

TC-10B

FREQUENCY-PROGRAMMABLE
ON/OFF CARRIER
TRANSMITTER/RECEIVER

System Manual

CC44-VER04

(Replaces CC44-VER03)


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TC-10B

System Manual

Table of Contents

Product Description	1	▶
Applications and Ordering Information	2	▶
Installation	3	▶
Test Equipment	4	▶
Installation/Adjustment Procedures	5	▶
Signal Path	6	▶
Design Verification Tests	7	▶
Maintenance	8	▶
Power Supply Module	9	▶
Keying Module	10	▶
Transmitter Module	11	▶
10W PA Module	12	▶
RF Interface Module	13	▶
Universal Receiver Module	14	▶
Receiver (solid state) Output Module	15	▶
Universal Checkback Module	16	▶
Optional Voice Adapter Module	17	▶

Important Change Notification

This document supersedes both the *TC-10B Frequency-Programmable On/Off Carrier Transmitter/Receiver System Manual CC44-VER03*, last printed in October 2000. The following list shows the most recent publication date for each chapter. Publication dates in **bold type** indicate changes to that chapter. For these chapters, the specific pages that have changed are listed for easy reference. Note that only significant changes, i.e., those changes which affect the technical use and understanding of the document and the TC-10B equipment, are reported. Changes in format, typographical corrections, minor word changes, etc. are not reported. Note also that in some cases text and graphics may have flowed to a different page than in the previous publication due to formatting or other changes. The page numbers below show the current pages on which the reported changes appear.

Each reported change is identified in the document by a change bar, || placed in the margin to its immediate left and/or right, as shown on this page.

<u>Chapter Number & Title</u>	<u>Publication Date</u>	<u>Pages with Changes</u>
Front Section	February 2002	ii,vi, vii,viii
1. Product Description	October 2000	
2. Applications and Ordering Information	February 2002	2-8,9
3. Installation	October 2000	
4. Test Equipment	October 2000	
5. Installation/Adjustment procedures	October 2000	
6. Signal Path	October 2000	
7. Design Verification Tests	October 2000	
8. Maintenance	September 1996	
9. Power Supply Module	January 1996	
10. Keying Module	January 1996	
11. Transmitter Module	February 2002	11-4,5,7,9,10
12. 10W PA Module	January 1996	
13. RF Interface Module	January 1996	
14. Universal Receiver Module	February 2002	14-5
15. Receiver (solid state) Output Module	April 1997	
16. Universal Checkback Module	October 2000	
17. Optional Voice Adapter Module	October 2000	



We recommend that you become acquainted with the information in this manual before energizing your TC-10B system. Failure to do so may result in injury to personnel or damage to the equipment, and may affect the equipment warranty. If you mount the carrier set in a cabinet, it must be bolted to the floor or otherwise secured before you swing out the equipment, to prevent the installation from tipping over.

You should not remove or insert printed circuit modules while the TC-10B is energized. Failure to observe this precaution can result in undesired tripping output and can cause component damage.

All integrated circuits used on the modules are sensitive to and can be damaged by the discharge of static electricity. You should observe electrostatic discharge precautions when handling modules or individual components.

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PREFACE

Scope

This manual describes the functions and features of the TC-10B Power Line Carrier Transmitter/Receiver. It is intended primarily for use by engineers and technicians involved in the installation, alignment, operation, and maintenance of the TC-10B.

Equipment Identification

The TC-10B equipment is identified by the Catalog Number on the TC-10B chassis nameplate. You can decode the Catalog Number using the information in Chapter 2.

Production Changes

When engineering and production changes are made to the TC-10B equipment, a revision notation (Sub number) is reflected on the style number and related schematic diagram. A summary of all Sub numbers for the particular release is shown on the following page.

Warranty

Our standard warranty extends for 60 months after shipment. For all repaired modules or advance replacements, the standard warranty is 90 days or the remaining warranty time, whichever is longer. Damage clearly caused by improper application, repair, or handling of the equipment will void the warranty.

Equipment Return & Repair Procedure

To return equipment for repair or replacement:

1. Call your PULSAR representative at **1-800-785-7274**.
2. Request an **RMA number** for proper authorization and credit.
3. Carefully pack the equipment you are returning.

Repair work is done most satisfactorily at the factory. When returning any equipment, pack it in the original shipping containers if possible. Be sure to use anti-static material when packing the equipment. Any damage due to improperly packed items will be charged to the customer, even when under warranty.

Pulsar Technologies, Inc. also makes available interchangeable parts to customers who are equipped to do repair work. When ordering parts (components, modules, etc.), always give the complete PULSAR style number(s).

4. Make sure you include your return address and the RMA number on the package.
5. Ship the package(s) to:

Pulsar Technologies, Inc.
Communications Division
4050 N.W. 121st Avenue
Coral Springs, FL U.S.A. 33065

Overview of this Publication

- Chapter 1 – Product Description and specifications.
- Chapter 2 – Applications and related catalog numbers for ordering.
- Chapter 3 – Installation.
- Chapter 4 – Test equipment
- Chapter 5 – Installation/adjustment procedures
- Chapter 6 – Signal path.
- Chapter 7 – Design verification tests.
- Chapter 8 – Maintenance procedures
- Chapters 9-17 – Module circuit descriptions and troubleshooting procedures.

The TC-10B circuitry is divided into seven (7) standard modules. In addition, Universal Checkback, TTL Transmitter and Voice Adapter modules are available as options. (See Figure 6-1, for a Functional Block Diagram.)

Contents of Carrier Set

The TC-10B carrier set includes the style numbers, listed below, with appropriate sub numbers representing revision levels. (To determine related style numbers, you may also refer to Table 2-3.)

Module	Style	Sub Number
Power Supply	1617C38 GXX	02
Keying	1606C29 G01	11
Transmitter	1610C01 G01	01
TTL Transmitter	1610C01 G02	14
10W PA	1606C33 G01	21
RF Interface	1609C32 G01	09
Universal Receiver	C020-RXVMN-203	06
Receiver Output	CC20-RXSMN-001	01
Universal Checkback	CC20-UCBMN-001	05
Voice Adapter	C020-VADMN-001	03

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FIGURES

Figure No.		Page No.
1-1	TC-10B Chassis and Control Panels with Optional Universal Checkback and Voice Adapter Modules	1-9
2-1	Directional-Comparison Blocking, Basic Elements and Logic Diagrams	2-2
2-2	Phase-Comparison Blocking, Basic Elements	2-3
2-3	Single Phase Comparison Blocking, Current Only Operation	2-4
2-4	Single Phase-Comparison Blocking, Distance-Supervised Operation	2-5
2-5	Simplified Application Schematic (Scheme A)	2-11
2-6	Simplified Application Schematic (Scheme B)	2-12
2-7	Simplified Application Schematic (Scheme C)	2-13
2-8	Simplified Application Schematic (Scheme D)	2-14
2-9	Simplified Application Schematic (Scheme E)	2-15
2-10	Simplified Application Schematic (Scheme F)	2-16
2-11	Simplified Application Schematic (Scheme G)	2-17
2-12	Simplified Application Schematic (Scheme H)	2-18
2-13	Simplified Schematic (Scheme K)	2-19
2-14	Simplified Applications Schematic (Scheme L)	2-20
2-15	Receiver Output Typical Connections for Microprocessor based relays	2-21
2-16	Receiver Outputs w/External Resistors for Electro-mechanical relays	2-21
3-1	Rear Panel – Mother Board	3-2
3-2	Cable Termination Diagram	3-4
3-3	Mechanical Outline Drawing	3-9
3-4	Connection Drawing and Jumper Options (Sheet 1 of 2).	3-10
3-5	Connection Drawing and Jumper Options (Sheet 2 of 2).	3-11
4-1	Extender Board	4-2
6-1	Interconnection and Block Diagram	6-6
9-1	Power Supply Front Panel	9-1
9-2	Power Supply Component Location	9-3
9-3	Power Supply Schematic	9-4
10-1	Keying Module Front Panel	10-1
10-2	Keying PC Board	10-5
10-3	Keying Schematic	10-6
11-1	Transmitter Front Panel	11-1
11-2	Optional TTL Module Front Panel	11-4
11-3	Transmitter PC Board	11-6

	11-4	Transmitter Schematic	11-7
	11-5	Transmitter Block Diagram	11-8
	11-6	TTL Transmitter PC Board	11-9
	11-7	TTL Transmitter Schematic	11-10
	12-1	10W PA Module Front Panel	12-1
	12-2	10W PA PC Board	12-4
	12-3	10W PA Schematic	12-5
	13-1	RF Interface Front Panel	13-1
	13-2	RF Interface PC Board	13-3
	13-3	RF Interface Schematic	13-4
	14-1	Universal Receiver Simplified Signal Flow Diagram	14-1
	14-2	Universal Receiver Front Panel	14-2
	14-3	Universal Receiver Location of SW1 Dip switch & J3	14-7
	15-1	Receiver Output Module — Simplified Signal Flow Diagram	15-1
	15-2	Receiver Output Module Front Panel	15-2
	15-3	Receiver Output PC Board	15-6
	15-4	Receiver Output Schematic	15-7
	16-1	Maximum Checkback Configuration	16-4
	16-2	Maximum Checkback Configuration with Timed Communications Mode	16-5
	16-3	Maximum Checkback Configuration with Coded Communications Mode	16-5
	16-4	Universal Checkback Module Front panel controls and indicators	16-6
	16-5	Initial Communication with the Checkback Module	16-11
	16-6	Sample Checkback Module Configuration	16-12
	16-7	Result of “Get Event 1” Command	16-16
	16-8	Example of a Remote Logon	16-17
	16-9	Universal Checkback Module –Timed Sequence (Master initiated)	16-27
	16-10	Universal Checkback Module –Timed Sequence (Remote 1 initiated)	16-28
	16-11	Universal Checkback Module simplified Component Layout	16-43
	17-1	Voice Adapter Module — Simplified Signal Flow Diagram	17-1
	17-2	Voice Adapter Module Front Panel	17-4
	17-3	Voice Adapter Module PC Board (C020VADMN)	17-6
	17-4	Voice Adapter Module Schematic (C030VADMN1 Sheet 1 of 2)	17-7
	17-5	Voice Adapter Module Schematic (C030VADMN2 Sheet 2 of 2)	17-8
	17-6	Connections for Remote Phone and External Alarm	17-9
	17-7	External Alarm Circuit for Use with Module Front Panel Jack	17-10
	17-8	Handset Schematic	17-10

TABLES

	Table No.	Page No.
	1-1 Transmitter/Receiver Specifications	1-3
	1-2 Keying Specifications	1-4
	1-3 Receiver Output Specifications	1-5
	1-4 Alarm & Level Option Specifications	1-5
	1-5 Checkback Option Specifications	1-5
	1-6 Voice Adapter Option Specifications	1-6
	1-7 Environmental Specifications	1-6
	1-8 Altitude Dielectric Strength De-Rating for Air Insulation	1-7
	1-9 Altitude Correction for Maximum Temperature of Cooling Air	1-7
	1-10 Power Requirement Specifications	1-8
	1-11 Weight and Dimension Specifications	1-8
	2-1 Directional Comparison Schemes for External and Internal Faults.	2-3
	2-2 TC-10B Catalog Numbers	2-8
	2-3 TC-10B Catalog Numbers/Module Style Numbers	2-9
	2-4 Voice Adapter Accessories.	2-10
	2-5 Other TC-10B Accessories	2-10
	2-6 External Resistor Requirements – Provided with Chassis, According to Voltage .2-10	2-10
	3-1 Attenuator Override Jumper Sensitivity Levels	3-7
	4-1 Recommended Test Equipment	4-1
	7-1 Voltage Specifications	7-1
	7-2 Universal Checkback Module DIP Switch Settings	7-2
	7-3 Voltage Levels	7-3
	7-4 Keying Logic.	7-4
	7-5 Level Detector and CLI Test Procedure Specifications.	7-5
	7-6 Receiver Output	7-6
	9-1 1617C38 Styles and Descriptions	9-1
	10-1 1606C29 Styles and Descriptions	10-1
	11-1 1610C01 /Styles and Descriptions	11-1

TABLES, Cont'd

Table No.	Page No.
12-1	1606C33 Styles and Descriptions12-1
13-1	1609C32 Styles and Descriptions13-1
14-1	Universal Receiver Style14-1
14-2	Receiver System Specifications14-3
14-3	ON-OFF Frequency Spacing Specifications (Minimum)14-4
14-4	AM Receiver (SW1-1 set to the ON position)14-4
15-1	CC20-RXSMN-001 Styles and Descriptions15-1
15-2	Output Table15-3
15-3	Receiver Output15-5
16-1	Universal Checkback Module Style and Description16-1
16-2	Universal Checkback Module DIP switch settings16-9
16-3	Factory preset configuration options16-10
16-4	Primary/fallback communications options16-25
16-5	Test and general settings16-38
16-6	Output states16-38
16-7	Test and communications options16-39
16-8	Times and intervals16-39
16-9	Information commands16-39
16-10	Clearing commands16-40
16-11	Action commands16-40
16-12	Logon commands16-40
16-13	Help commands16-40
16-14	Networking Troubleshooting16-41
17-1	C020-VADMN Styles and Descriptions17-1
17-2	Voice Adapter Module Electrical Characteristics17-3
17-3	DIP Switch Setting Functions17-5
17-4	Default (Normal) Settings for TC-10B Operation17-5

Chapter 1. Product Description

1.1 Standard Features

The TC-10B frequency-programmable power-line-carrier set offers the following features as standard:

- Programmable over 30–535kHz (in 0.5kHz steps) with direct frequency readout
- Frequencies are easily field-selectable by rotary switches (transmitter) -or- push button (receiver)
- Wideband (1,600Hz) receiver for use with all blocking systems
- Narrow band (800Hz) receiver for use with directional-comparison blocking systems where there is a need to improve signal-to-noise ratio (SNR)
- High receiver sensitivity: 22.5mV...(Standard setting)
 5mV...(High-sensitivity setting)
- Universal keying/receiver output
- 300-2,000Hz range audio channel for maintenance Voice Channel
- Built-in low/high level carrier test switches
- dc-to-dc isolated power supply
- 48, 125, and 250Vdc versions available

1.2 Standard Nomenclature

The standard nomenclature for PULSAR carrier protection equipment is as follows:

Cabinet – contains fixed-racks, swing-racks, or open racks

Rack – contains one or more chassis (e.g., the TC-10B)

Chassis – contains several printed circuit boards, called modules (e.g., Transmitter or Receiver)

Module – contains a number of functional circuits (e.g., Oscillator or Synthesizer)

Circuit – a complete function on a printed circuit board

1.3 TC-10B Chassis

The TC-10B chassis specifications include standard dimensions of:

Height – 5.25" (133.35 mm), requiring 3 rack units, each measuring 1.75" (44.45 mm)

Width – 19.00" (482.6 mm)

Depth – 13.50" (342.9 mm)

Each chassis is notched for mounting in a standard relay rack.

1.4 TC-10B Modules

The TC-10B circuitry is divided into standard modules with optional Voice Adapter, TTL Transmitter and Universal Checkback modules available, as shown on the Functional Block Diagram (Fig. 6-1). Circuit descriptions, complete with schematic diagrams, are shown in Chapters 9 through 17 with Sub Numbers that indicate appropriate revisions for each module, as follows:

<u>Chapter</u>	<u>Module</u>	<u>Schematic</u>
9.	Power Supply	1617C38-2
10.	Keying	1606C29-7
11.	Transmitter	1355D71-8
12.	10W PA	1606C33-20
13.	RF Interface	1609C32-8
14.	Universal Receiver	not user serviceable
15.	Receiver Output (Solid State)	CC30-RXSMN
16.	(Optional) Universal Checkback	not user serviceable
17.	(Optional) Voice Adapter	C030-VADMN

NOTE

See Chapter 2, Applications and Ordering Information, for ordering information. See Chapter 3, Installation, for a summary of jumper controls.

1.5 SPECIFICATIONS

The TC-10B meets or exceeds all applicable ANSI/IEEE standards.

1.5.1 Transmitter/Receiver

Table 1-1 lists the Transmitter/Receiver specifications for the TC-10B.

Table 1-1. Transmitter/Receiver Specifications.

Frequency Range	30–535 kHz in 0.5 kHz (500 Hz) steps, transmitter selection in 100 Hz steps
4-Wire Receiver Input Impedance	5,000 Ω or 1,000 Ω
RF Output Impedance	50, 75 or 100 Ω (nominal unbalanced)
Output Power	<ul style="list-style-type: none"> • 10 watts (max) • 100 watts (with optional external amplifier)
Frequency Stability	\pm 10 Hz (typical)
Nominal Receiver Bandwidths	<ul style="list-style-type: none"> • Narrow band: (800 Hz at 3 dB points) • Wide band (1600 Hz at 3 dB points) • On-Off Phase Comparison (3,500 Hz at 3 dB points)
Harmonic Distortion	55 dB below full power

Receive Sensitivity	
Narrow Band or Wide Band	<ul style="list-style-type: none"> • 22.5 mV (min) to 70 V (max) Standard setting • 5 mV (min) to 17 V (max) High setting

Table 1-1. System Specifications (Cont'd).

Minimum Channel Spacing	
Wideband	4 kHz
Narrow band	2 kHz
With Voice Adapter (both Narrow band and Wideband)	4 kHz
An external hybrid or other device offering at least 20 dB rejection of the adjacent channel must be used in the application	

Channel Speed at 15 dB Margin, Solid State Output	
Narrow Band (800 Hz)	3.8 ms (pickup) 6.0 ms (dropout) typical
Standard (Wide) Band (1,600 Hz)	2.4 ms (pickup) 3.8 ms (dropout) typical
Phase Comparison Band (3,500 Hz)	1.3 ms (pickup) 1.5 ms (dropout) typical

1.5.2 Keying

Table 1-2 shows the TC-10B keying specifications.

Table 1-2. Keying Specifications.

Carrier Start, Carrier Stop Auxiliary (Reduced Power) Keying	All optically isolated for operation at 15 V, 48 V, 125 V, or 250 Vdc, strappable for either presence or absence of voltage for keying, as well as carrier start or stop priority (maximum burden is 20 mA).
Manual Keying	Recessed push button switches for carrier start and auxiliary keying.

1.5.3 Receiver Outputs

Table 1-3 shows the TC-10B Receiver Output Specifications.

Table 1-3. Receiver Output Specifications.

Two independent relaying outputs	Both outputs (fully isolated) provide up to 1 A transistor switch for microprocessor relaying or 200 mA (into 24 ohms), 20 mA (into 2,200 Ω); will operate from any battery supply (20 to 280 Vdc)
One receive alarm output	One Form A 100 VA, 125 Vdc (maximum)
One carrier level output (optional)	0–100 μ A for external indicator

1.5.4 Alarm & Level Option

Table 1-4 shows Alarm & Level Option specifications for the TC-10B.

Table 1-4. Alarm & Level Option Specifications.

Alarm Contacts (dc Power Loss, RF "ON", and Receive at Margin; 3 separate relays)	Form A or B contacts (field strappable) rated 100 VA; 0.5 sec of dropout delay
Carrier Level Indication Meter Reading	–20 dB to +10 dB

1.5.5 Universal Checkback Options

Table 1-5 shows Universal Checkback Option specifications for the TC-10B.

Table 1-5. Universal Checkback Option Specifications.

<ul style="list-style-type: none"> • PC interface for controlling settings and operation • On-line help • User selectable encoded or timed carrier • Three user programmable outputs • Optional timed communications fallback • Optional low power tests 	<ul style="list-style-type: none"> • Automatic checkback tests done either periodically or at user specified times • Loopback test capability • Remote communications • Automatic clock synchronization • Optional carrier recovery
--	--

1.5.6 Voice Adapter Option

Table 1-6 shows the TC-10B Voice Adapter Option specifications.

Table 1-6. Voice Adapter Option Specifications.

Modulation	Amplitude Modulation with compandor
Transmission	Half-Duplex
Frequency Response	300Hz to 2 kHz
Signaling	Carrier alarm

1.5.7 Environmental

Table 1-7 shows the TC-10B environmental specifications.

Table 1-7. Environmental Specifications.

Ambient temperature range of air-contacting equipment	-20 to +60°C (derated per Table 1-9) (ANS C37.90.)
Relative humidity	Up to 95% (non-condensing) at 40°C (for 96 hours cumulative) (ANS/UL 508)
Altitude	<ul style="list-style-type: none"> • Up to 1,500 m (without derating) • Up to 6,000 m (using Table 1-8 and Table 1-9)
SWC and FAST Transient	All external user interfaces meet SWC and FAST Transients of ANS C37.90.1 and IEC 255-6
Dielectric	Only isolated inputs and outputs, and all alarms: 2,500 Vdc from each terminal to ground, derated per Table 1-8. (IEC 255-5)
Center conductor of coaxial cable to ground	3,000 Vdc impulse level, using 1.2 x 50 msec impulse
Electro-Magnetic Interference Compatibility:	IEEE Trial-Use-Standard P734/D5/R4 (ANS C37.90.2).

Table 1–8.
Altitude Dielectric Strength
De-Rating for Air Insulation

Altitude (Meters)	Correction Factor
1,500	1.00
1,800	0.97
2,100	0.94
2,400	0.91
2,700	0.87
3,000	0.83
3,600	0.79
4,200	0.74
4,800	0.69
5,400	0.64
6,000	0.59

1

Table 1–9.
Altitude Correction For Maximum
Temperature Of Cooling Air (ANS C93.5).

		Temperatures (Degrees C)		
				From Usual
Usual	1,500	55	40	—
Unusual	2,000	53	38	2
Unusual	3,000	48	33	7
Unusual	4,000	43	28	12

1.5.8 Power Requirements and Dimensions

Table 1-10 shows the TC-10B power requirement specifications.

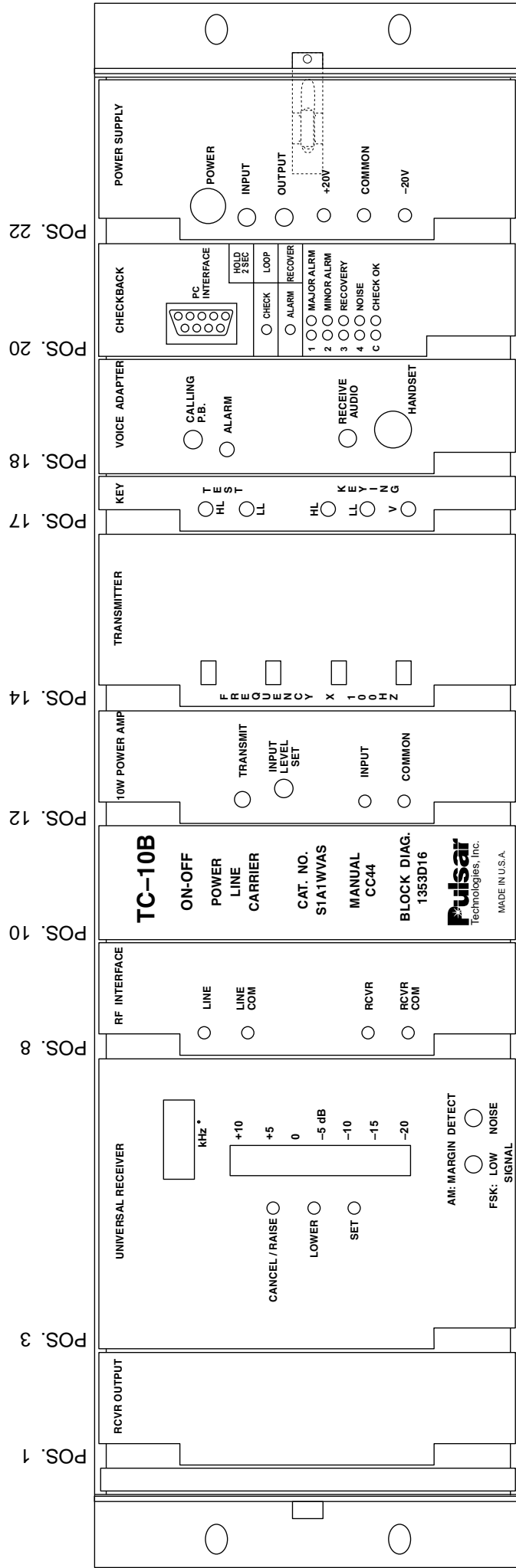
Table 1-10. Power Requirement Specifications.

Transceiver		Supply Current (Amps) At Nominal Voltage		
Nominal Battery Voltage	Permissible Voltage Range	Receive/ Standby	1 Watt Transmit	10 Watt Transmit
48/60 Vdc	38-70 Vdc	.630	.940	1.600
110/125 Vdc	88-140 Vdc	.240	.360	.600
220/250 Vdc	176-280 Vdc	.120	.180	.300

Table 1-11 shows the TC-10B weight and dimension specifications.

Table 1-11. Weight and Dimension Specifications.

Equipment	Net Weight		Height		Width		Depth		Rack Space
	lbs	Kg	inches	mm	inches	mm	inches	mm	
Transceiver	21	9.53	5.25	133.4	19.00	482.6	13.50	342.9	3 RU



FRONT VIEW

Figure 1-1. TC-10B Chassis and Control Panels with Optional Universal Checkback and Voice Adapter Modules. (1354D16A)

2.1 Protective Relay Applications Using ON/OFF Carriers

The TC-10B carrier set is particularly suitable for the following types of protective relay systems:

- Directional-Comparison Blocking
- Phase-Comparison Blocking
 - Current Only
 - Distance Supervised

2.1.1 Directional-Comparison Blocking

The basic elements for directional-comparison blocking systems are shown in Figure 2-1a and Figure 2-1b. At each terminal, the phase and ground trip units (P) must be directional and set to overreach the remote terminal; that is, they must be set to operate for all internal faults. Nominal settings of the distance units are 120 to 150 percent of the line. The start units (S) must reach farther, or be set more sensitively, than the remote trip units. Thus S₁ must be set more sensitively than P₂ or reach farther behind bus G. Likewise, S₂ must be set more sensitively than P₁ or reach farther behind bus H. In any case, the S and P relays should be similar in type. If the trip unit (P) is a directional overcurrent ground relay, the start (S) ground relay should be a similar non-directional overcurrent unit. The same principle applies for the phase relays.

When the TC-10B ON-OFF power line carrier is used with these schemes, except for possible auxiliary functions, **no signal is normally transmitted**, since the S units operate only during fault conditions.

Operation of the directional-comparison scheme (shown in Figure 2-1a and Figure 2-1b) is internal faults. Subscript 1 indicates relays at station G for breaker 1; subscript 2, relays at

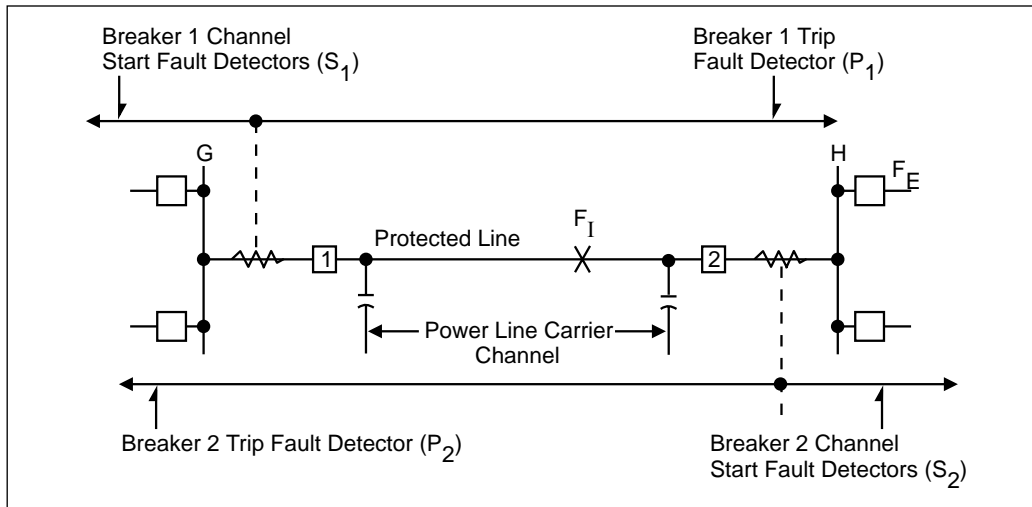
station H for breaker 2. (Figure 2-1c shows a solid-state logic version of Figure 2-1b.)

The schemes shown are still widely used for their flexibility and reliability. Since the communication channel is not required for tripping, internal faults that might short and interrupt the channel are not a problem. Over tripping will occur, however, if the channel fails or is not established for external faults within the reach of the trip fault detectors. Since the carrier transmitter is normally OFF, or non-transmitting, channel failure cannot be detected until the system is tested or until an external fault occurs. This limitation can be overcome by using the optional TC-10B checkback system with the TC-10B carrier.

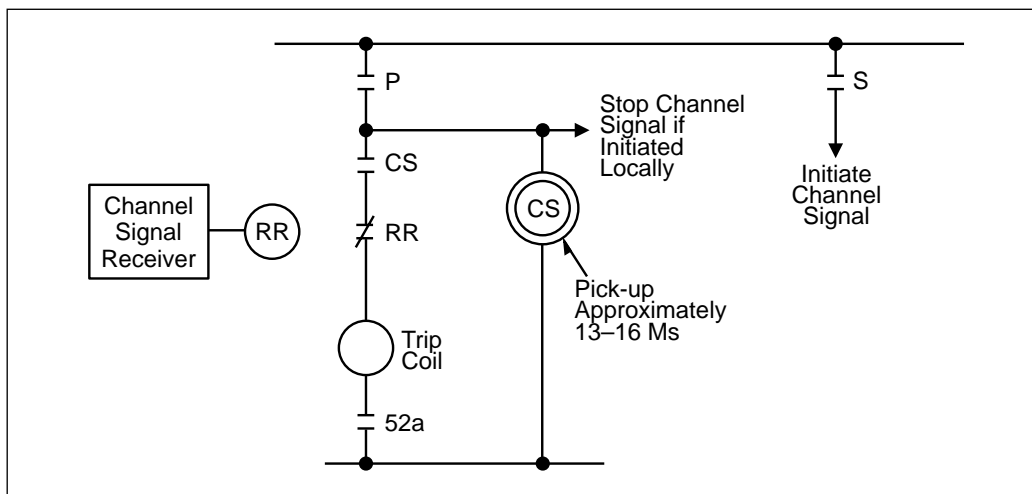
2.1.2 Phase-Comparison Blocking

Basic elements of the phase-comparison systems are shown in Figure 2-2. The system uses a composite sequence current network to provide a single-phase voltage output proportional to the positive, negative, and zero sequence current input. Sensitivity to different types of faults depends on the weighting factors or constants designed into the sequence current network. Adjustments to the network are provided.

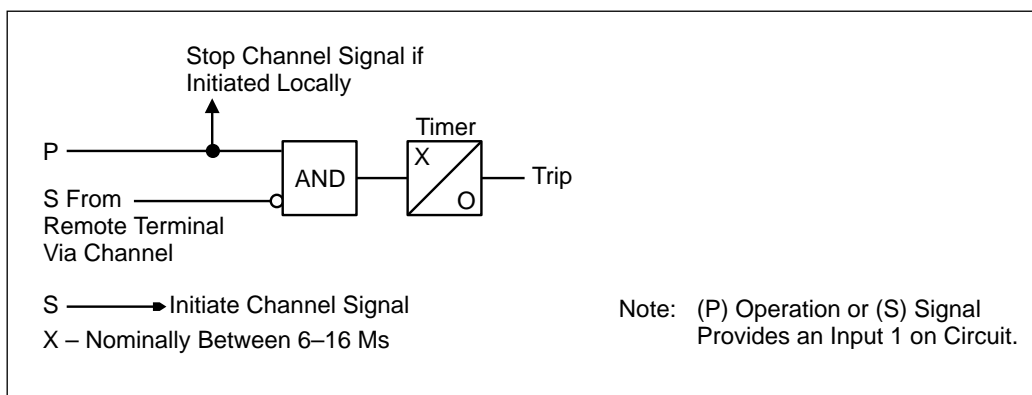
A squaring amplifier in the controlling relay converts the single-phase voltage output to a square wave. The positive voltage portion corresponds to the positive half-cycle of the filter voltage wave and the zero portion corresponds to the negative half-cycle. The square wave is used to key the TC-10B, transmitting to the remote terminal. The square wave from the remote terminal is compared to the local square wave, which has been delayed by an amount equal to the absolute channel delay time. This comparison of the local and remote square waves at each



2-1a – Basic Elements for directional-comparison blocking systems.



2-1b – Contact Logic (per Terminal).



2-1c – Solid State Logic (per Terminal).

Figure 2-1. Directional-Comparison Blocking, Basic Elements and Logic Diagrams.

Table 2–1. Directional Comparison Schemes for External and Internal Faults.

SCHEME FOR EXTERNAL AND INTERNAL FAULTS		
Type of Fault	Events at Station G	Events at Station H
External (F_E) For external faults, the CS unit or timer x/o assure that a blocking signal is established.	P_1 operates; S_1 does not see fault. Blocking signal received from station H. RR back contacts open (or 1 signal negates AND). No trip.	S_2 operates to key transmitter. Blocking signal sent to station G. P_2 does not see fault. No trip.
Internal (F_I)	P_1 operates; S_1 may or may not operate, but P_1 operation prevents transmission of a blocking signal. Breaker 1 tripped.	P_2 operates, S_2 may or may not operate but P_2 operation prevents transmission of a blocking signal. Breaker 2 tripped.

* For external faults, the CS unit or timer x/o assure that a blocking signal is established.

terminal determines whether a fault is internal or external.

Fault detectors are used to determine whether a fault has occurred and to supervise tripping. The fault detectors must be overreaching, i.e., set sensitively enough to operate for all internal phase and ground faults.

Because overcurrent fault detectors are normally used, voltage transformers are not required. Such a scheme is current only. Fault detectors should be set above maximum load, yet operate for all internal faults. Distance fault detectors, which require voltage transformers, are used on heavily-loaded or long lines when distance supervision is required.

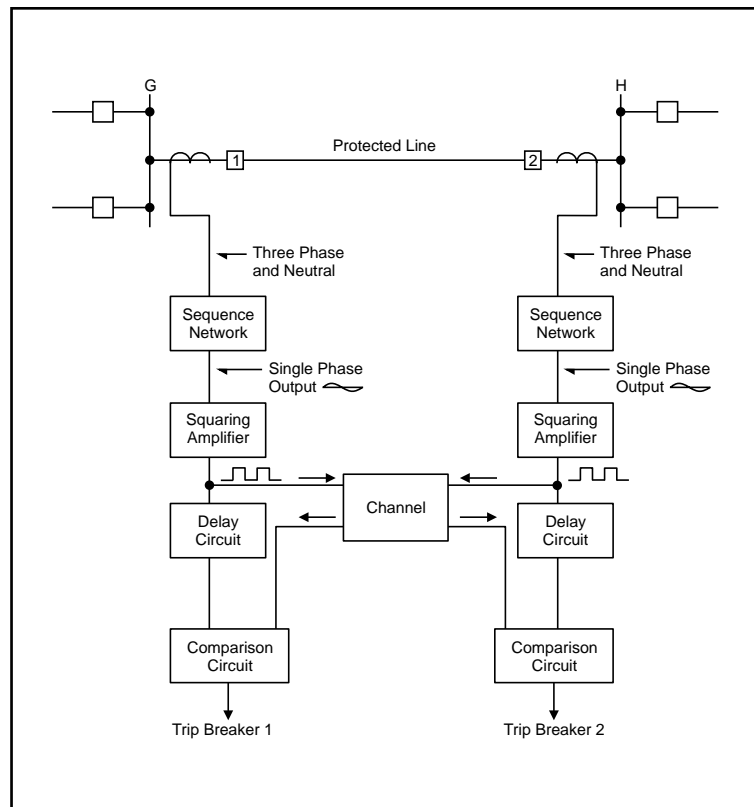


Figure 2–2. Phase-Comparison Blocking, Basic Elements.

2.1.3 Single Phase-Comparison Blocking, Current Only

In the current only system, the TC-10B is used with two overcurrent fault detectors (FD₁ and FD₂). FD₁, the carrier start unit, is set more sensitively than FD₂ and permits the local square wave signal to key the “ON/OFF” carrier transmitter. FD₂, set with a higher pickup than FD₁, is used to arm the system for tripping. For transmission lines less than 100 miles long, the FD₂ pickup is set at 125 percent of FD₁. For lines longer than 100 miles, the FD₂ pickup is set at 200 percent of FD₁. On a three-terminal line, FD₂ is set at 250% of FD₁, provided the line length between any two breakers is less than 100 miles. Phase-Comparison cannot occur until FD₂ operates. The purpose of the two fault detectors is to coordinate the comparison of the local and remote square waves with the keying of the carrier square wave. **The carrier must be started before the comparison is allowed** to ensure that the remote square wave has been received.

The basic operation of the system is shown in Figure 2-3. FD₁ and FD₂ at both terminals operate for an internal fault (F_I). The square wave inputs to the AND from the local currents are essentially in phase with those transmitted via the channel from the remote terminal. The local square wave turns the carrier “ON” and “OFF” to provide the square wave receiver output for the remote terminal.

A flip flop is energized if the inputs to the AND continue for 4 ms, providing a continuous trip output

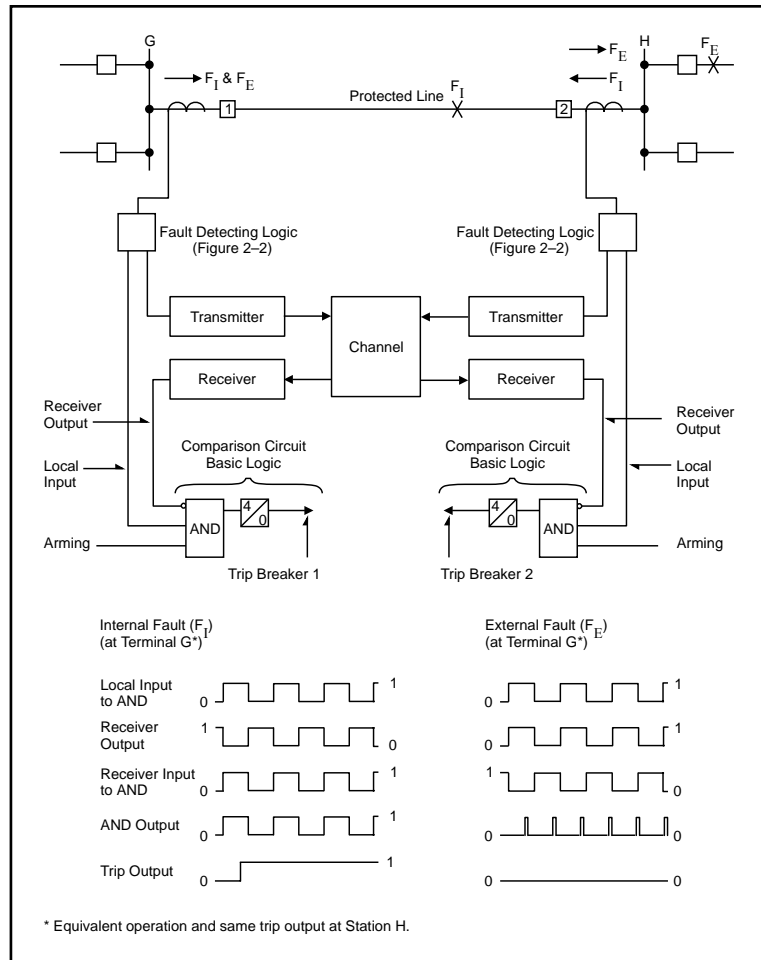


Figure 2-3.
Single Phase Comparison Blocking, Current Only Operation.

supervised by FD₂ operation. The 4 ms correspond to a phase angle difference of 90°, on a 60-Hz base, between the currents at the two terminals. The currents at the two ends of the line may be out of phase by up to 90° and still trip. This is a blocking system, since the receipt of a signal from the channel prevents tripping. The carrier signal, therefore, does not have to be transmitted through the internal fault. No received signal puts a “1” on the AND input. With the remote terminals open, this system provides sensitive instantaneous overcurrent protection for the entire line. As is characteristic of blocking systems, the channel is not required for tripping on internal faults.

For an external fault, such as F_E in Figure 2-3, blocking is essentially continuous, since the remote wave input to the AND is out-of-phase with the local square wave. The secondary ct currents are essentially out-of-phase for an external fault. The currents can, however, be in-phase by up to 90° on a 60-Hz base and still block.

2.1.4 Single-Phase, Distance-Supervised Comparison Blocking

A distance-supervised scheme should be used if the minimum internal three-phase fault current is less than twice the maximum load current. Twice maximum load current allows FD1 to operate positively on the minimum internal three-phase fault, yet reset when an external fault is followed by a maximum load current flowing through the line. The TC-10B operates in the same manner as when used with the current-only scheme, except for the fault detection and arming techniques.

Two sequence current networks and two distance relays supplement the two overcurrent fault detectors.

One sequence current network responds only to negative and zero sequence currents, detecting all phase-to-phase and ground faults (but not three-phase faults). The output of this adjustable network operates the conventional overcurrent FD1 and FD2 fault detectors. The two distance relays operate only for three-phase faults. Thus, FD2 provides the arming function for all unbalanced phase and ground faults, through the adjustable filter, and one of the distance relays (21P) provides arming for all three-phase faults.

The second and non-adjustable sequence current network operates through the squaring amplifier, providing the local square wave and the carrier-keyed square wave required for phase comparison. This signal is keyed by FD1 and the second distance relay (21S) to provide the carrier start functions. This second network responds to positive, negative, and zero sequence currents. Separate networks provide greater sensitivity: with phase-to-phase faults, for example, more than twice the sensitivity is gained.

The setting coordination of FD1 and FD2 overcurrent units is the same as for the current-only system. Settings for the two three-phase distance units are shown in Figure 2-4. Both 21S and 21P distance relays must be set to overreach both the local and remote terminal buses; 21S must be set further than 21P, as shown.

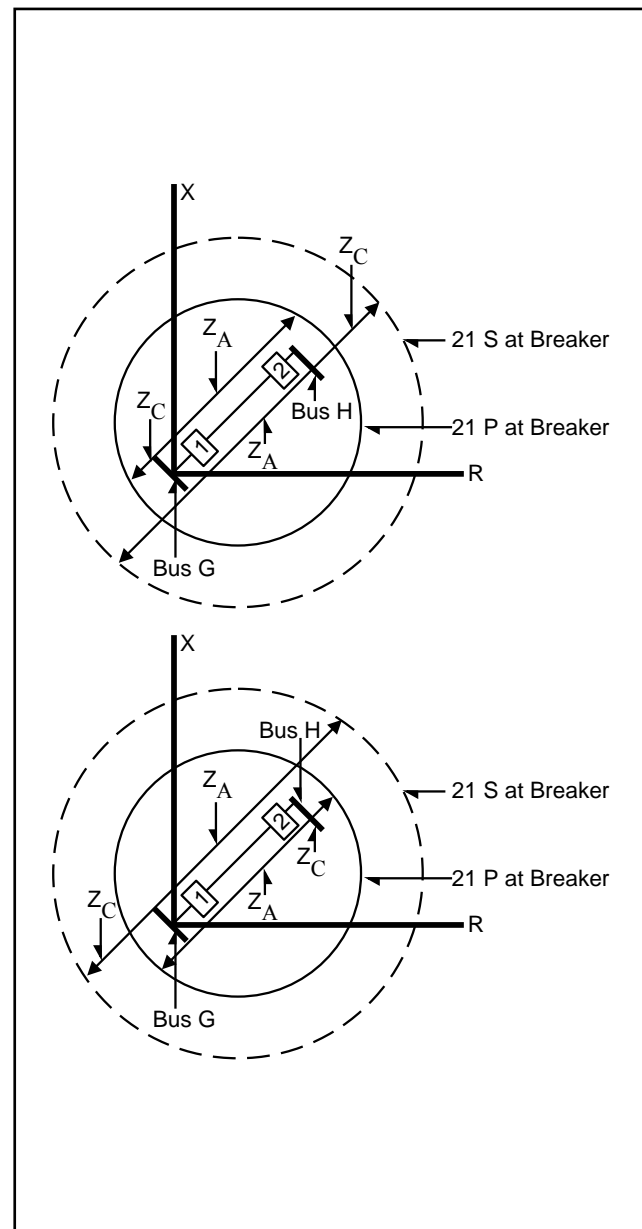


Figure 2-4. Single Phase-Comparison Blocking, Distance-Supervised Operation.

2.2 Special Application Considerations

Because the TC-10B is “ON/OFF” modulated, only one frequency (f_c) is required for line protection. When applied to **three terminal lines**, phase cancellation will occur when two or more transmitters are keyed simultaneously. To prevent this, you should offset transmitters by ± 100 Hz, using the thumbwheel frequency programming switches. The three frequencies should be:

- f_c
- $f_c - 100$ Hz
- $f_c + 100$ Hz

When using the TC-10B with the SKBU-1 Phase-Comparison, you must offset the transmitter frequencies from the center frequency by 100 Hz for all applications. In a two-terminal application, set the transmitter at one end 100 Hz above the center frequency, and the transmitter at the other end 100 Hz below the center frequency. Thus, the two transmitters are spaced 200 Hz from each other. For a three terminal line, you should offset the transmitter as described in the above paragraph.

The TC-10B does not have an adjustable filter or hybrid attached to the output of the transmitter.

If you are using the TC-10B in an application where no other power line carrier equipment is attached to the power line, then no further action is required. **However, in the application of Single Comparator Phase Comparison relaying, the TC-10B is to be operated in the four-wire mode (see RF Interface Module), with an external skewed hybrid between transmitter and receiver.**

If you are applying the carrier set with other transmitters, coupled through the same tuning equipment, you must apply a hybrid or a series LC unit to the transmitter output to isolate the other transmitters from the TC-10B transmitter. This will avoid the problems of intermodulation distortion. We suggest that you use a hybrid if the frequency spacing between all transmitters is within the bandwidth of the hybrid (usually 6%).

Check the manufacturers instructions for the actual spacing limitations of the hybrid you are using. If you cannot use a hybrid, then you may use a series LC unit to isolate the transmitters. In this case, the transmitters must have spacing such that the LC you are using will attenuate the external frequencies by at least 20 dB (if the other frequency is a 10 watt transmitter), and 30 dB (if the other frequency is a 100 watt transmitter).

2.3 Ordering Information

The TC-10B carrier is functionally compatible with earlier type carrier equipment (e.g., KR, TC, TC-10, TC-10A). That is, you may use the TC-10B with these other carrier types at the opposite end of the line, with or without voice function. You may use the same telephone handset unit with any of these ON-OFF carrier sets.

You may use the TC-10B carrier set with the following types of relay systems:

- All Directional-Comparison Blocking Systems
- Phase-Comparison Blocking Systems, e.g., SKBU-1 (**Requires 45-Vdc power supply — please see Table 2-5.**)

Simplified schematics of typical electro-mechanical systems are shown in Figure 2-5 through Figure 2-13 (schemes A thru K). These schemes indicate the different jumper positions required for particular applications. Simplified connections between the TC-10B and a microprocessor based relay are shown in Figure 2-14 (Scheme L).

Figure 2-15 shows the output circuit for microprocessor based relays (1 amp maximum output).

Figure 2-16 shows the resultant output circuit for 48, 125, and 250 Vdc systems.

Two variations of TC-10B are available:

- (1) Plug-in Voice Adapter Module with signaling as a push-to-talk maintenance voice channel - (see Chapter 17). A telephone jack is provided on the Voice Adapter Module, but you may

also use a remote jack or hookswitch. (See Figure 18-4, Scheme J, for the connection diagrams.)

- (2) Plug-in Universal Checkback Module for periodic testing of the carrier channel at programmable intervals (see Chapter 17). (See Figure 3-3 for connection diagrams.)

The equipment identification number (catalog number) is located in the middle of the front panel (just to the left of the 10W PA Module). The TC-10B catalog number comprises eight (8) characters, each in a specific position. This number identifies the unit's technical characteristics and capabilities, as well as any optional modules installed in the unit.

Table 2-2 provides a complete listing of the options for ordering a TC-10B, as well as a sample catalog number. To order one or more TC-10Bs, simply identify the features and optional modules you want for each chassis. For example, the typical catalog number shown in Table 2-2 — **S 1 A 1 W V A S** — orders a TC-10B with the following features:

Basic TC-10B Transmitter/Receiver

Power Output: 10 watt

Universal Checkback: Universal Checkback Module, PC programmable

dc/dc Converter Power Supply: 110/125 Vdc battery input

Bandwidth (Filter Range): Wideband filter

Voice Adapter: Voice Adapter Module with signaling

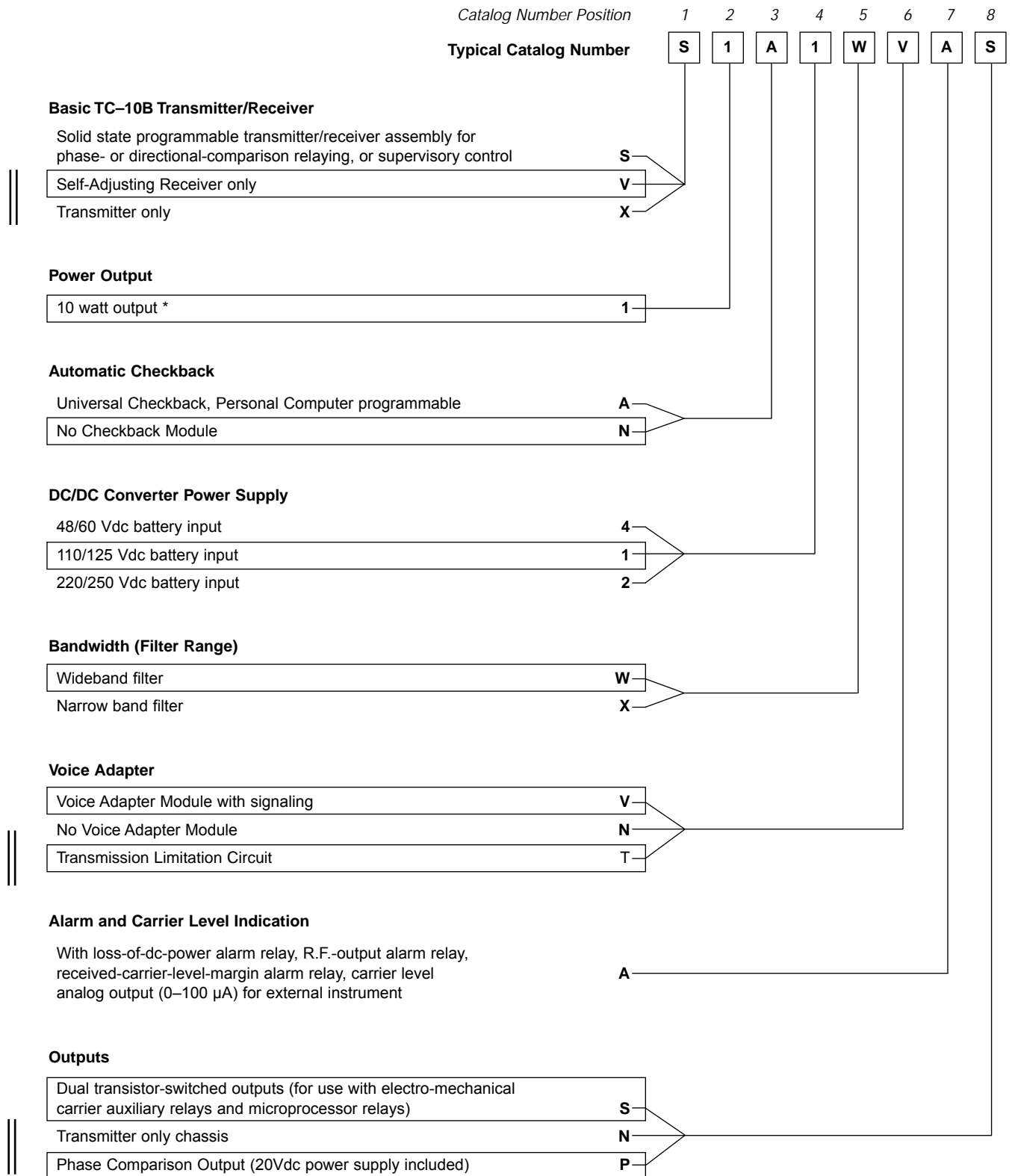
Alarm and Carrier Level Indication: with loss-of-dc-power alarm relay, R.F. output alarm relay, received-carrier-level-margin alarm relay, detect alarm, instrument indicating carrier level (-20dB to +10dB), carrier level analog output (0-100 μ A) for external instrument

Outputs: Dual transistor-switched outputs (for use with electro-mechanical carrier auxiliary relays and microprocessor relays)

Table 2-3 provides a further breakdown of the TC-10B catalog number by style numbers.

The accessories available for the TC-10B are listed, along with their style numbers, in Table 2-4 and Table 2-5. To order an accessory, simply give its style number.

Table 2-2. TC-10B Catalog Numbers



*For 50 or 100 watt output, see document CA44-VER03 (Linear Power Amplifier)

Accessories TC-10B/TCF-10B Extender BoardStyle # 1353D70G01
 TC-10B to KR mounting kitStyle # 1355D61G01

Table 2-4. TC-10B Voice Adapter Accessories.

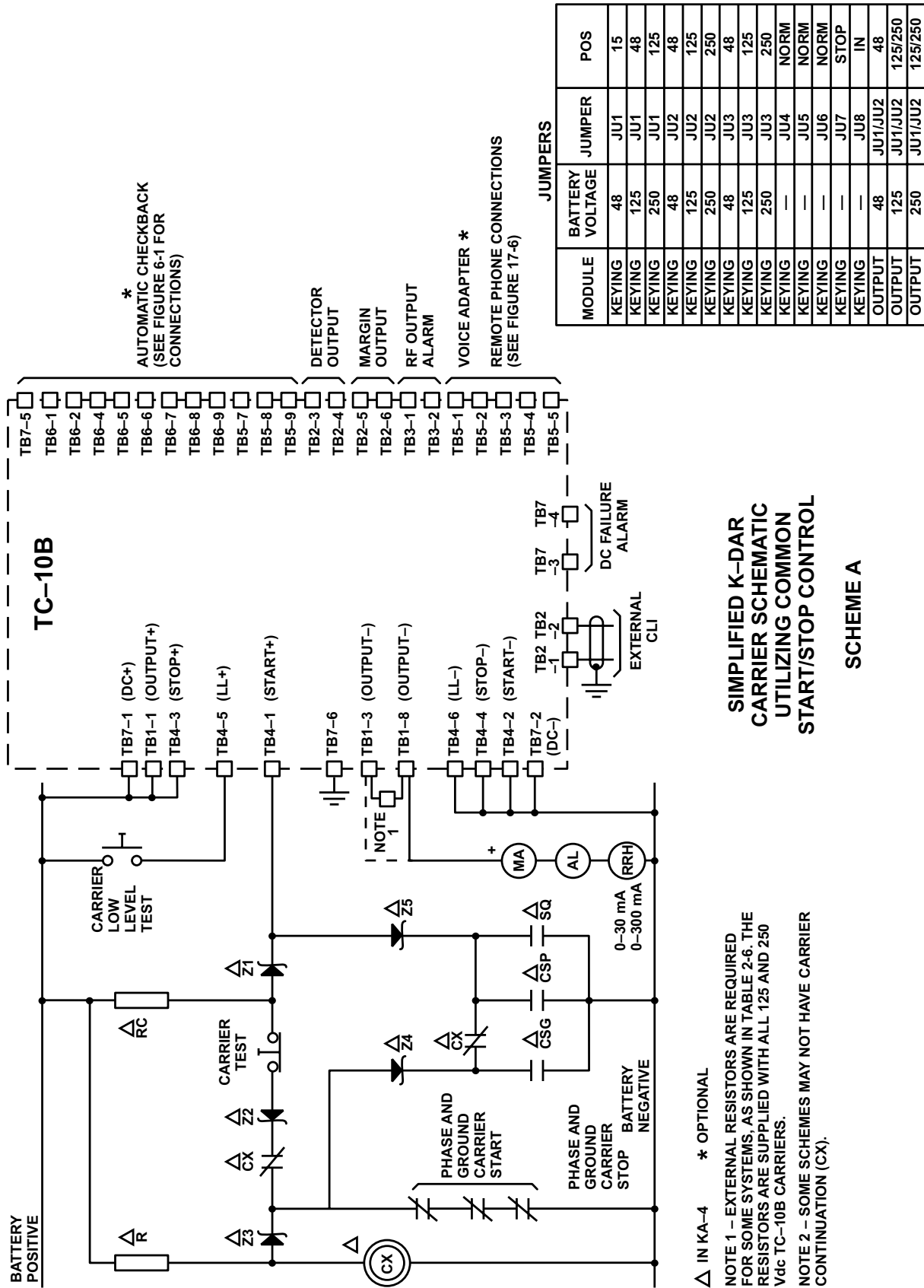
Accessories for Voice Adapter	Style Number
Sonalert (2,900 Hz, 60-250 Vdc)	SC250J
Telephone Hookswitch Assembly (panel mounting) with Noise Canceling Handset	205C266G05
Telephone Handset, Push to Talk, Noise Canceling (single prong plug)	1353D88G01
Telephone Jack, remote panel mounting (single prong plug)	715B674G03

Table 2-5. Other TC-10B Accessories

Other Accessories	Style Number
45V power supply for use with SKBU-1 Relaying System	
48V to 45V	5303D49G05
125V to 45V	5303D49G06
250V to 45V	5303D49G07

Table 2-6. External Resistor Requirements — Provided with Chassis, According to Battery Voltage.

Carrier Aux. Relay	Battery Voltage	Resistor
20 mA (220 Ω)	48	Not Required
20 mA (220 Ω)	125	3500 Ω , 5W
20 mA (220 Ω)	250	9200 Ω , 10W & 500 Ω , 40W
200 mA (25 Ω)	48	Not Required
200 mA (25 Ω)	125	Not Required
200 mA (25 Ω)	250	500 Ω , 40W



**SIMPLIFIED K-DAR
CARRIER SCHEMATIC
UTILIZING COMMON
START/STOP CONTROL
SCHEME A**

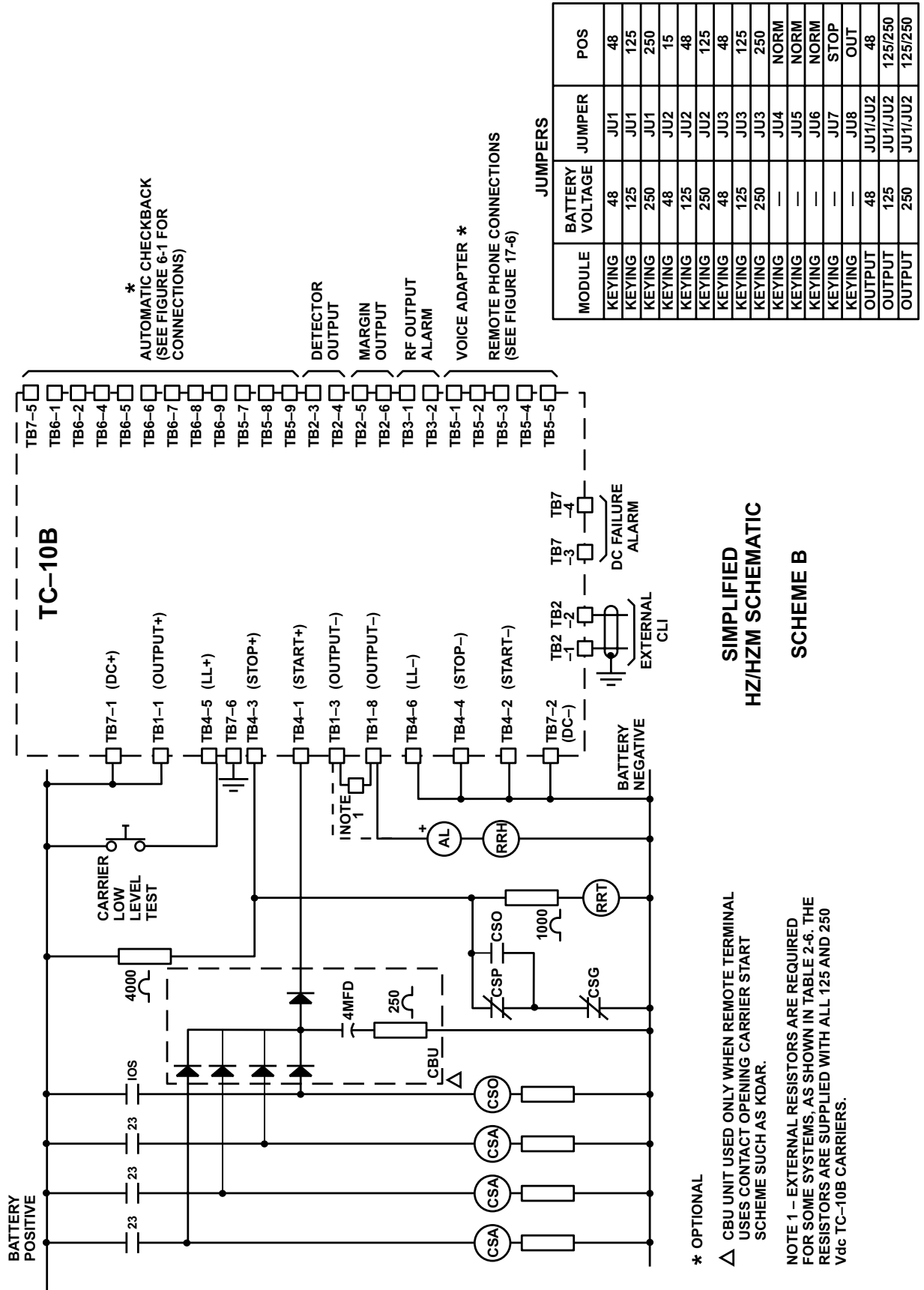
Δ IN KA-4 * OPTIONAL

NOTE 1 - EXTERNAL RESISTORS ARE REQUIRED FOR SOME SYSTEMS, AS SHOWN IN TABLE 2-6. THE RESISTORS ARE SUPPLIED WITH ALL 125 AND 250 Vdc TC-10B CARRIERS.

NOTE 2 - SOME SCHEMES MAY NOT HAVE CARRIER CONTINUATION (CX).

Figure 2-5. TC-10B Simplified Application Schematic - Scheme A (7833C63).

Figure 2-6. TC-10B Simplified Application Schematic – Scheme B (7833C63).



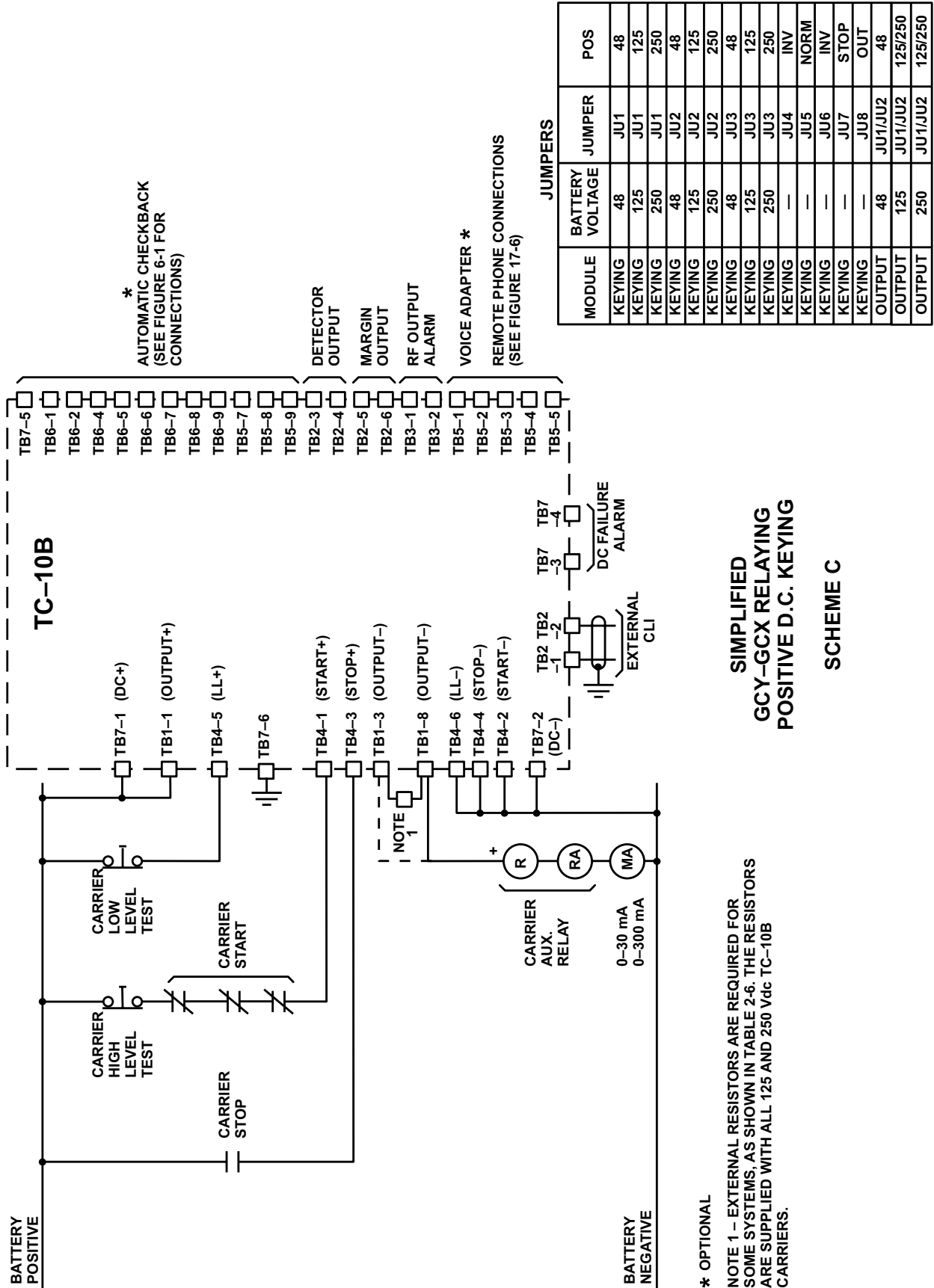
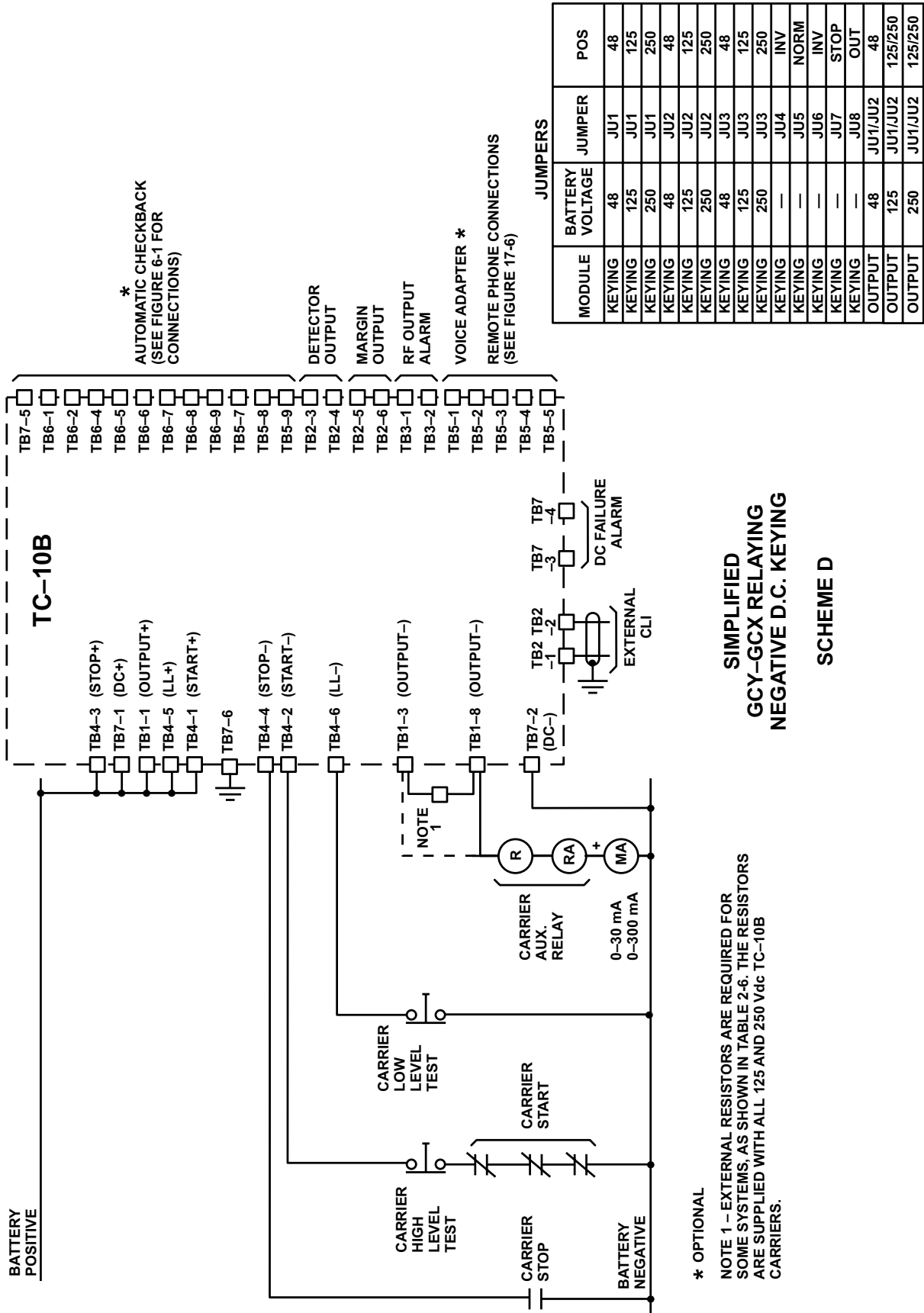


Figure 2-7. TC-10B Simplified Application Schematic – Scheme C (7833C63).

Figure 2-8. TC-10B Simplified Application Schematic – Scheme D (7833C63).



**SIMPLIFIED
GCY-GCX RELAYING
NEGATIVE D.C. KEYING
SCHEME D**

*** OPTIONAL**
NOTE 1 - EXTERNAL RESISTORS ARE REQUIRED FOR SOME SYSTEMS, AS SHOWN IN TABLE 2-6. THE RESISTORS ARE SUPPLIED WITH ALL 125 AND 250 Vdc TC-10B CARRIERS.

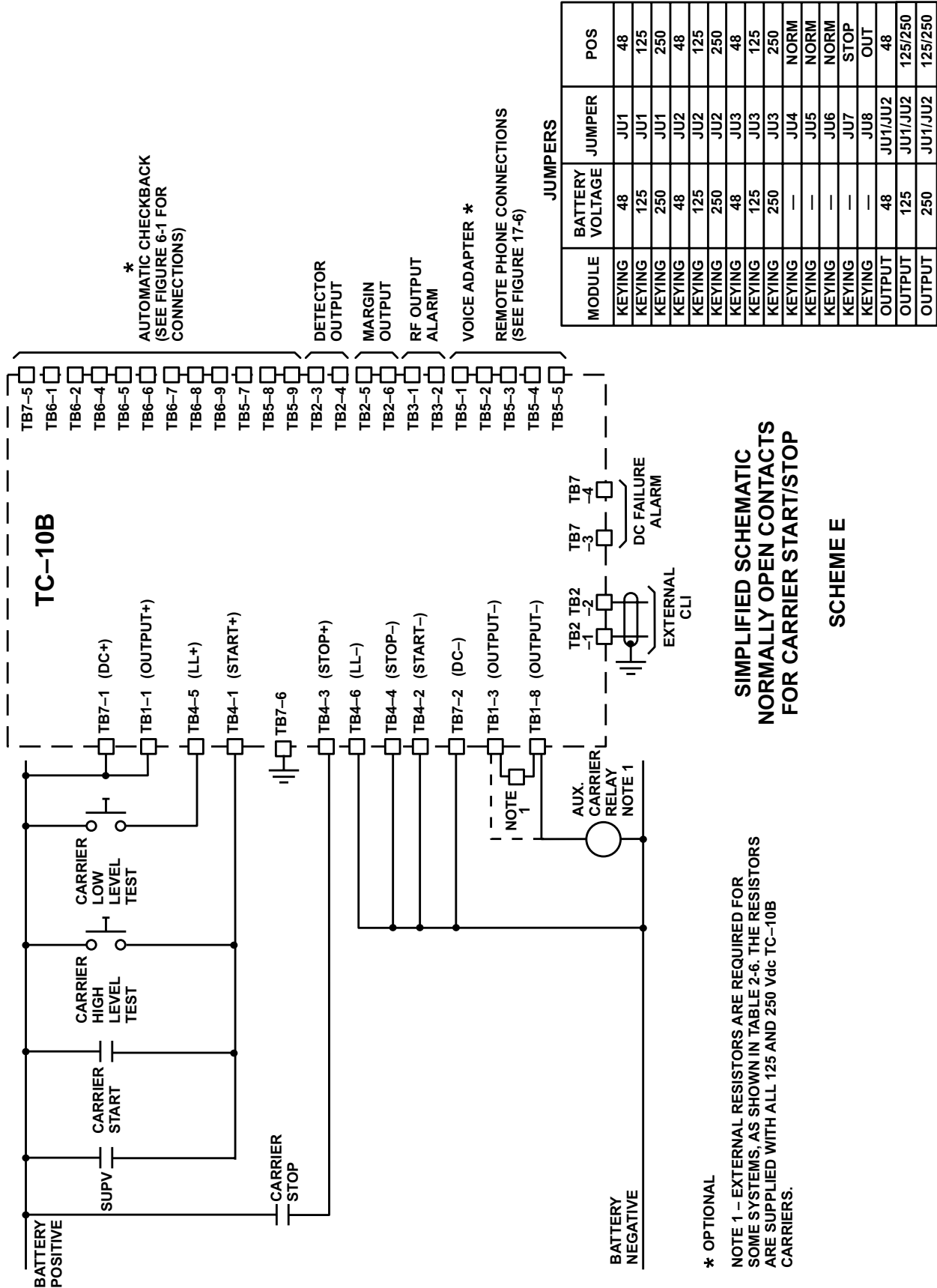
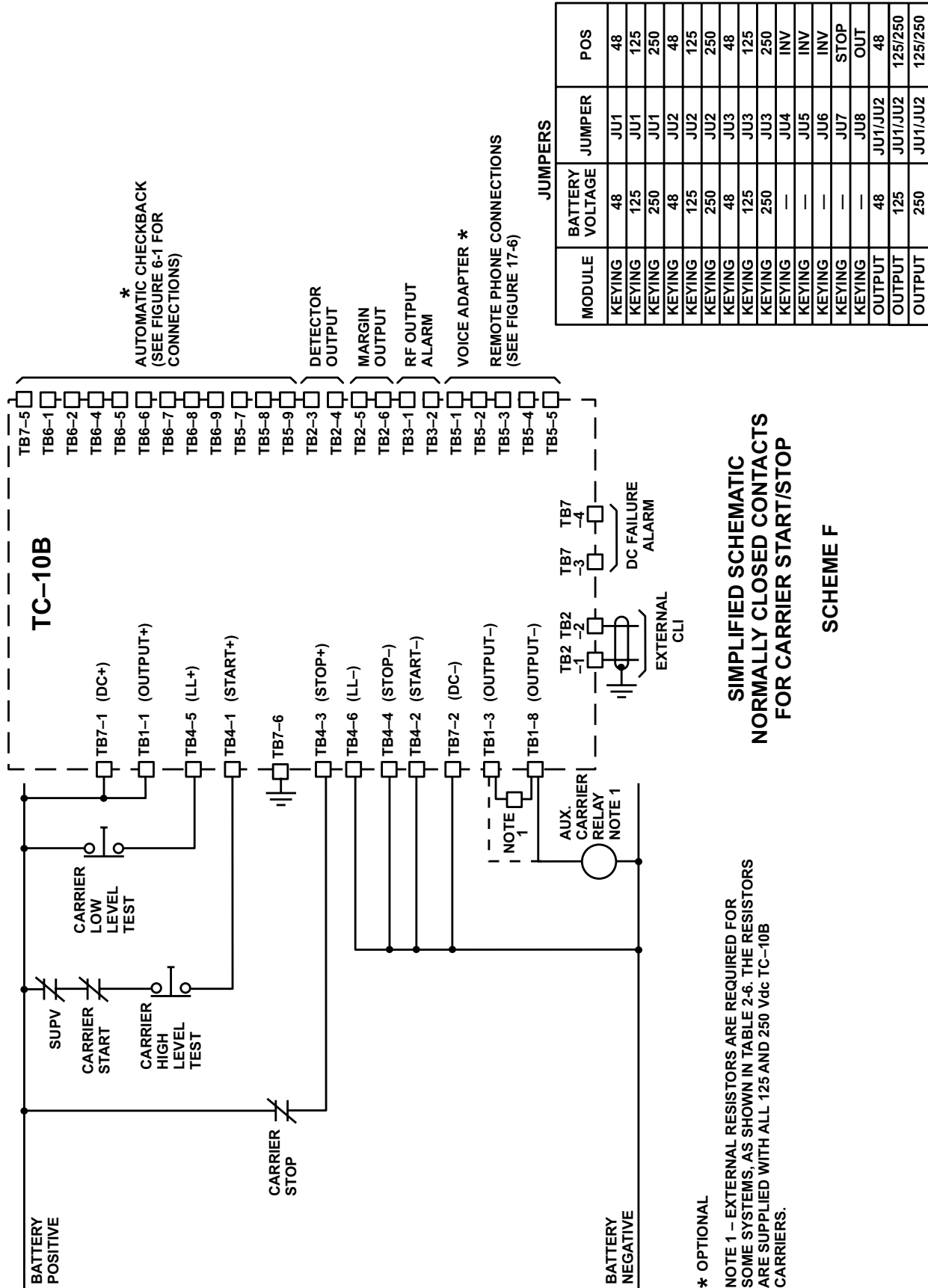


Figure 2-9. TC-10B Simplified Application Schematic - Scheme E (7833C63).

Figure 2-10. TC-10B Simplified Application Schematic – Scheme F (7833C63).



**SIMPLIFIED SCHEMATIC
NORMALLY CLOSED CONTACTS
FOR CARRIER START/STOP**

SCHEME F

*** OPTIONAL**
NOTE 1 – EXTERNAL RESISTORS ARE REQUIRED FOR SOME SYSTEMS, AS SHOWN IN TABLE 2-6. THE RESISTORS ARE SUPPLIED WITH ALL 125 AND 250 Vdc TC-10B CARRIERS.

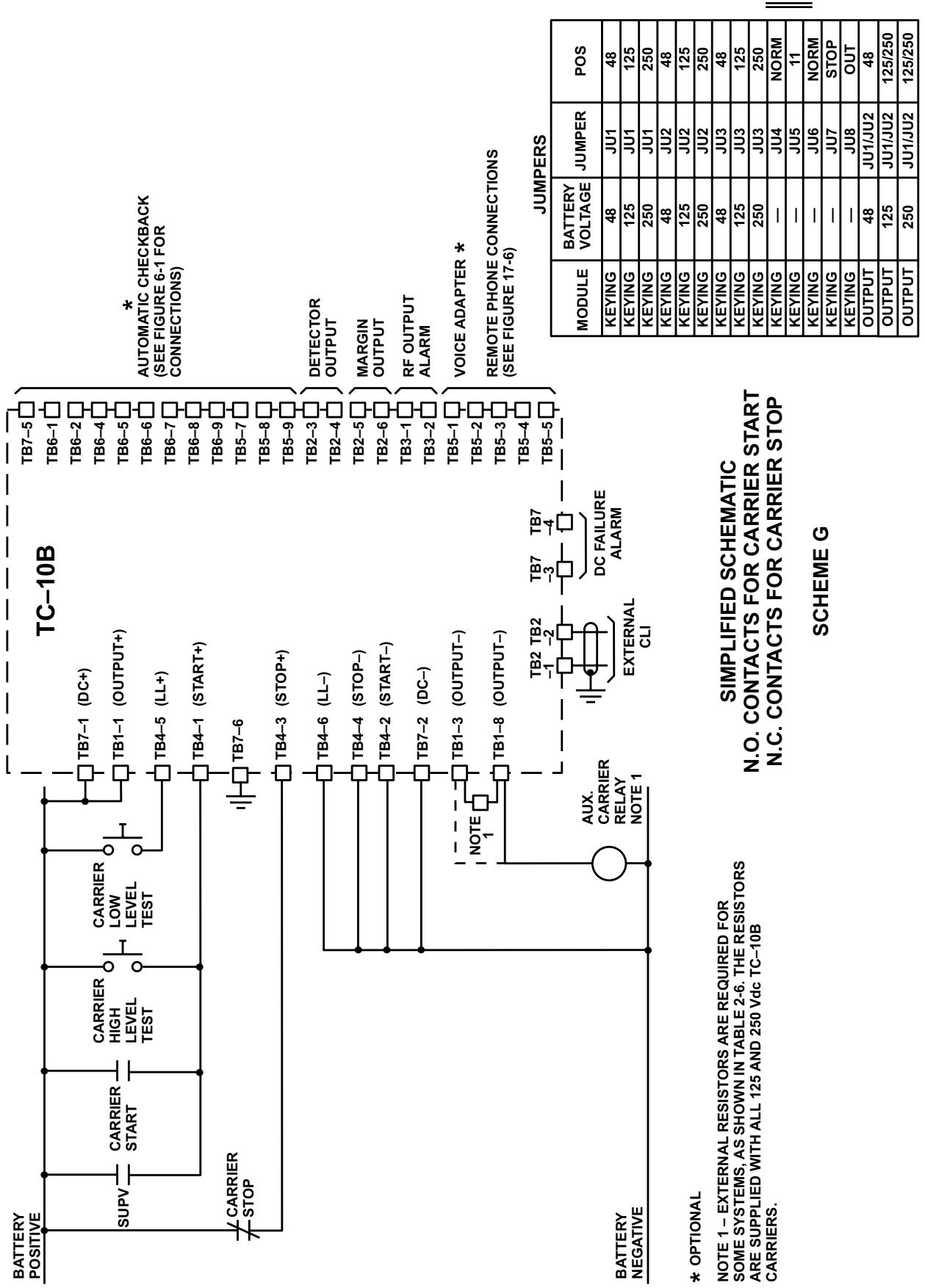


Figure 2-11. TC-10B Simplified Application Schematic - Scheme G (7833C63).

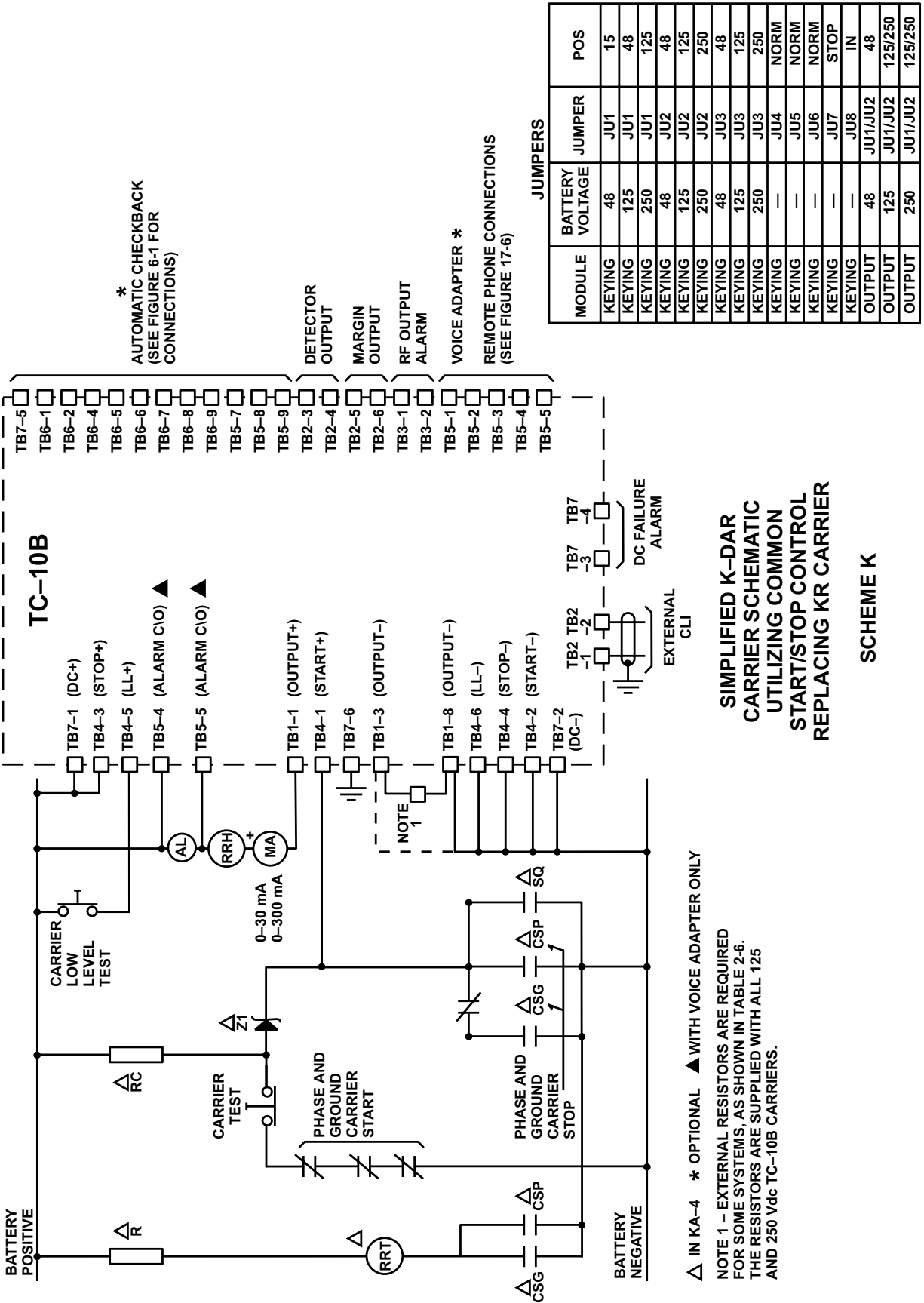


Figure 2-13. TC-10B Simplified Schematic - Scheme K (7833C63).

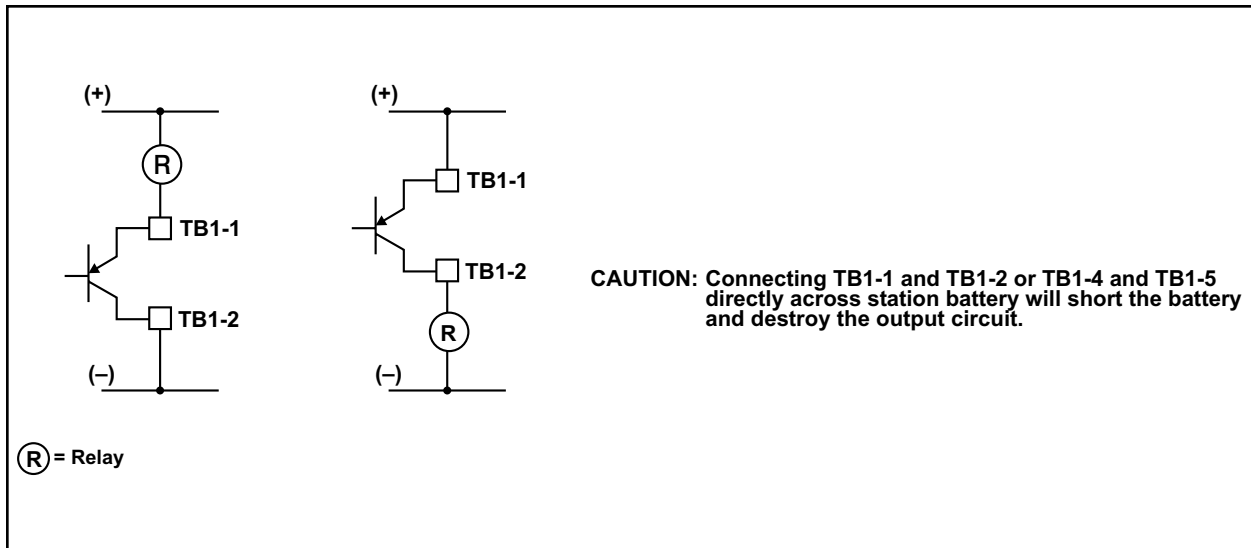


Figure 2-15. TC-10B Receiver Output Typical Connections for Microprocessor based Relays (up to 1A output switched from station battery).

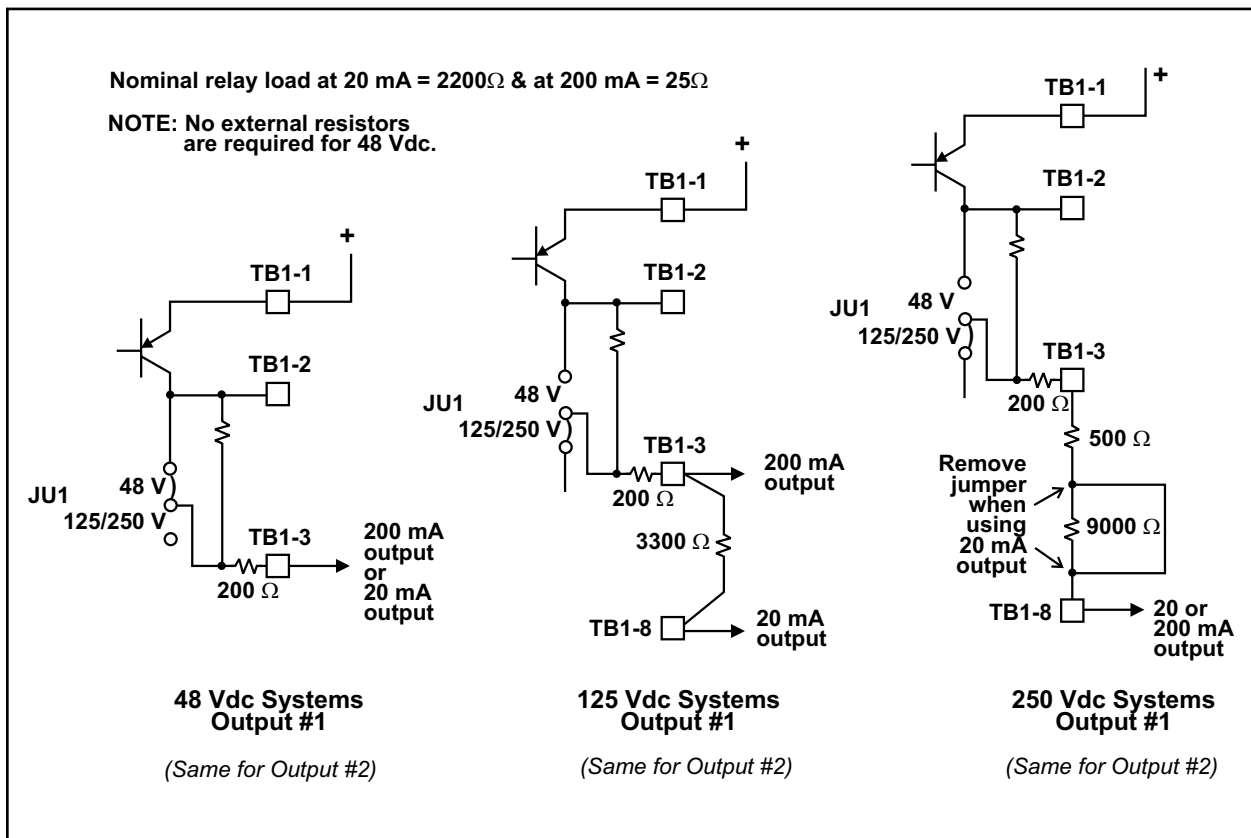


Figure 2-16. TC-10B Receiver Outputs with External Resistors for Electro-mechanical Relays (20 and 200ma outputs).

Chapter 3. Installation

3.1 Unpacking

If the TC-10B is shipped unmounted, it is in special cartons that are designed to protect the equipment against damage.

 CAUTION
<p><i>UNPACK EACH PIECE OF EQUIPMENT CAREFULLY SO THAT NO PARTS ARE LOST. INSPECT THE CONDITION OF THE TC-10B AS IT IS REMOVED FROM ITS CARTONS. ANY DAMAGE TO THE TC-10B MUST BE REPORTED TO THE CARRIER. DAMAGES ARE THE RESPONSIBILITY OF THE CARRIER AND ALL DAMAGE CLAIMS ARE MADE GOOD BY THE CARRIER. SEND A COPY OF ANY CLAIM TO PULSAR TECHNOLOGIES, INC.</i></p>

3.2 Storage

If you are setting the equipment aside before use, be sure to store it in its special cartons (in a moisture-free area) away from dust and other foreign matter.

3.3 Installation Location

Install the TC-10B in an area which is free from:


- Temperature exceeding environmental limits (See “Environmental Requirements” in Chapter 1)
- Corrosive fumes
- Dust
- Vibration

3.4 Assembly

You can assemble the TC-10B for use in any of the following configurations:

- Mounted in a fixed-rack cabinet.
- Mounted in a swing-rack cabinet
- Mounted on an open rack.

or in your own, customer-specified configuration. Refer to Figure 3-3 for mounting dimensions.

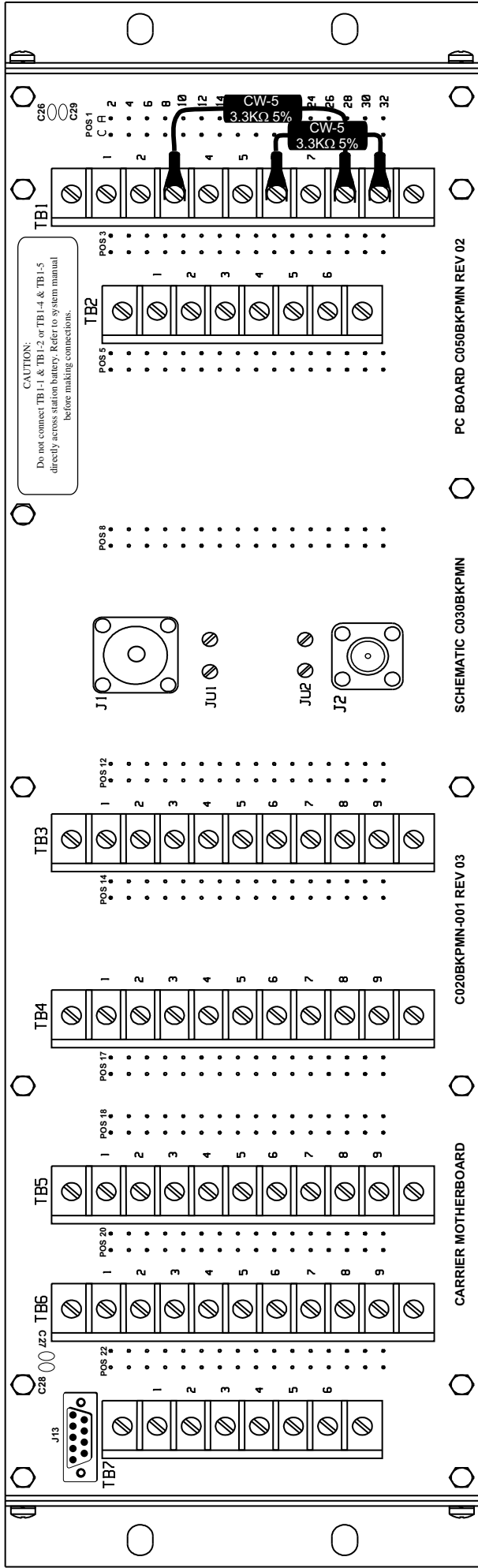
 CAUTION
<p><i>IF YOU ARE USING THE TC-10B WITH A SWING-RACK CABINET, MAKE SURE THAT THE CABINET IS FIRMLY FASTENED BEFORE OPENING THE RACK (TO PREVENT TIPPING).</i></p>

3.5 TC-10B Rear Panel Connectors

The following connectors are accessible from the Rear Panel (See Figure 3-1):

- Terminal Blocks
- Cable Jacks
- Jumpers
- Input/Output Pins
- RS-232 DB9 female (for future use)

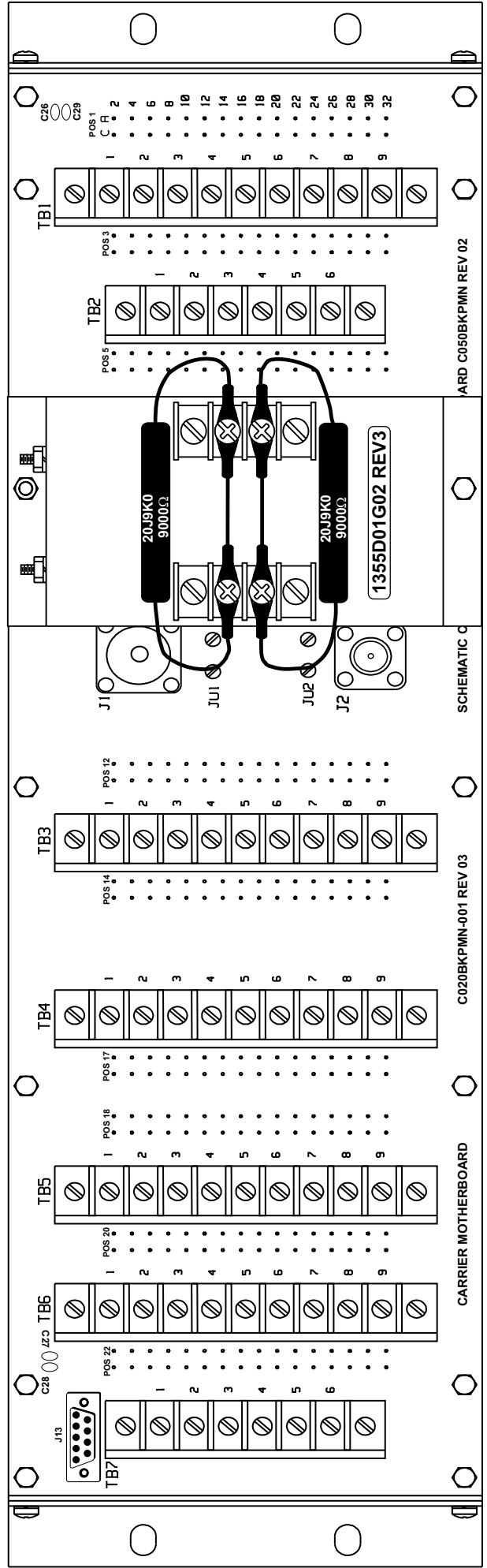
Figure 3-1. TC-10B Rear Panel – Mother Board (1354D16-12/1355D01).



STANDARD MOTHERBOARD (REAR VIEW)

Resistors are required for 125V units only

250V output resistors or 20V auxiliary power supply as required



3.5.1 Terminal Blocks

(Refer to Figure 3-4 for further explanation.)

TB7 Power Supply	(Terminals 1–4, 6)
TB7 Universal Checkback	(Terminal 5)
TB6 Universal Checkback	(Terminals 1–9)
TB5 Voice Adapter	(Terminals 1–6)
TB5 Universal Checkback	(Terminals 7–9)
TB4 Keying	(Terminals 1–6)
TB3 10W PA	(Terminals 1–6)
TB2 Level Detector	(Terminals 1–6)
TB1 Receiver Output	(Terminals 1–9)

3.5.2 Cable Jacks

- J1 RF Interface Module, RF line, thru 2-wire coaxial cable (UHF)
- J2 RF Interface Module Receiver, RF input line through 4-wire coaxial cable (BNC), when transmitter and receiver are separated.

3.5.3 Jumpers

- JU1 Not Included
- JU2 Not Included

3.5.4 Input/Output Pins of Modules

Pins labeled C and A provide 16 input/output connections per module (using even numbers 2 through 32 for all modules) as follows:

- Power Supply (pins are to the right of TB7)
- Automatic Checkback (pins are to the right of TB6)
- Voice Adapter (pins are to the right of TB5)
- Keying (pins are to the left of TB4)
- Transmitter (pins are to the left of TB3)
- 10W PA (pins are to the right of TB3)

- RF Interface (pins are to the right of cable jacks and jumpers)
- Receiver (pins are to the left of TB2)
- Level Detector (pins are to the left of TB1)
- Receiver Output (pins are to the right of TB1)

3.6 Connections

3.6.1 Safety Precautions

Read this Installation chapter thoroughly before making any connections to the TC–10B. *No one should be permitted to handle any of the equipment that is supplied with high voltage, or connect any external apparatus to the equipment, unless that person is thoroughly familiar with the hazards involved.*

Three types of connections are made:

- TC–10B equipment ground
- DC power supply and other connections
- Coaxial cables
- RS-232 (reserved for future use)



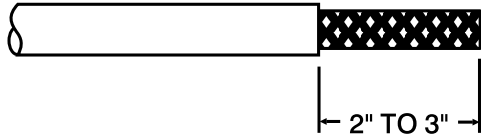
CAUTION

PRIOR TO MAKING CONNECTIONS, CLOSE THE RF GROUNDING KNIFE SWITCH IN THE CABINET THAT IS CONNECTED TO THE INCOMING COAXIAL CABLE.

3.6.2 TC–10B Equipment Ground

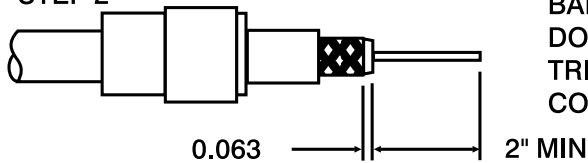
In addition to the TC–10B chassis ground connection that is made through the cabinet or rack, a ground connection is provided at the Rear Panel Terminal Block TB7. (See Figure 3-1.) A connection should be made between TB7 Terminal 6 and the earth ground connection at the TC–10B cabinet location.

STEP 1



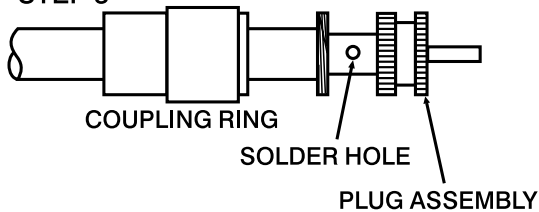
CUT THE END OF THE CABLE EVEN.
REMOVE BETWEEN 2" AND 3" OF THE VINYL
JACKET — TAKING CARE NOT TO CUT THE BRAID.

STEP 2



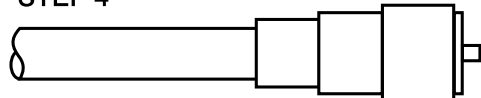
BARE 2" MINIMUM OF THE CENTER CONDUCTOR —
DO NOT NICK THE CONDUCTOR.
TRIM THE BRAIDED SHIELD 1/16" AND SLIDE THE
COUPLING RING ONTO THE CABLE.

STEP 3



SCREW THE PLUG ASSEMBLY ONTO THE CABLE.
SOLDER THE ASSEMBLY TO THE BRAID THROUGH
THE SOLDER HOLES.

STEP 4



SCREW THE COUPLING RING ONTO THE ASSEMBLY.

Figure 3-2. Cable Termination Diagram (9651A13).

3.6.3 DC Power Supply and Other Connections

Input terminals TB7-1 and TB7-2, on the rear of the TC-10B chassis, provide the connection points for the power supply (48, 125 and 250Vdc) and customer inter-connections. (See Figure 3-1). The terminal blocks can accept up to a 12 AWG wire with a ring lug type Burndy YAV1DL36/YAV10 or equivalent.

Any lead coming to or from the switchyard should be shielded twisted pair to reduce transients to below the Surge Withstand Capability of ANSI C37.90.1.

3.6.4 Coaxial Cable

A coaxial cable is required for a low-impedance path between the TC-10B (Transmitter and Receiver modules) and the Line Tuner (in the

NOTE

The type of coaxial cable we recommend is RG-213/U (52Ω, 29.5 PF/FOOT) with the following characteristics:

switchyard). Connection jack J1, on the Rear Panel, provides the point for coaxial cable connection from the TC-10B to the switchyard.

- Single-conductor
- #12 AWG
- 7 strand #21 copper
- Polyethylene insulator
- Copper shield
- Vinyl jacket (nominal O.D. 0.405 inch)

If the coaxial cable is to connect to related cabinets enroute to the switchyard, we recommend RG-58A/U cable from J1 to the related cabinets and RG-213/U from the cabinets to the switchyard. Install the coaxial cable according to the following guidelines:

1. Attach both ends of the coaxial cable in accordance with the Cable Termination Diagram

(see Figure 3-2, terminal block lugs, as required).

2. To hold carrier loss to a minimum, keep the cable the shortest possible length.

The minimum cable bending diameter is six times the cable diameter.



CAUTION

DO NOT GROUND TO THE END OF THE CABLE THAT IS CONNECTED TO THE LINE TUNER.

3. The copper braid of the cable must be grounded at the end which connects to the TC-10B.
4. Without grounding the copper braid of the cable, connect the cable to the ground terminal of the Line Tuner, at either of the following:

- Impedance Matching Transformer
- Wideband Filter

If you are connecting the cable directly to the line tuner, the cable connector can enter the line tuner base either through the side or the bottom of the base.



CAUTION

NEVER DISCONNECT THE CARRIER LEAD-IN BETWEEN THE LINE TUNER AND THE COUPLING CAPACITOR UNLESS THE LOW POTENTIAL END OF THE COUPLING CAPACITOR IS GROUNDED.

BEFORE DISCONNECTING THE CARRIER LEAD-IN CONDUCTORS, CLOSE THE RF GROUNDING SWITCH AT THE BASE OF THE COUPLING CAPACITOR.

WARNING: IF THIS GROUND IS NOT PROVIDED, DANGEROUS VOLTAGES CAN BUILD UP BETWEEN THE LINE TUNER AND COUPLING CAPACITOR.

3.6.5 RS-232 Connector

This RS-232 DB9 female connector is reserved for future use.

3.7 Disconnections

3.8 Jumper Controls

Jumpers are set during installation, depending on the particular TC-10B features and applications (see Figure 3-5).

NOTE

JU1 is shipped in the "NC" state.

3.8.1 Power Supply PC Board

Jumper JU1 for optional Alarm Relay establishes contact type during loss of power condition (NO/NC).

3.8.2 Keying PC Board

For proper selection of jumpers, refer to Figures 2-5 through 2-14.

JU1 Carrier Start	15V, 48V, 125V, 250V
JU2 Carrier Stop	15V, 48V, 125V, 250V
JU3 Low-Level Key	15V, 48V, 125V, 250V

JU7 Carrier Start/ Stop Priority START,STOP

JU6 Carrier Start NORM (+), INVERT (-)

JU5 Carrier Stop NORM (+), INVERT (-)

JU4 Low-Level Test NORM (+), INVERT (-)

JU8 Carrier Stop (KA-4, SKBU-1)

3.8.3 Transmitter PC Board

There are no jumpers on the Transmitter PC Board.

NOTE

JU1 is shipped in the "NC" state.

3.8.4 10W PA PC Board

Jumper JU1 for Alarm Relay establishes loss of power condition (NO/NC).

3.8.5 RF Interface PC Board

Matching Impedance Jumpers:

- JU4 50Ω
- JU3 75Ω
- JU2 100Ω

NOTE

JU1/JU5 are shipped in the "IN" (2-wire) state. JU4 is shipped in the "50Ω" state.

2-wire or 4-wire RF Termination

- JU1/JU5 "IN" (2-wire)
- JU1/JU5 "OUT" (4-wire)

Attenuator Override Jumper (JU6)
(See Table 3-1.)

3.8.6 Receiver/Detector & CLI PC Board

Jumper J3 for margin relay establishes NO or NC. The Universal Receiver Module has an 8 position DIP switch. This DIP switch is used to set various configuration options. Please refer to Chapter 14 for details.

3

Table 3–1. Attenuator Override Jumper Sensitivity Levels.

	Normal Sensitivity		High Sensitivity	
	Wideband	Narrow band	Wideband	Narrow band
JU6 Position	OUT	OUT	IN	IN
Minimum Sensitivity (mV)	60	20	15	5
Maximum Input Level	70	70	17	17
Impedance (Ω)	5,000	5,000	1,000	1,000

3.8.7 Receiver Output PC Board

Jumpers provide voltage selections as follows:

JU1

1. 48V
2. 125/250V

JU2

1. 48V
2. 125/250V

3.8.8 Universal Checkback PC Board

The Universal Checkback Module (see Chapter 16), unlike previous versions of the checkback module, does not use jumpers for settings. The module has just one jumper, which is not currently used:

JMP1 Reserved for future use

Settings are made using a computer connected to the front panel DB-9 connector. If a pc is not available there is a 4 pos. DIP switch onboard for making one of four standard factory settings (see table 16-2).

3.8.9 Voice Adapter PC Board

A jumper and a DIP switch are provided, as follows:

JMP1 Alarm Contacts (NO/NC)

When jumper is set in “NO” position, and relay is de-energized, the alarm contacts will be “OPEN”. When jumper is in “NC” position, and relay is de-energized, the alarm contacts will be “CLOSED”.

SW1 User Functions

In the closed/down position the DIP switch functions as follows;

- 1 Tone gives Alarm (TCF-10B)
- 2 Carrier gives Alarm (TC-10B)
- 3 Handset key mutes ear (TC-10B)
- 4 Beeper enabled

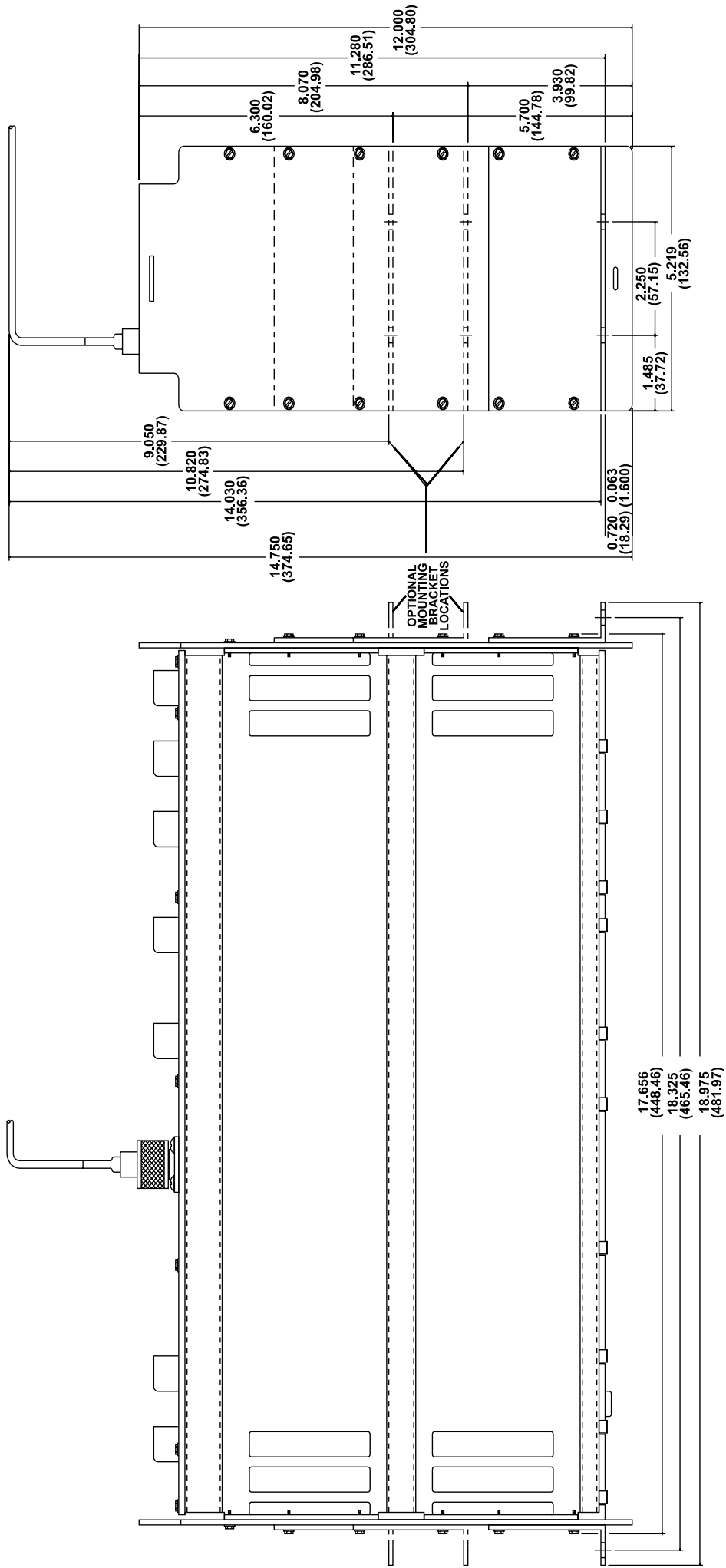
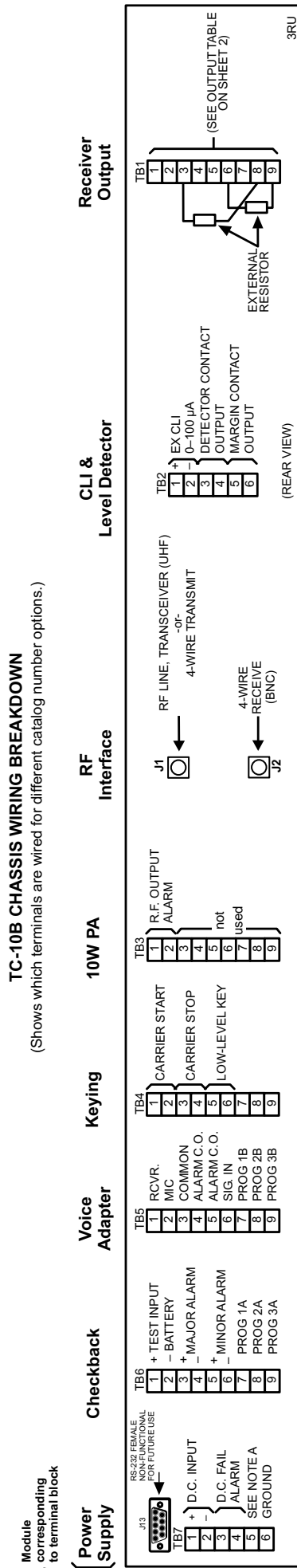


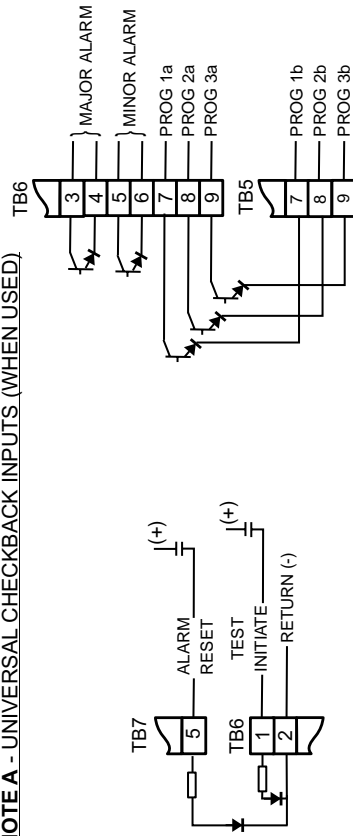
Figure 3-3. TC-10B Mechanical Outline Drawing (1354D48).

Figure 3-4. TC-10B Connection Drawing and Jumper Options (2064D87; Sheet 1 of 2).



J1 and J2 coaxial connectors may be wired out to terminal blocks or connected to RF hybrids. J1 is used for either the 2-wire transmitter output or the 4-wire transmitter output. J2 is used for the 4-wire receive input only.

NOTE A - UNIVERSAL CHECKBACK INPUTS (WHEN USED)



CHECKBACK -S1-

	S1	S2	S3	S4
CUSTOM	OFF	OFF	OFF	N/A
FAC.#1	ON	OFF	OFF	N/A
FAC.#2	OFF	ON	OFF	N/A
FAC.#3	ON	ON	OFF	N/A
FAC.#4	OFF	OFF	ON	N/A

AM RECEIVER/DETECTOR -S1-

SWITCH ON SW1	OFF	ON
2	NO VOICE ADAPTER	VOICE ADAPTER
3	UNUSED	
4	UNUSED	
5	UNUSED	
6	UNUSED	
7	PHASE COMPARISON 3,500 Hz BW	DIRECTIONAL COMPARISON BW PER SW1-8
8	1,200 Hz BW	600 Hz BW

JUMPER OPTIONS

POWER SUPPLY	CHECKBACK	VOICE	KEYING MODULE	POWER AMPLIFIER	RF INTERFACE	AM RECEIVER/DETECTOR	OUTPUT BOARD	TRANSMITTER
JU1 NORMALLY OPEN/ RESERVED	JMP1 RESERVED FOR FUTURE USE	JMP1 NORMALLY OPEN/ ALARM CONTACT	JU1 *CARRIER START JU2 *CARRIER STOP JU3 *LOW-LEVEL JU4 **LOW-LEVEL JU5 **STOP JU6 **START JU7 FOR TEST PURPOSES ONLY JU8 FOR USE WITH KA-4 AND SKBU-1	JU1 NORMALLY OPEN/ NORMALLY CLOSED CONTACT OUTPUT	JU1 IN 2-WIRE; OUT 4-WIRE JU2 IMPEDANCE - 100 OHM JU3 IMPEDANCE - 75 OHM JU4 IMPEDANCE - 50 OHM JU5 IN 2-WIRE; OUT 4-WIRE JU6 NORM/HIGH SENSITIVITY	J3 NORMALLY OPEN/ NORMALLY CLOSED CONTACT OUTPUT	JU1 48 OR 125/250 V JU2 48 OR 125/250 V	S5-1 OFF (UP) } NO S5-2 OFF (UP) } SHIFT S5-3 OFF (UP) } S5-4 OFF (UP) }

OPTIONS

VOICE ADAPTER MODULE
UNIVERSAL CHECKBACK MODULE

* EACH MUST BE STRAPPED FOR CORRECT VOLTAGE. REFER TO JUMPER TABLE IN FIGURES 2-14 (SIMPLIFIED SCHEMATICS) FOR TYPICAL APPLICATIONS.
** SELECTS SENSE OF INPUT DESIRED (NORMAL/INVERT).

OUTPUT TABLE						
For use with Microprocessor-based Relays						
			Terminal Connections OUTPUT #1		Terminal Connections OUTPUT #2	
1 Amp Switched Transistor Output			TB1-1 & TB1-2		TB1-4 & TB1-5	
For use with Electro-Mechanical Relay Systems						
Carrier Aux Relay	Battery Voltage (Vdc)	External Resistor (ohms/watts)	Terminal Connections OUTPUT #1	JU1 Position	Terminal Connections OUTPUT #2	JU2 Position
20 mA (2200 Ω)	48	None required	TB1-1 (+) & TB1-3	48	TB1-4 (+) & TB1-6	48
20 mA (2200 Ω)	125	3500/5	TB1-1 (+) & TB1-8	125/250	TB1-4 (+) & TB1-9	125/250
20 mA (2200 Ω)	250	9200/10 & 500/40	TB1-1 (+) & TB1-8	125/250	TB1-4 (+) & TB1-9	125/250
200 mA (25 Ω)	48	None required	TB1-1 (+) & TB1-3	48	TB1-4 (+) & TB1-6	48
200 mA (25 Ω)	125	None required	TB1-1 (+) & TB1-3	125/250	TB1-4 (+) & TB1-6	125/250
200 mA (25 Ω)	250	500/40	TB1-1 (+) & TB1-8	125/250	TB1-4 (+) & TB1-9	125/250

Chassis Options	Module Options	Terminal Block ID
Only offered as a transceiver (transmitter and receiver)	1. None (basic transceiver)	TB1 (1–9), TB2 (1-6), TB3 (1,2), TB4 (1–6), TB7 (1-4,6)
	2. Voice adapter	TB5 (1–6)
	3. Automatic Checkback	TB5 (7–9) TB6 (1–9) TB7 (5)

Figure 3–5. TC–10B Connection Drawing and Jumper Options (2062D38; Sheet 2 of 2).

Chapter 4. Test Equipment

Table 4-1 shows the equipment you should use to perform the Installation/Adjustment procedures (Chapter 5) and Design Verification Tests (Chapter 7).

Table 4–1. Recommended Test Equipment.

Equipment	Application
High-Impedance Selective Level Meter, 300 Hz-1 MHz (Rycom 6021A) ¹ -or- Acterna/Wandel-Golterman SPM-3A	<ul style="list-style-type: none"> • Impedance Matching • Transmitter Power Adjustment • Receiver Margin Setting
Digital Multimeter (Fluke 75) ¹	Check dc Supply/general troubleshooting
Reflected Power Meter, Auto VLF Power SWR Meter (Signal Crafter 70) ¹	Impedance Matching at Carrier Output
Oscilloscope (Tektronix) ^{1,2}	<ul style="list-style-type: none"> • Transmitter Power • Adjustment for Optional Voice Adapter Module
Non-Inductive Resistor, 50 Ohm, 25 W (Pacific) ¹	Transmitter Termination
Signal Generator (H/P 3325A) ^{1,2}	General ac output for lab measurements
Extender Board (1353D70G01)	(See Figure 4-1.)

CAUTION

WE RECOMMEND THAT THE USER OF THIS EQUIPMENT BECOME THOROUGHLY ACQUAINTED WITH THE INFORMATION IN THESE INSTRUCTIONS BEFORE ENERGIZING THE TC-10B AND ASSOCIATED ASSEMBLIES. YOU SHOULD NOT REMOVE OR INSERT PRINTED CIRCUIT MODULES WHILE THE TC-10B IS ENERGIZED. ALL INTEGRATED CIRCUITS USED ON THE MODULES ARE SENSITIVE TO AND CAN BE DAMAGED BY THE DISCHARGE OF STATIC ELECTRICITY. YOU SHOULD ALWAYS OBSERVE ELECTROSTATIC DISCHARGE PRECAUTIONS WHEN HANDLING MODULES OR INDIVIDUAL COMPONENTS. FAILURE TO OBSERVE THESE PRECAUTIONS CAN RESULT IN COMPONENT DAMAGE.

¹ Indicates "or equivalent" of the recommended equipment item.

² Required only for the design verification tests in Chapter 7.

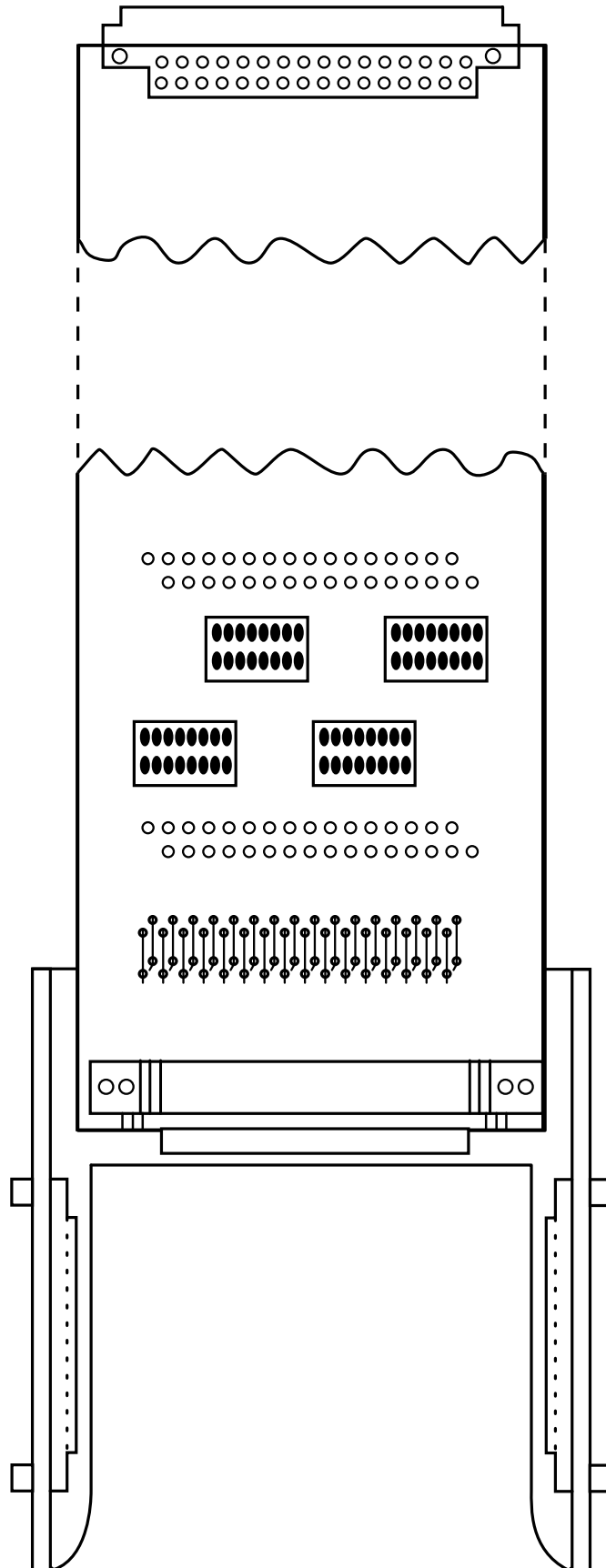


Figure 4-1. Extender Board.

Chapter 5. Installation / Adjustment Procedures

You perform routine adjustments in the field for the following purposes:

- Verifying initial TC-10B factory adjustments.
- Installing the TC-10B for your application.
- Changing the TC-10B operating frequencies.
- Periodic maintenance.

Be sure to run the adjustment tests in the following order:

1. Select the TC-10B Operating Frequency.
2. Review the Adjustment Data Sheets (at the end of this chapter); you should complete the data sheets as you perform the Adjustment Steps.
3. Select the TC-10B Keying Conditions.
4. Select the TC-10B Receiver Output.
5. Select the TC-10B Transmitter RF Output Impedance.
6. Check the Line Tuning and Matching Equipment.
7. Check the TC-10B Transmitter Power Levels.
8. Offset the TC-10B Transmitter Frequency. (3 terminal line application)
9. Set the TC-10B Receiver using the Remote Carrier signal.
10. Select the optimal Universal Checkback Module conditions.

To prepare the TC-10B for installation or routine adjustment tests, perform the following:

- Review the Test Equipment (Chapter 4).
- Review the Adjustment Data Sheets (at the end of this chapter); you should complete the data sheets as you perform the Adjustment Steps.
- Review the TC-10B Block Diagram as described under Signal Path (Chapter 6).
- Remove the cover from the front of the chassis. After removing the cover, set it in a safe place.



CAUTION

MAKE SURE THAT THE POWER HAS BEEN TURNED "OFF" USING THE POWER SWITCH (S1) ON THE POWER SUPPLY MODULE; THE INPUT (D3) AND OUTPUT (D11) LEDES SHOULD NOT SHOW RED LIGHTS.

If you are using the Alarm Relay, set jumper JU1 on the Power Supply Module.

5.1 Select the TC-10B Operating Frequency

1. Remove the Transmitter Module from the TC-10B chassis and select the operating frequency.
 - a) Using the module extractors, remove the Transmitter Module.
 - b) Select the Transmitter operating frequency (between 30 and 535kHz), by turning the four Transmitter rotary programming switches (in 0.1kHz steps), with a small screwdriver until the desired operating frequency appears through the (four) windows in the Transmitter control panel.
 - c) Using module extractors, insert the module back into the TC-10B chassis, by seating it with firm pressure.
2. Power up the TC-10B unit with the appropriate dc power. With a small screwdriver, depress the "SET" button on the front of the receiver module. The frequency display will begin to flash. Depress the raise or lower button until the desired frequency is displayed. Depress "SET" again to select this frequency. If you are not ready to set the sensitivity, depress the "CANCEL" button. If you are ready to set the sensitivity, depress the "SET" button and proceed with steps listed in section 6.8.

NOTE

You may use the "INVERT" positions on JU4 (LOW-LEVEL KEYING) and JU6 (HIGH-LEVEL KEYING) when it is impractical to hold down the (RECESSED) push-buttons ("HL" and "LL") on the Keying Module control panel.

5.2 Select TC-10B Keying Conditions

5.2.1 Keying Mechanisms

Keying mechanisms for the TC-10B are of two types:

- Control Panel source (e.g., using test push-buttons)
- Printed Circuit Board (PCB) source (e.g., using jumpers)

5.2.2 Keying Module Jumpers

1. Remove the Keying Module from the chassis and set jumpers JU1 through JU8 as desired (refer to Figures 2-5 through 2-16):

JU1 – Keying Voltage Carrier Start

- 15V
- 48V
- 125V
- 250V

JU2 – Keying Voltage Carrier Stop

- 15V
- 48V
- 125V
- 250V

JU3 – Keying Voltage Low-Level Key

- 18V
- 48V
- 125V
- 250V

JU4 – Sense of Input Low-Level

- NORM (+)
- INVERT(-)

JU5 – Sense of Input Carrier Stop

- NORM (+)
- INVERT(-)

JU6 – Sense of Input Carrier Start

- NORM (+)
- INVERT (-)

JU7 – Priority Start or Stop

- STOP
- START

JU8 – Carrier Stop Circuit

OUT Normally in this position

IN When used with KDAR or SKBU or applications that use a common start/stop keying circuit.

2. Two push button switches are provided for test purposes:
 - The top push button is marked “HL” for High-Level power (10W typical)
 - The bottom push button is marked “LL” for Low-Level power (1W typical)

Each push button is recessed, and can be activated by sliding an object (e.g., a pen or pencil) through each push button access location on the Keying Module front panel.

3. Check the LEDs at the bottom of the Keying Module control panel for indication of the keying condition: “HL” (High-Level key output), “LL” (Low-Level key output), and “V” (Voice-Level key output).

The JU7 STOP position inhibits the High-Level output, Low-Level output, and the Voice-Level output.

Both the Low-Level and High-Level outputs inhibit the Voice-Level output.

4. Insert the Keying Module back into the TC-10B chassis.

5.3 Select TC-10B Receiver Output

1. Remove the Receiver Output Module from the TC-10B chassis and set jumpers JU1 and JU2 according to the following options:

JU1

- 1) 48V
- 2) 125/250V

JU2

- 1) 48V
- 2) 125/250V

2. Insert the Receiver Output Module back into the TC-10B chassis.

5.4 Select TC-10B RF Output Impedance

1. Configure the RF Interface 2-Wire impedance. Remove the RF Interface Module from the TC-10B chassis and configure the output impedance by setting the jumpers as follows:
 - JU4, when set, provides 50 Ω
 - JU3, when set, provides 75 Ω
 - JU2, when set, provides 100 Ω
2. Select 2- or 4-wire Receiver input, using jumpers JU1 and JU5 as follows: IN position for 2-wire; OUT position for 4-wire. The normal configuration for the TC-10B is 2-wire.
3. Set jumper JU6 to the desired Receiver sensitivity range.
4. Insert the RF Interface Module back into the TC-10B chassis.

5.5 Check Line Tuning And Matching Equipment

1. Refer to the appropriate instructions for line tuning equipment.
2. Perform the required adjustments.



CAUTION

DO NOT ALLOW INEXPERIENCED PERSONNEL TO MAKE THESE ADJUSTMENTS. PERSONNEL MAKING THE ADJUSTMENTS MUST BE COMPLETELY FAMILIAR WITH THE HAZARDS INVOLVED.

5.6 Check TC-10B Transmitter Power Levels

With power “OFF”, remove the coaxial cable connection to the Hybrids or line tuning equipment and substitute a 50, 75 or 100Ω resistor termination (in accordance with the jumper settings in 5.3-1), at the output of the TC-10B (J1, UHF connector).

5.6.1 Check High-Level Output

1. Connect the Selective Level Meter to the 10W PA Module control panel at the test jacks:
 - TJ1 Input (top jack)
 - TJ2 Common (bottom jack)
2. Tune the meter to the Transmitter frequency.
3. Turn power “ON” at the Power Supply Module.

NOTE

The INPUT and OUTPUT LEDs should show red.

4. On the Keying Module control panel, press and hold the top push button (marked “HL”),

NOTE

The “HL” LED should show red.

to key the Transmitter at High Level power.

5. Record the Selective Level Meter reading (at TJ1, TJ2). The meter should measure .224Vrms (0dBm at 50Ω reference) for full High-Level keying (10W power). If the meter measures 0 dBm, skip to Step 8.
6. If the meter does not measure 0dBm, turn power “OFF” at the Power Supply Module and remove the Transmitter Module from the chassis. Place the extender board into the Transmitter Module position of the chassis. Then plug the Transmitter Module onto the extender board.
7. Adjust the 10W potentiometer (R13) on the Transmitter Module until the Selective Level Meter (at the 10W PA TJ1, TJ2) reads .224 Vrms (0dBm at 50Ω reference). Then place the Transmitter Module back in the chassis.

NOTE

The “HL” LED should not be red.

8. On the Keying Module control panel, release the “HL” push button to un-key the Transmitter Module.

5.6.2 Check Low-Level Output

With the conditions the same as for the High-Level output check, i.e.,

- Selective Level Meter at 10W PA Module control panel (TJ1, TJ2)
- Meter tuned to XMTR frequency
- Power “ON”

do the following:

1. On the Keying Module control panel, press the bottom push button (marked “LL”), to key the Transmitter at Low Level power.
2. Record the Selective Level Meter reading (at TJ1, TJ2). The meter should measure .0707Vrms (-10dBm at 50Ω reference) for Low-Level keying (1W power). If the meter measures -10dBm, skip to Step 5.

3. If the meter does not measure -10dBm, turn power “OFF” at the Power Supply Module, and remove the Transmitter Module from the chassis. Place the extender board into the Transmitter Module position of the chassis. Then plug the Transmitter Module onto the extender board.
4. Adjust the 1W potentiometer (R12) on the Transmitter Module, until the Selective Level Meter (at the 10W PA TJ1, TJ2) reads .0707 Vrms (-10dBm at 50Ω reference). Then place the Transmitter Module back in the chassis.

NOTE

We recommended that you set the low level power 10dB below full power. However, you may use any power level between 10W and 50mW.

5. On the Keying Module control panel, release the “LL” push button to un-key the Transmitter Module.

NOTE

The “LL” LED should not be red.

5.6.3 Check Voice-Level Output

Perform this procedure only if you are using the Voice Level Option.

With the conditions the same as for the High-Level output check, i.e.,

- Selective Level Meter at 10W PA Module control panel (TJ1, TJ2)
- Meter tuned to XMTR frequency
- Power “ON”

do the following:

1. Key the carrier set with the Push-to-Talk switch (on the handset), while muting the microphone, to key the Transmitter at Voice-Level (4.3W power, when High-Level is 10W power).

NOTE

The “V” LED should show red.

2. Record the Selective Level Meter reading (at TJ1, TJ2). The meter should measure .148Vrms (-3.6dBm at 50Ω reference) for Voice Keying. If the meter measures -3.6dBm, skip to Step 5.
3. If the meter does not measure -3.6dBm, turn power “OFF” at the Power Supply Module and remove the Transmitter Module from the chassis. Place the extender board into the Transmitter Module position of the chassis. Then plug the Transmitter Module onto the extender board.

NOTE

If a full power level (other than 10W) is used, the VF level should be set accordingly, i.e., 3.6dB below the High-Level value.

4. Turn the Voice Adjust potentiometer (R14), on the Transmitter Module, until the Selective Level Meter (TJ1, TJ2) reads .148Vrms (-3.6dBm at 50Ω reference). Then place the Transmitter back in the chassis.
5. Monitor the output of the carrier set with an oscilloscope at the 10W PA Module test jacks:
 - TJ1
 - TJ2
6. Voice key the Transmitter by pushing the Push-to-Talk switch (on handset) and using the signal generator at 1 kHz (TB5/2 and 3) to set the level to achieve the following voltages:
 - ≈ 62V p-p (at peak modulation)
 - ≈ 20V p-p (valley)
7. If the ratio of the voltages (0.62/0.20) do not approximate a value of 3, adjust potentiometer R11 on the Transmitter, as follows:
 - Clockwise if not enough signal (a value less than 3).

- Counterclockwise if too much signal (a value significantly greater than 3).

8. Un-key the Push-to-Talk switch (on handset).

5.6.4 Adjust the Transmitter Power Output Levels

1. Move the Selective Level Meter to the test jacks marked “LINE” (on the RF Interface control panel): TJ1 (Line – top jack) and TJ2 (Common – bottom jack)
2. On the Keying Module control panel, press and hold the bottom (“LL”) push button to key the Transmitter at Low-Level power.

NOTE

The “LL” LED should show red.

3. On the RF Interface Module control panel, configure the output impedance by setting a Jumper. The Selective Level Meter (TJ1, TJ2) should show a maximum reading (Vrms) for 1 W (+30dBm) power, as follows:
 - JU4, when set, provides 50Ω (7.07Vrms)
 - JU3, when set, provides 75Ω (8.6Vrms)
 - JU2, when set, provides 100Ω (10.0Vrms)
4. If the above (Vrms) values are not achieved, adjust the “INPUT LEVEL SET” potentiometer (R53) on the 10W PA Module control panel to obtain 7.07Vrms (for 50Ω reference).
5. On the Keying Module control panel, release the “LL” push button to unkey the Transmitter Module.
6. Check the High-Level key for 10W output.
7. Turn power “OFF” at the Power Supply Module.
8. Remove the 50, 75, or 100Ω resistor termination and replace the coaxial cable connection to the Line Tuner.

NOTE

If you want a final output power of less than 10 W, reduce power by adjusting the input level potentiometer (R53) on the 10W PA Module for the lower power. If a sufficiently low level is not obtainable using R53, repeat the above alignment procedures using the reduced level.

5.7 Offset TC-10B Transmitter Frequency

If the Transmitter frequency needs to be offset (for- three-terminal line applications), monitor the Transmitter frequency with a Frequency Counter.

NOTE

Customer personnel should use voice communications while working simultaneously, with transmitter #1 (near end) and transmitter #2 (far end), to perform the following procedure:

1. Make sure that the power is “OFF” at the Power Supply Module and remove the Transmitter Module from the chassis.
2. On the Transmitter Module, turn rotary switch S4 to raise or lower the Transmitter frequency (in 100Hz steps) as follows:
 - a) At Transmitter #1 (near end), turn rotary switch S4 clockwise to raise the frequency (center frequency +100Hz).
 - b) At Transmitter #2 (far end), turn rotary switch S4 counterclockwise to lower the frequency (center frequency –100Hz).

NOTE

The third terminal's transmitter should remain at center frequency.

3. Replace the transmitter module into the chassis and proceed to the next step.

5.8 Check TC-10B Receiver Margin Setting using Remote Carrier Signal

1. At the Power Supply Module, turn the power "ON".
2. Arrange for a received signal from the remote end.
3. Sensitivity setting:

On the Receiver module perform the following to complete the setting:

- a) Hit "SET" twice until the display reads "SET SENS?"
- b) With the remote signal being received (at the remote end, push the "HL button on the keying module), depress "SET" again.
- c) If you're not adjusting the 15dB margin, depress "SET" again. If you are, then depress "RAISE" or "LOWER" as required to adjust it up or down 5dB, then press set.
- d) If you are not going to adjust an external carrier level meter, depress "SET". Otherwise, press "RAISE" or "LOWER" as required, then press set.

NOTES:

1. The foregoing procedure adjusts the Receiver margin to the recommended 15dB value.
2. The Receiver bargraph CLI meter reading should be 0dB at this time.
3. In three-terminal line applications, the margin adjustment procedure should use the weaker of the two received signals.
4. When applying the TC-10B with a phase comparison relay, do not readjust the Receiver level when keying with a square wave signal. The CLI will read around -10dB, but this is an average reading of the on and off square wave. The receiver will still maintain the 15dB margin. The CLI reading is only accurate for a non-amplitude modulated signal.

- e) Unkey the remote carrier set & key the local carrier set by depressing the HL TEST button on the keying module and pressing the "SET" button on the receiver module.
 - f) This completes the setting of the receiver margin.
4. If you are just checking the sensitivity setting, read the Tri-color bar graph CLI while receiving a remote signal.

5.9 Select Optional Checkback Module Conditions

If you are using the optional Universal Checkback Module, select the desired conditions for the module's operation.

5.10 Prepare TC-10B for Operation

1. Be sure that power is "ON" at the Power Supply Module.
2. Replace the cover on the TC-10B control panel. Secure both latches by pushing inward and sideways until the cover is secure. You may lock the latches in place using meter seals.

This completes the "Routine Alignment" procedure. The TC-10B is ready to be put into operation.

NOTE

When placing the TC-10B into service, refer to the System manual that is appropriate for the relay system you are using with the TC-10B system.

TC-10B ADJUSTMENT DATA SHEET

(1) Power Supply

+20V(TJ1/TJ2) _____
-20V(TJ3/TJ2) _____
ALL LEDES "ON" — _____

(2) 10W PA

Voice PA "IN"(TJ1/TJ2) _____
LLPA "IN"(TJ1/TJ2) _____
VLPA "IN"(TJ1/TJ2) _____
HLLPA "IN"(TJ1/TJ2) _____
TRANSMIT LEDES "ON" — _____

(3) RF Interface

XMTR Frequency "OUT",(TJ1/TJ2) _____
Voice Level(TJ1/TJ2) _____
LL Level(TJ1/TJ2) _____
HL Level(TJ1/TJ2) _____
Residual Noise "OUT" w/XMTR Keyed(TJ1/TJ2) _____
Received Frequency,(TJ3/TJ4) _____
Received noise Level w/remote transmitter off . .(TJ3/TJ4) _____

(4) Receiver/CLI reading (Signal from other end)

Input Level(TJ1/TJ3) _____
Received Level(TJ2/TJ3) _____

LL Keyed(dB) _____
HL Keyed(dB) _____
Margin LED - _____
Detect LED "ON" - _____

(5) Receiver Output

Output 1(48V) _____
Output 1(125/250V) _____
Output 2(48V) _____
Output 2(125/250V) _____

(6) Rear of Chassis

Reflected Power(J1) _____ (%)

Test Performed By

Date

TC-10B JUMPER SETTINGS

(1) POWER SUPPLY

JU1 Power Alarm NO NC

(2) KEYING

JU1 Carrier Start 15V 48V 125V 250V

JU2 Carrier Stop 15V 48V 125V 250V

JU3 Low Level Key 15V 48V 125V 250V

JU4 Low Level INV NORM

JU5 Stop INV NORM

JU6 Start INV NORM

JU7 Stop/Start Priority Stop Start

JU8 KA-4/SKBU-1 IN OUT
(Common Start/Stop Lead? Yes = IN; No = OUT)

(3) 10W POWER AMPLIFIER

JU1 Power Monitor NO NC

(4) RF INTERFACE

JU1 2 Wire/4 Wire IN OUT
(2 Wire) (4 Wire)

JU2 Impedance – 100Ω IN OUT

JU3 Impedance – 75Ω IN OUT

JU4 Impedance – 50Ω IN OUT

JU5 2 Wire/4 Wire IN OUT
(2 Wire) (4 Wire)

JU6 Sensitivity HIGH NORM

(5) RECEIVER/DETECTOR

J3	Margin Contact	NO <input type="checkbox"/>	NC <input type="checkbox"/>
SW1	#1	FSK <input type="checkbox"/>	AM <input checked="" type="checkbox"/>
SW1	#2	OFF (No voice adapter) <input type="checkbox"/>	ON (Voice Adapter) <input type="checkbox"/>
SW1	#3	OFF (unused) <input type="checkbox"/>	ON (unused) <input type="checkbox"/>
SW1	#4	OFF (unused) <input type="checkbox"/>	ON (unused) <input type="checkbox"/>
SW1	#5	OFF (unused) <input type="checkbox"/>	ON (unused) <input type="checkbox"/>
SW1	#6	OFF (unused) <input type="checkbox"/>	ON (unused) <input type="checkbox"/>
SW1	#7	OFF (Phase Comparison 3,500Hz BW) <input type="checkbox"/>	ON (Directional Comparison BW per SW1-8) <input type="checkbox"/>
SW1	#8	OFF (1600Hz BW) <input type="checkbox"/>	ON (800Hz BW) <input type="checkbox"/>

(6) RECEIVER OUTPUT

JU1	Output #1	48V <input type="checkbox"/>	125/250V <input type="checkbox"/>
JU2	Output #2	48V <input type="checkbox"/>	125/250V <input type="checkbox"/>

(7) VOICE ADAPTER

JMP1	Jumper	NC (on left) <input type="checkbox"/>	NO (on right) <input type="checkbox"/>	
			ON (DOWN)	OFF (UP)
SW1-1	PB gives alarm (TCF-10B)		<input type="checkbox"/>	<input checked="" type="checkbox"/>
SW1-2	Carrier Alarm (TC-10B)		<input checked="" type="checkbox"/>	<input type="checkbox"/>
SW1-3	Push-to-talk handset (TC-10B)		<input checked="" type="checkbox"/>	<input type="checkbox"/>
SW1-4	Beeper enabled (Either)		<input type="checkbox"/>	<input type="checkbox"/>

(8) UNIVERSAL CHECKBACK

			<u>Pos. 1</u>	<u>Pos. 2</u>	<u>Pos. 3</u>	<u>Pos. 4</u>
SW3	Custom Settings Enabled	<input type="checkbox"/>	OFF	OFF	OFF	Not used
SW3	Factory Preset #1 Setting	<input type="checkbox"/>	ON	OFF	OFF	Not used
SW3	Factory Preset #2 Setting	<input type="checkbox"/>	OFF	ON	OFF	Not used
SW3	Factory Preset #3 Setting	<input type="checkbox"/>	ON	ON	OFF	Not used
SW3	Factory Preset #4 Setting	<input type="checkbox"/>	OFF	OFF	ON	Not used

Chapter 6. Signal Path

The following description of the TC-10B signal path is in accordance with the Functional Block Diagram (see Figure 6-1) and the Rear Panel previously shown (in Figure 3-1). You may find this discussion of signal path useful during Installation / Adjustment Procedures (Chapter 5) and Design Verification Tests (Chapter 7).

6.1 Power Supply Module

Terminal Block (TB7)

- | | |
|-------|--|
| TB7-1 | Positive Vdc (also pins C/A-12 and C/A-10) |
| TB7-2 | Negative Vdc (also pins C/A-14) |
| TB7-3 | Failure Alarm Signal (also pins C/A-16) |

NOTE

The Vdc is received from three (3) available groups of station batteries:

- 38-70Vdc (48-60Vdc nominal)
- 88-140Vdc (110-125Vdc nominal)
- 176-280Vdc (220-250Vdc nominal)

- | | |
|-------|---|
| TB7-4 | Failure Alarm Signal (also pins C/A-18) |
| TB7-5 | Spare Chassis Ground |
| TB7-6 | Chassis Ground |

Voltage Output to All Other Modules

Positive voltage outputs (+20Vdc) are available at pins A-2 and A-4, while negative voltage outputs (-20Vdc) are available at pins C-2 and C-4. Common to ground (pins C/A-30 and C/A-32).

Optional low-voltage power alarm relay outputs

Optional low-voltage power alarm relay outputs are available at pins C/A-16 and C/A-18.

6.2 Keying Module

Voltage Inputs

- | | |
|--------|------------------------|
| +20Vdc | Pins A-2 and A-4 |
| -20Vdc | Pins C-2 and C-4 |
| Common | Pins C/A-30 and C/A-32 |

Terminal Block (TB4)

- | | |
|-------|--|
| TB4-1 | Carrier (CXR) Start + (also pin A-10). |
| TB4-2 | Carrier (CXR) Start - (also pin C-10). |
| TB4-3 | CXR Stop + (also pin C-16). |
| TB4-4 | CXR Stop - (also pin A-16). |
| TB4-5 | Low-Level Key + (also pin A-22). |
| TB4-6 | Low-Level Key - (also pin C-22). |

Optional Inputs:

- | | |
|--------------------------------|----------|
| Checkback Test, High-Level Key | Pin C-8 |
| Checkback Test, Low-Level Key | Pin C-28 |
| Voice Key | Pin C-24 |

Outputs to Transmitter Module

- | | |
|----------------------|---------|
| High-Level (10W) Key | Pin A-8 |
| Voice (4.3W) Key | Pin A-6 |
| Any Transmitter Key | Pin C-6 |

Output to Receiver Module

- | | |
|---------------------|---------|
| Any Transmitter Key | Pin C-6 |
|---------------------|---------|

6.3 Transmitter Module

Voltage Inputs

+20Vdc	Pins A-2 and A-4
-20Vdc	Pins C-2 and C-4
Common	Pins C/A-30 and C/A-32

Inputs from Keying Module (4 V Standby, 19 V Keyed)

High-Level (10W) Key	Pins C/A-8
Voice (4.3W) Key	Pins C/A-6
Any Transmitter Key	Pin A-10

Input from Optional Voice Adapter Module:

AM Voice	Pins C/A-26
----------	-------------

Output to 10W PA Module

0dBm for 10W or -10dBm for 1W Transmitter output power	Pins C/A-28
---	-------------

6.4 10W PA MODULE

Voltage Inputs

+20Vdc	Pins A-2 and A-4
-20Vdc	Pins C-2 and C-4
Common	Pins C/A-30 and C/A-32

Terminal Block (TB3)

TB3-1	Optional RF Output Alarm (pins C/A-12)
TB3-2	Optional RF Output Alarm (pins C/A-14)

Input from Transmitter Module

0dBm for 10W output or -10dBm for 1W output	Pins C/A-28
--	-------------

Output to RF Interface Module

1W, 4.3W or 10W PA RF output	Pins C/A-16 and C/A-18
---------------------------------	---------------------------

6.5 RF Interface Module

Voltage Inputs

+20Vdc	Pins A-2 and A-4
-20Vdc	Pins C-2 and C-4
Common	Pins C/A-30 and C/A-32

Input from 10W PA Module

1W, 4.3W or 10W PA output power	Pins C/A-16 and C/A-18
------------------------------------	------------------------------

Output to Receiver Module

RF Output Signal	Pins C/A-28
------------------	-------------

Other Outputs

1) Cable Jacks

- J1** RF Interface module (C/A-12 and C/A-10) Transmitter RF output line, through coaxial cable (UHF)
- J2** RF Interface module (C/A-24 and C/A-22) Receiver RF input line through 5,000 Ω coaxial cable (BNC)

2) Jumpers

- JU1, JU5** 2-wire or 4-wire
- JU2, JU3, JU4** 50, 75, or 100 Ω output impedance

6.6 Receiver Module

Voltage Inputs

+20Vdc	Pins A-2 and A-4
-20Vdc	Pins C-2 and C-4
Common	Pins C/A-30 and C/A-32

Input from Keying Module

Any Transmitter Key	Pin C-6
---------------------	---------

Input from RF Interface Module

RF Input Signal	Pin C-28
-----------------	----------

RF Output to Optional Voice Adapter

Audio Signal	Pin C/A-26
--------------	------------

6.7 Receiver Output Module

Voltage Inputs

+20Vdc	Pins A-2 and A-4
-20Vdc	Pins C-2 and C-4
Common	Pins C/A-30 and C/A-32

Input from Level Detector Module

Positive (+10Vdc) Output Voltage	Pins C/A-26
Negative return for +10Vdc	Pins C/A-28

Terminal Block (TB1)

TB1-1 "In 1+"	Positive side of external source voltage 40–300Vdc
TB1-2 "1A Out 1"	1 Amp output
TB1-3 "Out 1"	Output for 200mA (48 or 125Vdc) or 20mA (48Vdc)
TB1-4 "In 2+"	(Same use as TB1-1)
TB1-5 "1A Out 2"	(Same use as TB1-2)
TB1-6 "Out 2"	(Same use as TB1-3)
TB1-7	(Unused at this time)
TB1-8 "Out 1C"	Output for 20mA (125 or 250Vdc) or 200mA (250Vdc)
TB1-9 "Out 2C"	(Same as TB1-8)

6.8 Optional Checkback Module

One module is represented that functions as a:

- Master -or-
- Remote

6.8.1 Connections for Master and Remote Module

Voltage Inputs

+ Voltage	TB6-1
- Voltage	TB6-2

Terminal Block (TB5, TB6 and TB7)

TB5-7	PROG 1B (–)
TB5-8	PROG 2B (–)
TB5-9	PROG 3B (–)
TB6-1	Test Input (+)
TB6-2	Reset/Input Return (–)
TB6-3	Major Alarm (+)
TB6-4	Major Alarm (–)
TB6-5	Minor Alarm (+)
TB6-6	Minor Alarm (–)
TB6-7	PROG 1A (+)
TB6-8	PROG 1B (+)
TB6-9	PROG 1C (+)
TB7-5	Reset Input (+)

6.9 Optional Voice Adapter Module

Voltage Inputs

+20Vdc	Pins A-2 and A-4
-20Vdc	Pins C-2 and C-4
Common	Pins C/A-30 and C/A-32

RF Input from Receiver Module

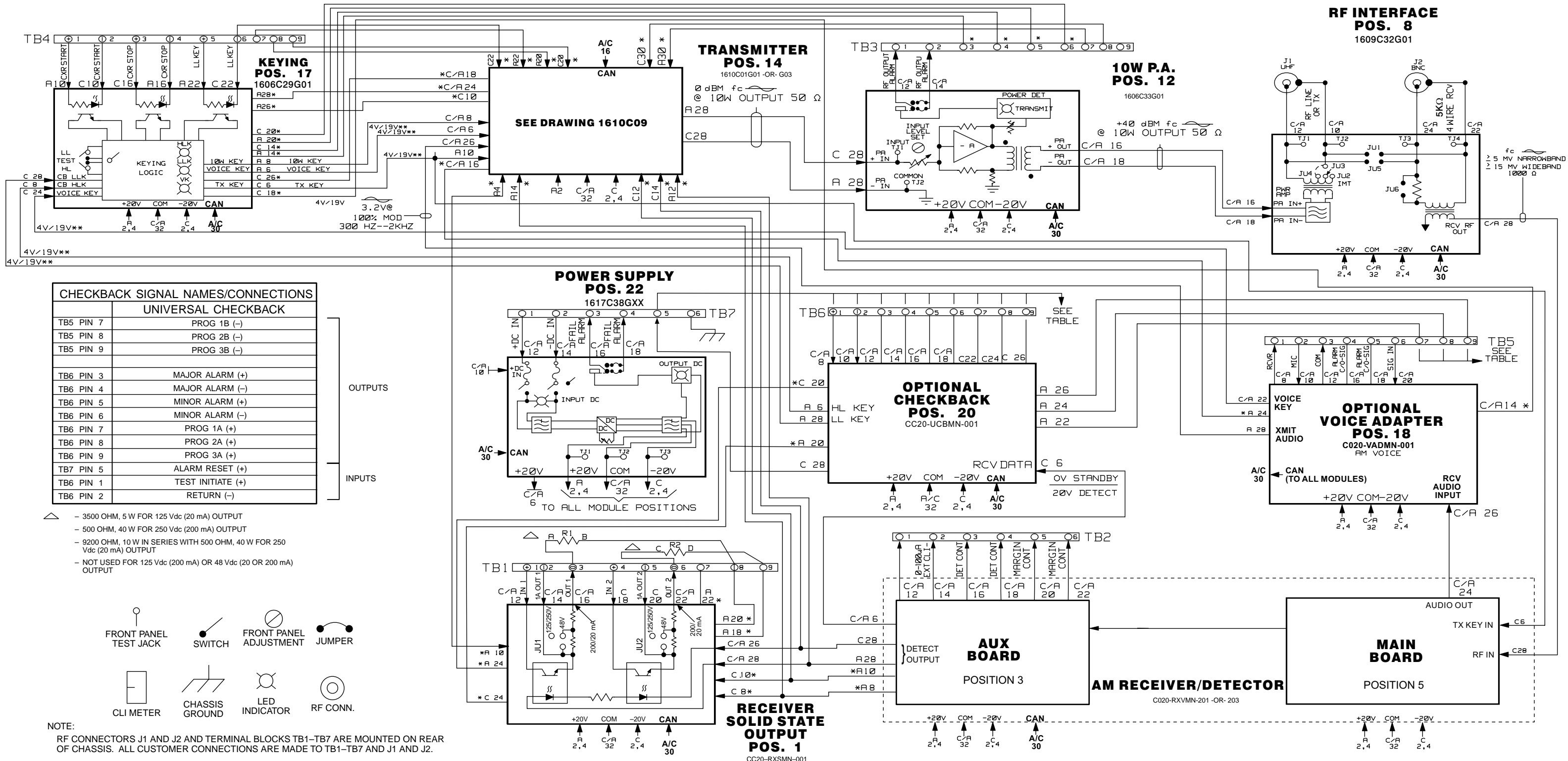
Audio In	C/A-26
----------	--------

Output to Keying Module Voice Key

Pins C/A-22

Output to Transmitter Module AM Voice

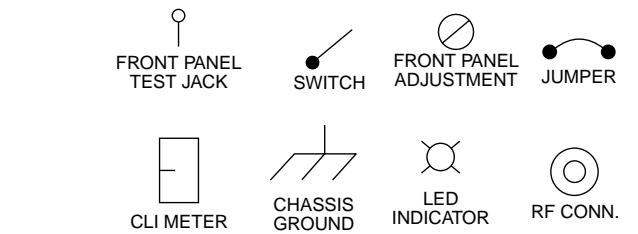
Pin A-28



CHECKBACK SIGNAL NAMES/CONNECTIONS

UNIVERSAL CHECKBACK	
TB5 PIN 7	PROG 1B (-)
TB5 PIN 8	PROG 2B (-)
TB5 PIN 9	PROG 3B (-)
TB6 PIN 3	MAJOR ALARM (+)
TB6 PIN 4	MAJOR ALARM (-)
TB6 PIN 5	MINOR ALARM (+)
TB6 PIN 6	MINOR ALARM (-)
TB6 PIN 7	PROG 1A (+)
TB6 PIN 8	PROG 2A (+)
TB6 PIN 9	PROG 3A (+)
TB7 PIN 5	ALARM RESET (+)
TB6 PIN 1	TEST INITIATE (+)
TB6 PIN 2	RETURN (-)

- △ - 3500 OHM, 5 W FOR 125 Vdc (20 mA) OUTPUT
- 500 OHM, 40 W FOR 250 Vdc (200 mA) OUTPUT
- 9200 OHM, 10 W IN SERIES WITH 500 OHM, 40 W FOR 250 Vdc (20 mA) OUTPUT
- NOT USED FOR 125 Vdc (200 mA) OR 48 Vdc (20 OR 200 mA) OUTPUT



NOTE: RF CONNECTORS J1 AND J2 AND TERMINAL BLOCKS TB1-TB7 ARE MOUNTED ON REAR OF CHASSIS. ALL CUSTOMER CONNECTIONS ARE MADE TO TB1-TB7 AND J1 AND J2.

* = NOT USED ON TC-10B

** = VOLTAGE INDICATED AS STAND BY/KEYED

CAUTION: DO NOT CONNECT TB1-1 & TB1-2 OR TB1-4 & TB1-5 DIRECTLY ACROSS STATION BATTERY. REFER TO CHAPTER 2, APPLICATIONS AND ORDERING INFORMATION BEFORE MAKING CONNECTIONS.

Figure 6-1. TC-10B Interconnection and Block Diagram (1353D61).

Chapter 7. Design Verification Tests

It is not intended to perform the Design Verification tests at installation. If you need to verify the design of the TC-10B, you should perform the following Verification Test (See Test Equipment in Chapter 4 and Signal Path in Chapter 6). Otherwise See Chapter 5.

7.1 Preliminary Checks

7.1.1 Check Chassis Nameplate.

Verify that the proper dc supply voltage and module options are on the chassis nameplate.

Check to ensure that all required modules are supplied and are installed in the proper chassis slots. The slots are labeled on the top edge of the chassis.

7.1.2 Check for Band-pass Filter Type on Receiver Module

Check SW1 for correct setting for AM.

7.1.3 Inspecting for the Correct dc Voltage

With the power "OFF," remove the Power Supply Module and inspect it for the correct dc voltage, as specified in Table 5-1.

7.2 Preliminary Settings

Before starting the test, set the jumpers on the various modules according to the instructions in the sections below.

7.2.1 Power Supply Module

JU1 N.C. (loss of power condition)

7.2.2 Keying Module

JU1 Set to dc supply voltage
JU2 Set to dc supply voltage
JU3 Set to dc supply voltage
JU4 NORM

Table 7-1. Voltage Specifications.

Specified	Style # 1617C38GXX
48V with Alarm Relay	G01
125V with Alarm Relay	G02
250V with Alarm Relay	G03

JU5 NORM

JU6 NORM

JU7 STOP

JU8 OUT

7.2.3 Transmitter Module

Set the four rotary switches to 250kHz or desired frequency.

7.2.4 10W PA Module

JU1 N.C. (loss of power condition)

7.2.5 RF Interface Module

Matching Impedance Jumper

JU4 (50 Ω)

2-Wire or 4-Wire RF Termination

JU1/JU5 (out, 4 wire)

Attenuator Override Jumper

JU6 (NORM Sensitivity)

7.2.6 Universal Receiver Module

J3 N.O. (margin relay)

7.2.7 Receiver Output Module

JU1 Set to dc supply voltage

JU2 Set to dc supply voltage

7.2.8 Universal Checkback Module (if supplied)

The DIP switch, labeled "SW3", is on the bottom left of the Module's PC board. The module reads the switch's setting at power-up to determine its configuration. Any changes to the switch's setting after power-up are ignored until you turn the power off and on again.

Using Table 5-2 as a guide, set the DIP switch to the desired setting. Note that only S1-S3 are used; S4 is reserved for future use. To set S1-S3, put them in the up position for OFF and the down position for ON. You can set the DIP switch to one of five possible configurations. All other switch combinations (of S1-S3) are invalid. If you mistakenly set a different combination, the module assumes the "CUSTOM" mode.

If you set the DIP switch to one of the factory preset settings, the module is locked into that configuration. You cannot customize the settings. For descriptions of the individual settings, please see the "Configuration Settings" section in chapter 16.

If you set the DIP switch to the "CUSTOM" option, you can use your PC or laptop to configure the module any way you want. (See "Using your PC to Communicate with the Universal Checkback Module" for complete configuration instructions.)

7.2.9 Optional Voice Adapter Module (if supplied)

- JMP1 N.O. / N.C. Alarm contact
- SW1-1 Off (Up) TCF-10B
- SW1-2 On (Down) TC-10B
- SW1-3 On (Down) TC-10B
- SW1-4 On (Down) Either

Table 7-2. Universal Checkback Module DIP Switch Settings.

S1	S2	S3	Settings Option
off	off	off	Custom Settings Enabled
on	off	off	Factory Preset #1 Settings
off	on	off	Factory Preset #2 Settings
on	on	off	Factory Preset #3 Settings
off	off	on	Factory Preset #4 Settings

7.3 ELECTRICAL TESTS

1. Refer to Figure 3-4 or Figure 7-1 for keying and output connections.
2. Connect the dc supply to the appropriate terminals on the rear panel (see Figure 3-4 or Figure 7-1).



CAUTION

ALWAYS TURN "OFF" dc POWER WHENEVER REMOVING OR INSTALLING MODULES.

3. Terminate the Transmitter output with a noninductive 50Ω, 10W resistor.
4. Connect the Selective Level Meter (Rycom 6021A) across the 50Ω resistor load.
5. Allow a one-hour warm-up period before making the final frequency adjustments.

7.3.1 Power Supply Module Tests

1. Remove all modules except for the Power Supply Module.
2. Turn "ON" the dc power; measure the dc voltage at the Power Supply test jacks with the meter reference connected to TJ2:
 - TJ1/TJ2 (+20Vdc ± 1Vdc).
 - TJ3/TJ2 (-20Vdc ± 1Vdc).

NOTE

Prolonged operation with no load can cause the power supply to shut down (see Chapter 9, Section 9.2.2).

3. Turn "OFF" the dc power. Insert all modules into their appropriate slots in the chassis.
4. Repeat Step 2 (above). Both LEDs (D3, Input, and D11, Output) on the Power Supply Module must be "ON".

5. Place the current meter (Fluke 75 or equivalent) in series with the dc supply, and check the standby (unkeyed) current for the appropriate voltage source, as follows:

<u>VOLTAGE</u>	<u>CURRENT</u>
48Vdc	.6A to .8A
125Vdc	.4A to .6A
250Vdc	.1A to .2A

7.3.2 Transmitter Module Tests

Levels

1. Using the appropriate voltage (15V, 48V, 125V, or 250V), key the carrier start and observe that the level across the 50Ω load is approximately 10W per Table 5-2.
2. Using the Keying Module push button switches, key the Transmitter (XMTR) Module for low-level (LL/1 W) and high-level (HL/10 W) power, as shown in the table below. If the voltage across the 50Ω load is not approximately equal to the value shown in Table 5-2, place the Transmitter (XMTR) Module on an extender board and make adjustments (using R13 for 10W and R12 for 1W, respectively).

Table 7-3. Voltage Levels.

Keyed Level	Volts Across 50Ω Load (V rms)	XMTR Adjust	dBm REF
LL – 1 W	7.07	R12	+30dBm
HL – 10 W	22.4	R13	+40dBm

3. Using the keying inputs on the rear of the chassis, key the Transmitter using the combinations listed below. Observe the output levels and logic per Table 5-3 below:

Keying Logic

Table 7-4. Keying Logic.

	Low-Level Start	High-Level Start	Stop	Output
(1)	ON			1W
(2)	ON		ON	NONE
(3)		ON		10W
(4)		ON	ON	NONE

NOTE

You can key low-level by placing the appropriate voltage (15V, 48V, 125V, or 250V) across TB4, pins 5 and 6, on the rear panel. You can key high-level start by placing the voltage across TB4, pins 1 and 2. You can key carrier stop by placing the voltage across TB4, pins 3 and 4.

7.3.3 Receiver Module Tests

DIP switch (SW1)

Pos. 1	Closed	Pos. 5	Open
Pos. 2	Open	Pos. 6	Open
Pos. 3	Open	Pos. 7	Closed
Pos. 4	Open	Pos. 8	Open

Received Signal Path

1. Set the Signal Generator to 250kHz at a level of 1.0Vrms (with TC-10B power on).

NOTE

Measure this level with an RF Voltmeter, don't rely completely on the display.

2. Measure the signal level between "RCVR" and "RCVR COM" on the RF Interface module to be 0.90 to 1.1V.
3. Measure the input signal level at the RF Interface module pins A/C 28 to GND to be

between 170mV and 230mV as read by the analyzer 1 Meg input.

NOTE

Do not use coaxial cable for this measurement.

4. Set the Signal Generator to 250kHz at a level of 112 mVrms (with TC-10B power on).

NOTE

Measure this level with an RF Voltmeter, don't rely completely on the display.

5. Push the SET button. The frequency display will begin flashing. Using the raise or lower button, set the frequency to 250kHz. Push the SET button again to accept this value.
6. Check that the display reads "Set Sens?...". Push the SET button to set the sensitivity. Check that the display reads "Sens Adjust? Hit Raise/Lower or Set when done...". Push the SET button to set. Check that the display reads "Set EXT CLI?". If necessary use the Raise or Lower button to adjust, otherwise push the SET button once more.

With an audio input level of 112mV, the CLI should read 0dB.

Voice Audio Output

1. Leave the Signal Generator channel A set at 250kHz and set channel B to 1.0kHz. Set %AM (percent modulation) to 50% (SHIFT key +AMPTD key). Set the modulation on the signal generator to channel A=INT. AM.
2. On the Receiver module, set SW1-2 ON. Put the extender card into the Voice Adapter slot and turn it on.
3. Measure Audio IN at pins A/C 26 to GND A/C 32 on the ext. card to be 1.7-2.0V p-p.

Table 5-5. Level Detector and CLI Test Procedure Specifications.

(mV)	CLI	LEDs on Module	LEDs ON Detect/Margin	LEDs on Fixture Detect/Margin
11.24	____dB	(-20 +/- 2dB)	OFF/OFF	OFF/OFF
353	____dB	(+10 +/- 2db)	ON/ON	ON/ON
20	____dB	(-15 +/- 2dB)	ON*/OFF	ON*/OFF
35.3	____dB	(-10 +/- 2dB)	ON/OFF	ON/OFF
63.3	____dB	(-5 +/- 2dB)	ON/OFF	ON/OFF
112.2	____dB	(0 +/- 2dB)	ON/ON	ON/ON
200	____dB	(+5 +/- 2dB)	ON/ON	ON/ON

*Only lights at this level

Receiver Sensitivity

Check the Carrier Level Indicator readings per Table 5-5.

7.3.4 Receiver Output Module Tests

Preliminary Steps

1. Connect a power supply source (48, 125, or 250Vdc) to the following Rear Panel terminals (with reference to TB7-2):
 - Receiver Output #1: TB1-1 (+)
 - Receiver Output #2: TB1-4 (+)
2. Connect the Signal Generator (H/P 3325A) to the chassis at the UHF RF Input jack (J1) on the rear panel.
3. Place the Receiver Output Module on an Extender Board (see Figure 4-1).

Receiver Output Test Procedure

1. Set the Signal Generator to 250 kHz, at a level between 150 and 250mV rms (The DETECT LED should be on.)
2. Measure the voltage level at TB1-2 with TB7-2 as a reference. This voltage should be the same as the power supply source (48, 125, or 250Vdc). Also, measure the voltage level at

TB1-5 with TB7-2 as a reference. This should be the same as the power supply source (48, 125, or 250Vdc).

3. Remove the input signal, ensuring that the output level drops out.
4. Load down the output by connecting the appropriate resistor as shown in table 7-6.
5. Insert a current meter (Fluke 75 or equivalent) in the circuit by connecting the meter across the open switches on the card extender for pins C/A 16 for OUTPUT #1 and C/A 22 for OUTPUT #2.
6. Current readings should be 16 to 30 mAdc for a 2200Ω resistor and 160 to 230 mAdc for a 25Ω resistor.
7. Disconnect the Signal Generator from the jack (J1) on the rear panel.
8. Re-install the Keying Module.

7.3.5 Optional Universal Checkback System Tests

A personal computer and a terminal emulation program are required to run the following tests.

Connect an RS-232 cable to the checkback unit. Logon to the Universal Checkback Module. Type in the word “super”. This will take you to a supervisor’s menu. Enter the manufacturer’s test by entering “5”. At that point, you will see the LEDs cycle, the outputs cycle and in the center there is a phrase saying “The quick brown fox jumped over the lazy dog”. If the module performs as indicated, the tests are complete.

7.3.6 Optional Voice Adapter Module Tests

Plug the handset into the (TJ1) front panel; if you have a remote handset, plug it into the remote panel connected to the rear panel (TB5). Key the carrier set with the push-to-talk switch on the handset. The Transmitter should be keyed at voice-level (4.3W when high-level is 10W).

You may turn the “RECEIVE AUDIO” (P1) adjustment as required to obtain a desirable listening level.

NOTE

The alarm/alarm cutoff LED will be illuminated whenever the handset is plugged in.

Table 7-6. Receiver Output.

Terminal	Resistor Load Value (ohms/watt)	Battery Voltage (Vdc)	JU1/JU2 Position	Current limit (mA)
Output #1				
TB1-3	2200/2	48	48	20
TB1-8	2200/2	125	125/250	20
TB1-8	2200/2	250	125/250	20
TB1-3	25/5	48	48	200
TB1-3	25/5	125	125/250	200
TB1-8	25/5	250	125/250	200
Output #2				
TB1-6	2200/2	48	48	20
TB1-9	2200/2	125	125/250	20
TB1-9	2200/2	250	125/250	20
TB1-6	25/5	48	48	200
TB1-6	25/5	125	125/250	200
TB1-9	25/5	250	125/250	200

Chapter 8. Maintenance

When individual module maintenance is required, either at the factory or at the customer installation (beyond the scope of routine alignment), the following procedures are applicable.

8.1 Precautions When Selecting Test Equipment

(See Chapter 4 for test equipment specifications.)

To prevent damage to solid-state components and circuits:

- 1) Use transformer-type signal generators, VTVMs and signal tracers, which isolate the test equipment from the power line. Whenever the test equipment uses a transformerless power supply, use an isolation type transformer. The test equipment ground should be isolated from the ac source ground.
- 2) Use multi-meters with at least 20,000 Ohms-per-volt sensitivity.



CAUTION

HIGH CURRENTS FROM A LOW-SENSITIVITY METER CAN DAMAGE SOLID STATE DEVICES.

8.2 Precautions When Using Test Equipment

1. Use a common ground between the chassis of the test equipment and the transistor equipment.



CAUTION

METERING TRANSISTOR CIRCUITS CAN CAUSE DAMAGE. FOR EXAMPLE: A BASE-TO-COLLECTOR SHORT DURING TRANSISTOR OPERATION CAN DESTROY THE TRANSISTOR.

2. When testing transistors and diodes, give special attention to the polarity of the meter leads.

For example: When measuring the forward resistance of a diode using a meter that has the internal battery connected to the metering circuit, be sure that:

- The lead marked (+) touches the diode anode.
 - The lead marked (-) touches the diode cathode.
3. When checking circuits with an oscillographic probe, be sure to discharge any built-up capacitive voltage by touching the probe to a ground before touching the circuit.

8.3 Periodic Checks

Every six months, take the following readings on the TC-10B Test Jacks (at the control panel).

We recommend that you keep a *log book* as a visible record of periodic checks, as well as a source for indicating any gradual degradation in a module's performance.

8.3.1 Power Supply Module

TJ1	+20Vdc
TJ2	Common
TJ3	-20Vdc

8.3.2 Keying Module

None.

8.3.3 Transmitter Module

None.

8.3.4 10W PA Module

TJ1	Input
TJ2	Common

8.3.5 RF Interface Module

TJ1	Line In
TJ2	Line Common
TJ3	Receiver In
TJ4	Receiver Common

8.3.6 Receiver Module

TJ1	Input
TJ2	Receive
TJ3	Common

8.3.7 Level Detector and CLI Module

None.

8.3.8 Receiver Output Module

None.

8.3.9 Optional Universal Checkback Module

None.

8.3.10 Optional Voice Adapter Module

None.

8.4 Inspection

A program of routine visual inspection should include:

- Condition of cabinet or other housing
- Tightness of mounting hardware and fuses
- Proper seating of plug-in relays and sub-assemblies
- Condition of internal and external wiring (the location where external wiring enters the cabinet should be sealed)
- Appearance of printed circuit boards and components
- Signs of overheating in equipment:
 - Interference with proper heat dissipation from surfaces
 - Clogged air vents (air filters should be removed and washed out)
- Dust which may cause short-circuits

8.5 Solid-State Maintenance Techniques

Use the following techniques when servicing solid state equipment.



CAUTION

WE RECOMMEND THAT THE USER OF THIS EQUIPMENT BECOME ACQUAINTED WITH THE INFORMATION IN THESE INSTRUCTIONS BEFORE ENERGIZING THE TC-10B AND ASSOCIATED ASSEMBLIES. FAILURE TO OBSERVE THIS PRECAUTION MAY RESULT IN DAMAGE TO THE EQUIPMENT.

YOU SHOULD NEITHER REMOVE OR INSERT PRINTED CIRCUIT MODULES WHILE THE TC-10B IS ENERGIZED. FAILURE TO OBSERVE THIS PRECAUTION CAN RESULT IN COMPONENT DAMAGE.

ALL INTEGRATED CIRCUITS USED ON THE MODULES ARE SENSITIVE TO AND CAN BE DAMAGED BY THE DISCHARGE OF STATIC ELECTRICITY. BE SURE TO OBSERVE ELECTROSTATIC DISCHARGE PRECAUTIONS WHEN HANDLING MODULES OR INDIVIDUAL COMPONENTS.

8.5.1 Preliminary Precautions

1. To avoid damage to circuits and components from a current surge, disconnect power before replacing or removing components or circuits.
2. Before placing new components into a defective circuit, check the circuit so that it cannot damage the new components.

8.5.2 Trouble-Detection Sequence

1. Evaluate test jack readings and other records of routine alignment.
2. Evaluate any symptoms detected audibly or visually.
3. Replace suspected plug-in components.
4. Further isolation of faults includes:
 - Voltage readings
 - Resistance readings
 - Signal injection
 - Re-alignment
 - Sensitivity measurements
 - Gain measurements
5. Replace suspected faulty components.
6. Check-out and adjust affected circuits.

8.5.3 Servicing Components Soldered Directly to Terminals

1. Avoid overheating from soldering by using a low-wattage soldering iron (i.e., 60W maximum).
2. Make sure there is no current leakage from the soldering iron.

NOTE

You may use an isolation transformer to prevent current leakage.

3. When soldering leads from transistors or diodes, use heat sinks, e.g., alligator clips.
4. You can remove molten solder from the board with a desoldering tool.
5. When removing a multi-lead component from a printed circuit board, first cut all leads and then remove the leads individually (to prevent overheating). If there are only a few leads, you can use a broad-tip soldering iron.

8.5.4 Servicing Components Mounted Directly on Heat Sinks

1. Remove the heat sink and bracket from the chassis by loosening the securing devices.
2. Remove the transistor, diode, or other device from the heat sink.
3. When replacing the transistor, diode, or other device, make certain that the device and the heat sink make secure contact for good heat dissipation. Mount a device first on the heat sink, and then on the board. Also, make sure that you replace all insulators, washers, spring washers and other mounting hardware as you originally found them.

NOTE

We recommend a very light coating of DC-4 (Dow-Corning 4 Compound Silicon Lubricant) for transistors and diodes that are mounted on heat sinks.

8.5.5 Servicing Metal Oxide Semiconductor (MOS) Devices

MOS devices may be vulnerable to static changes. Be sure to observe the special precautions described below both before and during assembly.



CAUTION

AVOID THE POSSIBILITY OF ELECTROSTATIC DISCHARGE.

Precautions to take before assembly

- Avoid wearing silk or nylon clothing, as this contributes to static buildup.
- Avoid carpeted areas and dry environments.
- Discharge body static by placing both hands on a metal, earth-grounded surface.

Precautions to take during assembly

- Wear a ground strap during assembly
- Avoid touching electrically conductive circuit parts by hand
- When removing a module from the chassis, always place it on a conductive surface which is grounded through a resistance of approximately 100K Ω

NOTE

Before touching a module with a test probe, connect the ground lead from the test equipment to the module. Always disconnect the test probe before removing the ground lead equipment.

- Make sure that all electrically powered test equipment is properly grounded.

Chapter 9. Power Supply Module

Table 9–1. 1617C38 Styles and Descriptions.

Schematic	1617C38-2
Parts List	1617C38-2

Group	Description
G01	48V WITH ALARM RELAY
G02	125V WITH ALARM RELAY
G03	250V WITH ALARM RELAY

9.1 Power Supply Module Description

The Power Supply Module for the TC–10B/TCF–10B has dual dc/dc high-frequency switching regulators which generate regulated voltage outputs of $\pm 20\text{Vdc}$ (between 1.5A and 2.0A for operation of the TC–10B/TCF–10B modules. It also provides protection from battery surge, transients, short circuits, and reverse voltage. The Power Supply Module can receive inputs from three available groups of station batteries: 38–70Vdc, 88–140Vdc, and 176–280Vdc.

9.1.1 Power Supply Control Panel

(This panel is shown in Figure 9-1.)

Front panel controls are as follows:

- 1) Push button Switch (with power-on indicator), ON/OFF (S1).
- 2) LEDs for indicating power:
 - INPUT, Red (LED1)
 - OUTPUT, Red (LED2)
- 3) Test Jacks:
 - +20Vdc, Red (TP3)
 - Common, Green (TP2)
 - -20Vdc, Black (TP1)

An optional low-voltage alarm relay indicating loss of power is available. When the alarm is activated, LED2 is “OFF”. LED1 may be “OFF” if input power is lost.

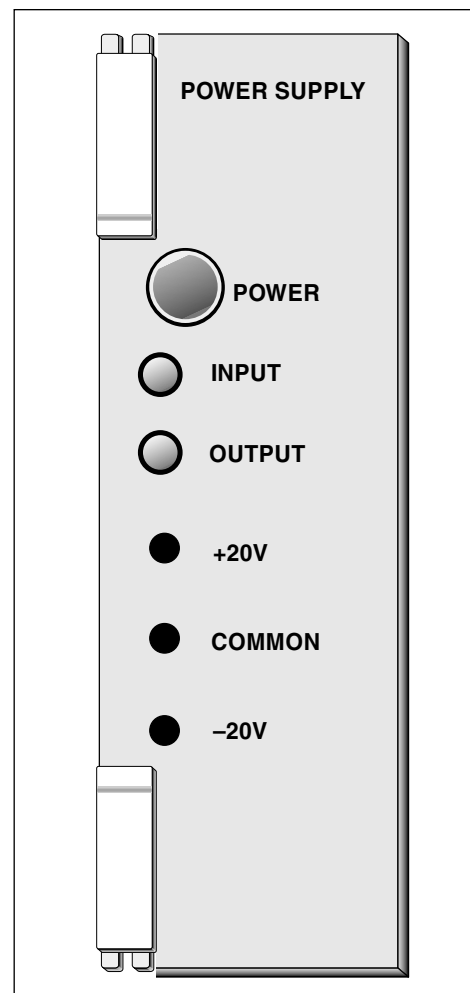


Figure 9–1.
Power Supply Module Front Panel.

9.1.2 Power Supply PC Board

Figure 9-2 shows component locations for the Power Supply Module.

Control is as follows:

Jumper J1 for optional Alarm Relay; establishes loss of power condition (NO/NC).

NOTE

When the alarm is part of the system, JU1 is shipped in the NC state.

9.2 Power Supply Circuit Description

The module comprises the following circuits:

- Fuses
- ON/OFF Switch
- Input Filter
- Power Alarm Failure Relay
- dc/dc Converter (2)
- Output Filter

Fuses

	<u>48V</u>	<u>125V</u>	<u>250V</u>
F1, F2	3A	1.6A	3/4A

ON/OFF Switch

S1 - Push button Switch (DPDT)

When in the "ON" position (pins 1 and 4), dc current flows through the input filter to the dc/dc converter.

Input Filter

The input filter (C1, C2, C3) contains zener diodes (Z1, Z2) that provide protection against surges, a diode (D1) that provides protection against reverse polarity, a differential choke XFMR (L1), and the Red Input LED1.

Power Alarm Failure Relay

This circuit includes:

- K1 - Alarm Relay
- J1 - Jumper (NO/NC)

Versions G04, G05, and G06 are without alarms.

In versions G01, G02, and G03 the field-selectable option can change the alarm contact de-energized state to NO or NC. (It is currently shipped in the NC de-energized state, and can be changed to NO if desired.)

DC/DC Converter

The two dc/dc converters (PS1 and PS2) operate at a maximum of 1MHz and, as a result, switching noise is outside the 30-535kHz range of the TC-10B/TCF-10B. The converter outputs, +20Vdc and -20Vdc, is fed to the output filter. (See Figure 9-3.)

Output Filter

The output filter for the +20V consists of C4, C6, C8, and Z4. The output filter for the -20V consists of C5, C7, C9, and Z3.

9.3 Power Supply Troubleshooting

The three test jacks on the control panel:

- TP3 (+20Vdc)
- TP2 (Common)
- TP1 (-20Vdc)

can be used to determine if the two voltages (+20Vdc, -20Vdc) are present. In addition, LED2 output indicates that the dc/dc converters are generating voltage. LED1 input indicates that voltage is present at the input of the dc/dc converter.

For basic troubleshooting, perform the following procedure:

1. If LED1 is not on with the module energized, turn off switch S1, remove and check the fuses (F1, F2) with an ohmmeter.
2. With the module de-energized, check the ON/OFF switch (S1) with an ohmmeter to be sure it opens and closes accordingly.

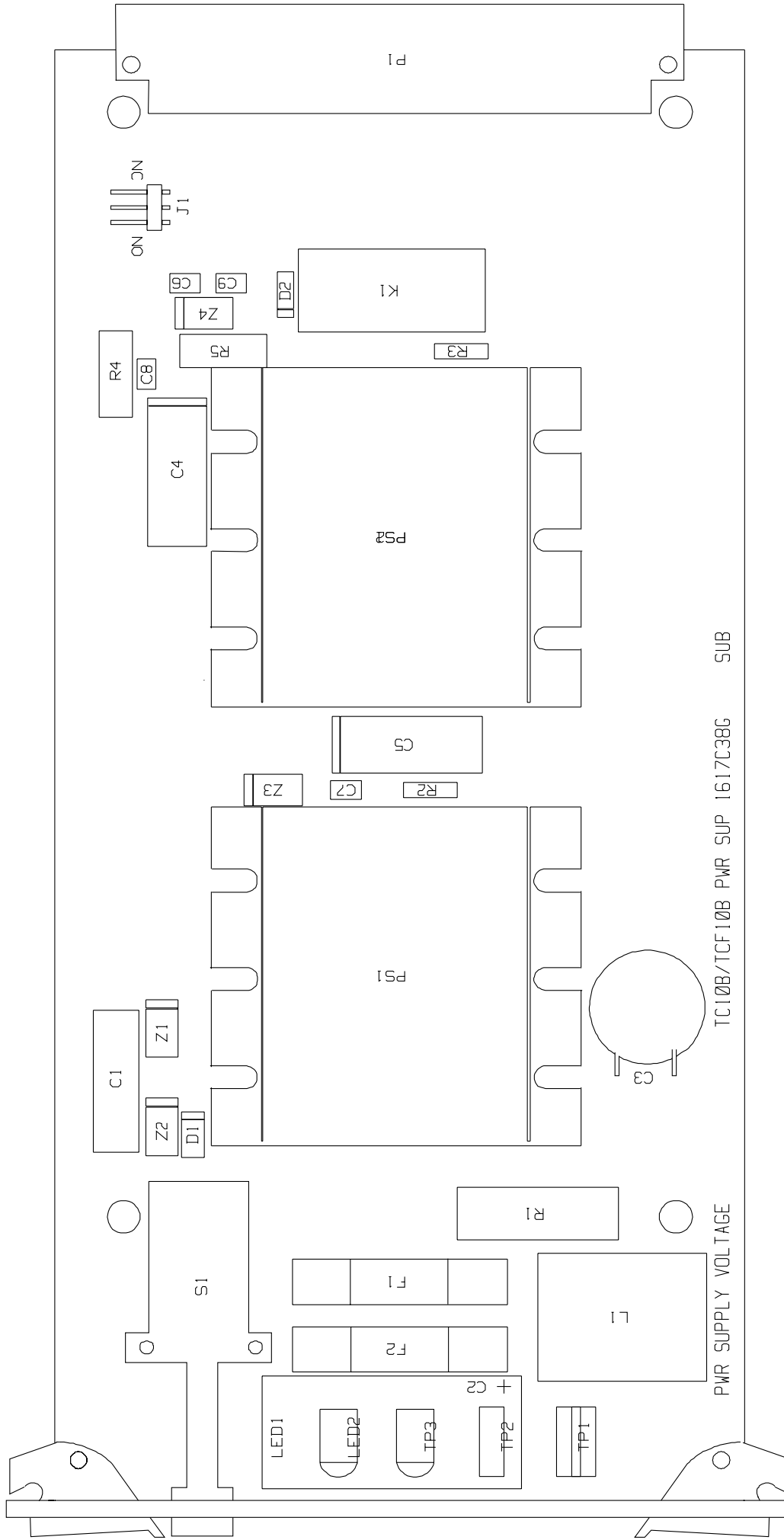
3. If LED2 is not on with the module energized, check the +20V and -20V outputs at TP3 and TP1, respectively. The one with voltage absent will require replacement of the associated dc/dc converter.

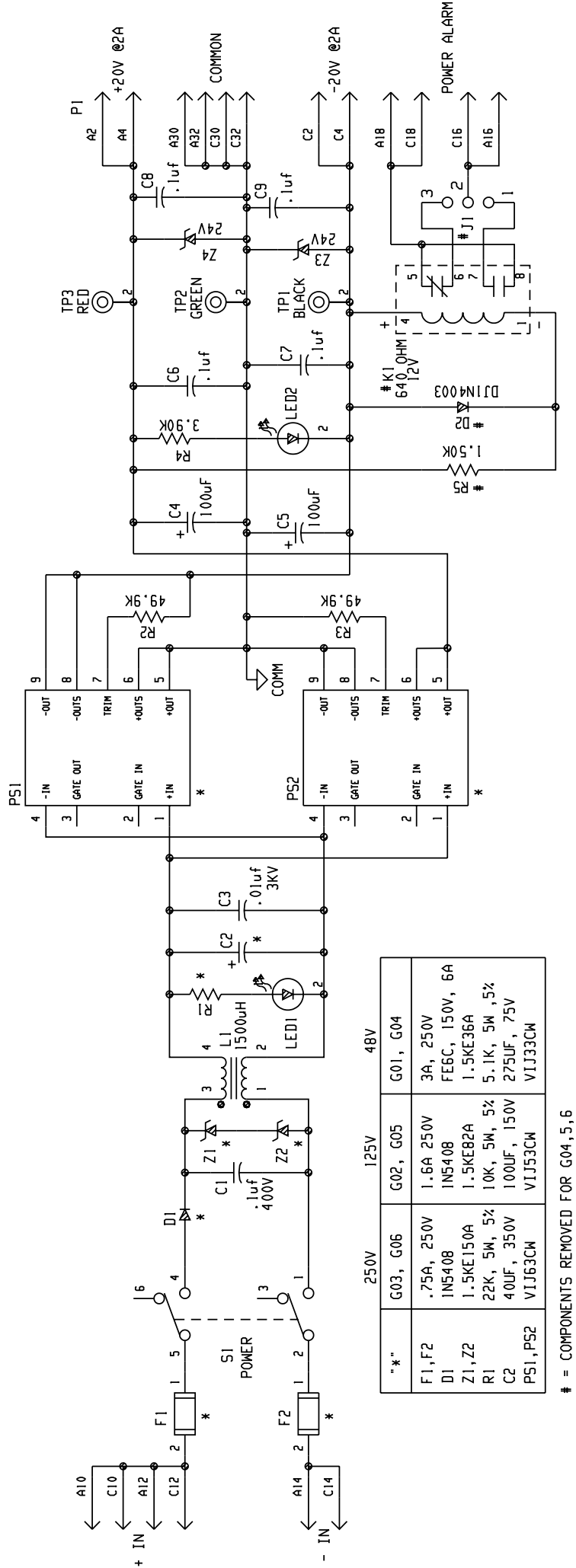


CAUTION

***BE CAREFUL NOT TO MISPLACE SCREWS,
SPRING WASHER OR INSULATING WASHER
USED FOR MOUNTING TRANSISTORS.***

Figure 9-2. TC-10B/TCF-10B Power Supply Component Location (1617C38).





	250V	125V	48V
"*"	G03, G06	G02, G05	G01, G04
F1, F2	.75A, 250V	1.6A 250V	3A, 250V
D1	1N5408	1N5408	FE6C, 150V, 6A
Z1, Z2	1.5KE150A	1.5KE82A	1.5KE36A
R1	22K, 5W, 5%	10K, 5W, 5%	5.1K, 5W, 5%
C2	40UF, 350V	100UF, 150V	275UF, 75V
PS1, PS2	V1J63CM	V1J53CM	V1J33CM

= COMPONENTS REMOVED FOR G04, 5, 6

Figure 9-3. TC-10B/TCF-10B Power Supply Schematic (1617C39).

Chapter 10. Keying Module

Table 10–1. 1606C29 Styles and Descriptions.

Schematic	1606C29-7
Parts List	1606C29-7

Group	Description
G01	Keying w/relay contacts

10.1 Keying Module Description

The TC–10B Keying Module controls the Transmitter Module as follows:

- Carrier Start (High-Level Test)
- Carrier Stop
- Low-Level Test
- Optional Checkback Test at High-Level (10W)
- Optional Checkback Test at Low-Level (1W)
- Optional Voice (4.3W)

Keying Module outputs are as follows:

- High-Level (10W)
- Voice (4.3W)
- Any Transmitter Key (1W, 10W, or Voice)

10.1.1 Keying Control Panel

(This panel is shown in Figure 10-1.)

Push button Switches (recessed)

- High-Level (HL) Power (S1)
- Low-Level (LL) Power (S2)

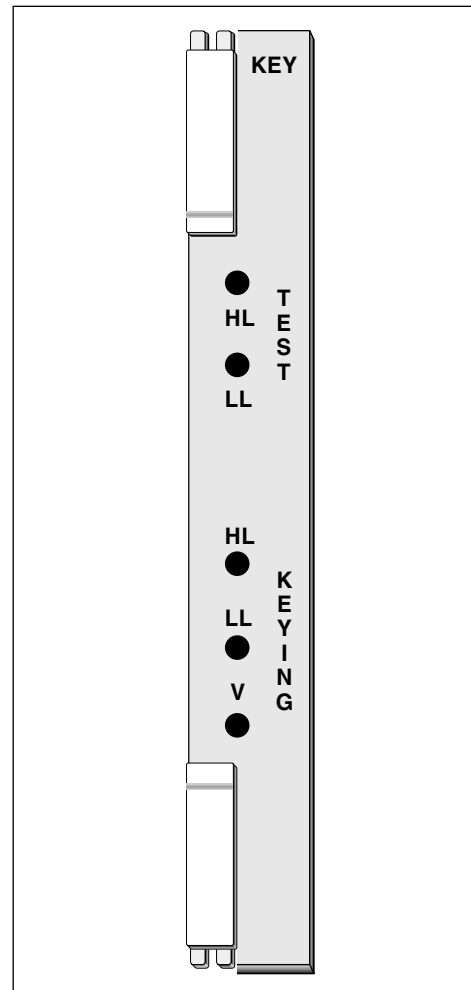


Figure 10–1.
Keying Module Front Panel.

LEDs for indicating Keying condition

- High-Level (10W), Red (D10)
- Low-Level (1W), Red (D11)
- Voice (4.3W), Red (D12)

10.1.2 Keying PC Board Jumper Controls

(The Keying PC Board jumper controls are shown in Figure 10-2.)

- JU1 Carrier Start 15V, 48V, 125V, 250V
- JU2 Carrier Stop 15V, 48V, 125V, 250V
- JU3 Low-Level Key 15V, 48V, 125V, 250V
- JU7 Carrier Start/Stop Priority
- JU6 Carrier Start NORM, INVERT
- JU5 Carrier Stop NORM, INVERT
- JU4 Low-Level Test NORM, INVERT
- JU8 Carrier Stop (KA-4, SKBU-1)

10.2 Keying Circuit Description

The Keying Module (see Figure 10-3) provides an optically-isolated interface between the carrier and the relay system and controls the operation of the Transmitter Module with the following customer inputs:

- Carrier Start (High-Level Test)
- Carrier Stop
- Low-Level Test
- Optional Checkback Test at High-Level
- Optional Checkback Test at Low-Level
- Optional Voice

Keying Module outputs are as follows:

- High-Level (10W)
- Any Transmitter Key
- Voice (4.3W)

The logic blocks used are as follows:

- “AND” gate
- “OR” gate
- “Exclusive OR” gate
- “Inverter”

Logic “1” is +18.6Vdc. Logic “0” is +3.6Vdc. The following truth tables describe the operation of the building blocks.

AND	<u>INPUTS</u>		<u>OUTPUTS</u>
	A	B	Y
	0	0	0
	0	1	0
	1	0	0
	1	1	1

OR	<u>INPUTS</u>		<u>OUTPUTS</u>
	A	B	Y
	0	0	0
	1	0	1
	0	1	1
	1	1	1

Exclusive OR	<u>INPUTS</u>		<u>OUTPUTS</u>
	A	B	Y
	0	0	0
	0	1	1
	1	0	1
	1	1	0

INVERTER	<u>INPUTS</u>	<u>OUTPUTS</u>
	1	0
	0	1

Customer inputs operate as follows:

Carrier Start

When jumper JU6 is in the NORM position, carrier start will be initiated when the proper voltage level (15V, 48V, 125V, or 250V) is applied to pins A-10/C-10. When JU6 is in the INVERT position, carrier start will be initiated when voltage is removed from the input A/C-10.

NOTE

Carrier start will initiate a High-Level test.

Carrier Stop

When jumper JU5 is in the NORM position, carrier stop will initiate when jumper JU2 (pins A-16/C-16) is set at the appropriate voltage level (15V, 48V, 125V, or 250V); when JU5 is in the INVERT position, carrier stop will initiate when voltage is removed.

Low-Level Test

When jumper JU4 is in the NORM position, a Low-Level test will initiate when jumper JU3 (pins A-22/C-22) is set at the appropriate voltage level (15V, 48V, 125V, or 250V); when JU4 is in the INVERT position, a Low-Level test will initiate when voltage is removed.

When the appropriate jumper is in place on the board, jumpers JU1, JU2, and JU3 provide logic “1” or “0” inputs. (Proper polarity of these input commands must be observed.)

You can manually initiate a Low-Level test by pressing the (recessed) push button switch (S2) on the front panel. You can manually initiate a High-Level test by pressing the (recessed) push button switch (S1).

You can initiate an optional High-Level checkback key through pin C-8. You can initiate an optional Low-Level checkback key through pin C-28. A voice key can be initiated through pin C-24.

Keying Module outputs are as follows:

High-Level (10W) Key	Pin A-8
Any Transmitter Key (1-W, 4.3W, or 10W)	Pin C-6
Voice (4.3W) Key	Pin A-6

Front panel LEDs are illuminated as follows:

D10	High-Level
D11	Low-Level
D12	Voice

You can make the STOP command inhibit the High-Level (10W) output by using jumper JU7. The STOP command also inhibits the Voice Key output. The Voice Key is inhibited by the High-Level and Low-Level Keys.

Zener diodes (D1, D2, D3) limit the input voltage to the optical isolators (I7, I8, I9), while also providing reverse voltage protection. Zener diodes (D14, D13) regulate primary power (pins A-2/A-4, pins A-30/A-32, pins C-30/C-32) down to 15V, while also providing reverse voltage protection.

Transistor (Q1), JU8, R40, D15, D16, D17, and R41 are used for special applications with KDAR and SKBU type keying circuits. These particular relay applications have a single line input for carrier start. The line has a tri-state condition, i.e., it is active high, active low, or open circuit. For example, as shown in Figure 2-13 in the Applications chapter, under normal operating conditions, the input to TB4-1 is an open circuit (while looking back into Z1). CSB, CSP, and SQ are open, and zener diode (Z1) is much larger than 20Vdc. When the carrier test switch is depressed, or the phase and ground carrier start contacts open, the line going to TB4-1 goes active high. If the phase and ground carrier stop contacts close, the line going to TB4-1 is active low.

As shown in the schematic of the keying load (Figure 10-3) and Q1 circuitry, when A-10 is high (same as TB4-1), carrier start is initiated and carrier stop is inhibited. This is caused by R40 and D15 saturating Q1 and shorting out the stop voltage applied to D7. C-16 is connected to the battery so that D2 ALWAYS has 20V across it. When TB4-1 (A-10) goes active low, Diode D17 shorts out the drive voltage to Q1, and internal diode I8 conducts, causing a STOP function to be generated. The following TRUTH table illustrates the operation:

<u>A10</u>	<u>CXR START</u>	<u>CXR STOP</u>
HIGH	YES	NO
LOW	NO	YES
OPEN	NO	NO

When operating with systems other than KDAR or SKBU, normally J8 is left out, and three separate command lines (START, STOP, and LL) are used.



CAUTION

DO NOT ATTEMPT TO FORCE A LOGIC "1" (+18.6VDC) ON ANY OUTPUTS OR INPUTS CONNECTED TO OUTPUTS. THIS COULD DAMAGE AN INTEGRATED CIRCUIT (IC).

10.3 Keying Troubleshooting

Should a fault occur in the Keying Module, place the module on an extender board. Six jumpers (JU1 through JU6) are used to select input keying voltages and the sense required. A seventh jumper (JU7) governs start/stop priority. The three optical isolators (I7, I8, I9) may be tested using the on-board +18.6Vdc source (D13 cathode). When a logic "1" is applied to any of the 15V inputs (R4, R9, or R14), with the jumper removed, pin 5 of the selected optical isolator (I7, I8, or I9) will go low.

You can check other components on the PC Board by conventional means.

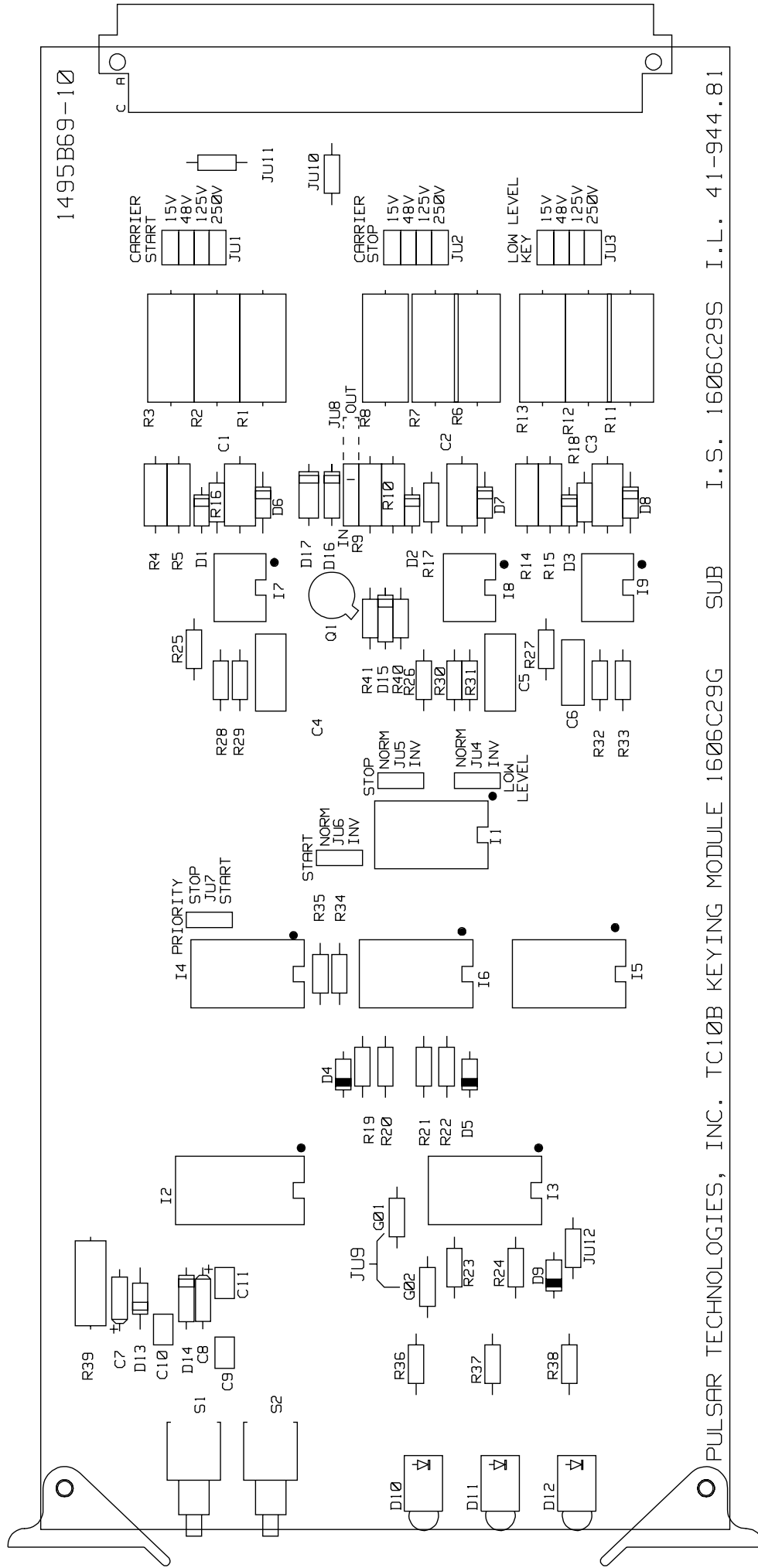
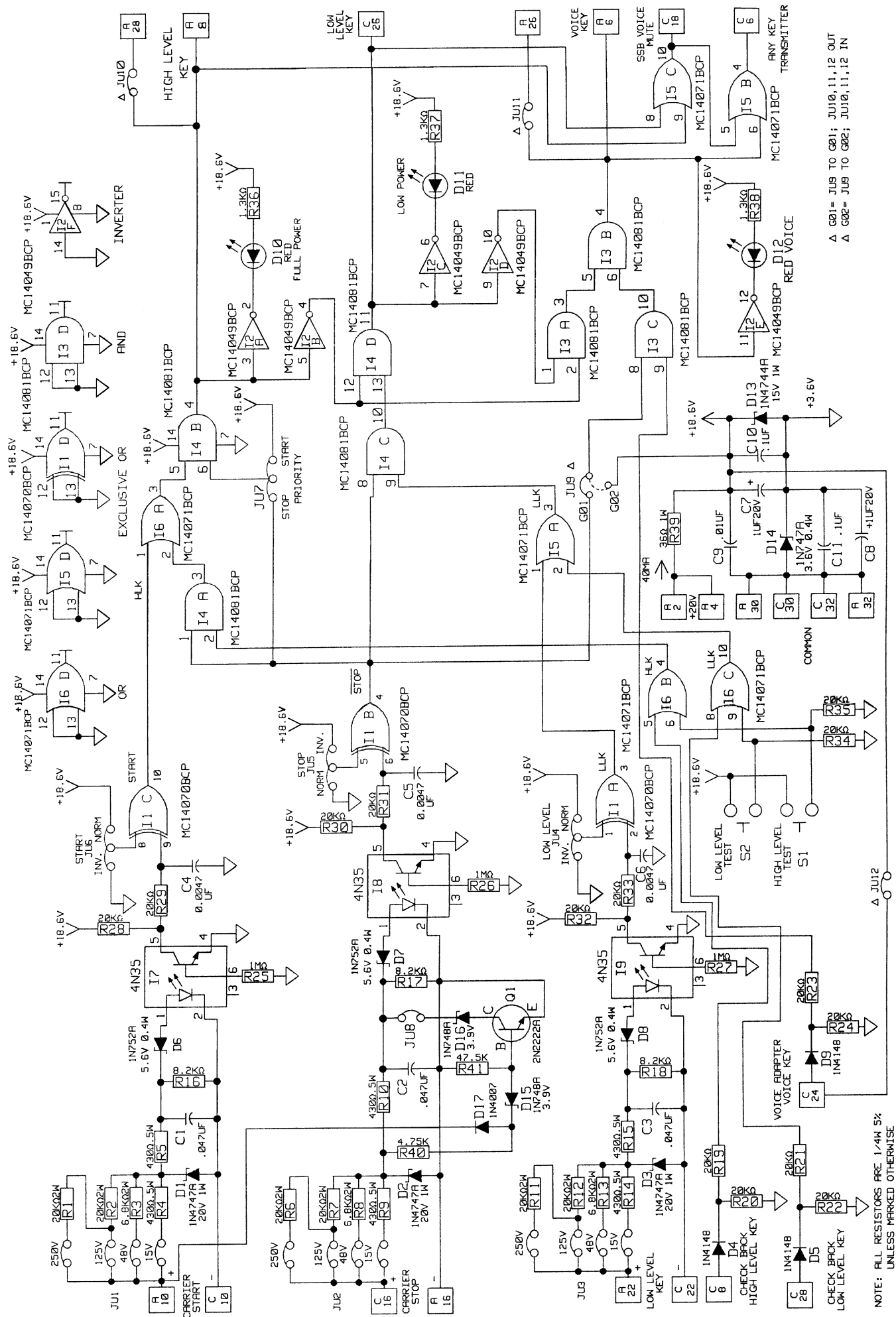


Figure 10-2. TC-10B Keying PC Board. (1495B69)

Figure 10-3. TC-10B Keying Schematic. (1606C29).



Δ G01= JUS TO G01; JUI0,1,1,12 OUT
 Δ G02= JUS TO G02; JUI0,1,1,12 IN

NOTE: ALL RESISTORS ARE 1/4W 5% UNLESS MARKED OTHERWISE

Chapter 11. Transmitter Module

Table 11–1. 1610C01 Styles and Descriptions.

Schematic	1355D71-8
Parts List	1610C01-11

Group	Description
G01	TRANSMITTER
G03	TRANSMITTER W/TTL

11.1 Transmitter Module Description

The function of the TC–10B/TCF–10B Transmitter Module is to provide the RF signal which drives the 10W PA Module. The Transmitter’s frequency range is from 30kHz to 535kHz, programmable in 0.1 kHz (100Hz) steps by four rotary switches on the Transmitter. The Transmitter is slaved to a crystal oscillator.

The TC–10B/TCF–10B Transmitter Module operates from keyed inputs (set by jumpers at the Keying Module):

- High-Level Key
- Any Transmitter Key
- Voice Key
- Shift High (TCF–10B only)
- Shift Low (TCF–10B only)

The Transmitter Module also operates with a signal from the Optional Voice Adapter Module:

- AM Voice

The Transmitter Module operates with either no shift (TC-10B) or one of three different frequency shifts (TCF-10B), selectable by a four-position dip switch (S5).

11.1.1 Transmitter Control Panel

(This panel is shown in Figure 11-1.)

Operator controls consist of four thumbwheel switches, representing the frequency range:

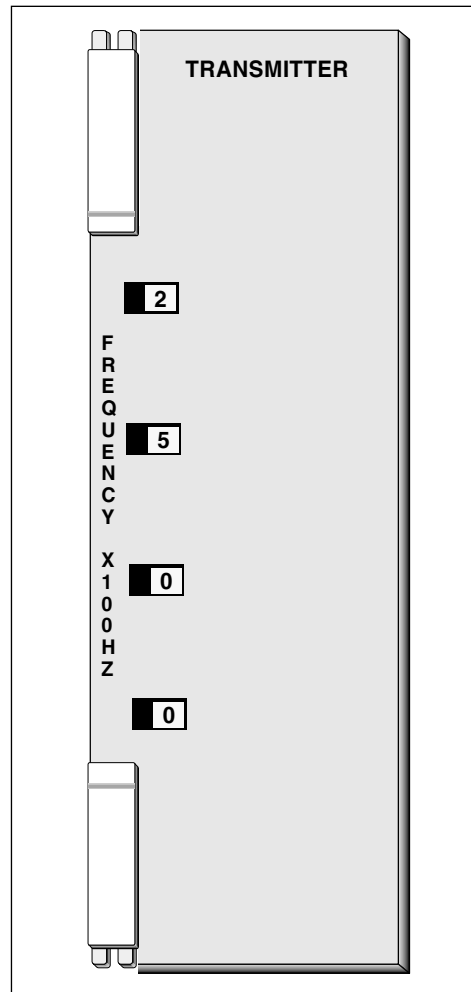


Figure 11–1.
Transmitter Module Front Panel.

- SW1 (x 100kHz)
- SW2 (x 10kHz)
- SW3 (x 1kHz)
- SW4 (x 0.1kHz)

After pulling the module, use a screw driver to set the thumbwheel switches: CW for higher frequency, CCW for lower frequency.

11.1.2 Transmitter PC Board

(The Transmitter PC Board is shown in Figure 11-3.)

Operator controls are as described below.

Potentiometers

- R13 Adjusts high-level (10W) output
- R12 Adjusts low-level (1W) output
- R14 Adjusts voice (4.3W) output level
- R1 Adjusts modulation of transmitter signal (peak-to-valley ratio of signal envelope)
- R29 Sets the offset in output amplifier, so that when 0dBm is generated, R29 is adjusted to minimize the 2nd harmonic distortion

Capacitor

- C19 Adjustment for 3.27680MHz clock oscillator

Switch

- S5 No shift used on TC-10B

Test Point

- TP1 Clock Oscillator Output

11.2 Transmitter Circuit Description

The function of the Transmitter Module (see Figure 11-4, Schematic 1355D71) is to provide the RF signal (0dBm/.001W, 50Ω balanced), which drives the 10W PA Module. The Transmitters frequency range is from 30kHz to

535kHz, programmable in 0.1kHz (100Hz) steps by four rotary switches on the Transmitter. The Transmitter Module operates from keyed inputs (set by jumpers at the Keying Module):

- High-Level (10W) Key (pins C/A-8)
- Any Transmitter Key (pin A-10)
- Voice Key (pins C/A-6)
- Shift High (pin C-10) (TCF-10B Only)
- Shift Low (pins A/C 24) (TCF-10B Only)

The Transmitter Module also operates from an audio signal from the Optional Voice Adapter Module: AM Voice (pins C/A-26). Refer to Figure 11-5, Transmitter Block Diagram.

Frequencies are selected using the four BCD (Binary Coded Decimal) switches (SW1 thru SW4); the range is from 30.0 to 535.0kHz, in 0.1kHz (100Hz) steps. The 15-bit output of the BCD switches is converted to a 13-bit binary number by the BCD-to-Binary converter (ROMs I1 and I2).

The 13-bit output of ROMs I1 and I2 provides an input to the Shift and Control Logic (I3), which consists of three parts:

1. A full adder/subtractor which functions under control of:
 - Shift High (Add)
 - Shift Low (Subtract)
2. A frequency-shift, in 50 Hz increments from 0 to 750Hz, selected by the 4-position dip-switch (S5).
3. A sequencer and multiplexer (MUX) which provides the following outputs to the Numerical Controlled Oscillator (NCO I4):
 - Address select (ADDR)
 - Write (WRN)
 - Load (LDSTB)
 - 2 (8-bit sequential) data bytes

The NCO (I4) generates digital sine functions of very precise frequency, to be used in conjunction with a D/A converter (I5) in analog frequency

generation applications. The NCO is designed to interface with and be controlled from an 8-bit bus.

The NCO maintains a record of phase which is accurate to 16 bits. At each clock cycle, the number stored in the 16-bit phase register is added to the previous value of the phase accumulator. The number in the phase accumulator represents the current phase of the synthesized sine function. The number in the Δ -phase register represents the change of phase for each cycle of the clock. This number is directly related to the output frequency by the following:

$$f_0 = \frac{f_c \times \Delta - \text{phase}}{2^{16}}$$

where: f_0 is the frequency of the output signal

and: f_c is the clock frequency (3.27680MHz)

The sine function is generated from the 13 most significant bits of the phase accumulator. The frequency of the NCO is determined by the number stored in the Δ -phase register, which may be programmed by two sequential 8-bit inputs.

The frequency programming capability of the NCO is analogous to sampling a sine wave where the sampling function is the clock.

If the output frequency is very low with respect to the clock (less than $f_c / 8096$), then the NCO output will sequence through each of the 8096 states of the sine function. As the output frequency is increased with respect to the clock, the sine function will appear to be more discontinuous, because there will be fewer samples in each cycle. At the Nyquist limit, when the output frequency is exactly half the clock, the output waveform reduces to a square wave. The practical upper limit of the NCO output frequency is about 40% of the clock frequency because spurious components created by sampling, which are at a frequency greater than half-the-clock frequency, become difficult to remove by filtering.

The 12-bit output of the NCO is applied to the input of the high-speed Digital-to-Analog Converter (I5), which converts a digital sine wave from the NCO to an analog output. The analog output from I5 is filtered by a 630kHz Low Pass Filter (C14, C13, L1, L2, C15), producing a 0.512

Vp-p output at the carrier frequency. The carrier frequency is applied to Modulator (I7), where it is modulated by a dc and/or ac signal from a 2kHz Low Pass Filter (I10, R24, R25, R26, C30, C31, C32). The output of I7 drives the Output Amplifier (I11) and associated components. The output of I11 is coupled through the Output Transformer (T1) to provide a 50 Ω balanced output.

The reference frequency to the NCO is generated by a Crystal-Controlled Clock Oscillator (CCCO), consisting of Y1, CMOS inverter (I6A), R3, R4, C19, C20, and C50, at a frequency of 3.27680 MHz. The CCCO is buffered by I6B, which drives the Shift and Control Logic (I3) and the NCO clocks. The modulator (I7) receives its inputs from the Analog MUX (I9) used for modulation selection, through the Low Pass Filter whose functions are described (in paragraphs 11.2.1, 11.2.2 and 11.2.3) below.

11.2.1 Low-Level Operation

When Transmitter key input voltage (pin A10) is present, it removes the reset from the NCO (I4). If no other input voltage is present (Transmitter key signal only), the voltage divider (R12, R10) supplies the modulating voltage to the modulator (I7), through the selected analog multiplexer (I9) channel. The 1 watt low-level operation is produced when I9 (both A and B) are either "0" or "1", causing I9 to connect inputs X0 and Y0, or X3 and Y3 to the outputs X and Y. Potentiometer R12 controls the low-level output, which is between 0 and 1mW.

11.2.2 High-Level Operation

When the 10W voltage is keyed, it produces a "1" at the I9 B input, causing channel 2 to be selected. If no other input voltage is present (10W key signal only), the voltage divider (R10, R13) supplies the modulating voltage to the modulator (I7) through the multiplexer (I9) channel.

The 10 watt high-level operation is produced when I9 A input is "0" and I9 B input is "1", causing I9 to connect inputs X2 and Y2 to the output X and Y. Potentiometer R13 controls the high-level output, which is between 0 and 1mW.

11.2.3 Voice Operation

When the Voice key input voltage is present, it produces a “1” at I9A input, causing channel 1 to be selected. If no other input voltage is present (Voice key signal only), the voltage divider (R10, R14) supplies the modulating voltage to the modulator (I7), through the selected analog multiplexer (I9) channel. The Voice operation is produced when I9 A input is “1” and I9 B input is “0”, causing I9 to connect X1 and Y1 to the outputs X and Y. Potentiometer R14 controls the voice carrier output level of the AM carrier, which is between 0 and 1mW. In addition, an ac signal from AM Voice Input is added to the dc level (through R8, R11, and C26) to modulate the carrier. The audio modulating level is adjusted (by potentiometer R11) to a maximum of 60% modulation.

On-board voltage regulation is provided by voltage regulators I8 (+5V), I12 (+15V), I13 (-15V) and associated components. The circuitry operates at +15V, +5V, or -15V. All bypassing is to common or PC Board ground. Additional regulated voltages of +4.3V and -4.3V are generated by I7 to provide an extremely stable reference for modulating control voltages (provided by R12, R13, and R14).

11.3 Optional Transmit Time Limiter (TTL) Transmitter Module

||The Transmit Time Limiter Transmitter Module is an optional transmitter module for the TC-10B. The main board is the same as the standard transmitter with the exception of an additional wire. The auxiliary board is the difference (see Fig. 11-6). Some applications may require a time limit on RF output. The TTL Transmitter module limits RF transmission time to a maximum of between 2 and 13 seconds. After which, it will energize an alarm relay, an LED on the front panel and force the transmitter off. The transmitter is then latched off and must be reset by pressing the front panel push-button.

11.3.1 Adjusting the TTL Transmitter

Using a universal counter or timer, i.e. HP5315A Universal Counter or equivalent:

NOTE:

Setup both channels of the timer counter for dry contact operation.

1. Connect the timer/counter start input across TB3-1 and TB3-2 (RF Transmit output relay) and verify that JU1 on the 10W Power Amp module is set to NO.
2. Connect the stop input of the timer/counter across TB3-7 and TB3-8 (alarm & lockout relay output) and verify that JMP1 on the TTL module is set to NO.

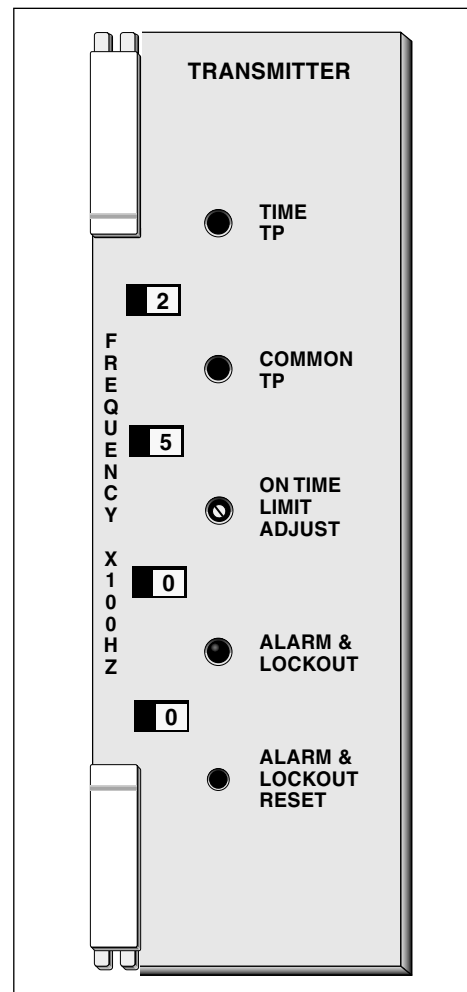


Figure 11-2.
TTL Transmitter Module Front Panel.

3. Press and hold either the “LL” or “HL” button on the keying module until the TTL module LED indicates “ALARM & LOCKOUT”.
4. Check the start and stop time on the timer/counter.
5. Press the “ALARM & LOCKOUT RESET” button on the transmitter. Turn the “ON TIME LIMIT ADJUST” CW to increase the “ON TIME” and CCW to decrease.
6. Repeat steps 3-5 until the desired timing is obtained.||

11.4 Transmitter Troubleshooting

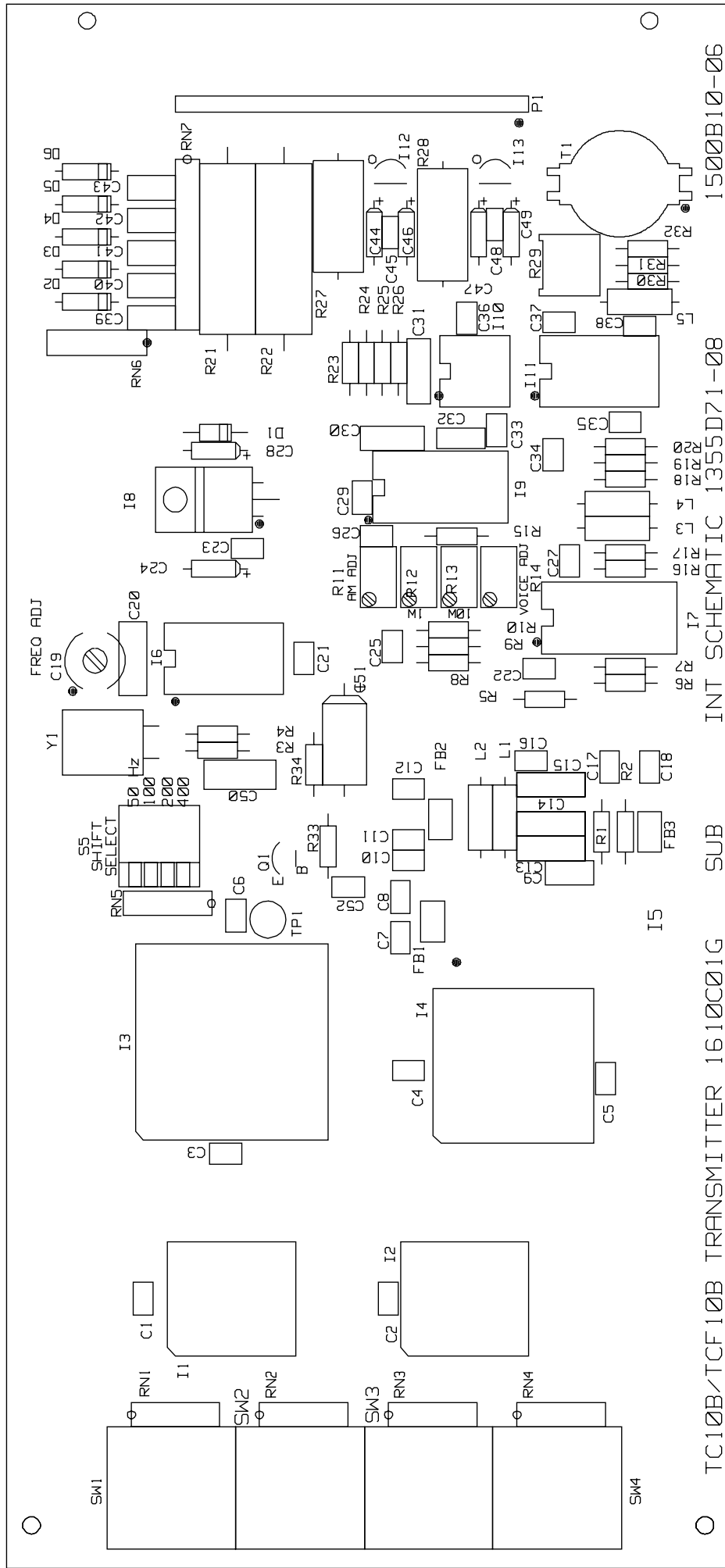
Should a fault occur in this module, place the module on an extender board. Check the RF output (30 - 535 kHz) on pins A/C-28. If there is a Voice Key or AM voice input, use an oscilloscope to examine the modulation envelope. You can check the ac and dc voltages provided on the schematic (Figure 11-4) at the appropriate points, for the conditions on the schematic (10W, 1W, and Voice).

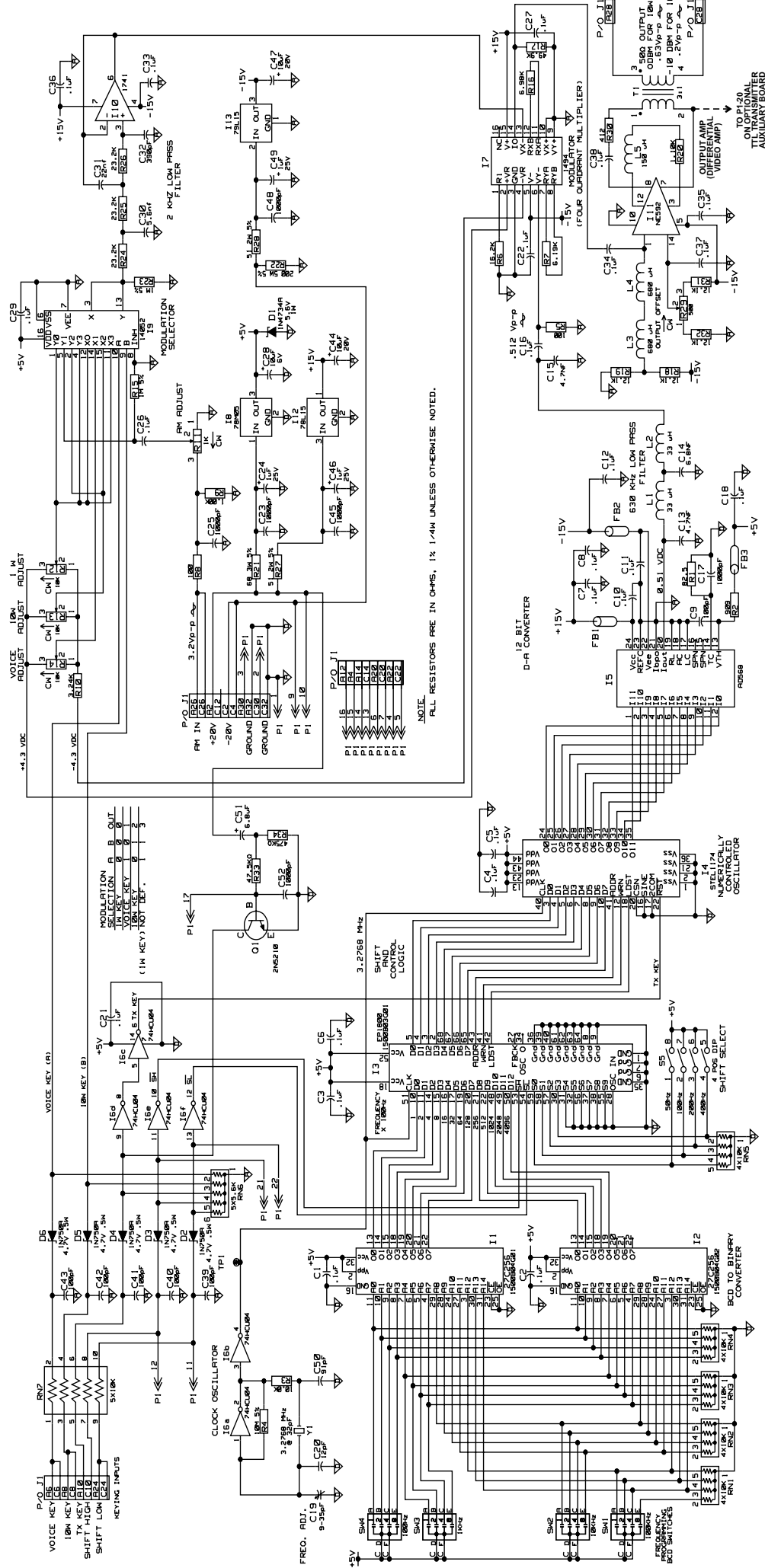
You can check all diodes, resistors, chokes and transistors by conventional means.

NOTE:

On Transmitter units, style no. 1610C01G03 (TTL), remove the auxiliary board prior to troubleshooting.

Figure 11-3. TC-10B/TCF-10B Transmitter PC Board (1500B10).

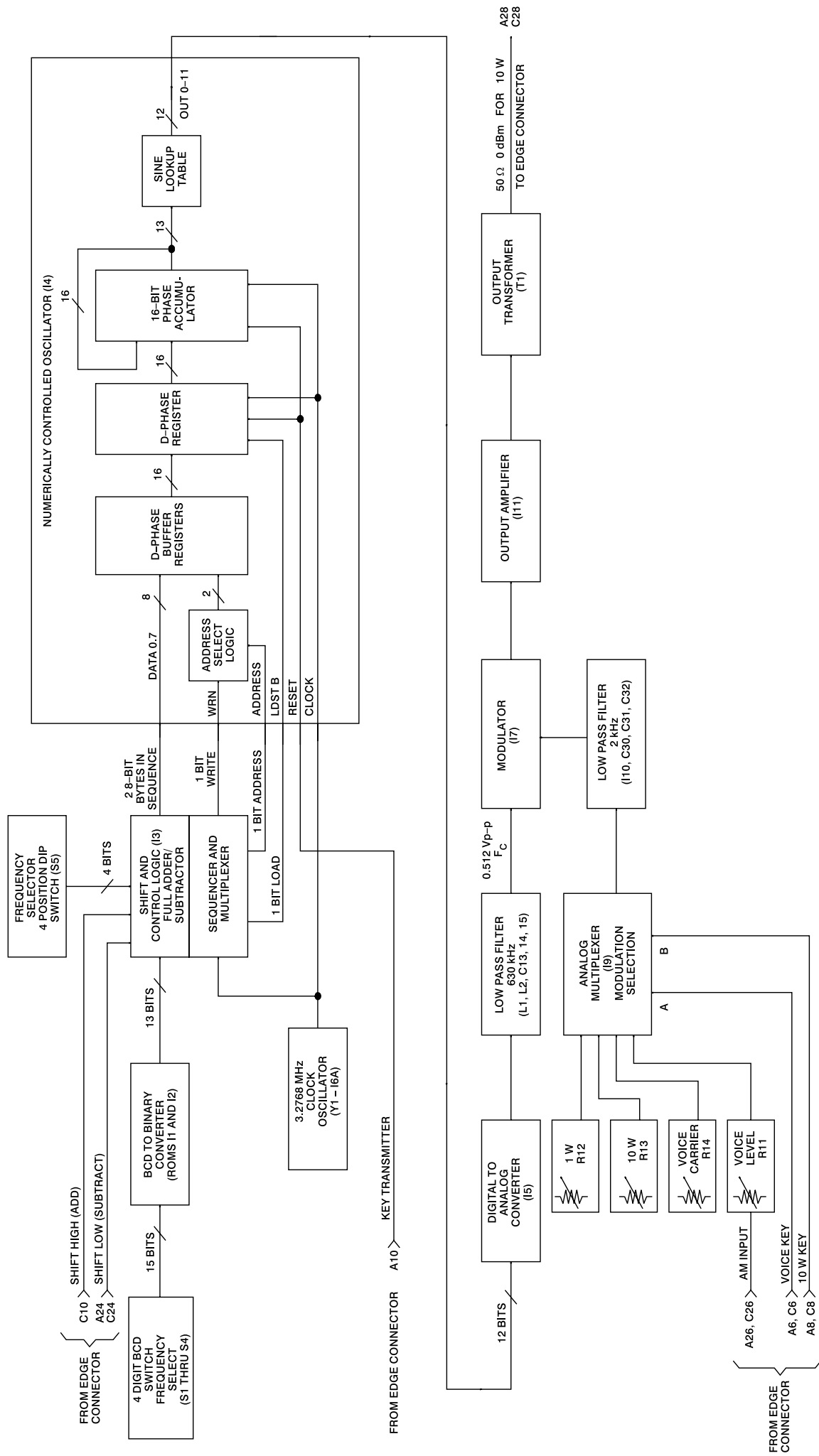




NOTE: ALL RESISTORS ARE IN OHMS, 1% 1/4W UNLESS OTHERWISE NOTED.

Figure 11-4. TC-10B Transmitter Schematic (1355D71).

Figure 11-5. TC-10B Transmitter Block Diagram (1610C09).



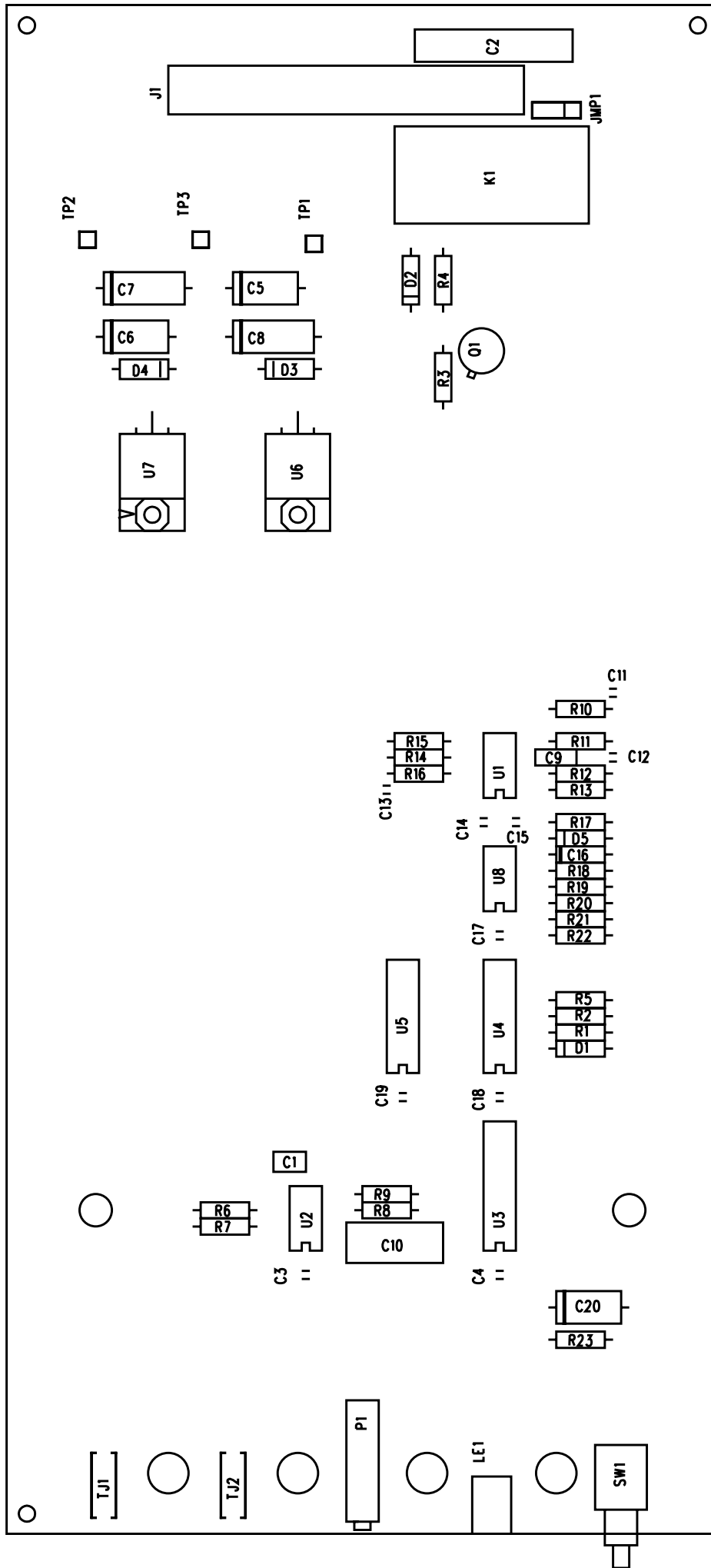
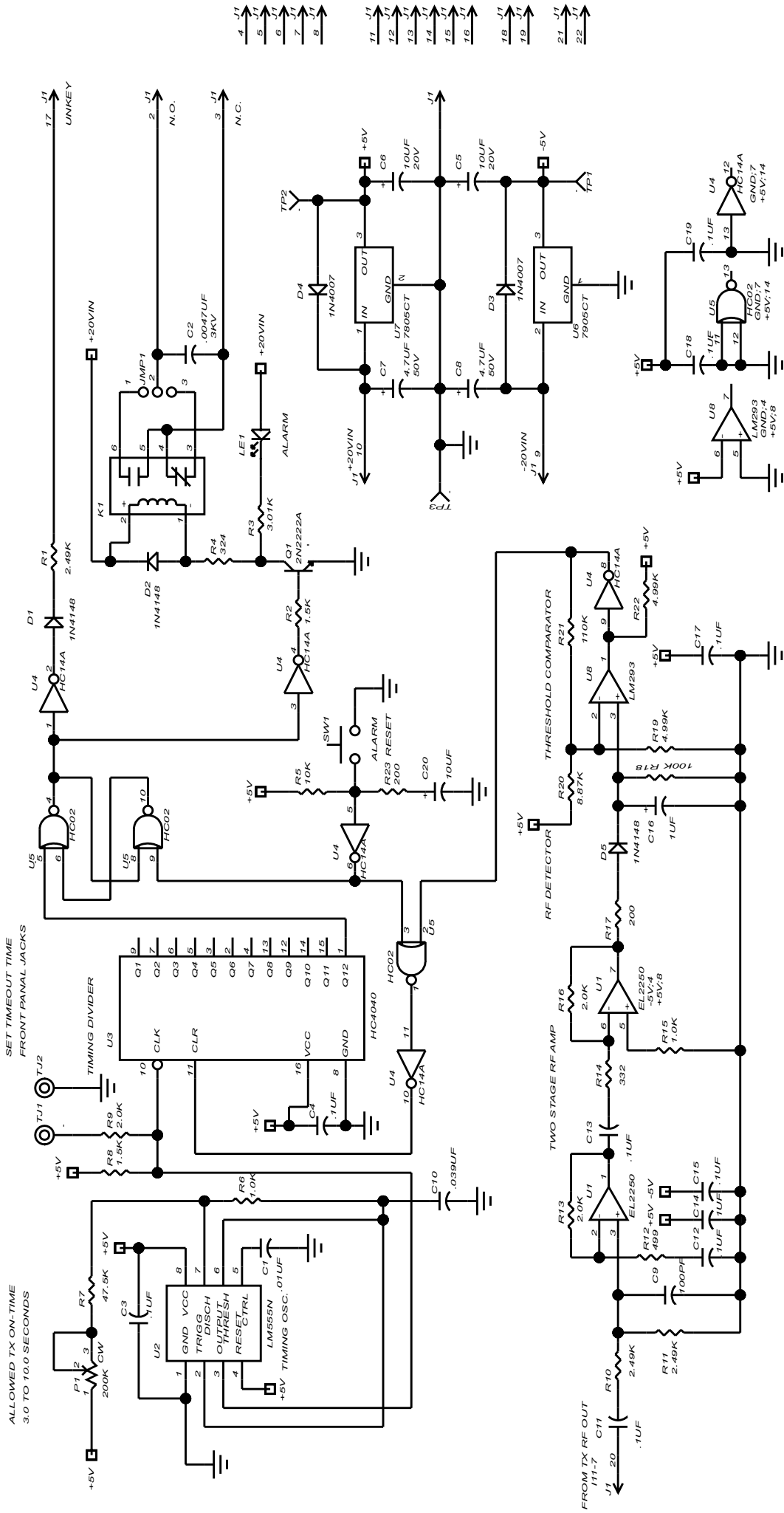


Figure 11-6. TC-10B Optional TTL Transmitter Component layout (CC20-TXMA1-001).

Figure 11-7. Optional TC-10B TTL Transmitter Schematic (CC30-TXMA1).



Chapter 12. 10W PA Module

Table 12–1. 1606C33 Styles and Descriptions.

Schematic	1606C33-20
Part List	1606C33-20

Group	Description
G01	WITH POWER ON RELAY

12.1 10W PA Module Description

The function of the TC–10B/TCF–10B 10W PA Module is to amplify a 0dBm (1mW) input to an output power level of 10W. You may also adjust the 10W PA for input power levels from 0.5mW to 2mW.

The 10W PA Module operates in a 30 to 535kHz range without tuning. The amplifier has a fixed gain of approximately 49dB (class A, complementary symmetry push-pull stage). Negative feedback is used to derive a nominal output impedance of 50Ω.

12.1.1 10W PA Control Panel

(This panel is shown in Figure 12–1.)

Operator controls are as Described below.

Potentiometer (R53) INPUT LEVEL SET

Adjusts power output level to 10W with 1mW input.

LED, TRANSMIT, RF Power Indication, Red (D6)

Test Jacks

- INPUT (TJ1)
- COMMON (TJ2)

Optional relay alarm for RF voltage

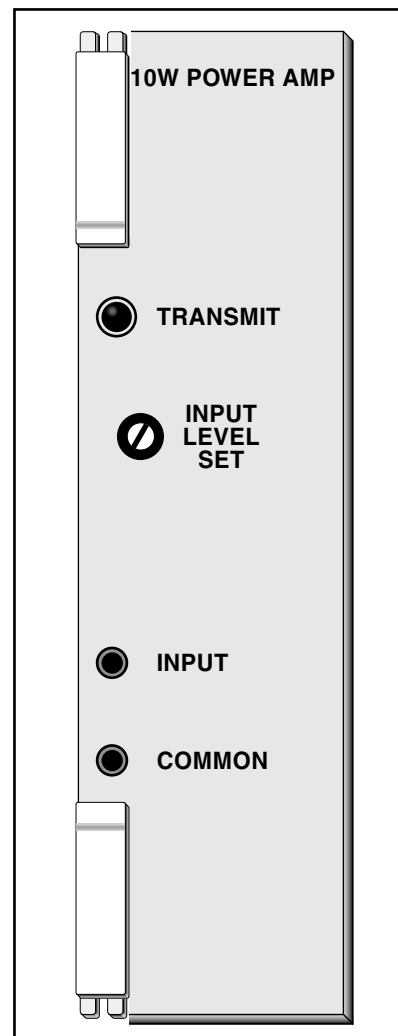


Figure 12–1.
10W PA Module
Front Panel.

12.1.2 10W PA PC Board

(The 10W PA PC Board is shown in Figure 12-2.)

Operator controls consist of a Jumper (JU1) for the Alarm Relay (NO/NC), which indicates loss of power condition (less than 1W).

12.2 10W PA Circuit Description

The function of the 10W PA Module (see Figure 12-3, Schematic 1606C33S) is to amplify a 0dBm (1mW) input to an output power level of 10W. The input from pins C28/A28 passes thru a 700kHz low pass filter (LPF) consisting of L1 and C1. Potentiometer (R53), labeled "INPUT LEVEL SET" on the front panel, is used to adjust the power level to 10W output with 1mW applied at the input.

The 10W PA Module operates in a 30 to 535kHz range without tuning. The amplifier has a maximum gain of approximately 49dB (class A, complementary symmetry push-pull stage). Negative feedback is used to derive a nominal output impedance of 50Ω.

All bypassing is done to common (pins A30/C30, A32/C32). Transistors QN1, QN2 and QN3 are 14 pin DIPs, each containing four individual transistors; QN1 is PNP, while QN2 and QN3 are NPN.

The LPF output drives the amplifier QN1 and QN2. QN1A/QN1B and QN2A/QN2B are configured as a differential amplifier, while QN1C and QN2C are constant current sources. The input signal is applied to the bases of QN1A and QN2A. Negative feedback is applied to the bases of QN1B and QN2B. At the positive side (QN2), the differential output from QN2A and QN2B is amplified by QN2D and Q2. At the negative side (QN1), the differential output from QN1A and QN1B is amplified by QN1D and Q1. The positive side power output transistor (Q6) is driven by Q5; the negative side power output transistor (Q7) is driven by Q4.

The no-load feedback is from transformer (T1) back thru the RC network of R21, C7, C2, C5 and R18 to the junction of R16 and R17, for the purpose of stability. The loaded feedback is derived from a sampling resistor (R33, R35, R36,

R37, R38, and R39, all in parallel) and fed back thru C28, C29 and R23. The overall no-load voltage gain is approximately 282. The overall loaded voltage gain is approximately 141. The partial loaded gain, between C28/A28 and the primary of T1, is approximately 38.

The alarm circuit (loss of RF signal condition) consists of QN3, Q8, K1 and associated components. The RF signal is monitored by C22, at T1 pin 1. The signal sample is amplified in QN3A and fed to QN3B and QN3C (QN3B and QN3C are configured as diodes). A voltage doubler is formed from C30, QN3C and QN3B. The output of QN3B drives QN3D, via R44 and R45. QN3D is saturated for an input of 1W to C22 (with reference to T1 secondary). As QN3D saturates, Q8 conducts, driving the front panel LED (D6, power monitor), causing K1 to energize (or de-energize), indicating loss of signal condition. Jumper JU1 allows the selection of an open circuit or a closed circuit for the loss of signal condition.

The +20Vdc line (leading to the alarm circuit, etc.) is filtered by C10, C11, L2, L4, C19, C20 and C21. The -20 Vdc (leading to C2/C4) is filtered by C12, C13, L3, C16, C17, C18 and L5.

12.3 10W PA Troubleshooting

To check individual transistors, e.g., Q1 thru Q8, QN1, QN2 and QN3, remove them first from the PC Board. Ohmmeter measurements of the transistors while in the PC Board are misleading because of other paths on the board.

You may remove the heat sink by unscrewing the four (4) corner screws and the hold-down screws for Q1 thru Q8. The 10W PA Module can operate at no-load conditions without the heat sink for short periods of time while you are troubleshooting.

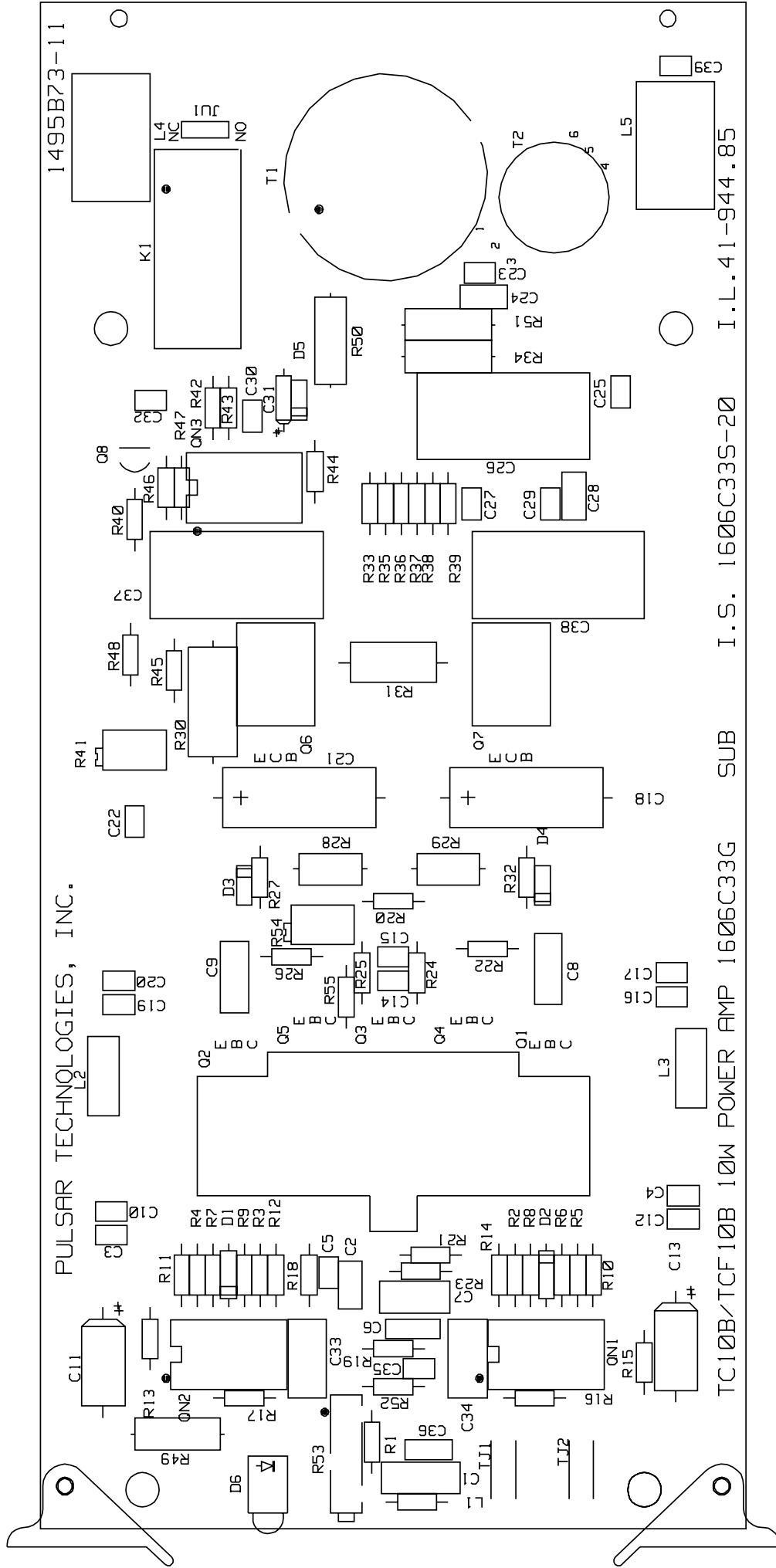


CAUTION

THE 10W PA IS, BASICALLY, AN OP-AMP PROVIDING VERY HIGH GAIN WITH NEGATIVE FEEDBACK. TRANSISTORS Q1 THROUGH Q5, Q6, AND Q7 ARE THERMALLY CONNECTED, I.E., THEY ARE MOUNTED ON THE SAME PART OF THE HEAT SINK. ANY FAILING TRANSISTOR MAY AFFECT OTHER TRANSISTORS. CHECK EACH TRANSISTOR SEPARATELY. IF NO FAULTS ARE FOUND, CHECK OTHER COMPONENTS.

BE CAREFUL NOT TO MISPLACE THE SCREWS, SPRING WASHER OR INSULATING WASHER USED TO MOUNT Q1 THROUGH Q8. DAMAGED SCREWS OR INSULATORS SHOULD NOT BE USED.

Figure 12-2. TC-10B/TCF-10B 10W PA PC Board (1495B73).



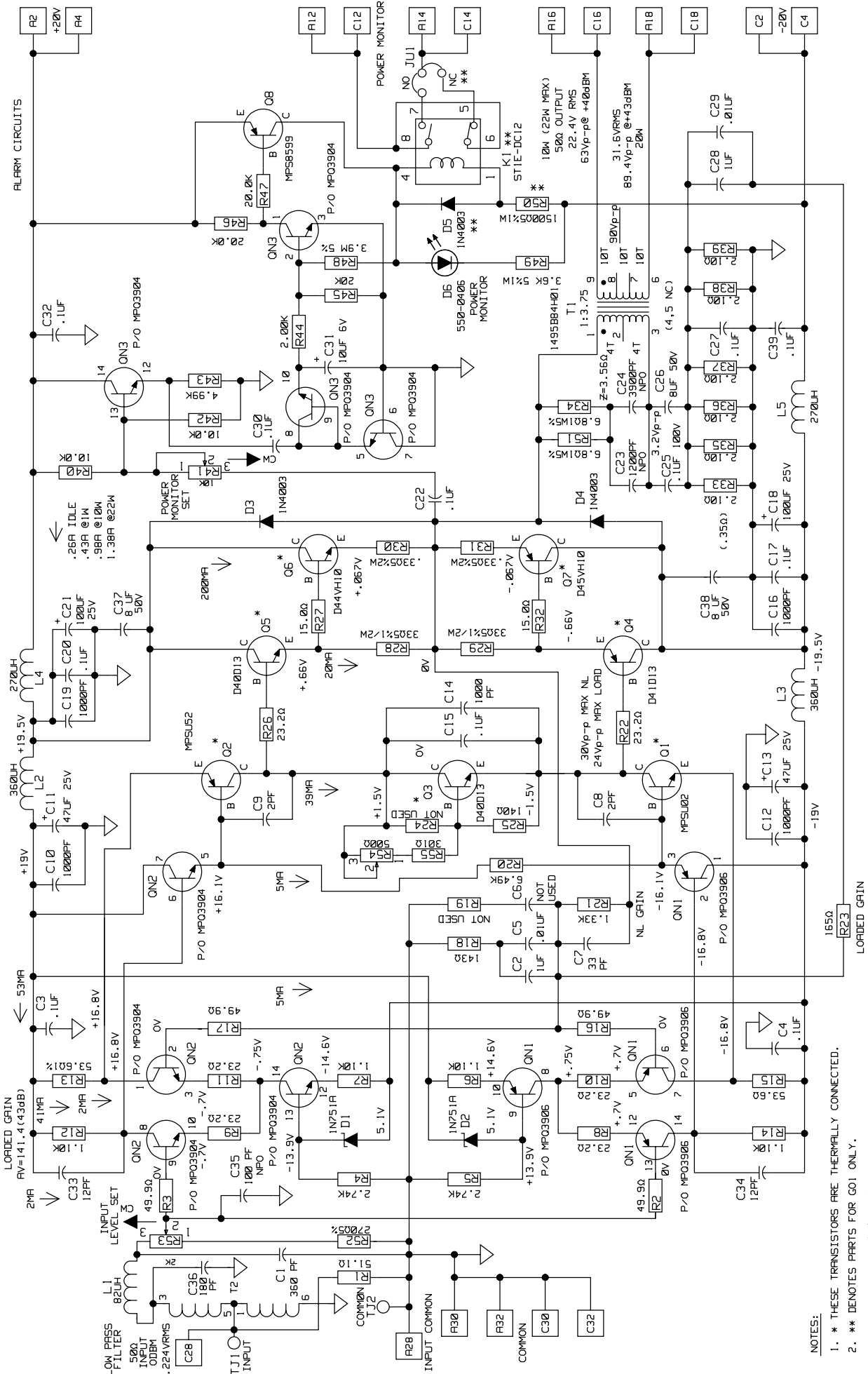


Figure 12-3. 10W PA Schematic (1606C33).

- NOTES:
1. * THESE TRANSISTORS ARE THERMALLY CONNECTED.
 2. ** DENOTES PARTS FOR G01 ONLY.
 3. RESISTORS ARE 1/4 W 1% UNLESS NOTED.
 4. ALL VOLTAGES WITH RESPECT TO COMMON (▽).

Chapter 13. RF Interface Module

Schematic	1609C32-8
Parts List	1609C32-8

Table 13–1. 1609C32 Styles and Descriptions.

Group	Description
G01	RF INTERFACE

13.1 RF Interface Module Description

The RF Interface Module, used with the TC–10B/TCF–10B, has several functions:

- Receives RF input from 10W PA Module.
- Matches output impedance at 50, 75, or 100Ω.
- Low-pass filter covers RF spectrum up to 550 kHz.
- Permits 2- or 4-wire operation.
- Protects against line surges with a gas tube device.

13.1.1 RF Interface Control Panel

(This panel is shown in Figure 13-1.)

Operator controls consist of Test Jacks:

- TJ1 Line In
- TJ2 Line Common
- TJ3 Receiver In
- TJ4 Receiver Common

13.1.2 RF Interface PC Board

(The RF Interface PC Board is shown in Figure 13-2.)

Operator controls are as follows:

Matching Impedance Jumpers

- JU4 50Ω
- JU3 75Ω
- JU2 100Ω

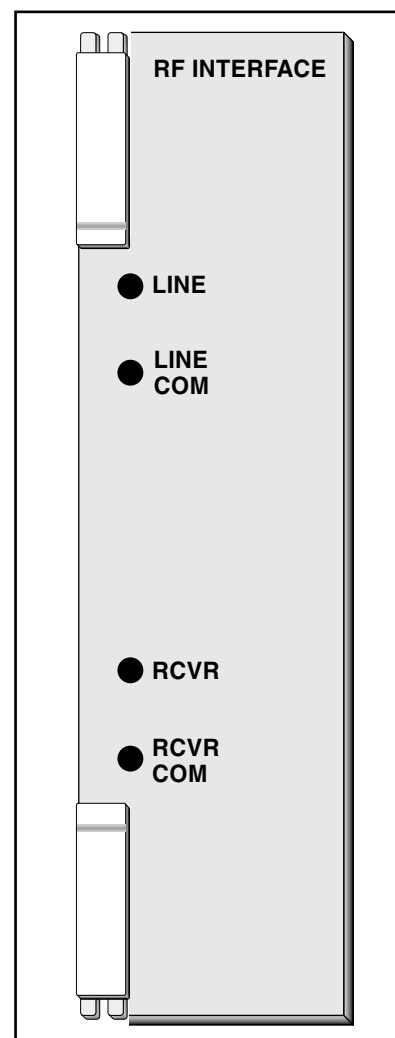


Figure 13–1.
RF Interface Module
Front Panel.

2-wire or 4-wire RF Termination

JU1/JU5	“IN”	2-wire
JU1/JU5	“OUT”	4-wire

Attenuator Override Jumper (JU6)

NORM Sensitivity	70Vrms at 5,000Ω
HIGH Sensitivity	17Vrms at 1,000Ω

13.2 RF Interface Circuit Description

This module receives RF input from the 10W PA Module at pins A16/C16 and A18/C18, and feeds the power through a balanced low-pass filter with a 550kHz cutoff (L3, L4, L1, L2 and associated components). RF is fed through transformer T1, for matching 50Ω (JU4), 75Ω (JU3), or 100Ω (JU2) resistance to the RF line output (45Vrms maximum) at pins 12A/12C and 10A/10C, which provide the two-wire UHF (J1) connection on the Rear Panel.

Four-Wire Receiver input is provided at pins 24 A/C and 22 A/C via the 4-wire BNC (J2) connector on the Rear Panel. Jumpers JU1 and JU5 simultaneously connect the four-wire Receiver input to RF line output:

- IN settings for 2-wire operation
- OUT settings for 4-wire operation

Isolation transformer T2, together with series resistor R1, forms an attenuator with 13 dB loss. Receiver input (at pins 28 A/C) is adjusted by jumper JU6:

- When in the NORM position, Receiver maximum input is 70Vrms at 5,000Ω
- When in the HIGH position, JU6 overrides the attenuator, providing lower input impedance (Receiver maximum input is 17Vrms at 1,000Ω).

13.3 RF Interface Troubleshooting

With the PC Board plugged into the chassis, you can monitor the voltage output to the RF line at TJ1 and TJ2. You can monitor receiver input at TJ3 and TJ4.

Should a fault occur in the RF Interface Module, you can remove the PC board and check the components by conventional means.

13.3.1 Capacitors

Remove from the circuit with jumpers JU2, JU3 and JU4 and check for shorts, dissipation factor, and capacitance. (Perform checks using a signal of 10kHz or higher.)

13.3.2 Inductors

Check with an ohmmeter.

13.3.3 Transformers

Check for open circuits.

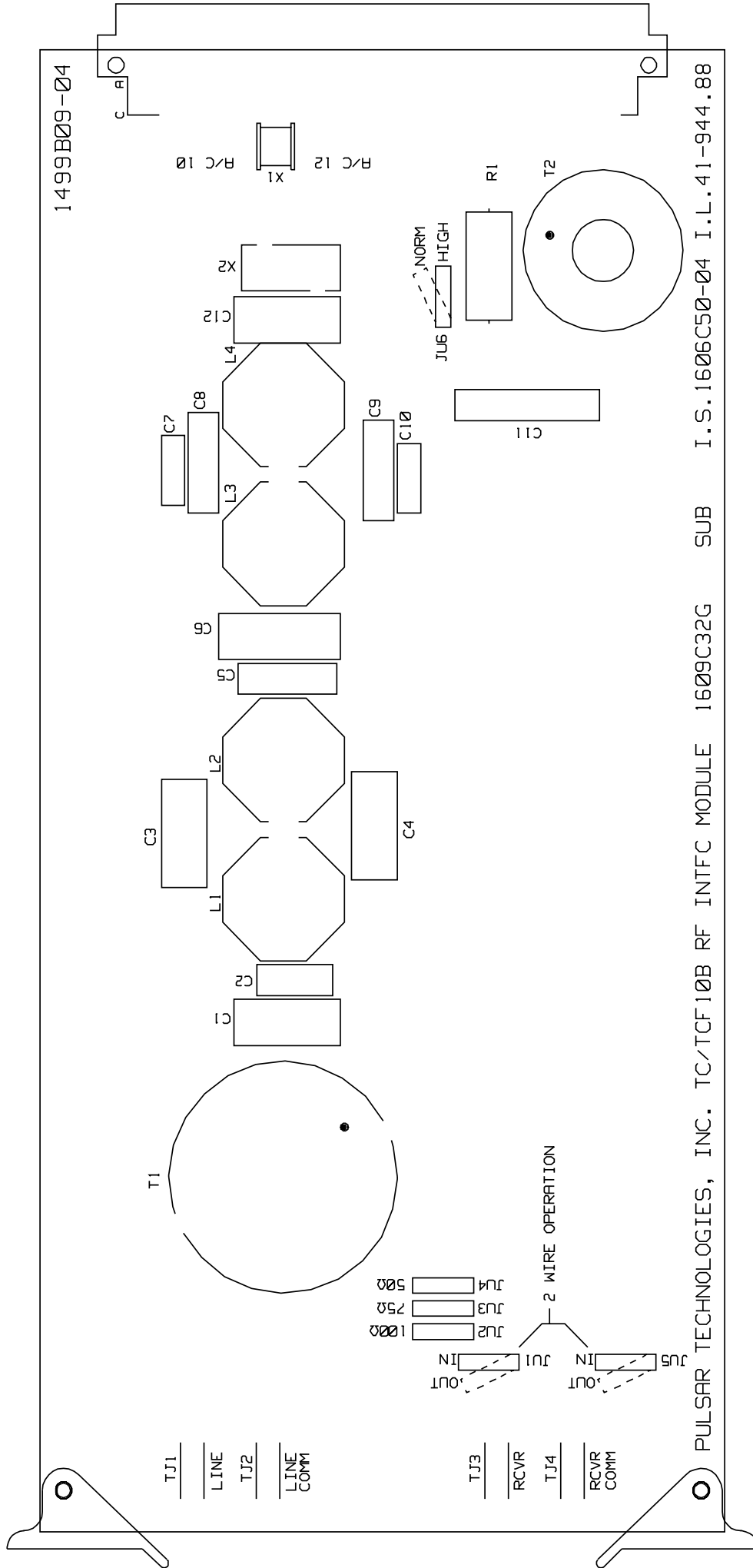
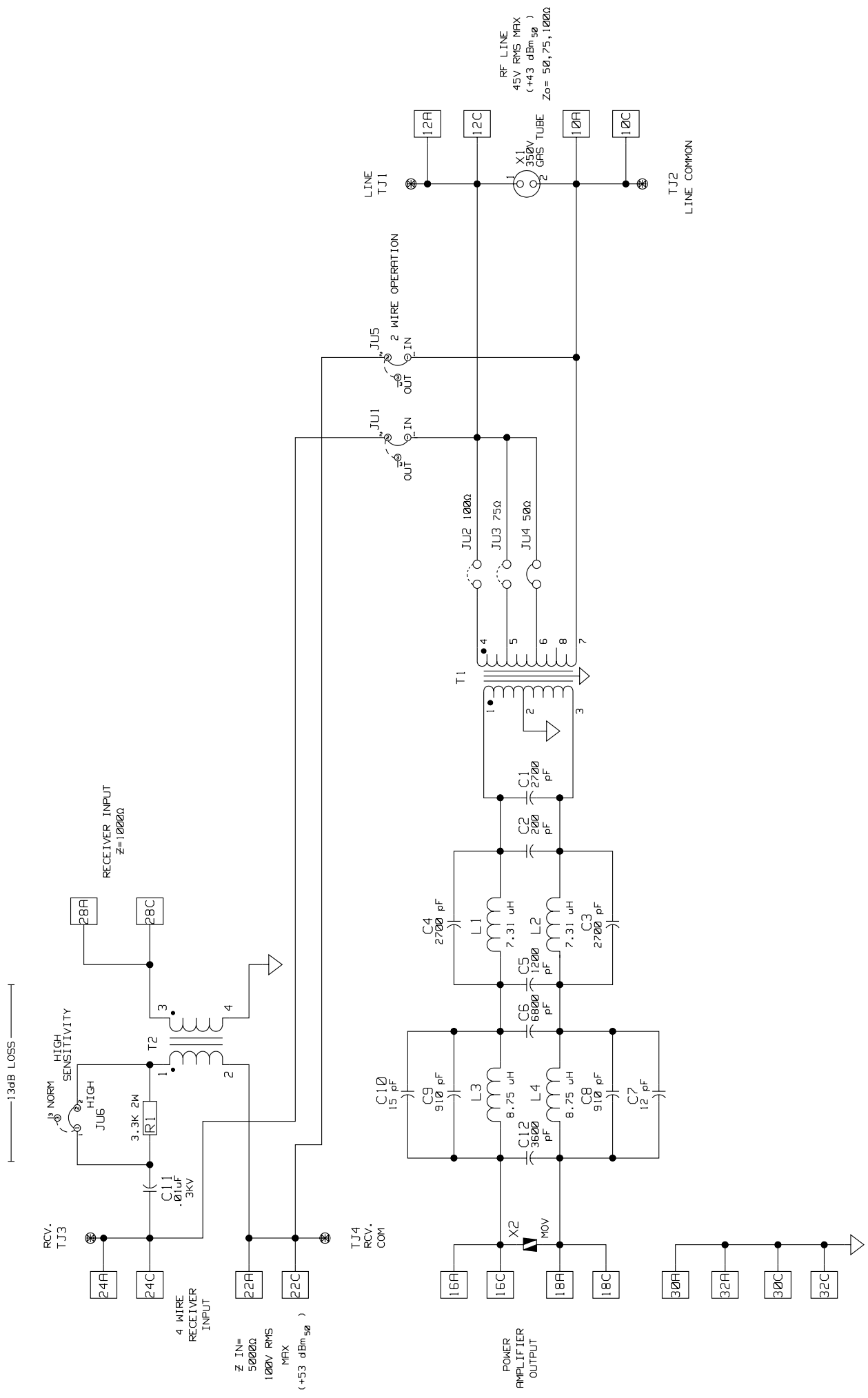


Figure 13-2. TC-10B/TCF-10B RF Interface PC Board (1609C32).

Figure 13-3. TC-10B/TCF-10B RF Interface Schematic (1606C50).



Ch. 14 Universal Receiver Module

Table 14–1. Universal Receiver Style.

The Universal Receiver is pin-for-pin compatible with the previous version of the Receiver and Detector modules.

Function	Style
Self Adj.Receiver/AM Detector	C020-RXVMN-201
Universal Receiver	C020-RXVMN-203

14.1 Receiver Module Description

The Universal Receiver Module is DIP switch selectable for use as either a Receiver/AM Detector for the TC–10B or a Receiver/FSK Discriminator for the TCF–10B.

The Receiver Module comprises two boards. The main (top) board contains all the circuitry required for the filtering and A/D conversions necessary to process the incoming RF signal. The auxiliary (bottom) board contains DC-voltage regulators and components specific to the Receiver/AM Detector.

The module’s double board combination slides into the same slots as the previous Receiver and

Detector modules. The single Universal Receiver with 2 boards replaced the 2 previous separate modules (Receiver & Detector). With the new Universal receiver, however, you do not need extender cards to make adjustments or change settings. You can perform all necessary settings and adjustments directly on the front panel.

The Universal Receiver Module is driven by the output of the RF Interface Module. The output of the Universal Receiver Module drives the necessary output module. The (primary) output module for the TC-10B is the Receiver Logic Module, as shown in Figure 14–1. The module’s audio output drives the optional Voice Adapter Module, if it is installed.

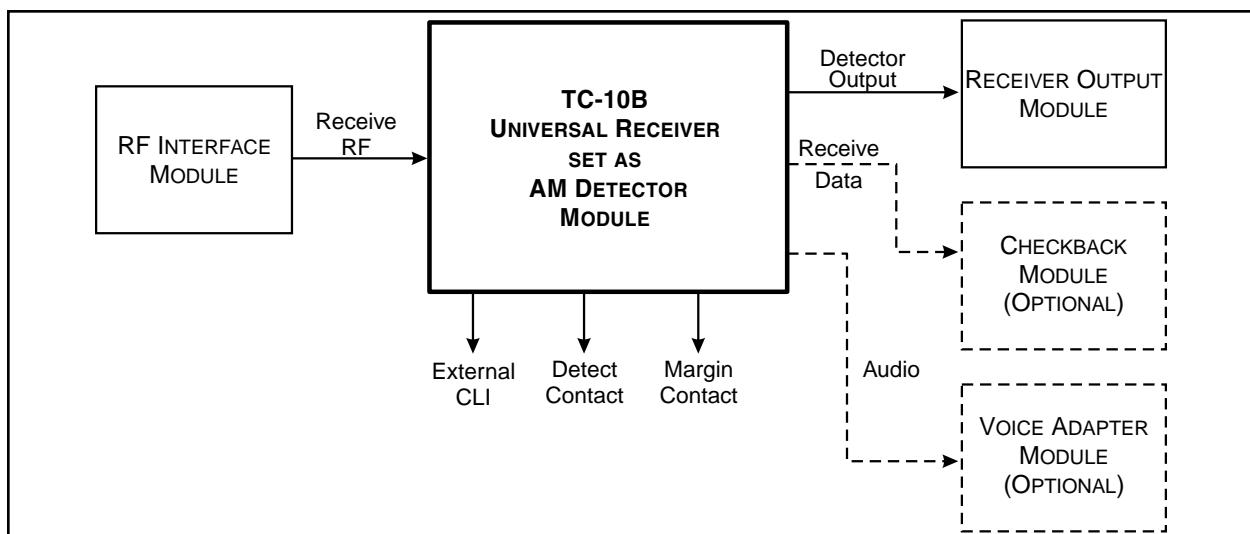


Figure 14–1. Universal Receiver— Simplified Signal Flow Diagram.

The receiver output is shown below.

Universal Receiver:

- RCVR Output

14.2 Front Panel Controls and Displays

The controls and displays, for the AM Receiver/Detector, along with the two alarm indicators at the bottom of the panel are shown in Figure 14-2 for the TC-10B. These controls and displays are described below. (Please see “Frequency & Sensitivity Setting” later in this chapter for setting instructions.)

Frequency Display

The frequency display is at the top right of the module’s front panel. It is a four- (4-) digit green LED. During normal operation, it shows the current receiving frequency. When in the “setting” mode, it displays instructions and various messages.

Carrier Level Indicator

The Carrier Level Indicator is directly beneath the frequency display. It provides a tri-color bar graph showing a range of -20 to +10dB, in 5dB increments. There is also an external CLI circuit to drive a remote 0-100 μ A external meter, 10 to 350Vdc.

Push button Controls

The recessed, push button controls are as follows:

CANCEL/RAISE—When in the “Setting” mode, this button raises the frequency, sensitivity, or external CLI settings. It also lets you skip the sensitivity setting option after you set the frequency.

LOWER—This button lowers the frequency, sensitivity, or external CLI settings.

SET—This button initiates the “Setting” mode and accepts the displayed settings,

Alarms

The alarms for the AM receiver are:

DETECT—Signal detector relay: normally open contact; relay is energized at minimum signal level setting

MARGIN—Margin relay: selectable normally open (NO) or normally closed (NC) contact; relay is energized when signal level is above the margin setting. Use J3 on the bottom board to set the NO or NC position.

14.3 Specifications

The Universal Receiver Module’s technical specifications are shown in Table 14-2.

The module’s ON-OFF frequency spacing specifications are shown in Table 14-3.

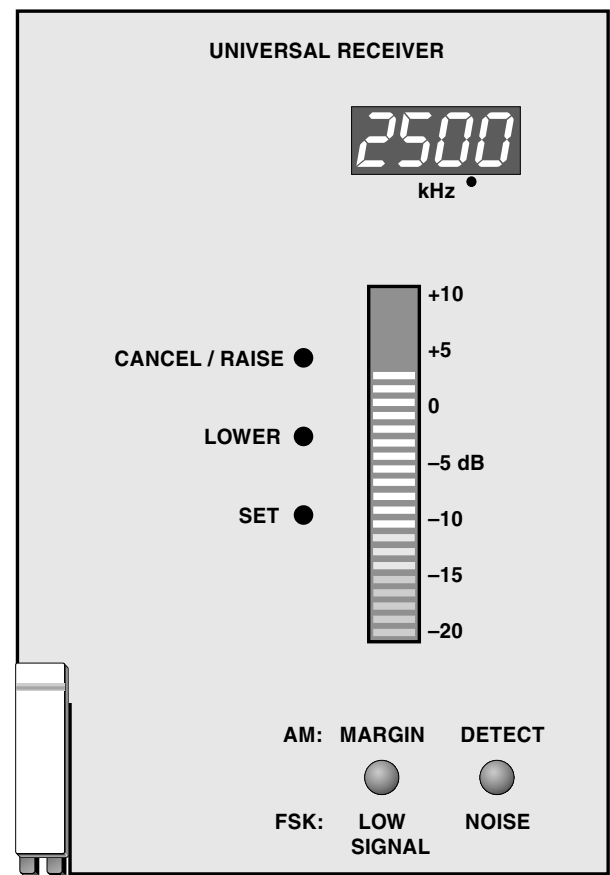


Figure 14-2. Universal Receiver Front Panel.

Table 14–2. Receiver System Specifications.

Frequency Range	30 to 535kHz, in .5kHz increments
4-Wire Receiver Input Impedance	5,000 Ω or 1,000 Ω (high sensitivity strapping)
Modulation	
CO20-RXVMN-203	Amplitude (On-off)
Nominal Bandwidths	<ul style="list-style-type: none"> • Narrow Band (800Hz at 3dB points) • Standard Band (1600Hz at 3dB points) • On-Off Phase Comparison (3,500Hz at 3dB points)
Receive Sensitivity (Narrow or Standard Band)	<ul style="list-style-type: none"> • 22.5mV (min) to 70V (max) Standard Setting • 5mV (min) to 17V (max) High setting
DETECT TIME (ON-OFF)**	
Remote Signal	
Narrow Band (800Hz)	3.8ms (pickup) – 6.0ms (dropout) typical
Standard (Wide) Band (1,600Hz)	2.4ms (pickup) – 3.8ms (dropout) typical
Phase Comparison Band (3,500Hz)	1.3ms (pickup) – 1.5ms (dropout) typical
Local Signal (keyed to 10 watts)	
Narrow Band (800Hz)	3.5ms (pickup) – 6.2ms (dropout) typical
Standard (Wide) Band (1,600Hz)	2.0ms (pickup) – 3.8ms (dropout) typical
Phase Comparison Band (3,500Hz)	1.0ms (pickup) – 1.6ms (dropout) typical

*Receiver set for 15 dB margin, no time delay, solid state output)

**Receiver set for 15 dB margin, solid state output)

14.4 Switch Settings

Table 14-4 shows the DIP switch settings for the Universal Receiver.

Table 14-3 ON-OFF Frequency Spacing Specifications (Minimum).

Narrow Band	2,000Hz
Standard (Wide Band)	4,000Hz
Phase Comparison Band	4,000Hz
All Voice Applications	4,000Hz

Table 14-4 Universal Receiver (SW1-1 set to the ON/AM position).

SWITCH ON SW1	OFF	ON
2	NO VOICE ADAPTER	VOICE ADAPTER
3	UNUSED	
4	UNUSED	
5	UNUSED	
6	UNUSED	
7	PHASE COMPARISON, 3,500Hz BW	DIRECTIONAL COMPARISON, BW PER SW1-8
8	1600Hz BW	800Hz BW

14.5 Frequency & Sensitivity Setting

To change settings on the Universal Receiver, complete the following sequence:

14.5.1. Push the SET button.

This causes the frequency display to begin flashing, indicating that the receiver is in the “setting” mode.

If you do not touch any of the buttons for approximately three minutes, the receiver exits the setting mode and reverts to the previous settings.

14.5.2. Set the frequency.

To keep the displayed frequency, press the SET button again.

To increase the frequency, push the CANCEL/RAISE button; to decrease it, push the LOWER button. Pushing either button once and releasing it raises or lowers the frequency by the minimum increment, 0.5kHz. Holding down either button for more than two seconds increases the incrementing speed. If you exceed the maximum of 535kHz, the display rolls over to the lower end, 30kHz, and continues scrolling.

After you have the desired frequency displayed, release the button. The display once again flashes, indicating that it is still in the “setting” mode and has not yet accepted the new setting. Press the SET button to accept the frequency setting.

14.5.3. Set the sensitivity.

After you set the frequency, the display scrolls this message: "Set Sens?... – Hit Set or Cancel...".

To keep the current sensitivity setting, press the CANCEL/RAISE button.

To tell the receiver to automatically set the sensitivity based on an incoming remote signal, press the SET button. This sets the receiver for a 15dB margin and calibrates the CLI meter to 0dB. While the receiver is setting the sensitivity, the display scrolls the message: "Working..."

At first the bar graph is blank. Then it gradually ramps up until it reaches approximately 0dB. The display then tells you whether the sensitivity level is okay or if there is a problem, such as a signal too weak to set for a minimum pickup level.

After the display gives the "-OK-" message, it then scrolls the message "Sens Adjust? – Hit Raise/Lower or Set when done..." Here, you can either accept the current setting or manually adjust the receiver sensitivity.

To accept the current setting, press the SET button. The receiver is now set for a 15dB margin, and the CLI reads approximately 0dB.

To manually adjust the receiver sensitivity up or down 10dB, push the CANCEL/RAISE or LOWER button. The CLI will track accordingly and remain at that level to indicate the sensitivity is set that much below or above the 15dB setting.

NOTE

Catalog no. S1A1WTAP or S1N1WTAP, units with Transmitter style 1610C01G03 only:

Prior to setting frequency and sensitivity levels, C16, (or R18) on the TTL Transmitter needs to be shorted out on both ends in order to disable the TTL function.

– or –

Press and hold the "ALARM & LOCKOUT RESET" button while setting the receiver frequency and sensitivity levels. After completion of receiver setup, remove jumpers on C16 and R18.

Sometimes the incoming signal may not be strong enough to raise the margin the full 10 dB. If this happens, the display says "Warning: signal too low for more gain - hit Set to continue.." When this happens, push the SET button. This lowers the sensitivity to an acceptable level and flashes the bar graph to remind you that you are still in the "setting" mode.

To accept the displayed level, push the SET button.

14.5.4. Set the external CLI.

Once you have completed the sensitivity setting, the display scrolls this message: "Set Ext CLI? – Hit Raise/Lower or Set when done..."

To calibrate the external CLI push the CANCEL/RAISE or LOWER button. The external CLI meter will move up and down accordingly. The external meter is a 100 μ A instrument. If it is calibrated in μ A, the meter should be set to read 67 μ A (this is equivalent to 0dB on the internal meter). The setting should be varied 3.3 μ A for each dB the margin adjustment has been raised or lowered from the 15kB margin. If the meter is calibrated in dB, set the meter to read equal to the internal CLI meter.

To accept the displayed level, push the SET button.

14.5.5. Set the local sensitivity.

"Hit Set to get Local Sens" appears after you have completed the external CLI calibration. Key on the local transmitter by pressing the recessed push button marked "HL" on the keying module.

Then hit the SET button. This sets the receiver sensitivity to the local 10W transmitter signal.

This completes the AM setting procedure.

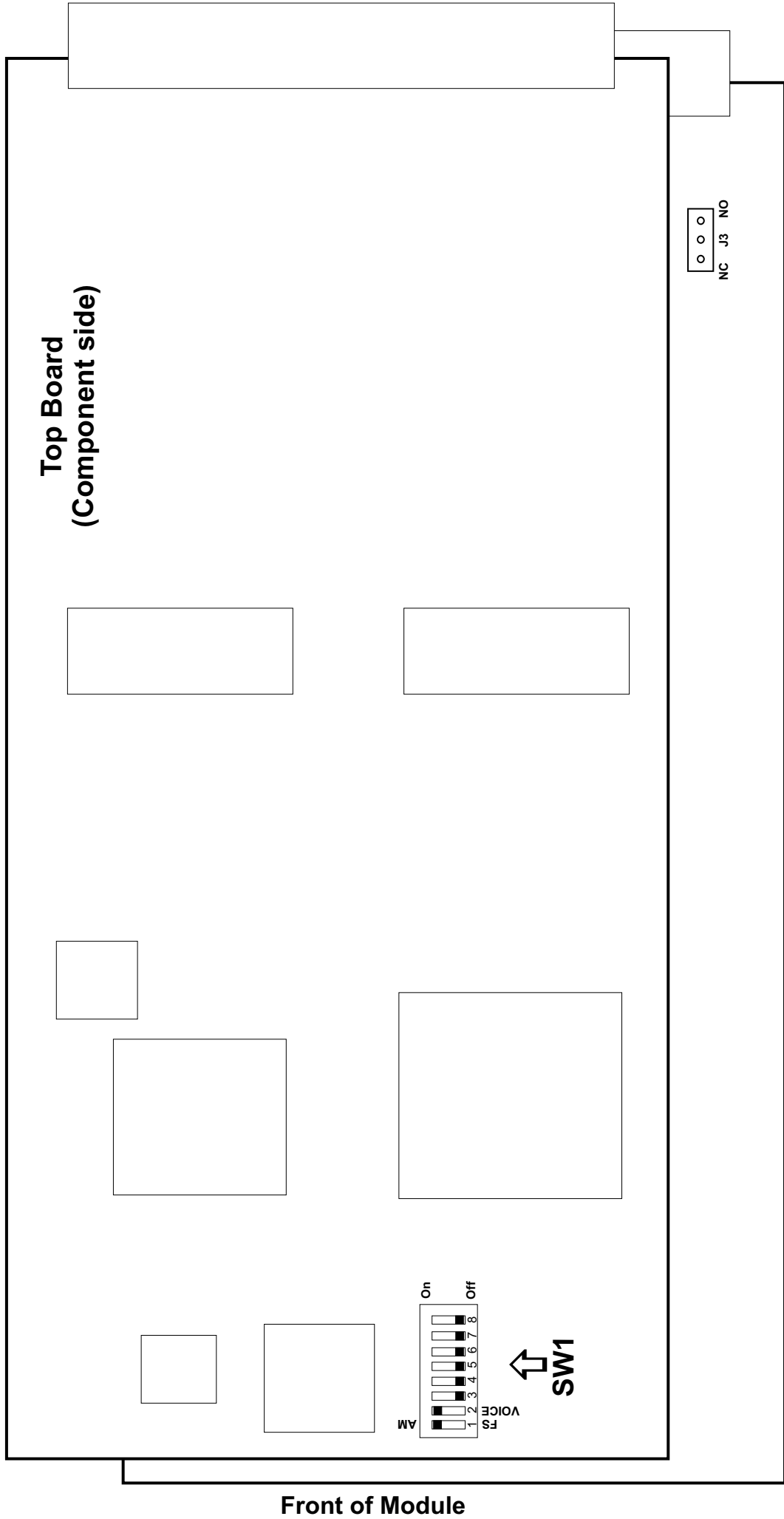


Figure 14-3. TC-10B Universal Receiver/ Location of SW1 Dip switch & J3

Chapter 15. Receiver (Solid State) Output Module

Schematic	CC30RXSM
Parts List	CC40RXSM

Table 15-1.
CC20-RXSMN-001 Styles and Descriptions.

Group	Description
001	Receiver (Solid State) Output

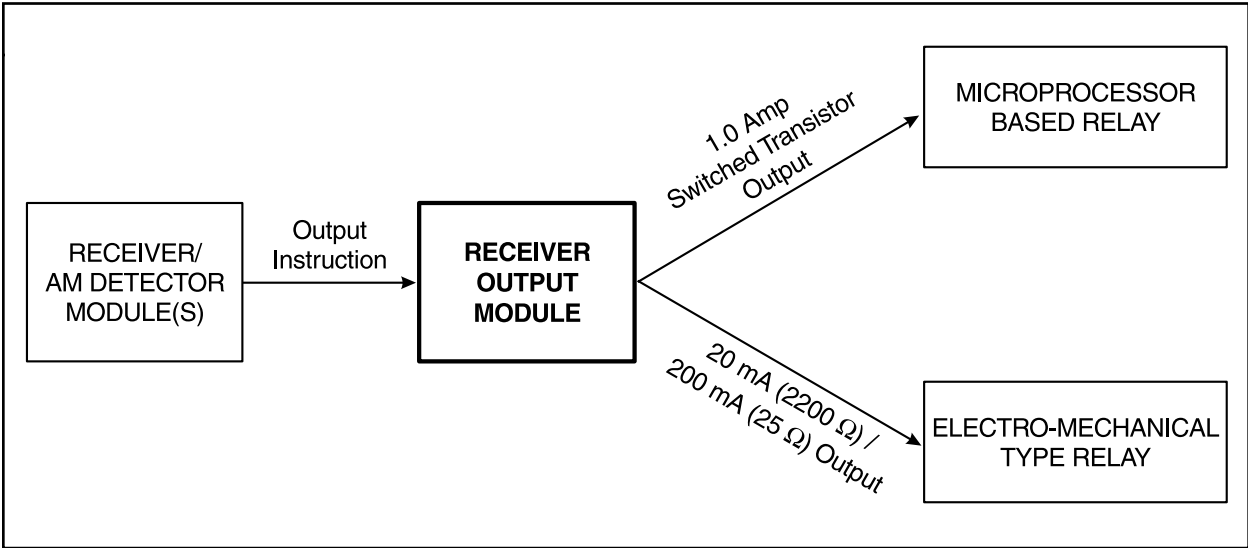


Figure 15-1. Receiver Output Module — Simplified Signal Flow Diagram.

15.1 Module Description

The TC-10B Receiver Output Module provides the appropriate outputs for both microprocessor based and electro-mechanical type relays. For a microprocessor based relay system, it provides two separate optically-isolated outputs between the carrier equipment and the relay. Both of these 1A switched transistor outputs are solid-state circuits. For the older, electro-mechanical type relay systems, the module also provides either a 20 mA (2200Ω) or 200mA (25Ω) output. All of these circuits may operate from voltage sources between 40 and 300Vdc.

Figure 15-1 provides a simplified look at the Receiver Output Module's function. After the Universal Receiver module(s) have received a signal (initiated by the relay attached to the carrier set at the other end) and determined that a carrier signal is present, they tell the Receiver Output Module to give an output to the (local) relay. The Receiver Output Module responds by giving the relay the appropriate output to provide blocking of the trip output. This lets the relay know the carrier is present so that it can ring the bell, sound the alarm, light the bulb, etc.

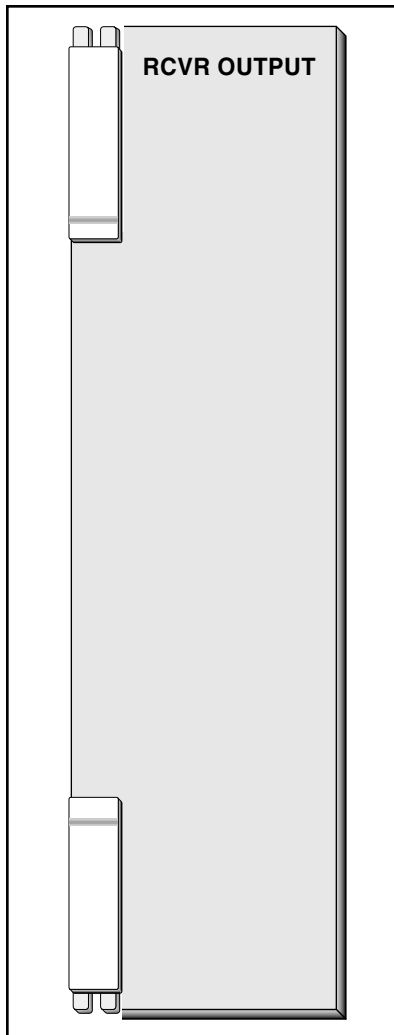


Figure 15-2.
Receiver Output Module
Front Panel.

The specific output the module gives to the relay is determined by the type of relay you are using and, for electro-mechanical type relays, how your relay circuit is set up.

Table 15-2 shows the connection options for both microprocessor based and electro-mechanical type relays. For further connection instructions for both types of relays, please see “Rear Panel Connections” later in this section.

15.1.1 Front Panel

As shown in Figure 15-2, the Receiver Output Module’s front panel has no buttons, switches, LEDs, or other controls or indicators. This is because the module’s function is automatic. The Receiver/AM Detector module(s) tell it when to send an output to the relay, and the type of output it sends is determined by the way the relay connection is configured.

15.1.2 Rear Panel Connections

You connect both microprocessor based and electro-mechanical type relays to the TB1 terminal block on the rear of the TC-10B carrier set. Table 15-2 shows the connection options for both types of relays. For information on the module’s external connections, refer to Figures 3-4 & 3-5 in Chapter 3 and Figure 6-1 in Chapter 6.

Connecting a Microprocessor Based Relay

For a microprocessor based relay, connecting to the carrier set is as simple as connecting your relay wires to the correct connection screws on terminal block TB1.

To send OUTPUT #1 to the relay, connect the positive station battery lead to TB1-1 and the lead to the relay to TB1-2.

To send OUTPUT #2 to the relay, connect the positive station battery lead to TB1-4 and the lead to the relay to TB1-5.

Connecting an Electro-Mechanical Relay

For an electro-mechanical relay system, you have six connection options, depending on the (dc) voltage of your station battery and the desired output. Table 15-2 on the following page shows the correct terminal connections, jumper settings, and external resistor requirements for each connection option. The external resistors are provided on all sets supplied with this module.

Table 15–2. Output Table.

For use with Microprocessor-based Relays						
1 Amp Switched Transistor Output		Terminal Connections OUTPUT #1	Terminal Connections OUTPUT #2			
		TB1-1 (+) & TB1-2		TB1-4 (+) & TB1-5		
For use with Electro-Mechanical Relay Systems						
Carrier Aux Relay	Battery Voltage (Vdc)	External Resistor (Ω /watts)	Terminal Connections OUTPUT #1	JU1 Pos.	Terminal Connections OUTPUT #2	JU2 Pos.
20mA (2200 Ω)	48	none required	TB1-1 (+) & TB1-3	48	TB1-4 (+) & TB1-6	48
20mA (2200 Ω)	125	3500/5	TB1-1 (+) & TB1-8	125/250	TB1-4 (+) & TB1-9	125/250
20mA (2200 Ω)	250	9200/10 & 500/40	TB1-1 (+) & TB1-8	125/250	TB1-4 (+) & TB1-9	125/250
200mA (25 Ω)	48	none required	TB1-1 (+) & TB1-3	48	TB1-4 (+) & TB1-6	48
200mA (25 Ω)	125	none required	TB1-1 (+) & TB1-3	125/250	TB1-4 (+) & TB1-6	125/250
200mA (25 Ω)	250	500/40	TB1-1 (+) & TB1-8	125/250	TB1-4 (+) & TB1-9	125/250

15.1.3 PC Board

The schematic for the Receiver Output Module's PC board is shown in Figure 15-4. The board has two jumpers labeled JU1 and JU2. If you are using electro-mechanical type relays, these jumpers must be set to match the station battery voltage for the relay circuit(s), see figure 15-3 for the jumpers' locations.

The options for jumpers JU1 & JU2, which you set as part of the circuit for OUTPUT #1 & #2, are:

- 48Vdc
- 125/250Vdc

Both jumpers have the same options.

15.2 Circuit Description

The Receiver Output Module provides the appropriate outputs from the carrier set to both microprocessor based and electro-mechanical type relays. The relay circuits may operate from voltage sources between 40 and 300Vdc.

This module is driven by the Universal Receiver module(s) at pins A/C-26 (+) and A/C-28 (–). The module's two optical isolators (U1 and U2) provide the following outputs, which are available depending on the output connection (see Table 15-2):

- 20mA
- 200mA
- 1A switched

Optical isolators U1 and U2 turn on together and share the following characteristics:

Isolation voltage: 7,500Vdc

Transistor rating: 400Vdc

The input from A-26 and A-28 energizes both optical isolators (U1 and U2). This initiates the circuit flow for both of the module's outputs. As described below, the two output circuits are virtually the same.

OUTPUT #1 Circuit Flow

The output from optical isolator U1 drives transistor Q1 to the ON state, which in turn drives transistor Q3 to the ON state. Transistor Q3 provides a 1A output on A-14 and C-14 and a 20mA/200mA output on A-16 and C-16, with the station battery tied to A-12 and C-12.

Resistor R2, capacitor C1, and metal oxide varistors M02 and M03 provide circuit protection against surges coming in from the outside world. Diode D1 provides reverse voltage protection — in case the outputs are connected backwards.

OUTPUT #2 Circuit Flow

The output from optical isolator U2 drives transistor Q2 to the ON state, which in turn drives transistor Q4 to the ON state. Transistor Q4 provides a 1A output on C-20 and a 20mA/200mA output on A-22 and C-22, with the station battery tied to C-18.

Resistor R1, capacitor C2, and metal oxide varistors M01 and M04 provide circuit protection against surges coming in from the outside world. Diode D2 provides reverse voltage protection — in case the outputs are connected backwards.

15.3 Troubleshooting

You can ensure the Receiver Output Module is getting the proper input from the Receiver/AM Detector module(s) by using the "Input Test" procedure described here. To make sure the module's outputs are correct, use the "Output Tests" procedure. To isolate and check faulty components, you can use your normal troubleshooting techniques.

15.3.1 Input Test

Use this procedure to verify that the Receiver Output Module is getting the proper input from the Receiver/AM Detector module(s). You will need the following:

- Extender board
- Digital volt meter

Preliminary Steps

1. Connect a power supply source (48, 125, or 250Vdc) to the following rear panel terminals attached to the Receiver Output Module (with reference to TB7-2):
 - OUTPUT #1: TB1-1 (+)
 - OUTPUT #2: TB1-4 (+)
2. Place the Receiver Output Module on an extender board (see Figure 4-1).
3. Connect the digital volt meter to pins A/C-26 (+) and C-28 (-).

Input Test Procedure

Check the input coming from the Receiver/AM Detector module(s) at pins A/C-26 (+) and C-28 (-); potential voltage should be +10Vdc.

1. Using the digital volt meter, measure the voltage level at pins A/C-26 (+) and C-28 (-). The potential voltage should be +10Vdc.
2. Disconnect the digital volt meter.
3. Re-install the Receiver Output Module.

15.3.2 Output Tests

Table 15–3. Receiver Output.

Use these tests to verify that the Receiver Output Module is providing the correct outputs for the relay system(s). You will need the following:

- Extender board
- Signal Generator (H/P 3325A)
- Fluke 75 (or equivalent) current meter
- Digital volt meter

Preliminary Steps

1. Remove the Keying Module from the chassis.
2. Connect a power supply source (48, 125, or 250Vdc) to the following rear panel terminals attached to the Receiver Output Module (with reference to TB7-2):
 - OUTPUT #1: TB1-1 (+)
 - OUTPUT #2: TB1-4 (+)
3. Connect the Signal Generator (H/P 3325A) to the chassis at the UHF RF Input jack (J1) on the rear panel.
4. Place the Receiver Output Module on an extender board (see Figure 4-1).

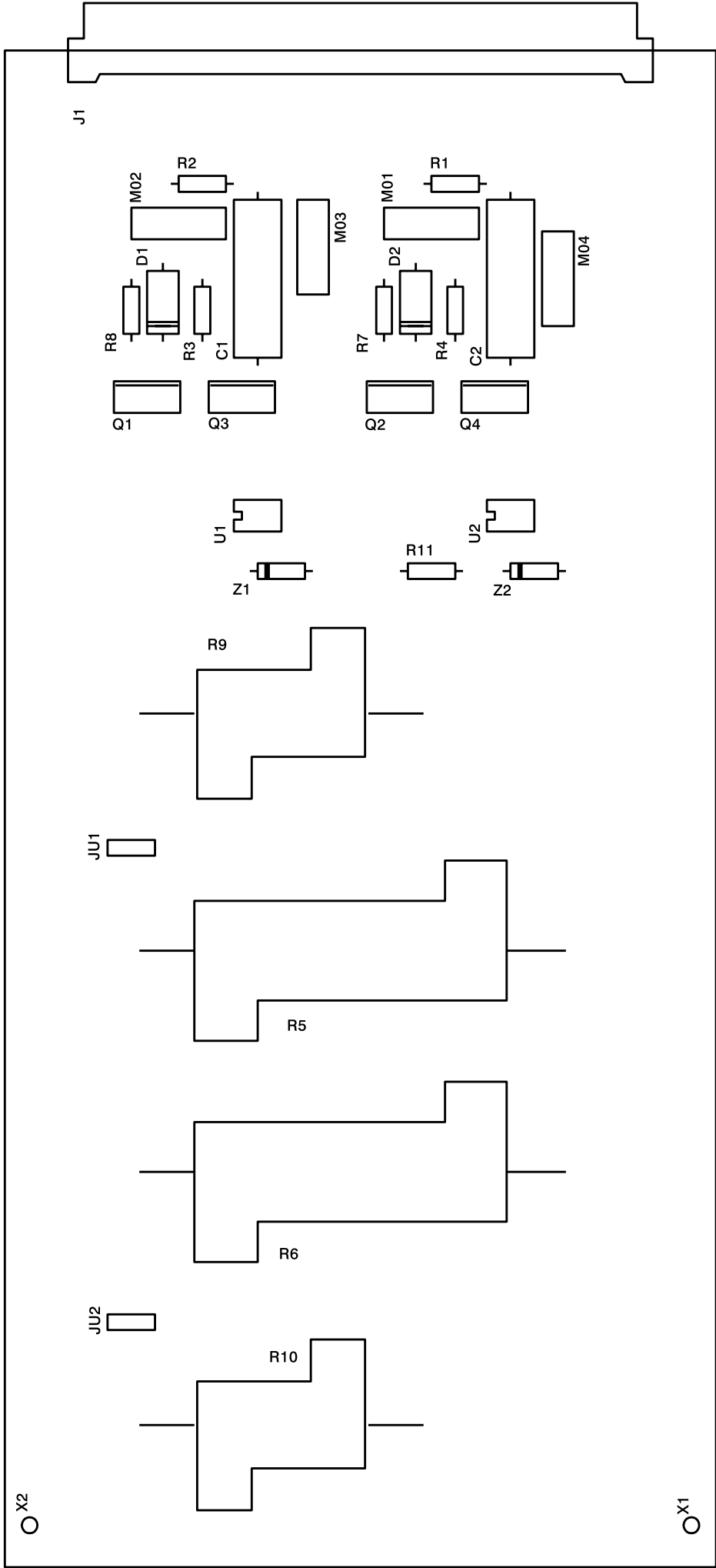
Output Test Procedure

1. Set the Signal Generator to 250 kHz, at a level between 150 and 250mVrms (The DETECT LED should be on.)
2. Use the digital volt meter to measure the voltage level at TB1-2 with TB7-2 as a reference. This voltage should be the same as the power supply source (48, 125, or 250Vdc). Also, measure the voltage level at TB1-6 with TB7-2 as a reference. This should be the same as the power supply source (48, 125, or 250Vdc).

Terminal	Resistor Load Value (ohms/watt)	Battery Voltage (Vdc)	JU1/JU2 Position	Current limit (mA)
OUTPUT #1				
TB1-3	2200/2	48	48	20
TB1-8	2200/2	125	125/250	20
TB1-8	2200/2	250	125/250	20
TB1-3	25/5	48	48	200
TB1-3	25/5	125	125/250	200
TB1-8	25/5	250	125/250	200
OUTPUT #2				
TB1-6	2200/2	48	48	20
TB1-9	2200/2	125	125/250	20
TB1-9	2200/2	250	125/250	20
TB1-6	25/5	48	48	200
TB1-6	25/5	125	125/250	200
TB1-9	25/5	250	125/250	200

3. Remove the input signal, ensuring that the output level drops out.
4. Load down the output by connecting the appropriate resistor, as shown in Table 15-3.
5. Insert a current meter (Fluke 75 or equivalent) in the circuit by connecting the meter across the open switches on the card extender for pins C/A 16 for OUTPUT #1 and C/A 22 for OUTPUT #2.
6. Current readings should be 16 to 30 mAdc for a 2,200 Ω resistor and 160 to 230 mAdc for a 25 Ω resistor.
7. Disconnect the Signal Generator from the jack (J1) on the rear panel.
8. Re-install the Keying Module.

Figure 15-3. TC-10B Receiver Output PC Board. (CC50RXSM)



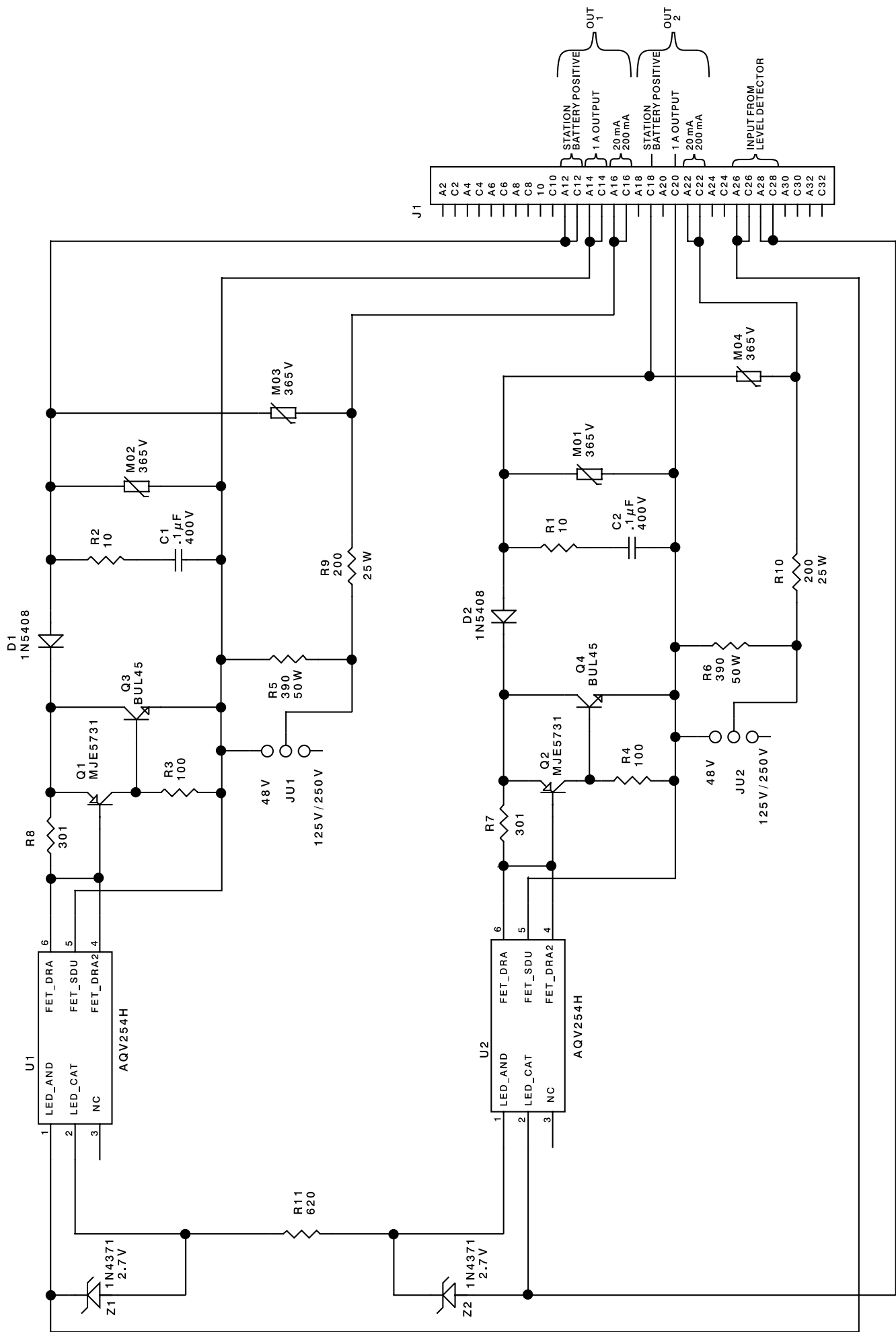


Figure 15-4. TC-10B Receiver Output Schematic. (CC30RXSM)

Chapter 16. Universal Checkback Module

Table 16–1. Universal Checkback Module Style and Description.

Schematic:	CC30-UCBMN
Parts Lists:	CC40-UCBMN

Style Number	Description
CC20-UCBMN-001	Universal Checkback/PC programmable

16.1 Universal Checkback Module Description	16-2
16.1.1 Operating Controls	16-3
16.1.2 System Assemblies	16-4
16.1.3 System Configuration	16-5
16.1.4 Front Panel	16-6
16.1.4.1 PC Interface	16-6
16.1.4.2 Front Panel Switches	16-6
16.1.4.3 Front Panel LEDs	16-7
16.1.5 Rear Panel Connections	16-7
16.1.5.1 Inputs	16-7
16.1.5.2 Outputs	16-8
16.1.6 PC Board	16-9
16.2 Installation and Setup	16-9
16.3 Communicating through the Front Panel	16-13
16.4 Communicating through the Rear Panel	16-14
16.5 Using Your PC to Communicate with the Universal Checkback Module	16-14
16.5.1 Establishing Communications	16-15
16.5.2 Configuration Settings	16-17
16.5.16.1 Enabling the Custom Settings Option	16-17
16.5.16.2 Setting Descriptions	16-18
16.5.3 Performing Checkback Tests	16-23
16.5.3.1 Physical Switch Request	16-23
16.5.3.2 Manual Request from Your PC	16-23
16.5.3.3 Automatic Timed Test	16-23
16.5.3.4 Automatic Periodic Test	16-23
16.5.3.5 Automatic Carrier Recovery	16-24
16.5.3.6 Remote-Initiated Periodic Tests	16-24
16.5.3.7 Remote-Initiated Timed Tests	16-25
16.5.4 Checkback Test Options	16-25
16.5.4.1 Keyed Carrier Timed Tests	16-26
16.5.4.2 Encoded Carrier Tests	16-26
16.5.4.3 Primary and Fallback Communications Modes	16-26
16.5.4.4 Communication Retries	16-26
16.5.5 Issuing Checkback Commands	16-26
16.5.5.1 Set Commands	16-29
16.5.5.2 Get Commands	16-34
16.5.5.3 Clear Commands	16-35
16.5.5.4 Action Commands	16-35
16.5.5.5 Logon/Logoff Commands	16-36
16.5.5.6 Help Commands	16-36
16.5.6 Distant Checkback Communications	16-37
16.5.6.1 Limitations and Concerns	16-37
16.5.7 Recovering Your Lost Password	16-37
16.5.8 Checkback Command Quick Reference	16-38
16.6 Troubleshooting	16-42
16.7 Drawings	16-42

16.1 Description

The Universal Checkback Module provides various ways to automatically or manually test the carrier channel. This new version of the module is a microprocessor-based design that can function either as a master or remote unit. It replaces the master (style numbers 1606C37G01 and 1606C37G02) and remote (style number 1606C38G01) Checkback Modules used in older systems. The module is designed for use both with the TC-10B "ON/OFF" carrier system and with other "ON/OFF" carrier systems using a UCBS. Its major features include:

- PC interface for controlling settings and operation
- On-line help
- User selectable encoded or timed carrier operation
- Three user programmable outputs
- Optional timed communication fallback
- Optional low power tests
- Optional carrier recovery
- Automatic checkback tests done either periodically or at user-specified times
- Loopback test capability
- Remote communications
- Automatic clock synchronization

PC Interface for Controlling Settings and Operation

You can control the module (and any other Universal Checkback Module in the network) by connecting your PC or laptop to the RS-232 interface on the module's front panel. If a PC or laptop is unavailable to the user then the on-board DIP switch can be used to select the standard factory settings.

On-line Help

Valid commands and features are displayed when you enter "help" on the command line. You can get help at the level you need, from general help to command-specific help.

Encoded or Timed Carrier Operation

The Universal Checkback Module lets you set your communication to a simple keyed on/off timed carrier or a more powerful encoded data message.

Optional Timed Communication Fallback

The Primary Communication mode is initially used for checkback tests. If the primary mode is "encoded" and it fails and Timed Fallback Communication is enabled, the module attempts one more try using a simple timed communication mode. If that succeeds, the module only issues a minor alarm.

Optional Low Power Tests

When enabled, the Universal Checkback Module performs checkback tests at both high and low power. The module issues a minor alarm if only the low power test fails, and a major alarm if the high power test fails.

Optional Carrier Recovery

When enabled, the Universal Checkback Module starts "carrier recovery mode" after a failed checkback test. In carrier recovery mode, the "master" module initiates a checkback test using a more frequent user interval, for example, every 15 minutes. After three consecutive successful checkback tests, the "master" reverts to normal operation and sets the "carrier recovery output". Remotes in carrier recovery mode suspend all checkback tests and wait until they receive three good checkback tests from the "master". At that time they also resume normal operation.

Automatic Checkback Tests done Periodically or at User-Specified Times

You can set the "master" checkback module to perform automatic checkback tests after the interval you specify has elapsed (e.g., six hours), or at each of four specific times (e.g., 1:00, 13:00, 5:00, and 23:00). These four times specify the hour during which you want an automatic checkback test to occur.

Loopback Test Capability

You can command a distant checkback module to energize its carrier for a duration you specify (e.g., 30 seconds), giving you time to set your local receiver's sensitivity or perform other tasks. Loopback tests are performed at both high and low power. In this case, the carrier is keyed on high power for 30 seconds, then low power for 30 seconds.

Remote Communications

You can access a distant checkback module while connected to any checkback module in the network. This lets you get settings, events and counts, and allows you to change a module's settings, clear events, etc. from a module many miles away.

Automatic Clock Synchronization

When enabled, the "master" checkback module synchronizes the clocks of all remotes in the network starting at 12:30 a.m.

16.1.1 Operating Controls

Unlike previous versions of the checkback module, the Universal Checkback Module has just one jumper, JMP1, which is reserved for future use. Instead, the module provides the following configuration and control options:

- A DIP switch that lets you select either one of four factory preset configurations or a "CUSTOM" option that allows you to set your own configuration
- Front panel switches that let you initiate checkback and loopback tests, clear alarms and the carrier recovery mode, and enable or disable the automatic testing functions
- Rear panel input connections that let you connect external switches to perform the same functions as the front panel switches
- A standard RS-232 (DB9 female) PC interface that lets you control the settings and operation of the module - as well as the other modules in the network - from your PC



CAUTION

Care should be taken when inserting or removing modules from the UCBS chassis. Modules should not be inserted or removed while the chassis has power supplied to it.

Figure 16-1 provides a simplified look at the module's function as part of a UCBS. The UCBS Power Supply/Interface Module, after receiving checkback data from another carrier set, sends it to the Universal Checkback Module. You can also send, or input, data directly to the module through the "input" connections on the rear panel or, using your PC, through the RS-232 interface connection on the module's front panel. Regardless of the method of input, the module responds to the incoming data as it is configured to do. The module outputs its data back through the UCBS Power Supply/Interface Module. The module also has five output connections, located on the rear panel. Two of these are permanently set to MAJOR ALARM and MINOR ALARM. You can configure the remaining three with one of five choices:

- Delayed alarm
- Test in progress
- Successful test
- Successful carrier recovery
- Disable automatic tests

16.1.2 System Assemblies

To test the carrier signal for a TC-10B carrier system, or network, install a Universal Checkback Module in the "Checkback" slot of each TC-10B chassis in the network. For other "ON/OFF" carrier systems, install a Universal Checkback Module in each "Universal Checkback Standalone (UCBS)" chassis in the network.

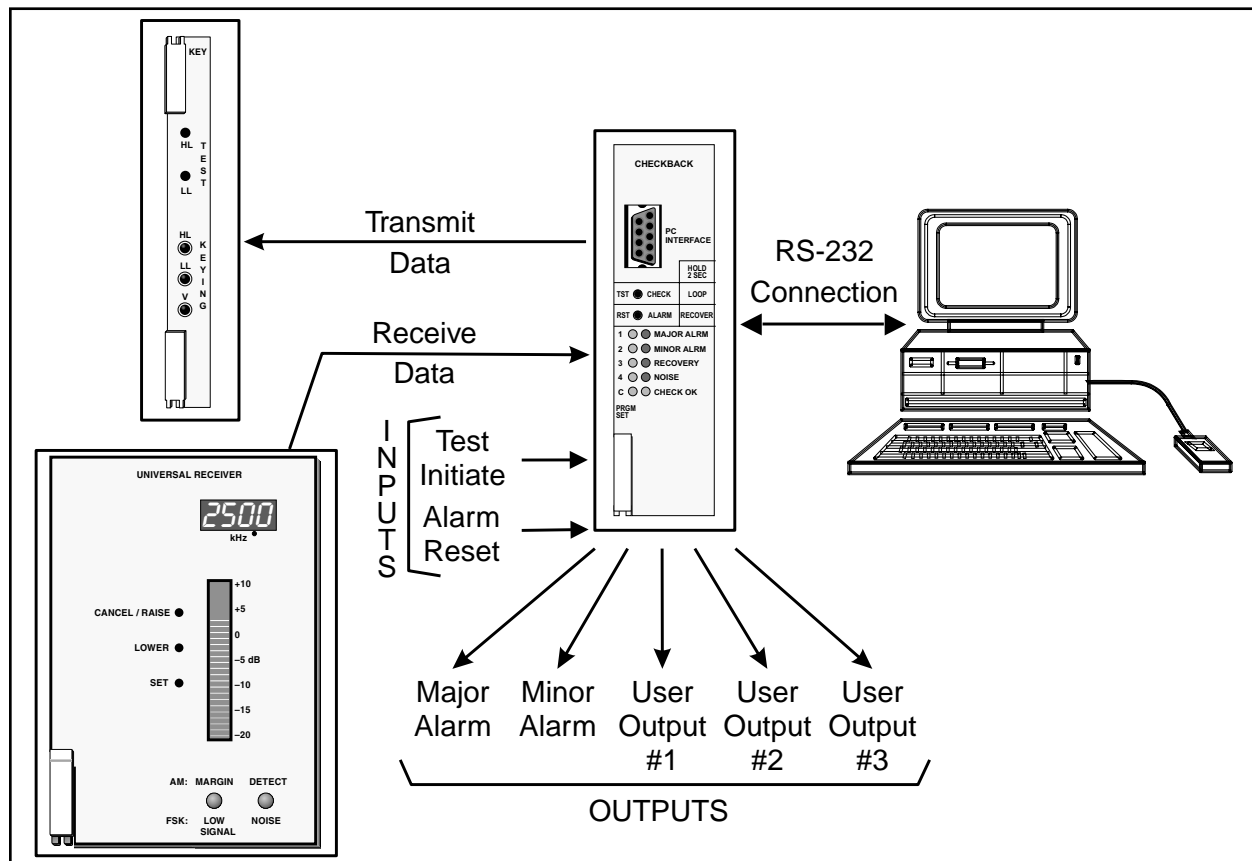


Figure 16-1. Universal Checkback as part of a TC-10B

16.1.3 System Configuration

The simplest network configuration for the Universal Checkback Module comprises two modules: one designated as the master; the other as the remote. The maximum number of modules you can have in a network depends on their Primary Communication Mode setting. This setting may be either "timed" or "coded". With the "timed" setting, you can have up to five checkback modules in a network,; one master and four remotes, as shown in Figure 16-2. With the "coded" setting, you can have up to eleven checkback modules in a network: one master and ten remotes, as shown in Figure 16-3.

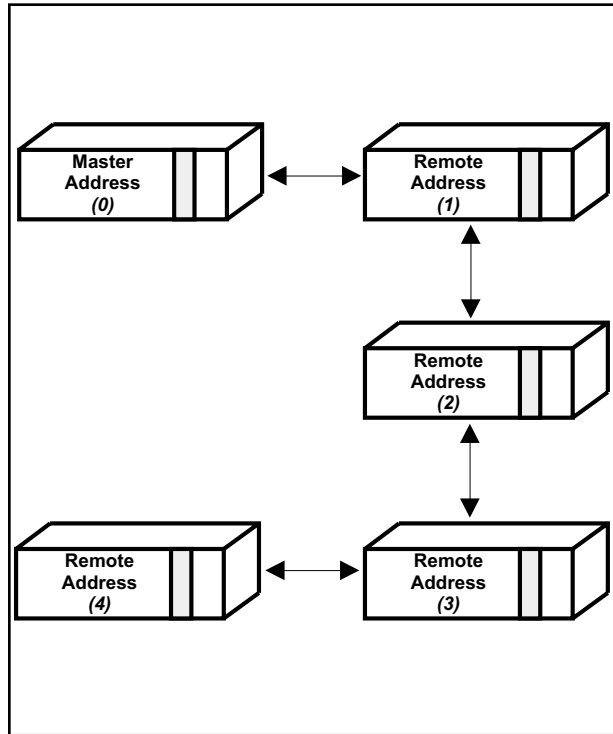


Figure 16–2. Maximum Checkback Configuration with Timed Communications Mode

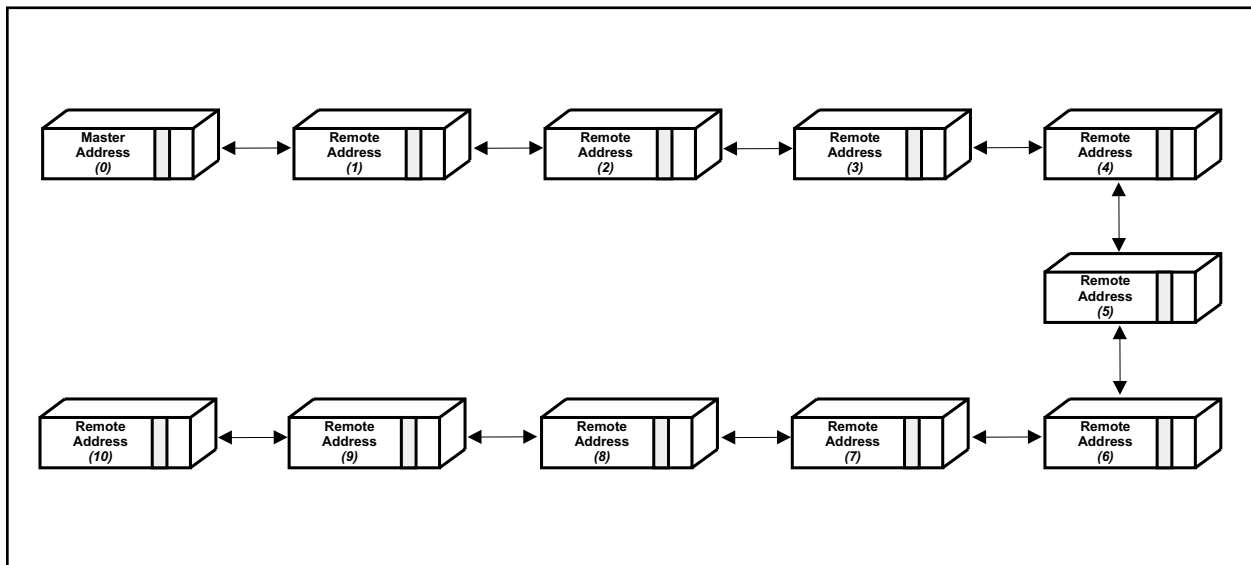


Figure 16–3. Maximum Checkback Configuration with Coded Communications Mode

16.1.4 Front Panel

The front panel (see Figure 16-4) of the Universal Checkback Module has a PC connector, two momentary switches, and ten LEDs. All of these are described later in this chapter.

16.1.4.1 PC Interface

The top of the front panel has a DB9 female connector labeled "PC INTERFACE" (see Figure 16-4). This connector is provided so that you can plug in a serial cable connected to a serial communication port on your PC or laptop. This should be a standard cable without a null modem. Once connected, you can control the module (and any other Universal Checkback Modules in the network) from your PC or laptop. For complete information on using your PC to control the module, please see the "Using Your PC to Communicate with the Universal Checkback Module" section later in this chapter.

16.1.4.2 Front Panel Switches

Just beneath the PC interface on the front panel are two recessed, momentary switches labeled "TST" and "RST" (see Figure 16-4). As shipped from the factory, the simplest way to interface with the Universal Checkback Module is through these two switches. You can use the top switch ("TST") to initiate tests and the bottom ("RST") for clearing data or canceling the carrier recovery mode. Here is how they work:

TST (TEST) Pressing and releasing this switch initiates a checkback test. Pressing and holding this switch for at least two seconds initiates a loopback test.

RST (RESET) Pressing and releasing this switch clears any (major or minor) alarms. Pressing and holding this switch for at least two seconds clears the carrier recovery mode.

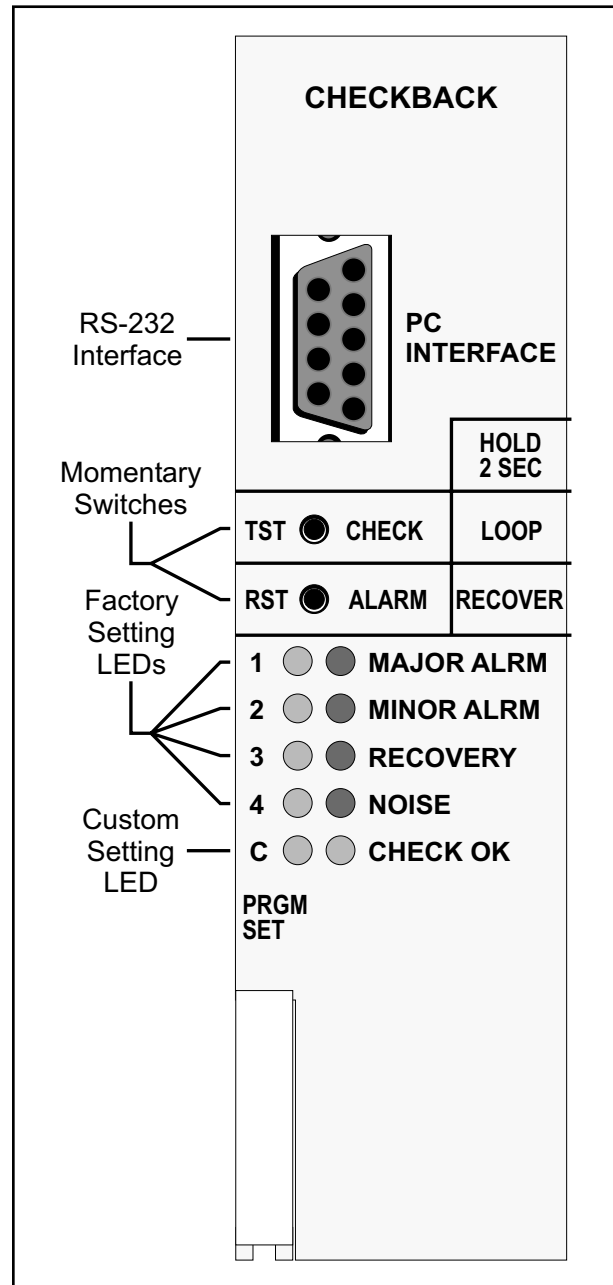


Figure 16-4. Universal Checkback Module — (Front panel Controls and Indicators)

TST+RST Pressing and releasing both switches simultaneously toggles the automatic test state. For example, if auto tests are enabled, they become disabled. They are re-enabled after you press these two again. Note that when you disable automatic testing, all front panel LEDs, except the one labeled "CHECK OK" and the one representing the active settings option, begin to flash. When you press the switches again and re-enable automatic testing, the LEDs stop flashing.

16.1.4.3 Front Panel LEDs

The module's front panel has ten LEDs. When you first power up the module, all ten LEDs flash momentarily. After that, they all go off, except the green LED on the left that indicates the current DIP switch settings. The LEDs work as follows:

LED	Function
1	When lit, this green LED indicates that the module's DIP switch is set to Factory Preset #1.
2	When lit, this green LED indicates that the module's DIP switch is set to Factory Preset #2.
3	When lit, this green LED indicates that the module's DIP switch is set to Factory Preset #3.
4	When lit, this green LED indicates that the module's DIP switch is set to Factory Preset #4.
C	When lit, this green LED indicates that the module's DIP switch is set to Custom Settings Enabled.

MAJOR ALRM—When lit, this red LED indicates that the module has failed the high power (10W) checkback test.

MINOR ALARM—When lit, this red LED indicates that the module has failed the low power (1W) checkback test.

RECOVERY—When lit, this red LED indicates that the module is in carrier recovery mode (after a failed checkback test).

NOISE—When flashing, this red LED indicates that the module has experienced a high number of spurious messages within a two-minute period.

CHECK OK—When lit, this green LED indicates that the most recent checkback test (since the module was activated) was successful. When not lit, it indicates either that the most recent checkback test was not successful or that no checkback test has occurred since the module was activated.

16.1.5 Rear Panel Connections

The module's rear panel terminal block connections are shown in Figure 3-5 and Figure 3-6. As described below, the module has both input and output connections.

16.1.5.1 Inputs

TB7-5(+) & TB6-2(-)

EXT. ALARM RESET—Momentarily closing the switch connected here clears any (major or minor) alarms. Closing the switch connected here for more than two seconds clears the module from carrier recovery mode.

TB6-1(+) & TB6-2(-)

EXT. TEST INITIATE—Momentarily closing the switch connected here initiates a checkback test. Closing the switch connected here for more than two seconds initiates a loopback test.

Note that closing both of the connected switches above at the same time toggles the module's automatic test state setting. For example, if auto tests are enabled, they become disabled. They are re-enabled after you close these two again. Note that when you disable automatic testing, all front panel LEDs, except the one labeled "CHECK OK" and the one representing the active settings option, begin to flash. When you press the switches again and re-enable automatic testing, the LEDs stop flashing.

16.1.5.2 Outputs

Although all checkback module outputs are actually solid state circuits, you can configure each of the five outputs to be either a normally open or a normally closed relay output. The module's Energized State setting (see *"Using Your PC to Communicate with the Universal Checkback Module"* later in this chapter) shows what an output does when its condition is true. For example, if a module fails a high power checkback test, it sets the major alarm. If you've programmed the MAJOR ALARM output to close when energized, this output closes immediately after the module fails the checkback test. After the module has passed a test, this output opens.

The MAJOR ALARM and MINOR ALARM outputs described below are permanently set. You can configure the remaining three with one of five choices:

Delayed Alarm—(Output set after a module fails to recover from auto recovery before the Carrier Recovery Window expires.)

Test In Progress—(Output set by the module initiating a checkback test for the duration of the test.)

Successful Test—(Output set after passing a checkback test.)

Successful Carrier Recovery—(Output set for one second after a successful recovery from automatic recovery mode.)

Disable Automatic Tests—(Output set when the user has disabled automatic checkback tests.)

You can program the two alarm outputs to seal or just momentarily toggle when an alarm occurs. When you select sealed operation, the alarm outputs stay in their true, or energized, states as long as the alarm exists. If you select momentary, the outputs go to their true states for only five seconds, then return to their previous states. For example, assume alarms are set to momentary action and the major alarm active state is closed. Normally this output is open. When a major alarm occurs, the MAJOR ALARM output closes for five seconds then opens again. The MAJOR ALARM output does not change (again) when the major alarm is cleared.

TB6-3(+) & TB6-4(-)

MAJOR ALARM—This output is energized (i.e., opened or closed) when the module fails a high power (10W) checkback test. If it is set for sealed operation, the output returns to its un-energized state when the module passes a high power checkback test. If it is set for momentary operation, it returns to its un-energized state after five seconds.

TB6-5(+) & TB6-6(-)

MINOR ALARM—This output is energized (i.e., opened or closed) when the module fails a low power (1W) checkback test. If it is set for sealed operation, the output returns to its un-energized state when the module passes a low power checkback test. If it is set for momentary operation, it returns to its un-energized state after five seconds.

TB6-7(+) & TB5-7(-)

USER DEFINED 1—This output is energized when the condition (one of the five listed above) you have programmed it to monitor becomes true. It remains energized until the condition is no longer true. It then reverts to its former state.

TB6-8(+) & TB5-8(-)

USER DEFINED 2—This output is energized when the condition (one of the five listed earlier) you have programmed it to monitor becomes true. It remains energized until the condition is no longer true. It then reverts to its former state.

TB6-9(+) & TB5-9(-)

USER DEFINED 3—This output is energized when the condition (one of the five listed earlier) you have programmed it to monitor becomes true. It remains energized until the condition is no longer true. It then reverts to its former state.

16.1.6 PC Board

The component layout for the Universal Checkback Module's PC board is shown in Figure 16-11. The module's PC board does not have any operator controls. The only "user" settings are those on the DIP switch labeled "SW3." This switch lets you select either one of four factory preset configurations or a "CUSTOM" option that allows you to set your own configuration, using a connected PC or laptop. For complete instructions on setting the DIP switch, please see the "Installation and Setup" section later in this chapter.

16.2 Installation and Setup

Typically, the Universal Checkback Module is already installed in the TC-10B Carrier set or

UCBS chassis when you receive it from the factory. By default, the module's DIP switch (SW3) is set to the Factory Preset #1 setting (see Table 16-3). If your Universal Checkback Module is already installed and the Factory Preset #1 setting is the configuration you want, skip the first three steps.

To install and configure a new Universal Checkback Module, complete the following steps.

Step 1. Unpack the module.

Open the carton and remove the Universal Checkback Module.

Step 2. Set the DIP switch.

The DIP switch, labeled "SW3", is on the bottom left of the Module's PC board. The module reads the switch's setting at power-up to determine its configuration. Any changes to the switch's setting after power-up are ignored until you turn the power off and on again.

Using Table 16-2 & Fig. 16-11 as guides, set the DIP switch to the desired setting. Note that only S1-S3 are used; S4 is reserved for future use. To set S1-S3, put them in the up position for OFF and the down position for ON. You can set the DIP switch to one of five possible configurations. All other switch combinations (of S1-S3) are invalid. If you mistakenly set a different combination, the module assumes the "CUSTOM" mode.

If you set the DIP switch to one of the factory preset settings, the module is locked into that configuration. You cannot then customize the

Table 16-2. Universal Checkback Module DIP Switch Settings.

S1	S2	S3	S4	Settings Option
off	off	off	not used	Custom Settings Enabled
on	off	off	not used	Factory Preset #1 Settings
off	on	off	not used	Factory Preset #2 Settings
on	on	off	not used	Factory Preset #3 Settings
off	off	on	not used	Factory Preset #4 Settings

Table 16-3. Factory Preset Configuration Options.

Setting	Factory #1	Factory #2	Factory #3	Factory #4
Address	Master	Remote #1	Master	Remote #1
Primary Comm	coded	coded	Timed	Timed
Fallback Time Mode	enabled	enabled	disabled	disabled
Last Remote	1	1	1	1
Interval Type	periodic	periodic	periodic	periodic
Auto Carrier Recovery	enabled	enabled	enabled	enabled
Auto Checkback Tests	enabled	enabled	enabled	enabled
Retries	3	3	3	3
Low Power Tests	enabled	enabled	enabled	enabled
User Output 1 Energized State	Closed	Closed	Closed	Closed
User Output 2 Energized State	Closed	Closed	Closed	Closed
User Output 3 Energized State	Closed	Closed	Closed	Closed
Major Alarm Energized State	Closed	Closed	Closed	Closed
Minor Alarm Energized State	Closed	Closed	Closed	Closed
User Output 1 Definition	delayed alarm	delayed alarm	delayed alarm	delay alarm
User Output 2 Definition	test in progress	test in progress	test in progress	test in progress
User Output 3 Definition	passed test	passed test	passed test	passed test
Alarm Output Action	sealed	sealed	sealed	sealed
Checkback Time 1	6:00	6:00	6:00	6:00
Checkback Time 2	12:00	12:00	12:00	12:00
Checkback Time 3	18:00	18:00	18:00	18:00
Checkback Time 4	0:00	0:00	0:00	0:00
Checkback Period	8 hours	8 hours	8 hours	8 hours
Loopback Duration	20 sec.	20 sec.	20 sec.	20 sec.
Carrier Recovery Period	60 min.	60 min.	60 min.	60 min.
Carrier Recovery Window	3 hours	3 hours	3 hours	3 hours
Automatic Clock Sync	enabled	enabled	enabled	enabled

settings. The four factory preset configurations are shown in Table 16-3. For descriptions of the individual settings, please see the "Configuration Settings" section later in this chapter.

If you set the DIP switch to the "CUSTOM" option, you can use your PC or laptop to configure the module any way you want. (See "Using your PC to Communicate with the Universal Checkback Module" for complete configuration instructions.)

Step 3. Insert the module into the carrier chassis.

Power down your UCBS chassis. Carefully insert the Universal Checkback Module into the top and bottom grooves of the slot labeled "CHECKBACK". Lock it into place using the white inject/eject lever on the front of the module. Power up the chassis. After a few seconds, all Checkback LEDs come on. Within a second, they all turn off except for one of the five DIP switch LEDs. This LED indicates which configuration the DIP switch is set to (see "Front Panel LEDs" earlier in this chapter).

Step 4. Connect your computer and establish communications.

Connect one end of a standard serial cable to the serial communications port on your computer and the other end to the DB9 (female) connector labeled "PC INTERFACE" on the module's front panel (see Figure 16-4). You don't need a null modem here, just a simple, straight cable.

Start a terminal emulation communication program (e.g., "Hyper Terminal" in Windows '95/98/NT, "Winterm" in Windows 3.1, or "Procomm" in DOS). Set the program's communication parameters as follows:

- Bits per second (data rate) = 9600
- Data bits (per word) = 8
- Stop bits = 1
- Parity = none
- Flow control (handshaking) = none

Because these are very common settings, you may only have to set the first one, bits per second (data rate).

Once you are connected, and the communication program is set correctly, the module should return some information. Your computer screen should look something like the one in Figure 16-5.

```

+-----+ Locally Logged on to 1 +-----+
| Bad Msg Rate: 0 | | 10:44:16 12/10/1998 |
| Normal Noise | | Periodic Time: 0:02:10 |
+-----+ +-----+

Remote 1 Checkback Module Configuration
Primary Comm. Mode: Coded Fallback Timed Comm: Enabled Last Remote:
1
Interval Type: Periodic Carr Recovery: On Retries: 3 Auto Tests: On
DIP Switch: Custom - Settings match: Factory 2 Low Power Tests: Enabled

Outputs Energized State User Definition Alarm Action
User defined 1 Close Test in Progress Sealed (fixed)
User defined 2 Close Delayed Alarm Sealed (fixed)
User defined 3 Close Successful Test Sealed (fixed)
Major Alarm Close ---- Sealed
Minor Alarm Close ---- Sealed

Checkback Time 1-4: 6:00, 12:00, 18:00, 0:00 - Inactive
Checkback Period: 8 hours Loopback Duration: 20 secs
Carrier Recovery Period: 60 mins Carrier Recovery Window: 3 hours
Auto Sync Time: Enabled Clock: 10:44:35 12/10/1998

Enter command:

```

Figure 16-5. Initial Communication with the Checkback Module.

The box in the upper left corner gives some idea of the amount of noise on the carrier line. When a checkback module receives a spurious message, it is usually due to line noise. The "Bad Msg Rate" shows how many spurious messages a module has seen in the last fifteen seconds. Also, the front panel LED labeled "NOISE" flashes if a module has seen a high number of spurious messages within a two-minute period. If the noise level gets too high, you will have problems communicating between checkback modules, and non-checkback communications may be affected as well.

The box in the upper right corner shows the module's current time and date. Beneath that you can see the amount of time elapsed since the last checkback test was sent or received. This timer is reset when a module is powered up.

If your screen seems to display part of the above information but contains garble, you probably started your communication program right in the middle of the checkback module saying something. To clean it up, clear the screen on your computer and give the checkback module a couple of seconds to redisplay.

At the password prompt (Enter password:), enter your password and press the ENTER key. The default password is "pulsar".

After you enter your password, the module displays the general settings on your computer screen. The module you are logged on to is identified at the top of the screen. Figure 16-6 shows a sample configuration.

Step 5. Set the password.

Now is a good time to set your own password. You can change the password at any time using the "set password" command (see *"Issuing Checkback Commands"* later in this chapter for complete instructions). Passwords can be from 0 to 10 characters long and are not case sensitive. That is, the module sees no difference between "ABC" and "abc". You can use both numbers and letters in a password, e.g., "abc123".

To change the password from "pulsar" to "mypassword", for example, type the following on the command line (Enter command:) and press the ENTER key:

set pwd mypassword

After you enter your new password once (or no password) the checkback module asks you to re-enter it for verification. When you re-enter it, the module completes the password change and tells you "Command Accepted".

Setting a password to nothing (i.e., just entering set pwd and pressing the ENTER key, then responding to the verification prompt by pressing ENTER again) disables the password system. Then just the ENTER key or any entry becomes a valid password. If you disable the password, the module flashes this warning: "Note: password will be disabled for this module".

If you later forget what the password is, see the *"Recovering Your Lost Password"* section 16.5.7 later in this chapter.

```

+-----+   Locally Logged on to 1   +-----+
| Bad Msg Rate: 0 |   | 10:44:16   12/10/1998 |
| Normal Noise   |   |   Periodic Time: 0:02:10 |
+-----+   +-----+
Event 1) Communications Error   11/24/1998 Time: 12:58:49.026

Enter command:
    
```

Figure 16-6. Sample Checkback Module Configuration.

Step 6. Set the time.

Set the module's time using the "set clock" command. For example, if the current time is 3:45:13 in the afternoon, type this and press the ENTER key:

```
set clock 15:45:13
```

Step 7. Set the date.

Set the module's date using the "set date" command. You *must* enter a four-digit year. For example, if today's date is December 10, 2000, type this and press the ENTER key:

```
set date 12/10/2000
```

Step 8. Adjust other settings if needed.

At this point you can modify any other settings that are specific to your system, if the DIP switch is set to the "CUSTOM" setting. (See the *"Using Your PC to Communicate with the Universal Checkback Module"* and *"Configuration Settings"* sections later in this chapter.)

Step 9. Initiate a manual checkback test.

If you have already installed another module in the system, and both are set, you can initiate a manual checkback test. Just press the upper momentary switch (labeled "TST") on the module's front panel. It does not matter if you are at a master or a remote; any module can initiate a checkback test. This final step proves whether the communications channel between all active modules is working.

Once you have set up your checkback modules, they may not need much attention. They will perform their automatic checkback tests for a long time without any special input from you. Sometimes, however, there may be a problem, or you may want to run special tests requiring you to interface with a checkback module. You can do that in one of three ways:

- Front panel switches

- Rear panel inputs
- Your PC or laptop computer

The following sections tell you how to use these three methods of communicating with the Universal Checkback Module.

16.3 Communicating through the Front Panel

As shipped from the factory, the simplest way to interface with a Universal Checkback Module is through the two momentary switches on the front panel. The top switch is used to initiate tests and the bottom for clearing data or canceling the carrier recovery mode. The instructions are simple:

To initiate a checkback test manually: Press and release the top switch (TST).

To request a loopback test: Press and hold the top switch (TST) for at least two seconds.

To clear alarms: Press and release the bottom switch (RST).

To clear "carrier recovery mode": Press and hold the bottom switch (RST) for at least two seconds

To enable/disable the automatic testing functions: Press both switches simultaneously. (This toggles the automatic test state. When you disable automatic testing, all front panel LEDs, except the one labeled "CHECK OK" and the one representing the active settings option, begin to flash. When you press the switches again and re-enable automatic testing, the LEDs stop flashing.)

16.4 Communicating through the Rear Panel

An alternative method of communicating with the Universal Checkback Module is through its rear panel. You can connect two external "input" switches to the rear panel (see "*Rear Panel Connections*" earlier in this chapter). You can use these switches to perform the same functions as the module's own front panel switches. Here is how:

To initiate a checkback test manually:

Close and quickly open the switch connected to TB6-1 & TB6-2.

To request a loopback test: Close for at least two seconds the switch connected to TB6-1 & TB6-2.

To clear alarms: Close and quickly open the switch connected to TB7-5 & TB6-2.

To clear "carrier recovery mode": Close for at least two seconds the switch connected to TB7-5 & TB6-2.

To enable/disable the automatic testing functions: Close both switches simultaneously. (This toggles the automatic test state. When you disable automatic testing, all front panel LEDs, except the one labeled "CHECK OK" and the one representing the active settings option, begin to flash. When you press the switches again and re-enable automatic testing, the LEDs stop flashing.)

16.5 Using Your PC to Communicate with the Universal Checkback Module

The most comprehensive method of communicating with the Universal Checkback Module is through the PC interface on its front panel. The amount of control you have over the module with this method of communication depends on the module's DIP switch setting. As noted earlier (see "Installation and Setup" earlier in this chapter), the DIP switch setting can be one of four factory presets or a "CUSTOM" option. (See "Installation and Setup" earlier in this chapter for more detail.)

If you select one of the factory presets, you can still issue all the "non-setting" commands to the module (e.g., checkback tests, clearing alarms). As for the setting commands themselves, you will only be able to use the following:

- Set password
- Set date
- Set clock

Selecting the "CUSTOM" option, on the other hand, allows you to change any setting at will.

The following sections tell you how to establish communications with the checkback modules in your network, configure their settings, perform checkback tests, issue checkback commands, and even recover your password if you forget it.

16.5.1 Establishing Communications

Once the Universal Checkback Module is installed (see *"Installation and Setup"* earlier in this chapter), establishing communications is simple. First, connect one end of a standard serial cable (no null modem) to the serial communications port on your computer and the other end to the DB9 (female) connector labeled "PC INTERFACE" on the module's front panel. Then, start a terminal emulation communication program (e.g. Hyperterminal) with the following communication parameters:

- Bits per second (data rate) = 9600
- Data bits (per word) = 8
- Stop bits = 1
- Parity = none
- Flow control (handshaking) = none

Once you are connected, the module should return the following information:

- Bad message rate
- Noise level
- Current date and time
- Elapsed time since the last checkback test

If your screen seems to display part of the above information but contains garble, you probably started your communication program right in the middle of the checkback module saying something. To clean it up, clear the screen on your computer (there should be some command or mouse click in the communications program to do this) and give the checkback module a couple of seconds to redisplay.

At the password prompt (Enter password:), enter your password and press the ENTER key. The default password is "pulsar".

After you enter your password, the module displays the general settings on your computer screen. The module you are logged on to is identified at the top of the screen.

If this is the first time you are communicating with the module, it is a good idea to set the password, time, and date, as well as any other settings that

require changing. (See *"Issuing Checkback Commands"* below for complete instructions).

You can change, or set, the password at any time using the "set password" command. For example, to change the password from "pulsar" to "mypassword", type the following on the command line (Enter command:) and press the ENTER key:

set pwd mypassword

After you enter your new password once, you are prompted to re-enter it for verification. When you re-enter it, the module completes the password change and tells you "Command Accepted".

Setting a password to nothing (i.e., just entering set pwd and pressing the ENTER key, then responding to the verification prompt by pressing ENTER again) disables the password system. Then just the ENTER key or any entry becomes a valid password. If you disable the password, the module flashes this warning: "Note: password will be disabled for this module".

If you later forget what the password is, see the *"Recovering Your Lost Password"* section later in this chapter.

To set the module's time, use the "set clock" command. For example, if the current time is 3:45:13 in the afternoon, type this and press the ENTER key:

set clock 15:45:13

To set the module's date, use the "set date" command. You *must* enter a four-digit year. For example, if today's date is December 10, 2000, type this and press the ENTER key:

set date 12/10/2000

At this point, you can modify any other settings (see *"Configuration Settings"* later in this chapter) that are specific to your system, if the DIP switch is set to the "CUSTOM" setting.

The Checkback Module is now waiting for your commands. These can include manual checkback requests, settings changes (see *"Customizing Settings"* later in this chapter), and requests for data from another checkback module. (For a complete list of commands, see *"Issuing*

Checkback Commands" and *"Checkback Command Quick Reference"* later in this chapter.)

You will remain logged on to the module as long as you continue communicating with it. After fifteen minutes of inactivity, the module automatically logs you off. You can also log off deliberately with the "logoff" command; this prevents unauthorized access to the checkback module.

Each Checkback Module in the carrier network should have a unique address. By definition, remote #1's address is "1", remote #2's address is "2", and so on. The master is always assigned address "0". These addresses are used to define how a checkback module behaves, as well as to allow distant communication between modules (see *"Distant Checkback Communications"* later in this chapter). You assign module addresses with the "set address" command (see *"Configuration Settings"* later in this chapter for details on how to assign a new address).

Let's say you want to examine the most recent target events at both the local checkback module and a distant module, and you are logged on to remote #1. To get the most recent event from the local module, type this and press the ENTER key:

get event 1

At this point your screen should look something like Figure 16-7, displaying event 1. You could also type "get event" without indicating a particular event or range and you'd get the most recent 16 events. (See *"Issuing Checkback Commands"* later in this chapter for more details on this command.)

Now you want to get the most recent event from the master module, which is across town. First you need to

log onto this distant module. Type this and press the ENTER key:

logon password>0

Here, "password" is the password stored at the master. The redirection symbol, ">", tells the checkback module that you want to redirect this command to another module, in this case module "0" (which is always the master). **Do not insert any spaces between the word "password" and the redirection symbol (>) or between the redirection symbol (>) and the "0".**

Note that if the password is disabled at the master, you could simply type this and press the ENTER key:

logon>0

Again, type "logon>0" as one word without any spaces.

Once you have successfully logged on, your screen displays all the checkback modules you are logged on to at the top center of your screen, something like Figure 16-8.

```

+-----+ Locally logged on to 1 +-----+
| Bad Msg Rate: 0 | | 15:09:19 10/13/1999 |
| Normal Noise | Remotely logged on to: | Time since last: 0:02:08 |
+-----+ Master +-----+

Remote 1 Checkback Module Configuration
Primary Comm Mode: Coded Fallback Timed Comm: Enabled Last Remote: 1
Interval Type: Periodic Carr Recovery: On Retries: 3 Auto Tests: On
DIP Switch: Factory 2 Low Power Test: Enabled

Outputs Energized State User Definition Alarm Action
User defined 1 Close Delayed Alarm Sealed (fixed)
User defined 2 Close Test in Progress Sealed (fixed)
User defined 3 Close Successful Test Sealed (fixed)
Major Alarm Close ---- Sealed
Minor Alarm Close ---- Sealed

Checkback Time 1-4: 6:00, 12:00, 18:00, 0:00 - Inactive
Checkback Period: 8 hours Loopback Duration: 20 secs
Carrier Recovery Period: 60 mins Carrier Recovery Window: 3 hours
Auto Clock Sync: Enabled Clock: 15:08:47 10/13/1999

Enter command:
Command OK
    
```

Figure 16-7. Result of "Get Event 1" Command.

To get the most recent event from the distant master, you would enter this command and press the ENTER key:

```
get event 1>0
```

As before, the redirection symbol sends this command to module "0", the master.

During a typical session you might get several local and distant events, examine distant settings, and maybe perform a manual checkback test.

16.5.2 Configuration Settings

As noted earlier in this chapter (see "*Installation and Setup*"), the Universal Checkback Module includes four preset factory configurations that you can select with the module's internal DIP switch. Your needs, however, may require a somewhat different setup. You can change the settings to your own configuration only if the DIP switch is set to the "CUSTOM" position.

16.5.2.1 Enabling the Custom Settings Option

To change the DIP switch to the "CUSTOM" setting, power down the unit and remove the module from the chassis. Set switches 1 through 3 to the "off" (up) position. (Note that this switch is only read at power-up; the module ignores any DIP switch changes once it is running.) Replace the module and power up the chassis. Then connect your computer to the module's 9-pin serial connector on the front panel.

Next, log onto the checkback module by entering its password. The module displays the current settings with the command prompt at the screen bottom. If you are setting the module for the first time, it is probably easiest to

start with one of the four factory configurations and modify that; for example, type this and press the ENTER key:

```
set factory 1
```

to change all settings to the factory 1 settings. The module displays the new settings. You can now pick and choose which settings you want to change. For example, to make this module remote #1, type this and press the ENTER key:

```
set address = 1
```

For a complete list of commands and settings see "*Issuing Checkback Commands*" later in this chapter.

After making the necessary changes, do not put the DIP switch back into one of the four factory settings. If you do, your carefully crafted setting modifications will be overwritten by the factory settings. If a setting is invalid, it is rejected by the checkback module, which displays a warning. For example, if you attempt to set the recovery window to 1,000 hours, the module displays a warning that indicates you can only set it between 1 and 24 hours.

```
+-----+ Locally logged on to Master +-----+
| Bad Msg Rate: 0 | | 15:09:19 10/13/1999 |
| Normal Noise | Remotely logged on to: | Time since last: 0:02:08 |
+-----+ 2 +-----+
```

Master Checkback Module Configuration

Primary Comm Mode: Coded Fallback Timed Comm: Enabled Last Remote: 1
Interval Type: Periodic Carr Recovery: On Retries: 3 Auto Tests: On
DIP Switch: Factory 2 Low Power Test: Enabled

Outputs	Energized State	User Definition	Alarm Action
User defined 1	Close	Delayed Alarm	Sealed (fixed)
User defined 2	Close	Test in Progress	Sealed (fixed)
User defined 3	Close	Successful Test	Sealed (fixed)
Major Alarm	Close	---	Sealed
Minor Alarm	Close	----	Sealed

Checkback Time 1-4: 6:00, 12:00, 18:00, 0:00 - Inactive
Checkback Period: 8 hours Loopback Duration: 20 secs
Carrier Recovery Period: 60 mins Carrier Recovery Window: 3 hours
Auto Clock Sync: Enabled Clock: 15:08:47 10/13/1999

Enter command:
Command OK

Figure 16–8. Example of a Remote Logon

16.5.2.2 Setting Descriptions

The checkback module can be configured in many ways. You can show a module's current settings by entering the "get settings" command (see *"Issuing Checkback Commands"* later in this chapter) while logged on. Figure 16-8 shows a typical settings screen. Following are descriptions of each setting.

The first line shows which module these settings are from. In this case we are looking at remote #1's settings. When installing modules, you assign each checkback module in your system a unique address. By definition, remote #1 is address "1", remote #2 is address "2", and so on. The master is always assigned address "0". When assigning remote addresses, always start with 1, then 2, etc. Do not leave any permanent gaps in the addresses, or you may see errors during checkback tests.

Primary Comm Mode

This setting shows the communication mode that is initially used when this module attempts a checkback test. There are two options: coded and timed. In coded mode, five-byte data messages are sent back and forth between modules. In timed mode, the carrier is simply held on for several seconds; the actual time specifies which module we are trying to communicate with: the master responds to a five-second carrier burst, remote #1 to 10 seconds, remote #2 to 15 seconds, and so on.

Fallback Timed Comm

When this setting is enabled and the Primary Comm Mode is set to "coded", the module shifts communications mode to timed communication once it has failed all attempts to perform a coded checkback test. If the primary communications mode is already set to timed, the fallback feature is ignored.

Examples: **set fall off**; **set fall disable**

Last Remote

Your network may contain more than two checkback modules (i.e., one master and one remote). Among other things, this setting lets the module know the final address to which it needs to send a checkback test request. If the primary communication mode is set to "timed", you can have up to four (4) remotes. If it is set to "coded", you can have up to 10 remotes.

Example: **set last 1**

Interval Type

This setting specifies how you want automatic checkback tests to be performed. You have two options: Timed and Periodic. In "timed" mode, automatic checkback tests are performed at your four user-specified times. These might be, say, 6:00, 12:00, 17:00, and 23:00. In "periodic" mode, automatic tests are performed every so many hours, for example, every eight (8) hours.

Example: **set interval timed**

Carrier Recovery

You can set a module to start "automatic carrier recovery" mode after failing a checkback test. In this mode, the module initiates more frequent automatic checkback tests until it has three successful, consecutive tests. It then reverts to the normal checkback schedule, that is, "timed" or "periodic" checkback tests.

A remote also starts its version of automatic recovery after failing its own checkback attempts. Once in automatic recovery mode, a remote does not initiate any automatic checkback requests. It remains in automatic recovery mode until it passes three checkback tests. Normally, these tests are issued automatically by the master, but you can speed things up by executing manual tests at a remote or the master. After three good tests, remotes also resume normal operation.

When starting automatic recovery mode, a module slowly flashes the front panel carrier recovery

LED (labeled "RECOVERY"). If the module has not recovered before the carrier recovery window expires (see below), this LED begins to flash rapidly, and the module sets the "delayed alarm".

Examples: **set recovery enable; set reco on**

Retries

During noisy line conditions, remote messages may contain errors that cannot be fixed at the destination module. With this setting, you can specify the maximum number of times you want the module to automatically resend a message. The valid range is zero (0) to 15 (times). A good compromise between communication speed and robustness is a setting of "3" to "5".

Example: **set retries 5**

Auto tests

Automatic checkback tests can be enabled or disabled. Normally, you would probably want them to be enabled. But if, for example, you are installing new checkback modules, you might want to disable automatic checkback tests until all units are in place. When auto tests are disabled at a module, it does not issue checkback tests unless manually commanded by you, the user. In

addition, the master module does not issue the automatic clock update at around 12:30 AM. In other words, no module sends any command, unless you specifically command it. You can enable/disable Auto tests in three ways: (1) with this command, (2) by pressing and releasing both front panel switches simultaneously, or (3) by momentarily closing the two external switches connected to the rear panel inputs. When auto tests are disabled, all the module's LEDs flash on and off every second.

Example: **set auto on**

DIP Switch

This shows the current DIP switch setting. This can be "CUSTOM" or one of the four factory presets. If this switch is set to CUSTOM, but the current settings are identical to one of the factory presets, it shows the matching preset. In Figure 16-8, this module's settings matched those we would get if the DIP switch were set to factory preset #2.

Low Power Tests

Here, you can enable or disable the low power setting during checkback tests. When enabled, all checkback tests initiated by this module are first performed on low power, then high power. When disabled, only the high-power test is performed.

Examples: **set low enable; set low on**

Outputs

Each checkback module has five outputs. Two of these are permanently set to major and minor alarms. You can configure the remaining three with one of five choices:

"delay" (Delayed Alarm): Output set after a module fails to recover from auto recovery before the "carrier recovery window" expires.

"testing" (Test In Progress): Output set by the module initiating the checkback test for the duration of the test.

"pass" (Successful Test): Output set after passing a checkback test.

"recover" (Successful Carrier Recovery): Output set for one second after a successful recovery from automatic recovery mode.

"disable" (Disable Automatic Tests): Output set when the user has disabled automatic checkback tests.

Examples:

set def1 test - Set user output 1 to show when a checkback test is in progress.

set def3 recover - Set output 3 to show successful automatic carrier recovery.

set def2 pass - Set output 2 to show a successful checkback test.

set def1 delay - Set output 1 to activate when a delayed alarm is initiated.

set def2 disable - Set output 2 to activate when a user disables auto tests.

Although all checkback module outputs are actually solid state circuits, each the five outputs can be set to act as either a normally open or a normally closed relay output. The Energized State shows how an output acts when its condition is true. For example, if a module fails a checkback test, it sets the major alarm. If you have programmed the major alarm output to close when energized, this output closes immediately after failing the checkback test. After the module has passed a test, this output opens.

Conversely, if you had programmed the major alarm output to open when energized, this output would open immediately after the module failed a checkback test and would close after it passed.

Examples:

set state1 open—Set user output 1 to open when the condition it is set to monitor becomes true.

set state2 close—Set user output 2 to close when the condition it is set to monitor becomes true.

set major open—Set the major output to open when the major alarm is active.

set minor close—Set the minor output to close when the minor alarm is active.

You can also program the two alarm outputs to seal or just momentarily toggle when an alarm occurs. When you select "sealed" operation, the alarm outputs stay in their "true" states as long as the alarm exists. If you select "momentary", the outputs go to their true states for only five seconds, then return to their previous states. For example, assume alarms are set to momentary action and the major alarm active state is closed. Normally this output is open. When a major alarm occurs, the major alarm output closes for five seconds, then opens again. The major alarm output does not change when the major alarm is cleared.

Examples:

set alarm sealed - Sets the major and minor alarms to remain in their active, or true, states as long as a major/minor alarm condition exists.

set alarm momentary—Sets the major and minor alarms to shift to their active, or true, states for five seconds when a major/minor alarm condition occurs.

Checkback Time 1-4

These settings let you set the four times at which you want to execute automatic checkback tests for timed checkback tests. When you set the Interval Type to "timed", the master initiates a checkback test at each of these times. You can set these times only to the nearest hour, using a 24-hour format. The master actually executes a timed test five minutes after the hour (e.g. 4:05). This delay provides some "fudge" room to compensate for unsynchronized checkback module clocks. Remotes that have their Interval Types set to Timed also use these times to initiate their own checkback tests, if they do not hear from the master within a grace period. The grace period is ten minutes after the hour for remote #1, fifteen minutes for remote #2, and so on.

If you do not want to use all four times, say you are only interested in three tests per day, you can simply set one of the times equal to another. For example, you could set time 1 to 12:00, time 2 to 6:00, time 3 to 18:00, and time 4 to 18:00 as well.

Example:

set time1 4—The module executes a checkback test at 4:05 a.m. if it is a master. If it is remote #1, it executes a test at 4:10, if it does not receive a checkback request from the master before this time.

If the current Interval Type is Periodic, the word "Inactive" is displayed next to the checkback times. This means that these times are disabled and checkback tests occur according to the periodic interval (e.g., in the above example, every 8 hours). When you set the Interval Type to "timed", these times become active and the Periodic time is inactive.

Checkback Period

As mentioned above, the checkback period is enabled when the Interval Type is set to "periodic". If you wanted three tests per day and really did not care about the time of day when they occurred, you could set this time to, say, 8 hours. Masters attempt periodic checkback tests at exactly this time, in our case eight hours since the last test. Remotes have a grace period before they, too, attempt a checkback test, if they have not heard from the master. For example, remote #1 would do a checkback test after eight hours and five minutes, if it did not receive a checkback test from another module.

Example:

set period 8—The module executes a checkback test eight hours after the last test, if it is a master. If it is remote #1, it executes a test at 8:05, if it does not receive a checkback request from the master before this time.

Loopback Duration

The loopback duration specifies how long a module holds the carrier on during a loopback test. Loopback tests are performed at both high and low power. If you are at remote #1 and request a loopback test at the master, it turns the carrier on high power then on low power for the duration of the time. You can use loopback tests to set the sensitivity of your local receiver or other such tasks. The range of times is four to 60 seconds. You can request loopback tests in three ways: (1) with this command (e.g., **do loop > 1** requests remote #1 to do a loopback test), (2) by pressing and holding the top front panel switch, or (3) by closing the switch connected to the rear input TB6-1/TB6-2 for five seconds.

Example:

set loop 25—Sets the loopback duration to 25 seconds.

Carrier Recovery Period

When the master is in carrier recovery mode after failing a checkback test, it begins initiating checkback tests according to the carrier recovery period. For example, if the carrier recovery period is 15 minutes, the master tries another checkback test every 15 minutes. It remains in carrier recovery mode and continues to initiate tests every 15 minutes, until it has successfully completed three checkback tests. At that time, it shifts back to the normal mode, either periodic or timed checkback tests.

Example:

set carrier 45—Sets the carrier recovery period to 45 minutes

Carrier Recovery Window

The carrier recovery window is a time limit for the delayed alarm. If a module goes into carrier recovery mode and does not recover before this time limit, it sets the delayed alarm. If any user-programmable output is set to delayed alarm, it becomes active. The main reason for having a carrier recovery window and delayed alarm is to cut down on nuisance alarms. With this window and the delayed alarm, you can design a system that only alerts you when a true, long-term problem exists. The valid range for this window is 1 to 24 hours.

Example:

set window 3—Sets the window to three hours.

Auto Clock Sync

When the auto clock sync is enabled, the master synchronizes all remote clocks to its own time, starting at 12:30 a.m. In practice, the synchronization is rough, within about +/- 2 seconds. But that is sufficiently accurate for Timed checkback testing.

Examples:

set sync off (or)

set sync disable

Clock

This shows the module's time and date. Use the set clock command to set the time, using the 24-hour format. Use the set date command to set the date, specifying all four digits for the year.

Examples:

set clock 0:02:45—Sets the time to 12:02:45 a.m.

set date 12/29/2003—Sets the date to December 29, 2003.

16.5.3 Performing Checkback Tests

The Universal Checkback Module's primary function is to perform checkback tests, verifying that your carrier communication path is operating. You can perform checkback tests in several ways:

- Physical switch request
- Manual request from your PC
- Automatic timed test
- Automatic periodic test
- Automatic carrier recovery
- Remote-initiated periodic tests
- Remote-initiated timed tests

16.5.3.1 Physical Switch Request

As noted earlier, you can physically initiate a checkback test from the module's front or rear panel. At the front panel, push and release the "TST" switch. At the rear panel, momentarily close the external switch connected to TB6-2/TB6-2. This works with both a remote or master module.

16.5.3.2 Manual Request from Your PC

Using your computer, you can manually request a test using the **do checkback** command. See "Issuing Checkback Commands" later in this chapter for details on using your PC to issue commands.

16.5.3.3 Automatic Timed Test

When this option is enabled, the master checkback module initiates checkback tests at four user-specified times. For example, you might set these times to be 4:00, 13:00, 14:00, and 23:00. You can only set times to the nearest hour. The test then occurs at the start of the hour plus five minutes, unless the module is busy with another message.

To enable this option, you must do the following:

1. Turn on the automatic test feature:
set auto on

This changes the "Auto Tests" setting to "On".

2. Set the interval type to "timed":
set int time

This changes the "Interval Type" setting to "Timed".

3. Set the four checkback test times:
set time[#] [hh]

Where "#" is the time's place in the daily sequence (i.e., 1, 2, 3, or 4), and "hh" is the desired hour in 24-hour format (e.g., 8, 12, 16, 20). This changes the "Checkback Time 1-4" setting to reflect the four times you specified.

You can only make these settings changes if the module's DIP switch is set to "CUSTOM".

16.5.3.4 Automatic Periodic Test

Instead of a timed test, you can set the master checkback module to initiate tests periodically, say, every four hours. The shortest interval you can set is one hour, and the longest is 120 hours. The periodic interval is reset after one of the following:

- Sending or receiving a good checkback test, including manual tests
- Attempting to execute a checkback test at the Periodic Interval.

To enable this option:

1. Turn on the automatic test feature:
set auto on

This changes the "Auto Tests" setting to "On".

2. Set the interval type to "periodic":
set int period

This changes the "Interval Type" setting to "Periodic".

3. Set the interval for the checkback tests:
set period[#]

Where "#" is the number of hours between tests. This changes the "Checkback Period" setting to the time you specified.

You can only make these settings changes if the module's DIP switch is set to "CUSTOM".

16.5.3.5 Automatic Carrier Recovery

Using the set recovery command, you can set a module to begin more frequent tests after failing any of the above checkback tests. With the carrier recovery mode enabled, the master module, after failing a test, switches to carrier recovery mode. In carrier recovery mode, checkback tests are performed periodically, but much more frequently than otherwise, for example, every 20 minutes. You can set this time from five minutes to one hour. After three consecutive successful tests, the carrier recovery output is set, and the master reverts to the normal automatic tests.

You can accelerate recovery by performing manual tests at the master module. After you execute three successful manual checkback tests, the master module counts these as carrier recovery tests and reverts to normal mode. Note that while in recovery mode, the master only sends low-power checkback tests. This ensures that the line conditions are good before resuming normal operation.

The module's local carrier recovery LED flashes while in carrier recovery mode. After passing the three tests, this LED changes to solidly on, and any user defined outputs set to carrier recovery are set for five seconds.

To enable the automatic carrier recovery mode, use the set recovery command:

set recovery on

This changes the "Carr Recovery" setting to "On".

16.5.3.6 Remote-Initiated Periodic Tests

In some cases, a remote module initiates its own checkback test. Obviously, you can always manually request a test by pressing the remote's test switch (TST), closing the external switch connected to the rear panel's TB6-1/TB6-2, or entering the **do checkback** command. But the remote automatically does a checkback test if it detects the master is late. When a remote is set to do automatic periodic tests, it determines the master is late if it does not receive a checkback request within the user period plus some delay, or grace period. For remote #1, this grace period is five minutes.

For example, let's say your remote is set for automatic periodic testing, with a period of eight hours. If it does not receive a checkback test within eight hours and five minutes, it executes a checkback test. If this test is successful, both the master and the remote's periodic timers are restarted at roughly the same time, and the master takes over for subsequent checkback tests, if both modules are set for the same periodic interval. Note that this situation can occur when you are first installing the checkback modules. The periodic timer starts as soon as the module is powered, so that one module will have a head start on the others. After the first successful checkback test, all the periodic timers in the network are synchronized, and the master initiates any future tests.

If you have more than one remote in your system, each has its own unique grace period. Remote #1 waits five (5) minutes, remote #2 waits 10 minutes, remote #3 waits 15 minutes, and so on.

For example, if neither remote #1 nor the master has initiated a checkback test for the interval plus 10 minutes, remote #2 executes a test.

Table 16–4. Primary/Fallback Communications Options.

Primary Mode	Fallback Timed	Description
Coded	Disabled	No more tries after max retry count
Coded	Enabled	Makes one last try using Timed Mode
Timed	Disabled	No more tries after max retry count
Timed	Enabled	No more tries after max retry count

For this scheme to work properly, it is important to keep all the module settings similar. If the master is set for automatic periodic testing, all remotes should also be set this way. If not, you may have more checkback tests occurring than you would expect at equally unexpected times. Also, the four execution times should be the same for all modules in the system.

16.5.3.7 Remote-Initiated Timed Tests

Just as with remote-initiated periodic testing, remotes set to timed testing initiate their own checkback tests if the master does not do a test in time. The "grace" period is longer for this mode: user time + 10 minutes for remote #1, user time + 15 minutes for remote #2, etc. That allows this scheme to work even when there is up to five minutes difference between the checkback modules' clocks.

For automatic timed testing, the clocks in the master and the remotes should be fairly close.

You can enable the automatic clock synchronization feature to keep your clocks synchronized (**set sync on**). When enabled, the master synchronizes all remote clocks to its own time starting at 12:30 a.m. In practice, the synchronization is rough, within about +/- 2 seconds, but that is sufficiently accurate for timed checkback testing.

16.5.4 Checkback Test Options

A single checkback test is a set of encoded data messages, a simple keyed carrier signal, or a mixture of both. You have several options for performing this test:

- Keyed carrier timed test
- Encoded carrier test
- Primary and fallback communication modes
- Communication retries

16.5.4.1 Keyed Carrier Timed Tests

This is the classic method where the checkback module simply turns on the carrier for a specific interval of time. Each module in the system is assigned a unique time and can recognize when the carrier has been on for the correct interval. The correct module responds by keying the carrier for a predetermined interval.

The module identifying times are:

- Master module recognizes a five-second carrier
- Remote #1- recognizes a 10-second carrier
- Remote #2- recognizes a 15-second carrier
- Remote #3- recognizes a 20-second carrier
- Remote #4- recognizes a 25-second carrier

In older systems, the first remote was assigned a five-second carrier. Universal Checkback Module remotes, however, are able to initiate checkback tests themselves. Thus, they must have a way of signaling the master module. For a graphical representation of the Carrier timed tests, please see Figures 16-9 & 16-10.

16.5.4.2 Encoded Carrier Tests

Encoded tests involve sending serial data messages back and forth between checkback modules. This method has two advantages over the keyed carrier method: (1) it is usually faster and (2) you can communicate with more modules. The disadvantage with this method is that it is more vulnerable to noisy line conditions that may result in a failure to send a good message. To prevent errors in the received data, the module sends a 16-bit CRC code with each message. This error detecting code enables the module to detect bad messages and, in some cases, repair them.

16.5.4.3 Primary and Fallback Communications Modes

A Universal Checkback Module first uses the primary communications mode when performing a checkback test. It makes several attempts to communicate, up to the number in the "Retries" setting. If all attempts fail, it switches to the timed communication mode, if "Fallback Timed Comm" is enabled and the "Primary Comm Mode" is coded.

Once in timed communication mode, the module makes one final attempt to get through. If that fails, it sets a major alarm. If it passes, no alarm is issued. Table 16-4 shows how all the communication combinations work.

16.5.4.4 Communication Retries

To increase the communication robustness, the checkback system can make repeated attempts to get a message or signal through to another module. When the channel is noisy or weak, multiple attempts are often successful. Setting a high retry number, say 15, increases the likelihood of success (slightly), but can cost a lot of time waiting for a failure. We think that three (3) to five (5) is a good compromise between speed and robustness.

16.5.5 Issuing Checkback Commands

Checkback commands are composed of English phrases, for example:

set clock 1:59:02 ↵

Here, the "↵" symbol means that, after typing the command, you must press the "ENTER" key to send it to the module.

Commands have several rules and properties:

- 1) You may combine several distinct commands on one line, if you separate each command with a comma. For example:
set clock 1:59:02, set retries = 4, set minor alarm open
- 2) The total command line length must be fewer than 60 characters.

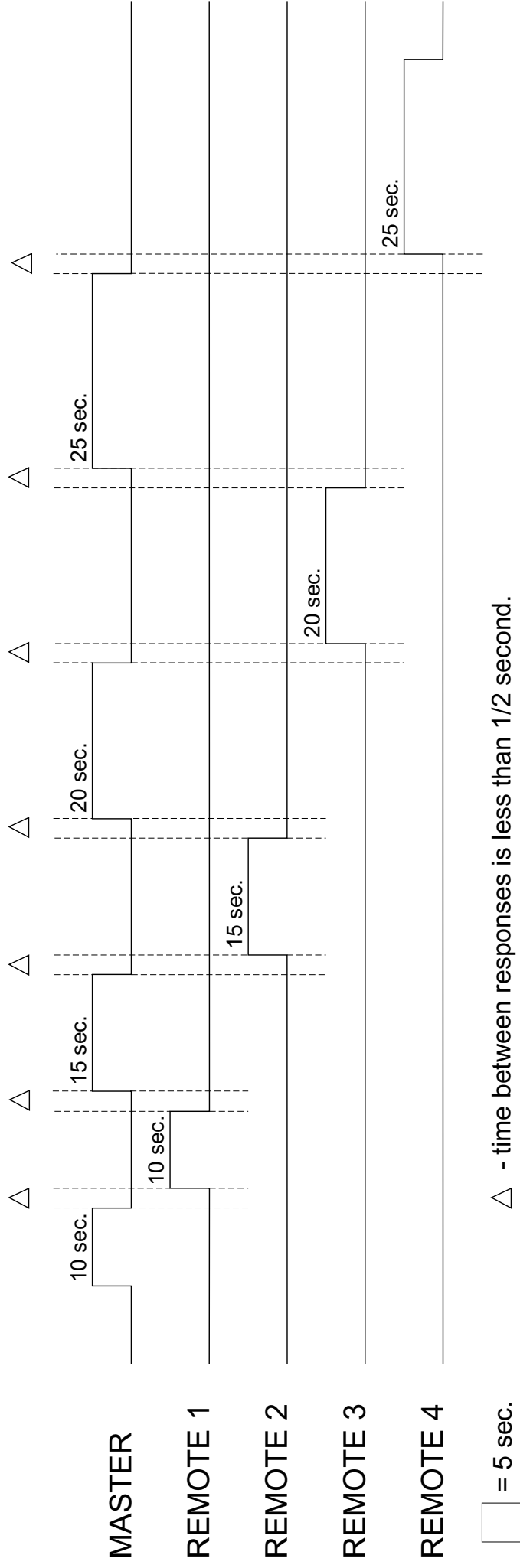
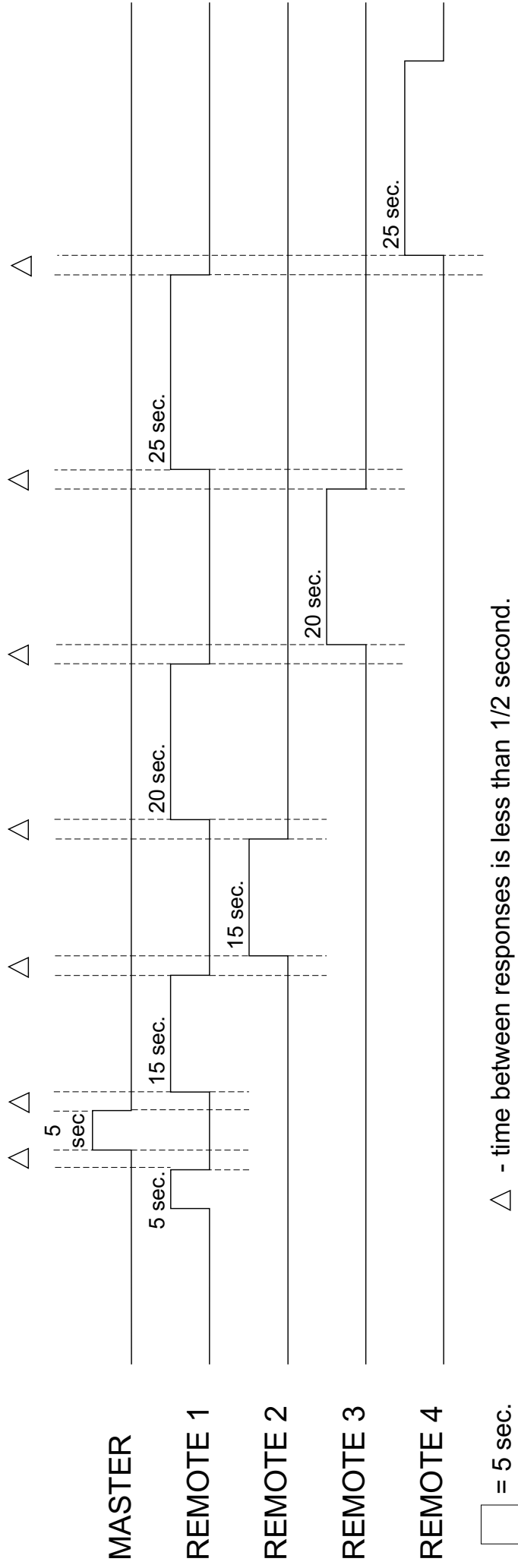


Figure 16–9. Universal Checkback Module – Timed Checkback Sequence (Master Initiation).

Figure 16-10. Universal Checkback Module – Timed Checkback Sequence (Remote 1 Initiation).



- 3) You may use an equal sign (=) with any command to increase clarity, but it is not required. For example: **set retries = 4** is identical to **set retries 4**.
- 4) Leading spaces and embedded spaces are permitted. For example: **set last 1** is the same as **set last 1**. The lone exception to this rule is the **logon** command. It must appear like this:

logon password>0

The rule for the logon command is: Do not insert any spaces between the word "password" and the redirection symbol (>) or between the redirection symbol (>) and the "0".

- 5) Commands are not case-sensitive; you can use either upper or lower case.
- 6) To save typing, you can recall recent commands using the up and down arrow keys. You can then edit these commands by backspacing and changing as needed.
- 7) You can abbreviate most commands using the first few command characters. Acceptable abbreviations are shown in the command lists below.

Checkback commands can have three formats:

- No parameters - Example: do checkback
- Non-numeric parameter - Example: set primary timed
- Numeric parameter(s) - Examples: set clock 13:59:45 and set address = 2

Commands can be grouped into several functional categories:

- | | |
|---------|----------------|
| • Set | • Action |
| • Get | • Help |
| • Clear | • Logon/Logoff |

In the following command lists, "{}" brackets indicate an optional parameter and "|" indicates that you must include either the parameter before the "|" symbol or the one after. For example, **set primary time | coded** means that you enter either **set primary time** or **set primary coded**. Remember that after typing any command, you

must press the ENTER key to send it to the module.

16.5.5.1 Set Commands

These commands configure the checkback module for service. Settings include communication modes, active output states, and clock time and date.

Set Address

Minimum abbreviation: **set addr n**

Sets a module's address. Addresses are used to direct a command into a specific checkback module. To specify the master module, assign it address "0". Set remote addresses sequentially with no gaps, starting with address "1". For example, in a three-module system, you would have address "0" at the master module, and remote #1 and #2 at the two remotes.

In coded communication mode, up to ten remotes are allowed, permitting a maximum address of "10". In timed communication mode, only four remotes are allowed, limiting the highest address to "4".

As with most settings, you can only change this one if the DIP switch is set to "CUSTOM".

Examples:

set address 0—The local module becomes the master.

set address 2—The local module becomes remote #2.

set addr 2 > 1—Remote #2's address changes to "1".

Set Primary Communication Mode

Minimum abbreviation: **set prim time | code**

Sets a module's primary communication mode. The primary mode is the default format for module to module communication. You can set this mode to either "timed" or "coded". Coded mode is less reliable than timed mode, but adds more communication features.

As with most settings, you can only change this one if the DIP switch is set to "CUSTOM".

Examples:

set prim timed—Sets the local module's primary communications mode to timed.

set primary code > 1—Sets remote #1's primary communications mode to coded.

Enable Fallback Timed Communication Mode

Minimum abbreviation: **set fall on | off**

Enables/disables a module's fallback timed communication mode for checkback tests. This mode is automatically invoked if communication problems occur during checkback testing.

As with most settings, you can only change this one if the DIP switch is set to "CUSTOM".

Examples:

set fall on—Enables the local module's fallback timed communications.

set fall off > 0—Disables the master's fallback timed communications mode.

Set Interval Type for Automatic Checkback

Minimum abbreviation: **set int peri | time**

Checkback modules perform automatic checkback tests either periodically or at user-specified times (see "*Set Time 1-4 for Timed Checkback*" and "*Set Period for Automatic Checkback*" below). This setting lets you specify which mode you want to use.

As with most settings, you can only change this one if the DIP switch is set to "CUSTOM".

Examples:

set check periodic—Sets automatic checkback tests to occur periodically using the interval specified in the "Checkback Period" setting.

set chec time—Sets automatic checkback tests to occur at the four times specified in the "*Checkback Time 1-4*" setting.

Enable Automatic Carrier Recovery Mode

Minimum abbreviation: **set reco on | off**

You can set the master module to start automatic carrier recovery mode after failing a checkback test. In this mode, the master initiates more frequent checkback tests until it gets three consecutive successful tests. It then reverts to the normal automatic test mode. You can set the frequency for these tests with the set carrier recovery period command. Successful manual tests while in this mode count toward recovering and can be used to speed up carrier recovery.

As with most settings, you can only change this one if the DIP switch is set to "CUSTOM".

Example:

set recovery on—Enables the automatic carrier recovery mode.

Enable Automatic Checkback Tests

Minimum abbreviation: **set auto on | off**

You can enable or disable a module's ability to automatically initiate checkback tests. When auto tests are disabled, a module only sends checkback tests when you manually command it to, either through a do checkback command or through the front or rear panel switches. In **addition, the** master module does not send the clock synchronization command at 12:30 a.m. This means that when auto tests are disabled, a module does not send any commands unless you specifically command it. This feature might be useful when you are installing checkback modules and the system is not complete. You can also toggle this setting by pressing both front panel switches simultaneously.

As with most settings, you can only change this one if the DIP switch is set to "CUSTOM".

Example:

set auto on—Enables automatic checkback tests.

Set Factory Preset

Minimum abbreviation: **set fact n**

There are four factory defined preset configurations which you can select. Using this command replaces your current settings with the factory configuration you specify. After this command, you can edit this configuration to your needs or leave it alone and use the factory defaults.

As with most settings, you can only change this one if the DIP switch is set to "CUSTOM".

Note that you can also select one of the factory presets by changing the internal DIP switch from "CUSTOM" to Factory 1, 2, 3, or 4, and then energizing the module. Changes with this method, however, are blocked until you put the DIP switch back to the "CUSTOM" position.

Example:

set fact 2—Replaces all settings with factory preset 2 settings.

Set Password

Minimum abbreviation: **set pwd pppppppppp**

Passwords can be from one to ten characters; you can include both numbers and letters in your password. Letters are not case sensitive. Each checkback module can have a unique password, or you can set them all the same. As usual, it is a good idea to write new passwords down, as you will be unable to log on without the correct password. If you do lose your password, you can recover it using the procedure described in "Recovering Your Lost Password" later in this chapter.

Unlike most settings, you can change the password no matter which setting the DIP switch is on.

Examples:

set pwd hello—Sets the local module's password to "hello".

set pwd bigdarnpwd—Sets the local module's password to the maximum size.

set pwd 9—Sets the local module's password to just "9".

set pwd pass1 > 1—Sets remote #1's password to "pass1".

Set Major Alarm Relay State

Minimum abbreviation: **set majo open | close**

Sets a module's major alarm relay state. You can set relays to either open or close on a major alarm condition.

As with most settings, you can only change this one if the DIP switch is set to "CUSTOM".

Examples:

set major closed—Closes the major alarm relay upon a major alarm.

set majo open>1—Opens remote #1's major alarm relay upon a major alarm.

Set Minor Alarm Relay State

Minimum abbreviation: **set mino open | close**

Sets a module's minor alarm relay state. You can set relays to either open or close on a minor alarm condition.

As with most settings, you can only change this one if the DIP switch is set to "CUSTOM".

Examples:

set mino open—Opens the minor alarm relay upon a minor alarm.

set mino close>0—Closes the master module's minor alarm relay upon a minor alarm.

Set Output State 1-3

Minimum abbreviation: **set state# open | close**

Similar to the above major and minor relay output states, you can set the active state of each of the three user-programmable outputs. The active state of each user output is independent of what you have defined it to monitor. For example, let's say you have programmed output 2 to monitor "test in progress." Then you set the output 2's active state to **close**. Now when this module initiates a checkback test, output 2's contacts closes. If you then changed the definition of output 2 to "passed test", then this output contact closes when the module passes a checkback test.

As with most settings, you can only change this one if the DIP switch is set to "CUSTOM".

Examples:

set state1 close—Closes output 1 contact when it is active.

set state3 open>2—Opens output 3 at remote #2 when it is active.

Set Output Definition 1-3

Minimum abbreviation:

set defi reco|delay|test|pass|disab

Checkback modules include three user-programmable outputs. You can set each of these to monitor one of five items:

"delay" (Delayed Alarm): Output set after a module fails to recover from auto recovery before the carrier recovery window expires

"testing" (Test In Progress): Output set by the checkback test-initiating module for the duration of the test

"pass" (Successful Test): Output set after initiating and passing a checkback test

"recover" (Successful Carrier Recovery): Output set for one second after a successful recovery from automatic recovery mode

"disable" (Disable Automatic Tests): Output set when the user has disabled automatic checkback tests. As with most settings, you can only change this one if the DIP switch is set to "CUSTOM".

Examples:

set def1 test—Sets user output 1 to show when a checkback test is in progress.

set def3 recover—Sets output 3 to show successful automatic carrier recovery.

set def2 pas—Sets output 2 to show a successful checkback test.

set def1 delay—Sets output 1 to activate when a delayed alarm is initiated.

set def2 disable—Sets output 2 to activate when users disables auto tests.

Set Alarm Outputs Sealed/Momentary

Minimum abbreviation: **set alar seal | mome**

You can set the major and minor alarm outputs to remain sealed after an alarm condition or to close for five seconds and then release.

As with most settings, you can only change this one if the DIP switch is set to "CUSTOM".

Examples:

set test open—Opens "test in progress" relay during a checkback test.

set testing close>0—Closes the master module's "test in progress" relay during a checkback test.

Set Retries Before Reporting a Failure

Minimum abbreviation: **set retr nn**

The retry number sets the number of times the checkback module attempts to communicate with another module after failing a message. If the module fails all the retry attempts, it logs a communications error. The default value is "3", but in a noisy system, you probably want to crank this number up. A maximum of "20" is allowed.

As with most settings, you can only change this one if the DIP switch is set to "CUSTOM".

Examples:

set retries 5—Allows five retries before logging an error.

set retr 0—Disables all retries.

set retries 20—Sets the module to the maximum number of retries.

Set Low Power Test On|Off

Minimum abbreviation: **set low on | off**

You can run low power checkback tests to determine system margins. When enabled, low power checkback tests precede the full power checkback tests.

As with most settings, you can only change this one if the DIP switch is set to "CUSTOM".

Examples:

set low on > 1—Enables low power tests at remote #1.

set low power off—Disables low power tests.

Set Time1-4 for Timed Checkback

Minimum abbreviation: **set time# hh**

You can set automatic checkback tests to execute up to four specific times during the day. These times, time1-time4, indicate the hour to perform a test. Tests are performed near the start of the hour, unless the carrier system is busy with some other task.

If you do not want to use all four times, set the extra times the same as those already set. For example, if you want time1 to be 1:00 and time2 to be 15:00, but do not want to use time3 and time4, set time3 and time4 to 15:00 or 1:00.

As with most settings, you can only change this one if the DIP switch is set to "CUSTOM".

Examples:

set time1 3—Sets time1 to execute an auto checkback test at 3:00 a.m.

set time2 2, time4 2—Sets time2 to execute an auto checkback test at 2:00, and disable time4.

set time1 = 13>1—Sets remote #1's time to 13:00 (note the optional equal sign for clarity).

Set Period for Automatic Checkback

Minimum abbreviation: **set peri hh**

Sets the interval or elapsed time between automatic checkback tests when they are set to execute periodically. This time is specified to the hour, and zero (0) hours are rejected.

As with most settings, you can only change this one if the DIP switch is set to "CUSTOM".

Example:

set period 4—Executes periodic auto checkback tests every four hours.

Set Loopback Duration

Minimum abbreviation: **set loop ss**

Loopback duration specifies in seconds how long a module keeps the carrier on during a loopback test. You can set this time from four (4) to 60 seconds. You start loopback tests either with the

do loopback command (see "Do Loopback Test") or with the front and rear panel loopback switches.

As with most settings, you can only change this one if the DIP switch is set to "CUSTOM".

Examples:

set loopback duration 5—Sets the local module's duration to five (5) seconds.

set loop 60 > 2—Sets remote #2's loopback duration to 60 seconds.

Set Automatic Clock Synchronization

Minimum abbreviation: **set sync on | off**

When enabled, the master module synchronizes the clocks of all remotes in the network starting at 12:30 a.m.

As with most settings, you can only change this one if the DIP switch is set to "CUSTOM".

Example:

set sync on—Enables automatic clock synchronization by the master.

Set Clock

Minimum abbreviation: **set cloc hh:{mm}{ss}}**

Updates the checkback module's clock. With this command, you can set the clock to the nearest second. Remember to enter times in 24-hour format.

Unlike most settings, you can set the clock no matter which setting the DIP switch is on.

Examples:

set cloc 1:02:56—Sets the local module's clock to 1:02:56 a.m.

set cloc 13:00:00 > 1—Sets remote #1's clock to 1:00 p.m.

set cloc 3—Sets the local module's clock to 3:00:00 a.m.

Set Date

Minimum abbreviation: **set date mm/dd/yyyy**

Updates the date setting for the checkback module's clock. You must enter all four digits for the year, e.g., 2005, or the command is rejected.

Unlike most settings, you can change the date no matter which setting the DIP switch is on.

Examples:

set date 1/2/2000—Sets the local module's date to January 2, 2000.

set date 1/2/2000 > 1—Sets remote #1's date to January 2, 2000.

Set All

Minimum abbreviation: **set all > n**

Set all allows you to update all of a distant module's settings at once with the local module's settings. Thus, it should always be directed to some other node (e.g., **set all > 2**). All settings except address, password, time, and date are set identical to the module making this command.

For example, if you're at remote #1 and you enter **set all > 0**, the master changes all its settings, like number of retries, and primary communication mode, to match remote #1's, but it remains a master because the address is not changed.

As with most setting commands, you can only execute this one if the DIP switch is set to "CUSTOM".

Examples:

set all > 1—Sets remote #1 to match the local module's settings.

set all > 0—Sets the master to match the local module's settings.

16.5.5.2 Get Commands

Get commands read a checkback module's current settings, events, status, or counts.

Get Settings

Minimum abbreviation: **get set**

Displays a checkback module's current settings. This includes its address, primary and fallback communication modes, alarm output control, and various times.

Examples:

get set—Gets and displays the local module's settings.

get set > 1—Gets and displays remote #1 settings.

Get Events

Minimum abbreviation: **get eve {nn {-mm}}**

Displays a module's stored events. Up to 250 events are stored in a Universal Checkback Module. You can call this command with a range of events (e.g., 10-45), a single event (e.g., 2), or you can supply no events. If you supply no events, the module displays the next event each time you request distant events or the next 10 events each time you request local events. When you enter a command to a distant module other than **get events**, the event display counter is reset to event 1 for that module.

Examples:

get event 100-107—Gets and displays local events 100 through 107.

get event 6—Gets and displays local event 6.

get event—Gets and displays the next 10 local events.

get eve 4 > 1—Get and displays remote #1's event 4.

get eve 1-10 > 1—Gets and displays remote #1's events 1 through 10.

get eve >1—Gets and displays remote #1's next event.

Get Status

Minimum abbreviation: **get sta**

Displays the status of a module's front panel LEDs.

Examples:

get status—Gets and displays the status of the local module's LEDs.

get status > 1—Get and displays the status of remote #1's LEDs

Get Counts

Minimum abbreviation: **get cou**

Displays a module's event counts. This shows the number of major and minor alarms, communication errors, checkback retries, checkback tests performed, successful checkback tests, and the elapsed time since these counts were reset (see "*Clear Event Counts*" and "*Set Retries Before Reporting a Failure*").

Examples:

get count—Gets and displays the local module's event counts.

get count > 2—Gets and displays remote #2's event counts.

Get All

Minimum abbreviation: **get all > n**

Get all compliments **set all** and allows you to replace all your local module's settings with those of a distant module. Like **Set All**, this command should always be redirected to some other module, e.g., **get all > 1**. All settings except address, password, time, and date are set identical to the distant module.

Examples:

get all > 1—Sets the local module's settings to match remote #1's.

get all > 0—Sets the local settings to match the master's.

16.5.5.3 Clear Commands

Clear commands let you clear the stored events or counts, or reset the alarm outputs

Clear alarms

Minimum abbreviation: **clr a** or **clear a**

Clears the alarm relays and display LEDs.

Examples:

clear alarms—Clears local alarms.

clr alarm > 1—Clears remote #1's alarms.

clr a>1—Clears remote #1's alarms.

Clear Events

Minimum abbreviation: **clr e** or **clear e**

Clears all stored events from the non-volatile memory. Make sure you really want to do this command before you actually do it, because you may delete a considerable amount of data.

Examples:

clr events—Clears all locally stored target events.

clear eve> 1—Clears remote #1's events.

clr e>1—Clears remote #1's events.

Clear Event Counts

Minimum abbreviation: **clr c** or **clear c**;

Clears the event counts which show the number of major and minor alarms, communication errors, communication retries, and the number of checkback test attempts and successes.

Examples:

clr c—Clears local counts.

clr c> 2—Clears remote #2's counts.

16.5.5.4 Action Commands

You can command a Universal Checkback Module to execute a loopback or checkback test with an action command.

Do Loopback Test

Minimum abbreviation: **do loop**

You can instruct a module to initiate a loopback mode for several seconds. During this time, the module's carrier remains on. The duration of this transmission is specified by the module's "Loopback Duration" setting (see "Set Loopback Duration").

Examples:

do loopback—Turns on the local carrier for the specified time.

do loop >1—Turns on remote #1's carrier for the specified time.

Do Checkback Test

Minimum abbreviation: **do chec**

You can initiate a manual checkback test with this command. As with automatic checkback tests, the last module in the system should be specified before executing this command - this tells the initiating Checkback Module which distant modules it needs to test.

Example:

do checkback—Performs a manual checkback test on all the other checkback modules in the network.

16.5.5.5 Logon/Logoff Commands

Checkback access is controlled by the **logon** and **logoff** commands. Before you can change or view settings, you must log onto a checkback module. When done, you can log off manually or wait fifteen minutes, when the system logs off automatically if there has been no activity.

Logon

Minimum abbreviation: **logon pwd**

Logon commands enable you to access a Universal Checkback Module to change settings or perform various tests. Logons are password protected (see "Set Password"), preventing unauthorized access.

Before communicating with a local checkback module, you must first log on. You then must log onto any distant module you want to access.

When entering any password, the characters you type are shown only as asterisks, e.g., logon ****.

When logging onto distant modules, do not insert any spaces between the "password" and the redirection symbol (>) or between the redirection symbol (>) and the distant module's address.

Examples:

logon mypass—Logs onto the local checkback module using password "mypass".

logon city1>1—Logs onto remote #1 with password "city1". Again, do not insert any spaces after you begin typing the password.

Note that "mypass" is displayed as "*****" and "city1" as "*****" when you enter them.

Logoff

Minimum abbreviation: **logoff**

The **logoff** command ends a session with a checkback module (see "Logon"). Logging off prevents unauthorized changes to the checkback module's configuration. The checkback module also automatically logs off all modules after fifteen minutes of no user activity.

Examples:

logoff—Logs off local and all distant checkback modules.

logoff > 2—Logs off remote #2 only; remains locally logged on.

16.5.5.6 Help Commands

Online help is available when you enter a **help** command. The checkback module can provide both general and command-specific help to simplify field use.

Help

Minimum abbreviation: **help**

Online help goes from general to specific.

Examples:

help—General help, lists all commands briefly.

help set—Discusses all the setting commands in more detail.

help retries—Gives examples and specific usage for the set retries command.

All commands are summarized in Tables 16-5 through 16-13 (see "*Checkback Command Quick Reference*" on the following page).

16.5.6 Distant Checkback Communications

Universal Checkback Modules can communicate with any others on the same network. Any command that you can execute at the module you are connected to can also be redirected to some distant module. For example, if you are at remote #2 and you want to change remote #1's major alarm output state to "closed" on alarm, you could type the following and press the ENTER key:

```
set major = closed > 1
```

The redirection character (>) tells the local checkback module to send this command on to remote #1, rather than execute this command locally. The master and all remote modules have the same communication privileges. That is, any module can redirect a command to any other module.

To communicate with a distant module, you must first log onto that module. This is a security measure designed to limit access. A checkback module's distant logon password is always the same as its local logon password, although every checkback module can have a unique password.

For example, let's say you are at remote #1. You want to log onto the master and its password is "dilbert". You type: **logon dilbert > 0** and press the ENTER key.

Note that this appears on the screen as: **logon *****>0**

Remember that address "0" is reserved for the master checkback module.

The distant logon remains in effect until you do one of the following:

- Log off the distant module

- Log off locally
- Do not communicate with the remote module for 15 minutes

If you want, you can log onto all checkback modules in the network at once. To remain logged on, however, you have to talk to each module before it times out.

16.5.6.1 Limitations and Concerns

1. The data rate is slow, 60 bits per second. A long command like get settings from a distant checkback module takes 30 seconds or more to complete, depending on the quality of the communication channel.
2. The system is only intended to support one module communicating at a time. If multiple modules attempt to talk, commands may fail, although any data that gets through will be accurate.
3. Changing a distant module's address is permitted, but avoid assigning it an address that is already in use - or you will not be able to talk to either module at that address until you can locally change one or the other's address.

16.5.7 Recovering Your Lost Password

Checkback modules are inaccessible when you do not know the correct password. If you somehow lose or forget yours, there is a way to recover it. From the "enter password" prompt, type **super** and press the ENTER key. This identifies you as a "super user". These letters (s u p e r) are displayed as asterisks, just as a normal password would be. This pops up the Super User Menu. Press "1" and the module displays ten four-character, hexadecimal numbers. For example:

```
d203 f659 26ac b4ed 1158 5302  
1bf4 1d86 8ab3 98e9
```

Following the screen directions, contact Pulsar, and we can decode these numbers and determine your current password.

16.5.8 Checkback Command Quick Reference

Table 16-5. Test and General Settings.

Command String	Function	Abbreviation
Set address n	Set node address - address 0 = master	Set addr n
Set primary comm timed	Simple, timed carrier communication	Set prim time
Set primary comm coded	Serial stream communication	Set prim code
Set fallback comm timed	Timed carrier for retry fallback comm.	Set fall time
Set fallback comm coded	Serial stream for retry fallback comm.	Set fall code
Set interval periodic	Do checkback at regular intervals	Set int peri
Set interval timed	Do checkback at specified hours	Set int time
Set recovery off	Enable automatic failure recovery	Set reco off
Set recovery on	Disable automatic failure recovery	Set reco on
Set auto off	Enable automatic checkback tests	Set auto off
Set auto on	Disable automatic checkback tests	Set auto on
Set factory default n	Configure to factory setting n, 0 = none	Set fact n
Set pwd password	Sets module password, 10 chars max.	Set pwd p
Set all	Sets all a distant module's settings	Set all > m
Get all	Sets local settings to match distant settings	Get all > m
Set sync on	Enables automatic clock synchronization	Set sync on
Set sync off	Enables automatic clock synchronization	Set sync on

Table 16-6. Output States.

Command String	Function	Abbreviation
Set major alarm open	Output opens for Major Alarm	Set majo open
Set major alarm close	Output close for Major Alarm	Set majo close
Set minor alarm open	Output open for Minor Alarm	Set mino open
Set minor alarm close	Output close for Minor Alarm	Set mino close
Set pass checkback open	Output opens for successful checkback	Set pass open
Set pass checkback close	Output closes for successful checkback	Set pass close
Set recovered open	Output opens for successful recovery	Set reco open
Set recovered close	Output closes for successful recovery	Set reco close
Set testing open	Output opens when test in progress	Set test open
Set testing close	Output closes when test in progress	Set test close
Set alarm contacts seal	Seal in alarm contacts	Set alar seal
Set alarm contacts momentary	Momentary alarm contacts	Set alar mome

Table 16–7. Test and Communications Options.

Command String	Function	Abbreviation
Set retries nn	Retries before reporting a failure, max = 20	Set retr nn
Set low power tests off	Do only the both high power tests	Set low off
Set low power tests on	Do both high and low power tests	Set low on
Set id failed off	Don't identify the failed end	Set id off
Set id failed on	Identify the failed end	Set id on

Table 16–8. Times and Intervals.

Command string	Function	Abbreviation
Set time1 checkback hh	Time 1 to do checkback test	Set time1 hh
Set time2 checkback hh	Time 2 to do checkback tests	Set time2 hh
Set time3 checkback hh	Time 3 to do checkback test	Set time3 hh
Set time4 checkback hh	Time 4 to do checkback test	Set time4 hh
Set periodic hours hh	Periodic checkback interval	Set peri hh
Set loopback duration ss	Seconds to do loopback test	Set loop ss
Set self test frequency mm	Minutes between self test recovery tries	Set carrier mm
Set time hh:mm:ss	Set node time - hours, min, sec	Set clock hh:mm:ss
Set date mm/dd/yy	Set node date - month, day, year	Set date mm/dd/yy

Table 16–9. Information Commands.

Command String	Function	Abbreviation
Get event n{-m}	Gets event n or events n to m	Get eve n{-m}
Get counts	Gets the node's current alarm & event count	Get cou
Get status	Displays the status of front panel leds	Get sta
Get settings	Gets the node's current settings	Get set

Table 16-10. Clearing Commands.

Command String	Function	Abbreviation
Clear alarms	Clears major and minor alarm outputs	Clr a
Clear events	Clears all stored events	Clr e
Clear counts	Clears event counts	Clr c

Table 16-11. Action Commands.

Command String	Function	Abbreviation
Do loopback	Initiates a loopback test	Do loop
Do checkback	Initiates a checkback test	Do chec

Table 16-12. Logon Commands.

Command String	Function	Abbreviation
Logon pwd	Logs onto a local or distant module	Logon pwd
Logoff	Logs off a local or distant module	Logoff

Table 16-13. Help Commands.

Command String	Function	Abbreviation
Help	General help display	Help
Help (command type)	Help (command type)	Command type (set, do, get, clear)
Help (command)	Any valid command	Help (command)

Table 16–14. Network Troubleshooting.

ALARMS				
Master Module		Remote Module		Probable Situation
Major	Minor	Major	Minor	
clear	clear	clear	clear	All OK
clear	clear	clear	set	Weak/noisy line
clear	clear	set	clear	Master or line failed
clear	clear	set	set	Remote failed
clear	set	clear	clear	Weak/noisy line
clear	set	clear	set	Weak/noisy line
clear	set	set	clear	Weak/noisy line or master failed
clear	set	set	set	Remote failed
set	clear	clear	clear	Remote or line failed
set	clear	clear	set	Remote or line failed
set	clear	set	clear	Line failed
set	clear	set	set	Remote failed
set	set	clear	clear	Master failed
set	set	clear	set	Master failed
set	set	set	clear	Master failed
set	set	set	set	Master and remote failed

16.6 Troubleshooting

You can identify and solve many checkback network problems by examining the major and minor alarms. If both high and low power checkback tests are enabled, the major and minor alarms work like this:

- If a module fails only the low power test, it sets the minor alarm
- If a module fails the high power test, it sets the major alarm
- If a module fails the high power test and can not receive its own messages, it sets both major and minor alarms

Armed with this information, you can usually identify a failed module or line problem. Table 16-14 lists all combinations for a two-module system and the probable situation.

To get the complete picture, you must wait long enough for all remotes to initiate their own checkback tests. For example, if the master has a major alarm, but the remote has no alarms, you can not determine if it failed to receive the command due to a bad line or because its receiver is dead. By waiting for the remote to initiate a checkback, you can tell if it is the line (major alarm) or the module (both alarms).

16.7 Drawings

The Universal Checkback Module's simplified component layout is shown in Figure 16-11. The schematics are available upon request. Figure 16-12 shows a simplified schematic with labeled inputs and outputs.

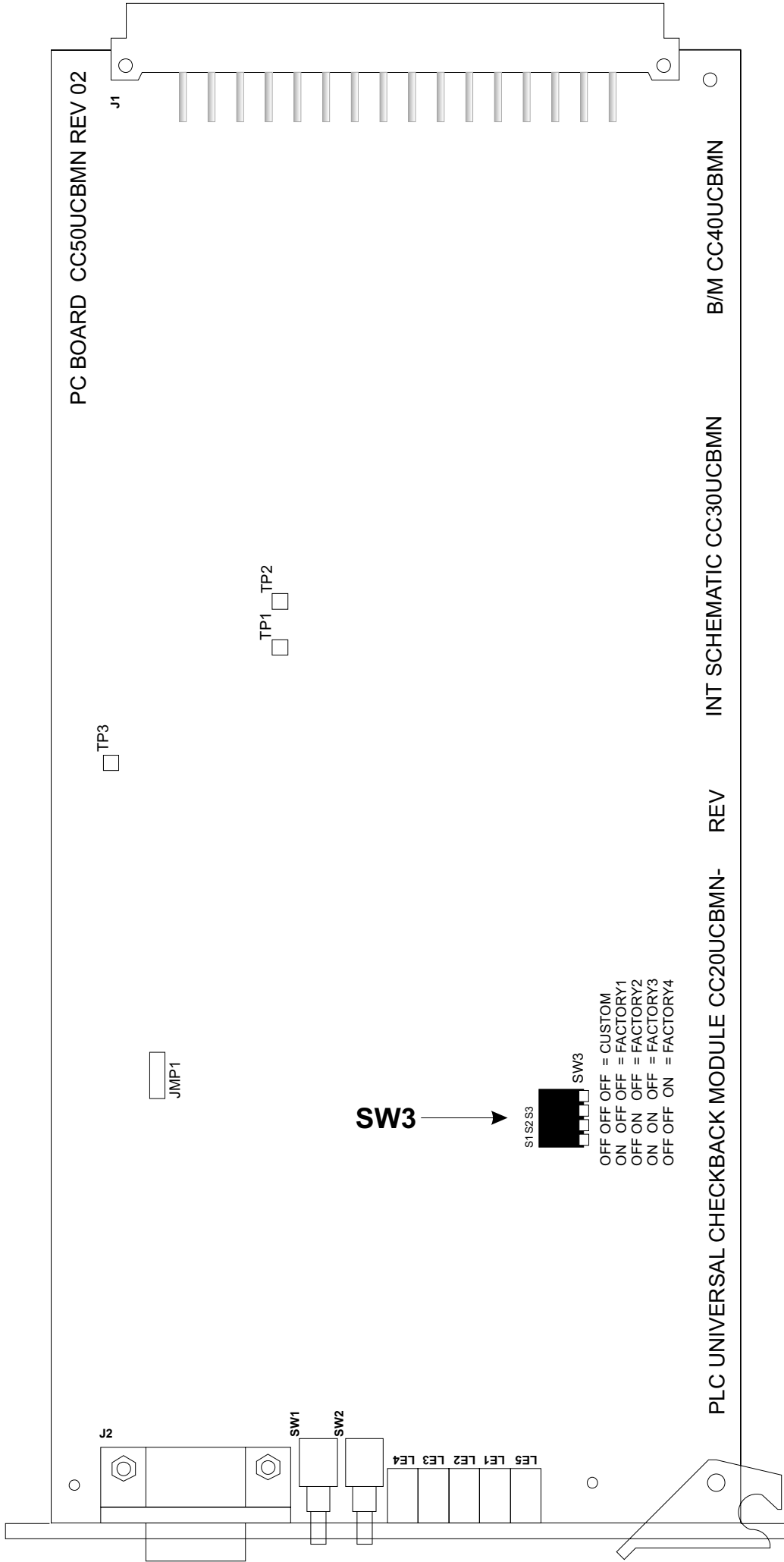
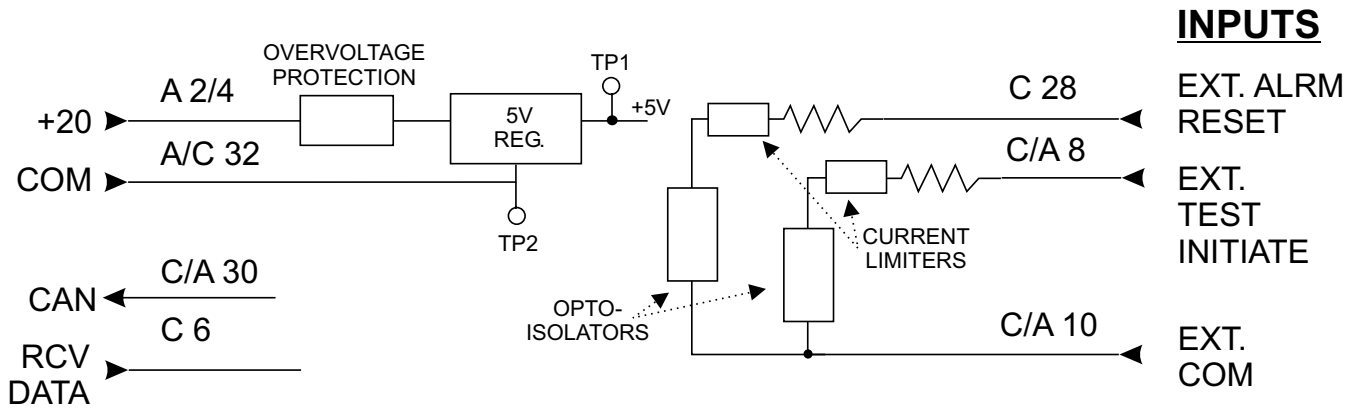


Figure 16–11. Universal Checkback Module – Simplified Component layout



OUTPUTS

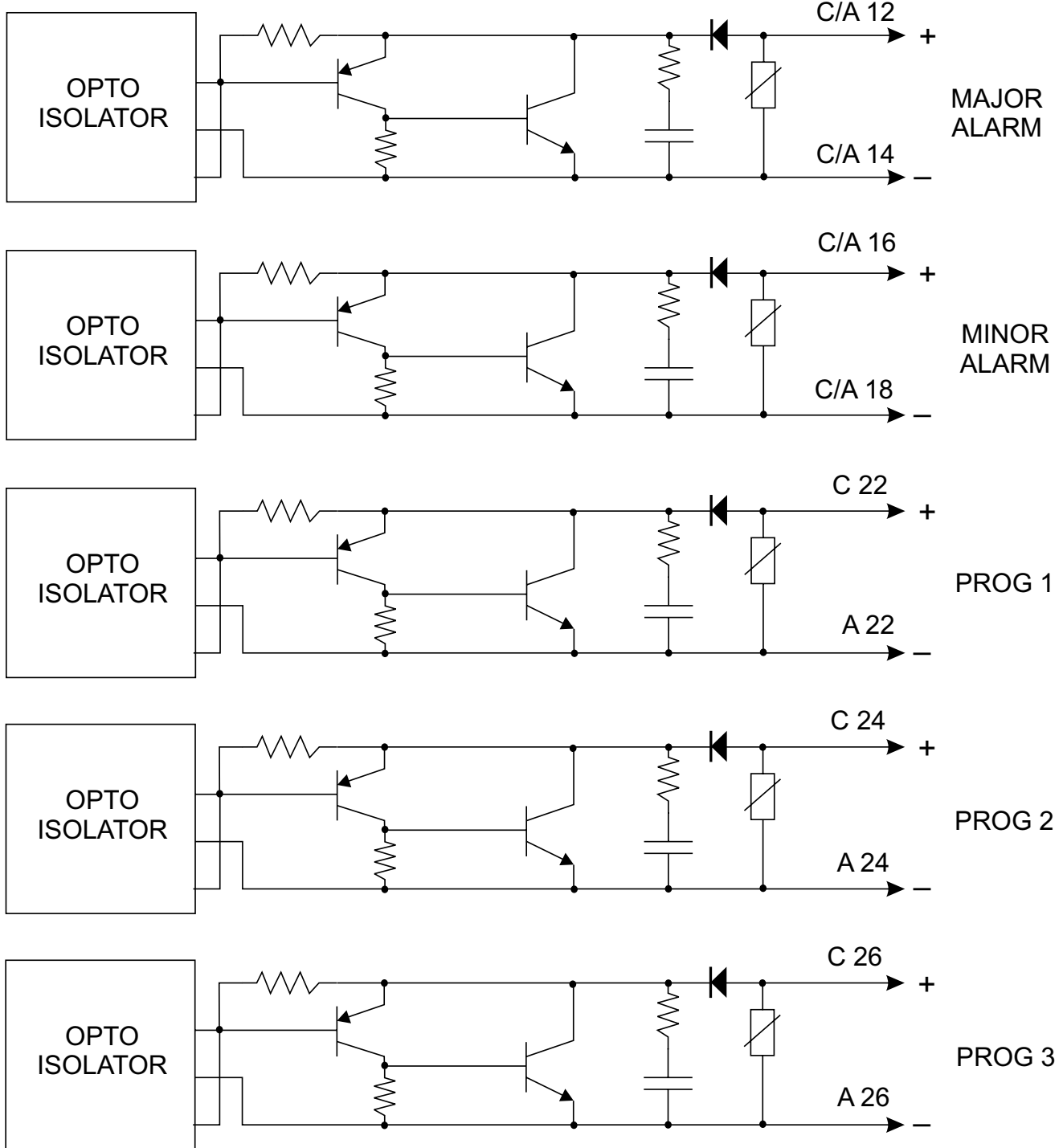


Figure 16-12. UCB Module Block diagram.

Chapter 17. Optional Voice Adapter Module

Table 17-1. Optional Voice Adapter Style and Description.

Schematic	C030-VADMN
Parts List	C040-VADMN

Style Number	Description
C020-VADMN-001	Optional Voice Adapter Module

17.1 Voice Adapter Module Description

The Voice Adapter Module provides voice communications between terminals of the TC-10B and TCF-10B carrier systems. You can use the same module in either type of system simply by changing the DIP switch settings (see the "Voice Adapter Module Settings" section later in this chapter). This chapter describes the module's use in TC-10B carrier systems.

The Voice Adapter Module also provides signaling, which includes an on-board audible alarm and LED to indicate incoming calls. For the TC-10B, voice communication is in half-duplex mode. That is, you can talk and listen, but not at the same time (like a two-way radio). This is because, in a TC-10B system, the module transmits and receives on the same frequency.

17.1.1 TC-10B Operation (Half-Duplex)

Figure 17-1 provides a simplified look at how the Voice Adapter Module operates when used in a TC-10B carrier system. It works like this:

Receive Direction

1. The Universal Receiver Module in the TC-10B system outputs an audio signal to the Voice Adapter Module.
2. The Voice Adapter Module filters the audio signal and runs it through an expander.
3. The Voice Adapter Module then amplifies the audio signal and sends it to the handset. (You can adjust the receive audio level by turning the RECEIVE AUDIO potentiometer on the module's front panel.)

Transmit Direction

1. The Voice Adapter Module filters the audio signal coming from the handset and runs it through a compressor.
2. The Voice Adapter Module then amplifies the audio signal and sends it to the Keying Module.

17.1.2 Handset Operation

You can connect the handset (with a push-to-talk switch) to the TC-10B in four different ways:

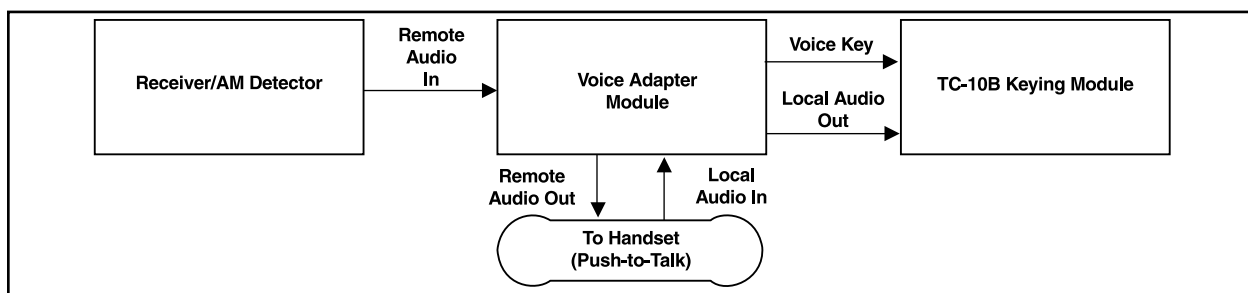


Figure 17-1. Voice Adapter Module — Simplified Signal Flow Diagram.

Option 1: Local Connection

Plug the handset into the Voice Adapter Module at the front panel "HANDSET" jack.

Option 2: Remote Connection

Connect the handset through a remote jack to the TC-10B rear panel (see Figure 17-6).

Option 3: Remote Hookswitch Connection

Remotely connect a hookswitch assembly which supports a handset to the TC-10B rear panel (see Figure 17-6).

Option 4: Combination Remote Hookswitch - Telephone Jack Connection

Remotely connect a telephone jack and a hookswitch assembly to the TC-10B rear panel (see Figure 17-6).

Option 1: Using the Local Handset Configuration

To configure your system for this option, set the DIP switch (SW1) to the normal, or default, settings as shown in Table 17-3.

To initiate signaling with this option:

1. Plug the handset into the Voice Adapter Module at the front panel "HANDSET" jack.
2. Press the push-to-talk switch on the handset.

This rings the other end of the system.

To answer a ring (at the receiving end) with this option, plug a handset into the Voice Adapter Module at the front panel "HANDSET" jack. This stops the ringing by turning off the internal alarm circuit. (The internal alarm circuit includes an audible beeping alarm, an alarm LED, and a relay contact output.)

To configure for external ringing, disable the internal beeper by setting SW1-4 to the UP (OPEN) position (see "DIP Switch Settings" later in this chapter). Then connect an external alarm, as shown in Figure 17-6.

Option 2: Using the Remote Handset Configuration

To configure your system for this option:

1. Disable the internal beeper by setting SW1-4 to the UP (OPEN) position.
2. Connect a remote handset jack and an external alarm circuit in series with the

NOTE

Whenever you are using a remote handset, you should disable the internal beeper and replace it with an external alarm.

TB5 terminal block on the TC-10B rear panel. Use the wiring diagram in Figure 17-6 as a guide.

To initiate signaling with this option:

1. Plug the handset into the remote handset jack.
2. Press the push-to-talk switch on the handset.

This rings the other end of the system.

To answer a ring (at the receiving end) with this option, plug the handset into the remote handset jack. The remote jack stops the ringing by interrupting the external alarm circuit.

Option 3: Using the Remote Hookswitch Configuration

To configure your system for this option:

1. Disable the internal beeper by setting SW1-4 to the UP (OPEN) position.
2. Connect a remote hookswitch and an external alarm circuit in series with the TB5 terminal block on the TC-10B rear panel. Use the wiring diagram in Figure 17-6 as a guide.

Note that, whenever you are using a remote handset, you should disable the internal beeper and replace it with an external alarm.

To initiate signaling with this option:

1. Lift the handset from the hookswitch.
2. Press the push-to-talk switch on the handset.

This rings the other end of the system.

To answer a ring (at the receiving end) with this option, lift the handset from the hookswitch. The hookswitch contacts stop the ringing by interrupting the external alarm circuit.

Option 4: Using the Combination Remote Hookswitch/Telephone Jack Configuration

To configure your system for this option:

1. Disable the internal beeper by setting SW1-4 to the UP (OPEN) position.
2. Connect a remote hookswitch, a remote telephone jack, and an external alarm circuit in series with the TB5 terminal block on the TC-10B rear panel. Use the wiring diagram in Figure 17-6 as a guide.

To initiate signaling with this option:

NOTE

Whenever you are using a remote handset, you should disable the internal beeper and replace it with an external alarm.

1. Lift the handset from the hookswitch and plug it into the remote telephone jack.
2. Press the push-to-talk switch on the handset.

This rings the other end of the system.

To answer a ring (at the receiving end) with this option, lift the handset from the hookswitch and plug it into the remote telephone jack. This stops the ringing by interrupting the external alarm circuit.

17.1.3 Electrical Characteristics

The Voice Adapter Module's electrical characteristics are shown in Table 17-1.

Table 17-2 Voice Adapter Module Electrical Characteristics.

Feature	Specification
Operating Temp Range	-20° to +65°C (Ambient)
Audio Frequency Response	300 to 2,000Hz (-3dB bandwidth)
Receiver Sensitivity	19mV min.
AGC Dynamic Range	Audio output \pm 2dB for RF level change of +10dB to -15dB on Receiver CLI meter
Signaling Tone	370Hz \pm 10Hz
Signaling Tone Detector	370Hz \pm 10Hz
Transmit Audio level	3.2V p-p (in limit) into 600 Ω
Receive Audio Squelch Threshold	-15dB on Receiver CLI meter
Powering	Module powered from +20V, common, and -20V power supply. Supply current is 40ma max from +20V supply & 10ma max from -20V supply when voice keyed
External Handset & Signaling Inputs	Meets IEEE impulse and IEEE SWC tests (ANSI C37.90.1).
Alarm Contact Terminals	Passes 2,500Vdc hi-pot for one min. (normal open/normal closed, jumper selectable).

17.2 Voice Adapter Front Panel

The Voice Adapter Module's front panel is shown in Figure 17-2. It provides the following operator controls:

Calling Push button (SW2)

This push button, labeled "CALLING P.B.", is not used with TC-10B carrier systems. It is used only with TCF-10B carrier systems.

Alarm LED (LE1)

This LED, labeled "ALARM", indicates when an incoming call is being received. At the same time the incoming signal activates this LED, it also activates the alarm relay and, if enabled, the audible alarm.

Receive Audio Level Adjustment (P1)

This potentiometer, labeled "RECEIVE AUDIO", adjusts the receive audio level.

Handset Jack (J2)

This jack, labeled "HANDSET", is for connecting the handset to the Voice Adapter Module. The handset schematic is shown in Figure 17-8.

17.3 Rear Panel Connections

The terminal block connections for the Voice Adapter Module are on the rear panel of the TC-10B chassis. They are shown in Figure 3-5.

The Voice Adapter Module's terminal block connections are used as follows:

TB5-1	External receiver output
TB5-2	External microphone input
TB5-3	Common
TB5-4	Alarm signal (NO or NC)
TB5-5	Alarm signal (NO or NC)
TB5-6	Signaling input (external calling switch, to be returned to common when signaling).

17.4 Voice Adapter Module Settings

The Voice Adapter Module has three types of user-configurable settings. These include the jumper JMP1 and the DIP Switch SW1 on the PC board and the RECEIVE AUDIO potentiometer on the module's front panel.

17.4.1 Receive Audio Level Setting

You can adjust the receive audio level by turning the RECEIVE AUDIO potentiometer (P1) on the module's front panel. Turn it clockwise to increase the receive audio level; counter-clockwise to decrease it.

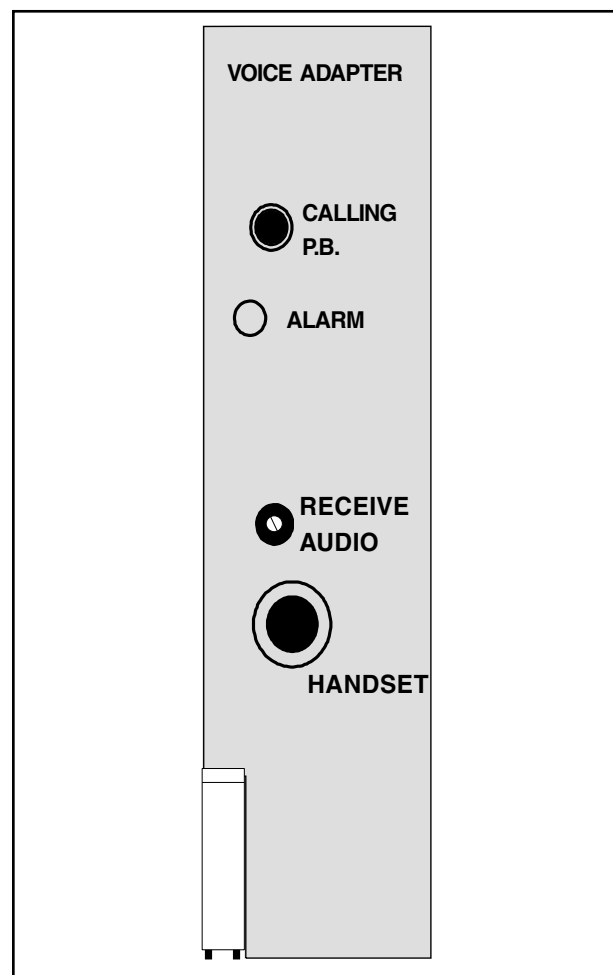


Figure 17-2. Voice Adapter Module – Front Panel.

17.4.2 Jumper Setting

The jumper JMP1 setting determines whether the external alarm connected to the rear panel (TB5-4, TB5-5) is normally open (NO) or normally closed (NC). The factory default is normally open.

17.4.3 DIP Switch Settings

The DIP switch (SW1) on the module's PC board lets you enable or disable several functions. Table 17-2 shows the function that is enabled for each of the four DIP switch positions when they are DOWN (CLOSED). When a switch position is UP (OPEN), its function is disabled. Table 17-3 shows the default settings when using the Voice Adapter Module in a TC-10B carrier system.

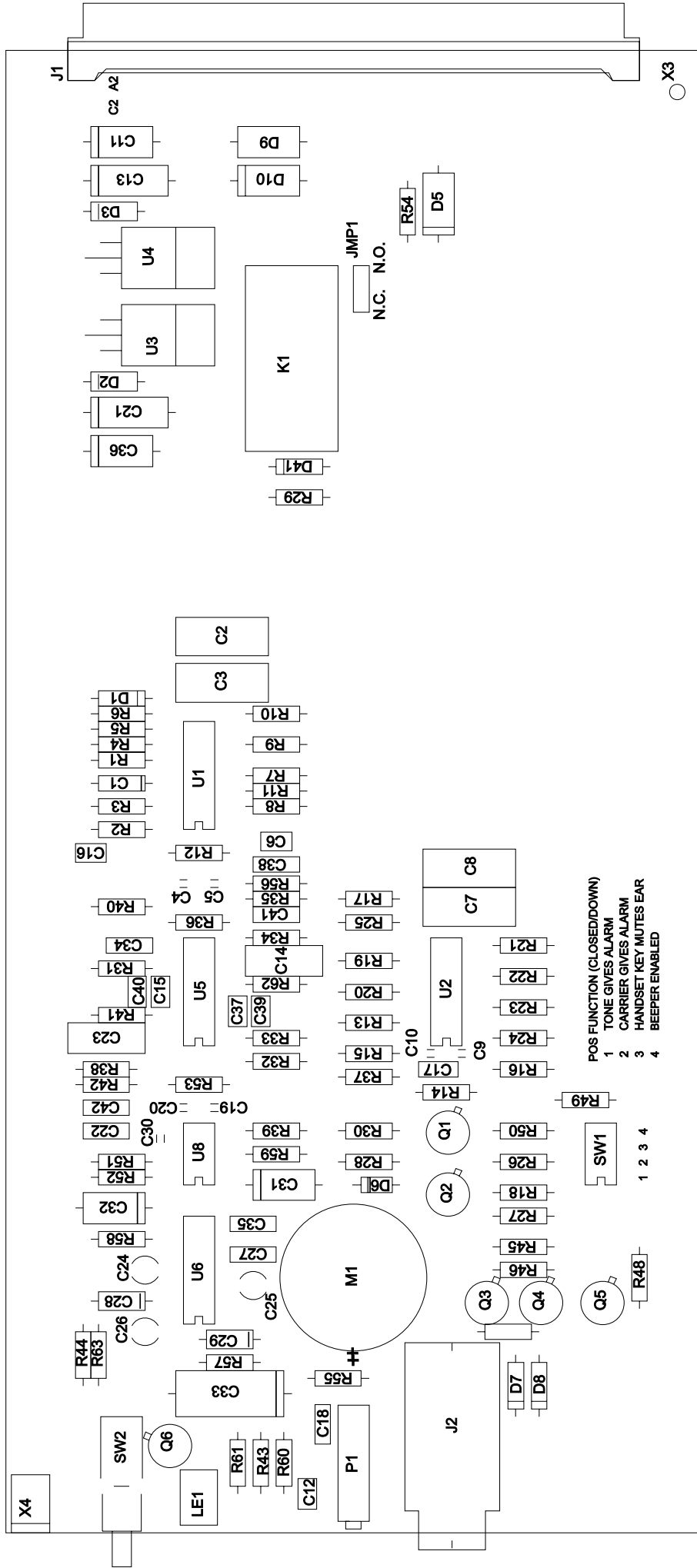
Table 17-3 DIP Switch Setting Functions.

Position	Function when DOWN (CLOSED)
SW1-1	Pushing "CALLING P.B." (on front panel) generates a tone that gives an alarm
SW1-2	Receiving a carrier signal gives an alarm
SW1-3	When the handset is keyed, the earphone is muted
SW1-4	Enables the audible internal alarm (beeper)

Table 17-4 Default (Normal) Settings for TC-10B Operation.

Position	Default (Normal) Setting
SW1-1	UP (OPEN)
SW1-2	DOWN (CLOSED)
SW1-3	DOWN (CLOSED)
SW1-4	DOWN (CLOSED)

Figure 17-3. Voice Adapter Module PC Board (C020VADMN).



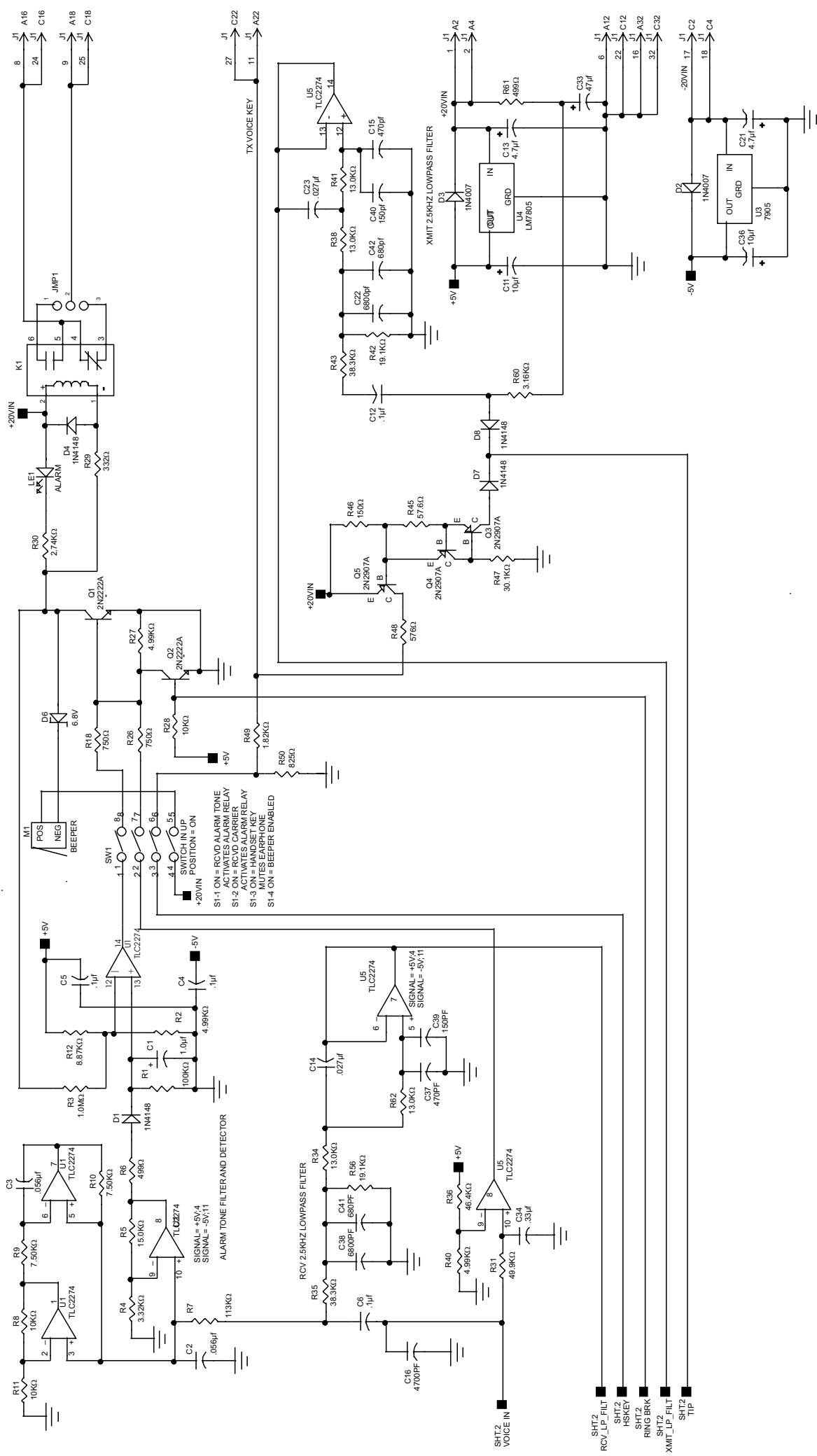
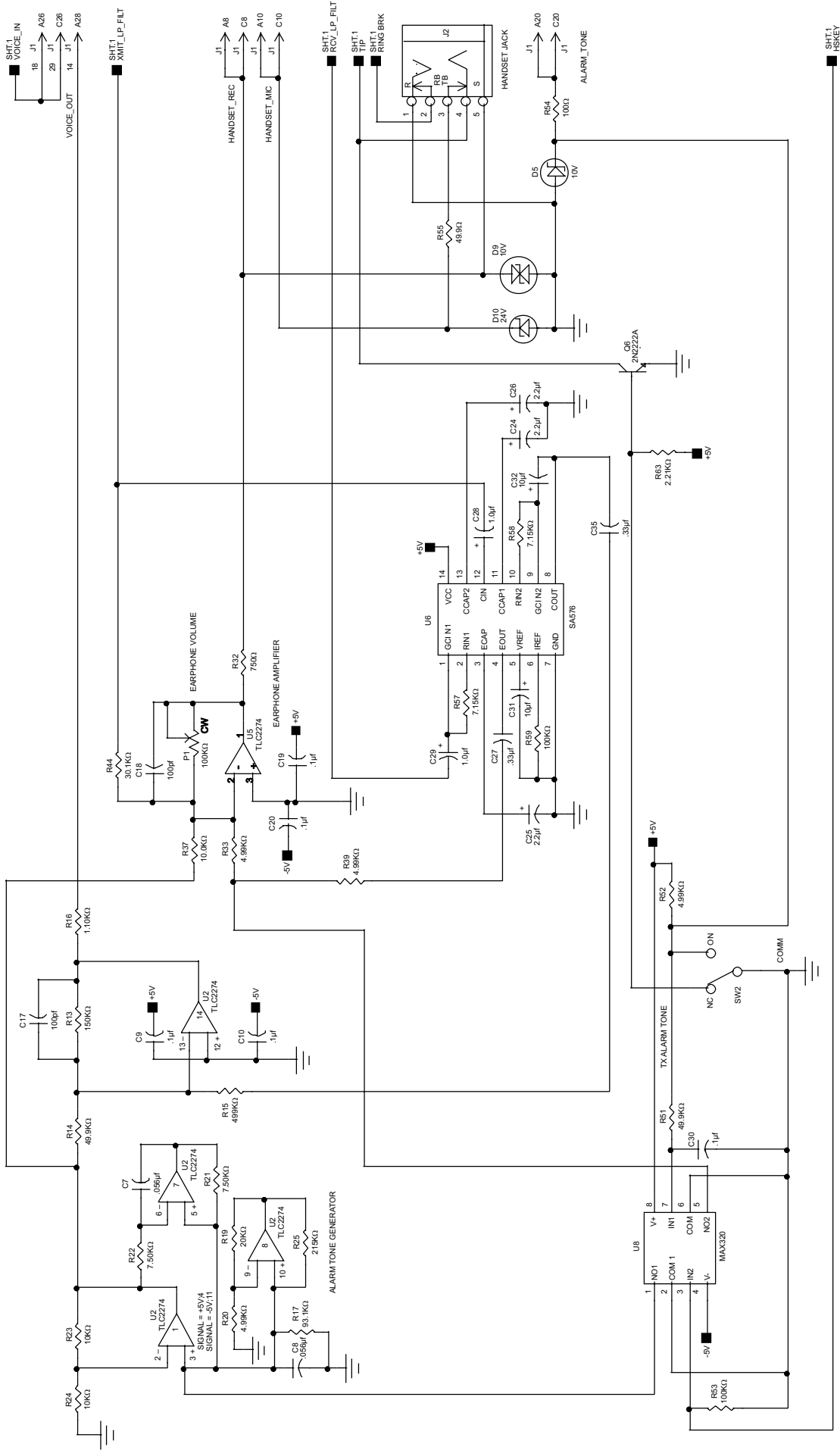


Figure 17-4. Voice Adapter Module Schematic (C030VADMN1) Sheet 1 of 2.

Figure 17-5. Voice Adapter Module Schematic (C030VADMN2) Sheet 2 of 2.



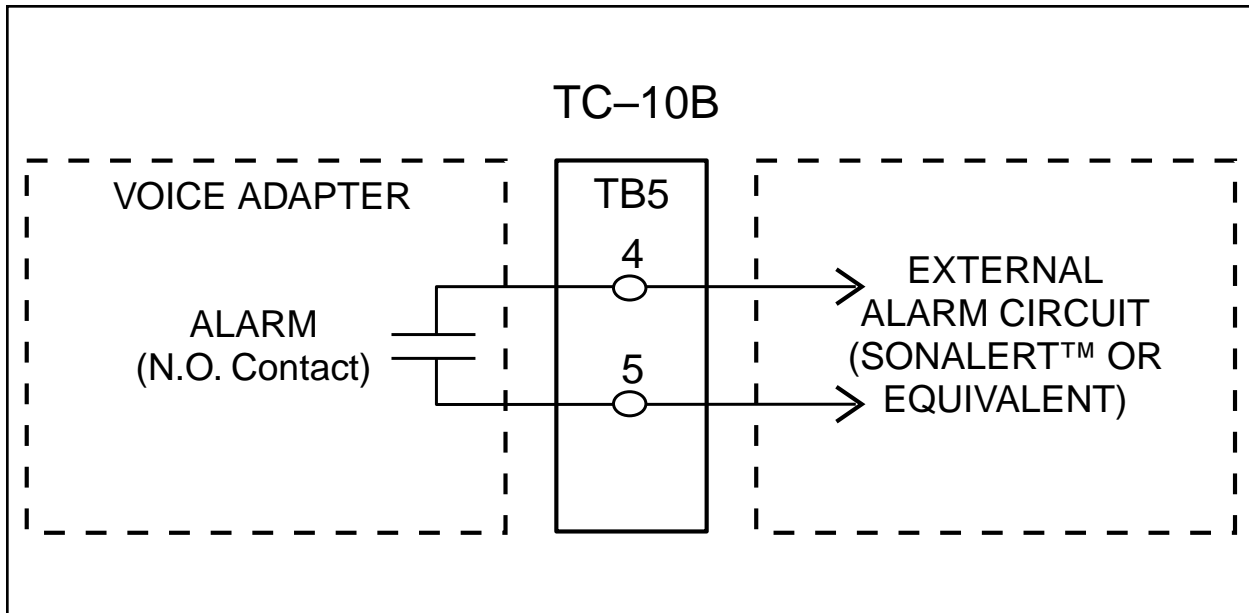


Figure 17-7. External Alarm Circuit for Use with Module Front Panel Jack (9651A88).

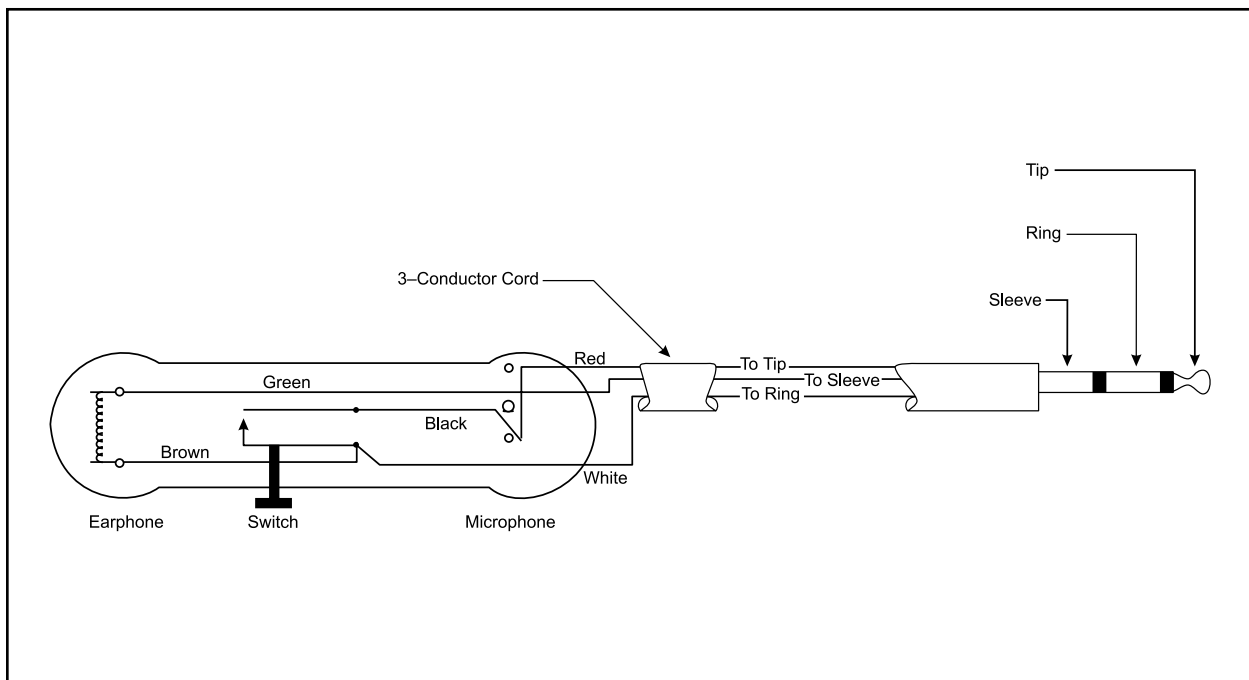


Figure 17-8. TC-10B Handset schematic.

