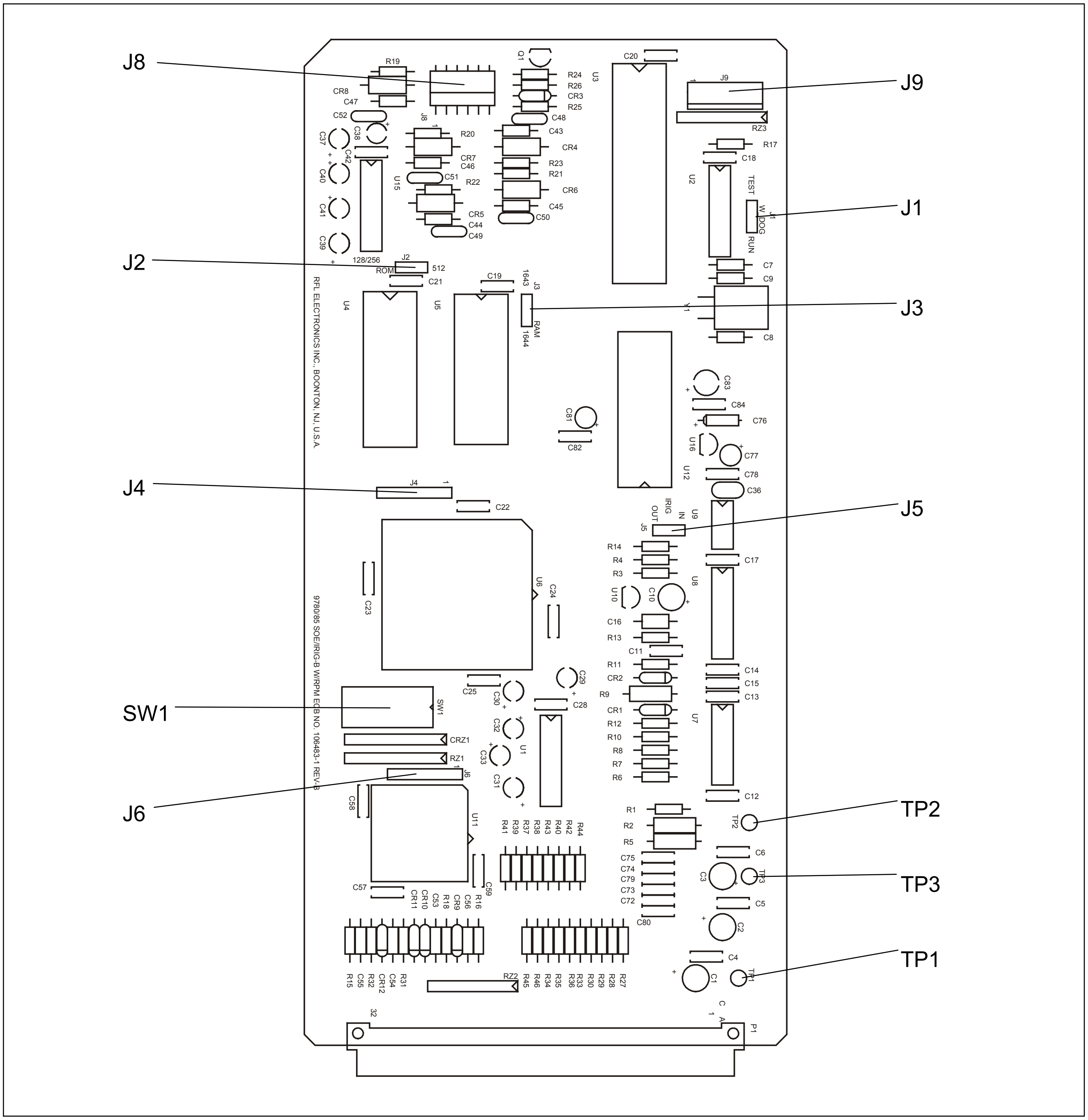


Figure 12-2. Controls and indicators for RFL 9785 SOE/IRIG-B module

Table 12-2. Controls and indicators, RFL 9785 SOE/IRIG-B module

Component Designator	Name/Description	Function					
J1	Jumper (RUN/TEST)	RUN position selects Normal operation. TEST position selects Test operation.					
J2	Jumper (512 or 128/256)	Header and jumper not installed. For factory use only.					
J3	Jumper (1643/1644)	1643 position selects DS1643 RAM. 1644 position selects DS1644 RAM.					
J4	Connector Header	Used for factory testing					
J5	Jumper (IN/OUT)	IN position selects IRIG-B clock. OUT position selects internal clock.					
J6	Connector Header	For future use					
J8	Connector Header	RS-232 connector					
SW1 (Note 1)	DIP Switch	Selects Operating Mode:	SW1-1	SW1-2	SW1-3	SW1-6	Mode
			ON	ON	ON	ON	9785
			OFF	ON	ON	ON	9780TX/RX
			ON	OFF	ON	ON	9780TX/TX
			OFF	OFF	ON	ON	9780RX/RX
			ON	ON	OFF	ON	9780RX
			OFF	ON	OFF	ON	9780TX
			ON	ON	ON	OFF	SP9785 (Note 2)
TP1	Test Point	Ground Reference					
TP2	Test Point	IRIG-B High					
TP3	Test Point	IRIG-B Low					

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 12-3. Replaceable parts, RFL 9785 SOE/IRIG-B module
Assembly No. 106480-1

Circuit Symbol (Figs. 12-3 & 12-4)	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, 0.033μF, 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	0630 452
U5	Integrated circuit, MOS, non-volatile SRAM, RTC, 8Kx8	0615 474
U6	Integrated circuit, MOS, CPLD	0615 472

Table 12-3. - continued. Replaceable parts, RFL 9785 SOE/IRIG-B module

Circuit Symbol (Figs. 12-3 & 12-4)	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 %V	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, right angle, 6-circuit	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

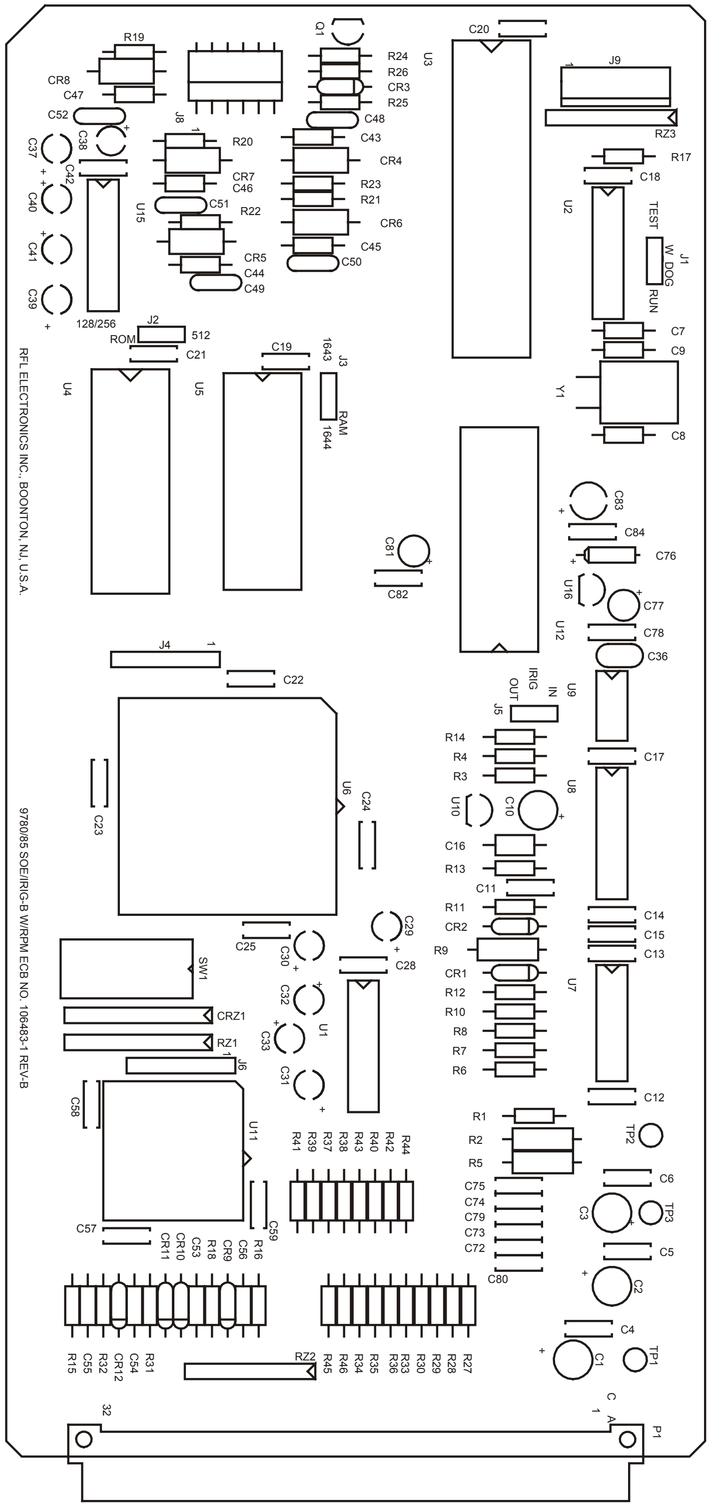


Figure 12-3. Component locator drawing, RFL 9785 SOE/IRIG-B module

Figure 12-4. Schematic, RFL9785 SOE/IRIG-B (Dwg. No. D-106484-F)

Please see Figure 12-4 in Section 22: Schematics.

12.3 SEQUENCE OF EVENTS/IRIG-B I/O MODULE

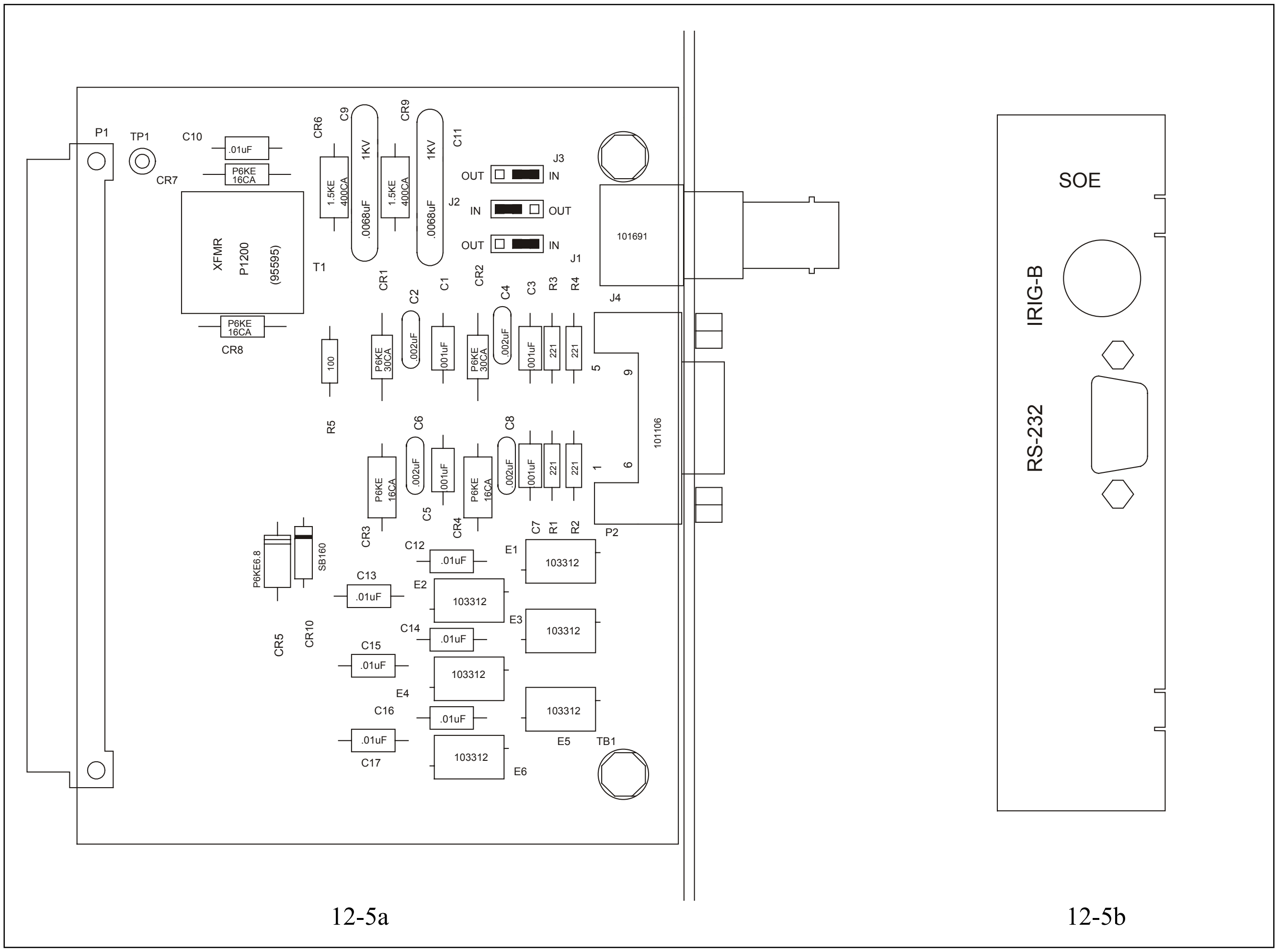


Figure 12-5. Board and panel views of RFL 9785 SOE/IRIG-B I/O module

12.3.1 DESCRIPTION

The RFL 9785 SOE/IRIG-B I/O module provides an interface between the IRIG-B receiver and the RFL 9785 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 12-5a, and a rear panel view is shown in Figure 12-5b.

12.3.2 CONTROLS AND INDICATORS

Figure 12-6 shows the location of all jumpers, test points and connectors on the RFL 9785 SOE/IRIG-B I/O module. The functions of these jumpers, test points and connectors are described in Table 12-4. All of these items are accessible only when the module is removed from the chassis or is on a card extender.

Table 12-4. Controls and indicators, RFL 9785 SOE/IRIG-B I/O module

<table>
<tr><th>Component Designator</th><th>Name/Description</th><th colspan="5">Function</th></tr>
<tr><td>J1</td><td>Jumper</td><td rowspan="3">Selects TTL or bipolar inputs:</td><td><u>INPUT</u>
Bipolar
TTL</td><td><u>J1</u>
OUT
IN</td><td><u>J2</u>
OUT
IN</td><td><u>J3</u>
OUT
IN</td></tr>
<tr><td>J2</td><td>Jumper</td><td></td><td></td><td></td><td></td></tr>
<tr><td>J3</td><td>Jumper</td><td></td><td></td><td></td><td></td></tr>
<tr><td>J4</td><td>Connector</td><td colspan="5">IRIG-B input</td></tr>
<tr><td>P2</td><td>Connector</td><td colspan="5">RS-232 connection</td></tr>
<tr><td>TB1</td><td>Terminal Board</td><td colspan="5">Optional voice terminal board</td></tr>
<tr><td>TP1</td><td>Test Point</td><td colspan="5">Signal common</td></tr>
</table>

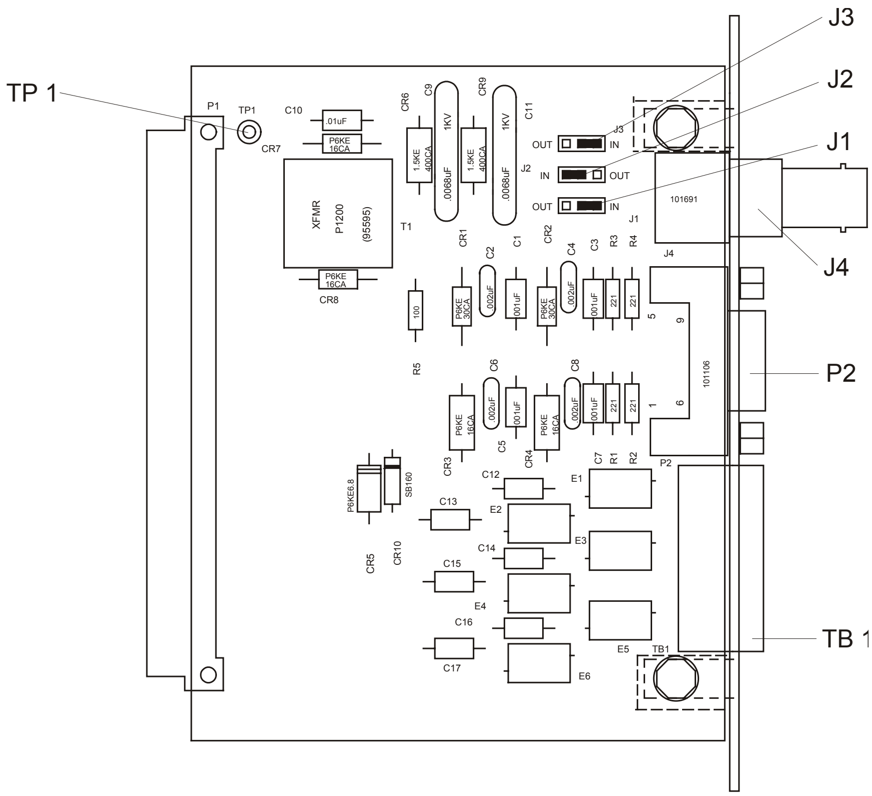


Figure 12-6. Controls and indicators for the RFL 9785 SOE/IRIG-B I/O module

Table 12-5. Replaceable parts, RFL 9785 SOE/IRIG-B I/O module
Assembly No. 106475-2

Circuit Symbol (Fig. 12-7 and 12-8)	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, SB160	96365
	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

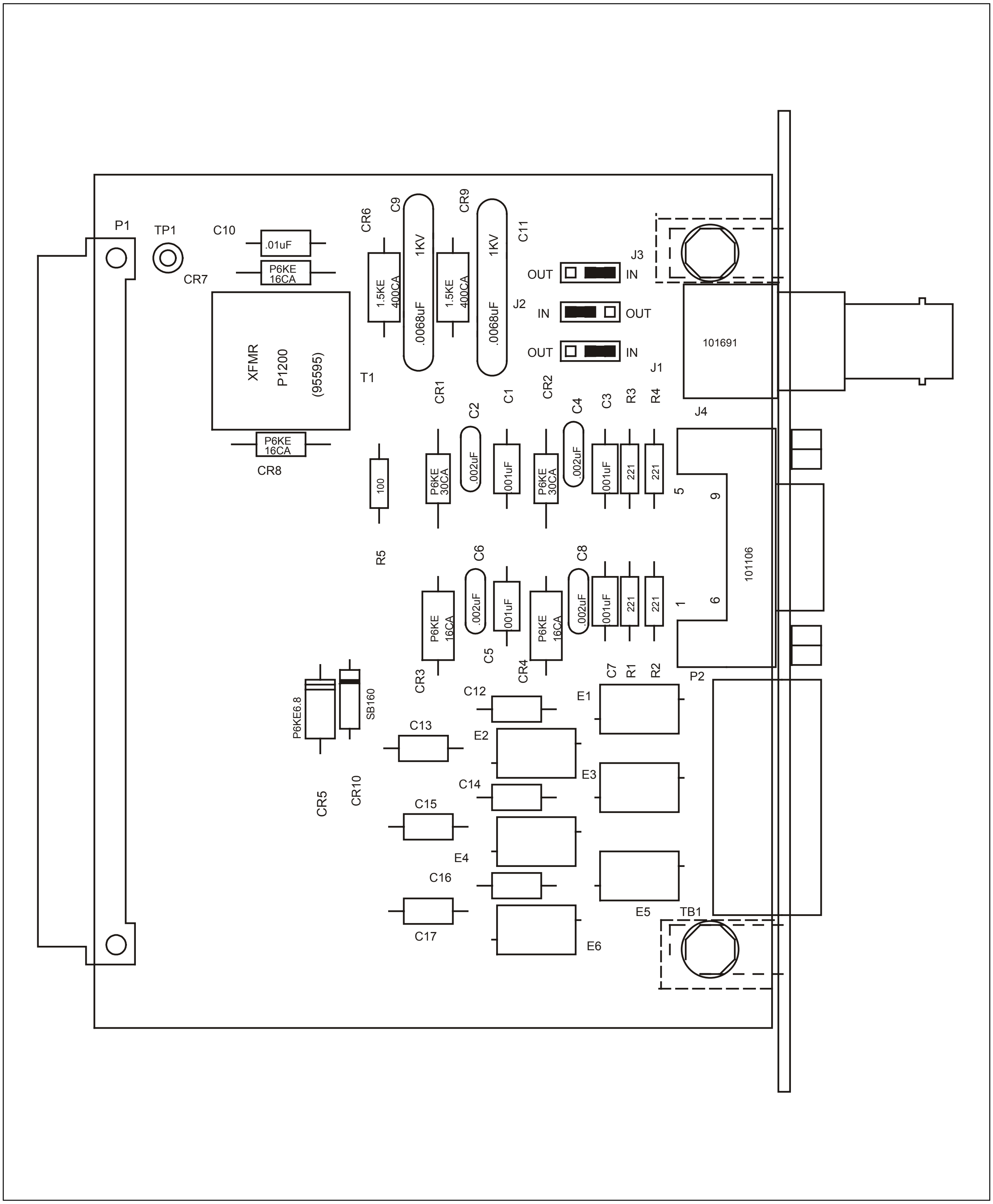


Figure 12-7. Component locator drawing, RFL 9785 SOE/IRIG-B I/O module

Figure 12-8. Schematic, RFL 9785 SOE/IRIG-B I/O (Dwg. No. D-106479-B)

Please see Figure 12-8 in Section 22: Schematics.

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Section 13. USING THE RS-232 PORTS TO ACCESS THE RFL 9785 SOE MODULE

13.1 INTRODUCTION

This section contains information on how to view the RFL 9785 sequence-of-events (SOE) log 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 9785 and a PC.

13.2 ESTABLISHING COMMUNICATIONS

A user can communicate with the RFL 9785 through the RS-232 connector on the front panel (DCE, data communication equipment) or rear panel (DTE, data terminal equipment) of the RFL 9785. Either a dumb terminal or a personal computer equipped with terminal emualtion 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 9785 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.

13.2.1 PHYSICAL CONNECTIONS

The front port of the 9785 is typically connected directly to a terminal or PC using a standard (straight-through) connector as shown in Figure 13-1. The rear port of the 9785 is intended for connection to a stand-alone modem or multi-port switch (such as the RFL 9660 Digital Switch) using a standard (straight-through) connector as shown in Figure 13-2.

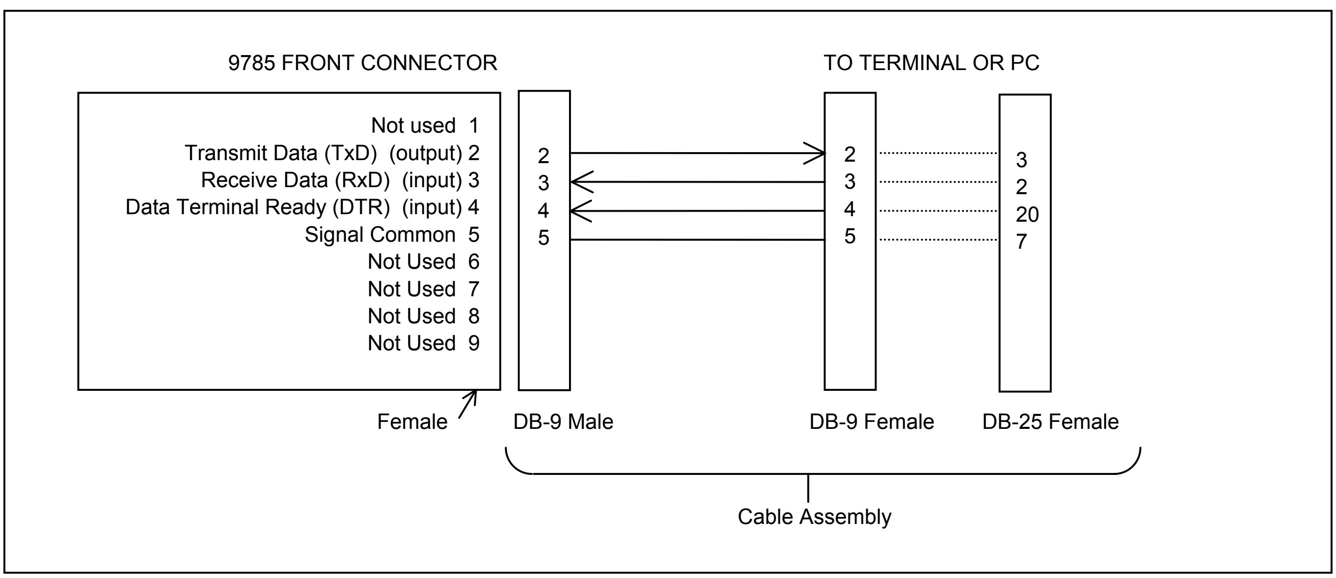


Figure 13-1. Making connections from the PC to the RFL 9785 front cover

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 9785 at the same time. Most ports drive the DTR line high.

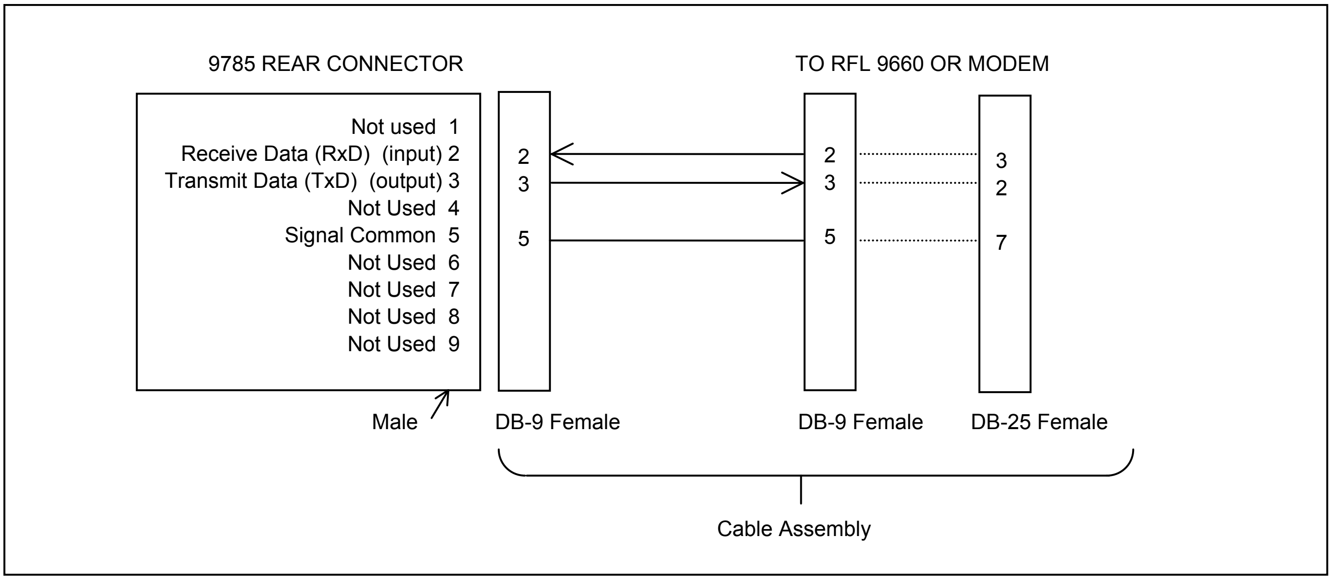


Figure 13-2. Making connections from the PC to the RFL 9785 rear connector

13.2.2 COMMUNICATIONS INFORMATION

The serial communications port on the terminal or PC must be configured to match the 9785:

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.

13.3 VIEWING APRIL COMMANDS

Once you have connected a terminal or PC to the RFL 9785 (either directly or through an RFL 9660 Digital Switch) and pressed the **[ENTER]** key the RFL 9785 will send the following prompt to your terminal:

9785>

This means that you have accessed the RFL 9785, and can now use APRIL commands to view lists of parameter settings, alarm conditions, and other information. To view a list of the APRIL commands, press the **[H]** and **[ENTER]** keys:

9785>H [ENTER]

This tells the RFL 9785 to send a list of APRIL commands called the "main menu" to your terminal. The main menu appears in Figure 13-3.

```
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
W – Window remote April
9785>
```

Figure 13-3. 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	13.3
V	Go to the values display	13.5
P	Go to the programming menu (password)	13.6
D	Go to the read settings menu	13.7
F	Go to the configure and software version display	13.8
U	Enter the update mode	13.9
X	Exit the update mode	13.9
S	Go to sequence-of-events menu	13.10
W	Window remote April	13.11

13.4 DISPLAYING APRIL HELP

Any time you need to see a list of APRIL commands while the “9785>” prompt is displayed, use the “H” command.

9785>H [ENTER]

When you invoke the “H” command, the APRIL command main menu shown in Figure 13-3 will re-appear on your screen.

13.5 VIEWING THE VALUES DISPLAY

To view the current status of the RFL 9785 values display, enter the “V” command.

9785>V [ENTER]

The “V” command tells the RFL 9785 to send a copy of the values display to your terminal. This display is for viewing only and cannot be changed by the user. A typical values display is shown in Figure 13-4.

```
#   ALARM                    STATUS
011  Tx Fail #1              Inactive
015  Power Fail #1           Inactive
016  Power Fail #2           Inactive
019  Checkback Fail          Active

#   SIGNAL                   STATUS

039  Reserve Key             Inactive
040  Remote Initiate         Inactive
041  Start                   Inactive
042  Stop                    Inactive
043  Block Output            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%
9785>
```

Figure 13-4. Typical values display for 9785 operating mode

The values display shows the parameter number for each alarm and signal, a brief description of its meaning, and its status. Full descriptions of alarms and signals are as follows:

011 – Tx Fail #1 This indicates that transmitter channel #1 has failed.

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.

016 – Power Fail #2 This indicates that a problem has been detected with power supply #2. This is only applicable in dual supply systems.

019 – Checkback Fail This indicates that the Checkback test has failed.

039 – Reserve Key This indicates if Reserve Key is active or inactive. When active, the power level has been reduced to one-tenth of the power level.

040 – Remote Initiate This indicates if Remote Initiate is active or inactive. When active, it causes the Checkback sequence to be activated.

041 – Start This indicates if Start is active or inactive. When active, it causes the unit to transmit a Block.

042 – Stop This indicates if Stop is active or inactive. When active, it overrides the Start input.

043 – Block Output This indicates if Block Output is active or inactive. When active, the unit is receiving a valid Block signal.

044 – IRIG-B Status This indicates if IRIG-B Status is active or inactive. When active, the unit is receiving a valid IRIG-B signal.

100 – RxCh1 Level Indicates the Channel 1 receive level (+/-10 dB from nominal). This is the same number that is displayed on the RFL 9785 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

104 – TxCh1 Actual PWR Indicates the actual power being transmitted into the load for Channel 1. 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.

13.6 THE PROGRAMMING MODE

You can use APRIL and your terminal to program the RFL 9785. To use your PC or terminal to program the RFL 9785, use the "P" command.

9785>P [ENTER]

The "P" command tells the RFL 9785 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 13-5 will appear.

```
H – Display progamming 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
9785-P>
```

Figure 13-5. Typical programming menu

You are now in the programming mode, as indicated by the "9785-P>" prompt on your screen. You may now use the programming commands to re-program the RFL 9785. For more information on each programming command, refer to the paragraph numbers listed below.

Command	Meaning	Paragraph
H	Display programming help	13.6.1
Q	Leave programming menu	13.6.2
SV	Save new settings	13.6.3
C	Change password	13.12.2
D	Display current settings and parameter numbers	13.6.4
##	Edit the parameter number "##"	13.6.4

13.6 DISPLAYING PROGRAMMING HELP

Any time you need to see a list of all the programming commands, use the “H” command.

9785-P>H [ENTER]

When you invoke the “H” command, the programming menu shown in Figure 13-5 will re-appear on your screen.

13.6.2 LEAVING THE PROGRAMMING MODE

NOTE

Before leaving the Programming Mode, if you don’t use the “SV” command your changes will be lost.

Whenever you are finished programming the RFL 9785, use the “Q” command:

9785-P>Q [ENTER]

The “Q” command tells the RFL 9785 to leave the programming mode and return to the normal “9785>” 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.

13.6.3 SAVING NEW PROGRAMMING SETTINGS

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

9785-P>SV [ENTER]

The “SV” command tells the RFL 9785 to store all the changes in its non-volatile memory. Once the changes are stored, the “9785-P>” prompt will re-appear.

Before you enter the “SV” command, the RFL 9785 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 13.6.4.)

13.6.4 DISPLAYING AND EDITING PARAMETER SETTINGS

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

9785-P>D [ENTER]

When you invoke the "D" command, the RFL 9785 sends a list of all current parameter settings to your terminal. A typical parameter settings display is shown in Figure 13-6.

```
#    PARAMETER        SETTING
999  System Label
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     N
9785-P>
```

Figure 13-6. 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 9785 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 9785's system clock (note that the time and date values entered will not take effect until stored using the "SV" command):

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]> _

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).

Enter the number for the Time parameter (051) 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]> _

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.

Enter the "SV" command to save your new system label:

9785-P>SV

Example 2: Editing the Channel 1 frequency setting.

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]> _

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

13.7 READING PARAMETER SETTINGS

The “D” command tells the RFL 9785 to send a list of all parameter settings to your terminal. This list of settings is called the “read settings” menu.

9785>D [ENTER]

A typical read settings menu for the Audio System appears in Figure 13-7. The settings described in paragraph 13.6.4 are shown, but you can’t change the displayed values. To change these values, you will have to enter the programming mode. (See paragraph 13.6 for more information.) The programming mode is password-protected, so only authorized persons can change the RFL 9785’s parameter settings.

```
#   PARAMETER        SETTING
999  System Label
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    N
9785-P>
```

Figure 13-7. Typical read settings menu

13.8 VIEWING CONFIGURATION AND SOFTWARE INFORMATION

The “F” command tells the RFL 9785 to send a configuration and software version display to your terminal. This display tells you how the RFL 9785 is configured, and what software versions are being used. These parameters cannot be changed by the user and are for display only.

9785>F [ENTER]

Typical configuration and software version display is shown in Figure 13-8.

```
SOE Module Configuration:
001  Type                   9785
002  Firmware Version       1.1
003  2nd Power Supply Yes
9785>
```

Figure 13-8. 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.

002 – Firmware Version This gives the version number of the software presently running in the SOE-IRIG-B Module.

003 – 2nd Power Supply Indicates if the system is configured for single or dual supply operation.

13.9 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 9785 operation. This mode is entered by using the "U" command.

9785>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 13-9. This is a display of all the measured parameter values. This screen can be used to monitor RFL 9785 operation. The update display shows the parameter numbers for each item, a brief description of its meaning, and its status. "N/A" indicates that the parameter is not applicable for this configuration system. To exit the update mode, press the **[X]** key, followed by the **[ENTER]** key. The screen on your terminal will be cleared, and the "9785>" prompt will re-appear.

```
Value Update - Type 'X<CR>' to Stop
011  Tx Fail #1             Inactive
015  Power Fail #1          Inactive
016  Power Fail #2          Inactive
019  Checkback Fail         Inactive
039  Reserve Key            Inactive
040  Remote Initiate        Inactive
041  Start                  Inactive
042  Stop                   Inactive
043  Block Output           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 13-9. Typical update display

13.10 THE SEQUENCE-OF-EVENTS MODE

The sequence-of-events log is a data file that keeps track of every time one of the RFL 9785 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:

9785>S [ENTER]

When you use the “S” command, a sequence-of-events menu similar to the one shown in Figure 13-10 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
9785-S>
```

Figure 13-10. Typical sequence-of-events menu

You are now in the sequence-of-events mode, as indicated by the “9785-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	13.10.1
D	Dump All Events To Port	13.10.3
E	See Directory Of Events	13.10.4
F	Force a Sequence of Events Record	13.10.5
R	Reset All Events	13.10.6
Q	Leave Sequence-of-Events menu	13.10.7
##	View an event record	13.10.8

13.10.1 DISPLAYING SEQUENCE-OF-EVENTS HELP

Any time you need to see a list of all the sequence-of-events menu commands, use the “H” command.

9785-S>H [ENTER]

When you invoke the “H” command, the sequence-of-events menu shown in Figure 13-11 will re-appear on your screen.

13.10.2 DUMPING THE SEQUENCE-OF-EVENTS LOG TO A PORT

To transfer the event records in the sequence-of-events log from the RFL 9785 to your terminal or PC, use the “D” command:

9785-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 13.10.3.

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 “9785-S>” prompt will re-appear on your screen.

13.10.3 VIEWING THE DIRECTORY OF EVENTS

To view a list of the events presently stored in the sequence-of-events log, use the “E” command:

9785-S>E [ENTER]

When you invoke the “E” command, a Directory Of Events display similar to the one shown in Figure 13-11 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 13.10.4 through 13.10.7.

```
003   06/18/1999 11:37:00.141    START            Active
002   06/18/1999 11:36:59.599    Reserve Key      Inactive
001   06/18/1999 11:36:59.067    Reserve Key      Active
9785-S>
```

Figure 13-11. Typical Directory of Events display

13.10.4 FORCING A SEQUENCE-OF-EVENTS RECORD

To force the SOE Module to record an SOE log entry, use the “F” command:

9785-S>F [ENTER

The “F” command tells the RFL 9785 SOE Module to create an entry in the log showing the status of all signals, time-stamped to the present time and date.

13.10.5 ERASING THE SEQUENCE-OF-EVENTS LOG

To erase the sequence-of-events log, use the “R” command:

9785-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

13.10.6 LEAVING THE SEQUENCE-OF-EVENTS MODE

To leave the sequence-of-events mode, use the “Q” command

9785-S>Q [ENTER]

The “Q” command tells the RFL 9785 to leave the sequence-of-events mode and return to the normal “9785>” prompt.

13.10.7 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”:

9785-S>1 [ENTER]

An individual record similar to the one shown in Figure 13-12 will appear.

The individual event record shown in Figure 13-12 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: RESERVE KEY         ACTIVE
                                   Event Time:    05/26/1999 15:54:53.067

011 Tx Fail #1        Inactve     015  Power Fail #2          Inactive
016 Power Fail #2     Inactive    019  Checkback Fail         Inactive
039 Reserve Key       Active      040  Remote Initiate        Inactive
041 Start             Inactive    042  Stop                   Inactive
043 Block Output      Inactive    044  IRIG-B Status          Unlocked
9785-S>
```

Figure 13-12. Typical individual event record

13.11 THE WINDOW REMOTE APRIL MODE

The Window Remote APRIL mode allows the user access an additional module through the same RS-232 port. This is typically used in a 9785 chassis to communicate with a 9785 Checkback Module also located in the chassis. To enter the Window Remote APRIL mode, use the “W” command

9785>W [ENTER]

When you invoke the “W” command, the RFL 9785 Checkback’s APRIL command main menu will appear on your screen. The prompt will now be changed to “9785CB>”, providing confirmation that the user is now communicating with the Checkback Module.

When you are finished accessing the Checkback Module, you can exit the Window Remote APRIL mode by entering three capital “X’s”:

Format: W_9785>XXX (do not press [ENTER] key)

The APRIL command main menu will re-appear on the screen, with the normal “9785>” prompt.

13.12 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 9785 settings and parameters. The only menu that is password protected is the Programming Menu.

13.12.1 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 9785’s memory. The RFL 9785 gives you three chances to enter the correct password. After the third incorrect password is entered, the RFL 9785 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.

13.12.2 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.

9785-P>C [ENTER]

When you invoke the “C” command, the RFL 9785 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 9785’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 14. VOICE MODULE

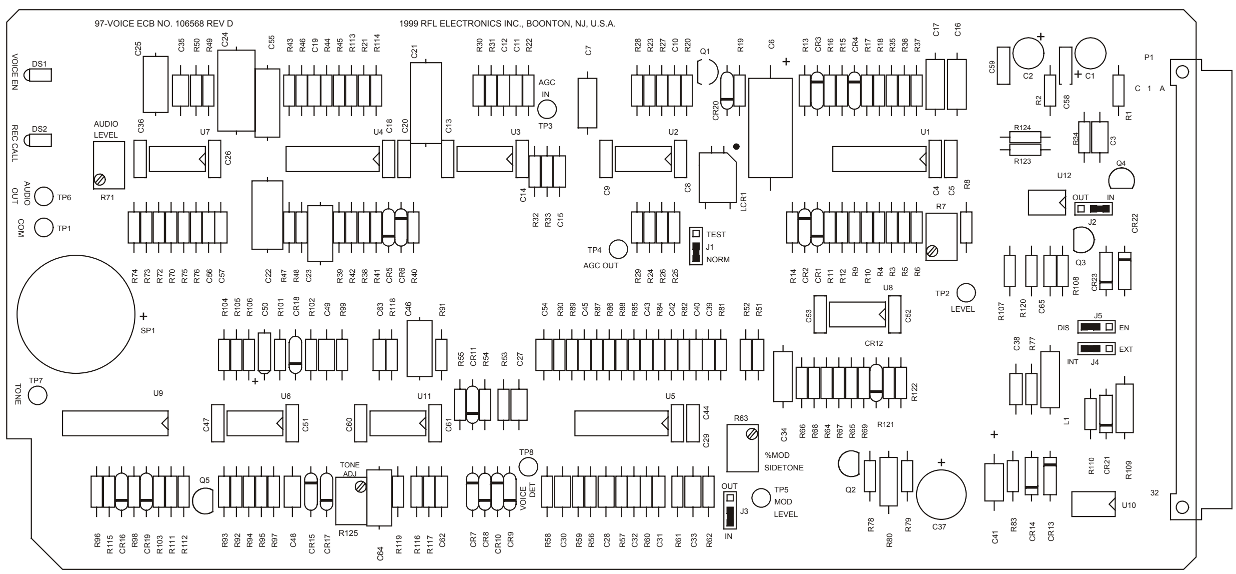


Figure 14-1. RFL 9785 Voice Module

14.1 DESCRIPTION

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

The optional RFL 9785 Voice Module (Fig. 14-1) contains a voice transmitter, a signaling tone oscillator, a signaling tone detector, and a voice receiver. When the RFL 9785 terminals at both ends of a protected line are equipped with voice modules and the other components that comprise the voice option, two-way voice communications can occur between the stations without the need for a telephone hook-up. The voice signals will be injected onto the powerline carrier.

The voice option is made up of three main components. These are a voice module, a voice filter (Figure 14-7), and a handset. When the voice option is used, the voice module is plugged into the appropriate slot in the front of the RFL 9785 chassis. In addition to this the voice filter must be plugged into the Receiver Detector module (see Section 11), and the handset must be plugged into the front of the RFL 9785 front panel or hard wired to the rear of the chassis.

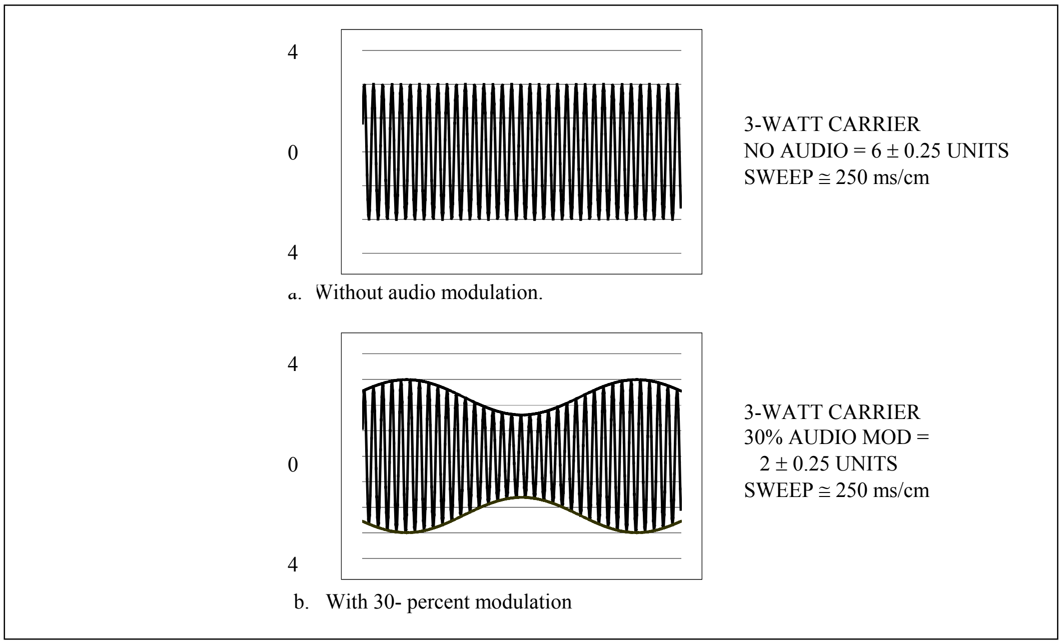
14.2 SPECIFICATIONS

As of the date this manual was published, the following specifications apply to the all RFL 9785 Voice Modules. Because all RFL products undergo constant refinement and improvement, these specifications are subject to change without notice.

Dynamic Range: 30 dB.

Input Signal: See Figure 14-2.

Frequency Response: Approximately 300Hz to 3Khz.



a. Without audio modulation.

b. With 30- percent modulation

Figure 14-2. Input signal from RL 9785 transmitter module

14.3 THEORY OF OPERATION

The RFL 9785 Voice Module contains a transmitter section, a receiver section, and a call tone circuit. A block diagram of the Voice Module appears in Figure 14-3.

14.3.1 TRANSMITTER SECTION

The transmitter section accepts voice signals generated by the carbon microphone in a telephone-type handset and prepares them for use in modulating the output carrier of the RFL 9785. The handset is connected to a mating jack on the front of the chassis, or directly wired to the rear of the chassis. It is routed to the voice module via the mother board on connector pins A24 (ground) and A25. Transistor Q2 provides the current necessary to operate the carbon microphone, which will vary between 15 and 20 mA. The signal generated by the microphone is fed to operational amplifier U5A, which serves as a high-pass filter with a 250-Hz cutoff frequency. The signal then passes to U5C, an operational amplifier with a diode bridge (CR7 through CR10) and Zener diode CR11 in its feedback circuit. U5C acts as a limiter, holding the peak signal amplitude to about 2.4 volts. This prevents overmodulation of the RFL 9785's carrier signal, which could be interpreted by the receiving station as a failure.

After limiting, the speech signal passes through operational amplifier U5D, which is connected as a low-pass filter with a 4-kHz cutoff frequency. Potentiometer R63 controls the amount of voice signal sent to the transmitter module (Section 7). This determines the percent modulation applied to the carrier.

Call tones from the call tone generator/detector section (para. 14.3.3) enter the speech signal path at the input of U5C, and then follow the same path as voice signals.

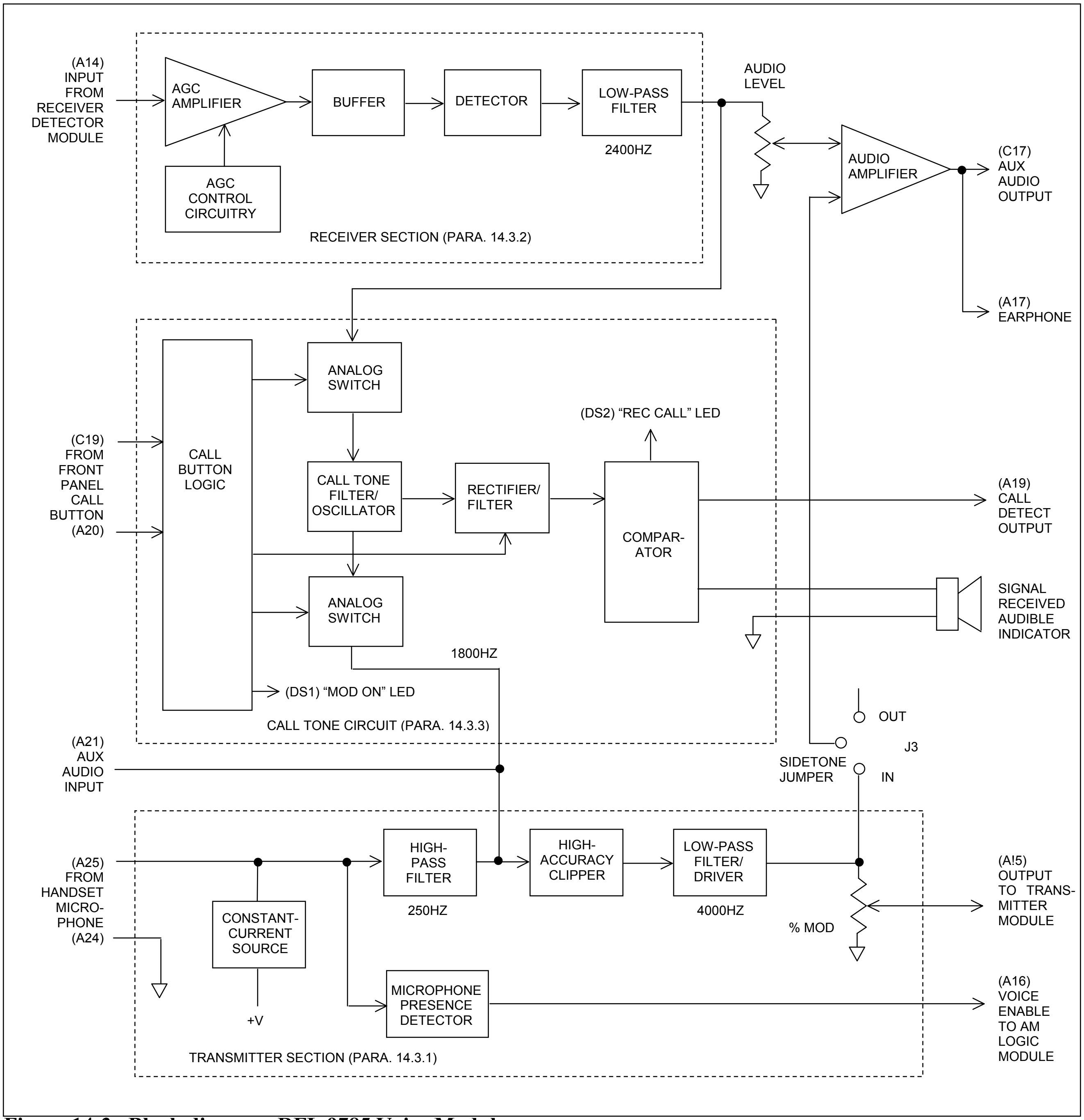


Figure 14-3. Block diagram, RFL 9785 Voice Module

Comparator U8B serves as a microphone presence detector, and controls the entire transmission process. When a carbon microphone is connected to the front panel jack, its low impedance is detected by U8B. This causes the output of U8B to shift from logic low to logic high. This logic high is passed to edge connector terminal A16 as the VOICE ENABLE signal. The AM Logic module (Section 6) uses this signal to produce an enable signal for the transmitter module when voice signals are transmitted.

VOICE ENABLE indicator DS1 will light when U8B is high, providing a visual indication that the VOICE ENABLE signal has been sent to the AM Logic module. U8B can be overridden by connecting the voice signal input at A14 to edge connector terminal A21, which is an auxiliary audio input.

Signals applied to the auxiliary audio input terminal at A21 are fed directly to the input of U5C, and from there to the transmitter module. These signals will modulate the carrier without being controlled by the enable signal from the AM Logic module.

14.3.2 RECEIVER SECTION

Voice signals are received by the RFL 9785 Voice Module as modulation on a 24-kHz carrier at edge connector terminal A14, and are fed to the input of buffer/amplifier U3. The output of U3 becomes the input for U2, an operational amplifier with the detector portion of photo-isolator LCR1 in its feedback circuit. The action of LCR1 makes U2 act as an AGC amplifier.

The output of the AGC amplifier is routed to J2 and edge connector terminal C13. In most RFL 9785 systems, J2 is strapped for AGC in. The AGC output is the reference signal for the AGC circuit. In some applications, additional control circuits may be added in series with the AGC amplifier output.

The AGC circuit reference signal is buffered, scaled and rectified by operational amplifier U1C and D, and is then fed to operational amplifier U1B, where it is compared with the reference voltage established by Zener diode CR3. U1B generates an error voltage that drives transistor Q1. The emitter portion of photo-isolator LCR1 is in series with the emitter of Q1, so when Q1 conducts, LCR1 varies the feedback resistance in U2, changing its gain and providing AGC action.

The gain-regulated output of U2 becomes the input for operational amplifier U1A, the first stage of the voice detector circuit. Operational amplifiers U4B and U4D, along with diodes CR5 and CR6, rectify and demodulate the signal. Operational amplifiers U4A, U4C, and U7A form a low-pass filter with a 2000-Hz cutoff frequency. This removes the 24-kHz portion of the demodulated signal, leaving only the audio portion.

The audio signal separated by the low-pass filter is fed to operational amplifier U7B, which serves as the audio amplifier. AUDIO LEVEL potentiometer R71 controls the audio level by setting the gain for U7B. The output of audio amplifier U7B is fed to edge connector terminal A17. From there, the received voice signal is fed to the receiver portion of the telephone handset connected to the mating connector on the front panel.

14.3.3 CALL TONE CIRCUIT

The call tone circuit is used to generate call tones to send to the remote station, and detect incoming call tones. Operational amplifiers U5B and U6B form the call tone circuit, which is controlled by analog switch U9, photo-coupled isolator U10, transistors Q3 and Q5, and their associated components.

14.3.3.1 CALL TONE GENERATION

When the PUSH TO CALL switch on the front panel is pressed, a 12-Vdc potential is placed across edge connector terminals C19 and A20. This will cause an LED inside U10 to light, making its output go high. This turns on Q5, which pulls U9 pins 9 and 16 low. With U9 pins 9 and 16 held low, the C and D sections of analog switch U9 close, completing a positive feedback path from U6B to U5B, causing the circuit to oscillate. Inductor L2 (see note below) and capacitor C46 hold the oscillation at their resonant frequency, 1800 Hz. This call tone signal is fed to the input of operational amplifier U5B in the transmitter section (para 14.3.1), where it enters the speech transmission path.

When Q5 is turned on, the logic high at U9 pins 1 and 8 opens the A and B switches in U9. With the A and B switches open, speech signals from the receiver section (para 14.3.2) are kept out of the call tone circuit.

14.3.3.2 CALL TONE DETECTION

When the call tone circuit is not generating tones, it is ready to detect incoming tones. In this state, Q5 is turned off and U9 switches A and B open. As a result, the feedback path between U6B and U5B is kept open, and no oscillations occur. Incoming signals are fed to the input of U5B by way of the receiver section (para 14.3.2), analog switch U9 switches C and D, and resistor R90. L2 (see note below) and C46 are connected in parallel across the output of U5B, and will resonate when an 1800-Hz tone is present in the incoming signal.

If an 1800-Hz tone is present, it will be amplified by U6B and rectified by diodes CR15 and CR17. The rectified signal is filtered by resistor R102 and capacitor C50, and then fed to U6A-2. Operational amplifier U6A acts as a comparator, which will turn on transistor Q3 via opto-coupler U12. Q3 drives a signaling device SP1 or a relay coil connected to terminal A18. REC CALL indicator DS1 is in series with U12 emitter, and lights to indicate that a call tone has been detected.

When the PUSH TO CALL switch on the front panel is pressed, Q5 is turned on and diode CR19 conducts. This will hold U6A-2 high, disabling the call tone detection function.

NOTE

L2 is equivalent to 77.62 mH and is formed by GIC (general impedance converter) circuit U11, R116-119 and C64.

14.4 CONTROLS AND INDICATORS

Figure 14-4 shows the locations of all controls and indicators on the voice module. These controls and indicators are described in Table 14-1. LEDs DS1 and DS2 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 14-1. Controls and indicators, RFL9785 Voice Module

Component Designator	**Name/ Description**	**Function**
DS1	LED, Voice enable	Lights when the local station is transmitting voice.
DS2	LED, Receiver call	Lights when a call is received from the station at the other end of the protected line.
J1	Jumper, normal/test	Controls the AGC circuit as follows: NORM: AGC circuit enabled TEST: AGC circuit disabled. Used during module alignment only. For proper module operation, J1 must be in the NORM position.
J2	Jumper, AGC in/out	Controls the AGC function as follows: IN: AGC function enabled OUT: AGC function disabled.
J3	Jumper, side tone in/out	Controls the sidetone (voice) fed back from the handset microphone to the handset headphone as follows: IN: Sidetone enabled OUT: Sidetone disabled.
J4	Jumper, alarm cutoff internal/external	Controls the location of the Alarm Cutoff contacts as follows: INT: Contacts located in handset plug. EXT: Contacts located at 9785 rear panel terminal block.
J5	Jumper, enable /disable	Controls Audible alarm as follows: ENABLE: Audible alarm enabled DISABLE: Audible alarm disabled.
R7	Potentiometer	Input level adjust
R63	Potentiometer	Controls the amount of signal sent to the transmitter module. This controls the % modulation to be applied to the carrier.
R71	Potentiometer	Audio level adjust
R125	Potentiometer	Tone adjust
SP1	Audible warning device	An audible tone is heard when a call is received from the station at the other end of the protected line.
TP1	Test point, Common	Ground reference
TP2	Test point, Level	Monitoring point for input signal level
TP3	Test point, AGC IN	Monitoring point for input of AGC circuit
TP4	Test point, AGC OUT	Monitoring point for output of AGC circuit
TP5	Test point, MOD LEV	Monitoring point for output of voice detector
TP6	Test point, AUD OUT	Monitoring point for audio output signal
TP7	Test point, TONE	Monitoring point for call tone
TP8	Test point, VOICE DETECT	Monitoring point for local voice signal

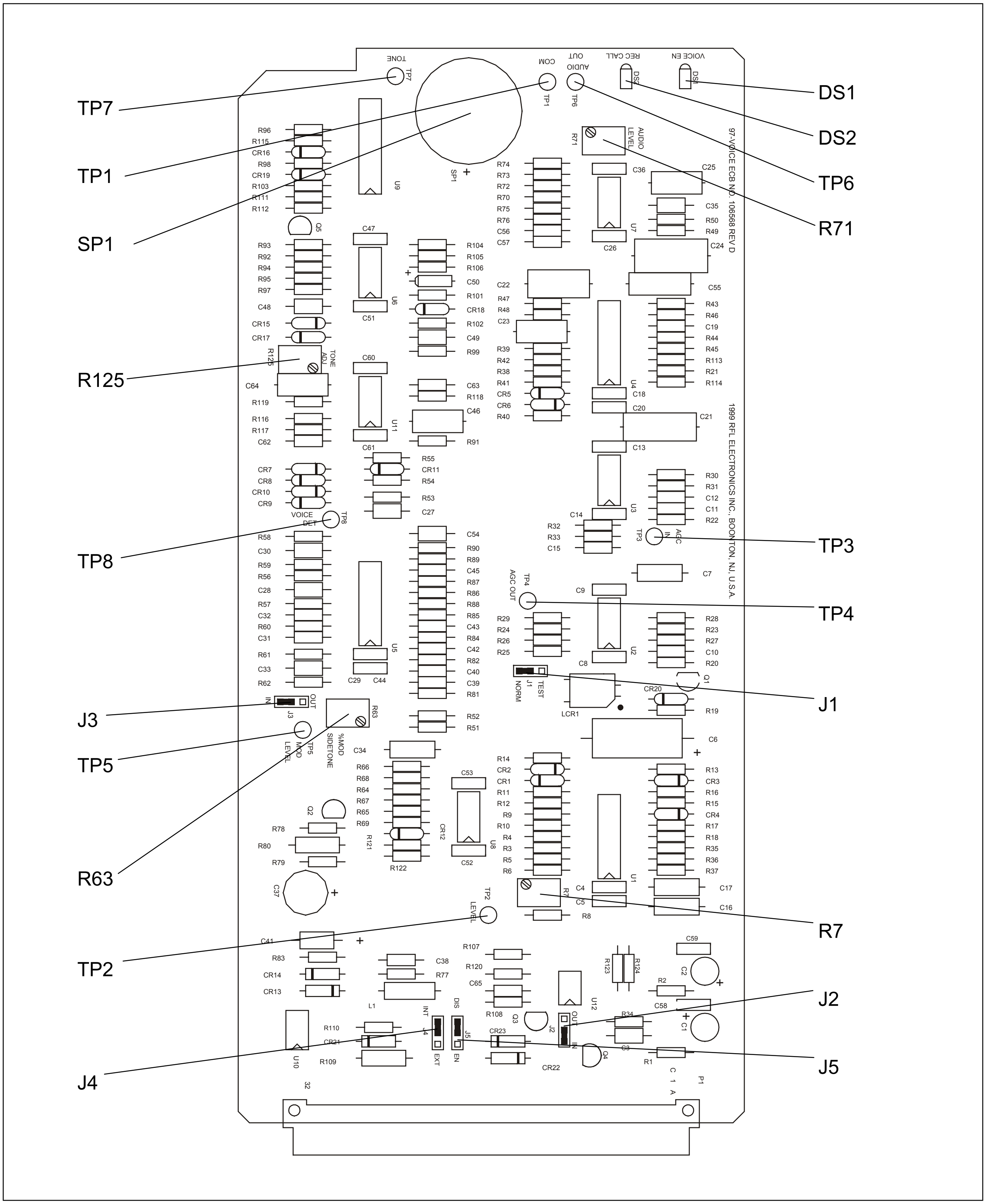


Figure 14-4. Controls and indicators, RFL 9785 Voice Module

Table 14-2. Replaceable parts, RFL 9785 Voice Module. Assembly No. 106565

Circuit Symbol (Figs. 14-4 & 14-5)	Description	Part Number
	CAPACITORS	
C1, 2	Capacitor, electrolytic, 47µF, 20%, 35V	1007 1578
C3, 27, 33, 35, 54	Capacitor, ceramic, 0.47µF, 20%, 50V	0135 54742
C4, 5, 8, 9, 13, 14, 18, 20, 26, 29,36,44, 46, 47, 51-53, 58, 59, 60, 61	Capacitor, ceramic dip, 0.1µF, 10%, 50V	0120 38
C6	Capacitor, electrolytic, 100µF, 20%, 25V	1007 1556
C7	Capacitor, ceramic, 0.0068µF, 5%, 100V	0125 16825
C10, 15	Capacitor, ceramic, 150pF, 5%, 100V	0125 11515
C11	Capacitor, ceramic, 0.0015µF, 5%, 100V	0125 11525
C12, 38, 56, 57	Capacitor, ceramic, 0.047µF, 10%, 50V	0130 54731
C16, 17	Capacitor, ceramic, 0.0056µF, 5%, 100V	0125 15625
C19	Capacitor, ceramic, 0.001µF, 5%, 100V	0125 11025
C21	Capacitor, polypropylene, 0.0315µF, 2%, 100V	0105 88
C22	Capacitor, ppa axial, 0.016µF, 2%, 100V	0105 124
C23	Capacitor, ppa axial, 0.0012µF, 2%, 100V	0105 123
C24	Capacitor, polypropylene, 0.043µF, 2%, 100V	0105 54
C25	Capacitor, ppa axial, 255pF, 2%, 100V	0105 122
C28	Capacitor, ceramic, 100pF, 5%, 200V	0125 21015
C30	Capacitor, ceramic, 0.0039µF, 5%, 100V	0125 13925
C31, 40, 42, 43	Capacitor, ceramic, 0.012µF, 10%, 50V	0130 51231
C32	Capacitor, ceramic, 270pF, 10%, 200V	0130 22711
C34	Capacitor, ceramic, 1µF, 20%, 50V	0135 51052
C37	Capacitor, tantalum, 15µF, 20%, 35V	1007 539
C39	Capacitor, ceramic, axial, 8200pF, 5%, 50V	0130 58225
C41	Capacitor, tantalum, 1µF, 10%, 35V	1007 1156
C45	Capacitor, ceramic, 15pF, 5%, 200V	0125 21505
C46, 64	Capacitor, ceramic dip, 0.1µF, 2%, Dipguard	1007 1476
C48, 49	Capacitor, ceramic, 0.27µF, 10%, 50V	0130 52741
C50	Capacitor, tantalum, 2.2µF, 20%, 25V	1007 645
C55	Capacitor, polypropylene, 0.012µF, 2%, 100V	0105 13
C62, 63	Capacitor, ceramic, 27pF, 5%, 200V	0125 22705
C65	Capacitor, ceramic, 0.01µF, 10%, 50V	0130 51031

Table 14-2. – continued. Replaceable parts, RFL 9785 Voice Module
Assembly No. 106565

Circuit Symbol (Figs. 14-4 & 14-5)	Description	Part Number
	RESISTORS	
R1, 2	Resistor, fixed composition, 2.7Ω, 5%, 1/4W	1009 900
R3, 6, 57, 62, 65, 81, 83, 92, 98	Resistor, metal film, axial, 1K, 1%, 1/4W	0410 1288
R4, 9-11, 13, 18, 27, 28, 33, 35, 37-40, 42, 45, 88, 99, 121	Resistor, metal film, axial, 10K, 1%, 1/4W	0410 1384
R5	Resistor, metal film, axial, 3.01K, 1%, 1/4W	0410 1334
R7, 71	Resistor, metal film, variable, 25K, 10%, 1/2W	90393
R8, 22, 29, 61, 74, 96	Resistor, metal film, axial, 100Ω, 1%, 1/4W	0410 1192
R12, 115	Resistor, metal film, axial, 4.75K, 1%, 1/4W	0410 1353
R14, 43, 66, 108, 120, 123, 124	Resistor, metal film, axial, 4.99K, 1%, 1/4W	0410 1355
R15, 78	Resistor, metal film, axial, 3.32K, 1%, 1/4W	0410 1338
R16	Resistor, metal film, axial, 30.1K, 1%, 1/4W	0410 1430
R17	Resistor, metal film, axial, 475K, 1%, 1/4W	0410 1545
R19	Resistor, metal film, axial, 2.21K, 1%, 1/4W	0410 1321
R20	Resistor, metal film, axial, 221Ω, 1%, 1/4W	0410 1225
R23	Resistor, metal film, axial, 6.65K, 1%, 1/4W	0410 1367
R24, 64, 70, 89, 94, 106	Resistor, metal film, axial, 100K, 1%, 1/4W	0410 1480
R25	Resistor, metal film, axial, 750Ω, 1%, 1/4W	0410 1276
R26	Resistor, metal film, axial, 7.5K, 1%, 1/4W	0410 1372
R30, 114	Resistor, metal film, axial, 31.6K, 1%, 1/4W	0410 1432
R31	Resistor, metal film, axial, 909Ω, 1%, 1/4W	0410 1284
R32	Resistor, metal film, axial, 18.2K, 1%, 1/4W	0410 1409
R34	Resistor, metal film, axial, 47.5Ω, 1%, 1/4W	0410 1161
R36, 101	Resistor, metal film, axial, 24.9K, 1%, 1/4W	0410 1422
R41	Resistor, metal film, axial, 787Ω, 1%, 1/4W	0410 1278
R44, 46-50, 58, 59, 60	Resistor, metal film, axial, 20K, 1%, 1/4W	0410 1413
R51, 76	Resistor, metal film, axial, 604Ω, 1%, 1/4W	0410 1267
R52	Resistor, metal film, axial, 38.3K, 1%, 1/4W	0410 1440
R53	Resistor, metal film, axial, 6.98K, 1%, 1/4W	0410 1369
R54, 55, 68	Resistor, metal film, axial, 15K, 1%, 1/4W	0410 1401
R56	Resistor, metal film, axial, 40.2K, 1%, 1/4W	0410 1442
R63	Resistor, metal film, variable, 1K, 10%, 1/2W	49995
R67	Resistor, metal film, axial, 392K, 1%, 1/4W	0410 1537
R69	Resistor, metal film, axial, 4.32K, 1%, 1/4W	0410 1349
R72, 87	Resistor, metal film, axial, 33.2K, 1%, 1/4W	0410 1434
R73	Resistor, metal film, axial, 3.16K, 1%, 1/4W	0410 1336
R75, 90	Resistor, metal film, axial, 1.5K, 1%, 1/4W	0410 1305
R77, 97, 110	Resistor, metal film, axial, 332Ω, 1%, 1/4W	0410 1242
R79	Resistor, metal film, axial, 562Ω, 1%, 1/4W	0410 1264
R80	Resistor, metal film, axial, 47.5Ω, 1%, 1/2W	0410 2161

Table 14-2. – continued. Replaceable parts, RFL 9785 Voice Module
Assembly No. 106565

Circuit Symbol (Figs. 14-4 & 14-5)	Description	Part Number
	RESISTORS	
R82	Resistor, metal film, axial, 26.7K, 1%, 1/4W	0410 1425
R84	Resistor, metal film, axial, 7.32K, 1%, 1/4W	0410 1371
R85	Resistor, metal film, axial, 365K, 1%, 1/4W	0410 1534
R86	Resistor, metal film, axial, 140K, 1%, 1/4W	0410 1494
R91	Resistor, metal film, axial, 34.8K, 1%, 1/4W	0410 1436
R93, 21	Resistor, metal film, axial, 68.1K, 1%, 1/4W	0410 1464
R95	Resistor, fixed composition, 10Ω, 5%, 1/4W	1009 823
R102	Resistor, metal film, precision, 562K, 1%, 1/8W	1510 2013
R103	Resistor, metal film, axial, 47.5K, 1%, 1/4W	0410 1449
R104, 107, 113	Resistor, metal film, axial, 3.92K, 1%, 1/4W	0410 1345
R105	Resistor, metal film, axial, 10.5K, 1%, 1/4W	0410 1386
R109	Resistor, metal film, axial, 681Ω, 1%, 1/2W	0410 2272
R111	Resistor, metal film, axial, 2K, 1%, 1/4W	0410 1317
R112	Resistor, metal film, axial, 825Ω, 1%, 1/4W	0410 1280
R116, 117, 118, 119	Resistor, metal film, axial, 887Ω, 1%, 1/4W	0410 1283
R122	Resistor, metal film, axial, 5.9K, 1%, 1/4W	0410 1362
	SEMICONDUCTORS	
CR1, 2, 4-10, 12, 15, 16-20	Diode, silicon, 1N914B/1N4448	26482
CR3	Diode, Zener, 3.3V, 400MW, 1N746A	18760
CR11	Diode, Zener, 2.4V, 500MW, 1N5221B	40476
CR13, 14, 21	Diode, silicon, rectifier, 1 AMP, 1N4003	30769
CR22, 23	Diode, surmetic, rectifier, 1N4001	38876
Q1, 3, 5	Transistor, silicon, NPN, 2N2222A	37445
Q2, 4	Transistor, silicon, PNP, 2N2907A	37439
U1, 4, 5	Integrated Circuit, linear, JFET, OP AMP	0620 151
U2, 3	Integrated Circuit, linear, OP AMP	0620 126
U6, 7, 8, 11	Integrated Circuit, linear, JFET, DUAL, OP AMP	0620 155
U9	Integrated Circuit, analog switch, QUAD, SPST, CMOS	0605 17
U10	Opto device, ISO coupler, MOC8021	90271
U12	Opto device, photo ISO, 4N35	47104
	MISCELLANEOUS COMPONENTS	
DS1	Opto device, LED, yellow, 5VDC	101763
DS2	Opto device, LED, red, 5VDC	101761
J1-5	Connector, header, single, 3-circuit	32802 3
L1	Inductor, molded, 1000μH, 5%	26529
LCR1	Opto device, photo-coupled RES	46546
P1	Connector, JK male, 64 contact, DIN	98457
SP1	Warning device, audible	30048
TP1, 2, 3, 4, 5, 6, 7, 8	Test point, terminal, orange	98441 3

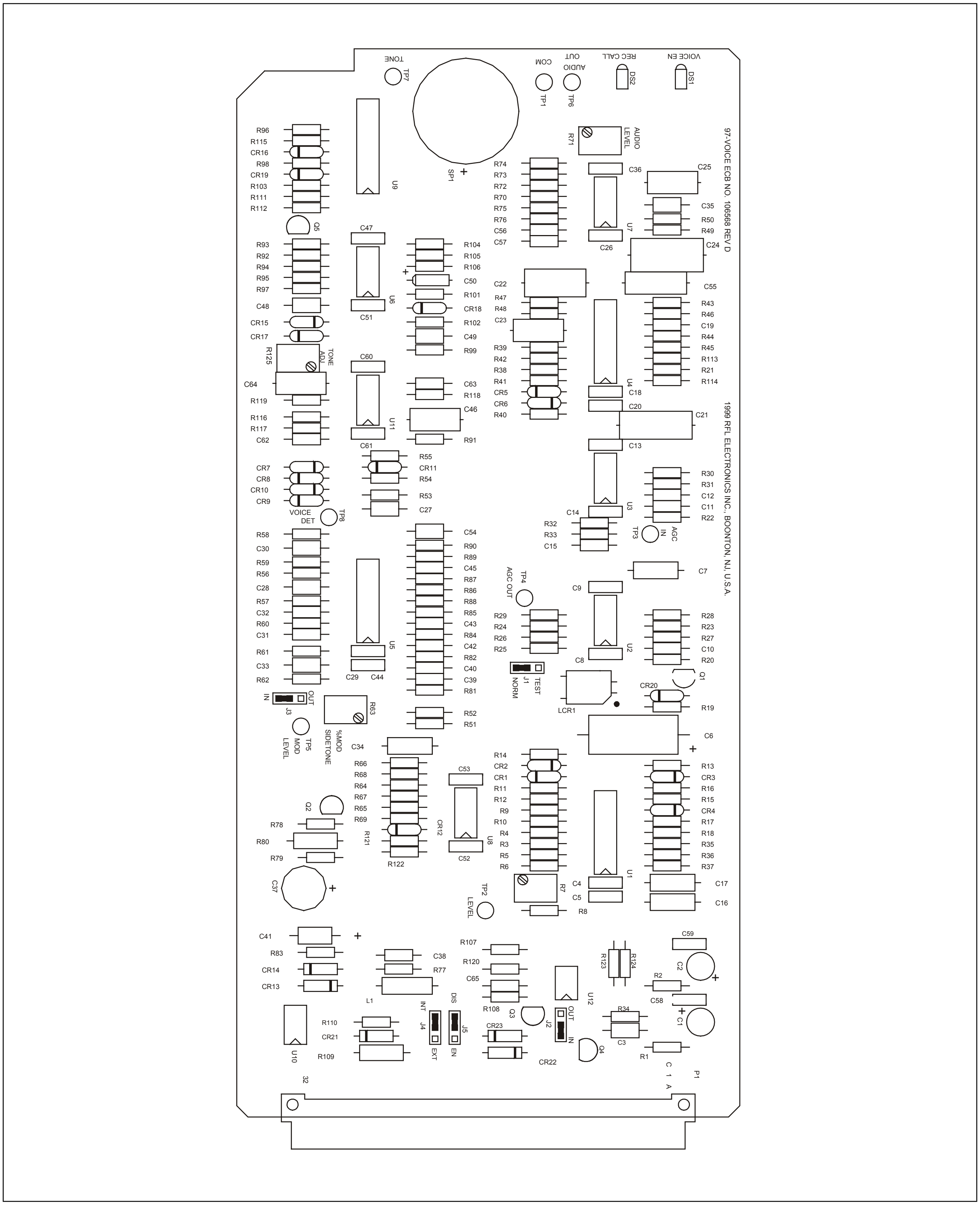


Figure 14-5. Component locator drawing, RFL 9785 Voice Module

Figure 14-6. Schematic, RFL 9785 Voice Module (Dwg. No. D-106569-C)

Please see Figure 14-6 in Section 22: Schematics.

14.5 VOICE FILTER

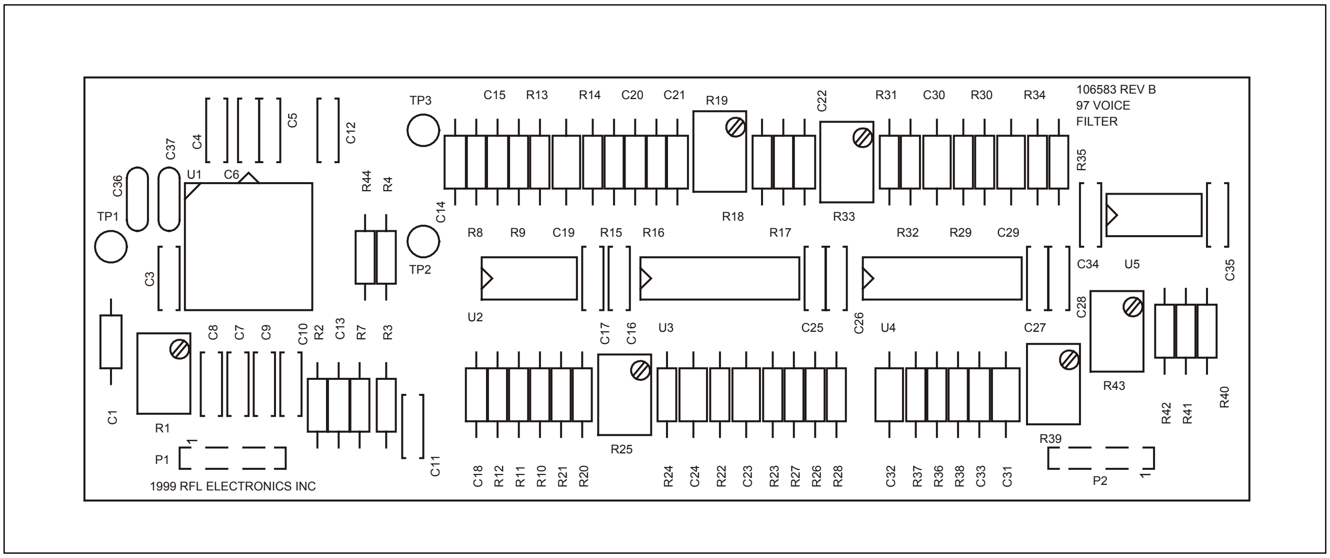


Figure 14-7. RFL 9785 Voice Filter

14.5.1 DESCRIPTION

The Voice Filter (Figure 14-7) plugs onto the Receiver Detector module (Section 11) only when the RFL 9785 has the voice option installed.

The voice filter is a 6Khz wide bandpass filter centered at 24Khz. It accepts the signal output from the Receiver Downshifter module (Section 10) and passes the portion of the band containing voice, to the Voice Module (Section 14).

The signal presented by the Receiver Downshifter module enters the Receiver Detector module on edge pin connector A14, which can be measured at test point TP2 of the Receiver Detector module. This is passed through connector J1-1/P1-1 to the input of the voice filter. The output of the voice filter is passed through connector J2-1/P2-1 to the main circuit board, and can be measured at test point TP3 on the Receiver Detector module.

Resistors R10, R11 and R12 which are connected in series, form a voltage divider for the output of the voice filter. The voltage divider has taps which are routed through an analog switch. The analog switch controls the voice output which can be voice high, voice low, or muted. The 24Khz voice output exits the Receiver Detector board on connector pin C14. It then enters the voice module on connector pin A14, where it is demodulated and further processed.

NOTE

The plug-on voice filter is only used on the RFL 9785 when the voice option is used. This filter contains five potentiometers. Only one of these potentiometers (R43) can be adjusted in the field, using the instructions given in Section 4 of this manual. Any attempt to adjust any other potentiometers on the voice filter may result in voice degradation.

14.5.2 CONTROLS AND INDICATORS

Figure 14-4 shows the locations of all controls and indicators on the voice filter. These controls and indicators are described in Table 14-3. All controls and indicators are only accessible when the voice module is removed from the chassis or is on a card extender.

Table 14-3. Controls and indicators, RFL 9785 Voice Filter

Component Designator	Name/ Description	Function
P1	Connector plug	Mates with J1 on Receiver Detector module (voice filter input)
P2	Connector plug	Mates with J2 on Receiver Detector module (voice filter output)
R1	Potentiometer	Not used on RFL 9785 voice filter
R19	Potentiometer	Upper notch adjustment (for factory adjustment only)
R25	Potentiometer	Passband balance adjust (for factory adjustment only)
R33	Potentiometer	Lower notch adjustment (for factory adjustment only)
R39	Potentiometer	Passband balance adjust (for factory adjustment only)
R43	Potentiometer	Output level adjust
TP1	Test point	Not used on RFL 9785 voice filter
TP2	Test point	Not used on RFL 9785 voice filter
TP3	Test point	Buffered input signal

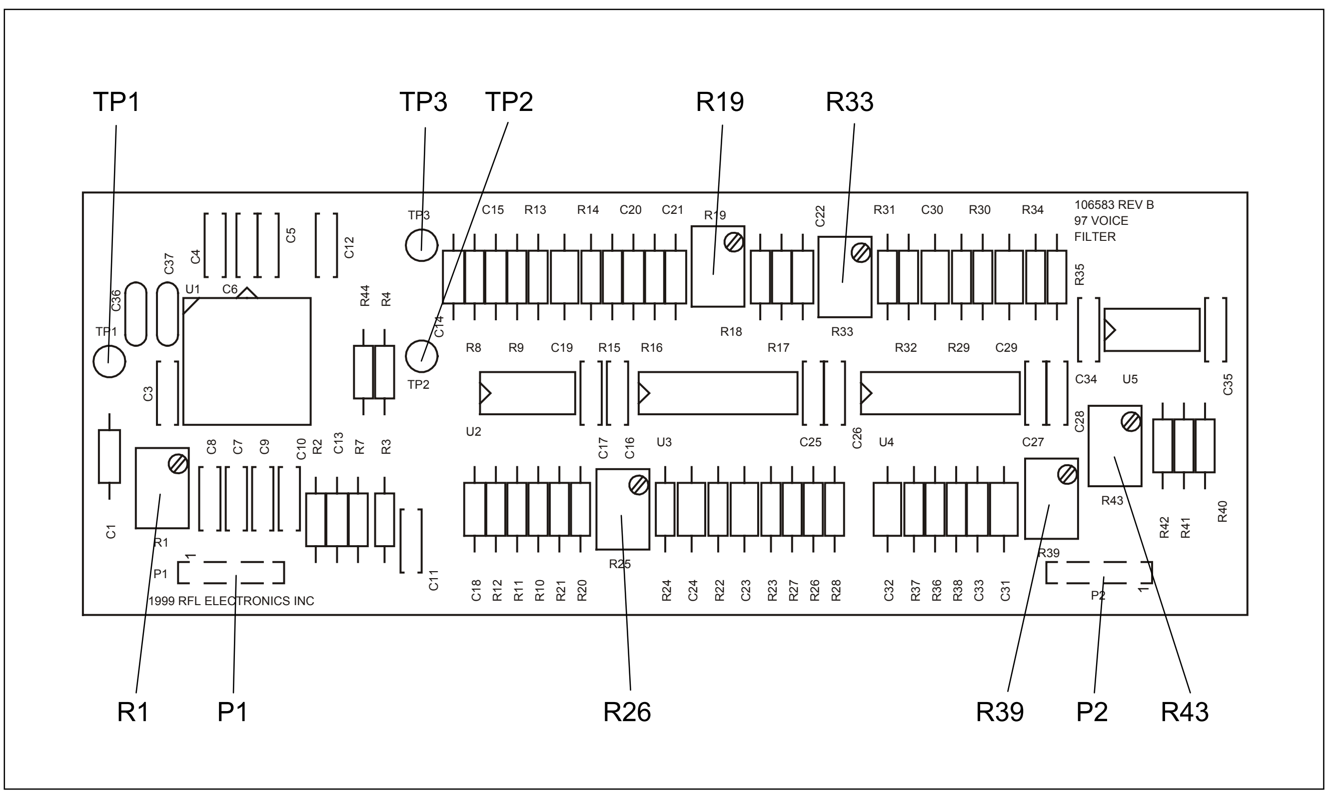


Figure 14-8. Controls and indicators, and component locator drawing, RFL 9785 Voice Filter

Table 14-4. Replaceable parts, Voice Filter, used on RFL 9785 Receiver/Detector Module Assembly No. 106580-2

Circuit Symbol (Figs 14-7 &14-8	Description	Part Number
	CAPACITORS	
C14	Capacitor, ceramic, 560pF, 5%, 100V	0125 15615
C15	Capacitor, ceramic, 330pF, 10%, 200V	0130 2331
C16, 17, 25-28, 34, 35	Capacitor, ceramic dip , 0.1µF, 10%, 50V	0120 38
C18, 21	Capacitor, ceramic, 10pF, 10%, 200V	0125 21001
C19, 23, 24	Capacitor, ceramic, 0.0027µF, 5%, 100V	0125 12725
C20, 22	Capacitor, ceramic, 0.0012µF, 5%, 50V	0125 51225
C29, 30, 31, 32	Capacitor, ceramic, 0.0022µF, 5%, 100V	0125 12225
C33	Capacitor, ceramic, 270pF, 10%, 200V	0130 22711
	RESISTORS	
R8, 10, 40, 41	Resistor, metal film, axial, 10K, 1%, 1/4W	0410 1384
R9	Resistor, metal film, axial, 100Ω, 1%, 1/4W	0410 1192
R11	Resistor, metal film, axial, 18.7K, 1%, 1/4W	0410 1410
R12	Resistor, metal film, axial, 5.11K, 1%, 1/4W	0410 1356
R13	Resistor, metal film, axial, 604Ω, 1%, 1/4W	0410 1267
R14	Resistor, metal film, axial, 453Ω, 1%, 1/4W	0410 1255
R15	Resistor, metal film, axial, 3.83K, 1%, 1/4W	0410 1344
R16, 17	Resistor, metal film, axial, 5.76K, 1%, 1/4W	0410 1361
R18, 21, 35	Resistor, metal film, axial, 5.36K, 1%, 1/4W	0410 1358
R19, 33, 39	Resistor, metal film, variable, 1K, 10%, 1/2W	49995
R20	Resistor, metal film, axial, 2.26K, 1%, 1/4W	0410 1322
R22	Resistor, metal film, axial, 1.5K, 1%, 1/4W	0410 1305
R23, 29	Resistor, metal film, axial, 2.67K, 1%, 1/4W	0410 1329
R24	Resistor, metal film, axial, 2.43K, 1%, 1/4W	0410 1325
R25	Resistor, metal film, variable, 500Ω, 10%, 1/2W	94296
R26	Resistor, metal film, axial, 7.32K, 1%, 1/4W	0410 1371
R27	Resistor, metal film, axial, 1.69K, 1%, 1/4W	0410 1310
R28	Resistor, metal film, axial, 1.62K, 1%, 1/4W	0410 1308
R30, 31	Resistor, metal film, axial, 3.32K, 1%, 1/4W	0410 1338
R32	Resistor, metal film, axial, 2.87K, 1%, 1/4W	0410 1332
R34	Resistor, metal film, axial, 9.53K, 1%, 1/4W	0410 1382
R36, 37	Resistor, metal film, axial, 3.24K, 1%, 1/4W	0410 1337
R38	Resistor, metal film, axial, 2.61K, 1%, 1/4W	0410 1328
R42	Resistor, metal film, axial, 1K, 1%, 1/4W	0410 1288
R43	Resistor, metal film, variable, 50K, 10%, 1/2W	93667
R44	Resistor, metal film, zero ohm, 1/4W size	1510 2217
	MISCELLANEOUS COMPONENTS	
P1, 2	Connector assembly, PC board, 5 circuit	43171 5
TP3	Test point, terminal, orange	98441 3
U2	Integrated circuit, linear, OP AMP	0620 126
U3, 4	Integrated circuit, linear, JFET, OP AMP	0620 151
U5	Integrated circuit, linear, JFET, dual OP AMP	0620 155

Figure 14-9. Schematic, RFL 9785 Voice Filter (Dwg. No. D-106584-A)

Please see Figure 14-9 in Section 22: Schematics.

Section 15. CHECKBACK MODULE

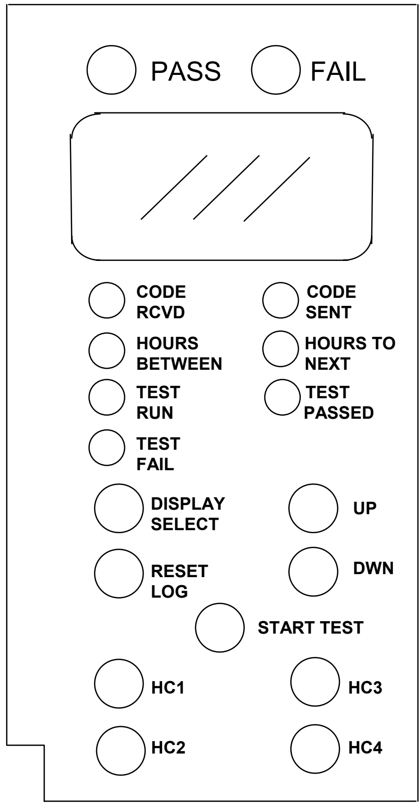


Figure 15-1. RFL 9785 Checkback Module, front panel view

15.1 DESCRIPTION

The RFL 9785 Checkback Module (Figure 15-1) is a microprocessor based checkback system. Control and logic signals are interfaced between the Checkback Module and the RFL 9785 system through the system mother board. The Checkback Module is also connected to the SOE Module or the Checkback Communications Module through the system motherboard. The user can communicate with the Checkback Module, if equipped, by using the RS-232 connector located on the RFL 9785 front panel, or by using the RS-232 connector located on the SOE I/O Module (RFL 9785 rear panel).

The front panel of the RFL 9785 Checkback Module serves as the local operator interface. It has pushbutton switches which allow the entry of operating parameters and control functions. A 3-digit LED display shows operating parameters, and LED annunciators display pertinent system data.

The Checkback Module can perform powerline carrier functionality testing on multi-terminal lines. Figures 15-2 through 15-4 are examples of multi-terminal configurations that can be tested by the Checkback Module.

Figure 15-2. Two-terminal line testing

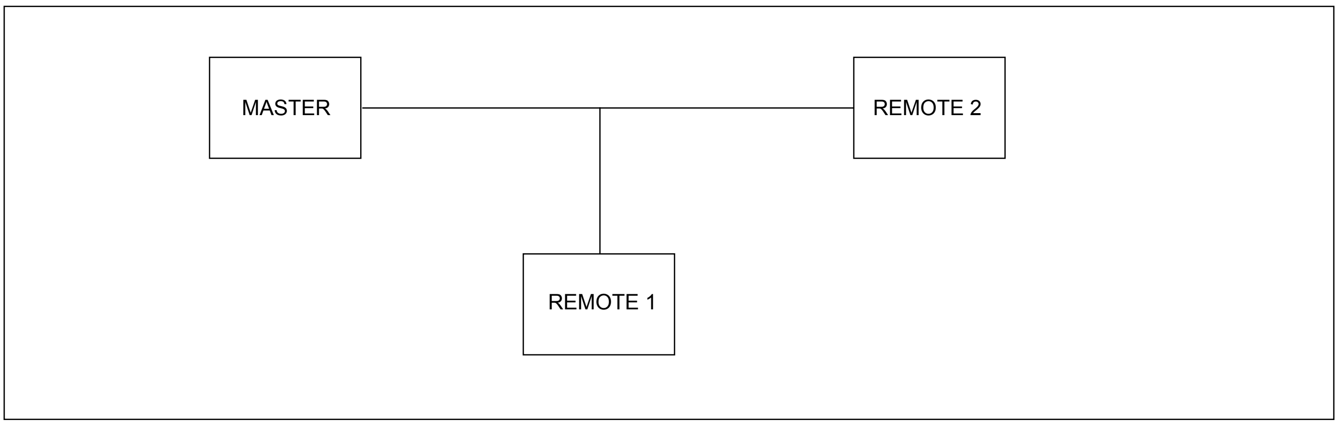


Figure 15-3. Three-terminal line testing

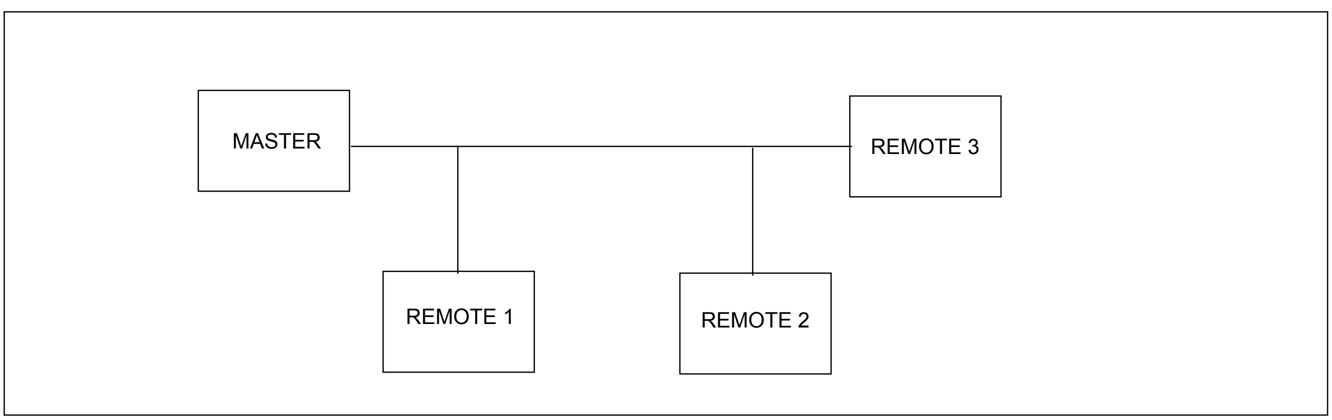


Figure 15-4. Four-terminal line testing

15.2 SPECIFICATIONS

As of the date this manual was published, the following specifications apply to all RFL 9785 Checkback modules. Because all RFL products undergo constant refinement and improvement, these specifications are subject to change without notice.

Codes: Capable of transmitting and receiving 16 asynchronous codes (01 through 16)

Test Log: Available through RS-232 port or optional Checkback Alarm Chassis (See Section 20)

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

15.3 TYPICAL CHECKBACK APPLICATION

A two-terminal line (Figure 15-5a) can be programmed with the RFL 9785 to perform the test sequence shown in Figure 15-5b. The Master station will initiate the test automatically once every 24 hours, starting 3 hours after the unit is programmed. Tests can also be initiated manually, or by external input. Each terminal is tested at both full-power and reduced-power levels, and each terminal can send a continuous carrier upon request from the other terminal (Figure 15-5c).

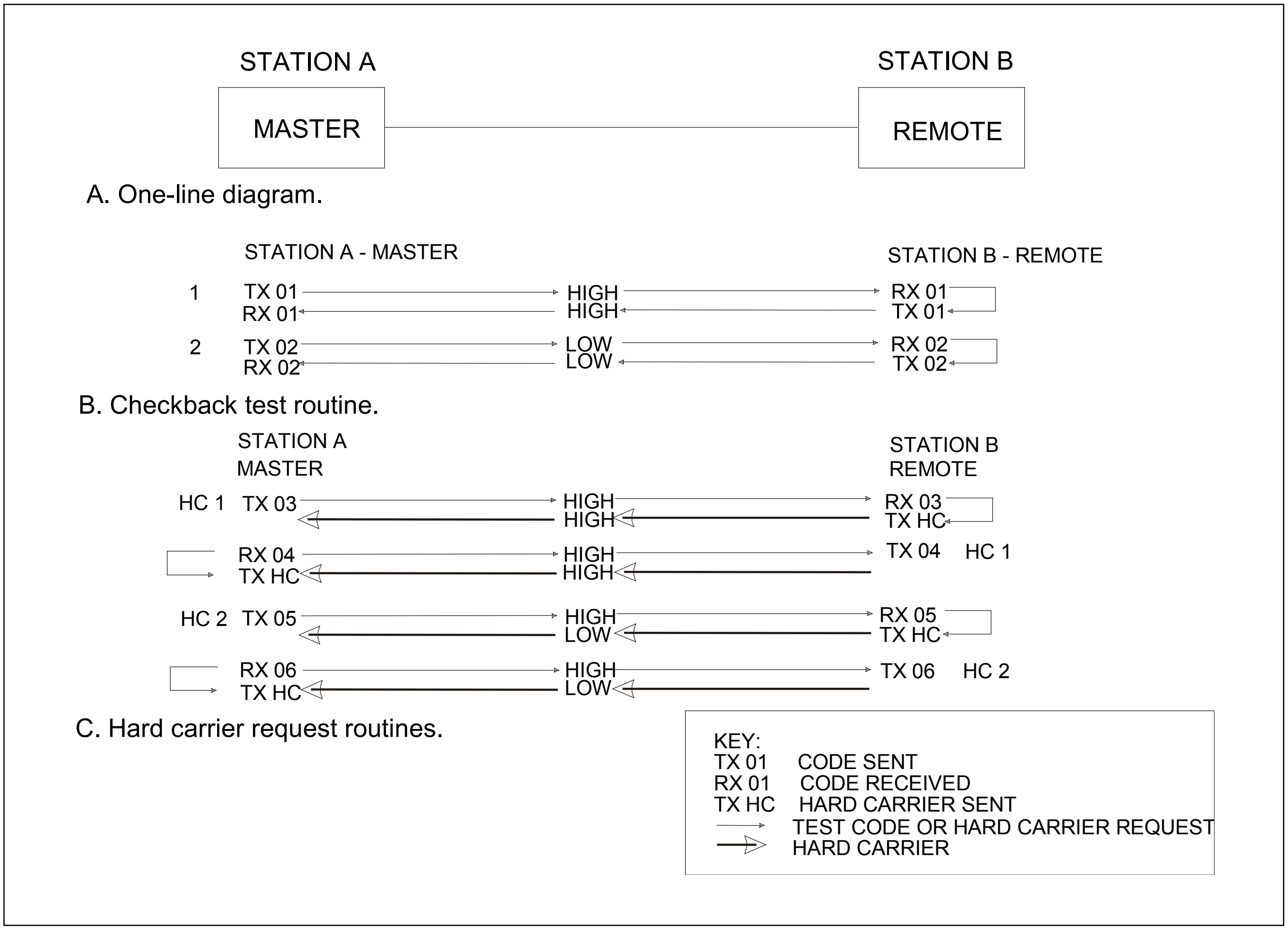


Figure 15-5. Checkback testing of typical two-terminal system

Figure 15-5b shows the checkback test routine used to test the two-terminal line shown in Figure 15-5a. This routine has two basic steps:

The Master sends Code 01 at full power (HIGH). The Remote receives Code 01, and sends Code 01 back at full power (HIGH).

The Master sends Code 02 at reduced power (LOW). The Remote receives Code 02, and sends Code 02 back to the Master at reduced power (LOW).

Four different hard carrier requests can be initiated, as shown in Figure 15-5c:

When the HC1 switch is pressed at the Master, Hard Carrier Request Code 03 is sent at full power. The Remote receives this code, and sends a continuous hard carrier back at full power.

When the HC1 switch is pressed at the Remote, Hard Carrier Request Code 04 is sent at full power. The Master receives this code, and sends a continuous hard carrier back at full power.

When the HC2 switch is pressed at the Master, Hard Carrier Request Code 05 is sent at full power. The Remote receives this code, and sends a continuous hard carrier back at reduced power.

When the HC2 switch is pressed at the Remote, Hard Carrier Request Code 06 is sent at full power. The Master receives this code, and sends a continuous hard carrier back at reduced power.

15.4 THEORY OF OPERATION

A block diagram of the RFL 9785 Checkback Module appears in Figure 15-6. Figure 15-20 is a component locator drawing and Figure 15-21 is a schematic diagram.

15.4.1 CPU AND MEMORY

U5 is the central processing unit (CPU) for the RFL 9785 Checkback Module. Its clock source is a 12-MHz oscillator formed from crystal Y2 and capacitors C26 and C27. A 64K EPROM U6, is used to store all program memory used by the CPU. An 8K static RAM U7, is used to store all user-entered operating parameters and system variables. A lithium battery inside U7 guards against data loss during power outages.

15.4.2 CPU I/O PORTS

CPU U5 has four I/O ports: Port 0 through Port 3.

Port 0 serves as a multiplexed, low-order address/data bus interface. During program memory fetches and data or I/O read/write operations, Port 0 first outputs the low-order address byte. It then reads or outputs the data byte to the bus (AD0 through AD7).

Port 1 is a general-purpose I/O interface. It is configured to input and output data and control signals to the Checkback Module. Port lines P1.0 through P1.3 are outputs, and P1.4 through P1.7 are inputs. Line P1.0 toggles at the end of each program pass to reset watchdog timer U3. Lines P1.1, P1.2 and P1.3 are row enable outputs for the front-panel pushbutton switch matrix. They pull low in sequence to enable each row of switches. Line P1.4, P1.5 and P1.6 are the column inputs for the 3 x 3 pushbutton switch matrix. These inputs are read when each row is enabled to determine which push button has been pressed. Line P1.7 is a spare input, whose state is determined by the position of strap J6.

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

Port 3 serves as an interface for several of the special features incorporated into the CPU. Line P3.0 is the Receive Data (RXD) input for U5's serial port, used for Head Slave/Slave communications. Line P3.1 is the Transmit Data (TXD) output for U5's serial port, which utilizes Mode 3 operation for Head Slave/Slave communications. It has one start bit, eight data bits, one parity bit, and one stop bit, at 9600 bps. Line P3.2 is the Communications Interrupt (/COMINT) input, generated when DUART U1 requires servicing. Line P3.6 is the write (/WR) output, line P3.7 is the read (/RD) output, and lines P3.3, P3.4, and P3.5 are not used in this application.

15.4.3 SERIAL PORT OPERATION

DUART U1 and its associated components control all RS-232 communications. U1 handles baud-rate generation, data formatting, handshaking, and Tx and Rx buffering so that a considerable burden is removed from the CPU. In addition, it provides a 9600-Hz clock on output line OP3, which is used for the shift register clock (SRCLK).

U1 occupies locations 4000H through 400FH on the memory-map. As such, the CPU handles read/write operations as though it were simply a RAM.

The serial data to/from the DUART is sent through the motherboard to the SOE Module. All user interface with the Checkback Module is performed through the SOE Module in the 9785 chassis. The connection between the two modules uses raw logic levels, rather than converting to RS-232 and back again. The RS-232 interface device (U4) is not utilized when the Checkback Module is used in a 9785 chassis.

15.4.4 EXTERNAL INPUTS

External inputs are interfaced to the RFL 9785 through DUART U1. All external inputs are provided with pull-up/down resistors, and RC noise filtering. After filtering, the inputs are connected to U1’s input lines IP1 through IP6.

When the CPU is ready to read input status, it enables U1 using address 400DH. The Read (/RD) line is pulled low, and the CPU places the status information on lines AD0 through AD7. When the bus has stabilized, the CPU reads the status in, and the sequence is completed.

15.4.5 CPU OUTPUTS

U2 is an XILINX XC95108 high-performance CPLD (Complex Programmable Logic Device) which is used to interface the Checkback outputs. The XC95108 is programmed as an address decoder, address latch, display latches and drivers, relay latches and drivers, shift register, flip-flops and logic gates. This includes 33 LED control lines, two status signals, and two lines which are used to drive MOSFETs Q1 and Q2 which drive the Test In Process (TIP) and Test Out relays.

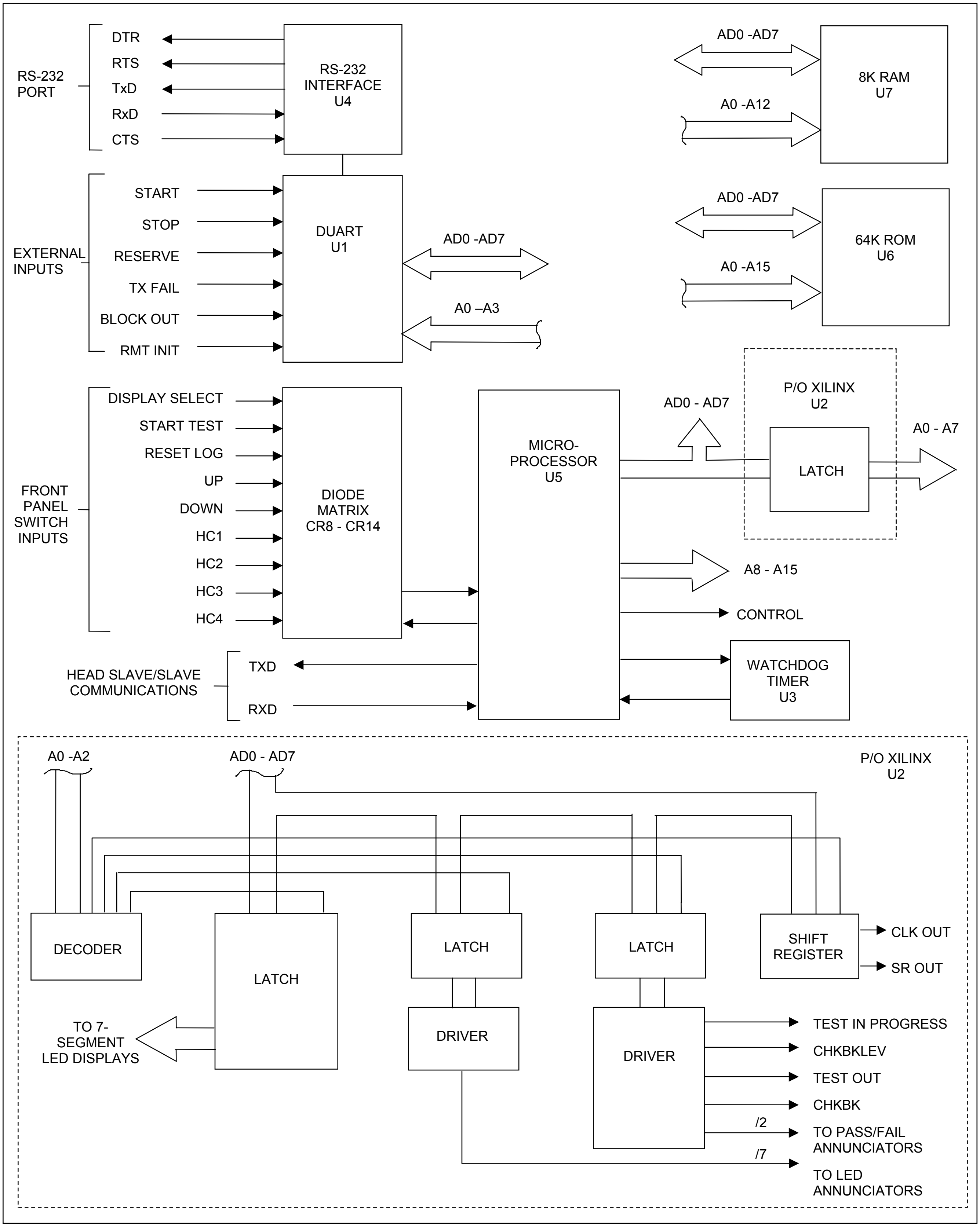


Figure 15-6. Block diagram, RFL 9785 Checkback module

15.5 CONTROLS AND INDICATORS

Figure 15-7 shows the location of all controls and indicators on the Checkback module front panel. Figure 15-8 shows the location of all controls and indicators on the Checkback module circuit board. These controls and indicators are described in Tables 15-1 and 15-2. LEDs DS1 through DS9 and switches SW1 through SW9 are accessible with the module installed in the chassis. All other controls are accessible when the module is removed from the chassis or is on a card extender.

Table 15-1. Controls and indicators, RFL 9785 Checkback Module front panel

Symbol	Description, Marking	Functional Description
DIG1 to DIG3	Seven-segment displays	Displays codes, numeric values, and “Err” error indications. “HC” will appear when one of the Hard Carrier Request switches is pressed and a hard carrier is being sent. “HCr” will appear when a hard carrier is being received. The information displayed is controlled by DISPLAY SELECT switch SW1. (See paragraph 15.6.1.1 for more information) All display segments will light momentarily in turn when power is applied to the module. This serves as a lamp test.
DS1	CODE RCVD indicator	Lights when the seven-segment display is showing the code number being received. Will flash when a valid code is received.
DS2	CODE SENT indicator	Lights when the seven-segment display is showing the code being sent.
DS3	HOURS BETWEEN indicator	Lights when the seven-segment display is showing the amount of time between automatic checkback tests. Can only be displayed on Master checkback modules.
DS4	HOURS TO NEXT indicator	Lights when the seven-segment display is showing the amount of time until the next automatic checkback test. Can only be displayed on Master checkback modules.
DS5	TEST RUN indicator	Lights when the seven-segment display is showing the number of tests run since the last time the test log was reset. Can only be displayed on Master checkback modules.
DS6	TEST PASSED indicator	Lights when the seven-segment display is showing the number of successful tests run since the last time the test log was reset. Can only be displayed on Master checkback modules.
DS7	TEST FAIL indicator	Lights when the seven-segment display is showing the number of test failures that have occurred since the last time the test log was reset. Can only be displayed on Master checkback modules.
DS8	PASS indicator	Lights if the system passed the last checkback test.
DS9	FAIL indicator	Lights if the system failed the last checkback test.
SW1	DISPLAY SELECT switch	Selects display mode. (See paragraph 15.6.1.1 for more information)
SW2	START TEST switch	Manually starts checkback test. (Tests can only be initiated at the Master.)
SW3	RESET LOG switch	Manually resets the test log. This sets the TESTS RUN, TESTS PASSED, and TESTS FAILED totals to zero.
SW4	UP switch	Increases value on display, one number, each time it is pressed.
SW5	DOWN switch	Decreases value on display, one number, each time it is pressed.
SW6	HC1 switch	Manually activates Hard Carrier 1 when pressed and held for five seconds.
SW7	HC2 switch	Manually activates Hard Carrier 2 when pressed and held for five seconds.
SW8	HC3 switch	Manually activates Hard Carrier 3 when pressed and held for five seconds.
SW9	HC4 switch	Manually activates Hard Carrier 4 when pressed and held for five seconds.

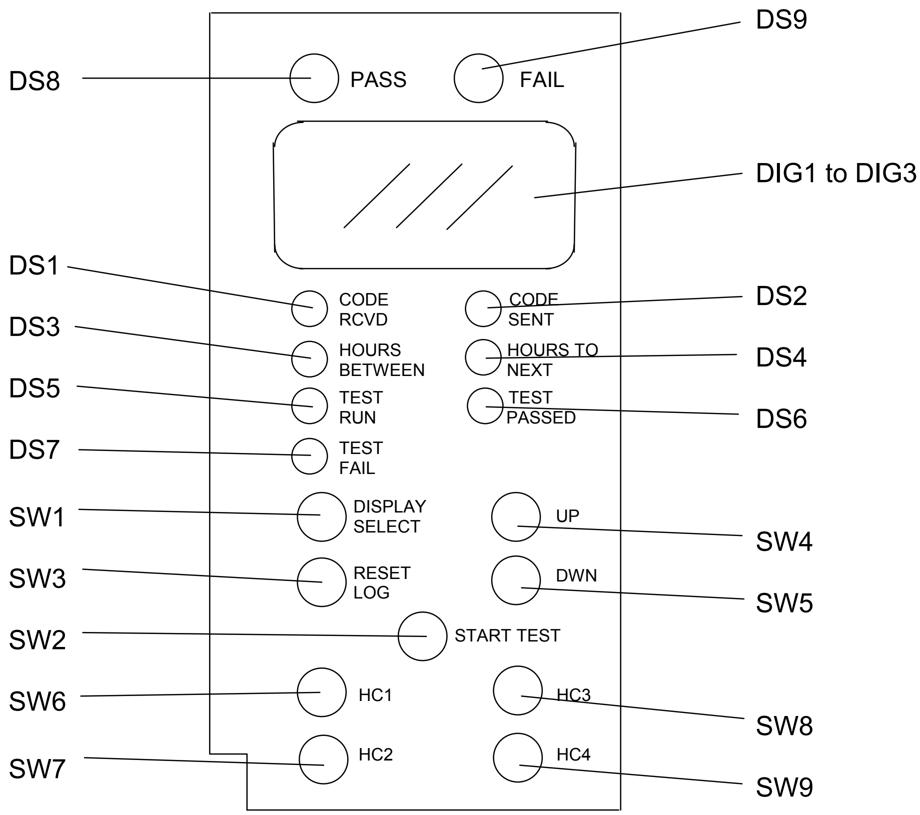


Figure 15-7. Controls and indicators, RFL 9785 Checkback module front panel

Table 15-2. Controls and indicators, RFL 9785 Checkback Module circuit board

Symbol	Description, Marking	Functional Description
J1	Connector header	XILINX test connector
J4	Connector header	For factory use only
J5	Jumper	Selects normal or test modes
J6	Jumper	Spare jumper
TP1	Test point	Clock out signal
TP2	Test point	Serial data out signal
TP3	Test point	Test in progress signal
TP4	Test point	Test out signal
TP5	Test point	Checkback signal
TP6	Test point	Checkback power level signal
TP7	Test point	Signal ground
TP8	Test point	Watchdog signal
TP9	Test point	RS-232 transmit data signal
TP10	Test point	RS-232 receive data signal

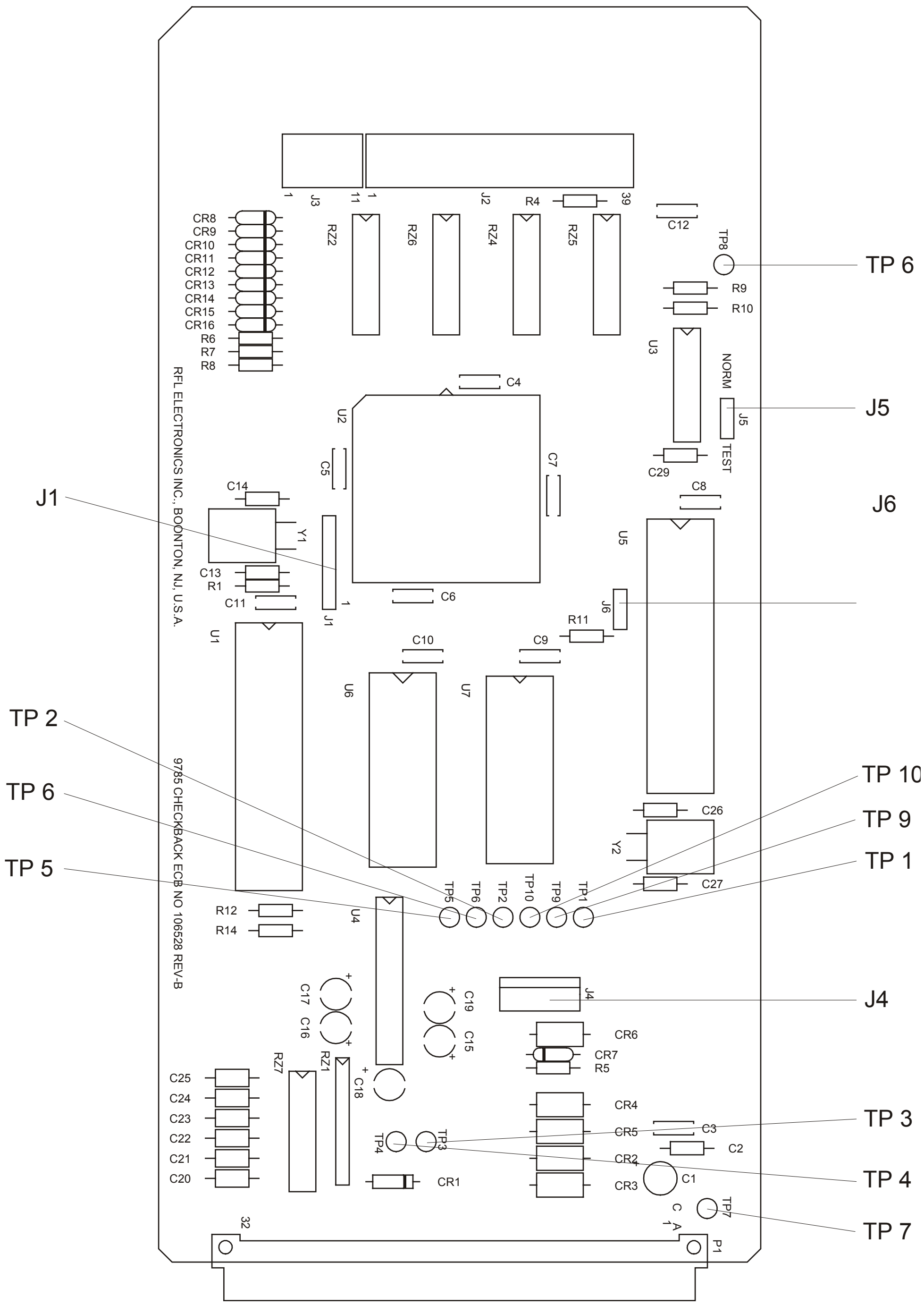


Figure 15-8. Controls and indicators, RFL 9785 Checkback module circuit board

15.6 CHECKBACK TESTING

The following paragraphs contain the instructions necessary for using the Checkback Module to test the RFL 9785. Instructions are also provided on programming the Checkback Module using APRIL (Asynchronous Programming and Remote Interrogation Language).

The Checkback Module's front panel contains controls and indicators that are used to initiate tests, monitor system functions during normal operation, initiate checkback tests, and reset the test log. These controls and indicators are shown in Figure 15-7, and described in Table 15-1.

15.6.1 OPERATING THE CHECKBACK MODULE BY USING THE FRONT-PANEL SWITCHES

The pushbutton switches on the front of the Checkback Module can be used to change display modes, set automatic checkback test times, run checkback tests manually, make hard carrier requests, and view checkback test results. All other Checkback Module functions must be accessed using a terminal or PC connected to the RS-232 connector on the RFL 9785's rear panel. See Section 13 for more information. The functions described below can also be performed through the rear-panel RS-232 connector.

15.6.1 1 CHANGING DISPLAY MODES

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

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

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

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

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

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

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

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

CODE SENT and CODE RCVD can be displayed at all checkback modules; the other modes can only be displayed at Master checkback modules. Most of these values are read-only, and cannot be changed by pressing front panel switches. The HOURS BETWEEN and HOURS TO NEXT values can be changed by using the procedure in paragraph 15.6.1.2.

15.6.1.2 SETTING AUTOMATIC TEST TIMES

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

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

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

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

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

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

3. Press and release the DISPLAY SELECT switch once.

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

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

The automatic test times are now set.

15.6.1.3 RUNNING CHECKBACK TESTS MANUALLY

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

15.6.1.4 MAKING HARD CARRIER REQUESTS

The HC1, HC2, HC3, and HC4 switches are used to make manual hard carrier requests. Each checkback can be programmed to send up to four hard carrier requests. (This programming must be done through the rear-panel RS-232 connector as described in paragraph 15.6.2.) If you press a switch for a hard carrier that has not been programmed, an "Err" error message will appear on the seven-segment display.

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

15.6.1.5 VIEWING CHECKBACK TEST RESULTS

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

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

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

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

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

15.6.1.6 RESETTING THE TEST LOG

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

NOTE

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

15.6.2 ACCESSING THE CHECKBACK MODULE FROM PC OR TERMINAL

You can use the RFL 9785's RS-232 port to access the Checkback Module from a dumb terminal or a personal computer equipped with a terminal emulator. If your RFL 9785 is equipped with an SOE Module, the Checkback Module can be accessed via an APRIL "W" command as described in paragraph 13.11. Once connected, you can use APRIL (**A**synchronous **P**rogramming and **R**emote **I**nterrogation **L**anguage) to view a list of parameter settings, change parameter settings as required, monitor system operation, or initiate checkback tests. Because APRIL is menu-based, you do not have to memorize the commands. Help screens can always be displayed by pressing the [H] and [ENTER] keys.

If your RFL 9785 is equipped with an SOE Module, the PC communicates with the SOE Module, and the SOE Module communicates with the Checkback Module using the APRIL "W" (window) command. If your RFL 9785 is equipped with a Checkback Comms Module instead of an SOE Module, the PC communicates directly with the Checkback Module, and the "W" command is not required.

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

For more information on connecting a PC or terminal to the RS-232 port, refer to Section 13 of this manual.

15.6.2.1 VIEWING APRIL COMMANDS

Once you have connected a terminal to the RFL 9785's RS-232 port (either directly or through an RFL 9660), press the [ENTER] key a few times. The Checkback Module will send the following prompt to your terminal:

9785CB>

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

9785CB>H [ENTER]

This tells the Checkback Module to send a list of APRIL commands to your terminal. A typical APRIL command list appears in Figure 15-9.

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

Command	Meaning	Paragraph
H	Display the main menu	15.6.2.2
A	Go to the alarms display	15.6.2.3
V	Go to the values display	15.6.2.4
P	Go to the programming menu	15.6.3
D	Go to the read settings menu	15.6.2.5
F	Go to the configure and software version display	15.6.2.6
T	Go to the test menu	15.6.4
U	Enter the update mode	15.6.2.7
X	Exit the update mode	15.6.2.7

```
RFL Electronics APRIL Remote Communications, Version 2.2 © 1993, 1998

H – Display the main menu
A – Go to the alarms display
V – Go to the values display
P – Go to the programming menu (password required)
D – Go to the read settings menu
F – Go to the configuration and software version display
T – Go to the test menu
U – Enter the update mode
X – Exit the update mode
9785CB>
```

Figure 15-9. APRIL commands for use with Checkback Module

15.6.2.2 DISPLAY

To view the current status of all Checkback Module alarms, enter the “A” command.

Format: 9785CB>A [ENTER]

The “A” command tells the Checkback Module to send a copy of the alarms display to your terminal. A typical alarm display is shown in Figure 15-10.

```
#    ALARM         STATUS (I/A       #    ALARM         STATUS (I/A)
----------------------------         ----------------------------
010  Tx Fail            A            011  Test Fail          I
012  Remote Alarm
9785CB> _
```

Figure 15-10. Typical alarm display

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

010 - Tx Fail
The RFL 9785 system being tested by the Checkback Module has failed to transmit a block.

011 - Test Fail
The last checkback test failed.

012 - Remote Alarm
Remote has not received a checkback test > 24 hours.

15.6.2.3 VIEWING THE VALUES DISPLAY

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

Format: 9785CB>V [ENTER]

The “V” command tells the Checkback Module to send a current copy of the parameter values to your terminal. A typical values display is shown in Figure 15-11.

```
#          DESCRIPTION           VALUE
---------------------------------------------------------------
001        Start Keyed           Inactive
002        Stop Keyed            Inactive
003        Reserve Keyed         Inactive
004        Block Received        Inactive
005        ChkBk Output          Inactive
006        Tests Since Rst       1
007        Tests Passed          1
008        Tests Failed          0
009        Last Failed           00
010        Last Rx Code          00
011        Hours To Next         3
9785CB>
```

Figure 15-11. Typical values display

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

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

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

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

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

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

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

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

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

15.6.2.4 VIEWING THE PARAMETER SETTINGS DISPLAY

The “D” command tells the Checkback Module to send a list of all parameter settings to your terminal. This list of settings is called the “read settings” menu.

Format: 9785CB>D [ENTER]

A typical read settings menu appears in Figure 15-12. All the currently-active parameter settings but you can’t change the displayed values. To change these values, you will have to enter the programming mode. See paragraph 15.6.3 for more information. The programming mode is password-protected, so only authorized persons can change the Checkback Module’s parameter settings.

#	PARAMETER	SETTING		#	PARAMETER	SETTING	
999	System Label	Station A					
020	Mode	Master		021			
022	Hard Tx 1	03		023	Hard Tx 2	05	
024	Hard Tx 3	00		025	Hard Tx 4	00	
026	Low Rx HC	06		027	High Rx HC	04	
028	HC Duration	30 sec		029	Hours Between	24	
030	Response Time	20 sec		031	Hours To Next	03	
032	Reset Log	No		033	Chassis Type	85P	
		Code	Power	Response			
034	Test One	01	H	01			
035	Test Two	02	L	02			
036	Test Three	00	H	00			
037	Test Four	00	L	00			
038	Test Five	00	H	00			
039	Test Six	00	L	00			
040	Test Seven	00	H	00			
041	Test Eight	00	L	00			
	Printer Triggers						
050	Receive Block	Inactive		051	Lose Block		Inactive
052	Test Fail	Active		053	Transmit Fail		Inactive
9785CB>							

(Note: 00 indicates parameter not programmed)

Figure 15-12. Typical read settings menu

15.6.2.5 VIEWING CONFIGURATION AND SOFTWARE INFORMATION

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

Format: 9785CB>F [ENTER]

A typical configuration and software version display is shown in Figure 15-13.

```
9785    Checkback Configuration:
060     Version         1.4
9785CB>
```

Figure 15-13. Typical configuration and software version display

15.6.2.6 THE UPDATE MODE

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

Format: 9785CB>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 15-14. This display is updated about once every two seconds. This screen can be used to monitor Checkback Module operation.

```
Value Update – Type ‘X<CR>’ to Stop
001  Start Keyed          Inactive
002  Stop Keyed           Inactive
003  Reserve Keyed        Inactive
004  Block Received       Inactive
005  ChkBk Output         Inactive
006  Tests Since Rst      1
007  Tests Passed         1
008  Tests Failed         0
009  Last Failed          00
010  Last Rx Code         00
011  Hours To Next        3
```

Figure 15-14. Typical UPDATE screen

To exit the update mode, press the [X] key, followed by the [ENTER] key. The screen on your terminal will be cleared, and the “9785CB>” prompt will re-appear.

15.6.3 PROGRAMMING THE CHECKBACK MODULE WITH PC OR TERMINAL

You can use APRIL and your terminal to program the Checkback Module by using the “P” command.

Format: 9785CB>P [ENTER]

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

9785CB> enter password:

Either enter the super-user password (“BCCE”) or the programming password that has been stored in the Checkback Module’s memory. The Checkback Module gives you three chances to enter the correct password. After the third incorrect password is entered, the Checkback Module enters a lock-out mode. This mode will last for about ten minutes, during which you will not be able to enter the programming mode.

If the proper password is entered, a programming menu similar to the one shown in Figure 15-15 will appear.

You are now in the programming mode, as indicated by the “9785CB-P>” prompt on your screen. You may now use the programming commands to re-program the Checkback Module. For more information on each programming command, refer to the paragraph number listed below next to the command.

```
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
9785CB-P> _
```

Figure 15-15. Typical programming menu

Command	Meaning	Paragraph
H	Display programming help	15.6.3
Q	Leave programming menu	15.6.3.4
SV	Save new setting	15.6.3.3
C	Change password	15.6.3.1
D	Display current settings and parameter numbers	15.6.3.2

15.6.3.1 CHANGING THE PROGRAMMING PASSWORD

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

Format: 9785CB-P>C [ENTER]

When you enter the "C" command, the Checkback Module sends the following prompt to your terminal:

enter super-user:

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

Current password is (current password)
enter new password:

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

repeat new password:

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

password modified

The new password is now stored in the Checkback Module's non-volatile RAM memory.

15.6.3.2 DISPLAYING PARAMETER SETTINGS

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

Format: 9785CB-P>D [ENTER]

When you enter the "D" command, the Checkback Module sends a list of all current parameter settings to your terminal. Typical parameter setting lists for the two Checkback Module configuration modes available when installed in an RFL 9785 (Master and Remote) are shown in Figures 15-16 and 15-17.

The following parameters appear on each parameter setting list:

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

020 - Mode
This parameter sets the configuration mode for the checkback module being programmed. Two settings are possible when the Checkback Module is installed in an RFL 9785: M (Master) and R (Remote). The Checkback Module's other two configuration modes (Head Slave and Slave) cannot be used when it is installed in an RFL 9785.

021 - Slave Number (Slave only)
This parameter is only used at Slave checkback modules. Since Parameter #20 (Mode) can only be set to "M" or "R" at Checkback Modules installed in an RFL 9785, this parameter is automatically set to "N/A."

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

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

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

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

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

027 - High Rx HC

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

028 - HC Duration

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

#	PARAMETER	SETTING		#	PARAMETER	SETTING
999	System Label	Station A				
020	Mode	Master		022	Hard Tx 1	03
023	Hard Tx 2	05		024	Hard Tx 3	00
025	Hard Tx 4	00		026	Low Rx HC	06
027	High Rx HC	04		028	HC Duration	30 sec
029	Hours Between	24		030	Response Time	20 sec
031	Hours To Next	03		032	Reset Log	No
033	Chassis Type	85P				
		Code	Power	Response		
034	Test One	01	H	01		
035	Test Two	02	L	02		
036	Test Three	00	L	00		
037	Test Four	00	L	00		
038	Test Five	00	L	00		
039	Test Six	00	L	00		
040	Test Seven	00	L	00		
041	Test Eight	00	L	00		
	Printer Triggers					
050	Receive Block	Inactive		051	Lose Block	Inactive
052	Test Fail	Inactive		053	Transmit Fail	Inactive
055	Test OK Pulse	No				
9785CB-P>						

Figure 15-16. Typical unprogrammed parameter settings list – Master Mode

#	PARAMETER	SETTING	#	PARAMETER	SETTING
999	System Label	Station A			
020	Mode	Remote	022	Hard Tx 1	03
023	Hard Tx 2	05	024	Hard Tx 3	00
025	Hard Tx 4	00	026	Low Rx HC	06
027	High Rx HC	04	028	HC Duration	30 sec
032	Reset Log	No	033	Chassis Type	85P

		Incoming	Response	Power
034	Test One	01	01	H
035	Test Two	02	02	L
036	Test Three	00	00	L
037	Test Four	00	00	L
038	Test Five	00	00	L
039	Test Six	00	00	L
040	Test Seven	00	00	L
041	Test Eight	00	00	L

Printer Triggers

050	Receive Block	Inactive	051	Lose Block	Inactive
052	Test Fail	Inactive	053	Transmit Fail	Inactive
054	Rem Alarm Enable	No			

9785CB-P>

Figure 15-17. Typical unprogrammed parameter settings list – Remote Mode

029 - Hours Between (Master only)

This parameter sets the amount of time between automatic checkback tests. This can be set from one to 24 hours, in one-hour increments, and can only be set at the Master checkback module. A value of 0 is used to disable automatic testing.

030 - Response Time (Master only)

This parameter sets the amount of time the Master checkback module will wait for a response from a remote terminal before declaring a test failure. This can be set from 1 second to 255 seconds in one-second increments, and can only be set at the Master checkback module. Most systems should operate properly with the response time set to 10 seconds.

031 - Hours To Next (Master only)

This parameter indicates the amount of time until the next automatic checkback test. Once it is initially set, this parameter's value is calculated, based on the setting of Parameter #29 (Hours Between). Its range is from 0 (run test immediately) to the value of Hours Between.

032 - Reset Log

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

033 - Chassis Type

This parameter must be set according to the type of chassis housing the checkback module being programmed. When housed in an RFL 9785 chassis, this parameter must be set to “85P.”

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

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

050 - Receive Block

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

051 - Lose Block

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

052 - Test Fail

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

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

053 - Transmit Fail

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

This parameter can only be set at checkback modules housed in RFL 9785 chassis.

054 - Rem Alarm Enabled (Remote only)

When set to Yes, an alarm and test failure relay will happen if >24 hours occurs between receiving a test request.

055 - Test OK Pulse (Master Only)

Test failure relay will remain in failure position except for a ten second pulse after a successful test.

To re-program any of the values shown on the parameter settings list, type in the number in the "#"column, and then press [ENTER]. The parameter will be displayed, with information about its setting below it. Type in the new setting, and then press [ENTER].

EXAMPLE:

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

9785CB-P> 20 [ENTER]

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

020 Mode Master
[M,R]>

The values allowed for this parameter appear between brackets; in this case, "M" for Master, "R" for Remote. To set the configuration to Remote, type in "R" and then press [ENTER]. The "Mode" parameter will be re-displayed, set to the new value.

020 Mode Remote

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

EXAMPLE:

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

9785CB-P> 52 [ENTER]

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

052 Test Fail Active
[Y:N]> _

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

052 Test Fail Inactive

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

EXAMPLE:

To change the System Label, type in the following:

9785CB-P> 999 [ENTER]

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

999 System Label
[any string]> _

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

999 System Label SUBSTATION 12

15.6.3.3 SAVING NEW SETTINGS

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

Format: 9785CB-P>SV [ENTER]

The “SV” command tells the Checkback Module to store all the changes in its non-volatile RAM memory. Once the changes are stored, the “9785CB-P>” prompt will re-appear.

Before you enter the “SV” command, the Checkback Module 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 15.6.3.2 of this section.)

15.6.3.4 LEAVING THE PROGRAMMING MODE

Whenever you are finished programming the Checkback Module, use the “Q” command:

Format: 9785CB-P>Q [ENTER]

The “Q” command tells the Checkback Module to leave the programming mode. The list of APRIL commands in Figure 15-10 will reappear, with the normal “9785CB>” prompt beneath it. If you changed any setting while in the programming mode, be sure to use the “SV” command described in paragraph 15.6.3.3 to save the changes before invoking the “Q” command; otherwise, your changes will be lost. To return to the 9785> prompt, enter three capitol “X’s” as described in paragraph 13.11.

Format: W_9785>XXX (do not press [ENTER KEY].

15.6.4 INITIATING TESTS WITH A PC OR TERMINAL

You can use APRIL and your terminal to initiate Checkback Module checkback tests. All test functions that are normally done using the pushbutton switches on the Checkback Module’s front panel can be done using a terminal. To use your PC or terminal to initiate tests, use the “T” command.

Format: 9785CB>T [ENTER]

The “T” command tells the Checkback Module to send a list of all test commands to your terminal. Since using the test commands will affect how the protection system operates, the “T” command is password-protected. When you enter the “T” command, the following prompt appears:

9785CB> enter password:

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

If the proper password is entered, a test menu similar to the one shown in Figure 15-18 will appear.

You are now in the test mode, as indicated by the "9785CB-T>" prompt on your screen. You may now use the test commands to initiate Checkback Module checkback tests. For more information on each testing command, refer to the paragraph number listed below next to the command.

Command	**Meaning**	**Paragraph**
H	Display test menu help	15.6.4.2
Q	Leave test menu	15.6.4.3
C	Change password *	15.6.4.1
T	Re-display tests (and select for running)	15.6.4.2

*- Superuser authorization required.

15.6.4.1 CHANGING THE TEST PASSWORD

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

Format: 9785CB-T>C [ENTER]

When you enter the "C" command, the Checkback Module sends the following prompt to your terminal:

enter super-user:

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

Current password is (current password)
enter new password:

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

repeat new password:

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

password modified

The new password is now stored in the Checkback Module's non-volatile RAM memory.

15.6.4.2 RUNNING TESTS

To run one or more Checkback Module tests, use the "T" command.

Format: 9785CB-T>T [ENTER]

When you enter the "T" command, the Checkback Module sends a list of all possible test routines to your terminal. A typical test routine list is shown in Figure 15-19.

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

060 - Key Carrier Low Power	This routine energizes the reduced-power output.
061 - Key Carrier High Power	This routine energizes the full-power output.
062 - Run Test Sequence	This routine initiates the checkback test sequence.
063 - Send Code #	This routine causes a specific code to be sent.
064 - Key Hard Carrier #1	This routine initiates Hard Carrier 1.
065 - Key Hard Carrier #2	This routine initiates Hard Carrier 2.
066 - Key Hard Carrier #3	This routine initiates Hard Carrier 3.
067 - Key Hard Carrier #4	This routine initiates Hard Carrier 4

```
H – Display test menu help
Q – Leave test menu
C – Change password (superuser authorization required)
T – Redisplay tests
## - Run this test
9785CB-T>
```

Figure 15-18. Typical test menu

```
  #   DESCRIPTION
------------------------------
060  Key Carrier Low Power
061  Key Carrier High Power
062  Run Test Sequence
063  Send Code  #
064  Key Hard Carrier  #1
065  Key Hard Carrier  #2
066  Key Hard Carrier  #3
067  Key Hard Carrier  #4
9785CB-T>
```

Figure 15-19. Typical test routine list

15.6.4.3 LEAVING THE TEST MODE

Whenever you are finished running checkback tests, use the "Q" command:
Format: 9785CB-T>Q [ENTER]

The "Q" command tells the Checkback Module to leave the test mode. The list of APRIL commands in Figure 15-9 will reappear, with the normal "9785CB>" prompt beneath it.

15.6.4.4 RETURNING TO NORMAL CHECKBACK MODULE OPERATION

Once you are finished accessing the Checkback Module using APRIL, make sure you have returned to the "9785CB>" prompt:

1. If you were in the Test Mode, press the [Q] and [ENTER] keys to return to the "9785CB>" prompt.

2. If you were in the Update Mode, press the [X] and [ENTER] keys to return to the "9785CB>" prompt.

When the "9785CB>" prompt is displayed, simply disconnect your PC or terminal from the Checkback Module's RS-232 connector. If you accessed the Checkback Module through an RFL 9660 Digital Switch, type in the deselect code (normally "BYE") to deselect the port, and then enter the "Q" command to terminate the session. (Refer to the RFL 9660 Instruction Manual for more information.)

Table 15-3. Replaceable parts, RFL 9785 Checkback module
Assembly No. 106525

Circuit Symbol (Figs 15-20 & 15-21)	**Description**	**Part Number**
	CAPACITORS	
C1	Capacitor, electrolytic, 47uF, 20%, 35V	1007 1578
C2	Capacitor, ceramic, 0.01uF, 10%, 50V	0130 51031
C3-12	Capacitor, ceramic DIP, 0.1uF, 10%, 50V	0120 38
C13, 14	Capacitor, ceramic, 10pF, 10%, 200V	0125 21001
C15-19	Capacitor, tantalum, 4.7uF, 10%, 20V	1007 1458
C20-25	Capacitor, ceramic, 0.0056uF, 5%, 100V	0125 15625
C26, 27	Capacitor, ceramic, 33pF, 5%, 200V	0125 23305
C29	Capacitor, ceramic, 120pF, 5%, 200V	0125 21215
	RESISTORS	
R1	Resistor, metal film, axial, 499K, 1%, 1/4W	0410 1547
R2, 3	Resistor, metal film, axial, 10K, 1%, 1/4W	0410 1384
R4	Resistor, metal film, axial, 137Ω, 1%, 1/4W	0410 1205
R5	Resistor, metal film, axial, 3.01K, 1%, 1/4W	0410 1334
R6-8, 11	Resistor, metal film, axial, 47.5K, 1%, 1/4W	0410 1449
R9, 10	Resistor, metal film, axial, 4.99K, 1%, 1/4W	0410 1355
R12-14	Resistor, metal film, axial, 20K, 1%, 1/4W	0410 1413
RZ1	Resistor, network, 22K, 8R/pkg, SIP	32876
RZ2	Resistor, network, 330Ω, 8R/pkg, DIP	44532
RZ4-6	Resistor, network, 680Ω, 8R/pkg, DIP	101651
RZ7	Resistor, network, 10K, 8R/pkg, DIP	27371

Table 15-3. - continued. Replaceable parts, RFL 9785 Checkback module

Circuit Symbol (Figs 15-20 & 15-21	Description	Part Number
	SEMICONDUCTORS	
CR1	Diode, Schottky, 1A, 20V, 1N5817	30150
CR2-6	Suppressor, transient, voltage, P6KE16CA	100572
CR7-16	Diode, silicon, 1N914B/1N4448	26482
Q1, 2	Transistor, VMOS, FET, VN10KM	0715 13
U1	Integrated circuit, MOS, DUART	0615 392
U3	Integrated circuit, peripheral, micro-processor, supervisor	0635 31
U4	Integrated circuit, interface, 5V, RS-232, line driver	0680 17
U5	Integrated circuit, MOS, micro-controller,	0615 357
U6	Integrated circuit, MOS, EPROM, 64K x 8, 70ns	0615 452
U7	Integrated circuit, non-volatile, SRAM, 8K x 8	0630 67
	MISCELLANEOUS COMPONENTS	
DIG1-3	Opto device, display, 5082-7651	102412
DS1-7, 9	Opto device, LED, red	38939
DS8	Opto device, LED, green	101468
J1	Connector, header, single, 7 CKT	32802 7
J2	Connector, housing, 40 CKT, DUAL, FEM	101667 40
J3	Connector, housing, 12 CKT, DUAL, FEM	101667 12
J4	Connector, wafer assembly, 6 CKT	97223 6
J5, 6	Connector, header, single, 3 CKT	32802 3
P1	Connector, JK male, 64 contact, DIN	98457
P2	Connector, header, dual, 20/40 CKT	101665 40
P3	Connector, header, dual, 6/12 CKT	101665 12
TP1-10	Test point, terminal, orange	98441 3
SW1-9	Switch, pushbutton, PC mounting	101655
Y1	Crystal, 3.6864 MHz	99215 12
Y2	Crystal, 12 MHz	99215 3

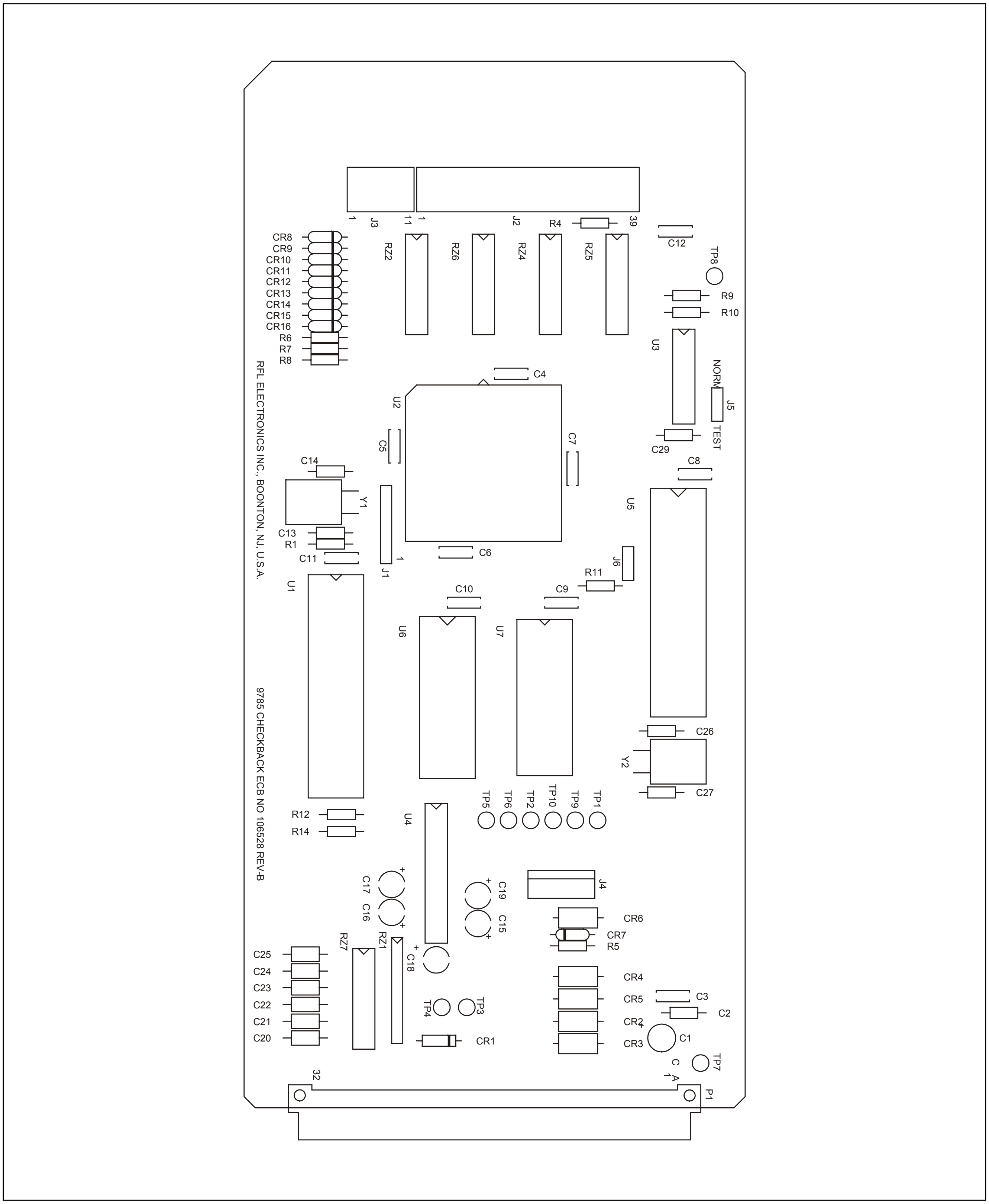


Figure 15-20. Component locator drawing, RFL 9785 Checkback module

Figure 15-21. Schematic, RFL 9785 Checkback (Dwg. No. D-106529-A) Sheet 1 of 3

Figure 15-21. Schematic, RFL 9785 Checkback (Dwg. No. D-106529-A) Sheet 2 of 3

Figure 15-21. Schematic, RFL 9785 Checkback (Dwg. No. D-106529-A) Sheet 3 of 3.

Please see Figure 15-21 in Section 22: Schematics.

Section 16. CHECKBACK COMMUNICATIONS MODULE

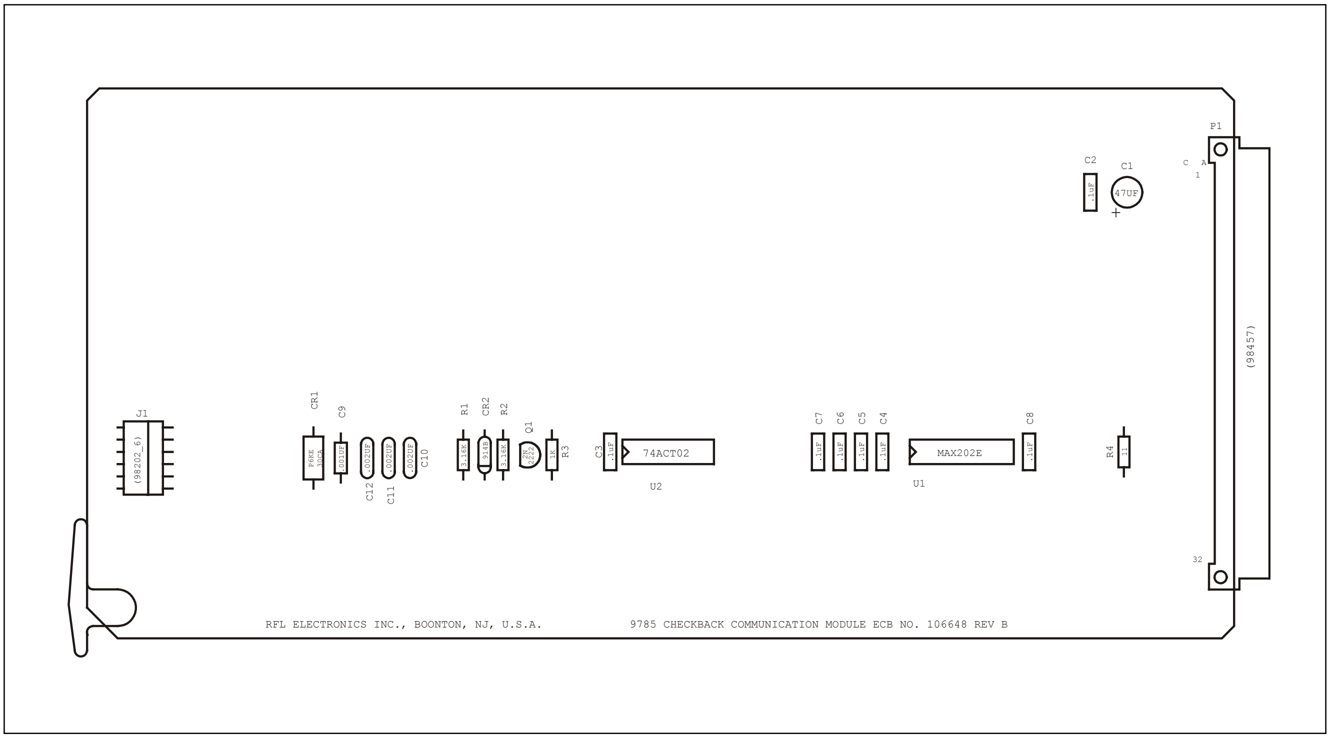


Figure 16-1. RFL 9785 Checkback Communications Module

16.1 INTRODUCTION

The Checkback Communications Module is only used in chassis that have a Checkback Module and no SOE Module. In this case, the Checkback Communications Module is installed in the same slot that the SOE module would have occupied. This module allows a PC to communicate directly with the Checkback module, without having to go through the SOE module. Refer to paragraph 15.6.2 for more information.

Table 16-1. Replaceable parts, RFL 9785 Checkback Communications Module
Assembly No. 106645

Circuit Symbol (Figs. 16-2 & 16-3)	Description	Part Number
C1	Capacitor, electrolytic, 47uF, 20%, 35V	1007 1578
C2-8	Capacitor, ceramic dip, 0.1uF, 10%, 50V	0120 38
C9	Capacitor, ceramic, 0.001uF, 10%, 100V	0130 11021
C10, 11, 12	Capacitor, ceramic disc, 0.002uF, 20%, 1kV	1007 942
CR1	Suppressor, transient voltage, P6KE30CA	100567
CR2	Diode, silicon, 1N914B/1N4448	26482
J1	Connector, wafer assembly, right angle, 6-circuit	98202 6
R1, 2	Resistor, metal film, axial, 3.16K, 1%, 1/4W	0410 1336
R3	Resistor, metal film, axial, 1K, 1%, 1/4W	0410 1288
P1	Connector, JK male, 64 contact, DIN	98457
Q1	Transistor, silicon, NPN, 2N2222A	37445
U1	Integrated circuit, RS232 driver/receiver	0680 29
U2	Integrated circuit, MOS, quad 2-input NOR gate	0615 376

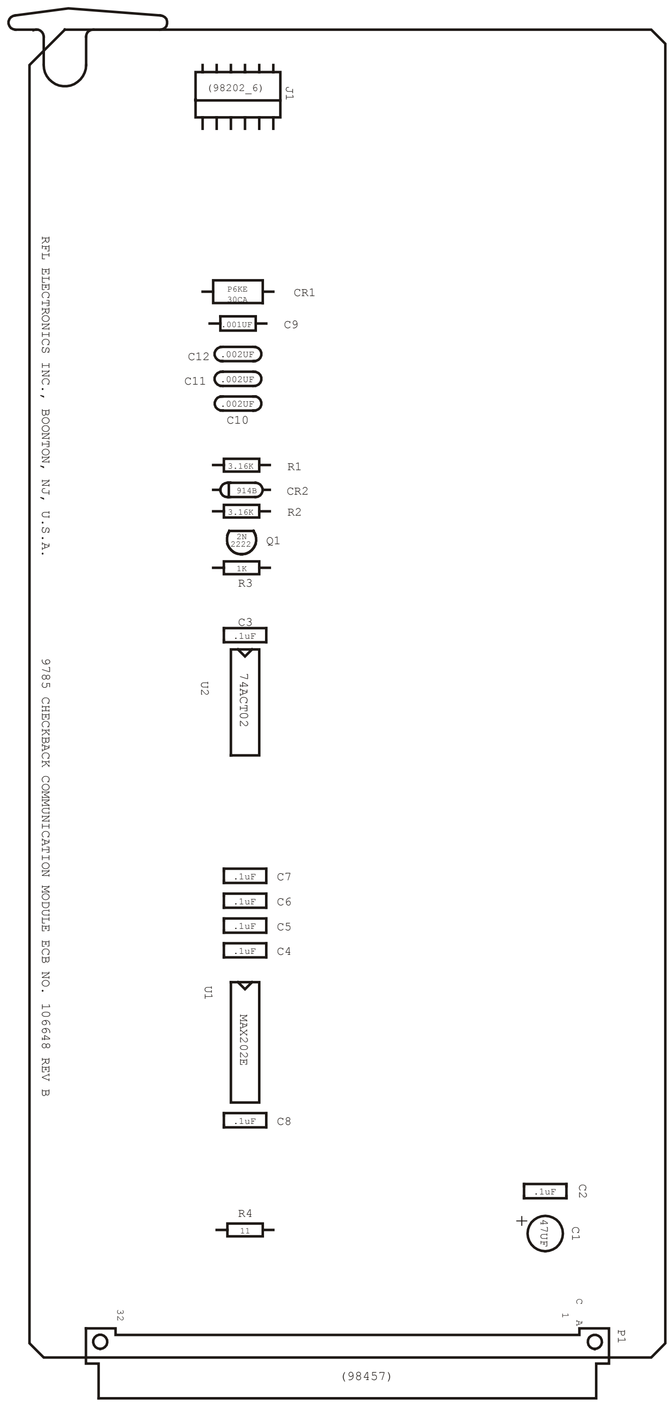
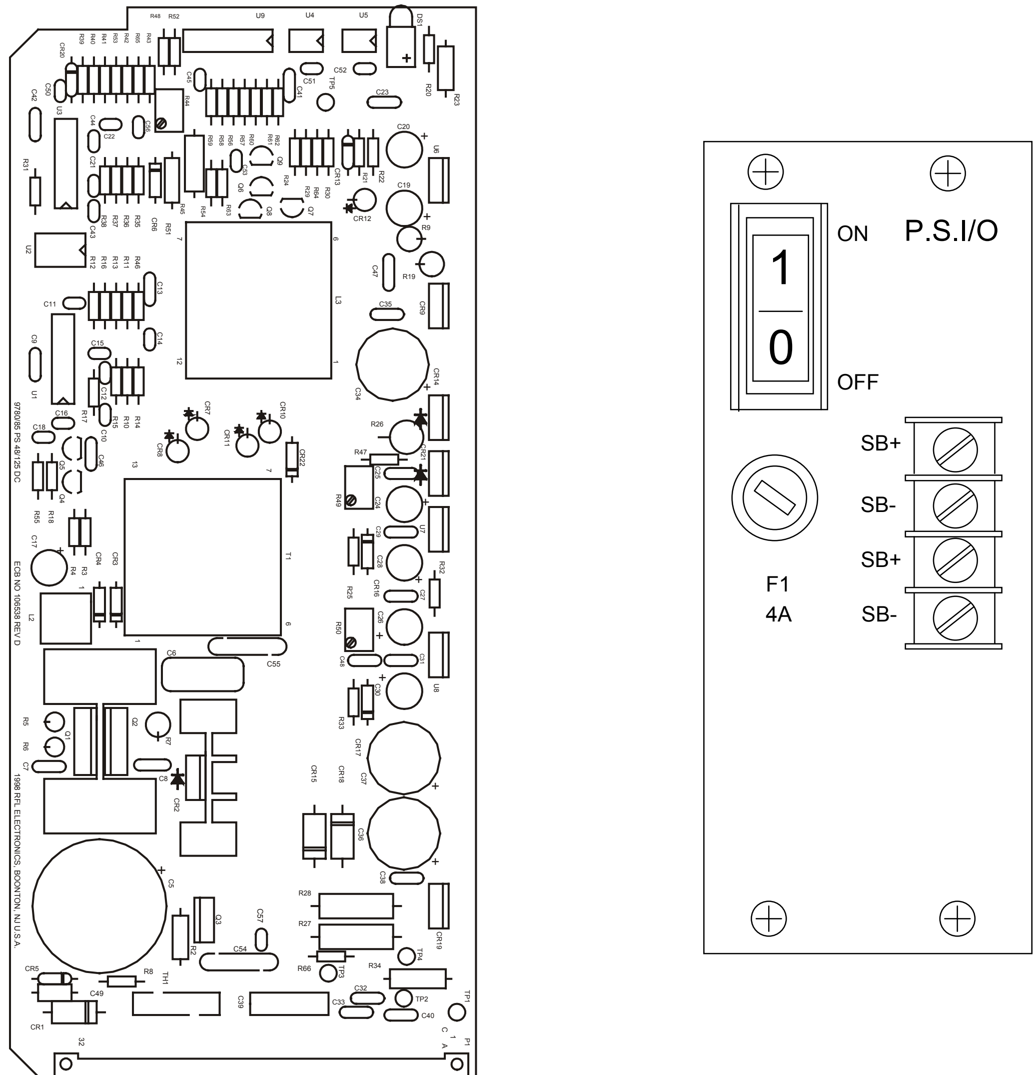


Figure 16-2. Component locator drawing, RFL 9785 Checkback Communications Module

Figure 16-3. Schematic, RFL 9785 Checkback Communications Module (Dwg. No. C-106649-A)

Please see Figure 16-3 in Section 22: Schematics.

Section 17. POWER SUPPLY MODULE & POWER SUPPLY I/O MODULE



a. Typical RFL 9785 Power supply module

b. Typical RFL 9785 Power supply I/O module

Figure 17-1. RFL 9785 Power Supply Module

17.1 INTRODUCTION

A 50-Watt Power Supply Module (Figure 17-1a) is used to supply regulated dc power to the RFL 9785 System. The power supply provides four regulated dc outputs: +5, +15, -15 and +12 volts. All outputs have overvoltage protection and short circuit protection. A Power Supply I/O Module (Figure 17-1b) is used to provide input power connections to the RFL 9785 chassis, and contains the power supply ON/OFF switch and an input fuse. Refer to paragraph 17.2 for more information on the RFL 9785 power supply module. Refer to paragraph 17.3 for more information on the RFL 9785 power supply I/O module.

17.2 POWER SUPPLY MODULE

Two different power supply modules are available for use with the RFL 9785, which provide the following choice of dc input voltages: 38Vdc to 150 Vdc, or 250Vdc. Table 17-1 summarizes the characteristics of the two models. Assembly numbers appear on the power supply circuit board assembly.

Table 17-1. Characteristics of RFL 9785 Power Supply Modules

Assembly Number	Input Voltage Range
106535-1	38Vdc to 150Vdc
106535-2	200Vdc to 300Vdc

17.2.1 SPECIFICATIONS

As of the date this manual was published, the following specifications apply to all RFL 9785 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:

Ταβλε 18–1. A @ 48 Vdc Line
0.60 A @ 125 Vdc Line
0.35 A @ 250 Vdc Line

Inrush Current with 50W Load:

Ταβλε 18–□. 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

17.2.2 THEORY OF OPERATION

The RFL 9785, 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.

17.2.3 CONTROLS AND INDICATORS

Figure 17-2 shows the location of all controls and indicators on the RFL 9785 Power supply module. These controls and indicators are described in Table 17-2. DS1 is visible with the RFL 9785 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 17-2. Controls and indicators, RFL 9785 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

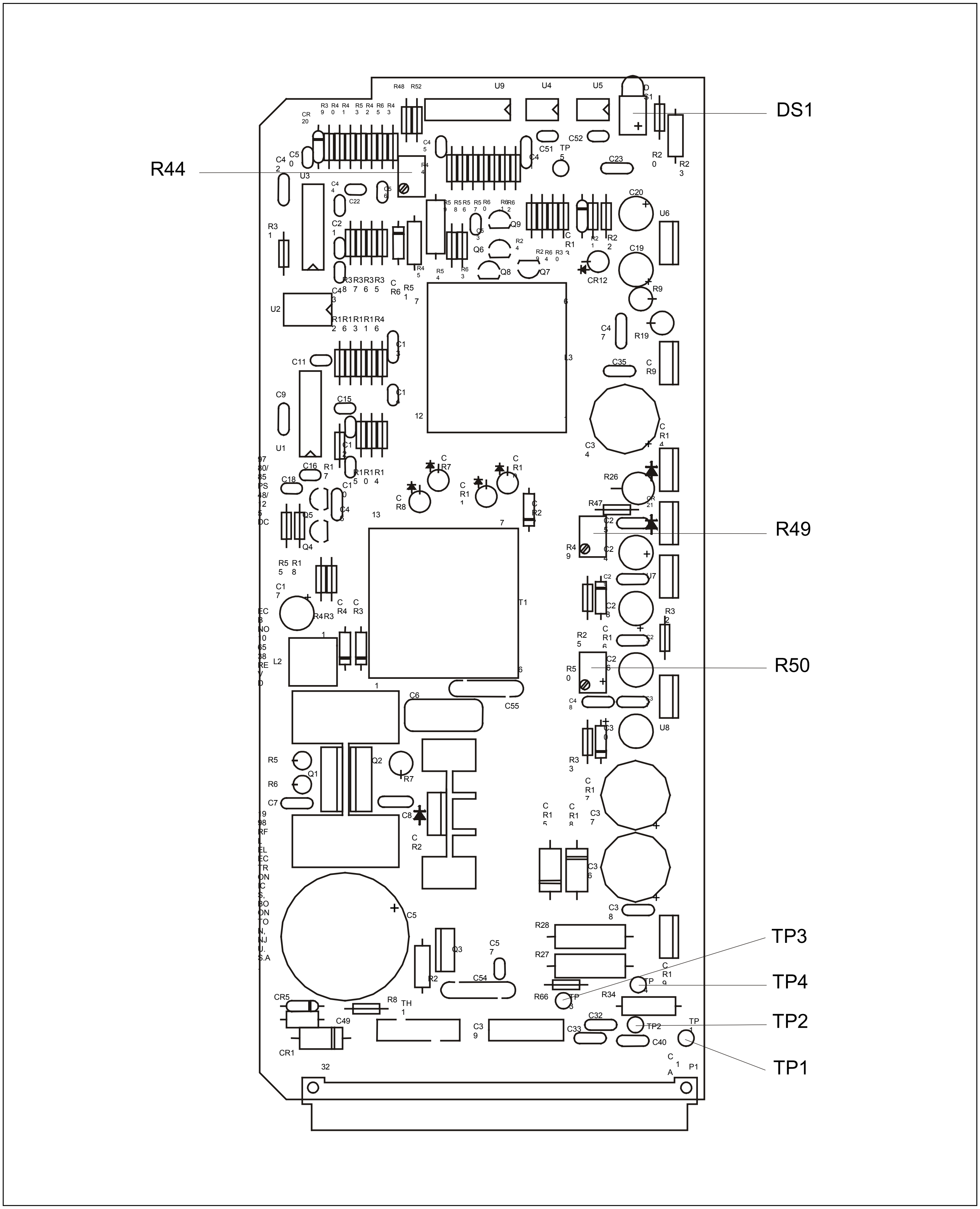


Figure 17-2. Controls and indicators, and component locator drawing, for RFL 9785 power supply module (Assembly No. 106535-1)

Table 17-3. Replaceable parts, RFL 9785 Power Supply module
Assembly No. 106535-1

Circuit Symbol (Figs 17-2 & 17-3)	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, 42, 46, 48	Capacitor, ceramic, 1µF, 10%, 50V	1001 6
C8, 47	Capacitor, ceramic disc, 470pF, 10%, 1000V	1007 378
C10, 16, 43, 44, 45, 50	Capacitor, ceramic dip, 0.01µF, 10%, 50V	1007 1667
C11	Capacitor, ceramic dip, 0.001µF, 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 17-3 - continued. Replaceable parts, RFL 9785 Power Supply module

Circuit Symbol (Figs. 17-2 & 17-3)	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	0140 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 1130
R53	Resistor, metal film, axial, 475Ω, 1%, 1/4W	0410 1257
R55	Resistor, fixed composition, 22Ω, 5%, 1/4W	0410 613
R56	Resistor, metal film, axial, 7.68K, 1%, 1/4W	0410 1373
R57, 59, 61	Resistor, metal film, axial, 2.94K, 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	Diode, 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 17-3 - continued. RFL 9785 Power Supply module

Circuit Symbol (Fig. 17-2 & 17-3)	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^{o}C	103370
TP1-5	Test point terminal, orange	98441 3

Figure 17-3. Schematic, RFL 9785 Power Supply 48/125 DC (Dwg. No. D-106539-E)

Please see Figure 17-3 in Section 22: Schematics.

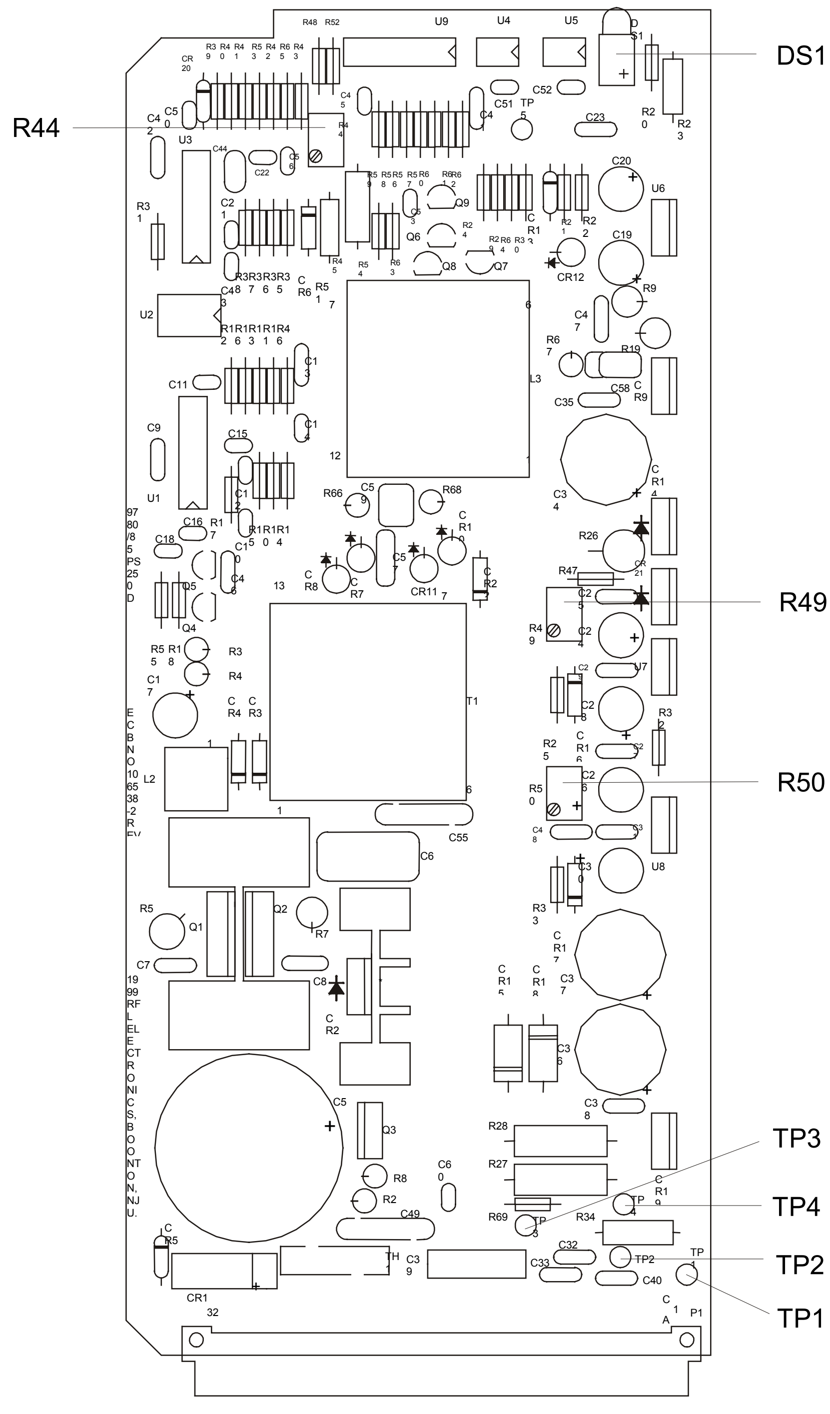


Figure 17-4. Controls and indicators, and component locator dwg, for RFL 9785 power supply module (Assy No. 106535-2)

Table 17-4. Replaceable parts, RFL 9785 Power Supply module
Assembly No. 106535-2

Circuit Symbol (Figs. 17-4 & 17-5)	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 17-4 - continued. Replaceable parts, RFL 9785 Power Supply module

Circuit Symbol (Figs. 17-4 & 17-5)	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	Diode, 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 17-4 - continued. Replaceable parts, RFL 9785 Power Supply module

Circuit Symbol (Fig. 17-4 & 17-5)	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 17-5. Schematic, RFL 9785 Power Supply 250 Vdc (Dwg. No. D-106539-C)

Please see Figure 17-5 in Section 22: Schematics.

17.3 POWER SUPPLY I/O MODULES

The RFL 9785 Power supply I/O module is located at the rear of the 9785 chassis directly behind the power supply module. It provides input power connections to the RFL 9785 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 9785 system. Table 17-5 summarizes the characteristics of the various models.

Table 17-5. Characteristics of RFL 9785 Power Supply I/O modules

Model Number	Assembly Number	Input Voltage	Application
9785 PSIO 38/150	106455-1	38 Vdc to 150 Vdc	Used with single 38-150 Vdc supply
9785 PSIO 250	106455-2	250 Vdc	Used with single 250 Vdc supply
9785 DUAL PSIO 38/150	106455-3	38 Vdc to 150 Vdc	Used with dual 38-150 Vdc supply
9785 DUAL PSIO 250	106455-4	250 Vdc	Used with dual 250 Vdc supply

17.3.1 CONTROLS AND INDICATORS FOR 106455-1 & -2 P.S. I/Os

Figure 17-6 shows the location of all controls on the RFL 9785 Single Power supply I/O module. These controls are described in Table 17-6.

Table 17-6. Controls and indicators, RFL 9785 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

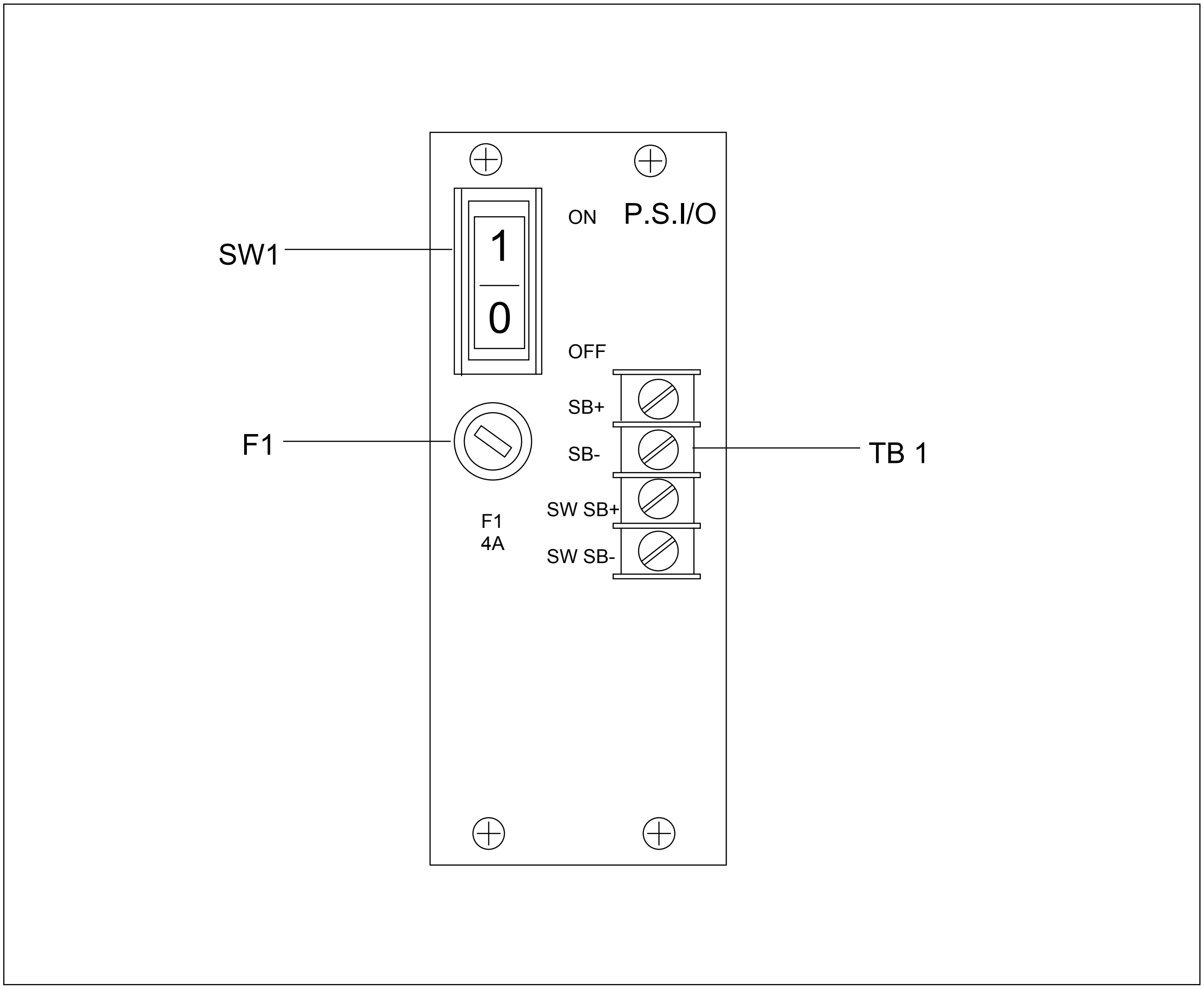


Figure 17-6. Controls and indicators, RFL 9785 Single Power Supply I/O module

Table 17-7. Replaceable parts, RFL 9785 Single Power Supply I/O module
Assembly No. 106455-1 and –2

Circuit Symbol (Figs. 17-7 & 17-8)	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	
	106455-1: V130LC20B	41079
	106455-2: V275LC40B	105447

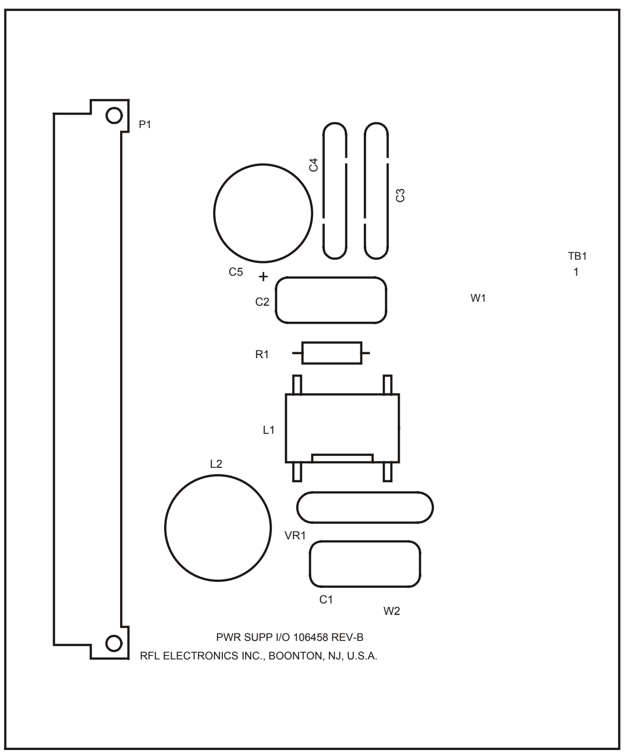


Figure 17-7. Component locator drawing, Single Power Supply I/O module

Figure 17-8. Schematic, RFL 9785 Power Supply I/O (Dwg. No. B-106459-A)

Please see Figure 17-8 in Section 22: Schematics.

17.3.2 CONTROLS AND INDICATORS FOR 106455-3 & -4 P.S. I/Os

Figure 17-9 shows the location of all controls on the RFL 9785 Dual Power supply I/O module. These controls are described in Table 17-8.

Table 17-8. Controls and indicators, RFL 9785 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

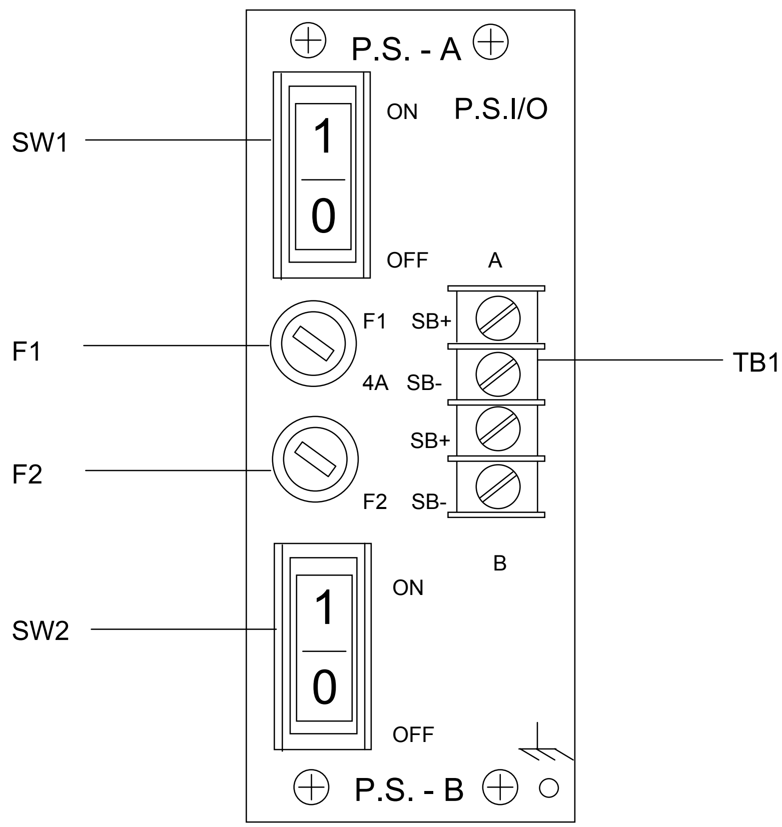


Figure 17-9. Controls and indicators, RFL 9785 Dual Power Supply I/O module

Table 17-9. Replaceable parts, RFL 9785 Dual Power Supply I/O module
Assembly No. 106455-3 and –4

Circuit Symbol (Figs. 17-10 & 17-11)	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, 4A, 250V, slo-blo	301122
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	
	106455-3: V130LC20B	41079
	106455-4: V275LC40B	105447

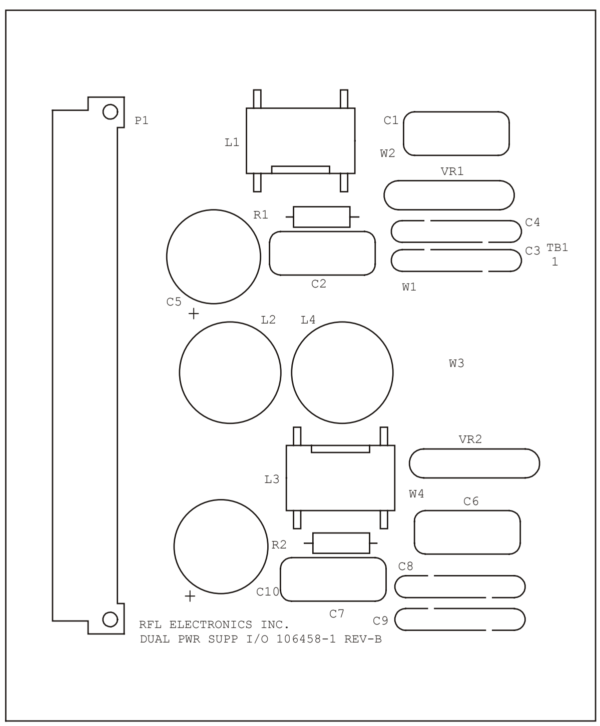


Figure 17-10. Component locator drawing, Dual Power Supply I/O module

Figure 17-11. Schematic, RFL 9785 Power Supply I/O Dual (Dwg. No. B-106459-1-A)

Please see Figure 17-11 in Section 22: Schematics.

Section 18. I/O MODULES

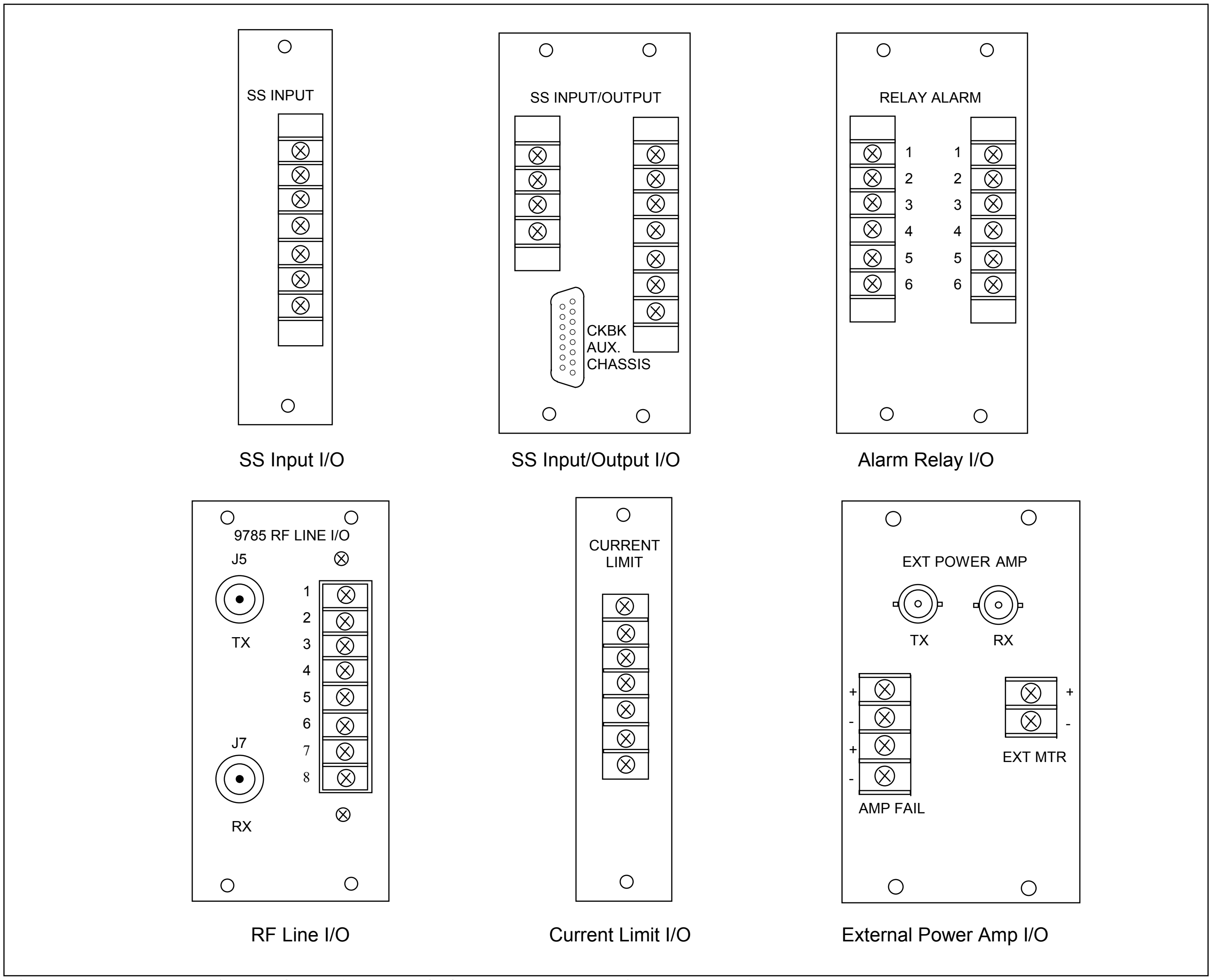


Figure 18-1. Panel views of the 6 types of I/O modules used in the RFL 9785

18.1 INTRODUCTION

The RFL 9785 I/O modules serve as an interface for input and output signals between the RFL 9785 and the line coupling equipment. There are six types of I/O modules that can be used with the RFL 9785. These are shown in Figure 18-1.

NOTE

Chassis power must be turned OFF before removing or installing any RFL 9785 I/O modules.

Table 18-1. RFL 9785 I/O modules Application Information

Assembly Number	I/O Module	See the following paragraphs for more information
106435-3	SS Input I/O (48/125V)	18.2
106435-4	SS Input I/O (250V)	
106435-5	SS Input I/O (5V)	
106635-1	SS In/Out I/O (48/125V)	18.3
106635-2	SS In/Out I/O (250V)	
106635-3	SS In/Out I/O (5/48V or 5/125V)	
106635-4	SS In/Out I/O (5/250V)	
106465	Alarm Relay I/O	18.4
106595	RF Line I/O	18.5
106510-1	Current Limit I/O (48V)	18.6
106510-2	Current Limit I/O (125V)	
106675	External Power Amp I/O	18.7

18.2 SOLID STATE INPUT I/O MODULE

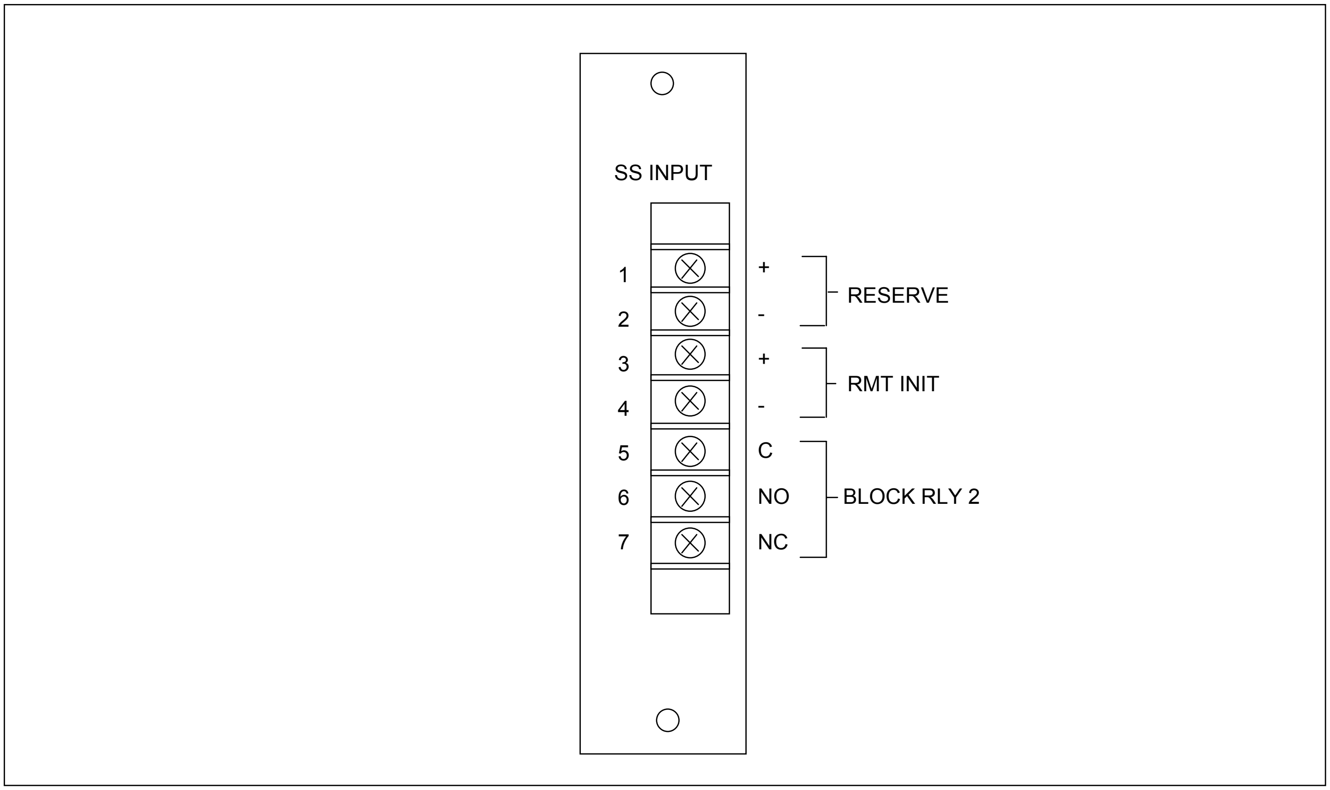


Figure 18-2. Solid State Input I/O module, rear panel view

18.2.1 DESCRIPTION

The Solid-State Input 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 reserve or remote initiate, and the output is used as a block output. The electro-mechanical output has N.O. and N.C. connections at the terminal block. All signals to and from the Solid-State Input I/O module interface directly with the 9785 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.

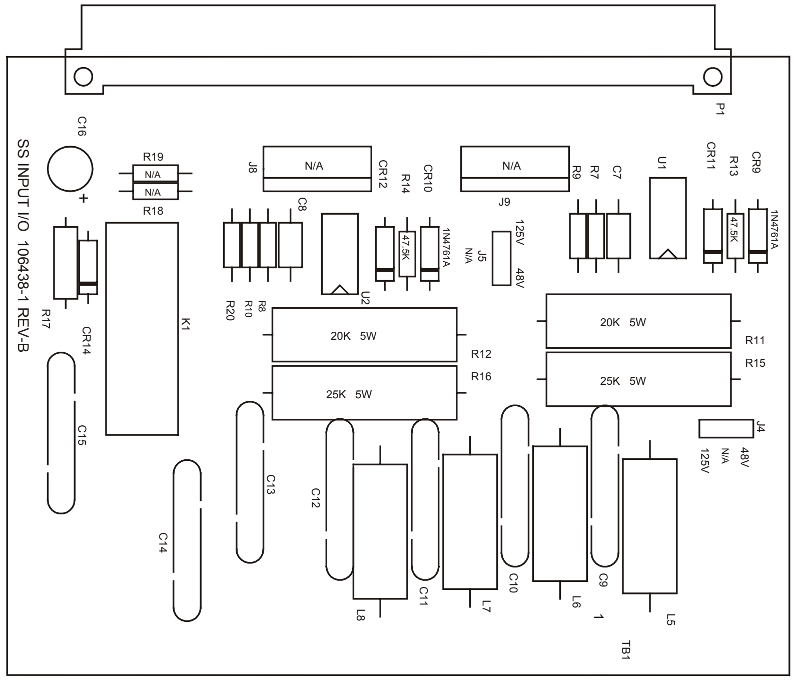
The Solid-State Input I/O module is primarily used for TX only applications. It can also be used for customer specific applications and can be mounted in a spare I/O slot, if available, or in an expansion chassis.

18.2.2 CONTROLS AND INDICATORS

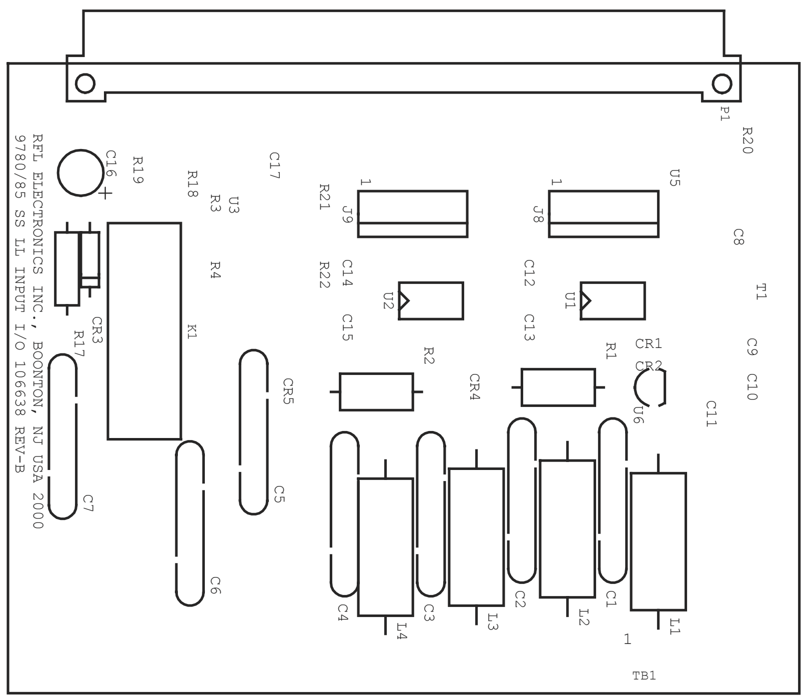
Figure 18-3 shows the location of all controls and indicators on the Solid State Input I/O module. These controls and indicators are described in Table 18-2. Only TB1 is accessible with the Solid State Input I/O module installed in the chassis. Jumpers J4 and J5 are accessible only when the module is removed from the chassis or is on a card extender.

Table 18-2. Controls and indicators, Solid State Input 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 18-3. Controls and indicators, and component locator drawing, Solid State Input I/O modules

Table 18-3. Replaceable Parts, RFL 9785 Solid State Input I/O module
Assembly No. 106435-3 and -4

Circuit Symbol (Figs. 18-3 & 18-4)	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 18-4. Schematic, RFL 9785 Solid-State Input I/O (Dwg. No. D-106439-3-A)

Please see Figure 18-4 in Section 22: Schematics.

Table 18-4. Replaceable Parts, RFL 9785 Solid State Input I/O module
Assembly No. 106435-5

Circuit Symbol (Figs. 18-3 & 18-5)	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

Figure 18-5. Schematic, RFL 9785 Solid-State Logic Level Input I/O (Dwg. No. D-106439-5-A)

Please see Figure 18-5 in Section 22: Schematics

18.3 SOLID STATE INPUT/OUTPUT I/O MODULE

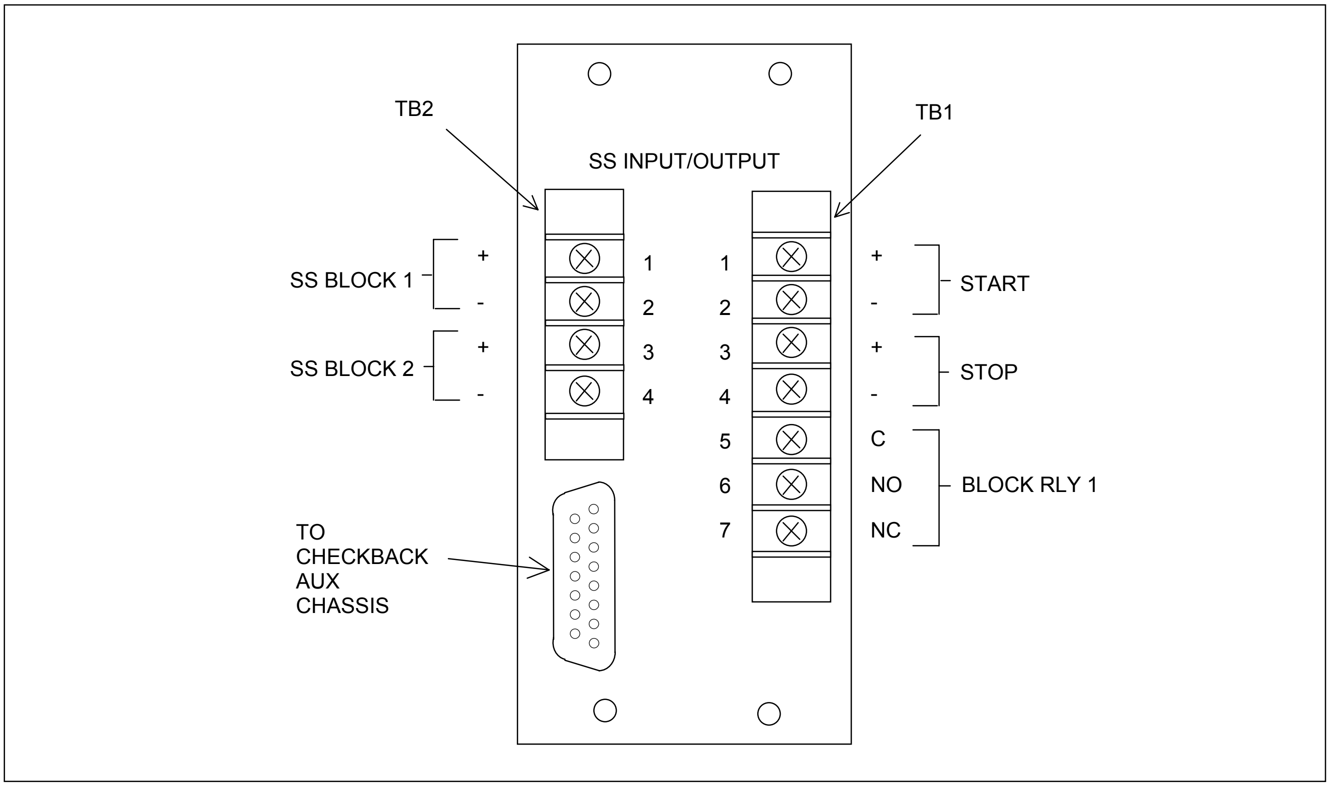


Figure 18-6. Typical Solid State Input/Output I/O module, rear panel view

18.3.1 DESCRIPTION

The Solid-State Input/Output I/O Module (Figure 18-6) provides two solid state inputs, two solid state outputs, and one electro-mechanical output. This I/O is available in four versions as described in Table 18-5. In general, the inputs are used for keying start/stop, the solid-state outputs are used for receiving block commands, and the electro-mechanical output is used as a block output. The electro-mechanical output has normally opened (NO), normally closed (NC) and common (C) connections at the terminal block. All signals to and from the Solid-State Input/Output I/O Module interface directly with the 9785 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. The 250V version does not have these jumpers.

The Solid-State Input I/O Module is primarily used for 9785 and 9780 TX/RX applications. It can also be used for future expansion and can be mounted in a spare I/O slot, if available, or in an expansion chassis.

Table 18-5. Solid-State Input/Output I/O Modules, general information

Assembly Number	Description	Controls & Indicators And Component Locator Drawing, See Figure:	Schematic Diagram See Figure:
106635-1	Solid-State Input/Output I/O (48/125V)	18-7	18-9
106635-2	Solid-State Input/Output I/O (250V)		
106635-3	Solid-State Input/Output I/O (5/48V or 5/125V)	18-8	18-10
106635-4	Solid-State Input/Output I/O (5/250V)		

18.3.2 CONTROLS AND INDICATORS

Figures 18-7 and 18-8 show the location of all controls and indicators on the Solid State Input/Output I/O modules. These controls and indicators are described in Table 18-6. Only TB1, TB2 and P101 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.

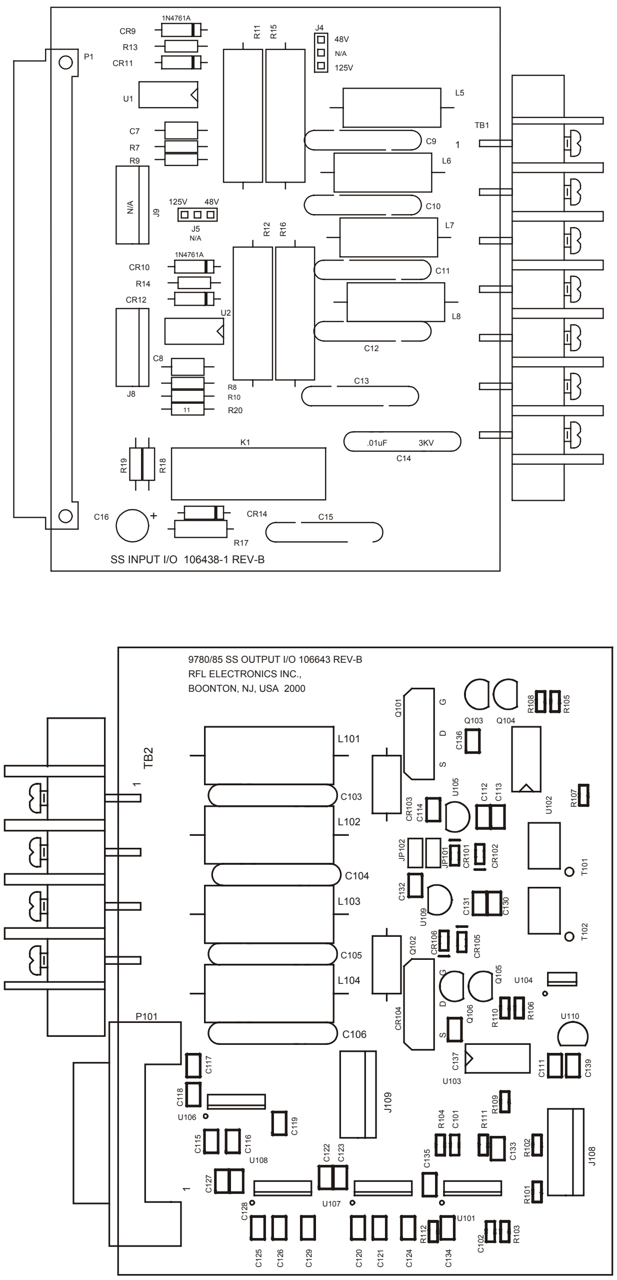


Figure 18-7. Controls and indicators and component locator drawing, Solid State Input/Output I/O Modules (Assembly No. 106635-1 and 106635-2)

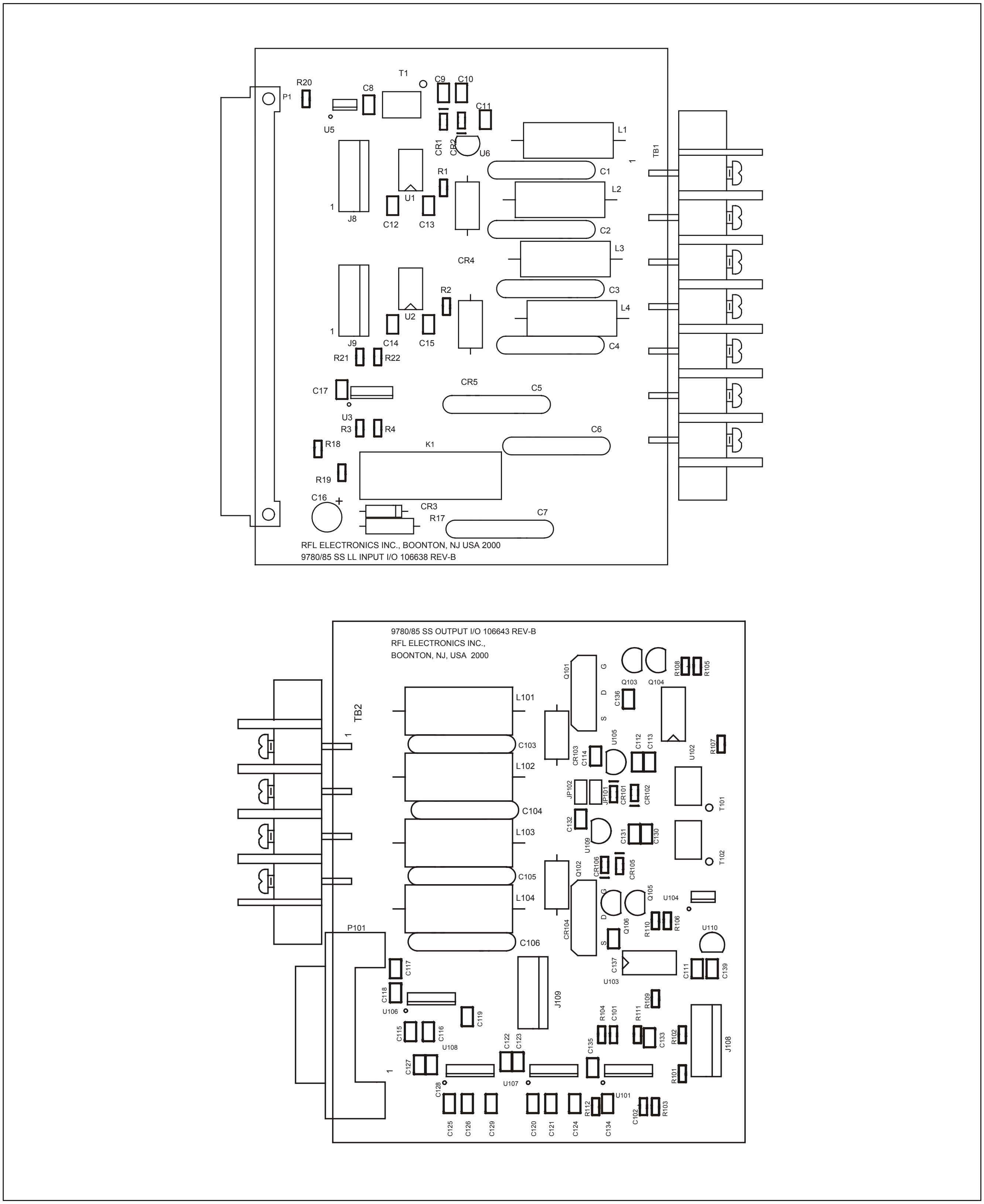


Figure 18-8. Controls and indicators and component locator drawing, Solid State Logic Level Input/Output I/O Modules (Assembly No. 106635-3 and 106635-4)

Table 18-6. Controls and indicators, Solid State Input/Output I/O modules (Assembly No. 106635-1, -2, -3, and –4)

Component Designator	Name/ Description	Function
J4	Jumper	Selects 48V or 125V operation (not used for 250V operation)
J5	Jumper	Selects 48V or 125V operation (not used for 250V operation)
TB1	Terminal block	Provides connections to line coupling equipment
TB2	Terminal block	Provides connections to line coupling equipment
P101	Checkback auxiliary chassis connector	Provides connection to checkback auxiliary chassis

Table 18-7. Replaceable parts, RFL Solid State Input/Output I/O module
Assembly No. 106635-1 and 106635-2, Input Boards

Circuit Symbol (Figs 18-7 & 18-9)	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	Diode, Zener, 20V, 5%, 1W, 1N4747A	20794
CR11, 12, 14	Diode, silicon, rectifier, 1A, 1N4003	30769
J4, 5	Connector, header, single, 3 CKT	32802 3
J8	Connector, wafer assembly, 4 CKT	97223 4
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	Resistor, wire-wound, 22K, 5%, 5W	1100 800
R13, 14	Resistor, metal film, axial, 11.5K, 1%, 1/4W	0410 1390
R15, 16	Resistor, wire-wound, 5K, 5%, 3.25W	1100 460
R17	Resistor, metal film, axial, 162Ω, 1%, 1/2W	0410 2212
R20	Resistor, metal film, axial, 11Ω, 1%, 1/4W	0410 1100
U1, 2	Opto device, optical isolator, 6N139	29592

Table 18-7. - continued. Replaceable parts, RFL Solid State Input/Output I/O module Assembly No. 106635-1 and 106635-2, Output Boards

Circuit Symbol (Figs 18-7 & 18-9)	Description	Part Number
	Output Board Components	
C101, 102	Capacitor, ceramic, 4700pf, 5%, 50V	151 05472040507
C103-106	Capacitor, ceramic disc, 0.01uf, 20%, 3kV	1007 1811
C111, 114-129, 132, 135-137, 139	Capacitor, ceramic, 0.1uf, 10%, 50V	151 10104040603
C112, 113, 130, 131	Capacitor, ceramic, 0.47uf, 10%, 16V	151 10474020603
C133, 134	Capacitor, ceramic, 0.01uf, 10%, 50V	151 10103040603
CR101, 102, 105, 106	Diode, general purpose, 1N4148	340 100
CR103, 104	106635-1: Suppressor, transient voltage, 1.5KE180CA	42064
	106635-2: Suppressor, transient voltage, 1.5KE350CA	101722
J108, 109	Connector, wafer assembly, 6 CKT	97223 6
L101-104	Inductor, 12uH, 4.5A, 10%	30436
P101	Connector, JK female, 15 pin, D-subminiature	95576
Q101, 102	106635-1: Transistor, MOSFET, N-channel, IRFP254	0715 36
	106635-2: Transistor, MOSFET, N-channel, IRFP460	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, 900uH	910 00100
TB1	Terminal block, 7 position, right angle	101463
TB2	Terminal block, modified	106426
U101	Integrated circuit, MOS, 74HC123	500 104
U102, 103	Opto device, opto-isolator, 6N139	29592
U104	Integrated circuit, linear transformer driver, MAX845	510 107
U105, 109, 110	Integrated circuit, linear voltage regulator, 5V, POS	0620 204
U106-108	Integrated circuit, RS232 dual driver/receiver	505 100

Figure 18-9. Schematic, RFL 9785 Solid State Input/Output I/O (Dwg. No. D-106639-B) Sheet 1 of 2

Figure 18-9. Schematic, RFL 9785 Solid State Input/Output I/O (Dwg. No. D-106639-B) Sheet 2 of 2

Please see Figure 18-9 in Section 22: Schematics.

Table 18-8. Replaceable Parts, RFL Solid State Input/Output I/O module
Assembly No. 106635-3 and 106635-4, Input Boards

Circuit Symbol (Figs 18-8 & 18-10)	Description	Part Number
	Input Board Components	
C1-7	Capacitor, ceramic disc, 0.01uF, 20%, 3kV	1007 1811
C8, 11-15, 17	Capacitor, ceramic, 0.1uF, 10%, 50V	151 10104040603
C9, 10	Capacitor, ceramic, 0.47uF, 10%, 16V	151 10474020603
C16	Capacitor, electrolytic, 100uF, 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, 9	Connector, wafer assembly, 6 CKT	97223 6
K1	Relay, SPST, 8A/300V, 6V/0.22W	101461
L1-4	Inductor, 10uH, 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, 900uH	910 00100
U1, 2	Opto isolator, 740L6010	101498
U3	Integrated circuit, MOS, 3-ST quad buffer, 74ABT125	500 101
U5	Integrated circuit, linear transformer driver, MAX845	510 107
U6	Integrated circuit, linear voltage regulator, 5V positive	0620 204

Table 18-8. - continued. Replaceable Parts, RFL Solid State Input/Output I/O module Assembly No. 106635-3 and 106635-4, Output Boards

Circuit Symbol (Figs 18-8 & 18-10)	Description	Part Number
	Output Board Components	
C101, 102	Capacitor, ceramic, 4700pf, 5%, 50V	151 05472040507
C103-106	Capacitor, ceramic disc, 0.01uf, 20%, 3kV	1007 1811
C111, 114-129, 132, 135-137, 139	Capacitor, ceramic, 0.1uf, 10%, 50V	151 10104040603
C112, 113, 130, 131	Capacitor, ceramic, 0.47uf, 10%, 16V	151 10474020603
C133, 134	Capacitor, ceramic, 0.01uf, 10%, 50V	151 10103040603
CR101, 102, 105, 106	Diode, general purpose, 1N4148	340 100
CR103	Suppressor, voltage, 6.8V, 5%, 600W, BIDIR	101497
CR104	106635-3: Suppressor, transient voltage, 1.5KE180CA	42064
	106635-4: Suppressor, transient voltage, 1.5KE350CA	101722
J108, 109	Connector, wafer assembly, 6 CKT	97223 6
L101-104	Inductor, 12uH, 4.5A, 10%	30436
P101	Connector, JK female, 15 pin, D-subminiature	95576
Q102	106635-3: Transistor, MOSFET, N-channel, IRFP254	0715 36
	106635-4: Transistor, MOSFET, N-channel, IRFP260	0715 37
Q103	Transistor, silicon, NPN, medium power	105421
Q104	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, 102	Transformer, 2:1, 900uH	910 00100
TB1	Terminal block, 7 position, right angle	101463
TB2	Terminal block, modified	106426
U101	Integrated circuit, MOS, monostable multivibrator, 74HC123	500 104
U102, 103	Opto device, opto-isolator, 6N139	29592
U104	Integrated circuit, linear transformer driver, MAX845	510 107
U105, 109, 110	Integrated circuit, linear voltage regulator, 5V, POS	0620 204
U106-108	Integrated circuit, RS232 dual driver/receiver	505 100

Figure 18-10. Schematic, RFL 9785 Solid State Logic Level Input/Output I/O (Dwg. No. D-106639-5-C) Sheet 1 of 2

Figure 18-10. Schematic, RFL 9785 Solid State Logic Level Input/Output I/O (Dwg. No. D-106639-5-C) Sheet 2 of 2

Please see Figure 18-10 in Section 22: Schematics.

18.4 ALARM RELAY I/O MODULE

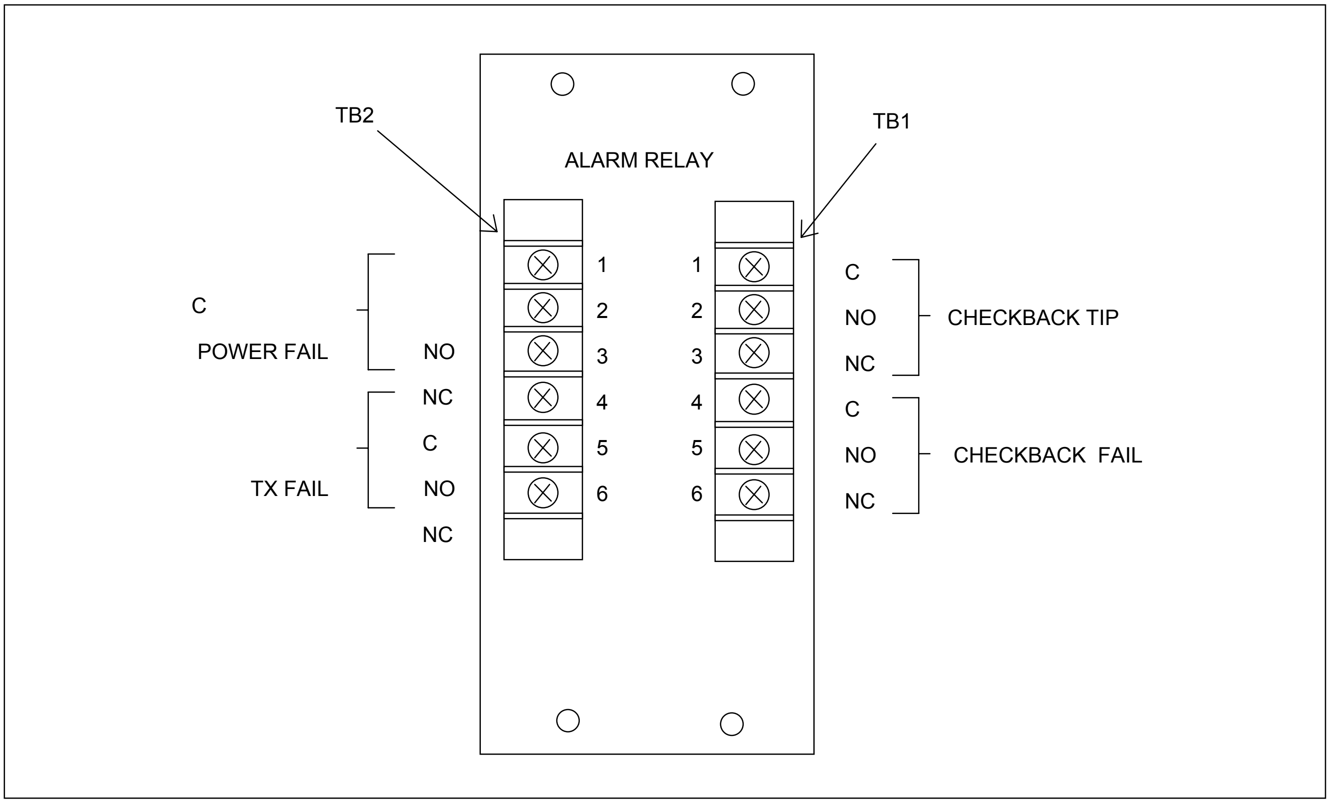


Figure 18-11. Alarm Relay I/O module, rear panel view

18.4.1 DESCRIPTION

The Alarm Relay I/O module (Figure 18-11) provides four electro-mechanical relay outputs. Each output is used to indicate a factory pre-defined alarm condition as shown in Table 18-9 below. Each electro-mechanical output has normally opened (NO), normally closed (NC) and common (C) connections at the terminal block. All signals to and from the Alarm Relay I/O interface directly with the various modules within the system.

User configuration is not required for this I/O module.

The Alarm Relay I/O module is used in all standard RFL 9785 applications. It can also be used for future expansion and can be mounted in a spare I/O slot, if available, or in an expansion chassis.

Table 18-9. Alarm Outputs

SYSTEM	ALARM CIRCUIT #1	ALARM CIRCUIT #2	ALARM CIRCUIT #3	ALARM CIRCUIT #4
9785	POWER FAIL	TX FAIL	CB TIP (CHECKBACK TEST IN PROGRESS)	CHECKBACK FAIL

Table 18-10. Replaceable Parts, RFL Alarm Relay I/O module
Assembly No. 106465

Circuit Symbol (Figs 18-12 & 18-13)	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 assembly, 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
J1, 2	Harness for J1 and J2	106467

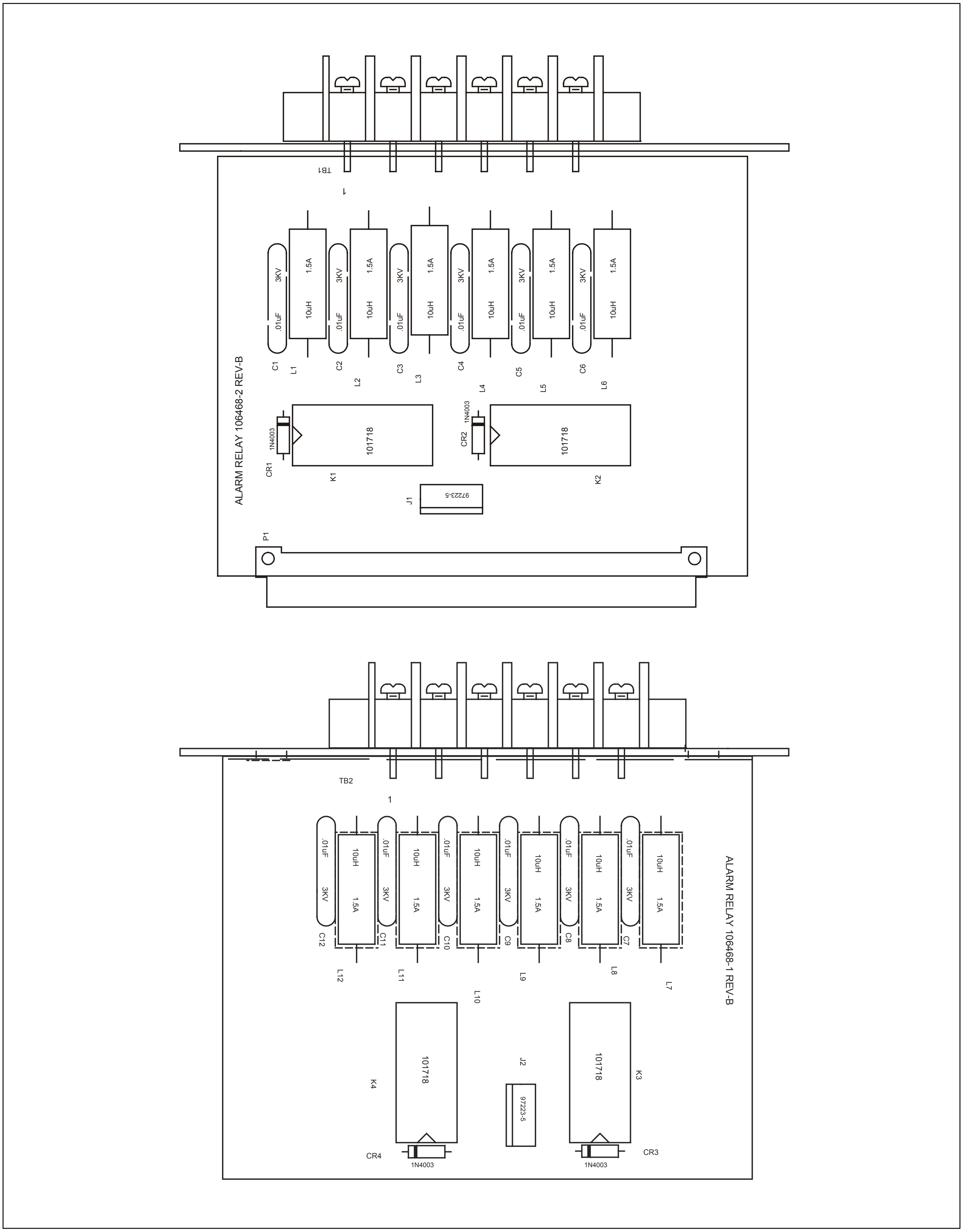


Figure 18-12. Component locator drawing, Alarm Relay I/O module. (Assembly No. 106465)

Figure 18-13. Schematic, RFL 9785 Alarm Relay I/O (Dwg. No. D-106469-C)

Please see Figure 18-13 in Section 22: Schematics.

18.5 RF LINE I/O MODULE

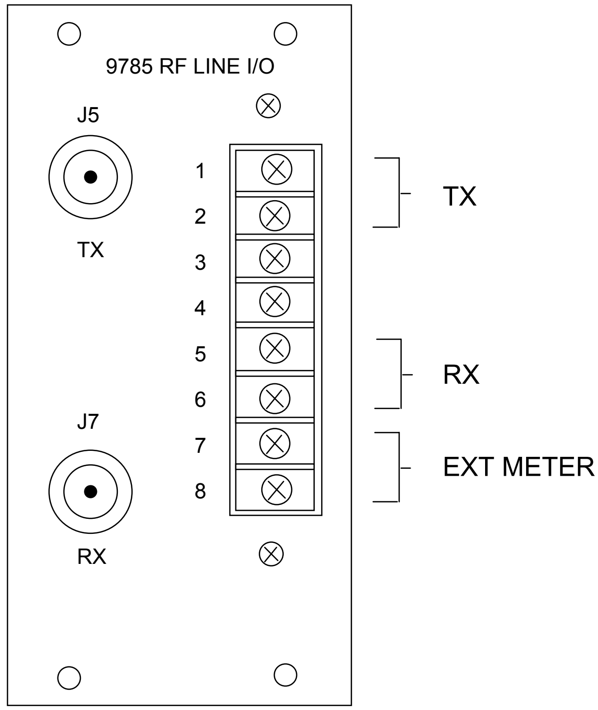


Figure 18-14. RFL Line I/O module, rear panel view

18.5.1 DESCRIPTION

The RF Line I/O module (Figure 18-14) has two UHF connectors with spark gaps, additional protection circuits and a selectable line termination impedance (50Ω, 75Ω or none). The top port J5, is for TX signals and the bottom port J7, is for RX signals.

18.5.2 CONTROLS AND INDICATORS

Figure 18-15 shows the location of all controls and indicators on the RF Line I/O module. These controls and indicators are described in Table 18-11. TB1, J5 and J7 accessible with the RF Line I/O module installed in the chassis. All others are accessible when the module is removed from the chassis or is on a card extender.

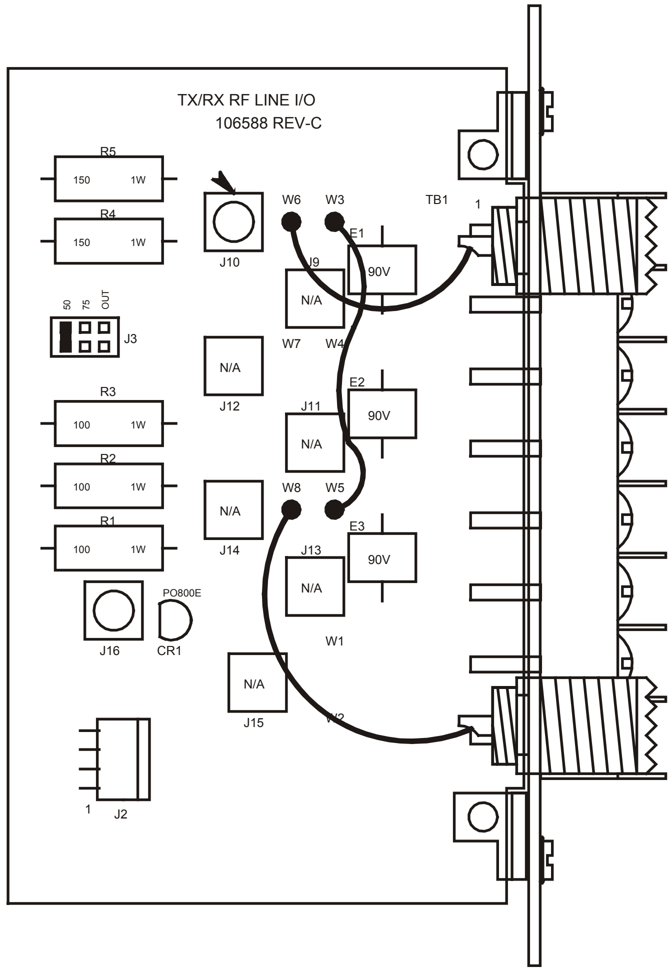


Figure 18-15. Controls and indicators, and component locator drawing, RFL Line I/O module

Table 18-11. Controls and Indicators for RF Line I/O module

Component Designator	Name/ Description	Function
J3	Jumper	Selects line termination impedance of 50Ω, 75Ω or OUT (greater than 30KΩ)
J5	UHF Connector	Used for TX signals
J7	UHF Connector	Used for RX signals
J10	Miniature Connector	
J16	Miniature Connector	
TB1	Terminal board	Provides connections to line coupling equipment

Table 18-12. Replaceable Parts, RF Line I/O module
Assembly No. 106595

Circuit Symbol (Figs 18-15 & 18-16)	Description	Part Number
CR1	Suppressor, transient, bi-directional, 75V	101473
E1-3	Arrestor, 2-element, gas tube	101472
J2	Connector, housing, 4-circuit	95067 4
J3	Connector, header, dual 3/6 circuit	32599 6
J5, 7	Connector, jack, coax female	101470
J10, 16	Connector, jack, female, 2 contact, SMB	101485
R1, 2, 3	Resistor, fixed composition, 100Ω, 5%, 1W	1009 182
R4, 5	Resistor, fixed composition, 150Ω, 5%, 1W	1009 183
TB1	Terminal block, 8-terminal, modified	101697 8

Figure 18-16. Schematic, RFL 9785 RF Line I/O (Dwg. No. C-106599-A)

Please see Figure 18-16 in Section 22: Schematics.

18.6 CURRENT LIMIT I/O MODULE

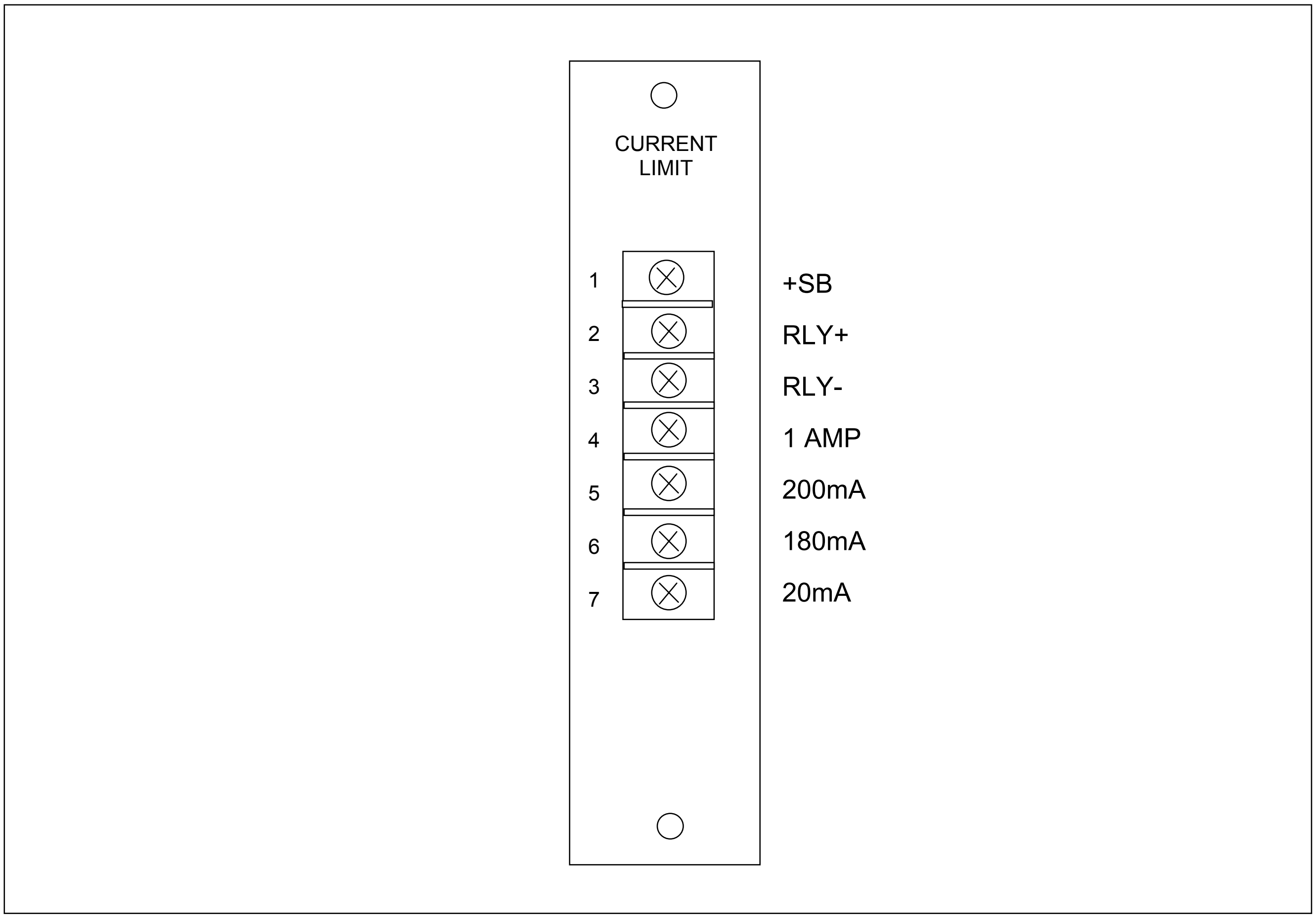


Figure 18-17. Current Limit I/O module, rear panel view

18.6.1 DESCRIPTION

The Current Limit I/O module (Figure 18-17) does not plug into the rear of the RFL 9785 chassis, like the other I/O modules in this section. Instead, it is hard mounted to the left inside wall of the chassis as viewed from the rear.

User configuration is not required for the Current Limit I/O module.

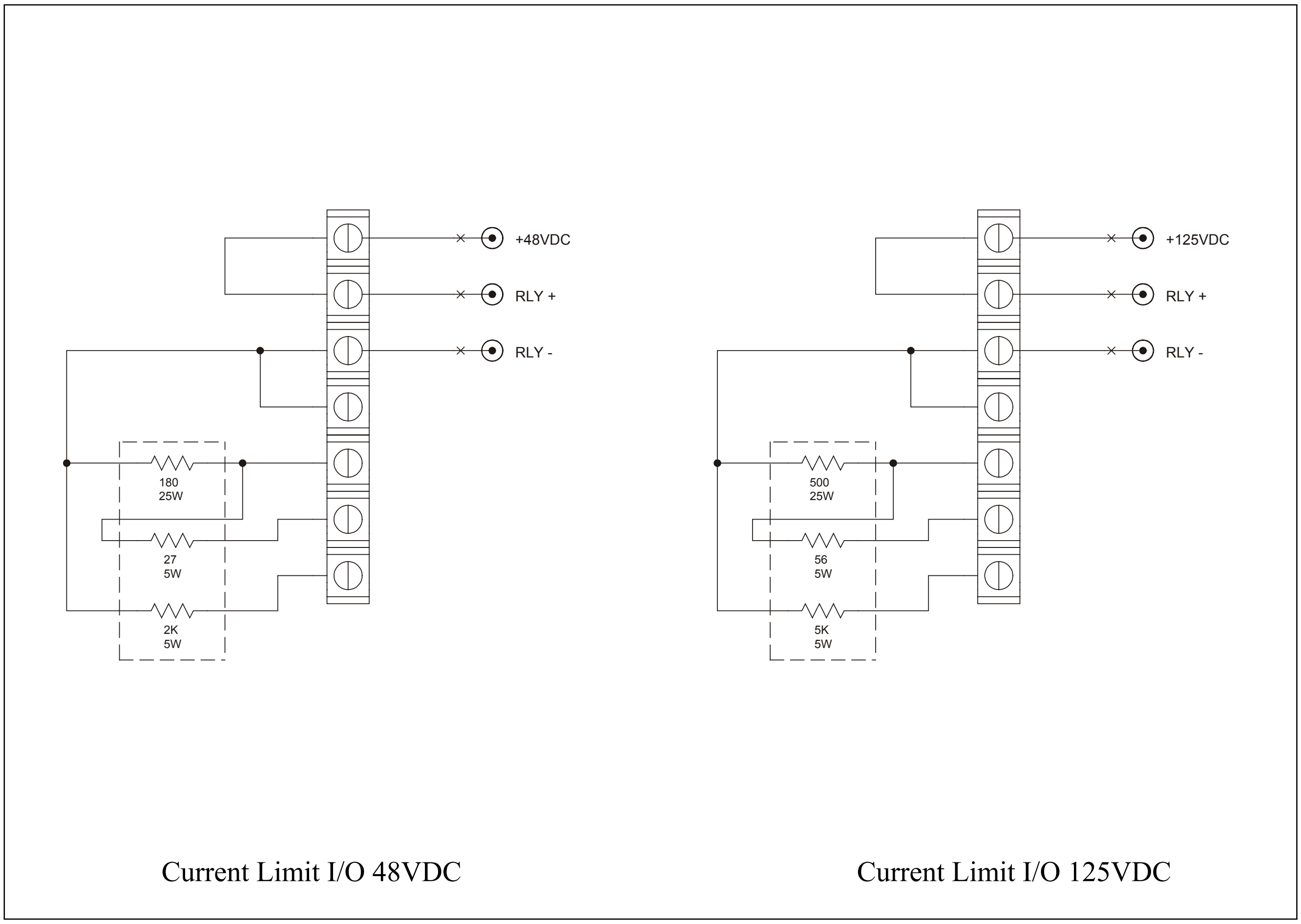


Figure 18-18. Schematic digram, Current Limit I/O Module

Table 18-13. Replaceable Parts, Current Limit I/O module
Assembly No. 106510-1, -2

Circuit Symbol (Fig. 18-18)	**Description**	**Part Number**
	106510-1	
R1	Resistor, wirewound, 180Ω, 1%, 25W	0305 6
R2	Resistor, wirewound, 27Ω, 1%, 5W	0305 4
R3	Resistor, wirewound, 2K, 1%, 5W	0305 8
	106510-2	
R1	Resistor, wirewound, 500Ω, 1%, 50W	0305 7
R2	Resistor, wirewound, 56Ω, 1%, 5W	0305 5
R3	Resistor, wirewound, 5K, 1%, 5W	0305 9

18.7 EXTERNAL POWER AMP I/O MODULE

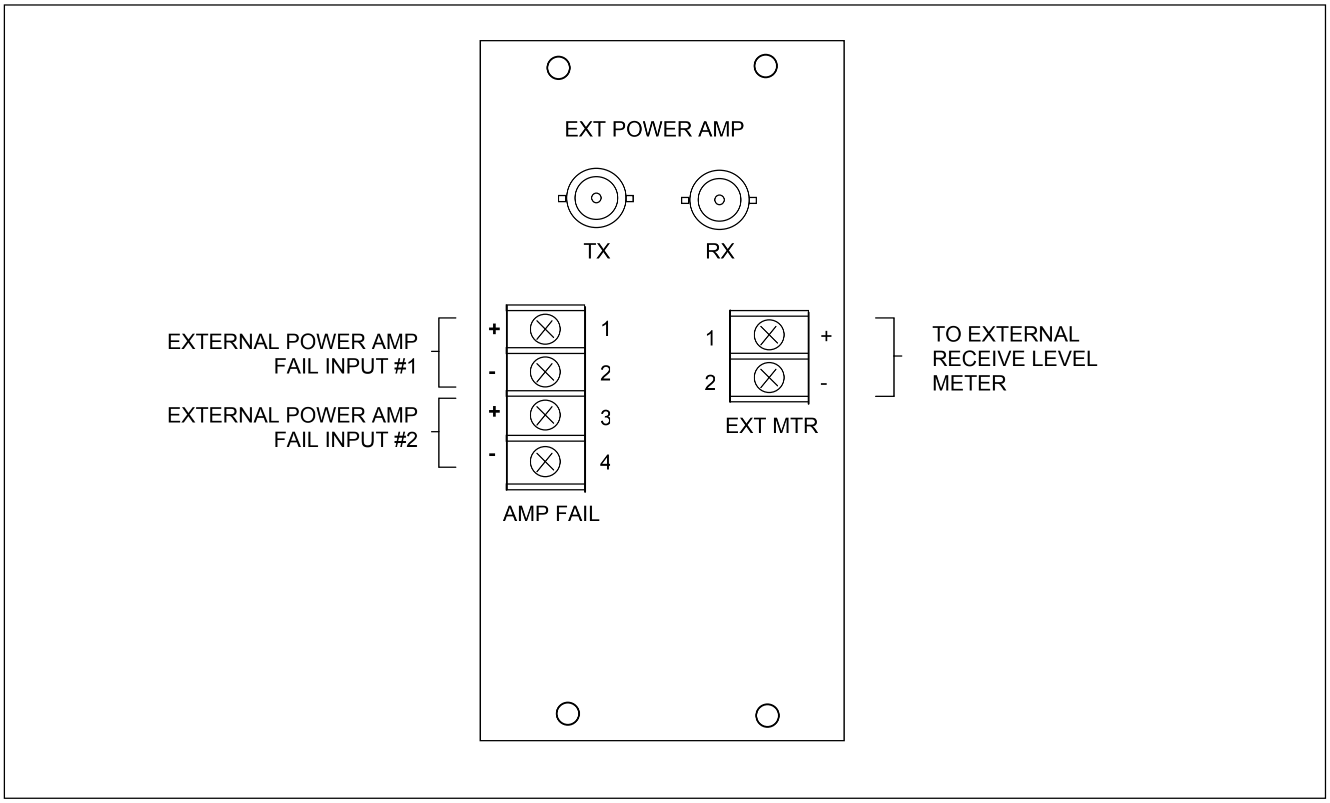


Figure 18-19. External Power Amp I/O module, rear panel view

18.7.1 DESCRIPTION

The external power amp I/O provides an interface when an external high power amplifier is used with the 9785. 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 18-19) 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 18-15.

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 18-14. 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 18-15. 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	

18.7.2 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 9785 receiver. In addition, connections are provided for an external power meter.

18.7.3 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 18-16. Replaceable Parts, RFL 9785 External Power Amp I/O module
Assembly No. 106675

Circuit Symbol (Figs. 18-20 & 18-21)	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

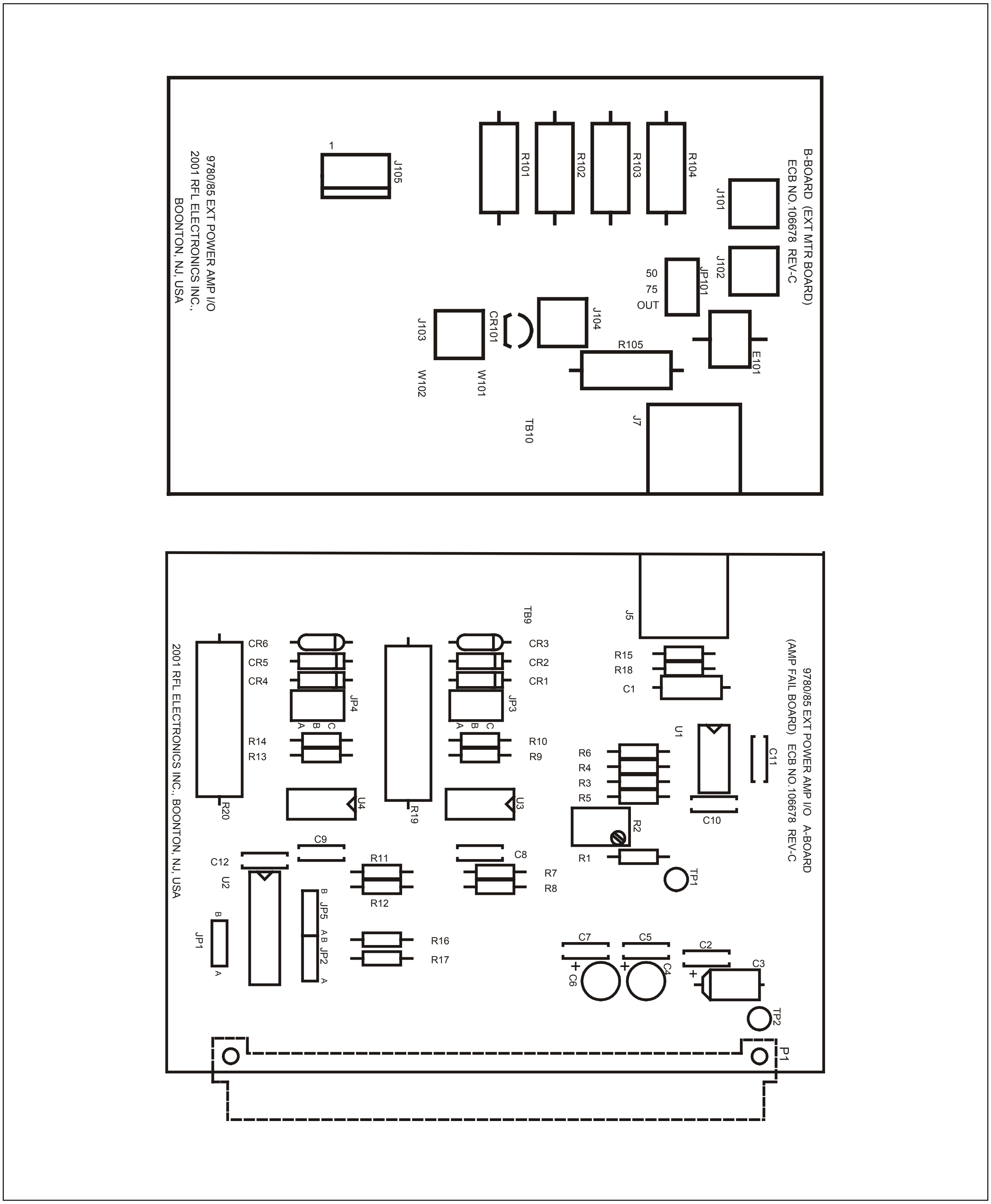


Figure 18-20. Component locator drawing, External Power Amp I/O module. Assembly No. 106675

Figure 18-21. Schematic, RFL 9785 External Power Amp I/O (Dwg. No. D-106679-A)

Please see Figure 18-21 in Section 22: Schematics.

Section 19. CHASSIS ASSEMBLY

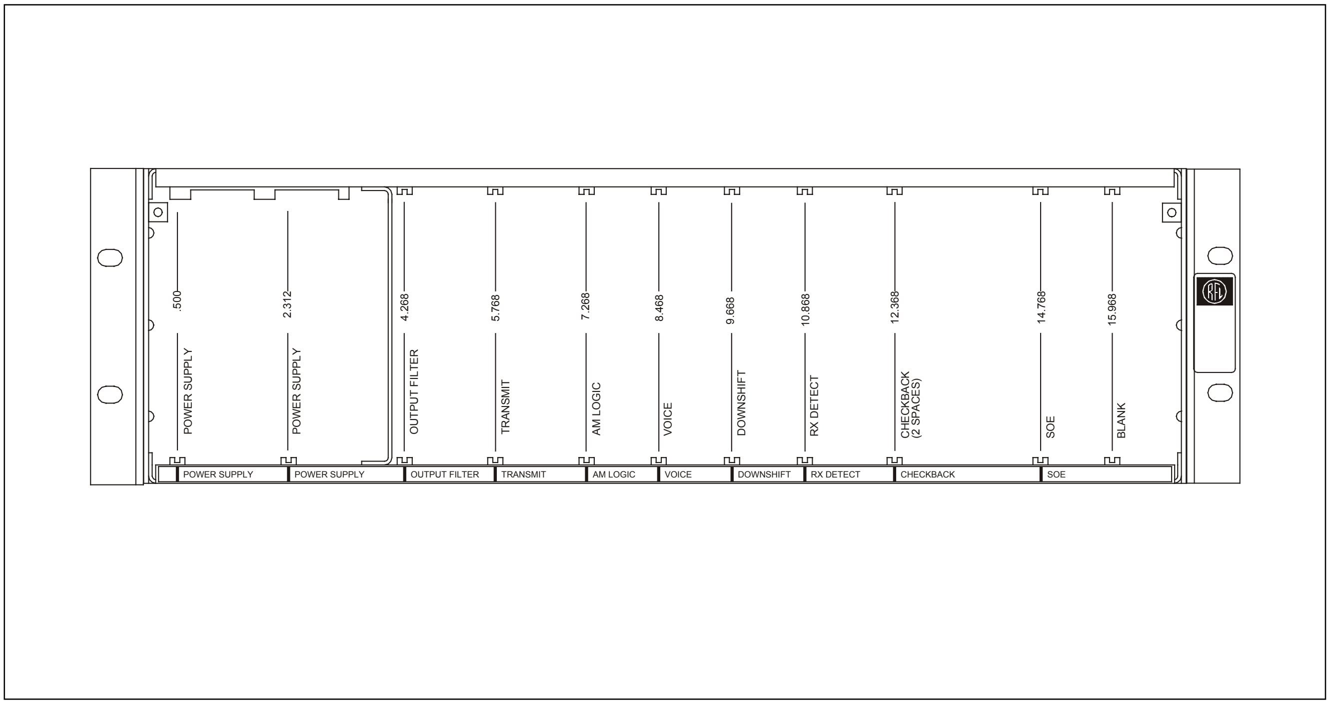


Figure 19-1. RFL 9785 Chassis Assembly, front view with cover removed

19.1 INTRODUCTION

The front view of the RFL 9785 chassis is shown in Figure 19-1. It uses the RFL 9785 Tx/Rx Motherboard as shown in Figure 19-2, which is a view of the motherboard from the rear of the chassis.

Table 19-1. Replaceable Parts, RFL 9785 Tx/Rx Motherboard. Assembly No. 106545-2

Circuit Symbol (Figs. 19-2 & 19-3)	**Description**	**Part Number**
C1, 2, 3, 13-21	Capacitor, ceramic disc, 0.1µF, 10%, 100V	0130 11041
C4, 5, 6	Capacitor, electrolytic, 1000µF, 20%, 10V	1007 1818
C7-12	Capacitor, electrolytic, 470µF, 20%, 25V	1007 1856
J1, 3, 7, 8, 9, 10	Connector, JK, female, 64 contact, DIN	101280 1
J2, 4, 6	Connector, JK, female, 64 contact, DIN	101281 1
J5	Connector, JK, female, 96 contact, DIN	101679 1
J11	Connector wafer assy, 8 ckt	97223 8
J14, 16, 17	Connector, jack, receptacle, SMB	101485
J18	Connector wafer assy, 2 ckt	97223 2

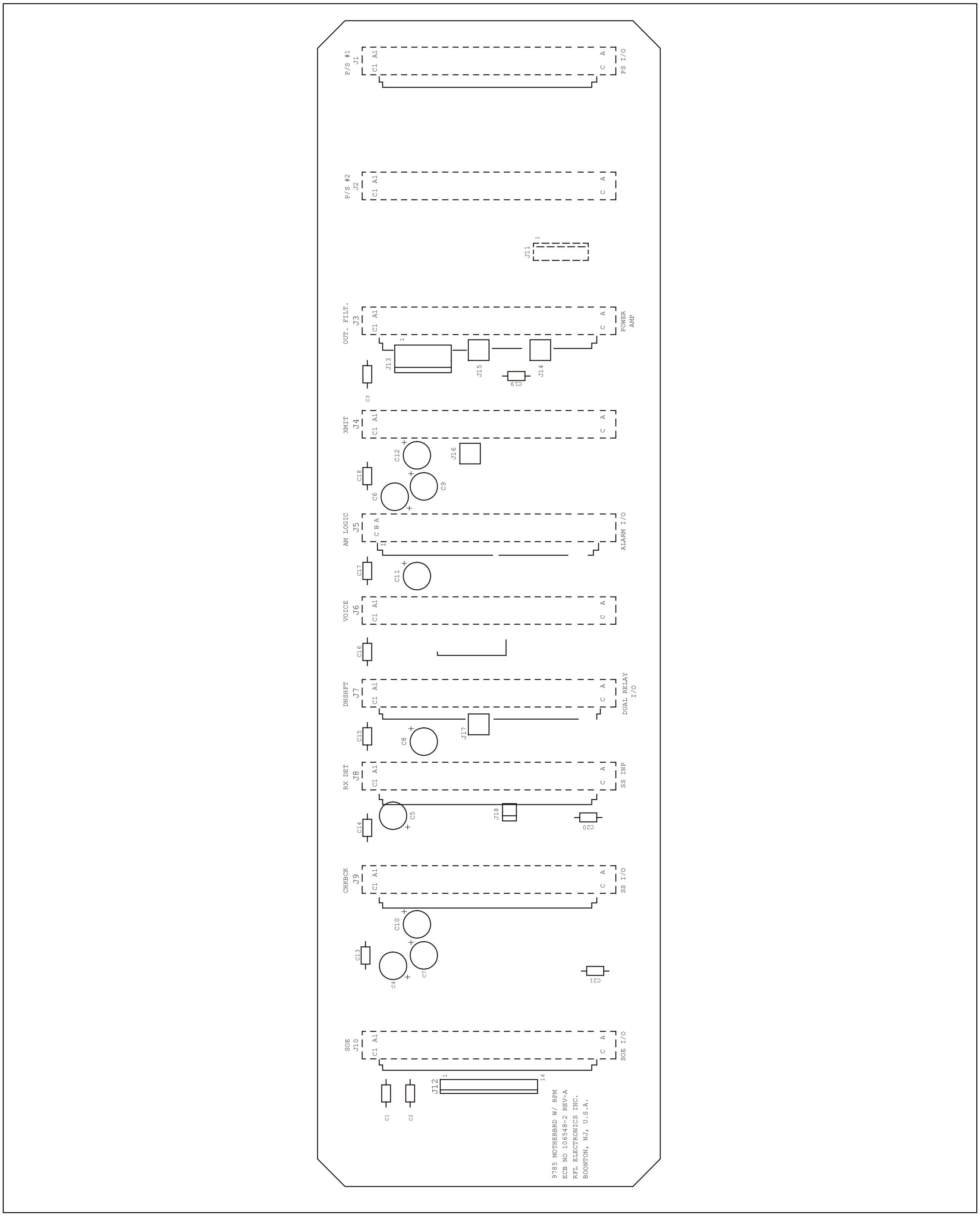


Figure 19-2. Component locator drawing, RFL 9785 Tx/Rx Motherboard.

Figure 19-3. Schematic, RFL 9785 Motherboard (Dwg. No. D-106549-2-A)

Please see Figure 19-3 in Section 22: Schematics.

Section 20. CHECKBACK ALARM CHASSIS

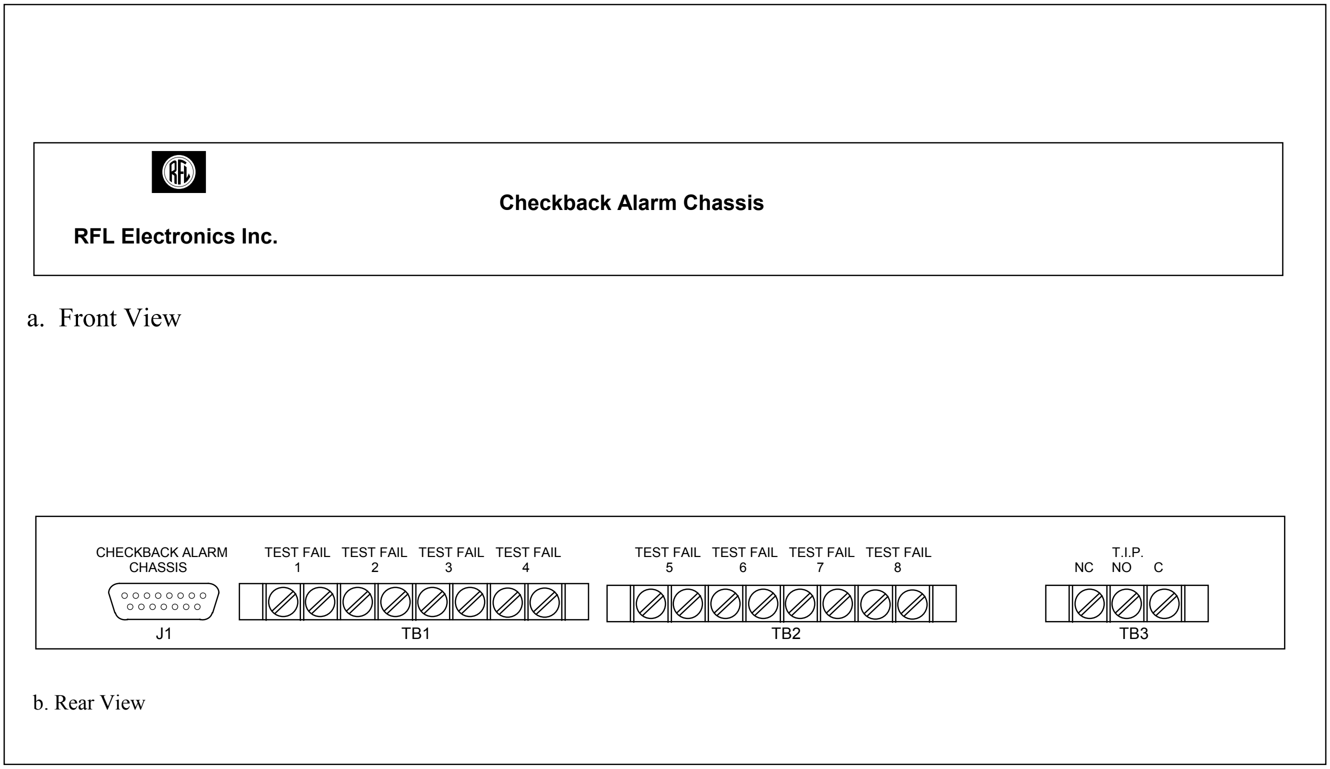


Figure 20-1. RFL 9785 Checkback Alarm Chassis, front and rear views

20.1 INTRODUCTION

The Checkback Alarm Chassis shown in Figure 20-1 allows a user to determine the results of Checkback Tests. The terminals at the rear of the chassis indicate the status of each of the eight Checkback Tests by means of a relay contact closure. There is one relay for each of the eight Checkback Tests. Each relay has common, normally open and normally closed contacts. When a relay is energized, its contacts close, thereby indicating a Checkback Test failure. See Section 15 for a description of the eight Checkback Tests. The Checkback Alarm Chassis is a 1U high chassis, and houses the RFL 9785 Checkback Alarm Board shown in Figure 20-2. When the Checkback Alarm Chassis is used, a cable supplied with the chassis must be connected between the J1 connector, and a mating connector on the 106635-X I/O module as shown in Section 18. A schematic diagram of the Checkback Alarm Board is shown in Figure 20-3.

Table 20-1. Checkback Alarm Chassis, general information

RFL Part Number	Nomenclature	See Figure:
106650	9785 Checkback Alarm Chassis	20-1
106655	9785 Checkback Alarm Board	20-2

Table 20-2. Replaceable Parts, RFL 9785 Checkback Alarm Board. Assembly No. 106665

Circuit Symbol (Figs. 20-2 & 20-3)	Description	Part Number
C1-8, 12-22	Capacitor, ceramic disc, 0.01uF, 20%, 3kV	1007 1442
C26-40, 43-47	Capacitor, ceramic dip, 0.1uF, 10%, 50V	0120 38
C41, 42	Capacitor, electrolytic, 47uF, 20%, 35V	1007 1578
CR1-4, 6-10	Diode, silicon rectifier, 1A, 1N4003	30769
J3	Connector header, single, 7 CKT	32802 7
K1-4, 6-10	Relay, SPDT, 12Vdc, 37.5mA	103678
L1-8, 12-22	Inductor, 10uH 5%, 1.5A max	30285
L26, 27	Inductor, axial, 47uH, 15%, 1.6A	105411
R1	Resistor, metal film, axial, 11 ohm, 1%, 1/4W	0410 1100
TB1, 2	Terminal block, 8 terminal, right angle	102926
TB3	Terminal block, 3 terminal, right angle	103709
U1, 2	Transistor array, ULN2803A	068012
U3	Integrated circuit, MOS, CPLD, XC9536-15PC44I	Call factory
U4,5,6	Integrated circuit, 5V, dual RS232	07207

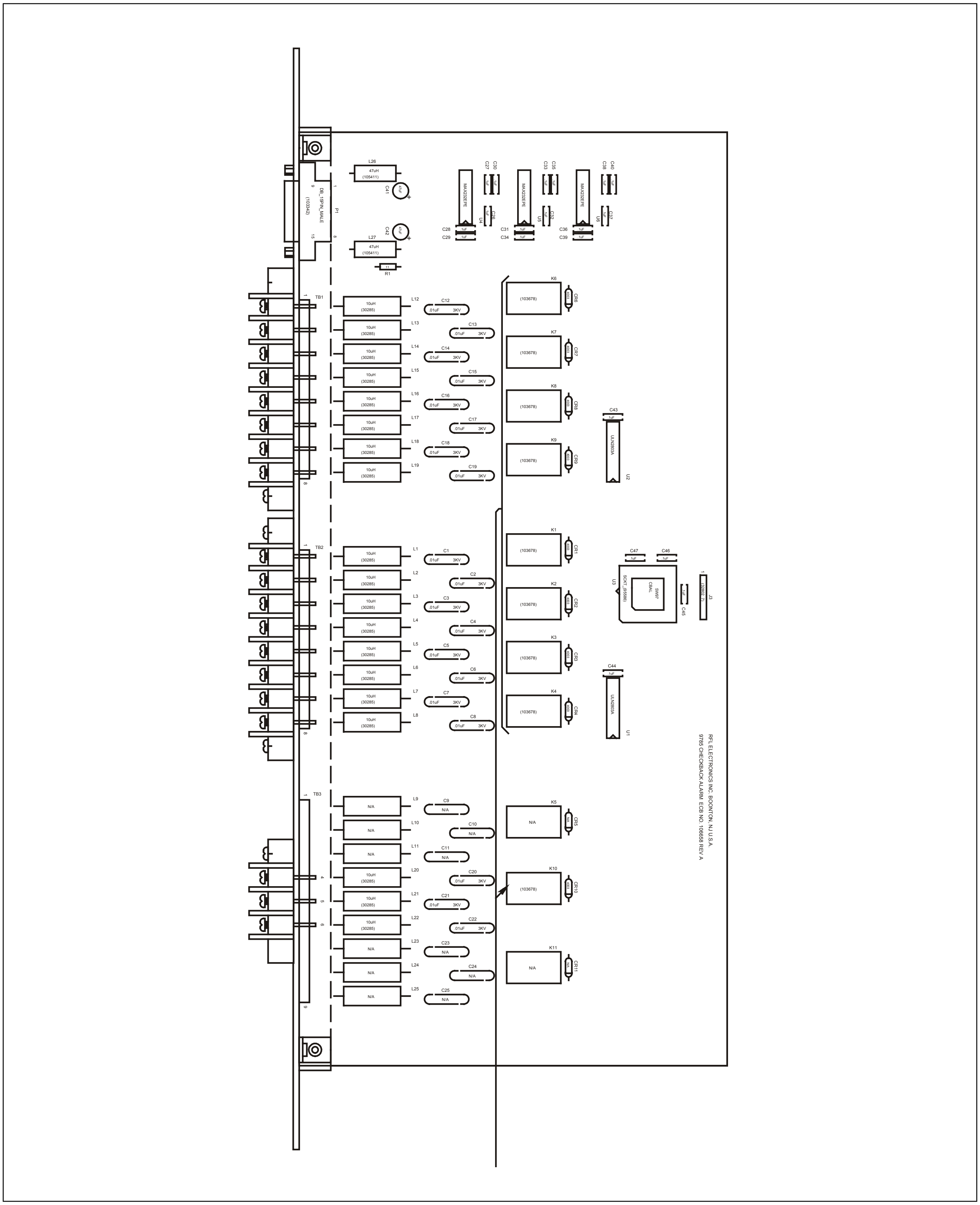


Figure 20-2. Component locator dwg, RFL 9785 Checkback Alarm Board. (Assy No. 106655, Dwg No. D-106655-A)

Figure 20-3. Schematic, RFL 9785 Checkback Alarm (Dwg. No. D-106659-A)

Please see Figure 20-3 in Section 22: Schematics.

Section 21. ACCESSORY EQUIPMENT

If any accessory equipment was furnished with your RFL 9785 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

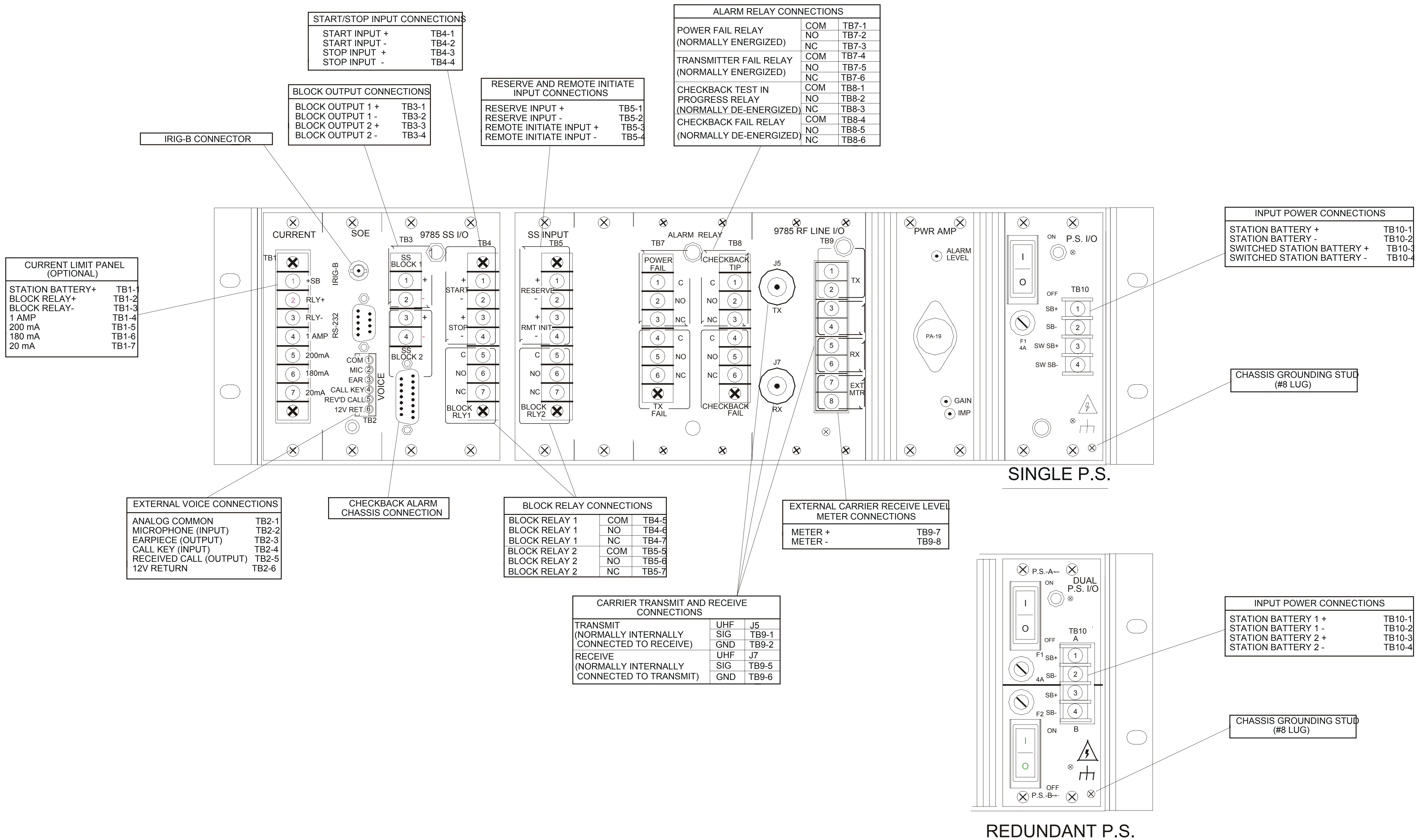


Figure 3-2. Rear Panel View of Typical RFL 9785 TX/RX Chassis (Dwg. No. D-106577-A)

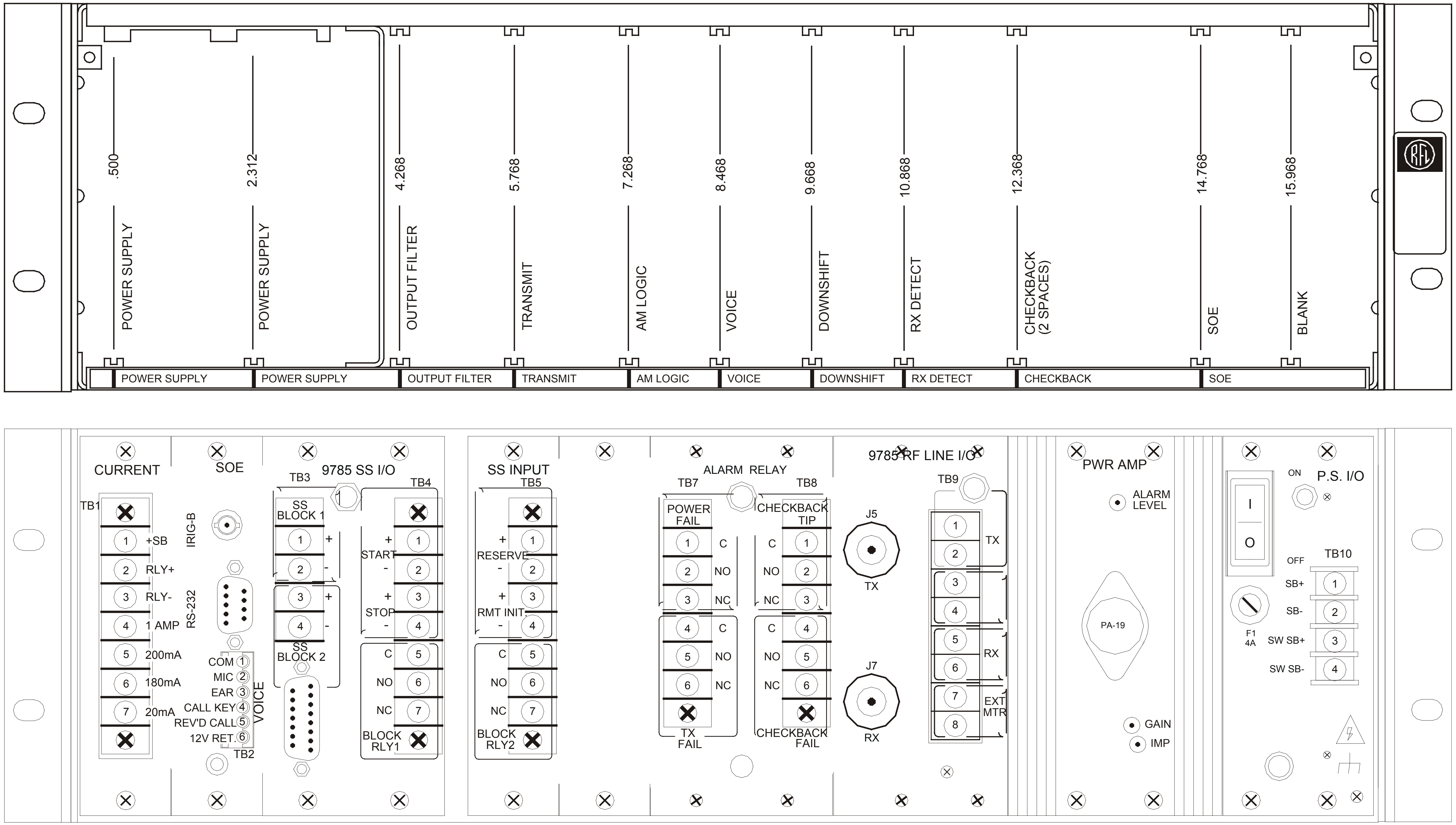


Figure 4-2. Locations of Circuit Board Modules in a Typical RFL 9785 Chassis (Dwg. No. D-106577-A)

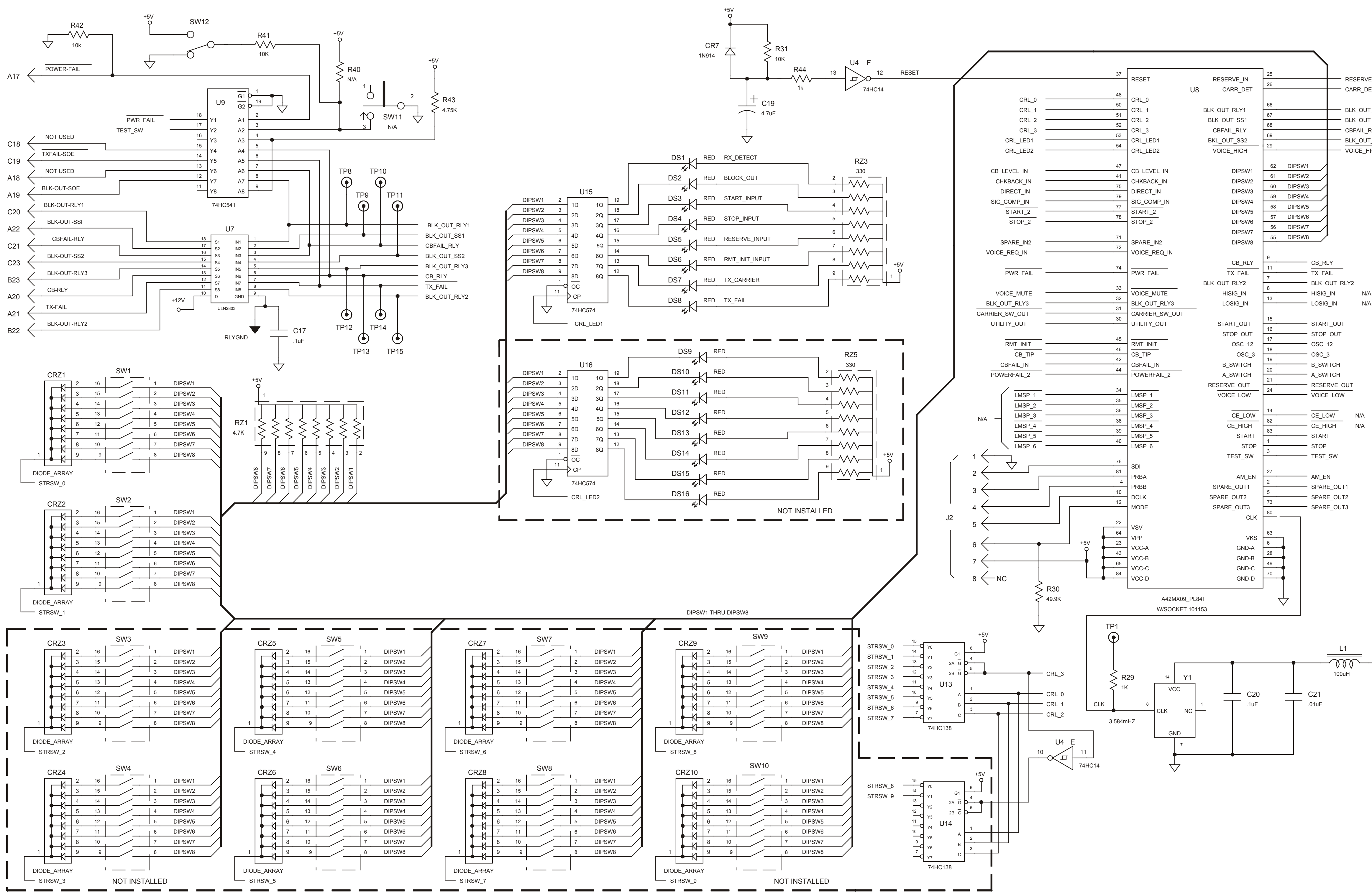


Figure 6-5. Schematic, RFL 9785 Am Logic (Dwg. No. D-106544-C) Sheet 1 of 2

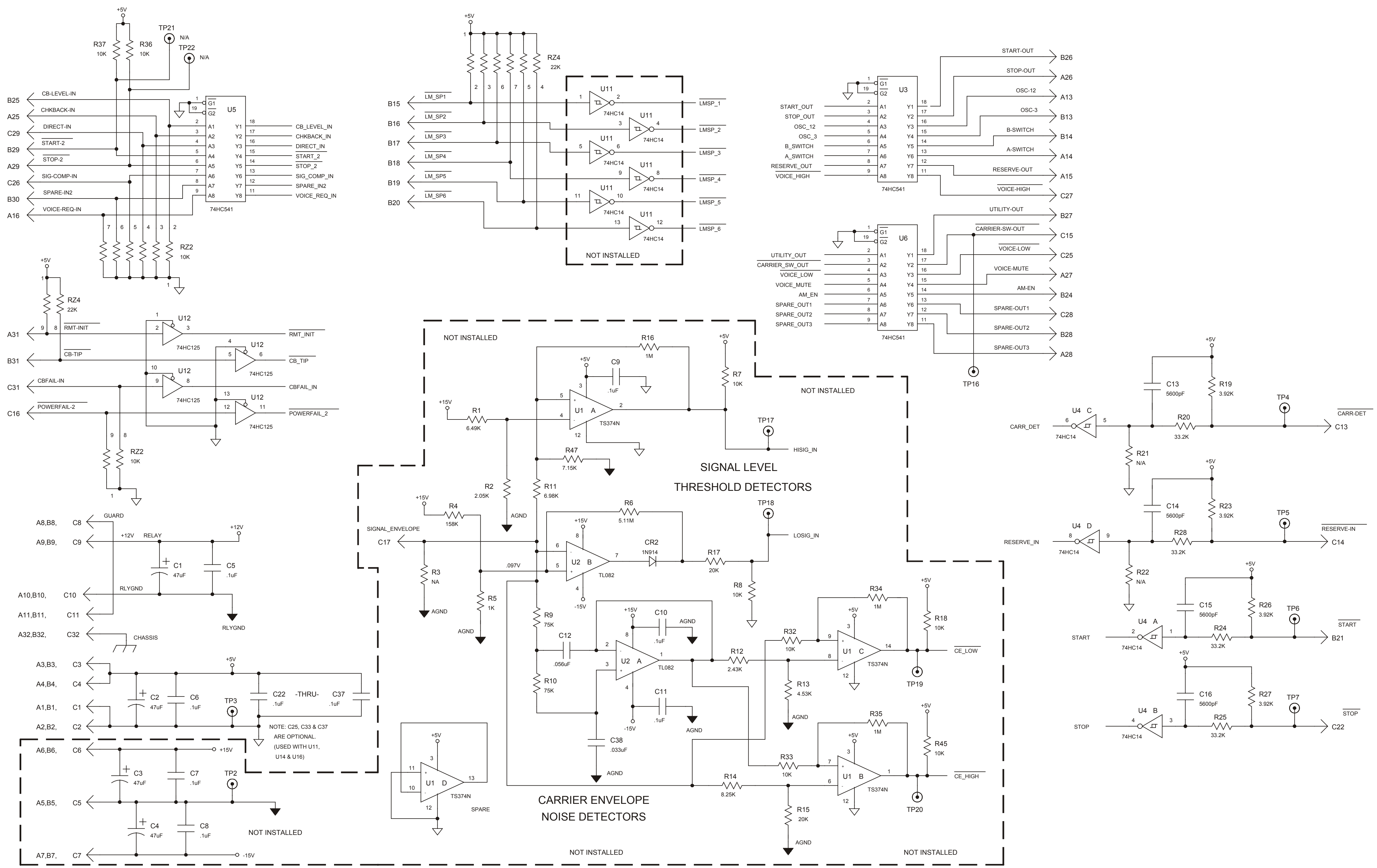


Figure 6-5. Schematic, RFL 9785 AM Logic (Dwg. No. D-106544-C) Sheet 2 of 2

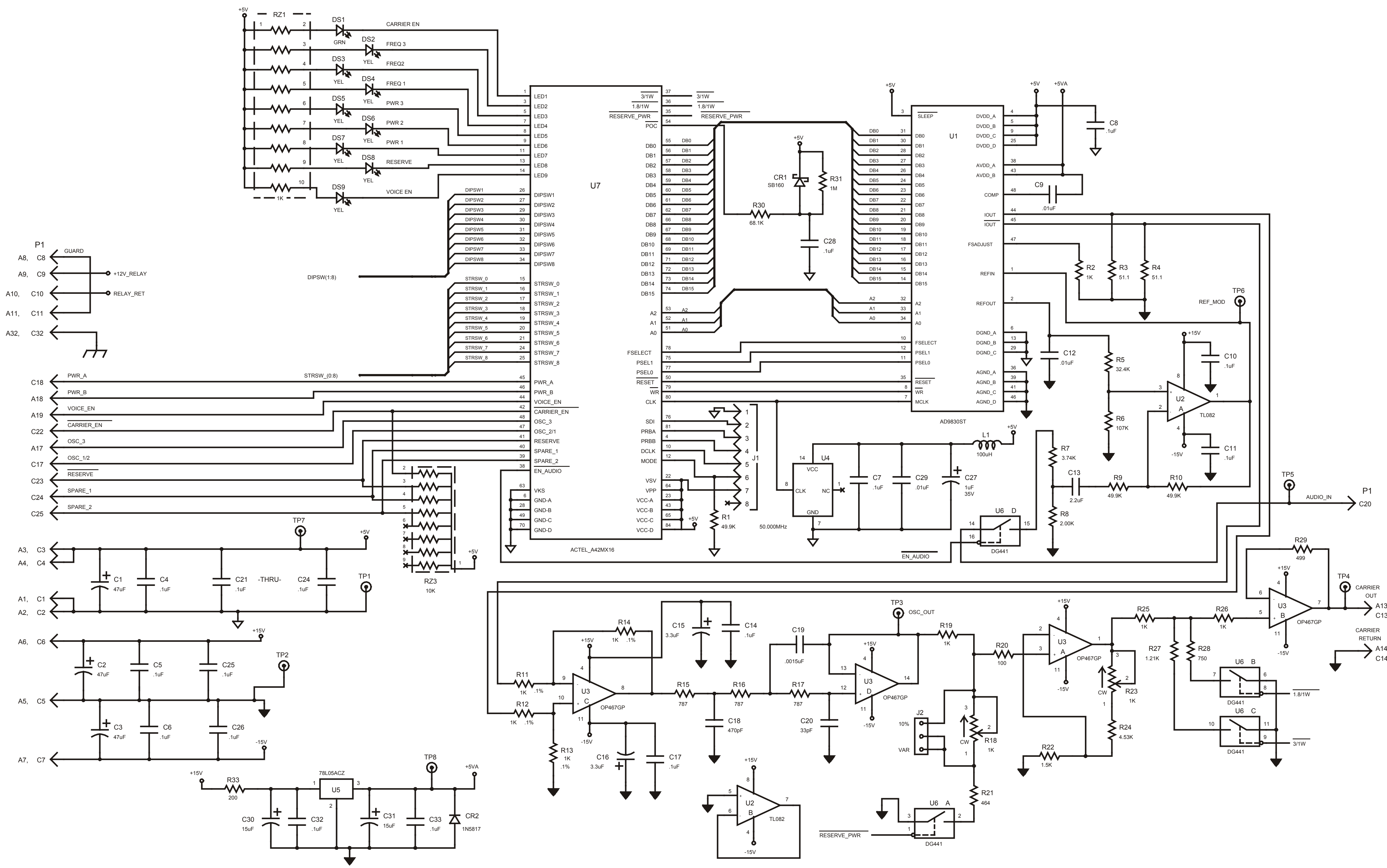


Figure 7-6. Schematic, RFL 9785 Transmitter (Dwg. No. D-106509-C) Sheet 1 of 2

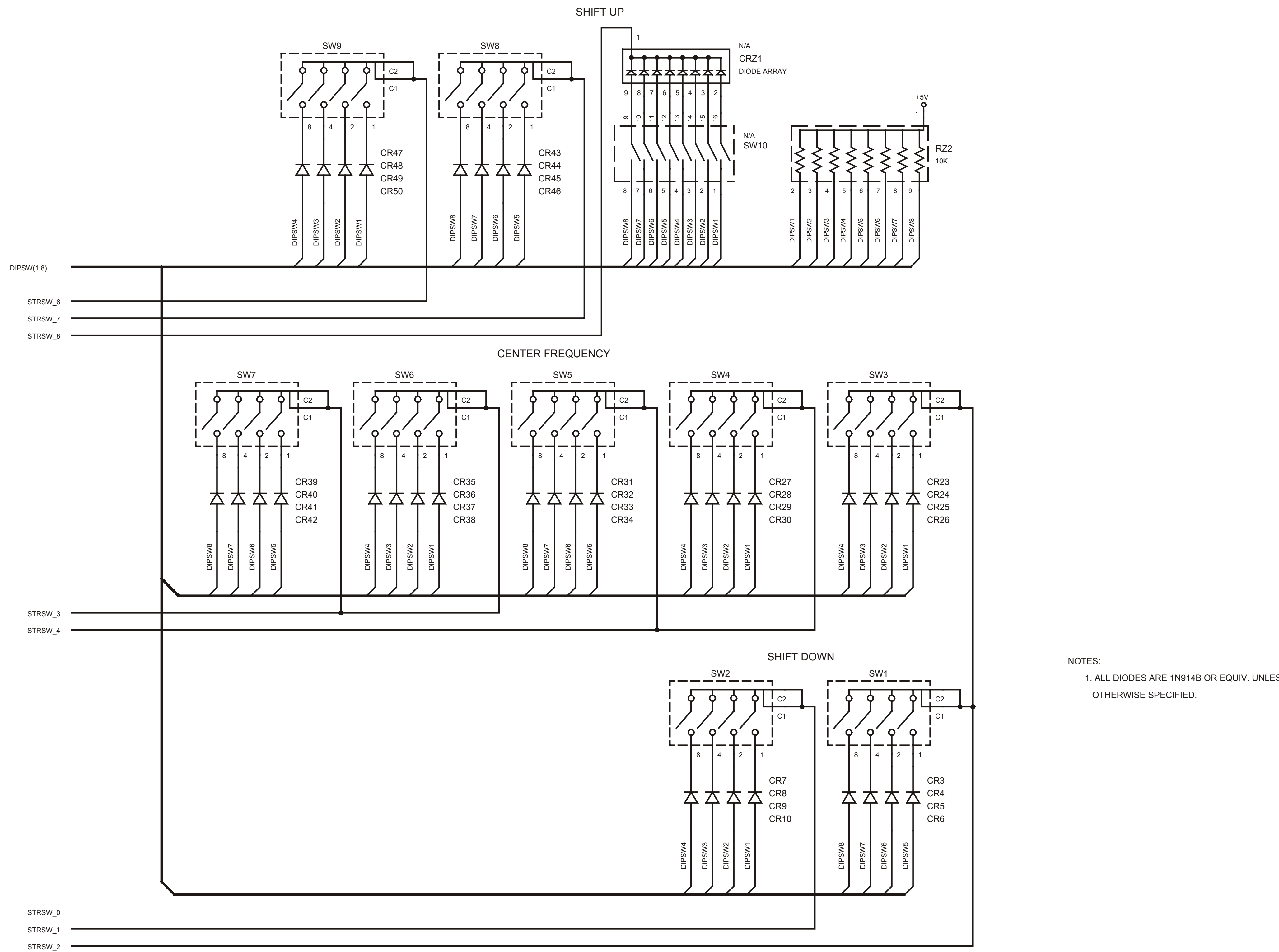


Figure 7-6. Schematic, RFL 9785 Transmitter (Dwg. No. D-106509-C) Sheet 2 of 2

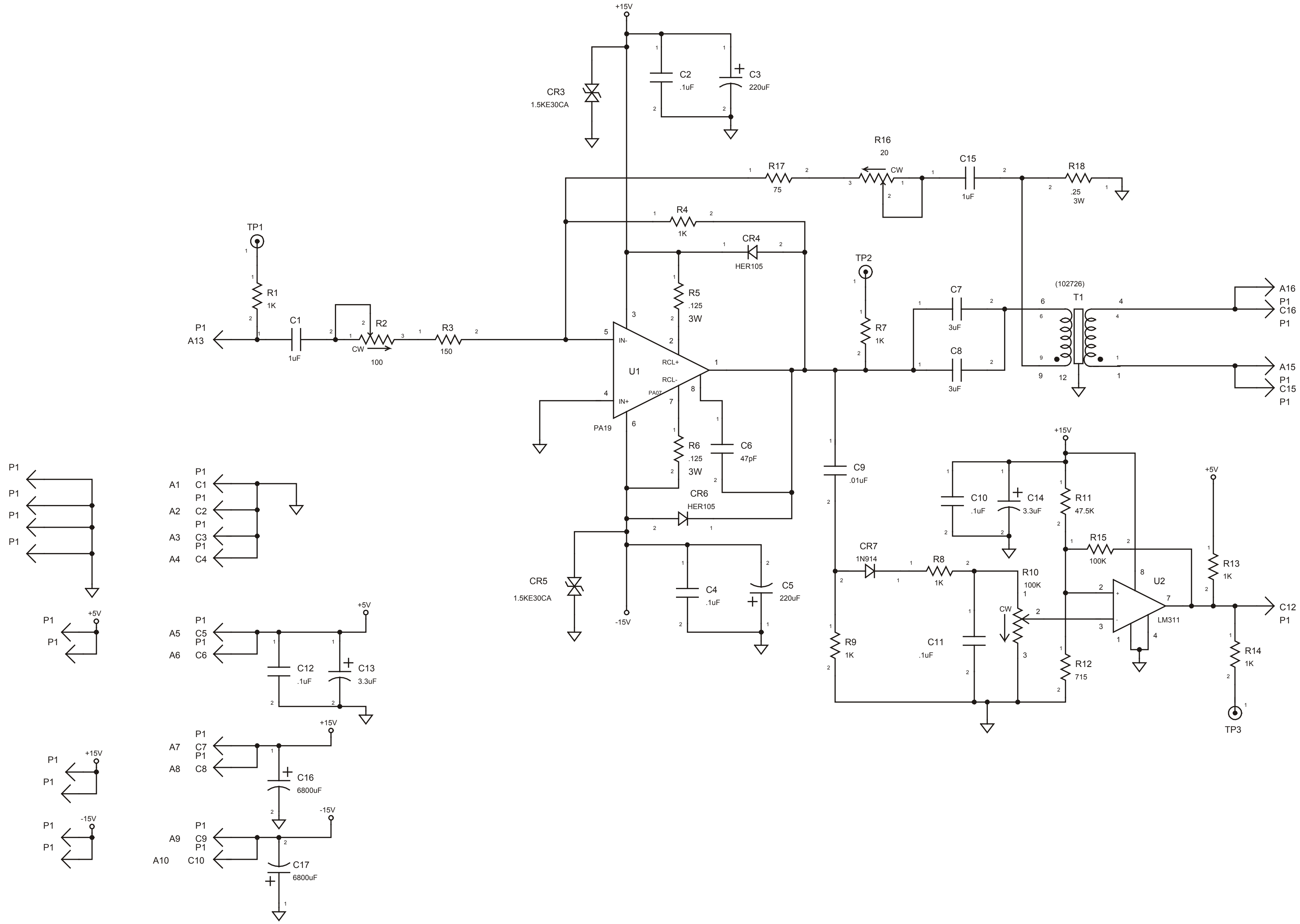
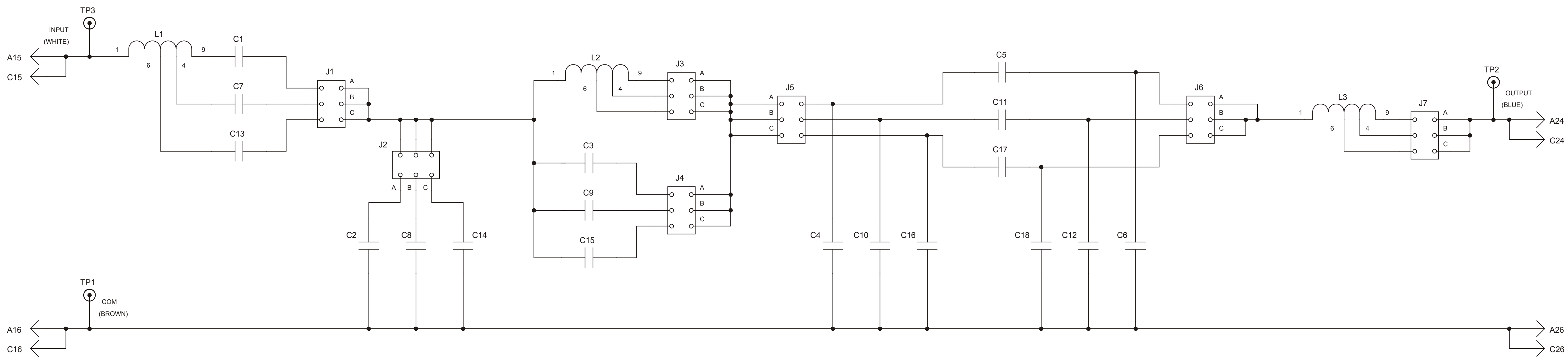
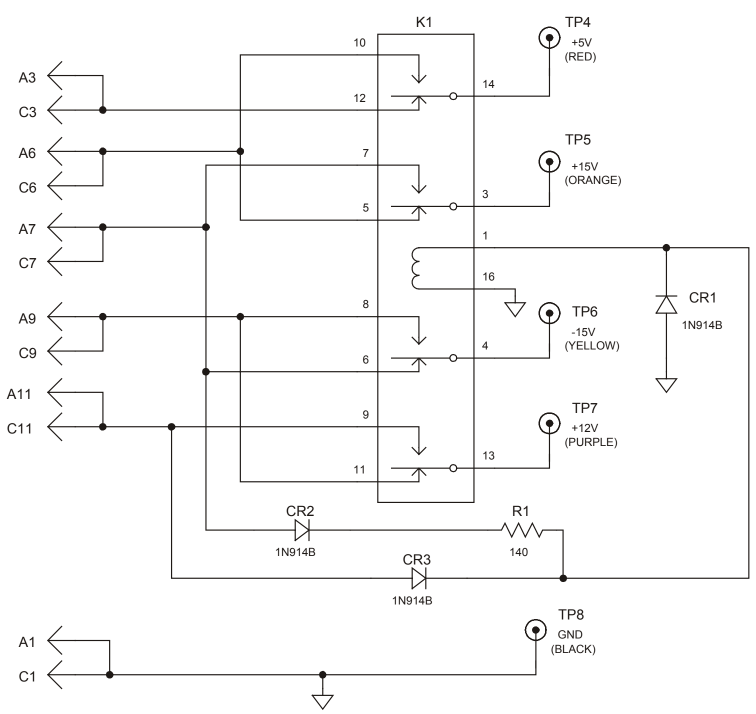


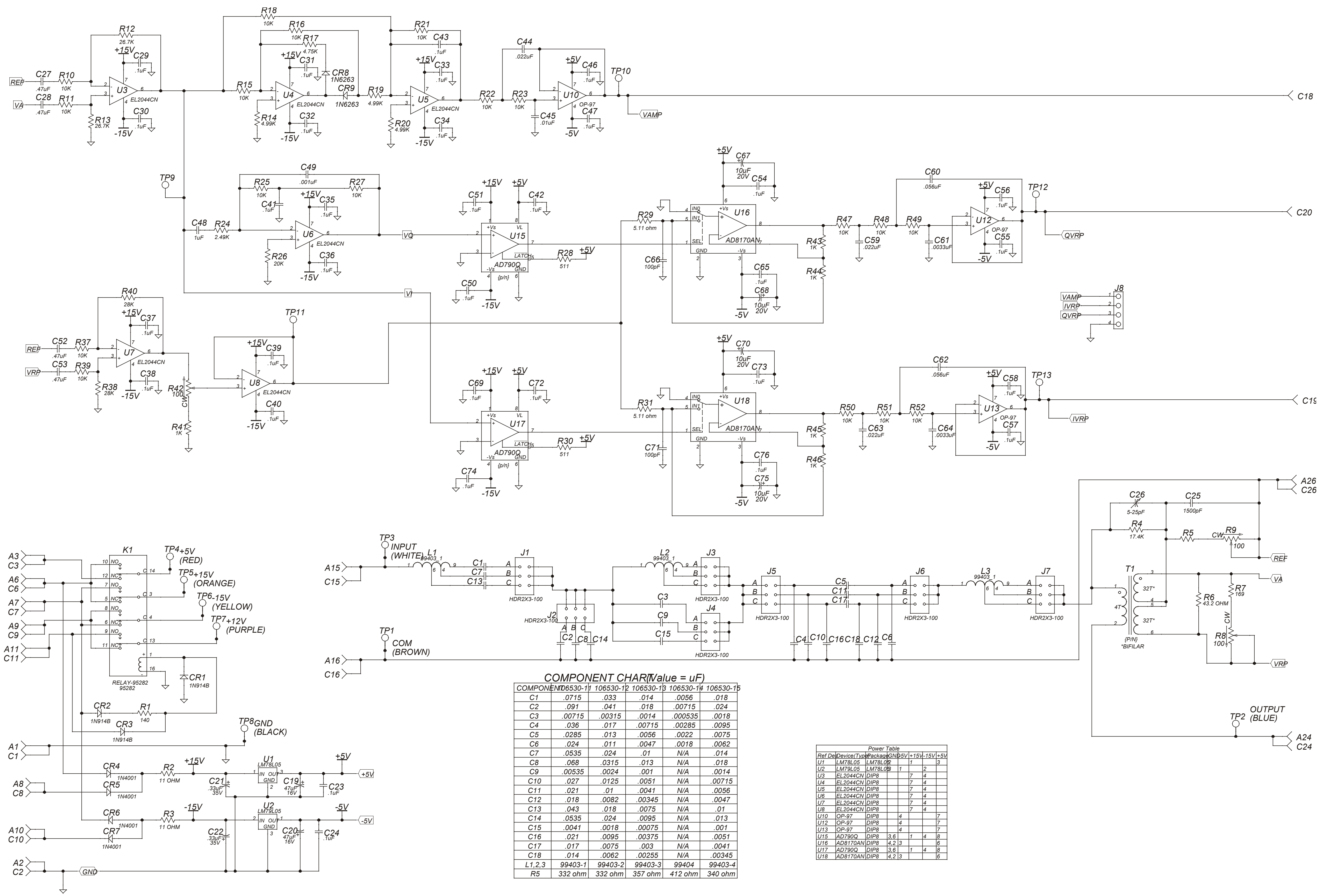
Figure 8-4. Schematic, RFL 9785 Power Amp (Dwg. No. C-106464-B)





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 9-6. Schematic, RFL 9785 Output Filters Without Reflected Power Meter, Assy Nos. 106530-1 to -5 (Dwg. 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 9-7. Schematic, RFL 9785 Output Filters With Reflected Power Meter, Assy Nos. 106530-11 to -15 (Dwg. No. D-106534-1-B)

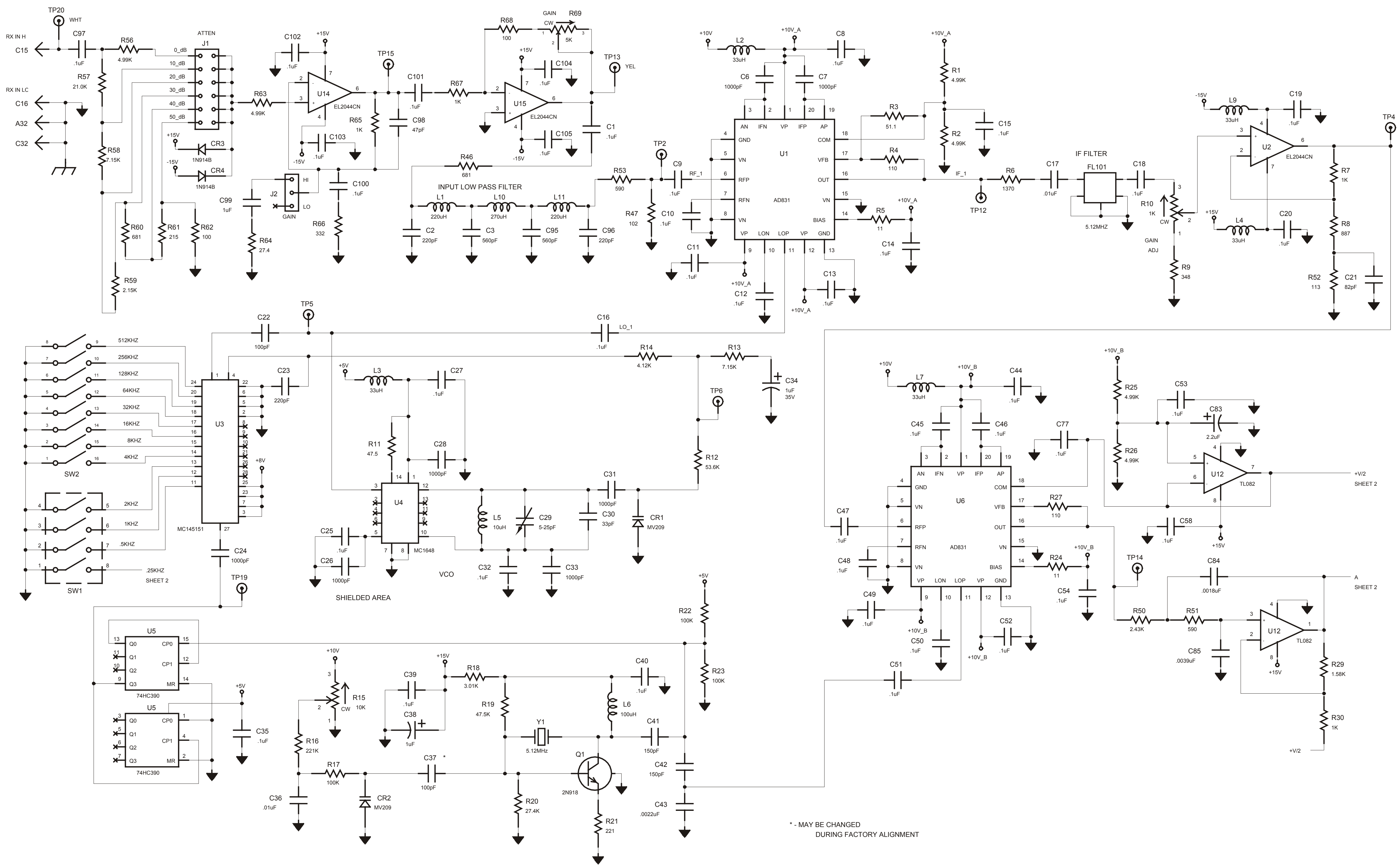


Figure 10-5. Schematic, RFL 9785 RX Downshifter (Dwg. No. D-106579-D) Sheet 1 of 2

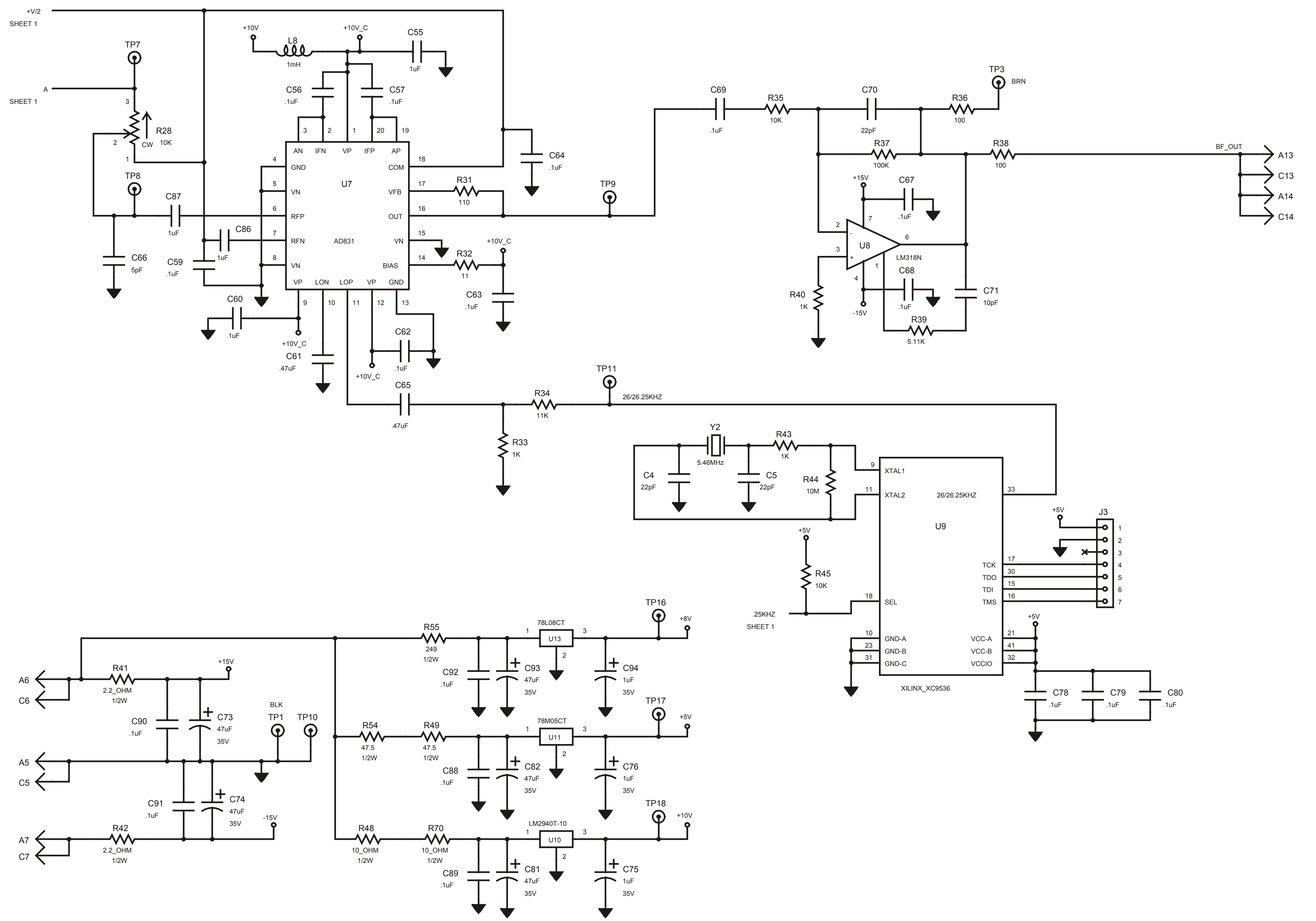
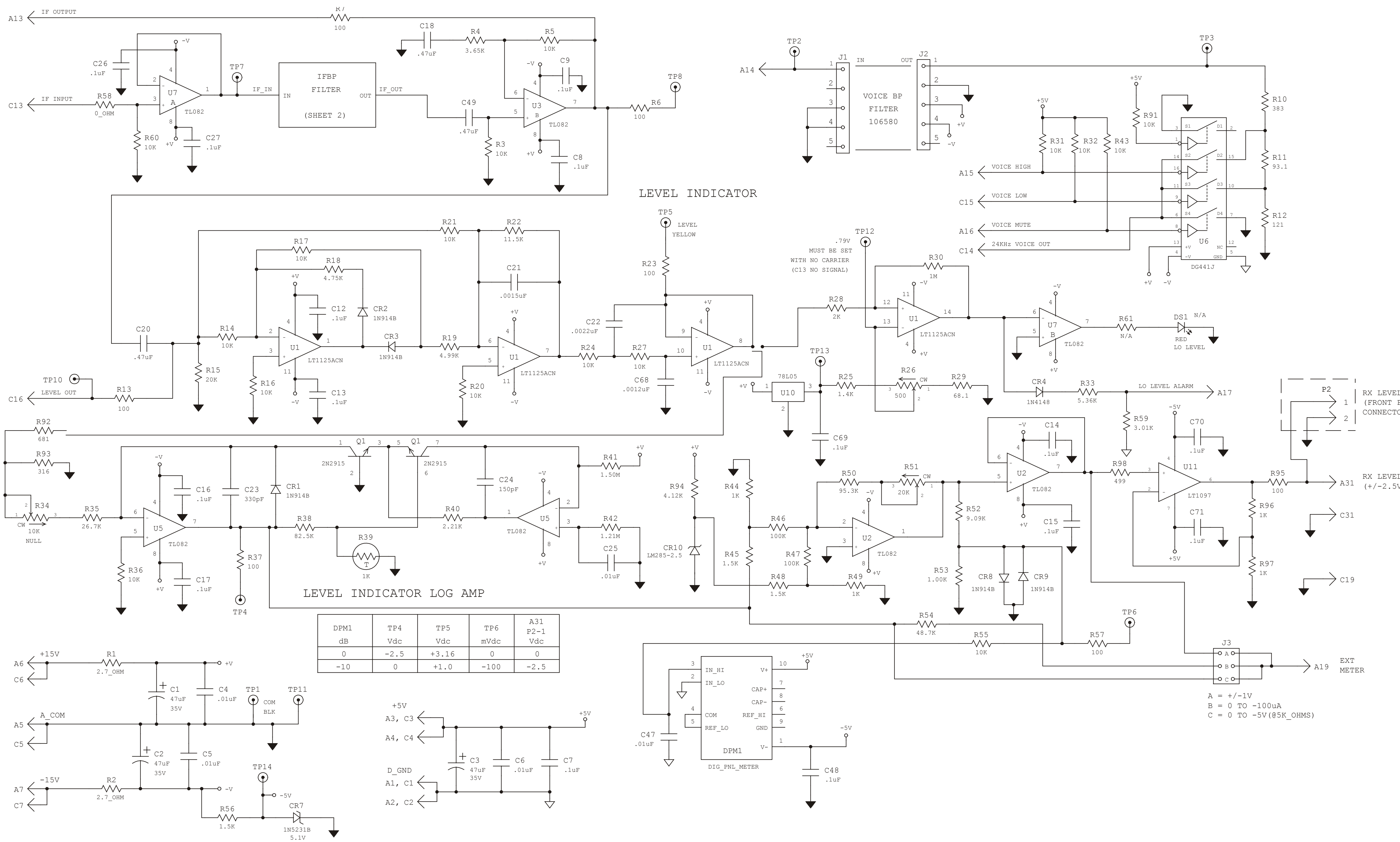
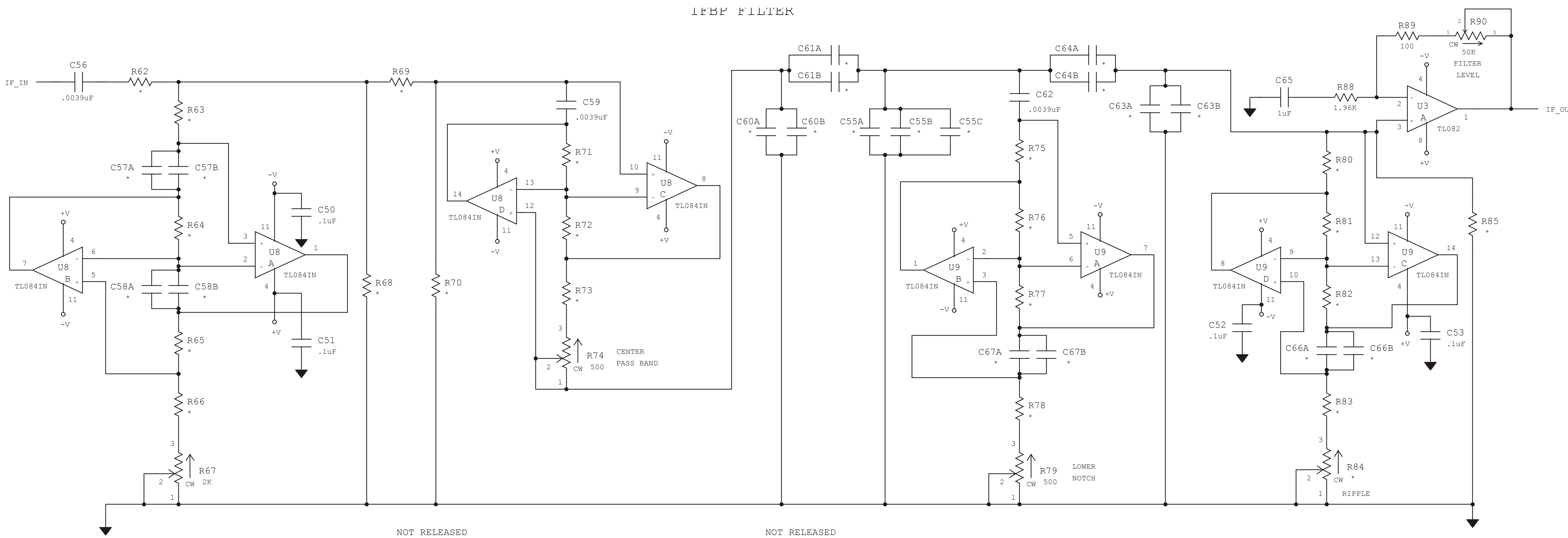


Figure 10-5. Schematic, RFL 9785 RX Downshifter (Dwg. No. D-106579-D) Sheet 2 of 2



DPM1 dB	TP4 Vdc	TP5 Vdc	TP6 mVdc	A31 P2-1 Vdc
0	-2.5	+3.16	0	0
-10	0	+1.0	-100	-2.5

Figure 11-5. Schematic, RFL 9785 RX Detector (Dwg. No. D-106519-E) Sheet 1 of 2



				NOT RELEASED REF. ONLY	
REF. DESIG.	106515-6 500Hz	106515-7 1000Hz	106515-8 1500Hz	106515-4 650Hz	106515-5 2000Hz
R62	511	511	499	511	511
R63	6.49K	3.32K	2.26K	4.99K	1.74K
R64	6.98K	3.92K	3.16K	5.49K	2.55K
R65	6.98K	3.92K	3.16K	5.49K	2.55K
R66	6.04K	2.94K	2.15K	4.42K	1.54K
R68	649	681	715	649	750
R69	11K	11K	11K	11K	11.3K
R70	845	1.87K	3.09K	1.13K	4.75K
R71	1.74K	1.74K	1.74K	1.74K	1.78K
R72	1.74K	1.74K	1.74K	1.74K	1.78K
R73	1.43K	1.47K	1.5K	1.47K	1.5K
R75	1.78K	1.96K	2.15K	1.87K	2.32K
R76	1.78K	1.96K	2.15K	1.87K	2.32K
R77	1.78K	1.96K	2.15K	1.87K	2.32K
R78	1.58K	1.74K	1.91K	1.62K	2.1K
R80	562	1.1K	1.65K	732	2.21K
R81	562	1.1K	1.65K	732	2.21K
R82	562	1.1K	1.65K	732	2.21K
R83	499	1K	1.58K	681	2.15K
R84	100	200	200	100	100
R85	34K	34.8K	34.8K	34.8K	35.7K

				NOT RELEASED REF. ONLY	
REF. DESIG.	106515-6 500Hz	106515-7 1000Hz	106515-8 1500Hz	106515-4 650Hz	106515-5 2000Hz
C57A	820pF	.0012uF	.0022uF	.0012uF	.0027uF
C57B	120pF	560pF	--	--	--
C58A	820pF	.0012uF	.0022uF	.0012uF	.0027uF
C58B	120pF	560pF	--	--	--
C60A	.0056uF	.0022uF	--	.0056uF	--
C60B	.0018uF	.0012uF	.0022uF	--	.0015uF
C61A	820pF	560pF	390pF	560pF	390pF
C61B	100pF	56pF	100pF	220pF	22pF
C55A	--	.01uF	.012uF	.033uF	.0068uF
C55B	--	.01uF	560pF	--	.0018uF
C55C	.047uF	--	--	--	--
C67A	.039uF	.0022uF	.0022uF	.0018uF	.0015uF
C67B	--	.0012uF	.001uF	.0018uF	.0015uF
C64A	.0012uF	820pF	560pF	.001uF	560pF
C64B	100pF	100pF	180pF	150pF	56pF
C63A	.01uF	.0039uF	.0022uF	.0056uF	.0022uF
C63B	560pF	.001uF	.001uF	.0022uF	100pF
C66A	--	.0056uF	.0039uF	.0068uF	.0022uF
C66B	.012uF	560pF	220pF	.0022uF	.001uF

Figure 11-5. Schematic, RFL 9785 RX Detector (Dwg. No. D-106519-E) Sheet 2 of 2

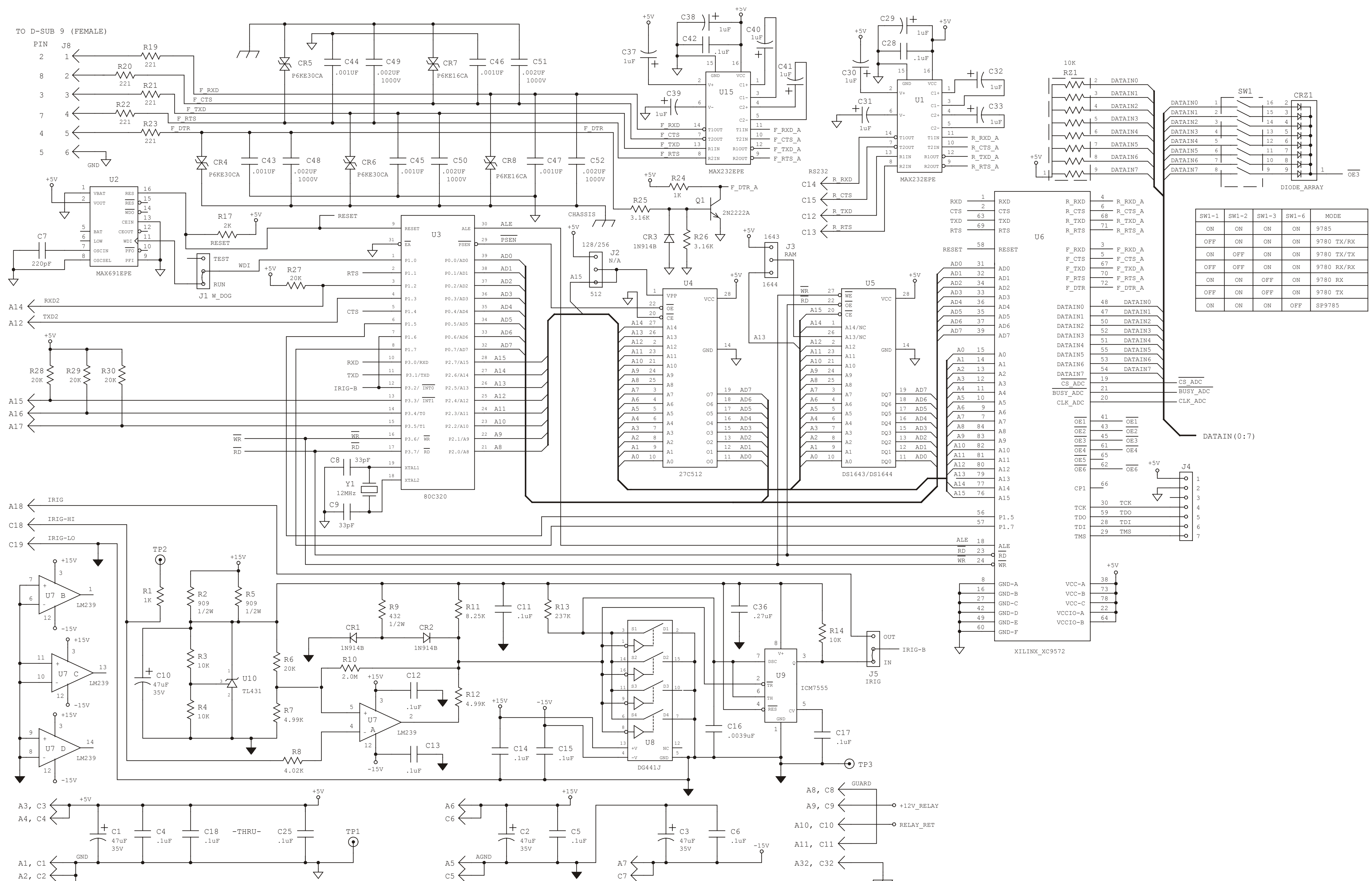


Figure 12-4. Schematic, RFL 9785 SOE/IRIG-B With Reflected Power Meter (Dwg. No. D-106484-1-B) Sheet 1 of 2

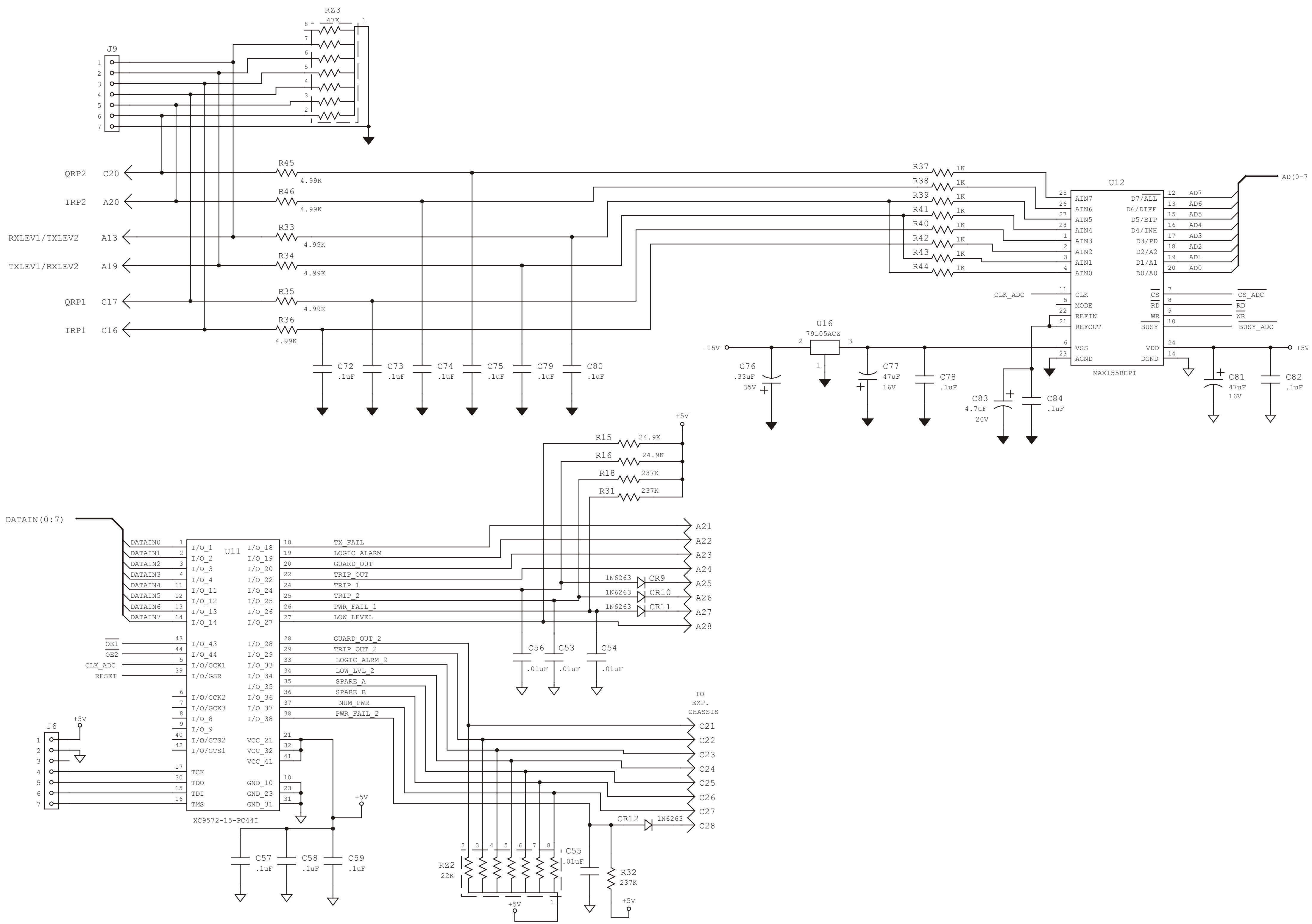


Figure 12-4. Schematic, RFL 9785 SOE/IRIG-B With Reflected Power Meter (Dwg. No. D-106484-1-B) Sheet 2 of 2

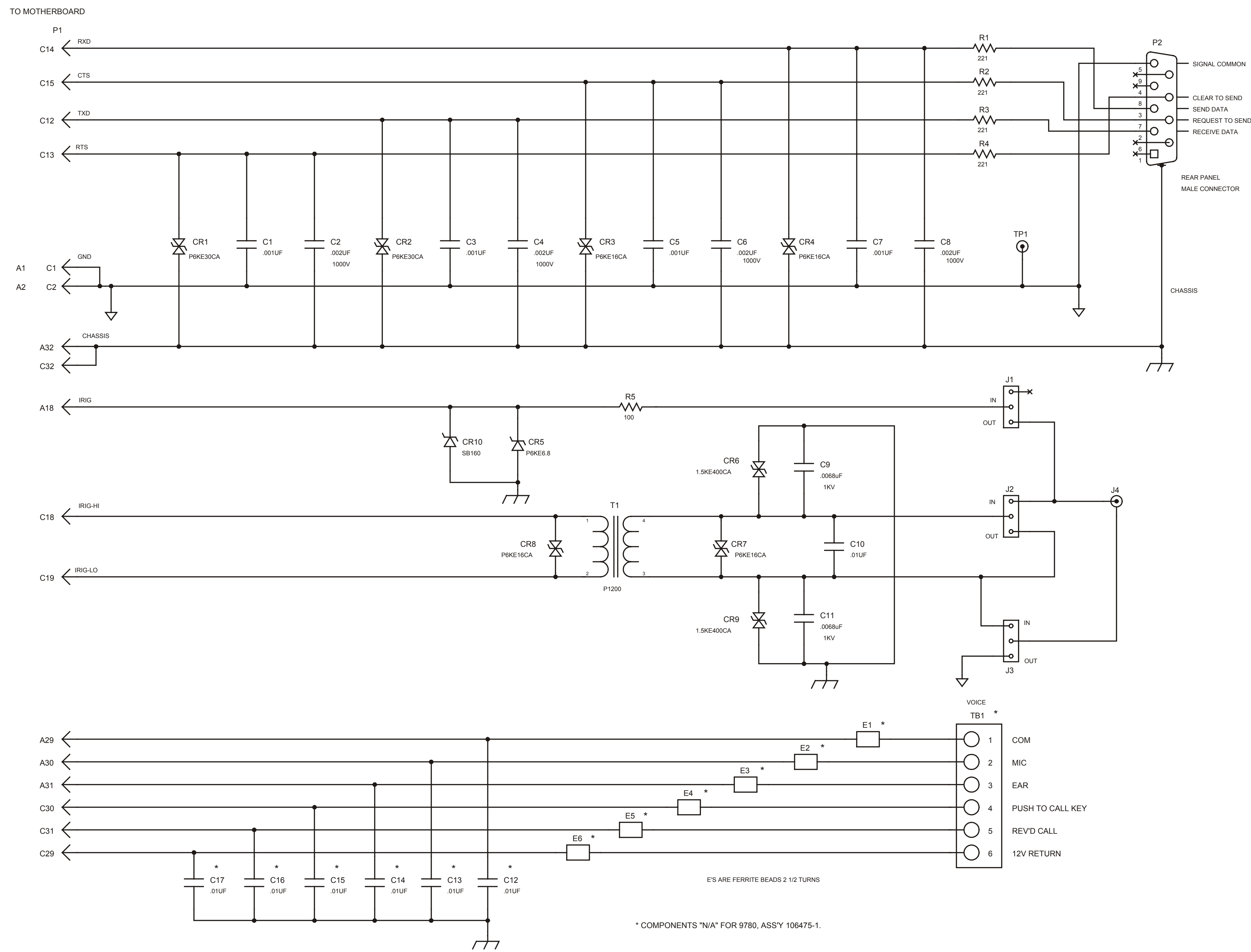


Figure 12-8. Schematic, RFL 9785 SOE/IRIG-B I/O (Dwg. No. D-106479-B)

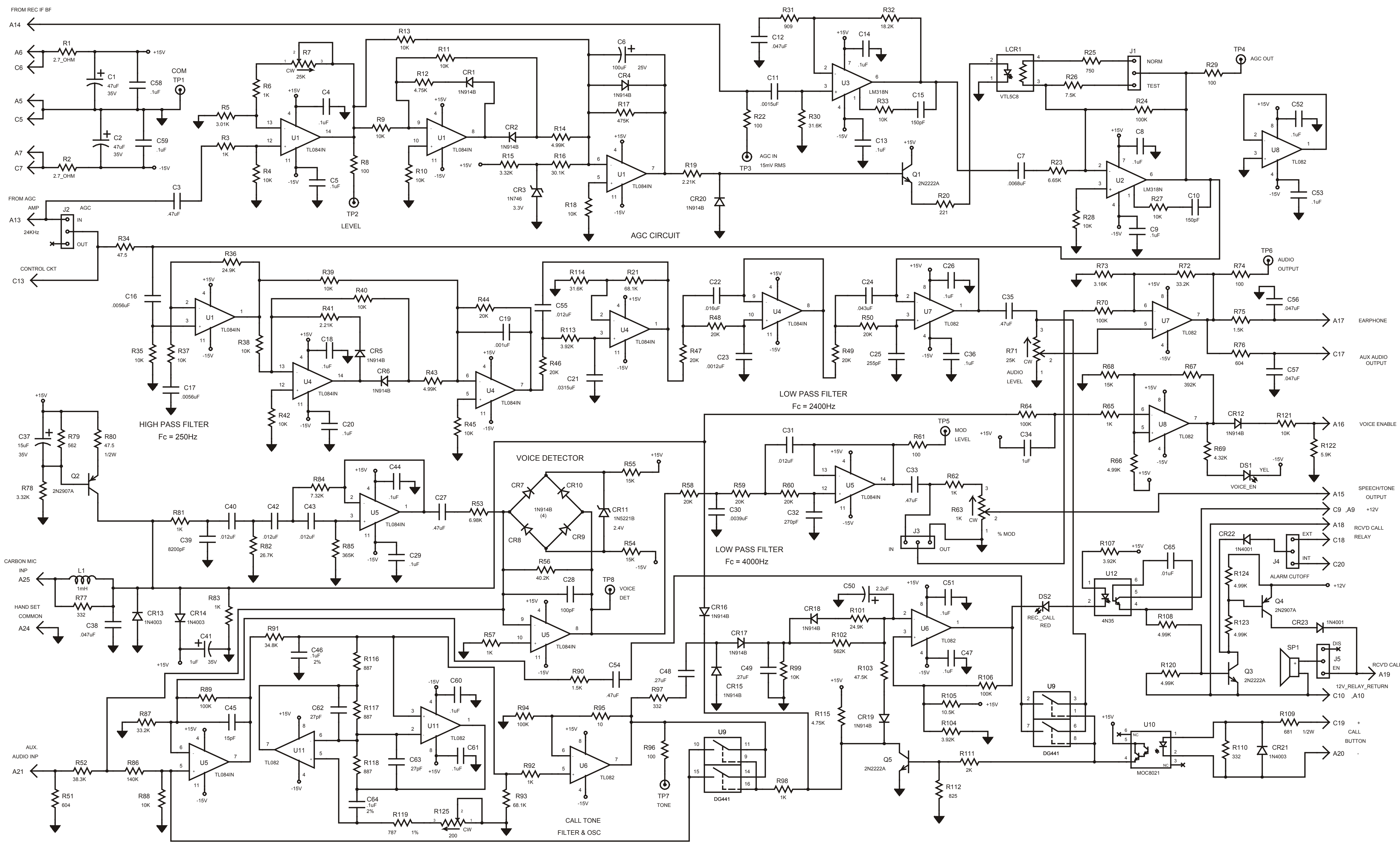


Figure 14-6. Schematic, RFL 9785 Voice Module (Dwg. No. D-106569-C)

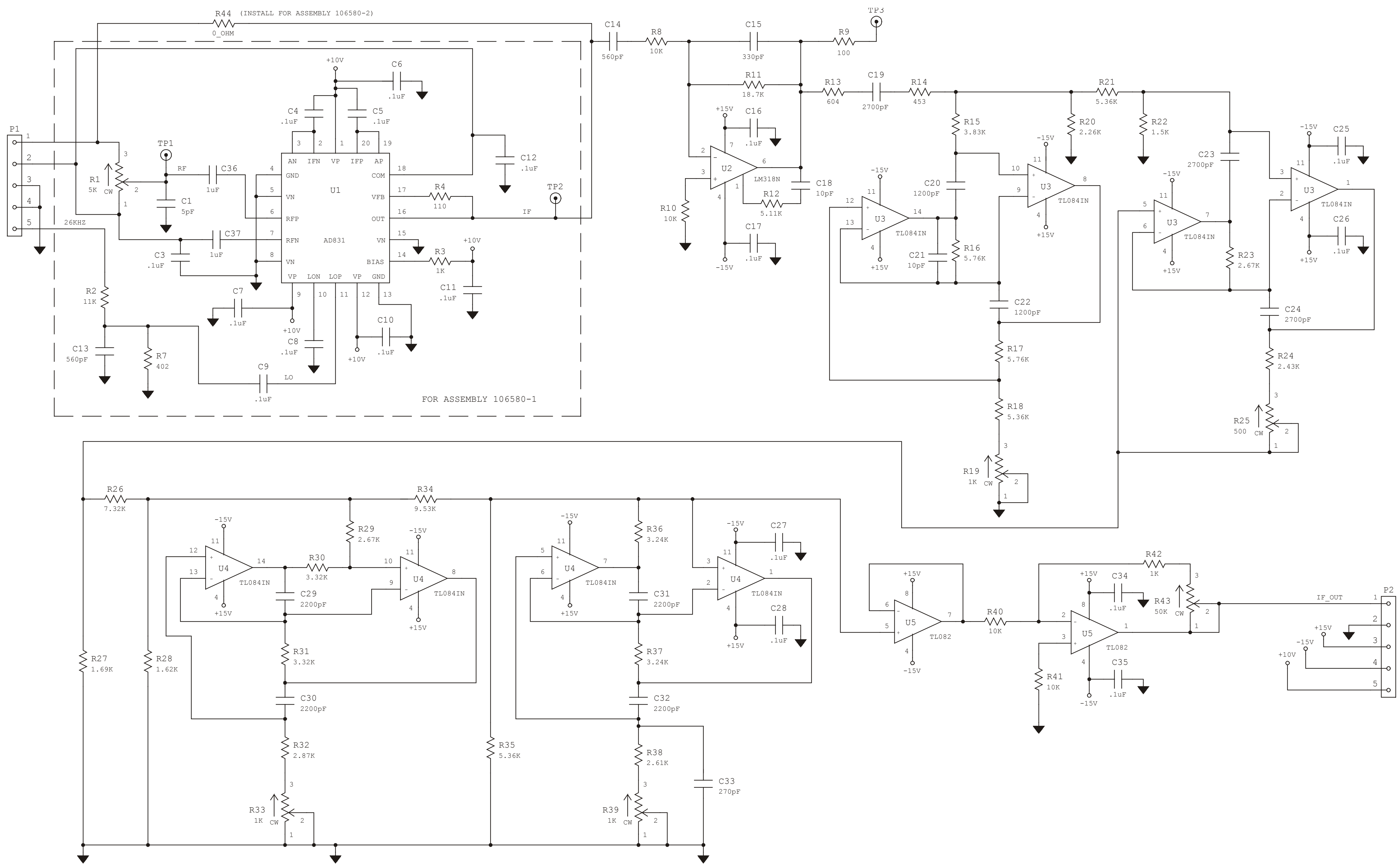


Figure 14-9. Schematic, RFL 9785 Voice Filter (Dwg. No. D-106584-B)

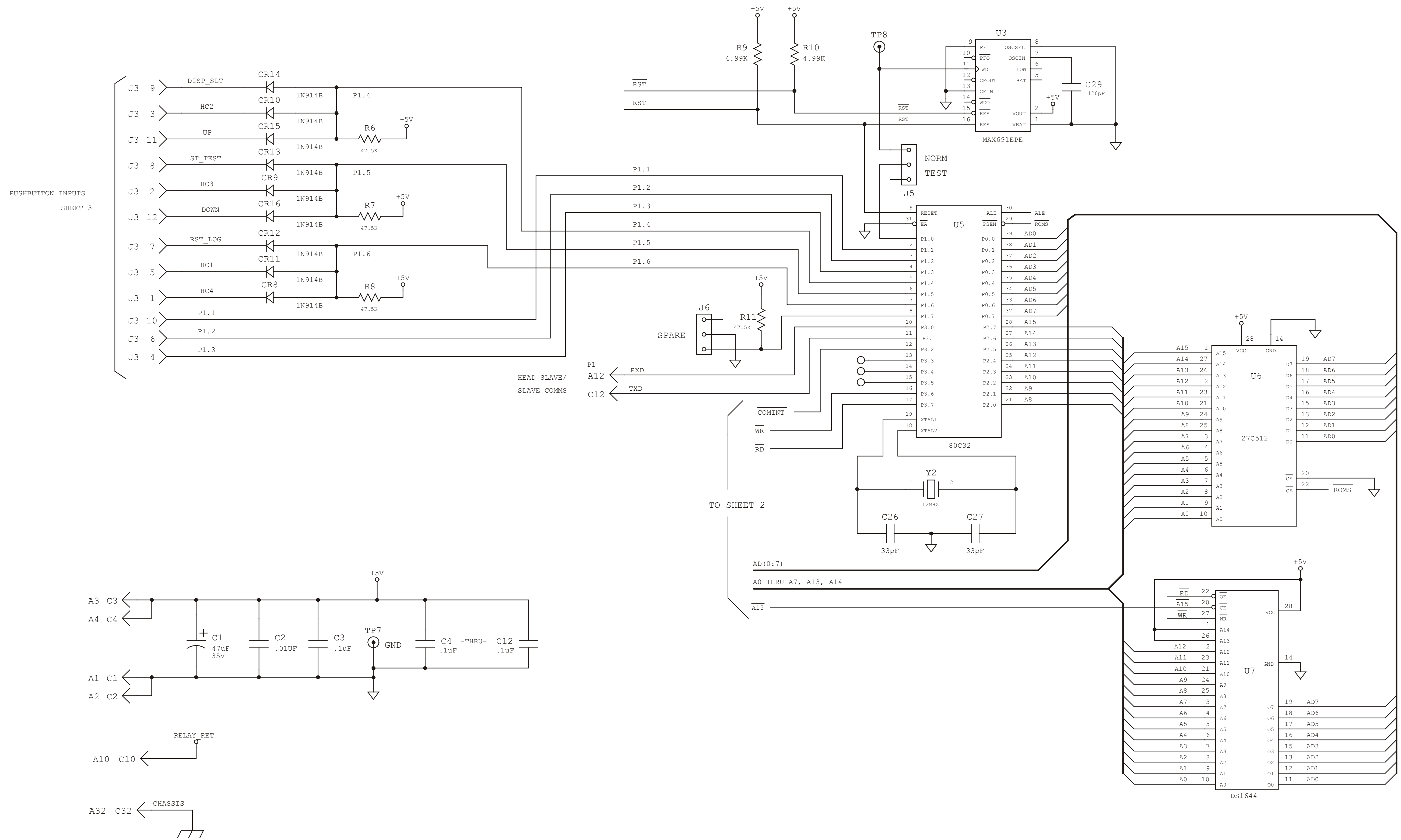


Figure 15-21. Schematic, RFL 9785 Checkback (Dwg. No. D-106529-C) Sheet 1 of 3

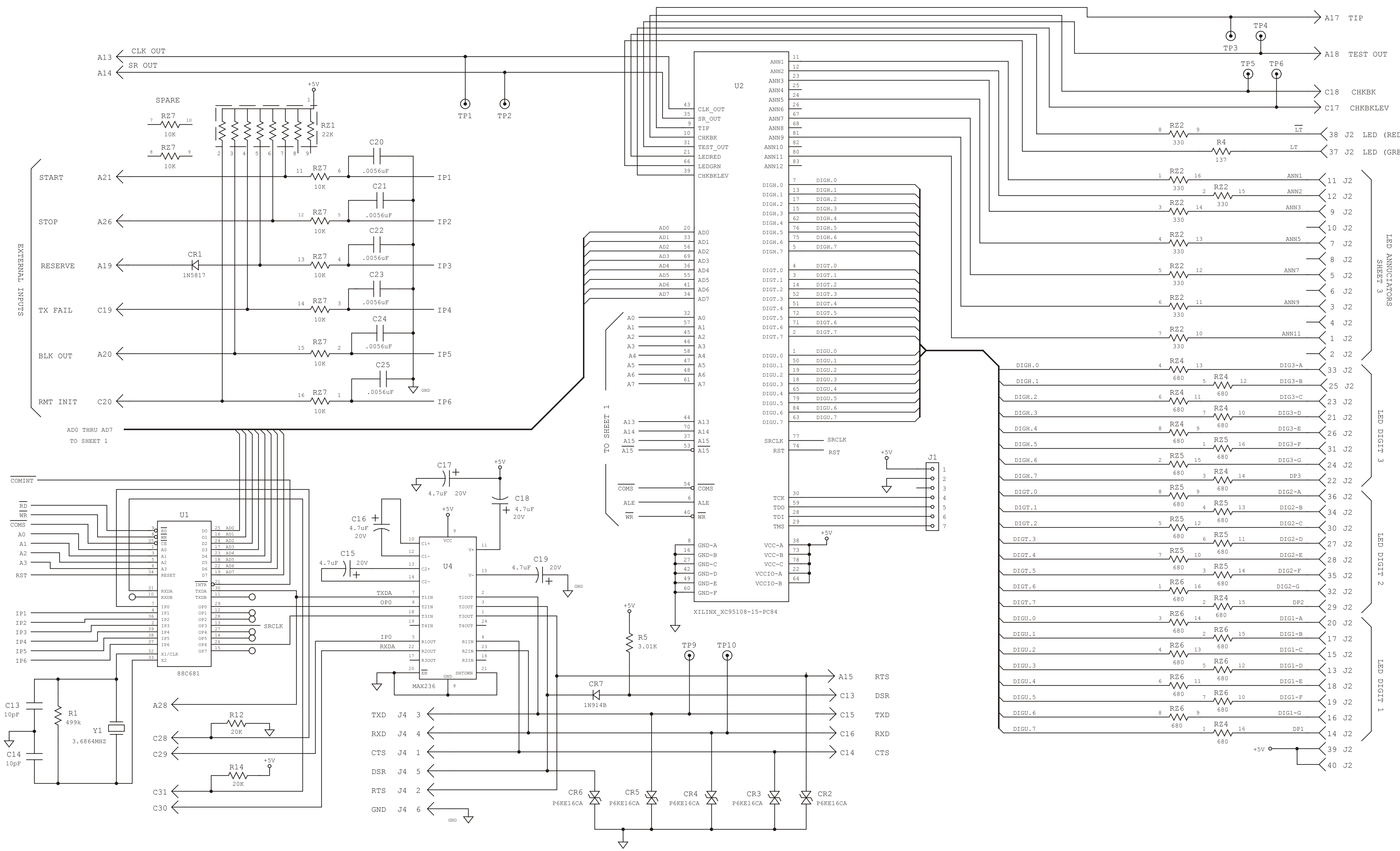
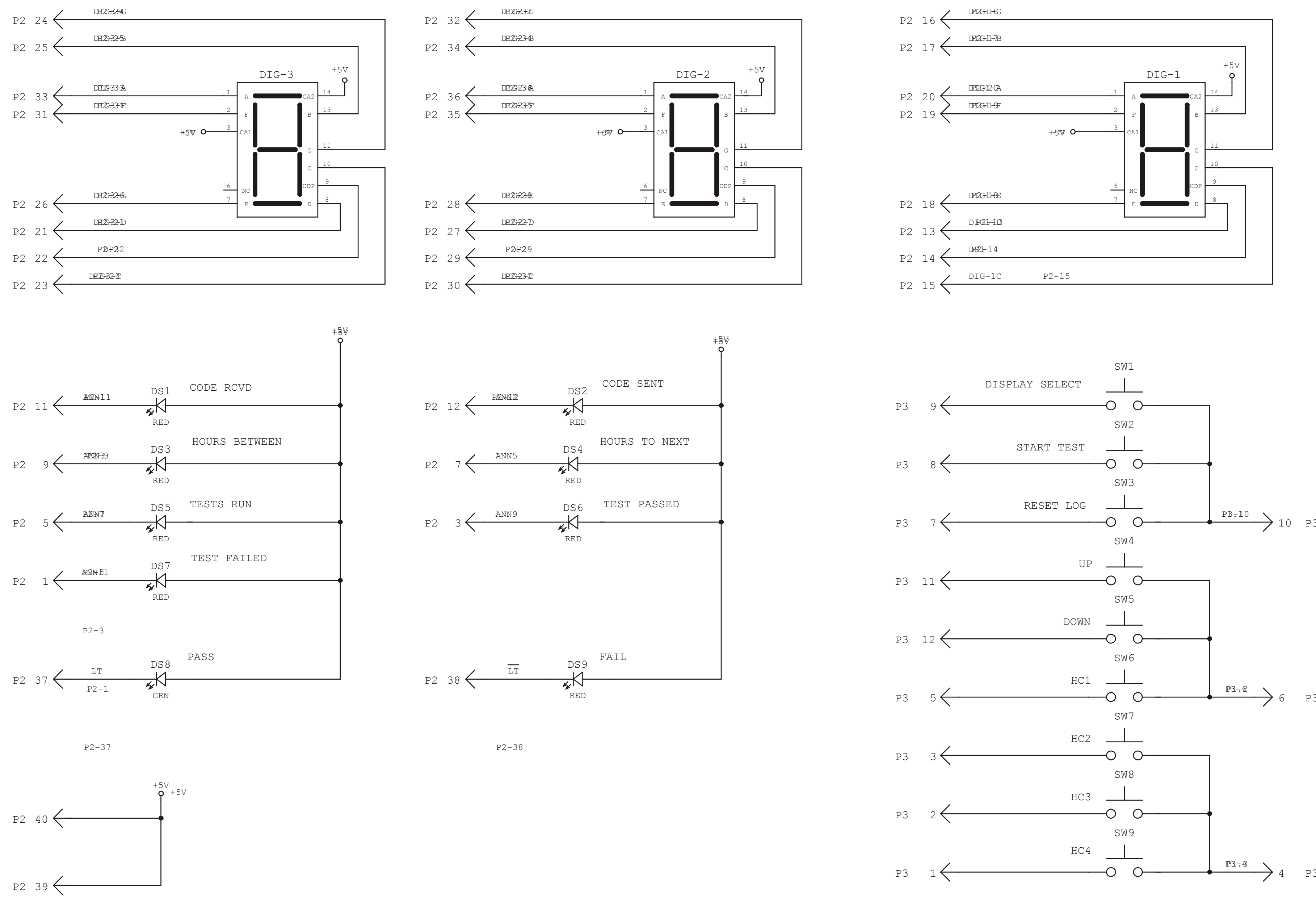


Figure 15-21. Schematic, RFL 9785 Checkback (Dwg. No. D-106529-C) Sheet 2 of 3



NOTE:
SCHEMATIC SHEET 3 APPLIES TO PANEL PC BOARD 106527 ONLY.

Figure 15-21. Schematic, RFL 9785 Checkback (Dwg. No. D-106529-C) Sheet 3 of 3

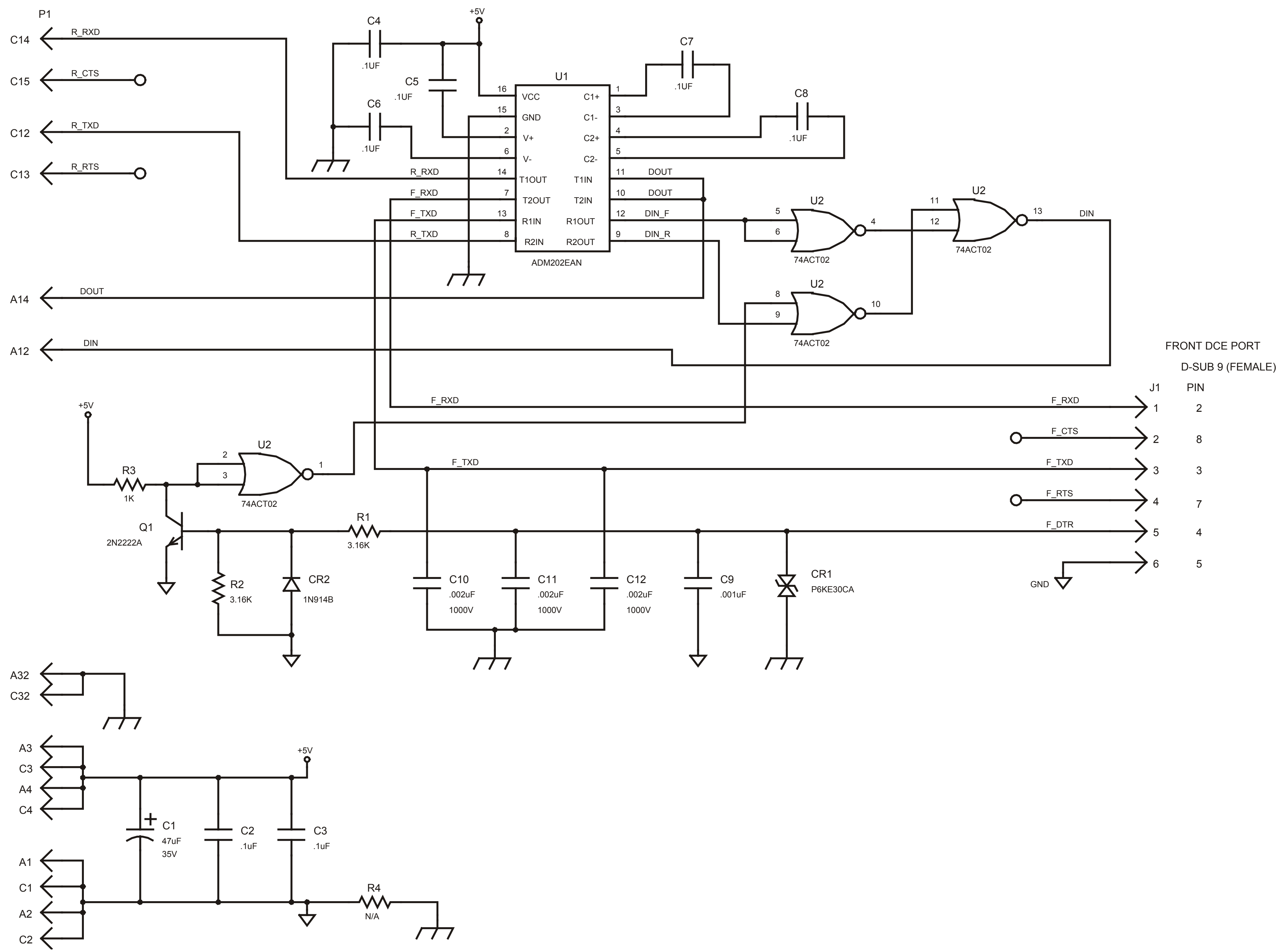


Figure 16-3. Schematic, RFL 9785 Checkback Communications Module (Dwg. No. C-106649-A)

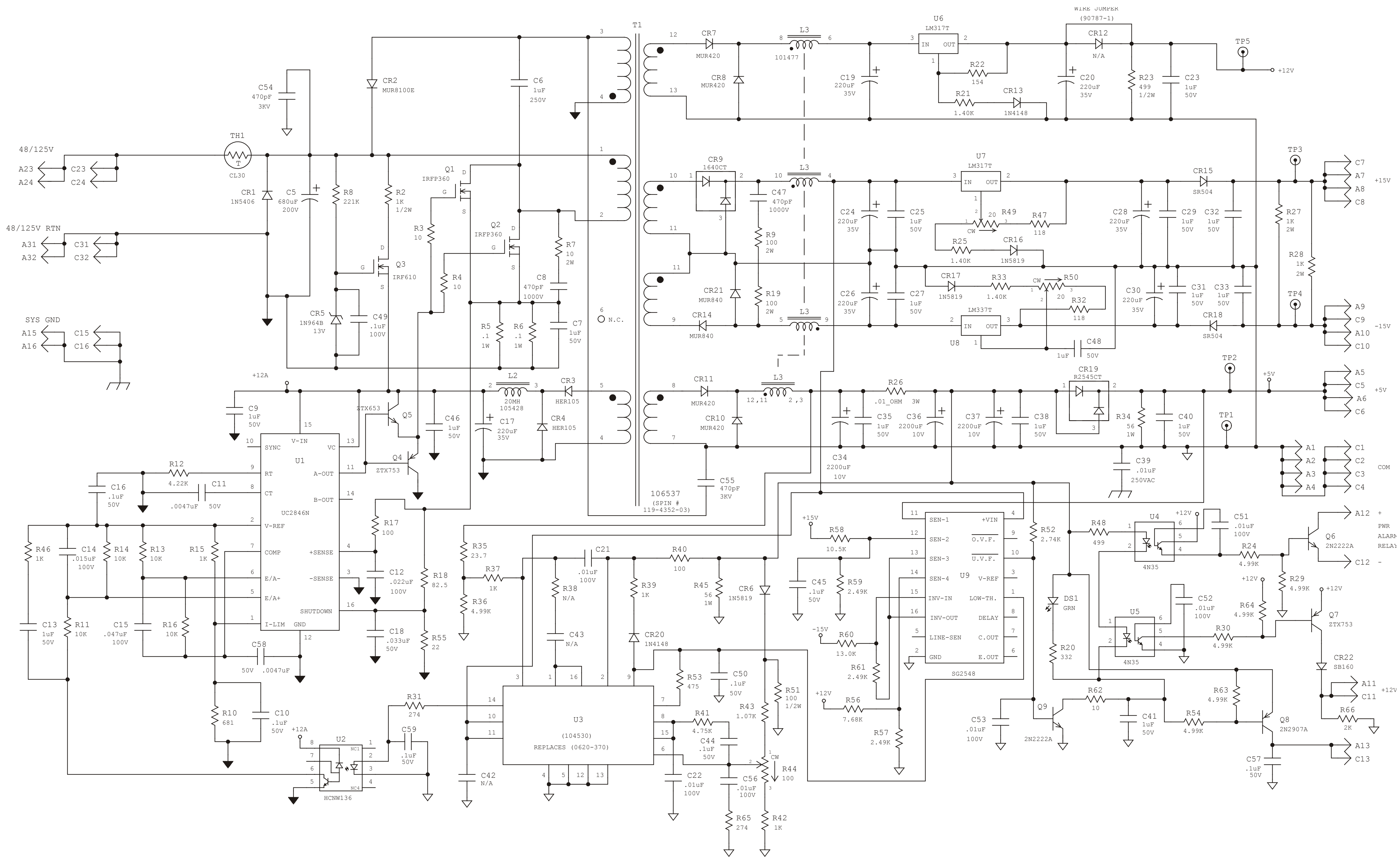


Figure 17-3. Schematic, RFL 9785 Power Supply 48/125 DC (Dwg. No. D-106539-G)

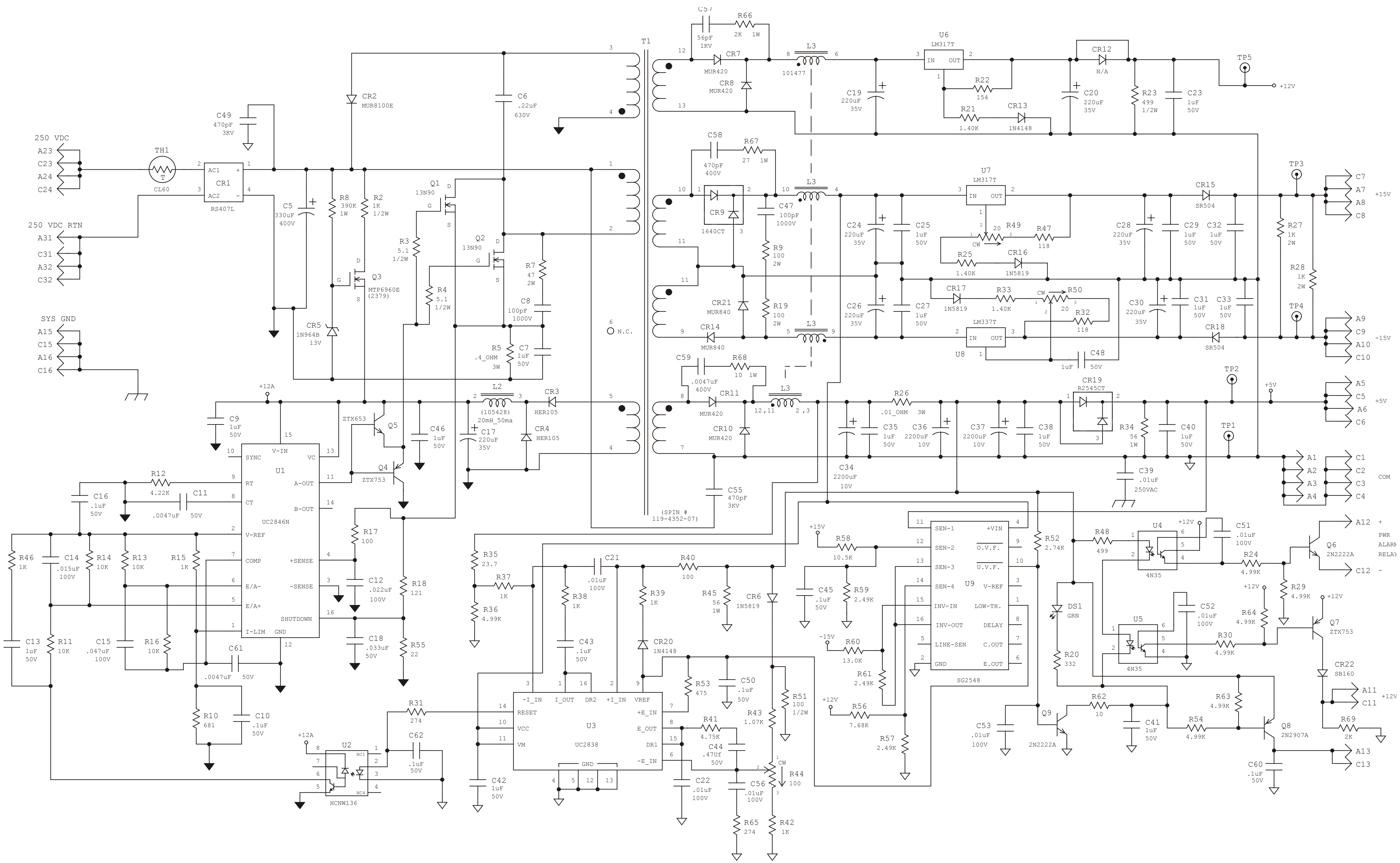
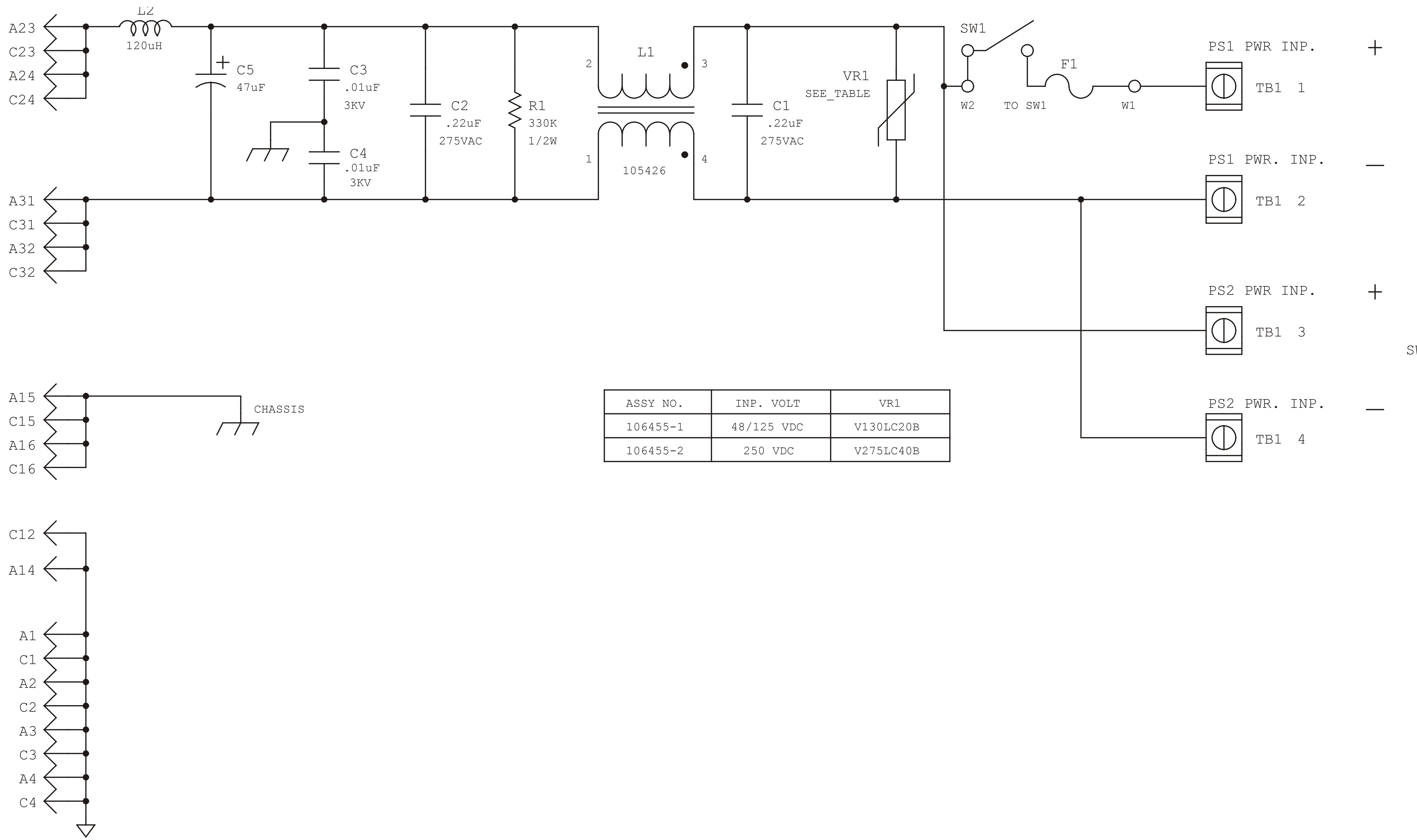
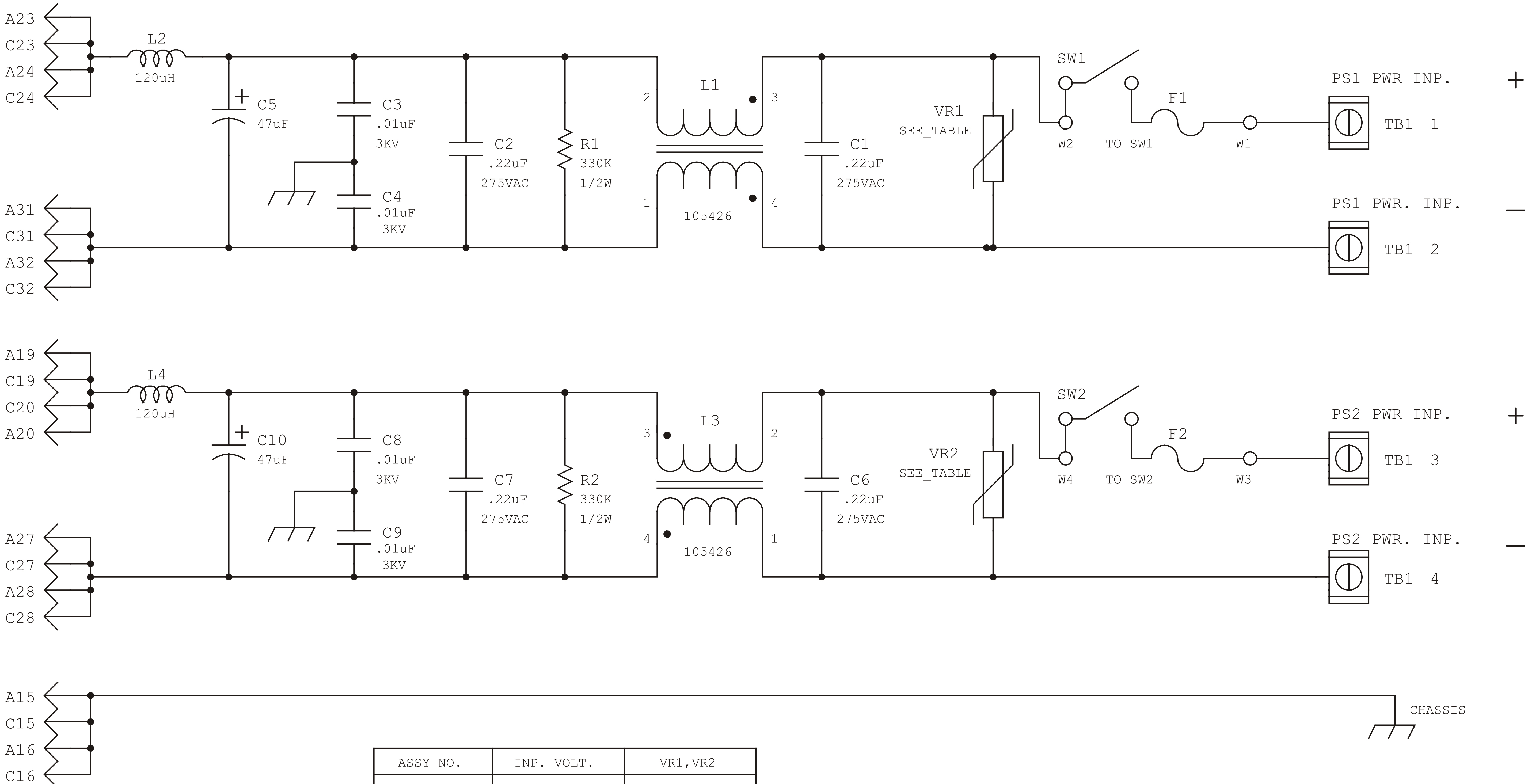


Figure 17-5. Schematic, RFL 9785 Power Supply 250 Vdc (Dwg. No. D-106539-2-E)



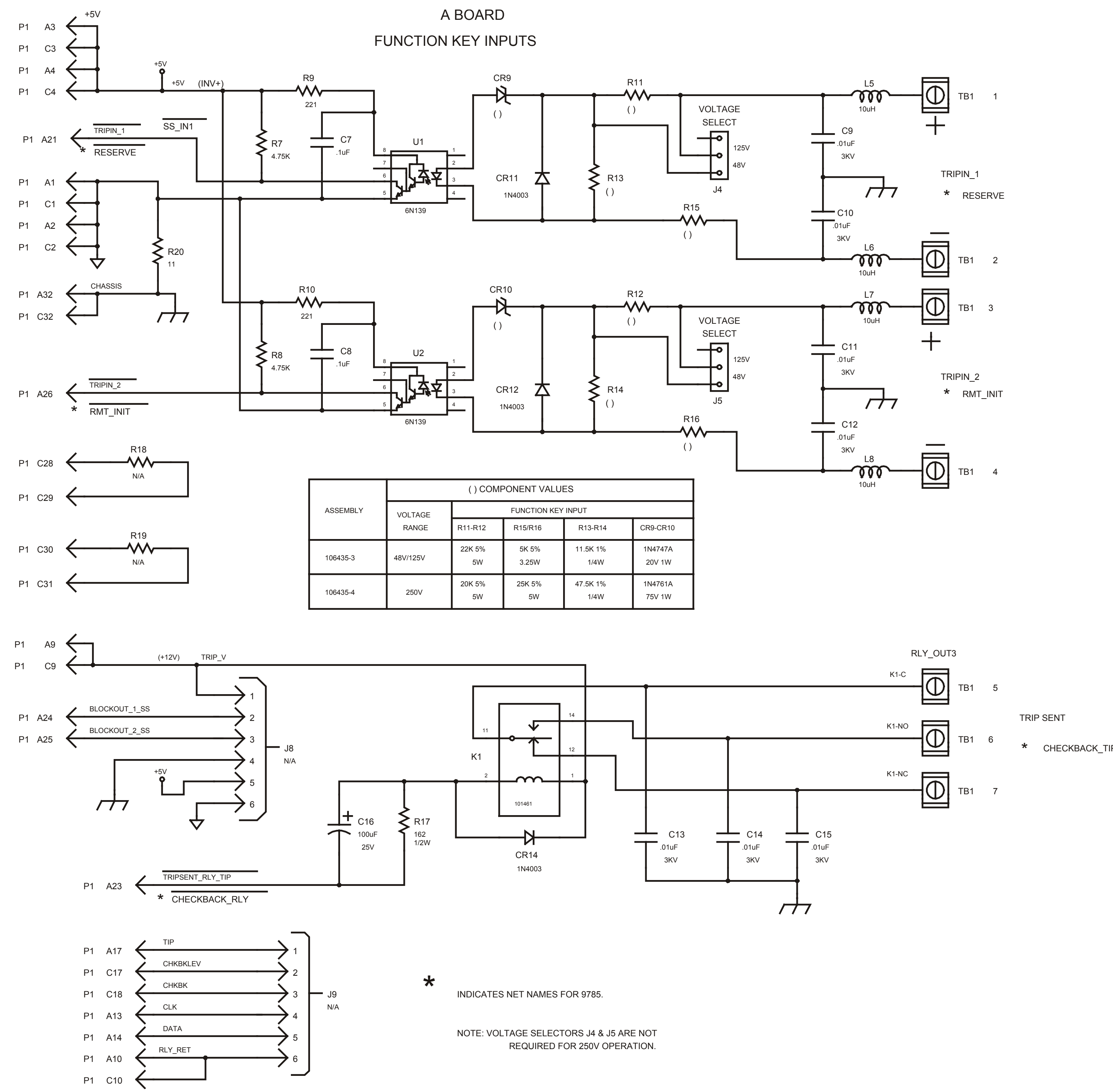
ASSY NO.	INP. VOLT	VR1
106455-1	48/125 VDC	V130LC20B
106455-2	250 VDC	V275LC40B

Figure 17-8. Schematic, RFL 9785 Power Supply I/O (Dwg. No. B-106459-B)



ASSY NO.	INP. VOLT.	VR1,VR2
106455-3	48/125 VDC	V130LC20B
106455-4	250 VDC	V275LC40B

Figure 17-11. Schematic, RFL 9785 Power Supply I/O Dual (Dwg. No. B-106459-1-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 18-4. Schematic, RFL 9785 Solid-State Input I/O (Dwg. No. D-106439-3-A)

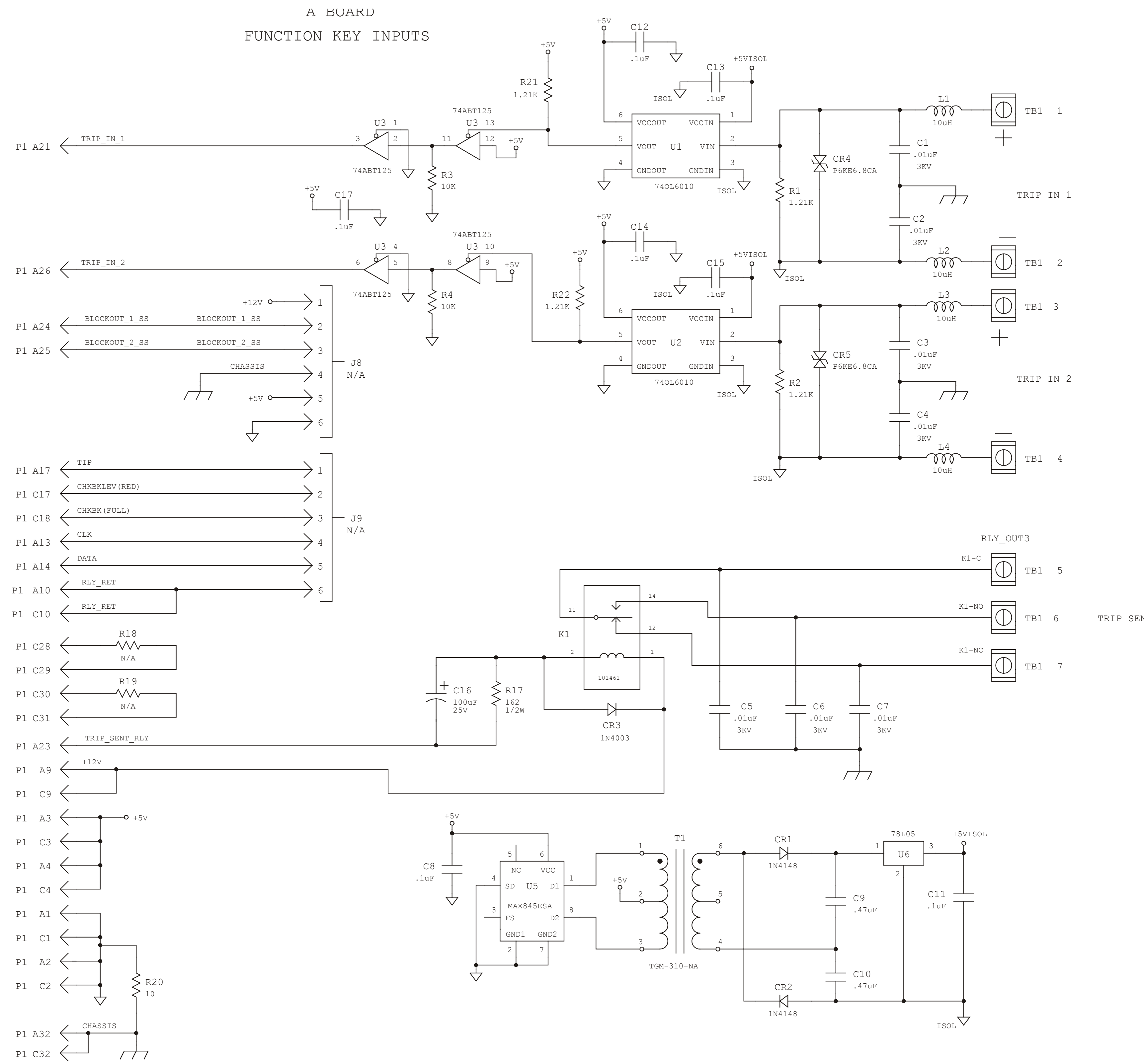
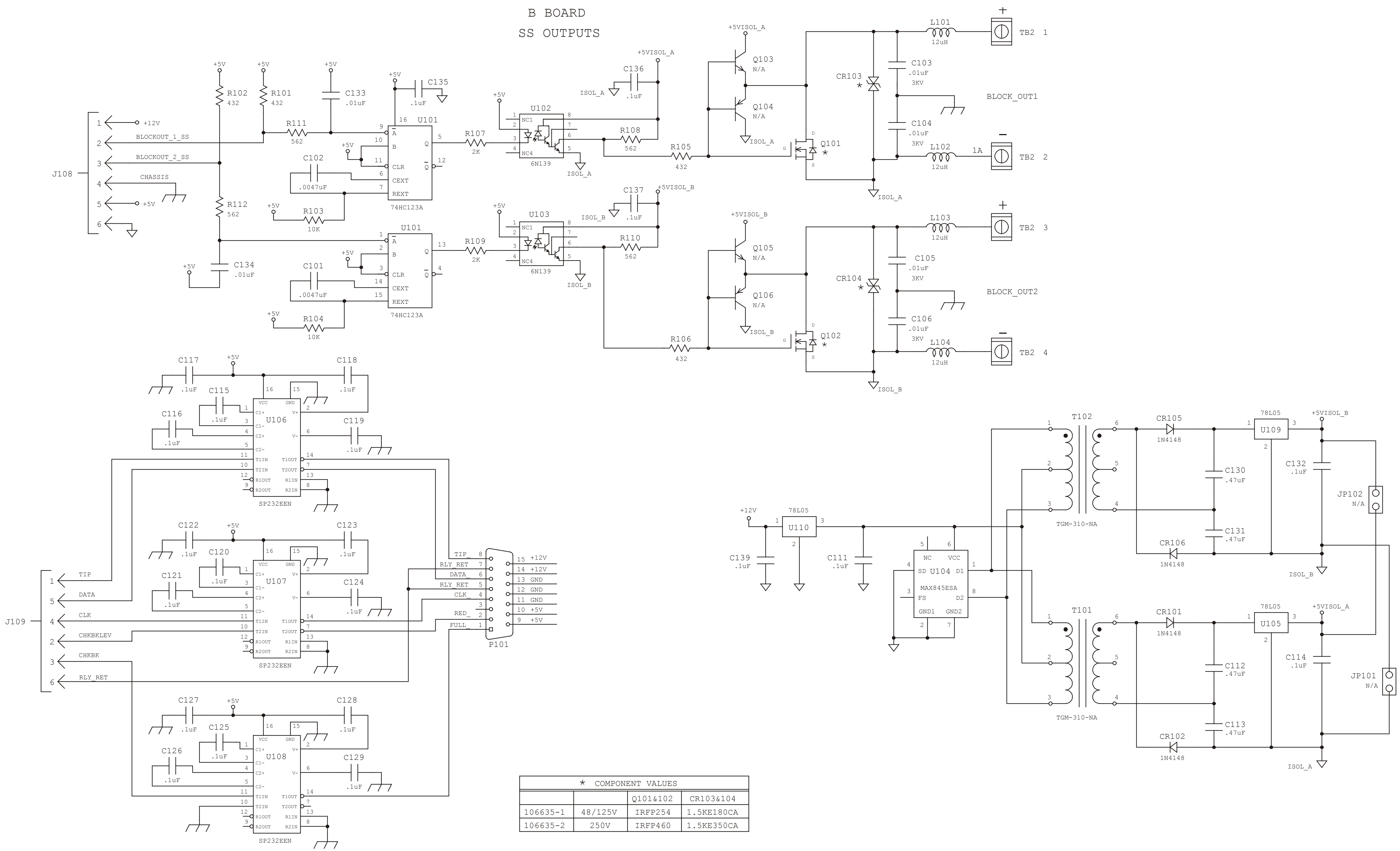
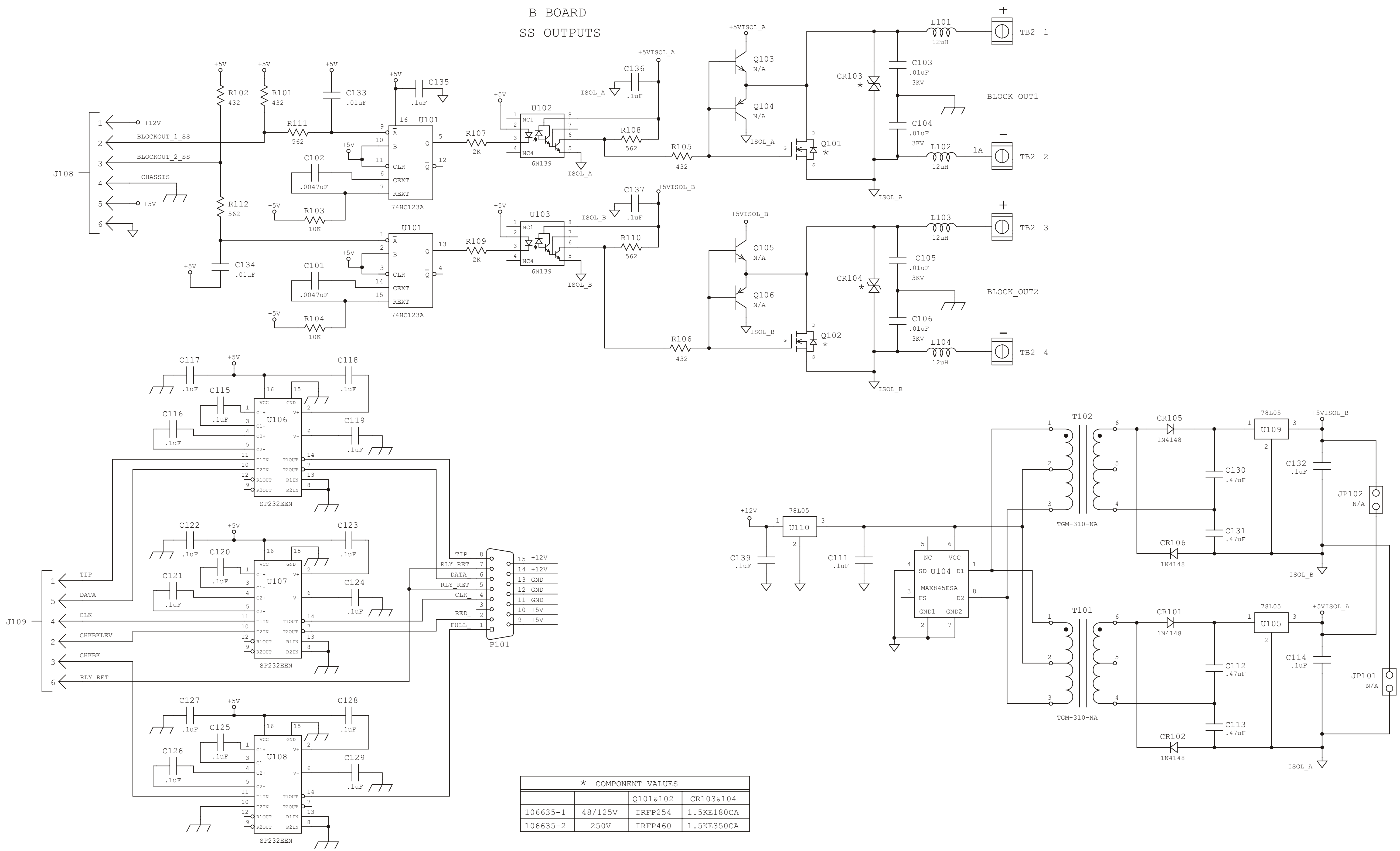


Figure 18-5. Schematic, RFL 9785 Solid-State Logic Level Input I/O (Dwg. No. D-106439-5-B)



* COMPONENT VALUES			
		Q101&102	CR103&104
106635-1	48/125V	IRFP254	1.5KE180CA
106635-2	250V	IRFP460	1.5KE350CA

Figure 18-9. Schematic, RFL 9785 Solid state Input/Output I/O (Dwg. No. D-106639-C) Sheet 1 of 2



* COMPONENT VALUES			
		Q101&102	CR103&104
106635-1	48/125V	IRFP254	1.5KE180CA
106635-2	250V	IRFP460	1.5KE350CA

Figure 18-9. Schematic, RFL 9785 Solid-State Input/Output I/O (Dwg. No. D-106639-C) Sheet 2 of 2

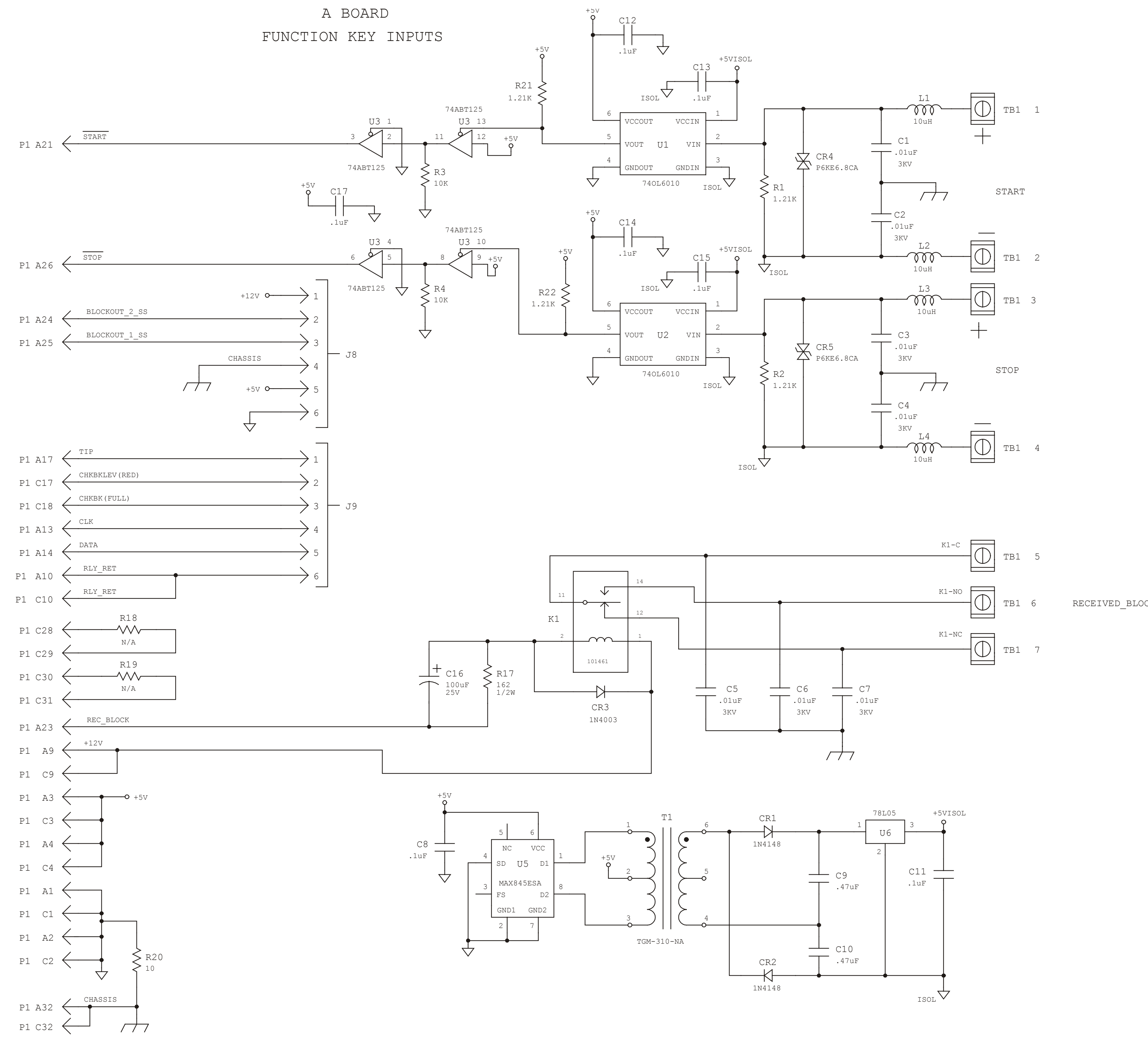
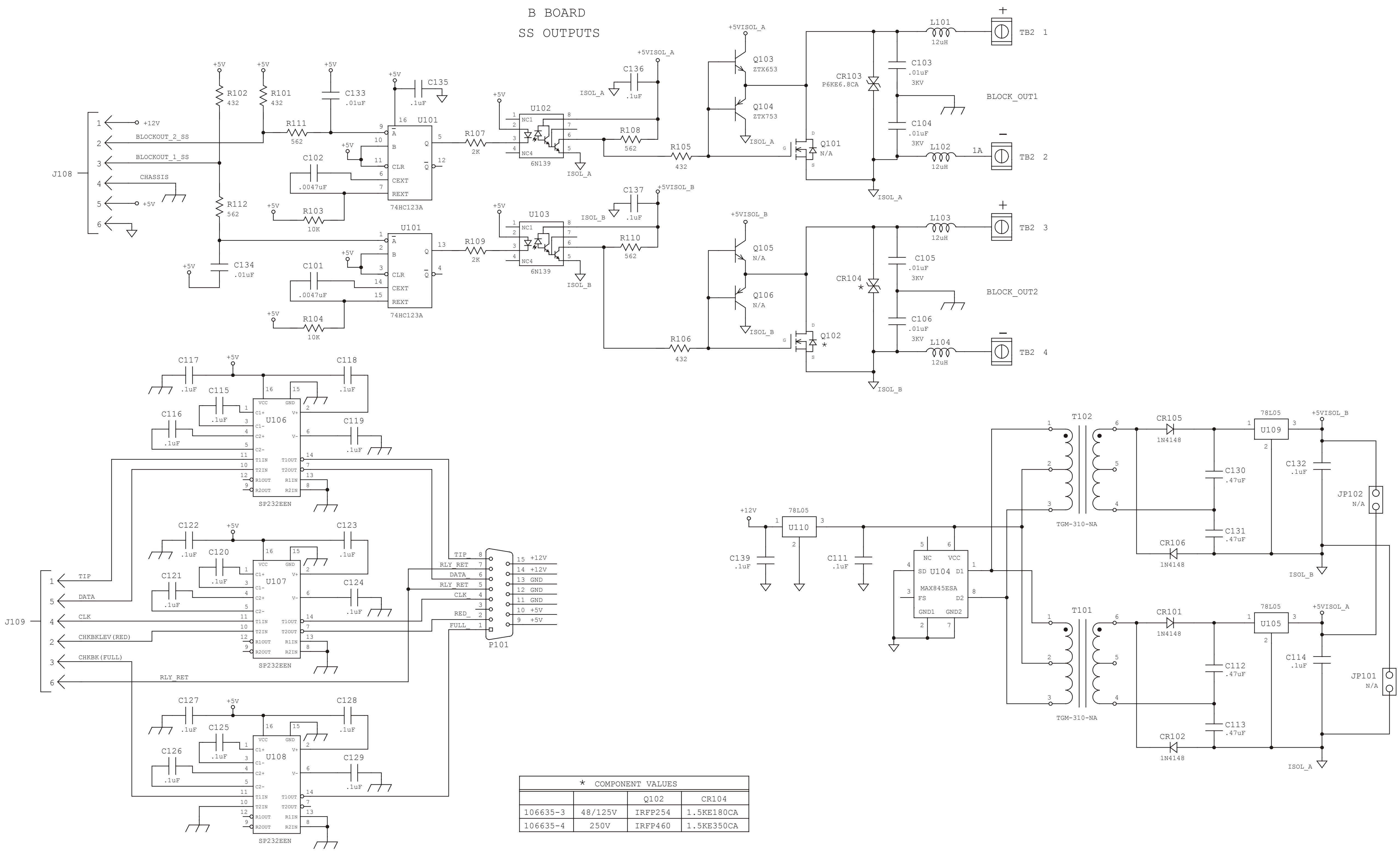
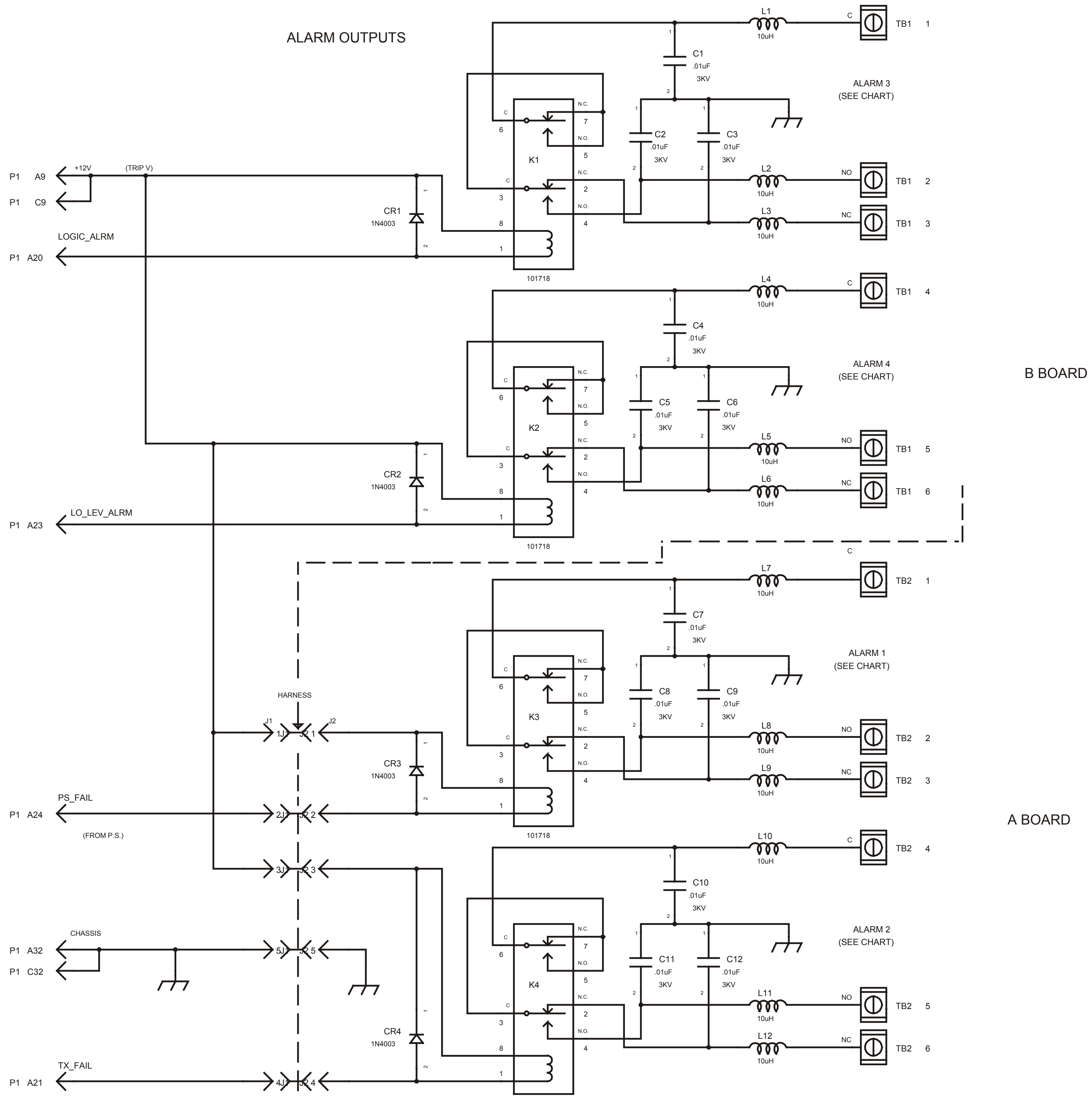


Figure 18-10. Schematic, RFL 9785 Solid State Logic Level Input/Output I/O (Dwg. No. D-106639-5-C) Sheet 1 of 2



* COMPONENT VALUES			
		Q102	CR104
106635-3	48/125V	IRFP254	1.5KE180CA
106635-4	250V	IRFP460	1.5KE350CA

Figure 18-10. Schematic, RFL 9785 Solid-State Logic Level Input/Output I/O (Dwg. No. D-106639-5-C) Sheet 2 of 2



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 18-13. Schematic, RFL 9785 Alarm Relay I/O (Dwg. No. D-106469-C)

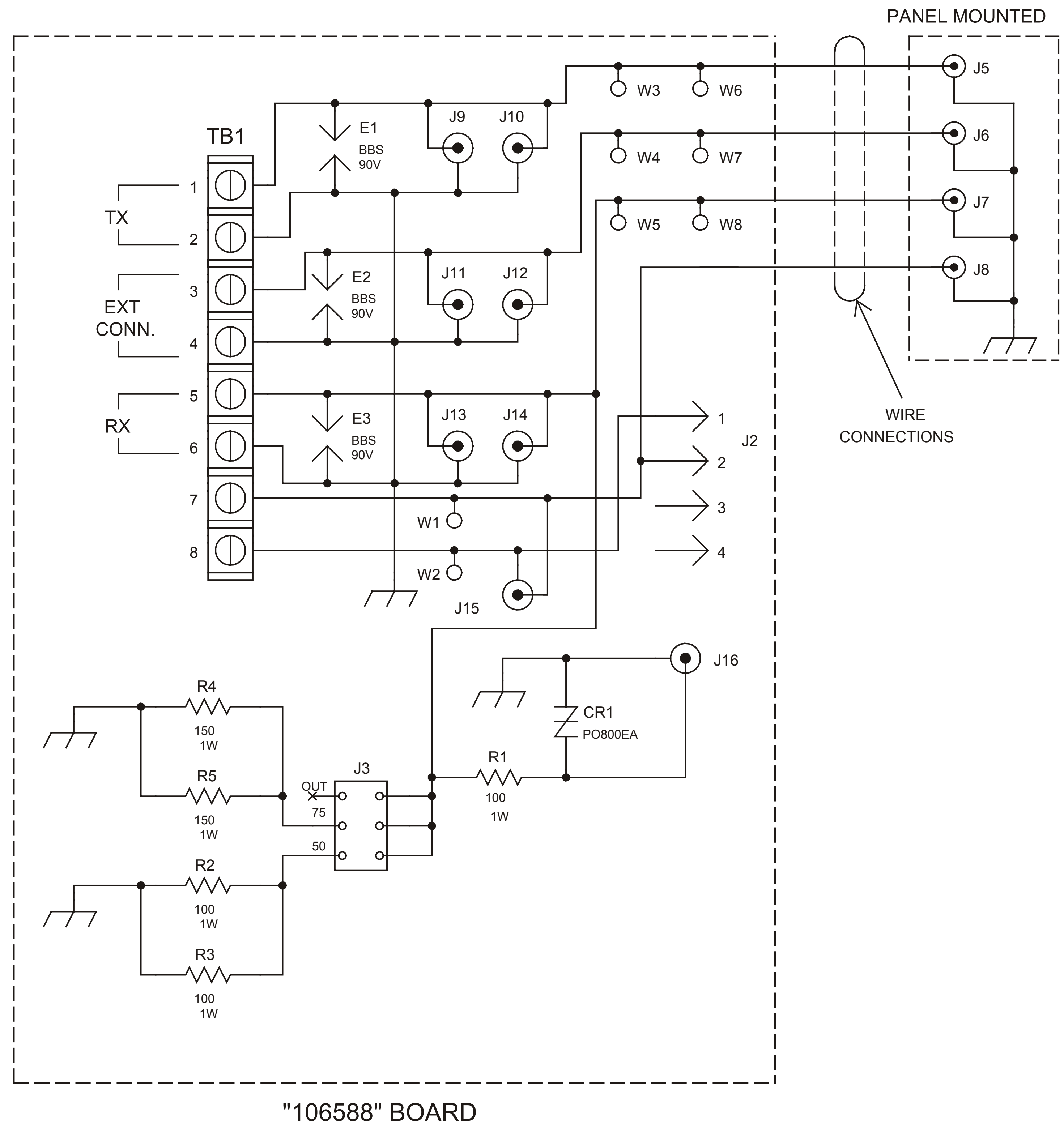


Figure 18-16. Schematic, RFL 9785 RF Line I/O (Dwg. No. C-106599-A)

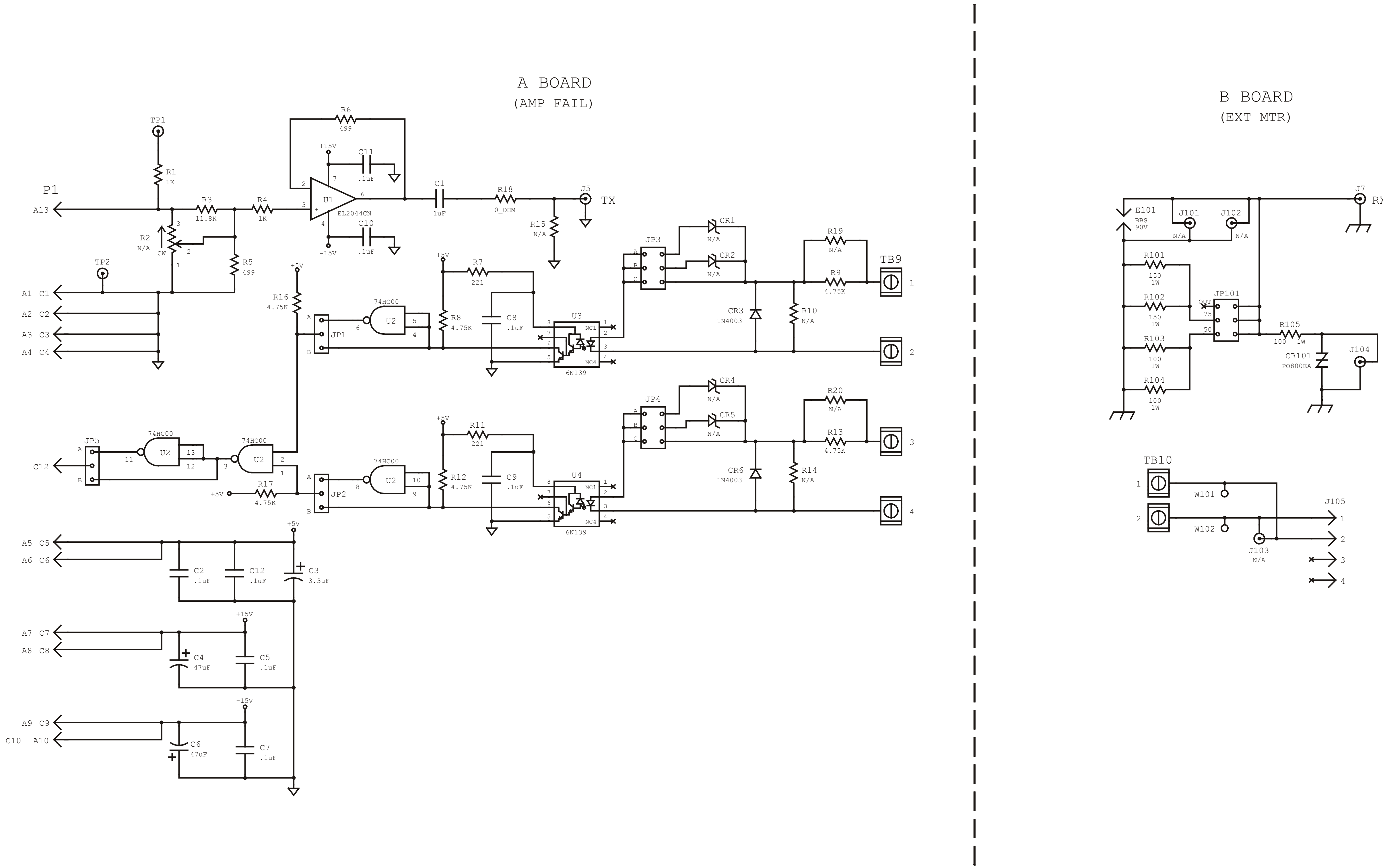


Figure 18-21. Schematic, RFL 9785 External Power Amp I/O (Dwg. No. D-106679-A)

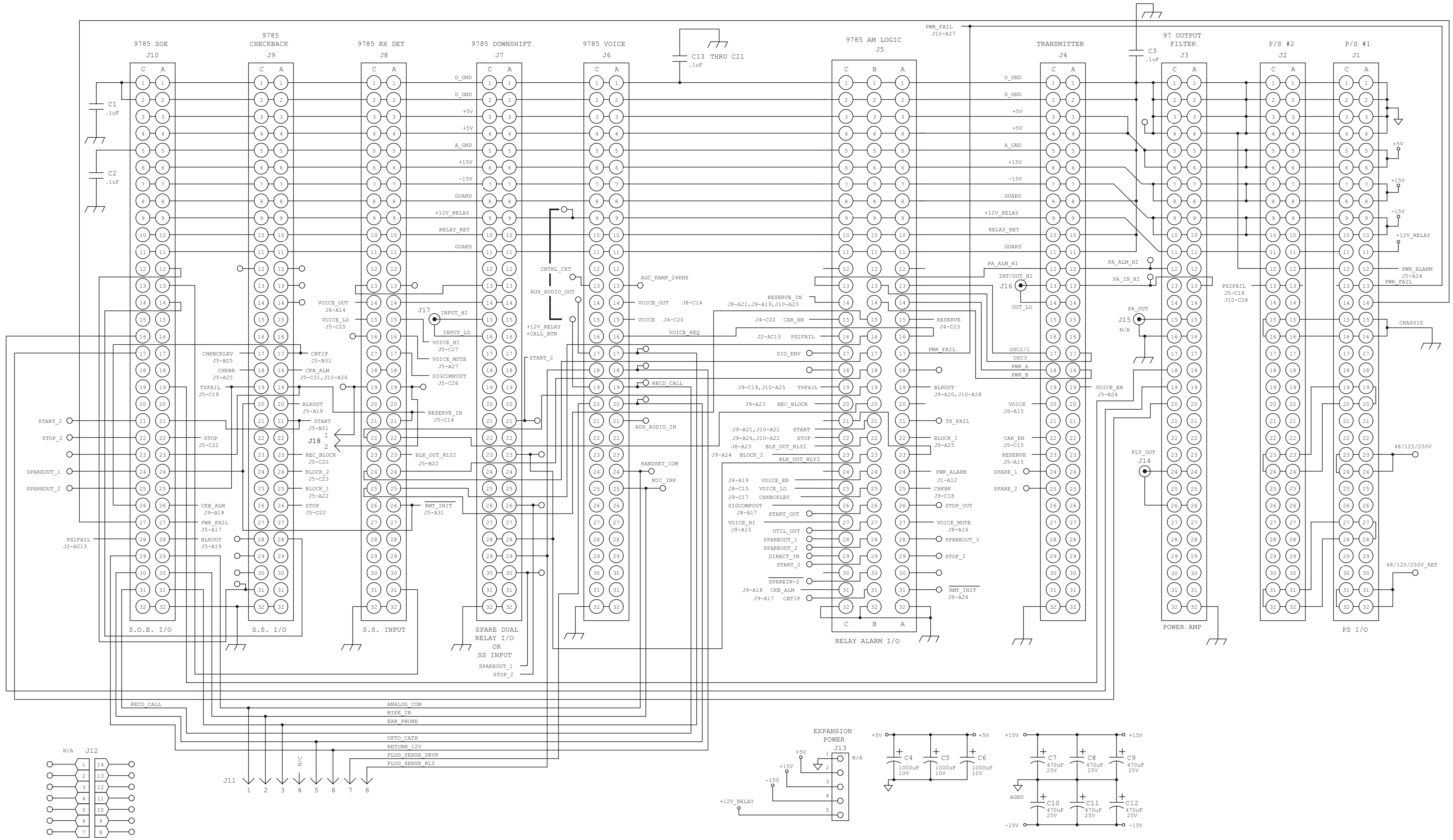


Figure 19-3. Schematic, RFL 9785 Motherboard (Dwg. No. D-106549-2-A)

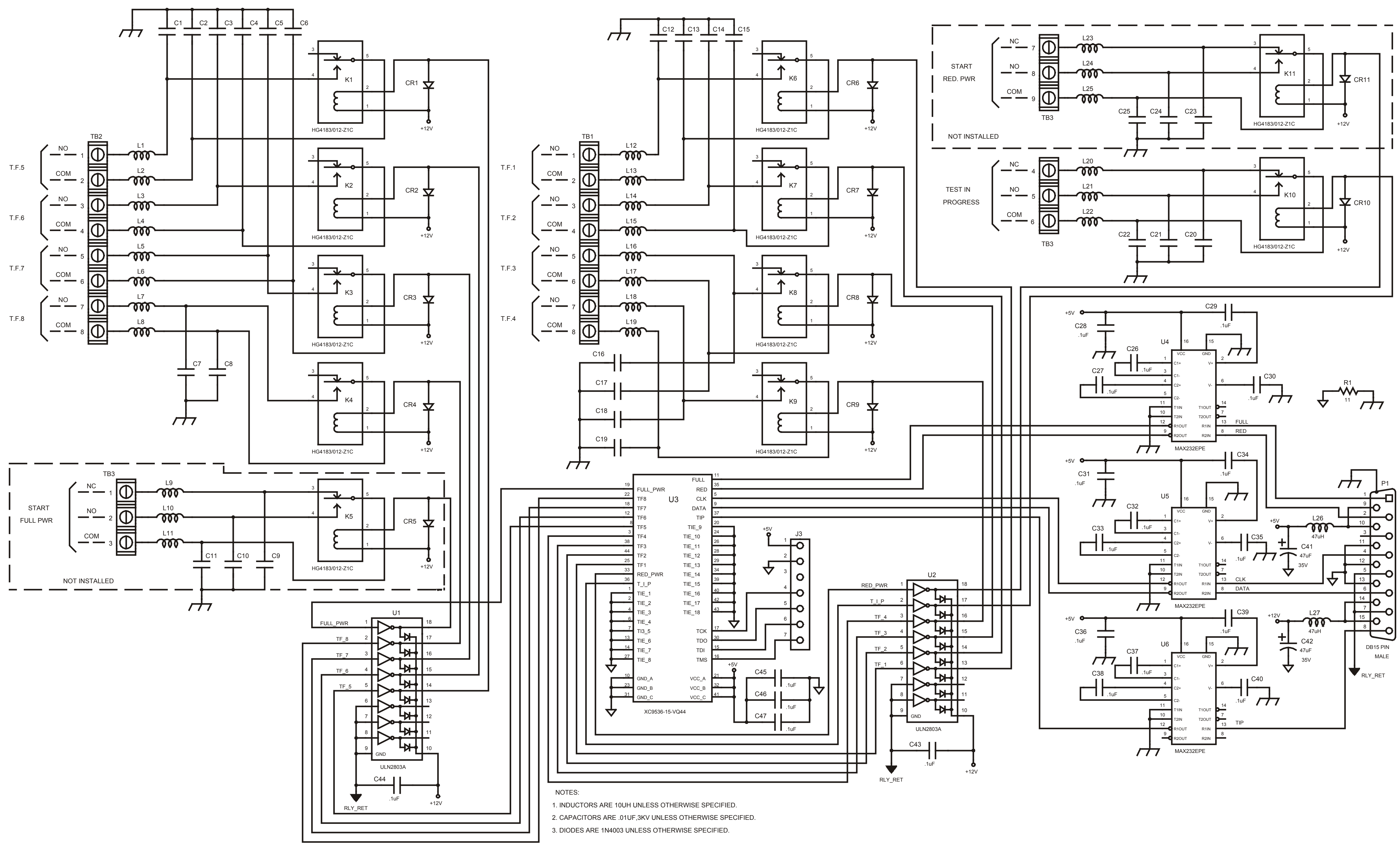


Figure 20-3. Schematic, RFL 9785 Checkback Alarm (Dwg. No. D-106659-A)