TM-8076405505

RADIO TELEPHONE INTERFACE UNIT

RTU-200

OPERATION and MAINTENANCE MANUAL

SUNAIR 3101 SW Third Avenue, Ft. Lauderdale, FL 33315-3389

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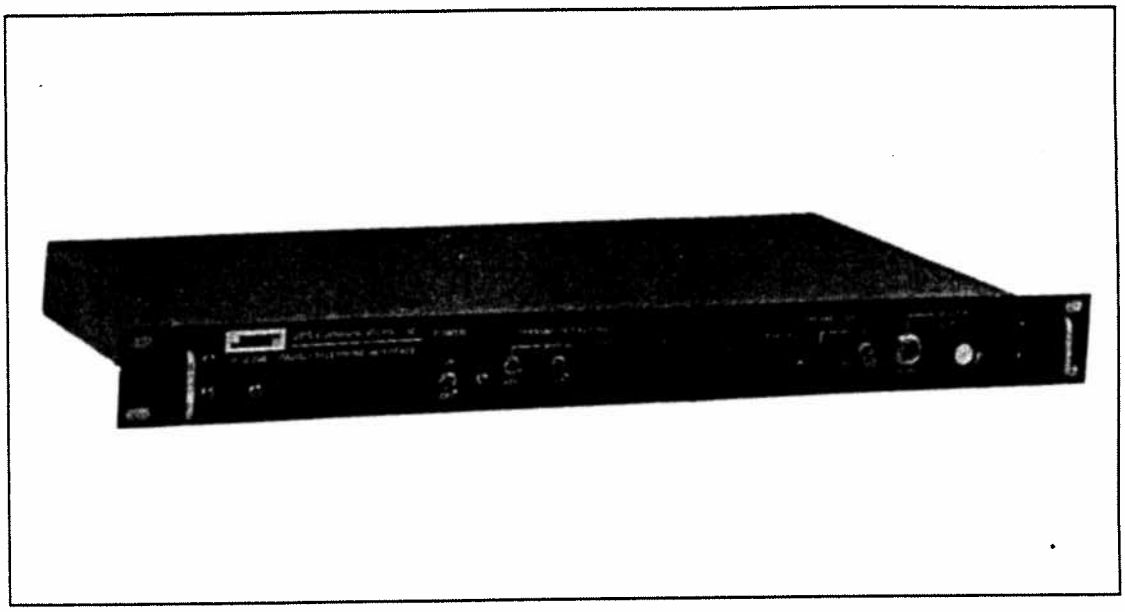
SUNAIR ELECTRONICS, INC.

OPERATION and MAINTENANCE MANUAL



RTU-200
RADIO/TELEPHONE INTERFACE UNIT

Designed and Manufactured by:

JPS Communications, Inc.
P.O. Box 97757
Raleigh, NC 27624-7757

Publication # 5890 600200 Revision 3.6 July 1994

PRODUCT SERVICE:

In case of difficulty please contact the Sunair Product Service Department, between the hours of 8:00 AM and 5:00 PM or write to:

Product Service Dept.
Sunair Electronics, Inc.
3101 SW Third Avenue
Ft. Lauderdale, FL 33315-3389
U.S.A.

Telephone: (305) 525-1505

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NOTICE

JPS Communications, Inc. reserves the right to make changes to the equipment without prior notice.

PROPRIETARY STATEMENT

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SECTION 1

GENERAL INFORMATION

1.1 SCOPE

This instruction manual provides the information necessary to install, operate, repair and maintain the RTU-200 Radio/Telephone Interface Unit.

1.2 DESCRIPTION

For specifications, see Table 1.1 on page 1-3.

1.2.1 GENERAL

The RTU-200 Radio/Telephone Interface Unit is designed for use in a communications console to provide trouble-free automatic connection between a radio system and telephone or other two-wire line. The unit is equally suited for use with HF, VHF, UHF or satellite systems and is applicable to full duplex, half duplex or simplex systems. Transmitter keying may either be controlled manually from the front panel, or by a built-in voice operated transmit (VOX) facility.

The RTU-200 patches a telephone into a radio link through a very simple procedure. First, a radio-to-radio link is established. The radio operator then places a phone call to a far telephone that will be patched into the radio link. To do this, the radio operator uses a local phone that is plugged into the rear panel of the RTU-200. Once this telephone-to-telephone link is made, the operator simply throws the Connect Switch on the front panel. The RTU-200 adapts to the telephone line, and the far telephone becomes part of a telephone-to-radio-to-radio communications link.

The RTU-200 is the most advanced piece of equipment of its type. Using a unique adaptive hybrid implemented with a Digital Signal Processor, the RTU-200 eliminates conventional VOX and hybrid adjustments for quick and simple system set-up.

The unit works by measuring the characteristics of the telephone line each time the CONNECT switch is engaged. A short burst of white noise is placed on the telephone line. During the noise burst, the adaptive hybrid in the unit measures the signal reflected from the phone line and uses this measurement to achieve a broadband hybrid balance on the reactive phone line. This is simply not possible with any type of conventional active or passive hybrid. Not only does this provide a deep, broadband null, but the action is completely automatic and the unit continuously adapts to changing line conditions, making operation insensitive to line impedance.

The input and output levels are adjustable from the front panel to accommodate all types of radio systems. A set-up mode allows the adjustment of the RTU-200 receiver and transmitter signal levels with no external test equipment required.

The unit will interface all types of two-wire lines, such as normal dial-up lines, dedicated lines, or twisted-pair field wire. Although the output impedance is fixed at 600Ω, the adaptive hybrid in the unit will give excellent hybrid balance regardless of the impedance of the line connected to the unit.

The RTU-200 has been designed for easy integration into a communications console. During normal phone patch operation, audio signals are passed between a telephone line and a radio, conditioned by the RTU-200. Rear panel connectors, labeled RADIO (P1) and TEL LINE (J2) accept these audio signals from the communications system. The units rear panel has two additional connectors which allow the radio and the telephone line to be used by other parts of the communications system when the unit is de-activated.

When the RTU-200 is in the DISCONNECT mode, or if power is off, signals are routed as follows:

1. The telephone line audio at J2 is routed to the TEL SET connector, J1. A local telephone set, connected to J1, allows the console operator to place and receive calls normally whenever the phone patch is not in use.
2. Radio audio signals are routed to the AUX AUDIO (P2) connector. This allows other console equipment to control and exchange audio with the radio.

When the RTU-200 is in the CONNECT mode, the audio lines in the AUX AUDIO connector are completely disconnected. The local telephone at the TEL SET (J1) connector is also disconnected if internal jumpers JP4 and JP5 are in the SWITCHED positions.

The RTU-200 also features remote operation, allowing control of the unit from a custom console panel. Control lines for all front panel controls are present in the REMOTE (P3) connector. Pulling the /RMT signal low disables all front panel controls and allows control only by the control lines in the REMOTE (P3) connector.

1.2.2 ASSEMBLIES

The RTU-200 contains just one assembly, the main PC board, with three general sections of circuitry: the Audio Section, the DSP Section, and the Power Supply Section. These are described briefly in the following paragraphs.

Refer to the RTU-200 Simplified Schematic along with the text. The DSP Section is shown in dotted lines; the remainder

contains the Audio Section and front panel components. The Power Supply is not shown in the simplified schematic. Refer to Section 4 for more details.

1.2.2.1 Audio Section

The Audio Section consists of operational amplifier circuits which handle the audio interfaces to the RTU-200. The amplifiers provide gain adjustability to accommodate various input and output levels, and also provide impedance transformation and output drive capability.

1.2.2.2 DSP Section

The Digital Signal Processor (DSP) section is the heart of the unit, as the adaptive hybrid is implemented with the DSP. From a hardware standpoint, the DSP section consists of a TMS320E15 DSP interfaced with dual analog interface Sics. A parallel I/O is also provided. Each analog interface circuit consists of A/D and D/A converters with filtering before the A/D and after the D/A. Two units are required because audio signals at two different circuit points must be sampled. The DSP hardware also includes a power-up reset circuit to insure that the unit always starts properly upon application of power or following a momentary power outage.

From a software standpoint, the following functions are implemented in software in the DSP section: the adaptive hybrid, the VOX, an audio peak detector, the noise generator for measuring the telephone line characteristics, an audio delay and the transmit set-up tone generator. In addition, the DSP handles all of the peripheral functions of the unit, such as remote control, checking the front panel switches and driving the front panel indicators.

1.2.2.3 Power Supply Section

The power supply in the RTU-200 is a conventional passive regulator type using a small PC mounted line transformer. The supply furnishes regulated voltages of +12V, -12V, +5V and -5V to the unit, and has ample margin to allow flawless operation even under severe line voltage extremes. Optional DC supply circuitry allows the RTU-200 to be run from a +12V or +24V DC power source.

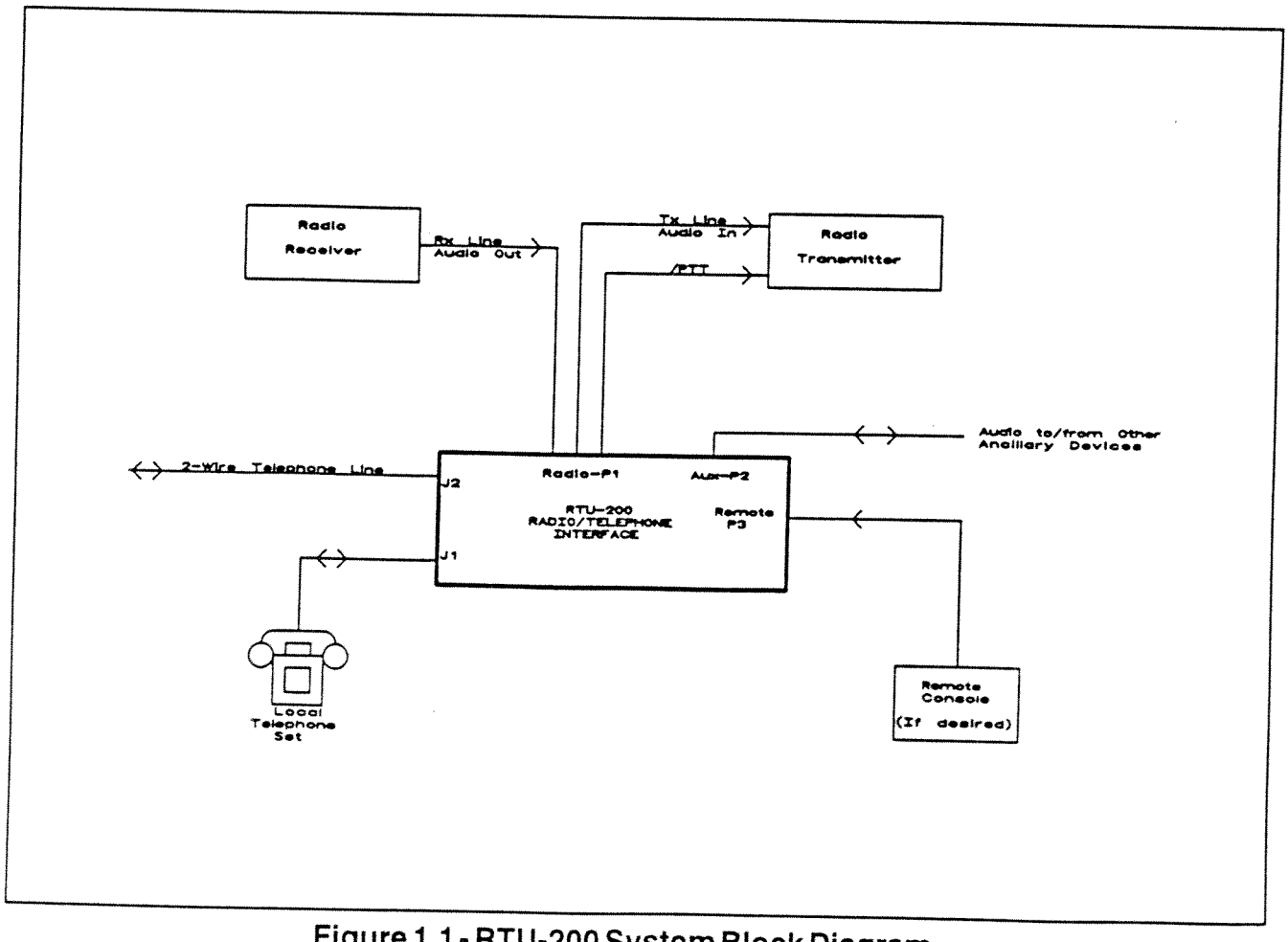

Figure 1.1 - RTU-200 System Block Diagram

TABLE 1.1

RTU-200 SPECIFICATIONS

TELEPHONE LINE INTERFACE	
Output Level to Phone Line	Nominally -9 dBm. (Adjustable -15 to +6 dBm in 3 dB steps).
Input Level from Phone Line	Nominally -9 dBm. (Adjustable -15 to +6 dBm in 3 dB steps).
Frequency Response	300 to 3200 Hz, ±2 dB.
Output Impedance to Phone Line	600Ω.
VOX Sensitivity	16 ±2 dB below phone line input level setting.
VOX Hang Time	1 Second or 1.5 Seconds, (Internally Adjustable).
Hybrid Balance/Adaptation Speed (into 600Ω)	-30 dB over 300 to 3200 Hz BW within 1.25 Sec. measured with white noise source.
Ultimate Hybrid Balance (into 600Ω)	-50 dB typical over 300 to 3200 Hz BW; measured with a single tone.
Hybrid Impedance Matching Capability	0 to ∞ Complex Impedance.
Phone Line Connections	RJ-11C Connector (J2) and Screw Terminals.
RADIO INTERFACE (P1, DB-9)	
Input Impedance	Balanced 600Ω or Unbalanced 600Ω or 56kΩ.
Input Level	-20 to +10 dBm, front panel adjustable.
Output Impedance	600Ω, balanced.
Output Level	-20 to +10 dBm, front panel adjustable.
Frequency Response	300 to 3200 Hz ±2 dB.
Key Transistor Output	Open Collector NPN Transistor, 50V & 100mA max. Switching Speed: 10*m*sec.
Key Relay Output	Low Level Relay Contacts, 60VA max. Switching Speed: 5 msec.
GENERAL	
Local Telephone Set Connections	RJ11C Connector (J1) and Screw Terminals.
Monitor Output	600Ω Output allows monitoring both sides of the conversation at the Front Panel Phone Jack and Remote Connector.
Daisy-Chain Audio Input/Output (P2, DB-9)	Radio Audio is routed to this connector when the RTU-200 is in Disconnect Mode or power is off.
Aux Connector (P3, DB-9)	Monitor Output, Remote Key, Remote VOX/Manual, Remote Connect/Disconnect.
Indicators	Power On, Peak Level, Connected, Keyed, Ready.
Front Panel Controls	Power On/Off Switch, VOX/Manual Switch, Key Switch, Connect/Disconnect Switch, TX Level Adjust, and RX Level Adjust, Monitor Jack Level.
AC Input Power	115 or 230 VAC ±15%, 47 - 63 Hz, 15 VA typical.
Size	1.70" H x 19" W x 10" D (4.32 x 48.26 x 25.4 cm)
Weight	6 lbs. (2.7 kg)
ENVIRONMENTAL	
Operating Temperature	-20°C to +55°C
Storage Temperature	-40°C to +85°C.
Humidity	Up to 95% @ 55°C.
Shock	MIL-STD-810D, method 516.3 procedure VI.
Vibration	MIL-STD-810D, method 514.3 Category I.

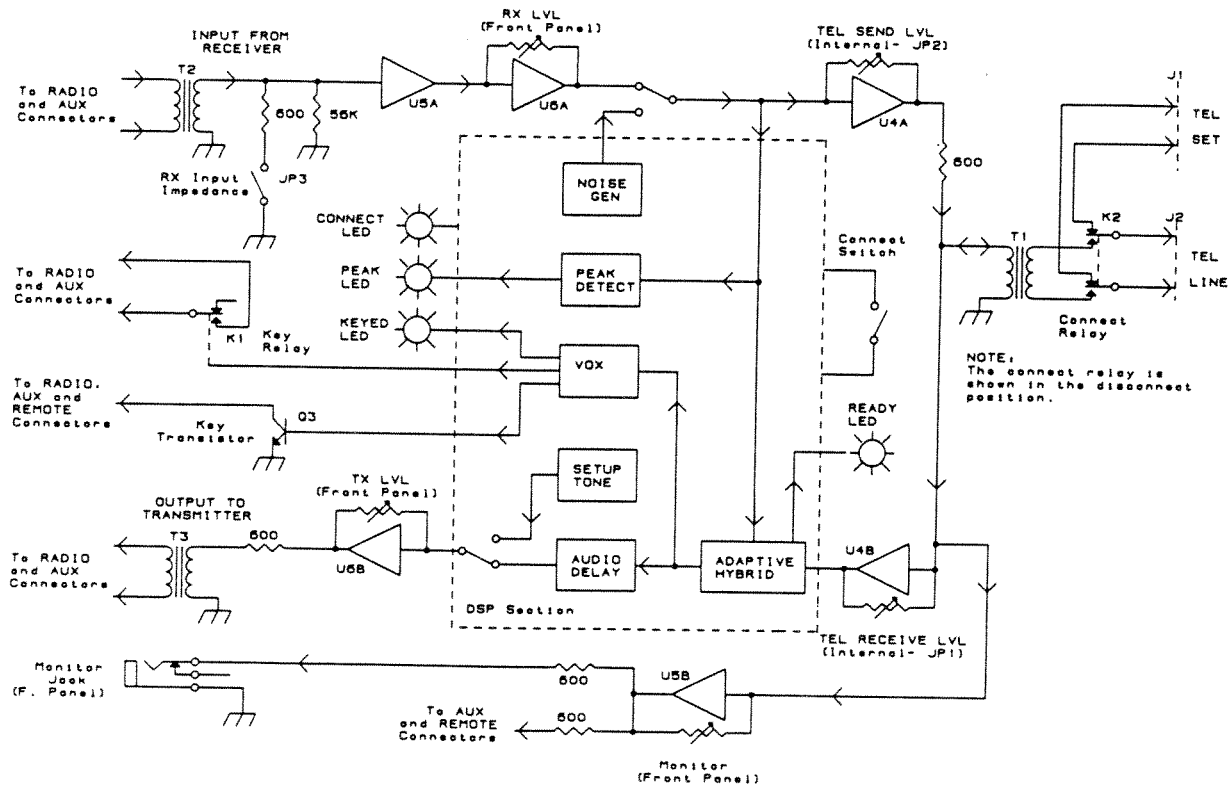

Figure 1.2 - RTU-200 Simplified Schematic Diagram

TABLE 1.2

EQUIPMENT and ACCESSORIES SUPPLIED

Qty	Item	JPS Part Number
1	RTU-200	5890-600000
	with +12VDC Supply Option	5890-690010
	with +24VDC Supply Option	5890-690011
1	Operation & Maintenance manual	5890-600200
1	Accessory Kit consisting of:	5890-600150

Qty	Item	
1 ea.	Line Cord	0313-037770
2 ea.	Fuse, 3AG, 1/4A, slow blow (For 115V)	0650-003100
2 ea.	Fuse, 3AG, 1/8A, slow blow (For 230V)	0650-001100
1 ea.	Conn, cable, DB-9 receptacle	0360-009000
2 ea.	Conn, cable, DB-9 plug	0360-009100
3 ea.	HW, clamp, cable, for DB-9 connector	0827-000001
5 ea.	Screw, 10-32 x 3/8 (For rack mounting)	0837-103200
5 ea.	Washer, Flat Nylon (For rack mounting screws)	0848-100001
6 ea.	Screw, fl. hd.,6-32,5/16, 100 degree (For cover mounting, spare)	0833-063205

TABLE 1.3

OPTIONAL EQUIPMENT - NOT SUPPLIED

Item	JPS Part Number	Description
Rack Slide Kit	5911-294000	2 quick disconnect rack slide assemblies. Brackets and hardware included.
Depot Spares Kit	5890-691000	Spares for 3 to 5 RTU-200 units.
Spare PC Board Kit	5890-692000	One spare RTU-200 PC board & installation kit.
	5890-692010	Spare PC Board Kit with +12VDC Supply Option.
	5890-692011	Spare PC Board Kit with +24VDC Supply Option.
Spare Parts Kit	5890-693000	Spares (except PC Board) for one RTU-200 Unit.
Cable Assembly, Audio	5890-604030	12 foot length; RTU-200 Audio plug one end, other end unterminated.
Cable Assembly, Remote	5890-604050	As above, but remote plug one end.
Telephone Interface Kit	5890-604040	Kit for connecting RTU-200 with RJ11C phone equipment. Contains 2 ea. 15' Modular Plug-to-Plug Cords, 2 ea. Dual In-Line Couplers, and 1 ea. Modular T Adapter.

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SECTION 2

INSTALLATION

2.1 GENERAL

This section provides the instructions for unpacking, inspection, installation and set-up. Also included are directions for reshipment of damaged parts or equipment.

2.2 UNPACKING AND INSPECTION

After unpacking the unit, retain the carton and packing materials until the contents have been inspected and checked against the packing list. If there is a shortage or any evidence of damage, do not attempt to use the equipment. Contact the carrier and file a shipment damage claim. JPS' Customer Service Department should be given a full report including the following information:

1. Order Number
2. Equipment Model and Serial Numbers
3. Shipping Agency
4. Date(s) of Shipment

The JPS customer service department can be reached by phone at (919) 790-1011, by fax at (919) 790-1456.

Upon receipt of this information, JPS will arrange for repair or replacement of the equipment.

2.3 RESHAPING OF EQUIPMENT

If it is necessary to return the equipment to the manufacturer, a Returned Material (RM) number must first be obtained from JPS. This number must be noted on the outside of the packing carton and on all accompanying documents. When packing the unit for reshipment, special attention should be given to providing adequate packing material around connectors and other protrusions, such as front panel controls. Rigid cardboard should be placed at the corners of the unit to protect against corner damage during shipment. Damage to the corners of the front panel is the most common type of damage seen after reshipment of inadequately packed units.

Shipment should be made prepaid consigned to:

JPS Communications, Inc.
Customer Service Department
5720-M Capital Blvd.
Raleigh, North Carolina 27604
U.S.A.

Plainly mark with indelible ink all mailing documents as follows:

U.S. GOODS RETURNED FOR REPAIR
VALUE FOR CUSTOMS - $100.00

Mark all sides of the package:

FRAGILE - ELECTRONIC EQUIPMENT

Inspect the package prior to shipment to be sure it is properly marked and securely wrapped.

2.4 INSTALLATION OVERVIEW

Five quick and simple steps are needed to properly install the RTU-200. These steps are:

1. Provide mechanical mounting for the unit.
2. Provide the proper primary power for the unit.
3. Configure the unit properly.
4. Interconnect the unit with a radio & phone system.
5. Perform line level adjustments.

The RTU-200 is then ready to begin normal operation.

2.5 INSTALLATION CONSIDERATIONS

Careful attention to the following installation suggestions should result in the best unit/system performance. Figure 2.1 provides overall unit dimensions.

The RTU-200 must be installed in a structure which provides both protection from the weather and assurance of ambient temperatures between -20 and +55 degrees C. Since the unit is neither splashproof nor corrosion resistant, it must be protected from exposure to salt spray. When the unit is mounted in a cabinet with other heat-generating equipment, the use of a rack blower is suggested to keep the cabinet interior temperature rise to a minimum.

NOTE

Before actually installing the unit into a rack, read paragraph 2.8 to determine if any internal configuration options must be changed that would necessitate removal of the units top cover.

The RTU-200 Radio/Telephone Interface Unit is designed to be mounted in a standard EIA 19" rack by means of chassis slides (may be ordered from JPS. See Table 2.2 Optional Equipment.) The unit weighs too much to be installed in a rack supported only by front panel ears. Screws are provided in the accessory kit for securing the unit to the rack via the front panel.

2.5.1 FCC PART 68 REGULATIONS

The RTU-200 has been designed to comply with FCC Part 68 regulations regarding equipment connected to telephone lines, but is not officially certified. If tested compliance to FCC Part 68 is required, external equipment can be installed between the RTU-200 and the telephone line to provide compliance.

2.6 POWER REQUIREMENTS

The RTU-200 is designed to operate from 115V or 230V, 47 to 63 Hz, single phase AC power source. The unit will meet all of its specifications over a voltage range of ±15% from nominal. Power consumption is 10 VA typical, 15 VA maximum. If the DC Supply option is installed, the RTU-200 will operate from a either +12V or +24V DC supply, depending on how the option is configured. If both DC and AC supply voltages are applied at the same time, the unit will be powered by the AC supply. Allowable DC voltage levels are: for the +12V supply, 11 to 15VDC; and for the +24V supply, 22 to 30VDC. DC current drain is 400mA typical throughout both voltage ranges.

2.7 LINE VOLTAGE SELECTION

CAUTION

To prevent damage to the unit, check the power line voltage selection before applying power. Also be certain that the unit is connected to a grounded outlet.

As shipped from the factory, the RTU-200 is normally set for the correct line voltage in the area where it will be installed, but the voltage selection should be checked before initial operation. The number visible through the window in the line power module (located on the rear panel) indicates the nominal line voltage range in the following manner:

100 or 120 position: nominal 115V Operation
220 or 240 position: nominal 230V operation

(The number will be easier to see if the clear fuse cover is slid to the left with the line cord removed.) To change the voltage selection, remove the line power cord and slide the clear plastic fuse cover to the left, exposing the fuse. Pull the small handle marked "Fuse Pull", rotate the handle to the left and remove the fuse. With the "Fuse Pull" handle to the left, pull the voltage selector card from its slot and replace it with the desired operating voltage appearing at the top left side. Rotate the "Fuse Pull" handle back to the right and snap the fuse back into the metal clips. The fuse should be either a 1/4 A time-delay fuse for 115V operation or a 1/8 A time-delay fuse for 230V operation.

To replace a blown fuse, follow the same procedure, except that the voltage selector card need not be removed.

2.8 CONFIGURING THE RTU-200

If the RTU-200 is to be operated into a dial-up telephone line, and if 600Ω is a satisfactory impedance for the radio receiver input to the RTU-200, then no internal configuration options need to be changed. The factory settings of these options should be correct for more than 90% of the applications of the RTU-200. There are, of course, instances where these options must be changed, so an explanation of each option follows.

There are five configuration options internal to the RTU-200. These are:

Ref	Option	Factory Setting
JP1	Telephone Receive Level	-9 dBm
JP2	Telephone Send Level	-9 dBm
JP3	RX Line Input Impedance	600Ω
JP4,JP5	Local Phone Connection	Switched
JP6	VOX Hangtime	Short

If an option must be changed, refer to Figure 2.2, Location of Internal Options. Remove the top cover of the unit by removing the three Phillips head screws along each edge. Be sure to replace all of the screws when replacing the top cover.

2.8.1 SETTING TELEPHONE SEND AND RECEIVE LEVELS

The audio signal levels which interface the RTU-200 to the telephone line are adjustable via jumpers JP1 and JP2. The levels are adjustable (into 600Ω) from -15 to +6dBm in 3dB steps. The send (sent into the phone line) and receive (received from the phone line) signals are normally set to identical levels. The headers are positioned on the board so that the levels are the same when the two jumpers are installed exactly adjacent to each other.

Recommended Settings:

Type of System	Send Lvl	Rec Lvl
Dial-Up lines in most non-U.S. phone systems	-9 dBm	-9 dBm
PBX Systems	-12 dBm	-12 dBm
Field Wire not connected to a telephone network	0 dBm	0 dBm

When using the RTU-200 in a domestic U.S. dial-up telephone network, the MAXIMUM level allowed into a telephone line at the subscriber end is -9 dBm. Putting more level into the line than this will NOT increase performance, but will result in distortion, crosstalk into other circuits and the telephone company may disconnect the call. When operating into a PBX system, the level should be set at -12 dBm. Higher levels than these may be only used into field wire or dedicated or private lines which are KNOWN to accommodate higher levels.

The receive level may be adjusted differently from the send level to adjust the sensitivity of the VOX operation in special situations. See paragraph 3.4.6 for more information.

2.8.2 RX LINE INPUT IMPEDANCE

Jumper JP3 selects the input impedance of the RTU-200 input from the radio receiver to be either 600Ω or 56kΩ. The normal setting is 600Ω, but if a high input impedance for bridging is needed, the impedance may be set to 56kΩ.

2.8.3 VOX HANGTIME

The RTU-200 VOX circuitry remains in the keyed state for a short time after a transmit audio signal is no longer detected. This delay, called hangtime, ensures that the VOX is not de-activated between syllables or during short pauses in speech. The standard VOX hangtime duration for the RTU-200 is one second. Internal jumper JP6 allows the setting of a longer 1.5 second hangtime if required. Jumper settings marked on the PC board are SHORT for one second and LONG for 1.5 seconds. Following any change to the JP6 setting, the unit must be turned off and back on again before the change will take effect, as the DSP chip reads JP6 only during its power-up routine.

2.9 INTERCONNECT INFORMATION

Interconnect cables should be shielded for best performance. The telephone set and line connectors accept a standard RJ11C modular plug. These connections are repeated on the terminal block on the rear panel. Figure 2.5, Interface Details, gives simplified interconnect information.

2.9.1 TELEPHONE SET

Connect a local telephone set to J1 or the terminal strip. Telephone set polarity is unimportant. Jumpers JP4 and JP5 set the local telephone set to either Switched or Constant mode. When set to Constant, the local telephone is always connected to the telephone line. When set to Switched, the local telephone is disconnected from the line whenever the RTU-200 is in the Connect mode (CONNECT LED On).

2.9.2 TELEPHONE LINE

Connect the telephone line to J2 or the terminal strip. The unit will work with either an AC or DC telephone line. Telephone line polarity is unimportant.

2.9.3 RADIO SYSTEM

Connect the radio system to the RADIO (P1) connector. The TX output and RX input are designed to interface with 600Ω line connections at the radio, but the RTU-200 audio interface is extremely flexible and can accommodate a wide variety of sources and loads. By making different connections, the inputs and outputs may be configured for balanced or unbalanced lines, and the RX input impedance may be set to 600Ω or high impedance via internal jumper JP3. (The balanced configuration should be used if possible, because it is the most noise-immune.) Figure 2.4 details the various audio wiring options.

2.9.4 OTHER DEVICES

Other devices in the communications system which interface with the radio system may connect to the AUX AUDIO (P2) connector. This will provide access to radio audio when the RTU-200 is in DISCONNECT mode or the RTU-200 main power is off.

2.9.5 REMOTE CONTROL

For remote control of the RTU-200, connections must be made to the REMOTE (P3) connector. This connector contains all of the signals necessary for remote control of the unit, plus the monitor output and keyline.

TABLE 2.1

J1 - TEL SET Connector

PIN	SIGNAL	COMMENT
1	NC	No Connection.
2	TSC	Second Line Connection to J2-2.
3	TSA	Telephone Set Connection A.
4	TSB	Telephone Set Connection B.
5	TSD	Second Line Connection to J2-5.
6	NC	No Connection.

TABLE 2.2

J2 - TEL LINE Connector

PIN	SIGNAL	COMMENT
1	NC	No Connection.
2	TSC	Second Line Connection to J1-2.
3	TLA	Telephone Line Connection A.
4	TLB	Telephone Line Connection B.
5	TSD	Second Line Connection to J1-5.
6	NC	No Connection.

TABLE 2.3

P1- RADIO Connector

PIN	SIGNAL	COMMENT
1	RXB	Bal Receive Audio Input.
2	GND	Chassis Ground.
3	TXA	Bal/Unbal 600 Ohm Transmit Audio Output.
4	KA	Key Relay Contact A.
5	KT	Key Transistor Output.
6	RXA	Bal/Unbal Receive Audio Input.
7	TXB	Bal 600 Ohm Transmit Audio Output.
8	NC	No Connection.
9	KB	Key Relay Contact B.

TABLE 2.4

P2- AUX AUDIO Connector

PIN	SIGNAL	COMMENT
1	RXB	Bal Receive Audio Input.
2	GND	Chassis Ground.
3	TXA	Bal/Unbal 600 Ohm Transmit Audio Output.
4	KA	Key Relay Contact A.
5	KT	Key Transistor Output.
6	RXA	Bal/Unbal Receive Audio Input.
7	TXB	Bal 600 Ohm Transmit Audio Output.
8	MON	Monitor Audio Output.
9	KB	Key Relay Contact B.

TABLE 2.5

P3- REMOTE Connector

PIN	SIGNAL	COMMENT
1	GND	Chassis Ground.
2	KC	Key Relay Contact C.
3	MON	Monitor Audio Output.
4	/KEY	TTL Input; Low to Key in Remote Mode.
5	/REM	TTL Input; Low to put RTU-200 into Remote Mode.
6	KT	Key Transistor Output.
7	KD	Key Relay Contact D.
8	/CONNECT	TTL Input; Low to Connect in Remote Mode.
9	MAN/VOX	TTL Input; Low for VOX Keying in Remote Mode.

TABLE 2.6

TERMINAL BLOCK Connections

Left to Right as viewed from the rear of the unit:

TERM	SIGNAL	COMMENT
6	GND	Chassis Ground.
5	DC IN	DC input for optional DC supply.
4	TLA	Telephone Line Connection A.
3	TLB	Telephone Line Connection B.
2	TSA	Telephone Set Connection A.
1	TSB	Telephone Set Connection B.

2.10 SETUP AND ADJUSTMENTS

For proper operation of the RTU-200, the radio transmit and receive levels must be properly set. The radio receiver level into the RTU-200 is of particular importance, because excessive level here can cause telephone line overloading, distortion, VOX falsing and poor hybrid operation. It is also important that the output level to the transmitter be set so that excessive compression does not occur in transmitters with a compressor.

The RTU-200 has a special set-up mode that makes setting these levels simple.

2.10.1 ENTERING THE SET-UP MODE

The set-up mode connects the transmitter and receiver audio to the RTU-200, and generates a standard-level 1 kHz tone to the transmitter to aid in setting the transmit level. While in set-up mode, the input signal level from the receiver may also be set using the Peak LED.

NOTE

It is not necessary to be in the set-up mode to set the receiver audio level using the Peak LED. The Peak LED is operational whenever the RTU-200 power is on and the unit is in CONNECT mode.

To enter the set-up mode:

1. Switch the RTU-200 Power to OFF.
2. While holding the Manual Key switch down, switch the RTU-200 power ON. (Hold the Man-ual Key down until the Connect LED lights.)
3. The READY indicator blinks as a reminder that the unit is in the set-up mode.

To leave the set-up mode:

1. Switch the RTU-200 Power to OFF.

2.10.2 SETTING THE TRANSMIT LEVEL

In the set-up mode, the RTU-200 generates a 1 kHz test tone of the same amplitude as voice peaks received from a telephone line. This test tone is applied to the transmitter's audio input. Adjusting the front panel TX LVL so that the transmitter is just fully modulated by this test tone will set the correct transmit level in the majority of cases.

1. While in setup mode, key the transmitter by placing the MANUAL KEY switch in the up (locking) position.

2. Adjust TX LVL so that the transmitter is just fully modulated. If the transmitter is an AM or SSB type, use its output power meter (if available) to determine the amount of modulation. Do this by advancing the TX LVL control clockwise just until the power meter stops rising. This will produce maximum modulation without activating the radios compressor.

If the transmitter is an FM type, a deviation meter may be necessary to determine the amount of modulation.

NOTE

The RF Power meters on most SSB transmitters do not respond accurately to voice peaks, so a low RF meter indication on actual voice from the RTU-200 may make the transmitter appear to be under modulated. If the TX LVL is increased in an attempt to compensate for a low meter indication, level compression will likely result which will degrade system performance. If there is any doubt about the amount of modulation being obtained, monitor the RF output with an oscilloscope to observe the true condition.

3. Occasionally a lousy phone line will not output the expected audio level and following the instructions in step 2 of this paragraph will result in undermodulation of the transmitter. In this case, the TX LVL adjustment should be advanced clockwise until an acceptable modulation level is reached using actual phone line audio.

NOTE

Avoid excessive level into the transmitter. While most modern transmitters have modulation limiters which will not allow them to overmodulate, excessive level into the transmitter will cause level compression of the signal which effectively degrades the hybrid null provided by the RTU-200. This is particularly important with a full duplex system which may oscillate if too much level compression is used. For best results, adjust the TX LVL so that the transmitter is just fully modulated by the test tone or actual phone line audio.

4. Unkey the transmitter when complete.

2.10.3 SETTING THE RECEIVER LEVEL

The audio level into the RTU-200 from the radio receiver is set from the front panel by the RX LVL adjustment. The PEAK LED is provided as a guide to setting this level. The level is correctly set when the PEAK LED flashes occasionally (once per second to once every few seconds) in response to incoming audio. If the indicator flashes continuously, the level is too high and must be reduced.

To set the level, tune the receiver to a station with a strong signal which will provide maximum audio into the RTU-200. Adjust the RX LVL control clockwise (to increase the level) or counterclockwise (to decrease the level) as necessary until the PEAK Indicator flashes occasionally.

The range of the RX LVL control is about -20 dBm to +10 dBm, so if the correct level cannot be set using the RX LVL control alone, it may be necessary to adjust the audio output at the radio itself until the correct level is obtained.

NOTE

The proper operation and excellent performance of the RTU-200 will not be obtained if the audio level from the receiver into the RTU-200 is not set correctly. Excessive audio will overload the telephone line and equipment, causing distortion, VOX falsing and poor hybrid operation. In addition, the telephone company may cut off a call in progress which contains audio high enough to bleed over into other circuits.

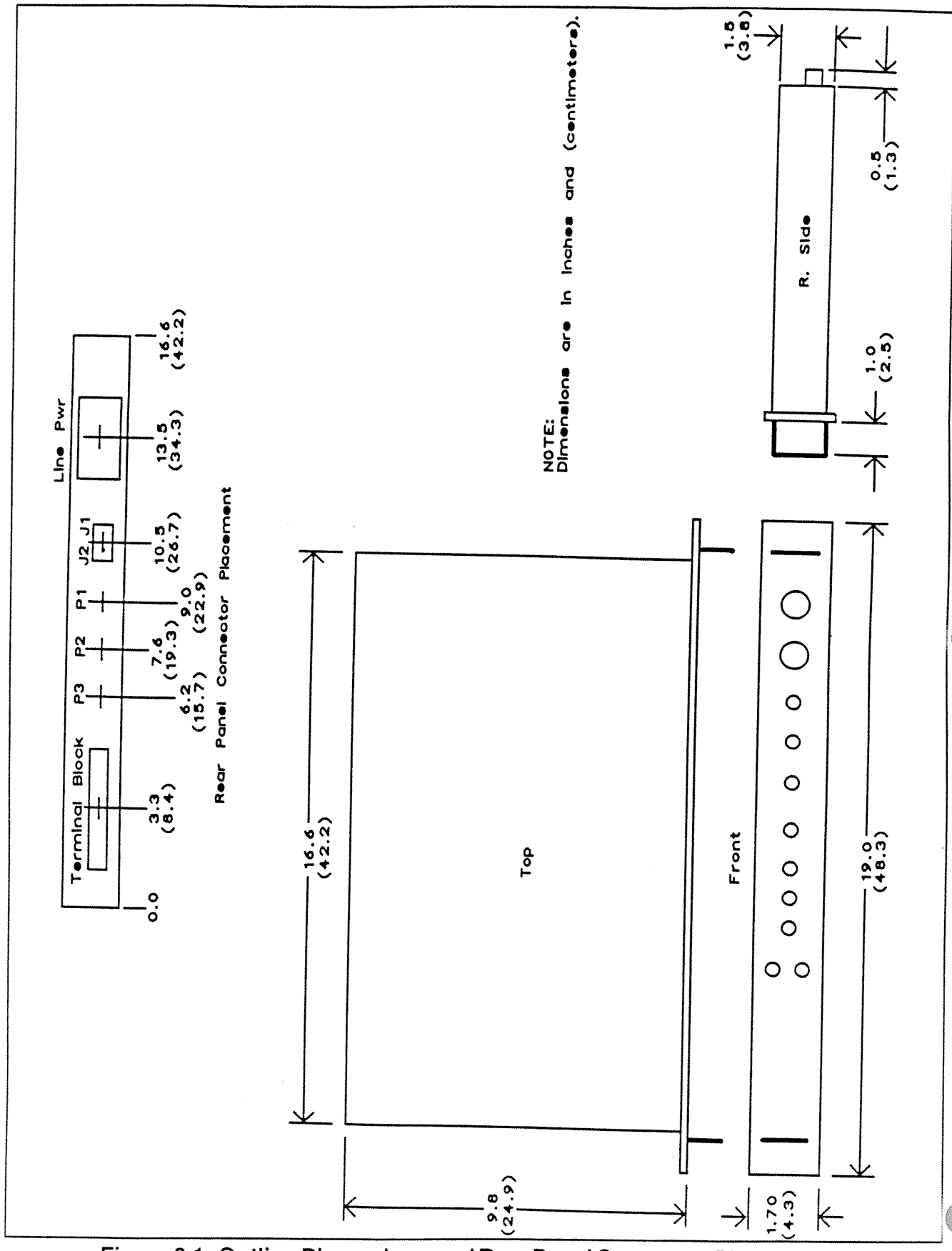


Figure 2.1 - Outline Dimensions and Rear Panel Connector Placement

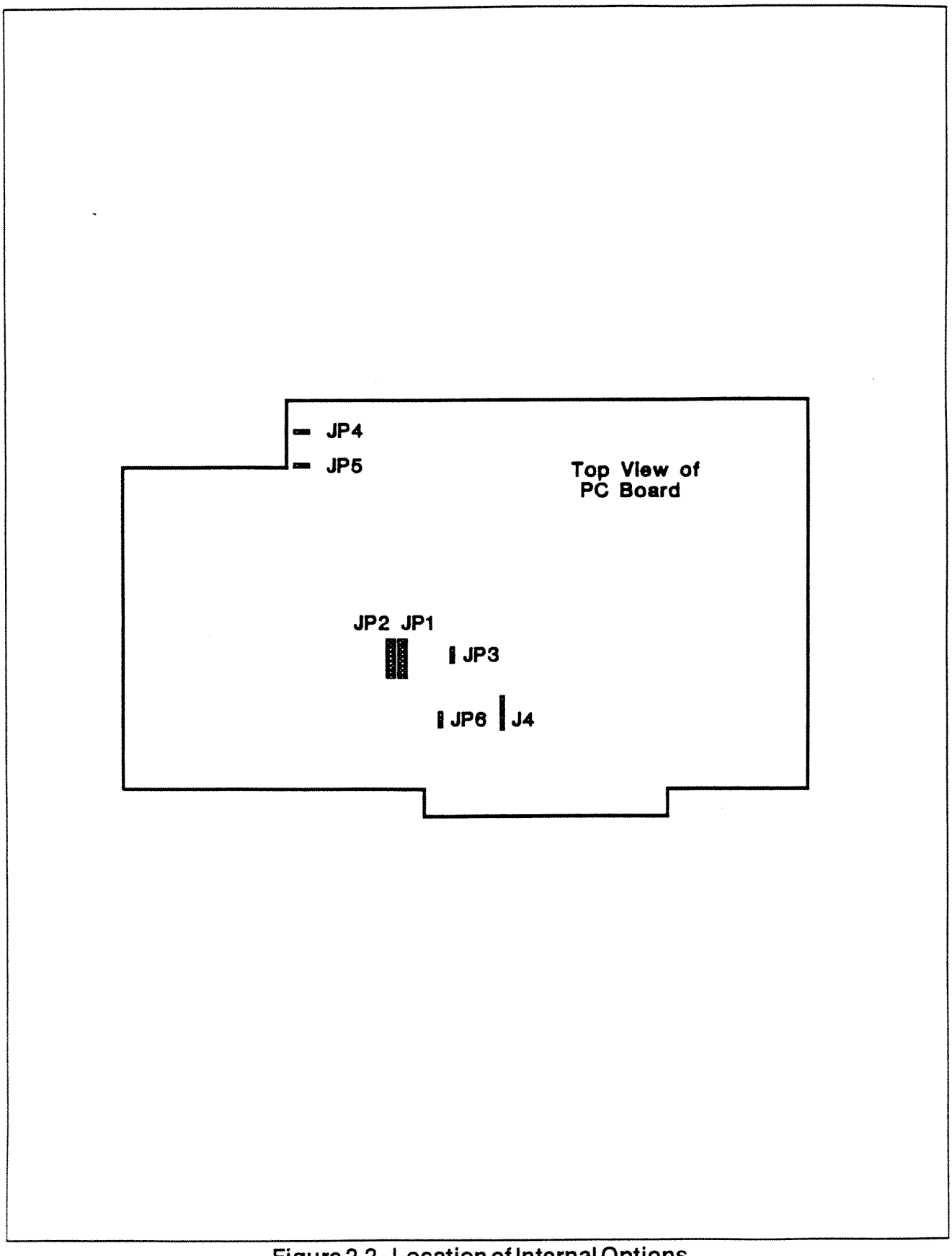
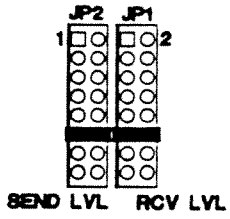


Figure 2.2 - Location of Internal Options

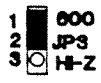
RTU-200 Internal Settings



TELEPHONE LINE SEND AND RECEIVE LEVEL SETTINGS	
JP1,2 POS	LEVEL
1,2	+6 dBm
3,4	+3 dBm
5,6	0 dBm
7,8	-3 dBm
9,10	-6 dBm
11,12	-9 dBm
13,14	-12 dBm
15,16	-15 dBm

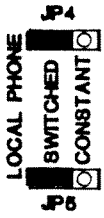
Jumper Settings for Telephone Line Send and Receive Levels

Jumpers shown installed at -9 dBm positions.

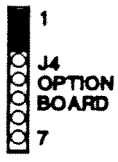


RX Line Input Impedance Selection
Jumper shown in 600 ohm position.

VOX Hangtime Selection
Jumper shown in SHORT position.



Local Phone Connection Selection
Options are:
CONSTANT Always Connected
SWITCHED Disconnected when RTU-200 makes Remote Telephone to Radio System Link (CONNECT LED ON)
Jumpers shown in SWITCHED position.



J4 Option Board Connector
Jumper must short J4-1 and J4-2 whenever Option Board is not installed.

Figure 2.3 - Internal Jumper Details

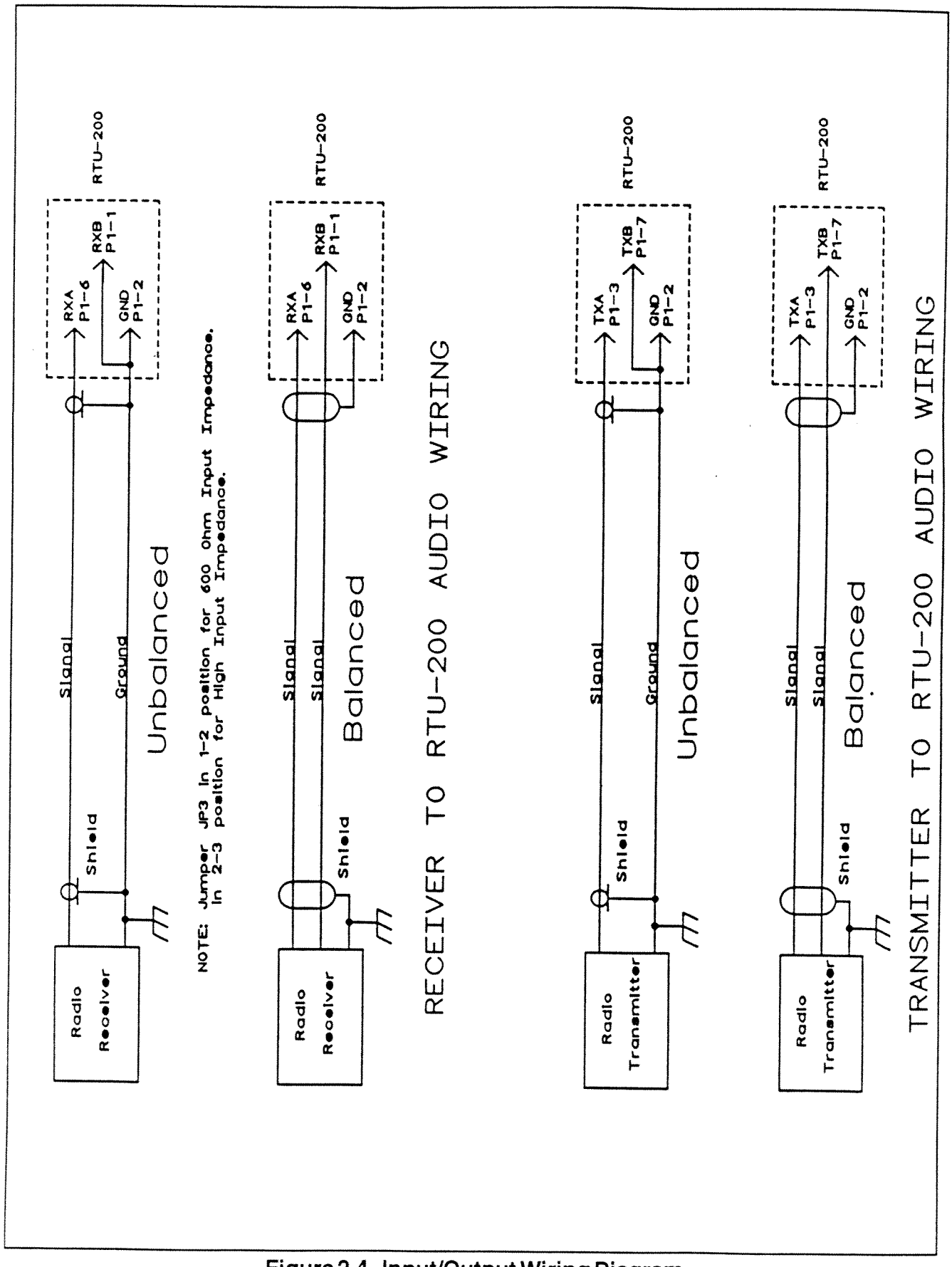


Figure 2.4 - Input/Output Wiring Diagram

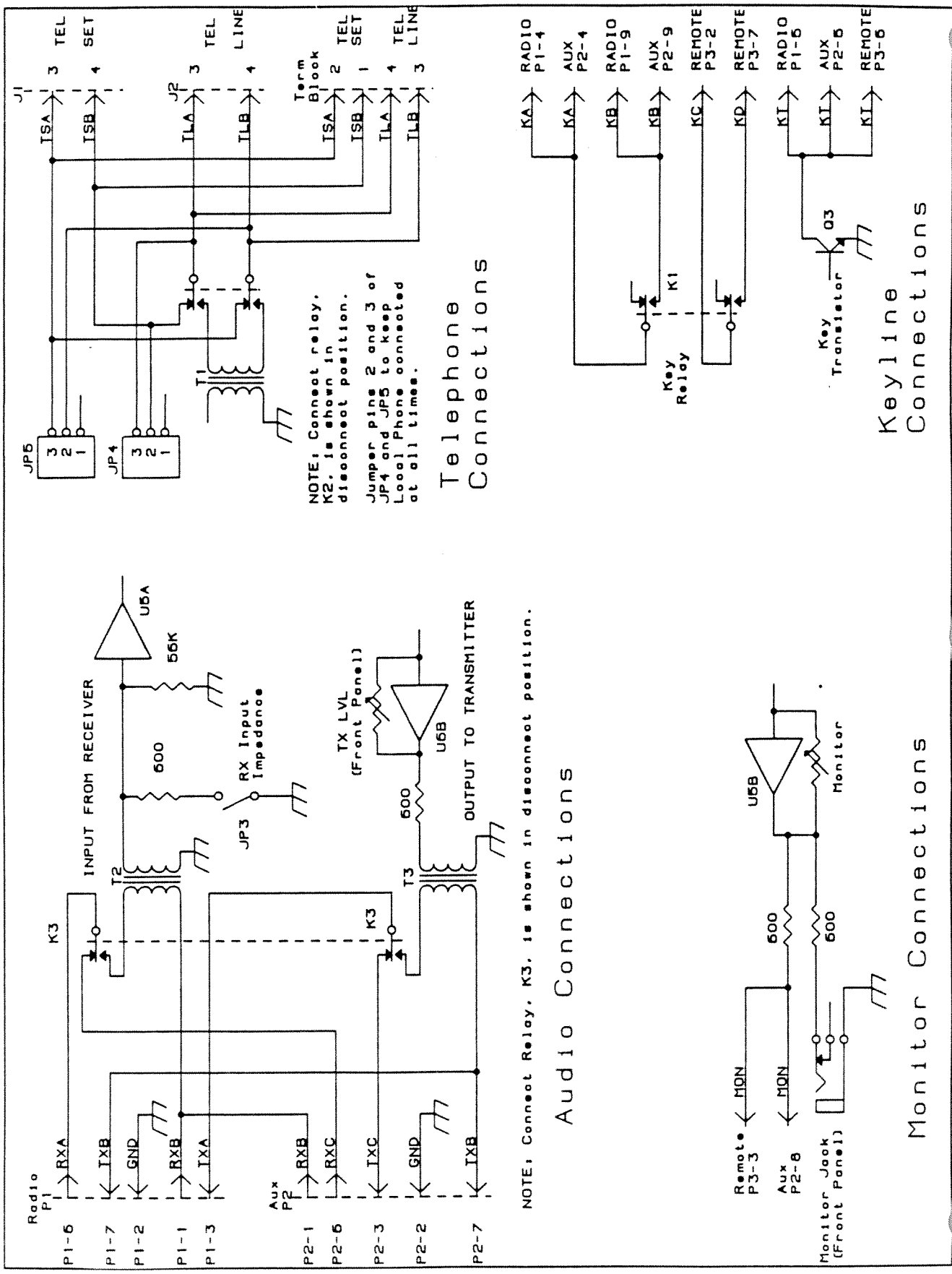


Figure 2.5 - Interface Details

SECTION 3

OPERATION

3.1 GENERAL

This section contains information and instructions required for proper operation of the RTU-200. For a description of the operation of any equipment used with the RTU-200, refer to the manual for the companion equipment.

3.2 FRONT PANEL CONTROLS and INDICATORS

3.2.1 MAIN POWER SWITCH

The Main Power switch controls the AC line power to the unit. It also switches the DC input power if the optional DC supply is installed.

3.2.2 MAIN POWER INDICATOR

This red Light Emitting Diode (LED) is lighted when the units main power is ON.

3.2.3 MANUAL KEY SWITCH

This switch operates the key relay and key transistor in the RTU-200 to cause a connected transmitter to transmit. The switch is momentary when pressed downward and locking when pressed upward.

This switch is functional only when the unit is not being remotely controlled. Holding this switch down while turning on the units main power causes the RTU-200 to enter the Setup mode (described in paragraph 2.10.1).

3.2.4 MANUAL/VOX SWITCH

This switch determines if the keying of the transmitter may be done by the Voice Operated Xmit (VOX) facility in the RTU-200.

When the switch is in the VOX position, the key relay and transistor are controlled by voice on the telephone line. The VOX operates when it detects a signal on the telephone line. It has a "hang" time to keep it from dropping out on short pauses in speech.

The VOX facility is controlled by the READY Indicator such that the VOX will not operate when the READY Indicator is not lighted. This switch is not functional when the unit is being remotely controlled.

3.2.5 KEYED INDICATOR

This red LED lights when the key circuits in the RTU-200 are active. It lights whenever the unit is keyed: by the VOX function, Manual Key switch, or remote control.

3.2.6 READY INDICATOR

This green LED lights when the RTU-200 hybrid has adapted to the telephone line and is ready to operate. If the unit cannot successfully adapt to the line the LED will not come on. If this happens, the unit will still operate, but the hybrid balance will be poor. For this reason the VOX will be disabled.

3.2.7 RX AND TX LEVEL ADJUST

These controls are accessible through the front panel and can be adjusted with a small flat blade screwdriver. The TX LVL sets the audio level out of the RTU-200 to the radio transmitter. Its approximate range is +10 dBm to -20 dBm.

The RX LVL adjust sets the audio level into the RTU-200 from the radio receiver. Its range is also approximately +10 dBm to -20 dBm.

3.2.8 PEAK LEVEL INDICATOR

This yellow LED flashes on incoming audio peaks to indicate the proper adjustment of the RX LVL control. The input audio level is correct when the PEAK LED flashes occasionally on program peaks. If the indicator flashes continuously, the input level is too high and should be reduced (see paragraph 2.10.3).

NOTE

The Peak LED will be on momentarily each time the Connect Switch is thrown, as the white noise generated for the adaptation cycle is detected.

3.2.9 CONNECT INDICATOR

This green LED lights when the RTU-200 is connected to the telephone line. This occurs when the Connect Switch is in the CONNECT position, or when the unit is instructed to connect via remote control.

3.2.10 CONNECT SWITCH

This switch controls the connection of the RTU-200 to the telephone and audio circuits. When the switch is in DISCONNECT position, the telephone line is disconnected from the unit and patched through to the telephone set, and the audio in/outs in the AUDIO (P1) connector are patched through to the AUX AUDIO (P2) connector. Thus, the RTU-200 is

effectively out of the circuit.

When the switch is thrown to the CONNECT position, the phone line and the audio in the RADIO (P1) connector are connected to the RTU-200. The unit then starts its adaptation cycle by putting a burst of white noise onto the phone line. When the adaptation cycle is complete, the READY LED will light and the unit is ready for operation.

3.2.11 MONITOR JACK AND CONTROL

The Monitor Jack provides a convenient way for the operator to monitor both sides of the telephone conversation. The jack will accept a standard 1/4 inch monaural phone plug and has a 600Ω output impedance. The headphone volume at the jack is adjustable with the Monitor control.

3.3 REAR PANEL CONNECTORS

3.3.1 TERMINAL BLOCK

The Terminal Block contains two telephone line connections, two telephone set connections, a spare and a ground connection. The block is provided as a convenience for connecting the telephone line and/or a telephone set which does not have U.S. standard RJ11C connectors.

3.3.2 REMOTE (P3)

The Remote connector contains signals for parallel remote control of the RTU-200. These signals are provided to allow the unit to be controlled from a remote console.

3.3.3 AUX AUDIO (P2)

This connector provides access to radio audio signals whenever the power is off or the unit is in DISCONNECT mode. In this condition, these lines are passed through the unit from the RADIO (P1) connector. This feature is provided so that other equipment in the system may have access to the radios audio when the RTU-200 is not in use.

3.3.4 RADIO (P1)

This is the main connector for interface between a radio system and the RTU-200. It contains transmit and receive audio and keylines.

3.3.5 TEL LINE (J2)

This RJ11C jack provides the telephone line connections. When the unit is in CONNECT mode, the telephone line is switched to the RTU-200 phone patch circuitry. When the unit is in DISCONNECT mode, the RTU-200 is bypassed and the telephone line is routed to the TEL SET (J1) connector. The line connections are made to terminals 3 and 4, with terminals 2 and 5 (to accommodate a second line) permanently connected to terminals 2 and 5 of J1.

3.3.6 TEL SET (J1)

This RJ11C jack allows the connection of a telephone set (telephone) to the telephone line. If Internal jumpers JP4 and JP5 are in the SWITCHED positions, the telephone is connected to the telephone line only when the RTU-200 is in the DISCONNECT mode or the unit's main power is off. When the unit is switched to CONNECT, this jack is disconnected from both the line and the unit. If JP4 and JP5 are in the CONSTANT positions, the telephone set at J1 is always connected to the telephone line, including the time that the telephone line is routed to the RTU-200 during operation. This allows the local telephone set to be used as a monitoring device during operation.

3.3.7 AC POWER

This is a combination AC Power connector, fuseholder and line voltage selector. It incorporates a line filter for protection from RF pickup by the power line from close-proximity transmitters.

3.4 OPERATION

The RTU-200 is very simple to operate, but the following explanation of the adaptation cycle will be helpful in understanding the operation of the unit:

3.4.1 INITIAL ADAPTATION CYCLE

The two-wire to four-wire hybrid in the RTU-200 initially adapts to the phone line each time the Connect Switch is engaged. To do this, it measures the characteristics of the line using a white noise source (built into the unit), which is placed on the line for a short time. While the noise source is connected, the amount of signal 'reflected' from the phone line is measured and adaptation takes place. The adaptation cycle minimizes the reflected signal at all frequencies from the phone line. When initial adaptation is complete, the noise source is switched off, the Ready LED lights, and the unit is ready for operation. This normally takes less than one second.

For adaptation to be successful, the far end of the phone line must be quiet, that is, there must be no signal coming into the RTU-200 from the phone line during adaptation. If there is, the unit may not be able to adapt, but will keep trying for up to ten seconds. For example, the far end user must not be talking during the adaptation cycle. If the Ready LED does not come on within one second after the Connect Switch is thrown, wait a short time longer. If the unit still does not go ready, chances are that there is excessive noise on the phone line, and it is best to hang up and redial.

Because the adaptation algorithm is very robust, the condition of an un-quiet phone line is about the only case where the RTU-200 will fail to adapt, as the hybrid has the ability to adapt to line conditions from a short to an open circuit as well as the impedance presented by the extremely complex distributed network of a telephone line.

3.4.2 CONTINUOUS ADAPTATION

Once the initial adaptation is complete and the unit begins operating, the adaptation process proceeds continuously using the receiver audio sent down the phone line. This feature enables the RTU-200 to automatically adapt its hybrid balance to changing telephone line conditions.

3.4.3 OPERATING PROCEDURE

A communications link will be established between a local radio set, a distant radio set and a far telephone. The far telephone will be patched through the local radio set to the distant radio set allowing communication directly between the distant radio set and the far telephone.

Begin with the RTU-200 installed, its power on and in DISCONNECT mode.

1. A link is established between the local radio set and the distant radio set.

2. Using a telephone set plugged into J1 of the RTU-200, the operator at the local radio set places a call to the far telephone.

3. When the telephone to telephone link is established, the radio operator advises that a phone patch is being set up. He may want to advise that he is about to throw the Connect Switch, and that conversation should be halted until after the short noise burst is heard. The operator then flips the Connect Switch to the CONNECT position. If internal jumpers JP4 and JP5 are in the SWITCHED positions the local telephone is then disconnected from the phone line.

4. The RTU-200 automatically adapts itself to the phone line and its Ready LED lights: a complete link is now established between the distant radio set and the far telephone, via the RTU-200 and the local radio set.

5. Progress of the call may be monitored via the Monitor jack on the RTU-200 front panel. When the communication is complete, the radio operator switches the RTU-200 to DISCONNECT.

6. Alternatively, a call could have been placed from the far telephone to the local radio operator requesting a phone patch. The operator would then establish a radio link with a far radio set, and switch the RTU-200 to CONNECT.

3.4.4 TRANSMITTER KEYING, HALF-DUPLEX

For a normal half-duplex radio link, it is assumed that the VOX in the RTU-200 has been set up to key the transmitter. The VOX responds to signals on the telephone line and operates the keying circuits when voice is present. Once the VOX has tripped, it stays active for a short time following the loss of audio to prevent dropout on pauses between syllables. (This delay, called VOX Hangtime, can be set for either a LONG or SHORT duration. See section 2.8.3 for details. The unit also incorporates a short audio delay, which allows the VOX to key the transmitter a short time before the audio arrives, so that the RF output can be at full power to avoid missing part of the first syllable.

The VOX in the RTU-200 is generated within the DSP and is extremely sensitive and reliable. However, there are occasions when the audio level from the telephone line is too low to operate the VOX reliably. In this case, it will be necessary to key the transmitter manually. To do this, simply operate the Manual Key to key the transmitter. The transmitter may also be keyed at any time by taking the remote /Key input low.

3.4.5 TRANSMITTER KEYING, FULL DUPLEX

In a full duplex system, the transmitter stays keyed continuously, because the system can receive and transmit at the same time. Thus, VOX is not required. In this case, the transmitter may be keyed from the RTU-200 by placing the Key switch up, so that it locks in KEYED position.

3.4.6 CHANGING VOX SENSITIVITY

Non-standard telephone line conditions existing where the RTU-200 is installed could make VOX sensitivity always too high or too low. In this case, the VOX sensitivity may be changed by changing the position of Jumper JP1 inside the unit. To do this, it is permissible to set JP1 and JP2 for different levels, contrary to the instructions in paragraph 2.8.1. Refer to Figure 2.2, Location of Internal Options, for the location of JP1 and JP2.

If the VOX sensitivity is too low (transmitter does not key reliably on voice), move JP1 to a more negative level than JP2, but do not move it more than two positions (-6 dBm) lower. For example, if JP1 and JP2 are both in the -9 dBm position, move JP1 only to the -12 dBm position to increase the VOX sensitivity.

If the VOX sensitivity is too high (transmitter keys on noise other than spoken words), move JP1 to a more positive level than JP2, for example, if JP1 and JP2 are both in the -9 dBm position, moving JP1 only to the -6 dBm position will decrease the VOX sensitivity. When decreasing the VOX sensitivity, JP1 may be moved as many positions positive with respect to JP2 as necessary.

3.5 REMOTE CONTROL

The RTU-200 contains a facility for parallel remote control of its functions. This is provided so that control of the unit may be incorporated into a custom console.

Signals for remote control are in the REMOTE (P3) connector. The /REM signal enables remote operation. When this signal is taken low, the RTU-200 front panel controls are disabled and control of the unit passes to the P3 signals of Man/VOX and / Connect. Note that the /Key input is active at all times, whether the /REM signal is low or not. Figure 3.2 shows one example of remote control of the unit. The diagram shows that the control lines must be pulled low to operate. This can be done with actual switches (as shown) or by other means, such as logic circuits or transistor switches.

3.6 SELF TEST

The RTU-200 has a self-test routine which operates automatically each time the unit is powered up. this routine tests the internal DSP RAM plus certain functions of the DSP chip, and performs this test so quickly that its operation is not apparent to the user. The unit indicates self-test failures by lighting the Ready and Peak LEDs continuously; the unit will also refuse to respond to any controls. If this occurs, the DSP chip, U7, is faulty and must be replaced.

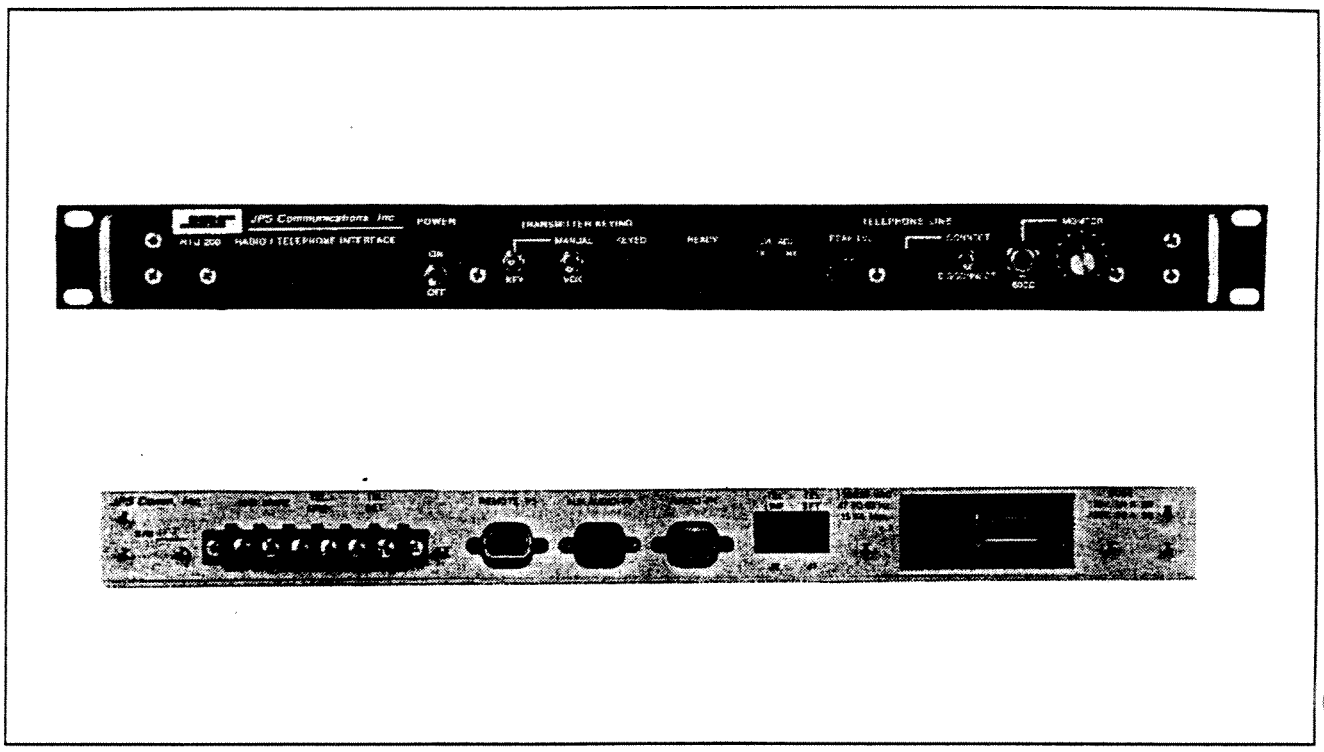


Figure 3.1 - Front and Rear Views

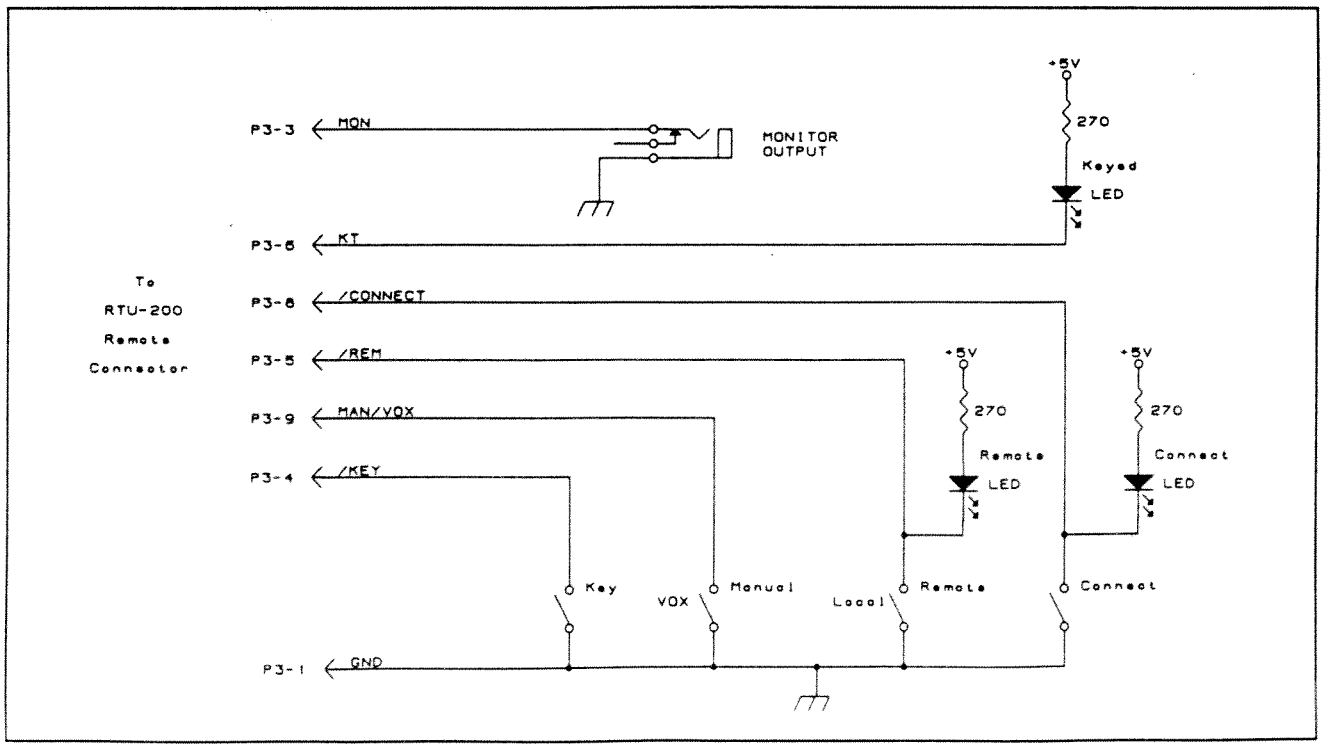


Figure 3.2 - Remote Control of the RTU-200

SECTION 4

THEORY OF OPERATION

4.1 GENERAL

This section gives enough theory of operation detail to allow field troubleshooting of the RTU-200 audio and power supply sections. The same level of detail is not supplied for the DSP hardware section because it is considered impractical to field troubleshoot because of the specialized knowledge and test equipment required. If a fault is suspected in the DSP hardware section, factory repair is required.

4.2 AUDIO CIRCUITS

The Audio Circuitry is detailed in Figure 5.5. It includes all circuitry which is not DSP hardware or Power Supply.

4.2.1 RECEIVER INPUT AMPLIFIER

The input from a receiver is connected to P1-1 and P1-6. Pin P1-1 is connected to one side of the input transformer and is common with P2-1. Pin P1-6 is connected to contacts of relay K3, which routes the signal to P2-6 when the power is off or the unit is in DISCONNECT. When the Connect Switch is thrown, the input signal on P1 is applied to the primary of T2, a 1:1 audio transformer. The secondary of T2 is connected to amplifier U5A, configured as a high input impedance voltage follower.

The input impedance of the receiver input is determined by Jumper JP3, which, in 1-2 position, places a 620Ω resistor across the secondary of T2. With JP3 in the 2-3 position, the 620Ω is disconnected, leaving the 56kΩ resistor to set the input to high impedance.

The output of U5A is fed to amplifier U6A, a gain adjustable amplifier which sets the receiver input signal level. The nominal output level of U6A is 0 dBm. The adjustment range of R30 allows 0 dBm to be produced at U6A-1 with input signals from -20 dBm to +10 dBm.

Circuits U1A and U1B are analog gates turned on by a high level signal at pins U1A-1 and U1B-16, respectively. Normally, U1B is off and U1A is on, allowing signal to pass to R19. During the adaptation cycle, however, U1A is off and U1B is on, cutting off input audio and allowing the noise source to pass to R19. The action of these gates is controlled by OUT 0 from the DSP section. The noise source is generated in software in the DSP, and fed from OUT B to U1B-14. U1A-3 is also connected to In C, an analog input to the DSP section. In is via this input that the adaptive hybrid samples the telephone send signal and measures its level to drive the Peak LED on the front panel.

4.2.2 TELEPHONE SEND CIRCUITS

Amplifier U4A generates the telephone send signal (the audio which is sent down the phone line from the RTU-200). U4A is configured as an inverting stage with R19 as its input resistor and its gain set by a feedback resistor selected by the jumper plug on header JP2. Resistor R56 connected to J5-1 is an auxiliary input for test purposes. The send level calibration assumes that there is a 0 dBm signal level at U1A-3, the input to U4A. (If the setup is done properly, this is assured by the Peak LED, which is set to flash at a peak level equivalent to 0 dBm.) The calibration assures that when a 600Ω load is placed on the telephone line terminals, the signal level at TP3 will be 3 dB lower than stated send signal level. This 3 dB margin allows some headroom for peaks in the program material without overdriving the phone line.

Resistor R1 establishes the output impedance of the telephone send amplifier, and (in parallel with R18) determines the terminating impedance for the phone line.

Zener diodes CR2 and CR3 protect the circuitry in the RTU-200 from high voltage spikes on the phone line. T1 is a 1:1 audio transformer which couples to the phone line. Capacitor C8 and similar capacitors C7 and C27 compensate for the leakage inductance of the transformers to produce a better frequency response. Capacitor C7 keeps any phone line DC current out of T1. Instead of using the secondary of T1 to sink the phone line DC holding current, an active constant current load is used which consists of CR1, Q1 and Q2 and associated components.

The constant current load provides a means of sinking the DC holding current from the phone line so that the RTU-200 will seize and hold the line. Bridge CR1 corrects the DC polarity so that a positive voltage is always applied to the collector of Q1, eliminating the need to be concerned about the polarity of the phone line. Transistors Q1 and Q2 are connected as a constant current load and C9 insures that the load does not respond to audio frequencies, so that the load appears as a very high impedance in parallel with the transformer secondary. When the load is in operation, the DC voltage from TP1 to TP2 should be between 4V and 8V.

The phone line connections are made via J2 or the terminal block to relay K2, which, when the power is off or the unit is in DISCONNECT, disconnects the phone line from the internal circuitry. A local telephone set plugged into J1 is connected constantly to the telephone line or is connected only when K2 disconnects the telephone line from the unit, depending on the

settings of internal jumpers JP4 and JP5. Components L1 through L4 and associated capacitors form Pi-Section filters to remove RF from the normally unshielded phone lines.

4.2.3 TELEPHONE RECEIVE CIRCUITS

Amplifier U4B is the telephone receive amplifier which gets its input from the telephone line via R18 from transformer T1. U4B's gain is adjustable (via jumper plug connections at JP1) to accommodate various telephone receive signal levels, just as U4A's gain is adjusted by jumper JP2 to produce various output signal levels. The gain of U4B is such that a signal coming from the telephone line of 3 dB less amplitude than the telephone receive level jumper, JP1, is set for will produce a 0 dBm signal at U4B-7. (If JP1 is in the -9 dBm position, a -12 dBm signal from the phone line will produce 0 dBm at U4B-7.) This 3 dB factor makes up for the typical loss between the RTU-200 and the central office.

Since the telephone send signal is applied to T1 through R1, the telephone send signal mixes with the telephone receive signal at this point, and the mixed send/receive signal appears at output U4B-7. The amount of send signal mixed in is frequency dependent and depends on the telephone line impedance. The mixed signal at U4B-7 is applied to an analog DSP input at In A so that the adaptive hybrid can sample the telephone receive signal. The function of the DSP hybrid is to remove the telephone send signal content and pass only the telephone receive signal to the transmitter output circuits.

4.2.4 MONITOR OUTPUT

Since the signal at U4B-7 contains both the telephone send and receive audio, it is convenient to use this as the point to monitor both sides of the conversation. U5B is the monitor amplifier, which is fed with the audio from U4B-7 through a volume control pot located on the front panel. U5B-7 drives the front-panel Monitor Jack through R22 and drives isolated rear panel outputs via R23.

4.2.5 TRANSMITTER AUDIO OUTPUT

The audio output to the transmitter is provided by gain-adjustable amplifier U6B. The amplifier gets its input signal from analog output Out A from the DSP section, the output of the adaptive hybrid. The audio is fed through U1D, which is on normally, but turned off during the initial adaptation cycle. The adjustment range of R33 is such that with 0 dBm audio at U1D-6, the signal on the secondary of T3 (loaded with 600Ω) can be adjusted between +10 dBm and -20 dBm.

4.2.6 MISCELLANEOUS CIRCUITS

U2 is an open-collector inverting driver which is used to buffer the parallel outputs from the DSP. The outputs from the DSP, Out 1 (Keyed), Out 2 (Connect), Out 3 (Ready LED) and Out 4 (Peak LED) are each connected to two drivers: one for the key relay and one for the key transistor.) These signals all go high (TTL High:>2.5V) to make their respective functions active. The outputs of U2 all go low (TTL Low: <0.6V) to activate their functions. Resistors R50 through R54 are current limiters for the front-panel LEDs.

The key transistor, Q3, is driven by inverter U3B from driver output U2-14. Transistor Q4 is turned on during DSP reset to hold off Q3 and make sure that an unwanted key command is not given during the power-on cycle.

4.3 DSP HARDWARE

The DSP hardware circuitry is detailed in Figure 5.6. Its general purpose is to convert analog signals to the digital domain, operate on and manipulate these signals digitally using the DSP chip, then convert the result back to analog. This makes it possible to implement functions such as the adaptive hybrid, which would be impossible or impractical to implement using purely analog techniques.

4.3.1 DIGITAL SIGNAL PROCESSOR CHIP

The heart of the DSP section is U7, a TMS320E15 DSP chip which contains a built-in EPROM for program storage. The unit runs at 20 MHz and produces a 5 MHz signal at the U7-6 CLKOUT. This signal supplies timing for U10 and U12, the Analog Interface Chips. U10 then supplies an interrupt to the DSP chip at U7-5 every 130 microseconds, which is the analog sampling interval.

4.3.2 RESET GENERATOR

U16 is a reset generator which insures an orderly power-up sequence for the DSP and associated components. It senses the voltage on the +5V line and generates a reset while the voltage is below approximately 4.55V. As the voltage rises above the threshold, a delay is generated by C48 to insure processor clock stability before operation commences.

4.3.3 PARALLEL OUTPUT

Latch U17 provides an eight-output parallel interface from the DSP.

4.3.4 PARALLEL INPUT

Latch U11 provides an eight-input parallel interface to the DSP.

4.3.5 ANALOG INTERFACE

Chips U10 and U12 provide the analog interface to the DSP section. These TLC32040 chips contain an A/D converter for analog input, a D/A converter for analog output, an anti-alias filter before the A/D, and a reconstruction filter after the D/A. These chips provide the DSP section with two analog inputs and two analog outputs. The chip uses the master clock provided by U7 to establish the analog sample rate, which is 7692.3 samples/second, or one sample every 130 *n*seconds.

U8, U9, U13 and U14 form a serial/parallel interface between the analog interface chips and the DSP.

4.4 DSP SOFTWARE

The DSP software is contained in the EPROM which is integral to the DSP chip. For this discussion, it might be helpful to refer to Figure 1.2, the RTU-200 Simplified Schematic. All of the following functions are implemented in software by the DSP.

4.4.1 ADAPTIVE HYBRID

The adaptive hybrid performs the central function of the RTU-200. Its purpose is to separate and isolate the telephone receive signal by subtracting the telephone send signal from the mixed telephone send and receive signals. If this subtraction is done perfectly, the telephone receive signal is completely isolated. The digital adaptive hybrid in the RTU-200, while not achieving perfection, comes close, giving as much as 40 dB isolation when measured with a broadband noise source. Comparable isolation for a conventional hybrid would likely be only 10 dB, measured in the same way.

The adaptive hybrid continuously samples the telephone send signal at In C, samples the mixed telephone send and receive signals on In A, and outputs the isolated telephone receive signal on Out A.

The hybrid function also contains a threshold detector which is used to light the Ready LED and allow VOX operation when balance has been achieved.

4.4.2 NOISE GENERATOR

A pseudo-random noise generator is implemented to speed adaptation. The input receiver audio is switched off and the noise generator switched on during the adaptation cycle. The wide bandwidth of the noise assures that the hybrid is adapted over the full audio bandwidth.

4.4.3 PEAK DETECTOR

A peak detector monitors the receive audio bus and flashes the Peak LED on audio peaks which exceed 0 dBm. This function aids in setting up the RTU-200 with the proper audio levels.

4.4.4 VOX

A VOX (Voice Operated Xmit) function monitors the output of the adaptive hybrid and triggers if the audio exceeds a preset level. Once triggered, it stays active for a short time (VOX hangtime) following the loss of audio to prevent VOX drop out on pauses between syllables. Internal jumper JP6 selects either a SHORT (standard) or LONG hangtime. The basic VOX sensitivity is fixed in software, but can be effectively varied by adjusting the telephone receive signal level (JP1), which adjusts the gain between the telephone line and the adaptive hybrid input. See section 2.8 for details of internal jumper settings.

4.4.5 AUDIO DELAY

The adaptive hybrid output is delayed before being sent to the transmitter output amplifier, U6B. The delay insures that the transmitter is keyed a sufficient time before the audio arrives so that the entire first speech syllable is transmitted.

4.4.6 SET-UP TONE GENERATOR

A 1 kHz audio tone is generated during the set-up mode to aid in adjusting the transmitter output audio level. The tone is switched in during set-up in place of the adaptive hybrid output.

4.4.7 SELF TEST

The software contains a self test function which executes immediately on power-up. The function tests the on-chip RAM (Random Access Memory) and basic DSP operation. If the self test fails, the unit will not operate and the Ready and Peak Level LED's will be on.

4.5 POWER SUPPLY

The power supply detailed, in Figures 5.7 and 5.8. It supplies regulated DC voltages of ±5V and ±12V.

4.5.1 STANDARD AC SUPPLY

The RTU-200's AC power supply is a conventional passive regulator supply with a small PC mounted line transformer. The AC power supply circuitry is standard on all units, including those which have the optional DC supply installed. Some of the AC supply's circuitry is used in conjunction with the DC supply when it is installed.

Transformer T4 has dual primaries for 115 or 230 VAC operation, and has dual 15 VAC secondaries. T4 and bridge CR4 along with capacitors C60 and C61 are configured as a positive and negative full wave circuit supplying unregulated ±20VDC to the regulators. The regulators are all standard three-terminal types. Each positive regulator uses a finned heatsink for improved cooling.

CR5 is a Schottky rectifier which keeps the -5V supply from rising positive during power-up or supply failure.

4.5.2 OPTIONAL DC POWER SUPPLY

The DC power supply option allows the RTU-200 to be powered from either a +12V or +24V DC source as well as the standard AC supply line input. The DC supply circuitry is not installed unless this option is requested. The components installed configure the supply for either +12V or +24V operation. This circuitry is reverse-polarity protected.

If the DC Supply Option is installed in the unit, it can still be powered via the main AC line. If AC and DC power are simultaneously applied, the unit will draw power from the AC line only (auto take-over).

The DC supply input is filtered by choke L101 and capacitors C101 through C104. If the DC input is +12V, this filtered supply feeds the +5V regulator directly via CR103 and supplies +12V via CR101 and CR104. If the DC input is +24V, it feeds the +12V via CR101 and CR104. If the DC input is +24V, it feeds the +12V regulator through R105, and this +12V regulator feeds the +5V regulator. U101 is a high-efficiency switching regulator which generates the negative voltage for the -12V and -5V regulators.

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SECTION 5

MAINTENANCE AND REPAIR

5.1 GENERAL

Included in this section are the Test Procedures and performance evaluation criteria for the supplied equipment. Also provided is a Fault Analysis Table (Table 5.1) to aid in isolating a fault. Table 5.2 identifies replaceable parts.

5.2 PREVENTIVE MAINTENANCE

There are no preventive or periodic maintenance requirements for this equipment.

5.3 REPAIR OR REPLACEMENT

The repair or replacement of damaged and/or defective parts generally requires techniques which are standard in the industry. Carefully examine the equipment to determine the most correct and least time-consuming method required to make the repair.

5.3.1 GENERAL PRECAUTIONS AND NOTES

1. Disconnect power from the unit before attempting any repair or replacement of components.
2. Replace defective connectors only with identical items.
3. Carefully observe lead dress and component orientation when repairing circuits. Keep component leads as short as possible.
4. Reference to the component side of a printed circuit (pc) board denotes the side of the board on which the majority of components are mounted. The solder or circuit side refers to the side opposite the components.

5.4 ALIGNMENT

No alignment is required or possible other than setting levels for the telephone line, receiver input and transmitter output. These are done as a part of the normal equipment setup procedure.

5.5 PERFORMANCE TESTING

This section describes how to test and verify the basic performance of the RTU-200. Extensive test procedures pinpointing the location of internal faults to the component level are beyond the scope of this manual.

5.5.1 TEST EQUIPMENT REQUIRED

1 ea. Audio Signal Generator, 600Ω Output.
1 ea. Noise Generator or Radio Receiver
1 ea. Audio Voltmeter, Hi-Z Input. (HP 400H or equivalent).
1 ea. Resistor, 560Ω to 680Ω, 1/4W to 1W.

5.5.2 HYBRID BALANCE MEASUREMENT

The test procedure outlined below allows measurement of the hybrid balance, or trans-hybrid loss, attainable with the RTU-200. This characteristic determines how much radio receiver input signal will leak into the transmitter output of the RTU-200. In the test set-up, the noise generator simulates the radio receiver, the audio voltmeter simulates the transmitter and the resistor simulates the telephone line. If the hybrid balance were perfect, the trans-hybrid loss would be ∞ and none of the receiver signal would leak into the transmitter (the audio voltmeter in this set-up would measure nothing except residual noise).

The RTU-200 trans-hybrid loss specification is at least 30dB when measured with a noise source with an output bandwidth which matches the RTU-200's bandwidth This means that the noise output measured by the audio voltmeter should be at least 30dB below the noise input to the RTU-200's hybrid. The test is performed with a 600Ω resistor simulating the phone line in order to have a repeatable standard impedance on which to base the specification. In actual use, the hybrid balance of the RTU-200 is excellent into impedances other than 600Ω (such as the complex impedances of the telephone lines) and is far better than any conventional hybrid under these conditions.

The procedure for this test using a noise generator is listed in paragraph 5.5.2.1. If a noise generator is not available, the alternate test method which employs an audio signal generator (see paragraph 5.5.2.2) may be used. Figure 5.1 shows equipment interconnections necessary to perform this test.

NOTE

The accuracy of the trans-hybrid loss measurement depends on the bandwidth of the noise generator used to perform the test. It is possible, however, to achieve an evaluation of the unit to within a few dB tolerance without a commercial noise generator by using the audio output of an SSB or AM receiver that has no antenna connected. This type of receiver with a 2.5 to 3.5 kHz SSB IF bandwidth makes an ideal noise generator for this measurement because the output noise is band limited by the receiver's IF filters. (FM

receivers, however, have too wide a noise bandwidth and will produce erroneous results using this procedure.) The receiver's noise output should be between -20dBm and 0dBm so that the RTU-200 can be adjusted for the correct hybrid input level.

5.5.2.1 MAIN HYBRID TEST PROCEDURE

1. Disconnect the RTU-200 from all other equipment and connect the test equipment as shown in figure 5.1.

2. The Telephone Receive Lvl (JP1) and the Telephone Send Lvl (JP2) must have the same setting. The absolute level is unimportant, as long as JP1 and JP2 are installed adjacent to each other.

3. Start with the Key Switch centered, the Manual/VOX Switch in MANUAL position and the Connect Switch in DISCONNECT position. Place the RTU-200 in Set-up Mode (see paragraph 2.10.1 for instructions).

4. Adjust the front panel TX LVL control so the audio voltmeter reads -6 dBm (0.387V rms). This sets the transmit signal output path in the RTU-200 for unity gain.

5. Adjust the front panel RX LVL control so that the Peak Lvl LED flashes rapidly and is on about 50% of the time. (This is different from the instructions in paragraph 2.10.3, which set the RX LVL for voice peaks rather than noise). This will set the average noise level into the RTU-200's hybrid to approximately -7dBm (the exact figure depends on the characteristics of the noise source).

6. Remove the unit from Set-up Mode by turning the RTU-200 Main Power OFF, then back ON.

7. Flip the Connect Switch in CONNECT position to start the initial adaptation cycle.

8. When the initial adaptation cycle is complete, the noise output can be read on the audio voltmeter. The voltage should be less than -37dBm (10.9 mV). The trans-hybrid loss is the difference between this reading and the approximate -7 dBm noise level.

5.5.2.2 ALTERNATE HYBRID TEST PROCEDURE

This alternate test procedure uses a more easily obtainable audio signal generator in place of the noise generator. While this procedure can not give a complete picture of the unit's performance in actual use, it will allow a determination of whether or not the RTU-200 is operating properly.

1. Disconnect the RTU-200 from all other equipment and connect the test equipment as shown in figure 5.1, except use an audio signal generator in place of the noise generator.

2. The Telephone Receive Lvl (JP1) and the Telephone Send Lvl (JP2) must have the same setting. The absolute level is unimportant, as long as JP1 and JP2 are installed adjacent to each other.

3. Start with the Key Switch centered, the Manual/VOX Switch in MANUAL position and the Connect Switch in DISCONNECT position. Place the RTU-200 in Set-up Mode (see paragraph 2.10.1 for instructions).

4. Adjust the front panel TX LVL control so the audio voltmeter reads -6dBm (0.387V rms). This sets the transmit signal output path in the RTU-200 for unity gain.

5. Set the output amplitude of the audio signal generator to about 0dBm (0.775V rms). Adjust the front panel RX LVL control so that the Peak Lvl LED just comes on. This will set the average noise level into the RTU-200's hybrid to approximately 0dBm.

6. Remove the unit from Set-up Mode by turning the RTU-200 Main Power OFF, then back ON.

7. Set the audio generator frequency to about 1 kHz.

8. Flip the Connect Switch in CONNECT position to start the initial adaptation cycle.

9. When the initial adaptation cycle is complete, the tone output can be read on the audio voltmeter. The voltage should be typically less than -50dBm (2.5 mV). The trans-hybrid loss is the difference between this reading and the approximate 0 dBm tone level.

NOTE

The reading should be made as soon as the adaptation cycle is complete. The RTU-200 continuously adapts itself to the conditions to which it is exposed. With the single tone input presented by this test, the unit will eventually adapt to reject only this single tone instead of the intended broad range of frequencies. This may take several seconds to several minutes, and an erroneous reading will result when this happens. The reading will always be correct (and an accurate depiction of operation under normal conditions) immediately following the initial adaptation cycle, since the unit has adapted broad band using its own noise source, and has not yet had time to adapt to the single tone only.

10. To measure the unit at a different frequency, change the audio generator frequency and repeat steps 8 and 9.

5.5.3 VOX SENSITIVITY MEASUREMENT

The following test procedure measures the sensitivity of the VOX in the RTU-200. This is the amplitude of the incoming signal from the telephone line required to trigger the VOX.

5.5.3.1 VOX TEST PROCEDURE

1. Disconnect the RTU-200 from all other equipment and connect the test equipment as shown in figure 5.2.

2. The setting of the Telephone Receive Lvl (JP1) must be known. To determine, remove the top cover and note the position of JP1.

3. Start with the Key Switch centered, the Manual/VOX Switch in VOX position and the Connect Switch in DISCONNECT position.

4. Set the audio signal generator frequency to 1 kHz and output amplitude to less than -40 dBm (7.7 mV rms).

5. Flip the Connect Switch in CONNECT position to start the initial adaptation cycle.

6. When the initial adaptation cycle is complete, slowly increase the audio generator amplitude until the Keyed LED on the RTU-200 comes on. The audio generator amplitude at this point (read directly by the audio voltmeter) is the VOX sensitivity. The VOX sensitivity is dependent on the setting of the Telephone Receive Lvl (JP1). It should be 16 _ 2 dB below the JP1 setting as listed in the table below:

JP1 Setting	VOX Sensitivity
+6	-10 ± 2 dBm
+3	-13 ± 2 dBm
0	-16 ± 2 dBm
-3	-19 ± 2 dBm
-6	-22 ± 2 dBm
-9	-25 ± 2 dBm
-12	-28 ± 2 dBm
-15	-31 ± 2 dBm

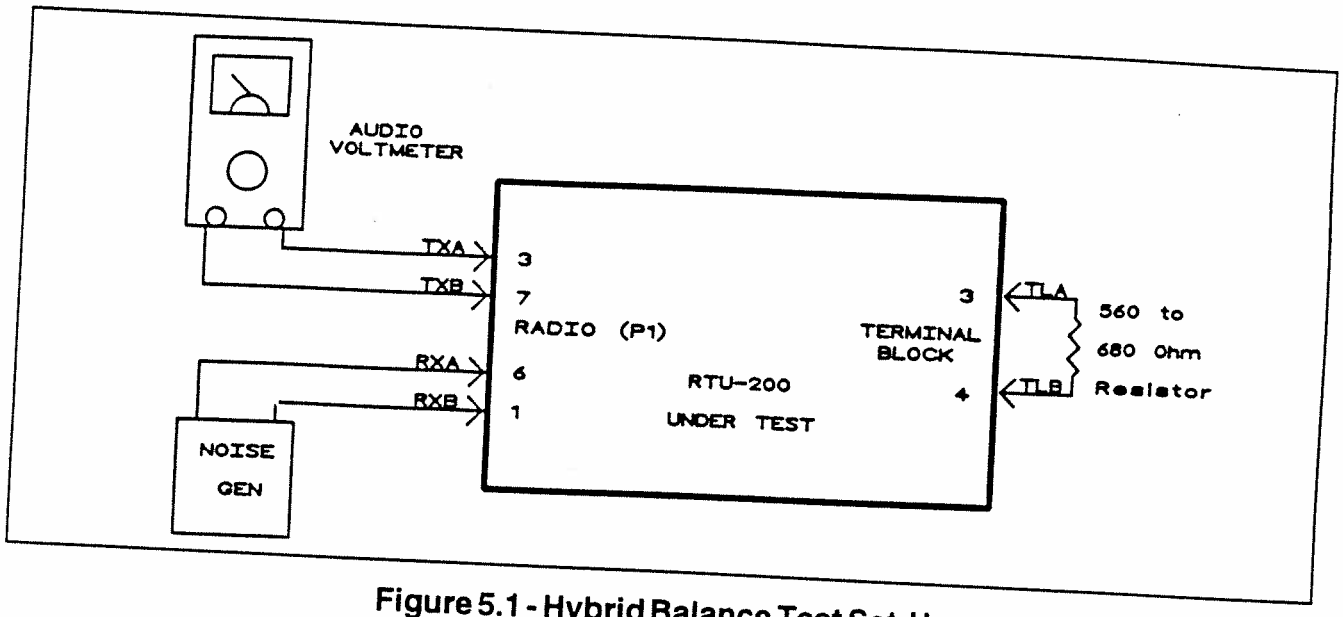

Figure 5.1 - Hybrid Balance Test Set-Up

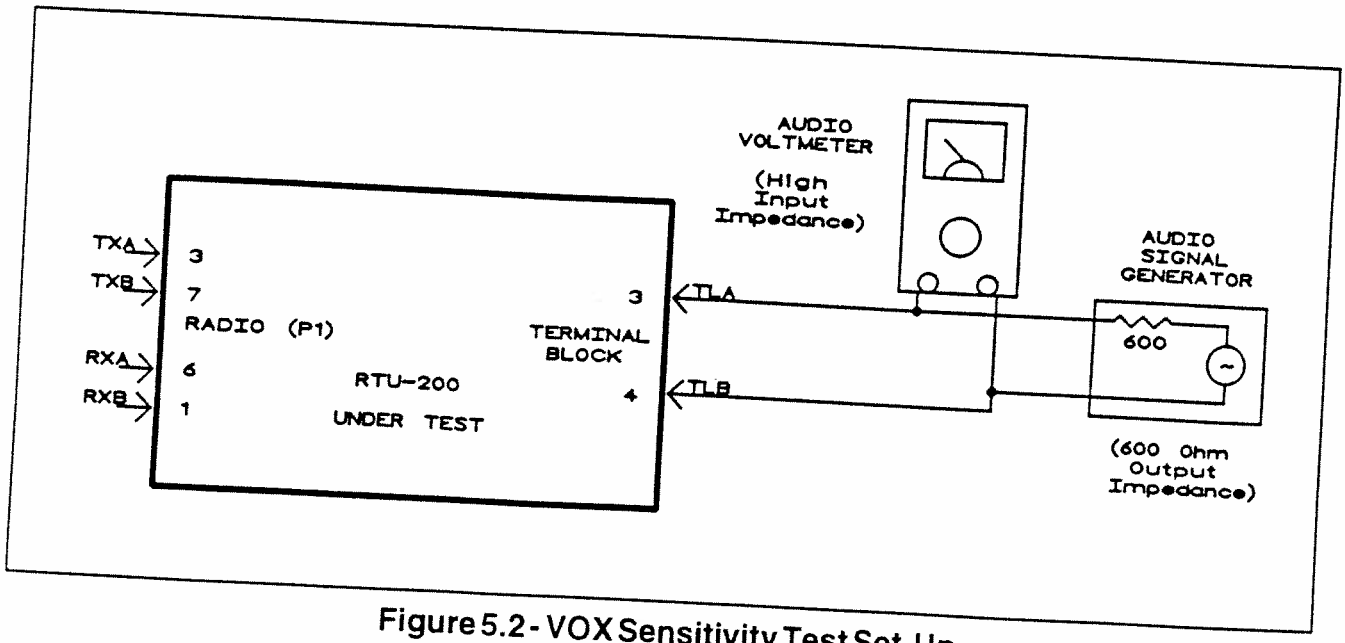

Figure 5.2 - VOX Sensitivity Test Set-Up

TABLE 5.1

RTU-200 FAULT ANALYSIS

SYMPTOM	POSSIBLE FAULT
No LED indicators are lighted after power-up.	Check AC power source and power line connection. Check RTU-200 fuse. Check for proper seating of the line voltage selector card (see paragraph 2.7).
At power-up, Ready and Peak Lvl LEDs are lighted; front panel switches do not operate.	The unit has failed to pass the self test function. Check for proper seating of IC U7 in its socket. Contact JPS Communications.
At power-up, the Ready LED flashes at about a 1 Hz rate.	The unit is in set-up mode. Be sure that the Manual Key Switch is in the center position when turning on the power. See paragraph 2.10.1.
At power-up, Power LED is lighted, but dim. Unit does not function.	Voltage selector card is in the 230 VAC position and the unit is being operated from 115 VAC. See paragraph 2.7.
Power LED is on and bright, but Key and Connect switches do not function.	The /REM signal, pin 5 in the REMOTE (P3) connector is pulled low, putting the unit into Remote mode. The disables the front panel switches.
The Ready LED takes several seconds to come on after the Connect Switch is thrown.	The unit is having trouble during the initial adaptation cycle. Probable noise, conversation, dial tone or busy signal on the phone line.
The Ready LED never comes on after the Connect Switch is thrown.	The unit has not been able to complete the initial adaptation cycle. Probably extreme noise, dial tone, busy signal or other type signal present on the phone line. Be certain that a good telephone connection is obtained using the local telephone set before putting the RTU-200 into CONNECT mode.
The VOX does not function.	The VOX is disabled while the Ready LED is not on and in Manual Key mode. Incoming telephone audio too low. See paragraph 3.4.5.
Manual Key Switch does not function.	This switch functions only while the RTU-200 is not being remotely controlled.
The Peak LED does not ever flash on incoming audio.	Audio input from the receiver either disconnected to too low. Adjust RX LVL maximum clockwise. If still not flash, check cable connections and receiver output level at the receiver.
The Peak LED is on nearly continuously.	Excessive audio level from the receiver. Adjust RX Lvl maximum counter-clockwise. If still flashes too often, check the receiver audio output level at the receiver.
VOX false triggers on audio peaks from the receiver.	Excessive audio level from the receiver or overdrive of the telephone line. IF the Peak LED is flashing normally on voice peaks (see paragraph 2.10.3), check the position of telephone send level jumper, JP2. See paragraph 2.8.1. Also, extremely bad phone line is possible.

TABLE 5.2

RTU-200 Replaceable Parts List

JPS Part Number	Description	Reference Designator
5890-601000	**Chassis Assembly**	
3620-07000	Conn, cable, 7-pin, AMP	To PCB J1
3700-03001	Conn, misc, phone jack, 3-ckt, mono	Monitor Jack
3700-06001	Conn, misc, barrier strip, 6-pos	Terminal Block
6320-00010	Filter, misc, fused, w/AC connector	AC Power Connector
8101-63400	Handle, 5/32 dia., 1.25" mtg ctr	Handles
8200-33800	HW, cable tie, 3 3/8" long	Line filter cable to Power Switch
8280-63200	HW, nut, hex, 6-32 x 5/16 x 7/64	SS For Terminal Block Mounting
8330-44005	HW, screw, fl hd, 4-40, 5/16, SS	Handle Mounting Screw
8350-63205	HW, screw, pn hd, 6-32, 5/16, SS	Mount Brackets, Rails to Panels
8350-63210	Hw, screw, pn hd, 6-32, 5/8, SS	For Terminal Block Mounting
8510-60000	HW, washer, split, SS, #6	For mtg brackets, rails, term block
1110-125001	Knob, blk, 0.5D, .125ID, no skirt	For Volume Pot
1221-000000	Lamp, LED, clip, mounting	Mounting Clip for LEDs
1221-535400	LED, .200 dia, ylw	Peak Level LED
1221-545200	LED, .200 dia, grn	Ready & Connect LEDs
1221-575200	LED, .200 dia, red	Main Power & Key LEDs
1610-103101	Pot, 1t, 10k, aud tpr, 1/8 shft, pn	Monitor Volume Pot
1910-012500	Sleeving, blk shrink, .125 ID	
1946-120001	Sw, toggle, SPDT, 0.4A, Gold	VOX/Manual & Connect Switches
1946-140000	Sw, toggle, SPDT, mom, 0.4A, Gold	Manual Key Switch
1946-220000	Sw, toggle, DPDT, 6A, Silver, Power	Main Power Switch
2312-024000	Wire, 1 cond, strnd, blk, #24, IPVC	7-pin Connector to Terminal Block
2312-024010	Wire, 1 cond, strnd, brn, #24, IPVC	Line filter
2312-024080	Wire, 1 cond, strnd, gry, #24, IPVC	J3 connector
2312-024090	Wire, 1 cond, strnd, whi, #24, IPVC	Line filter
2312-026000	Wire, 1 cond, strnd, blk, #26, IPVC	J3 connector and front panel wiring
2312-026010	Wire, 1 cond, strnd, brn, #26, IPVC	J3 connector and monitor switch
2312-026020	Wire, 1 cond, strnd, red, #26, IPVC	J3 connector and monitor switc
2312-026030	Wire, 1 cond, strnd, orn, #26, IPVC	J3 connector and monitor switc
2312-026060	Wire, 1 cond, strnd, blu, #26, IPVC	J3 connector
2312-026080	Wire, 1 cond, strnd, gry, #26, IPVC	J3 connector
5890-601100	RTU-200, Chassis side rail	
5890-601150	Bracket, Angle, 1/2 x 1/2	
5890-601350	RTU-200, Rear Panel, S/S Black	
5890--601500	**PCB Assembly, RTU-200**	
3200-20500	Cap, elect, 2.2uF, 50VDC	C9
3201-02350	Cap, elect, 1000uF, 35VDC	C60,61
3202-20250	Cap, elect, 22uF, 25VDC	C1,2,4,5,19,20,21,32,33,35,36
3231-00102	Cap, disc cer, 10pF, 5%, NPO, 100V	C30,31
3231-01102	Cap, disc cer, 100 pf, 100V	C38
3233-31101	Cap, disc cer, 330pf, 100V	C71 (install on circuit side of bd)
3271-02101	Cap, mylar, 1nF, 10%, 100V	C10,11,12,13,14,15,16,17
3271-03101	Cap, mylar, 0.01uF, 10%, 100V	C3,6,8,18,22,23,24,25,26,27,28,37,44
3271-04101	Cap, mylar, 0.1uF, 10%, 100V	C40,47,49,50,51,52,53
3271-05100	Cap, mylar, 1 uF, 10%, 100V	C7
3274-74500	Cap, mylar, 0.47uF, 10%, 50V	C62,64,66,68
3640-03100	Conn, Header, 3-pin single row	JP3,4,5,6,J5

RTU-200 Replaceable Parts List (Cont.)

JPS Part Number	Description	Reference Designator
5890-601500	**PCB Assembly, RTU-200 (Cont.)**	
3640-07100	Conn, Header, 7-pin single row	J3,4
3640-16100	Conn, Header, 16-pin dual row	JP1,JP2
3670-09000	Conn, DB9, shielded female, PC mount	P3
3670-09100	Conn, DB9, shielded male, PC mount	P1,2
3700-02000	Conn, misc, jumper, 2 circ, female for	JP1,2,3,4,5,6 and J4 and spare
3700-06000	Conn, RJ11C Modular Jack, PC mount	J1,2
3802-00000	Crystal, 20.000 MHz	Y1
4200-00060	Diode, Bridge, 600V, 1A	CR1,4
4230-58180	Diode, Schottky, 1N5818, 1A, 30V	CR5
4300-62670	Diode, trans sup, 1N6267, 6.8V, 5W	CR2,3
8280-44000	HW, nut, hex, 4-40 x 1/4 x 3/32, SS	For P1-3,Q1,3,U22,23
8350-44005	HW, screw, pn hd, 4-40, 5/16, SS	For U24,25
8350-44006	HW, screw, pn hd, 4-40, 3/8, SS	For P1-3,Q1,3,U22,23
8440-63201	HW, spacer, swage, 6-32 x 1/8	
8440-63202	HW, spacer, swage, 6-32 x 3/16	
8470-00000	HW, Term, turret, small, 1/16 board	E1-27, TP1-12
8480-40000	HW, washer, flt, SS, #4	For Q1,3
8490-40000	HW, washer, int tooth, SS, #4	For P1-3,Q1,3, & U22-25
8510-40000	HW, washer, split, SS, #4	For P1-3
8705-04100	Heatsink, T0-220, black, 0.85 high	for U22,23
9103-33000	Inductor, molded, small, 33uH, 5%	L1,2,3,4,5
9200-00200	Insulator pad, for crystal	For Y1
9310-74040	IC, dig, 74HC04N, hex inverter	U3
9317-42990	IC, dig, 74HC299N, 8-bit shift reg	U8,9,13,14
9317-43740	IC, dig, 74HC374N, Oct D FF, 3-stat	U11,17
9353-20150	IC, dig, TMS320E15 DSP, 40 pin DIP	U7
9360-74001	IC, dig, 74LS00N, Quad Nand	U19,21
9360-74002	IC, dig, 74ALS00N, Quad Nand, Advan	U18,20
9360-74742	IC, dig, 74ALS74N, Dual D FF, Adv.	U15
9533-20400	IC, lnr, TLC32044CN A/D, D/A	U10,12
9540-00820	IC, op amp, TL082CP, dual biFET	U4,5,6
9580-78050	IC, V reg, MC7805ACT, 5VDC	U22
9580-78120	IC, V reg, MC7812ACT, 12VDC	U23
9580-79050	IC, V reg, MC7905ACT, -5VDC, 1A	U25
9580-79120	IC, V reg, MC7912CT, -12VDC, 1A	U24
9590-02120	IC, lnr, DG212CJ Quad Analog Gate	U1
9590-20030	IC, lnr, ULN2003AN, 7 drv, 50V, .5A	U2
9590-77051	IC, lnr, TL7705ACP, V superv	U16
1611-103150	Pot, 15 turn, 10k, Horiz PC Mount	R30,33
1810-012014	Relay, low pwr, DPDT, 12VDC	K1,2,3
1820-100000	Resistor, carb, 1/4w, 10 ohm	R25,38
1820-102000	Resistor, carb, 1/4w, 1000 ohm	R24,35,50,51,52,53,54
1820-103000	Resistor, carb, 1/4w, 10K ohm	R3,11,18,21,36,37,39,40,41,42,43,44
1820-132000	Resistor, carb, 1/4w, 1300 ohm	R9
1820-153000	Resistor, carb, 1/4w, 15K ohm	R2,12
1820-182000	Resistor, carb, 1/4w, 1800 ohm	R8
1820-203000	Resistor, carb, 1/4w, 20K ohm	R13
1820-223000	Resistor, carb, 1/4w, 22K ohm	R26
1820-242000	Resistor, carb, 1/4w, 2400 ohm	R7,60,61,62,63,64,65,66,67

RTU-200 Replaceable Parts List (Cont.)

JPS Part Number	Description	Reference Designator
5890-601500	**PCB Assembly, RTU-200 (Cont.)**	
1820-273000	Resistor, carb, 1/4w, 27K ohm	R14
1820-362000	Resistor, carb, 1/4w, 3600 ohm	R6,20,31
1820-393000	Resistor, carb, 1/4w, 39K ohm	R15
1820-472000	Resistor, carb, 1/4w, 4700 ohm	R19,56
1820-512000	Resistor, carb, 1/4w, 5100 ohm	R5,70
1820-561000	Resistor, carb, 1/4w, 560 ohm	R32
1820-563000	Resistor, carb, 1/4w, 56K ohm	R16,28
1820-621000	Resistor, carb, 1/4w, 620 ohm	R1,22,23,27,29,57
1820-682000	Resistor, carb, 1/4w, 6800 ohm	R4,10
1820-822000	Resistor, carb, 1/4w, 8200 ohm	R34
1820-823000	Resistor, carb, 1/4w, 82K ohm	R17
1821-102000	Resistor, carb, 1/2w, 1000 ohm	R71
1823-020000	Resistor, carb, 2w, 2.0 ohm, 5%	R72
1827-750030	Resistor, ww, 3w, 75 ohm	R73,74
1920-400001	Socket, IC, non-rettin, 40pin WDIP	For U7
2020-016000	Xfmr, aud, 600ohm CT:600ohm CT	T1,2,3
2021-330000	Xfmr, pwr, 115/230VAC, 30VAC@.4A	T4
2040-080200	Xstr, bipolar, darl, MJE802, NPN	Q1
2041-003400	Xstr, bipolar, MJE340, NPN, 300V	Q3
2043-041240	Xstr, bipolar, sml sig, 2N4124, NPN	Q2,4
5890-601520	RTU-200, PC Board, Raw	

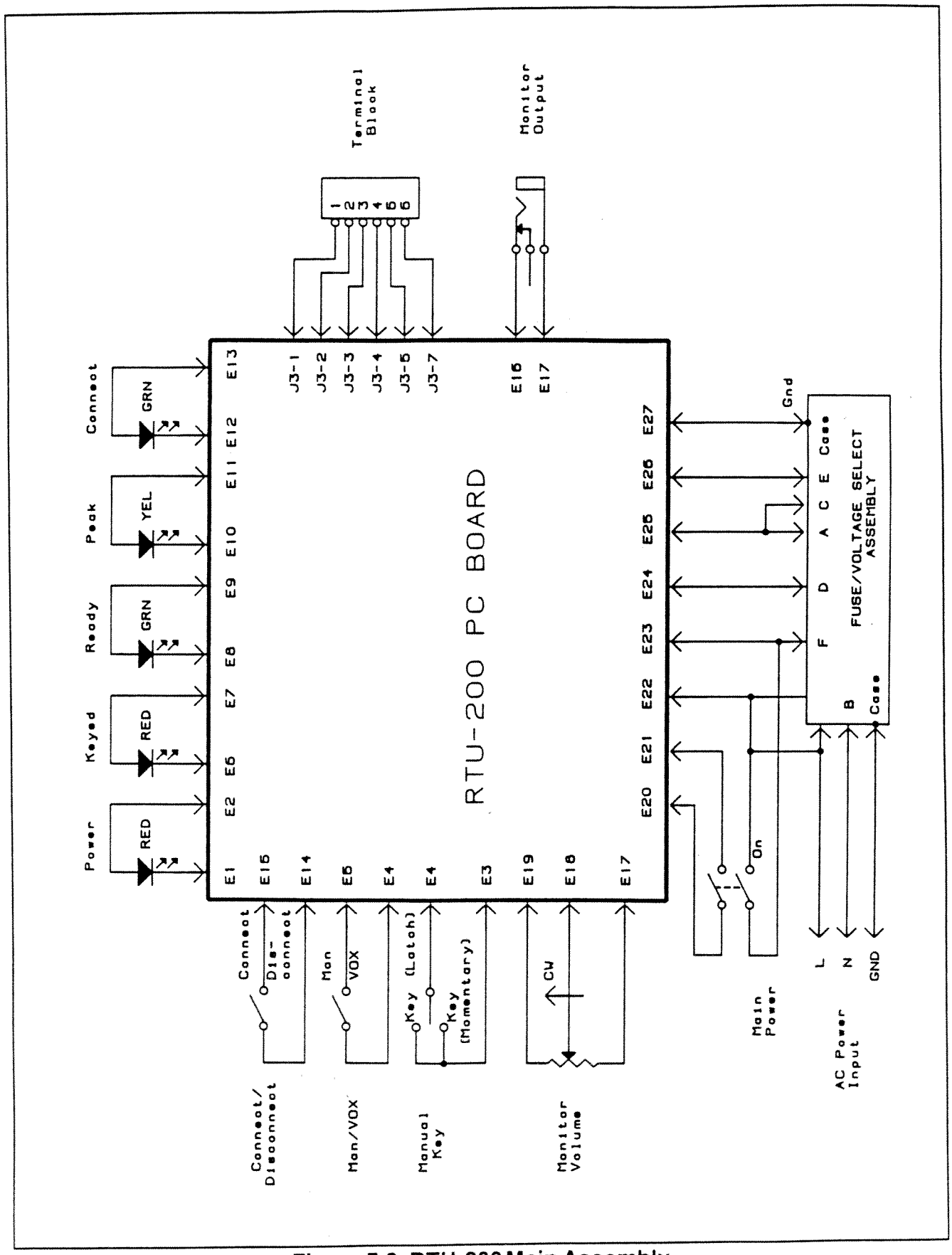

Figure 5.3 RTU-200 Main Assembly

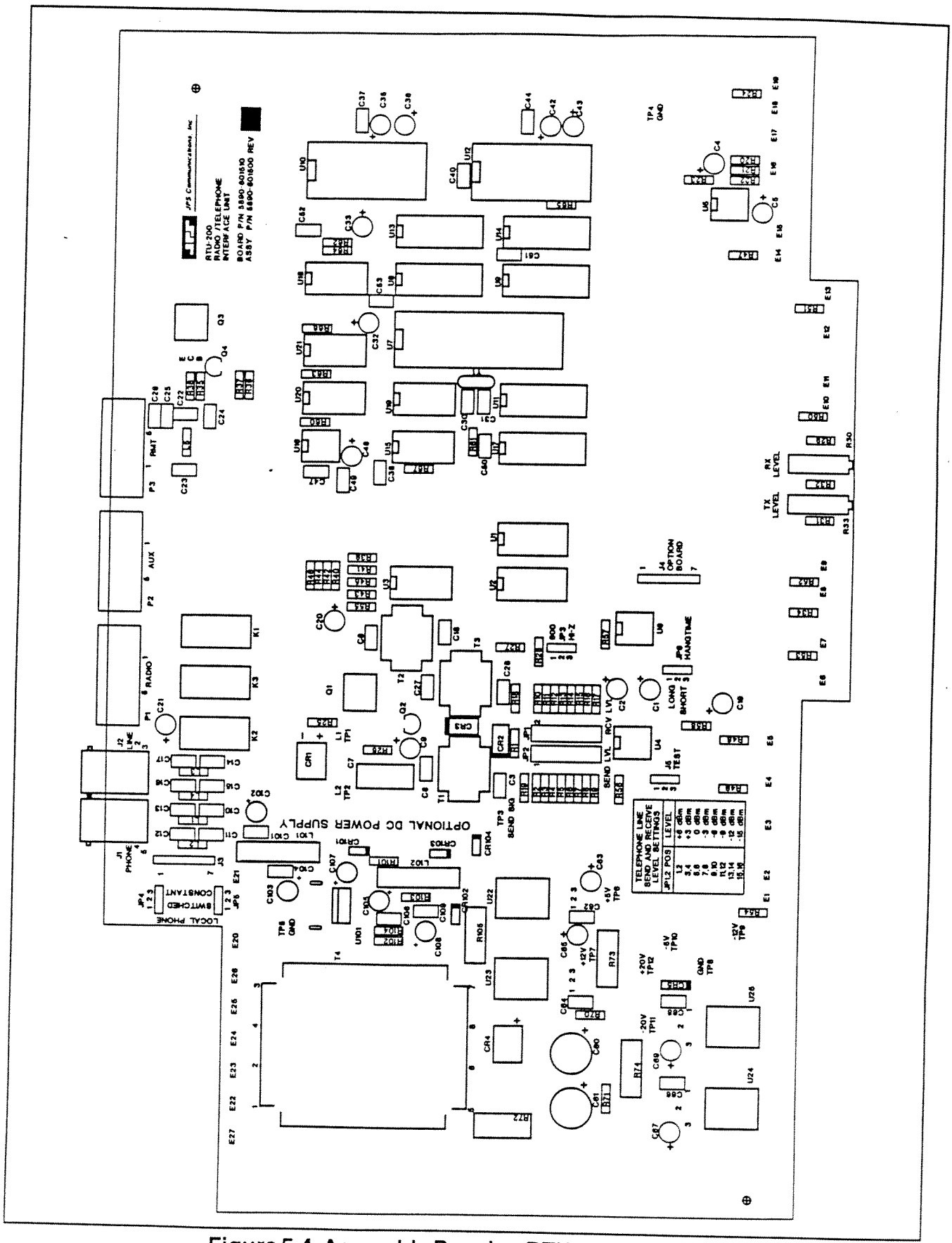

Figure 5.4 Assembly Drawing RTU-200 PC Board

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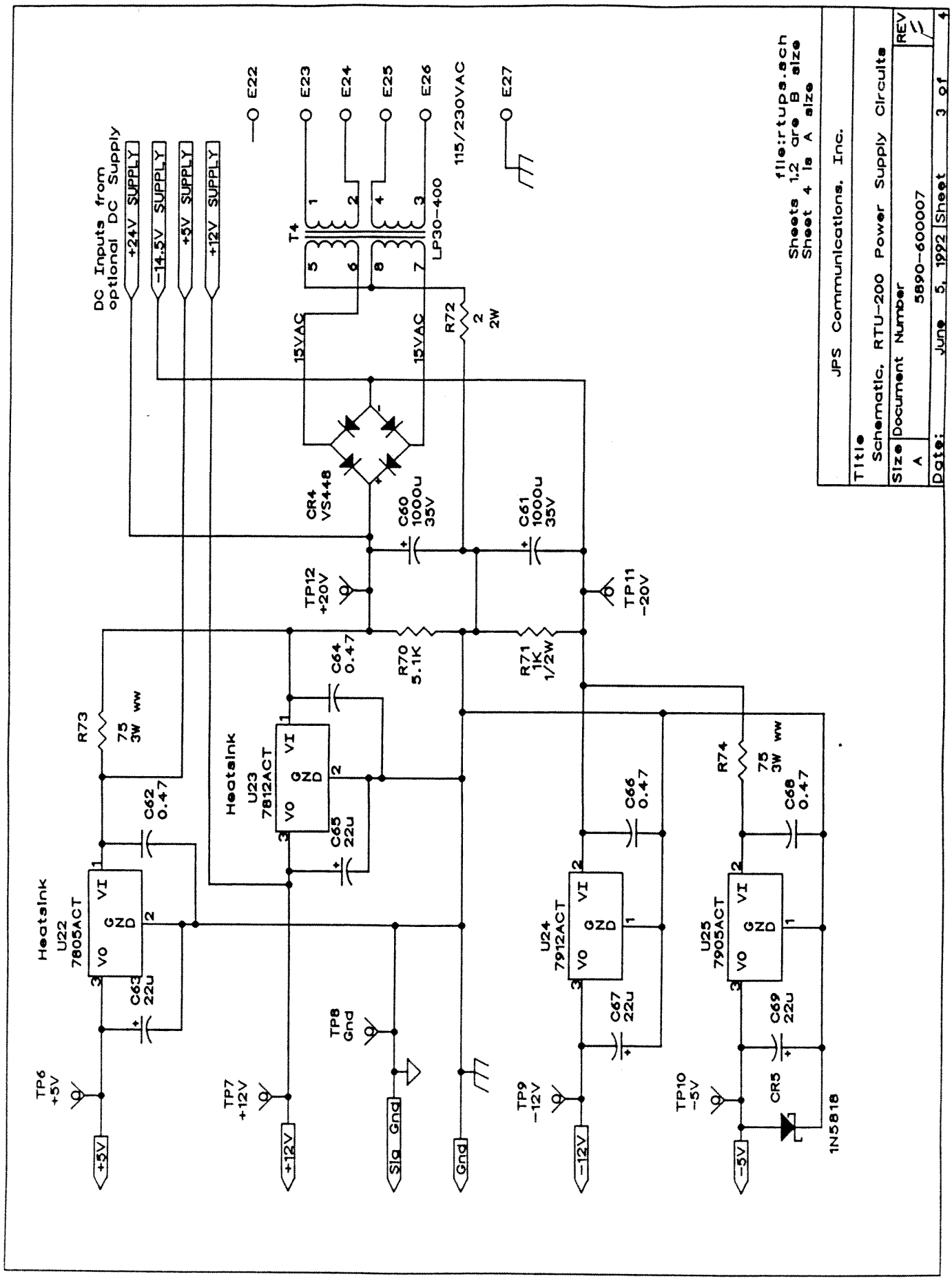


Figure 5.7 Power Supply Circuits

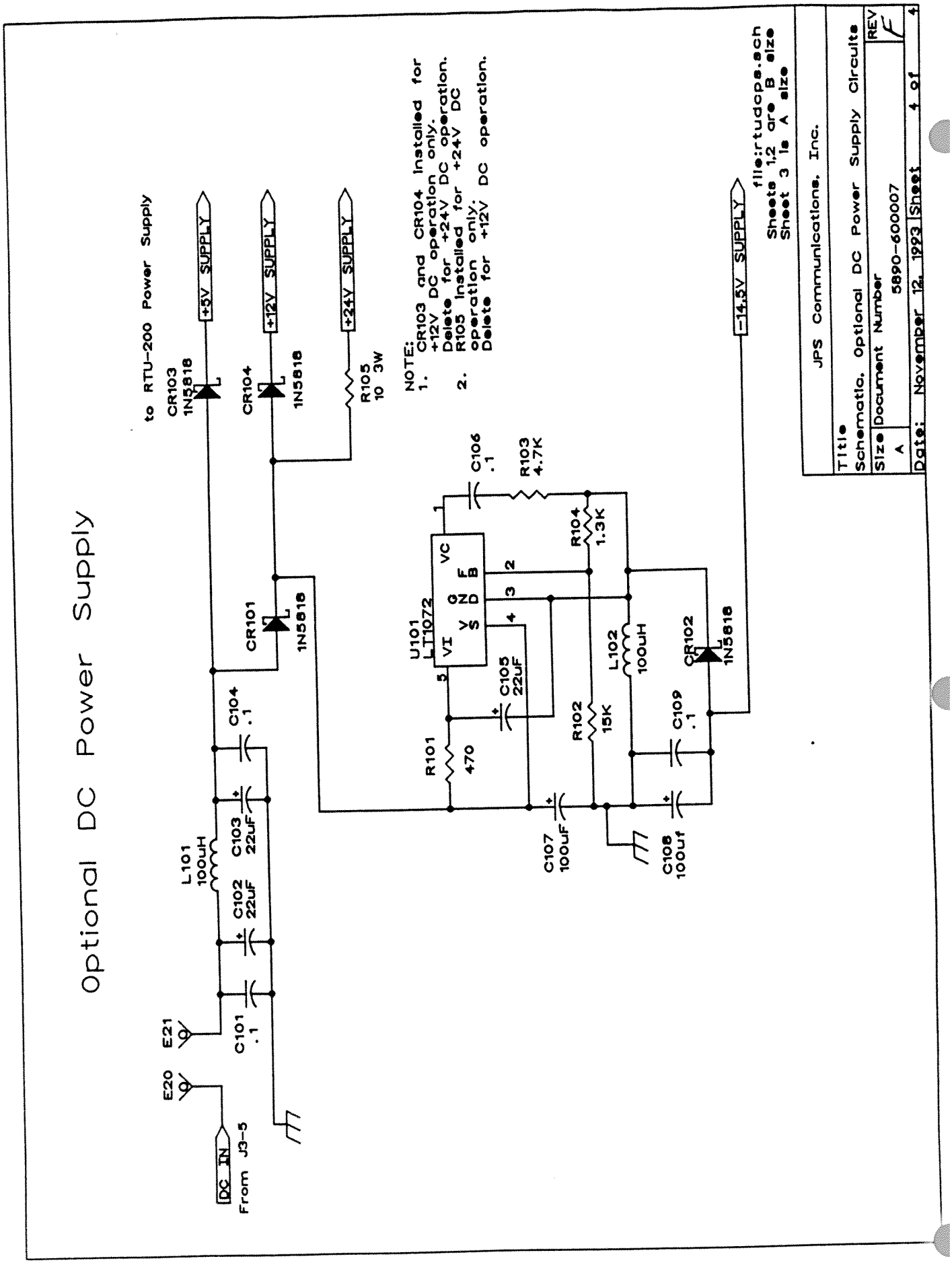
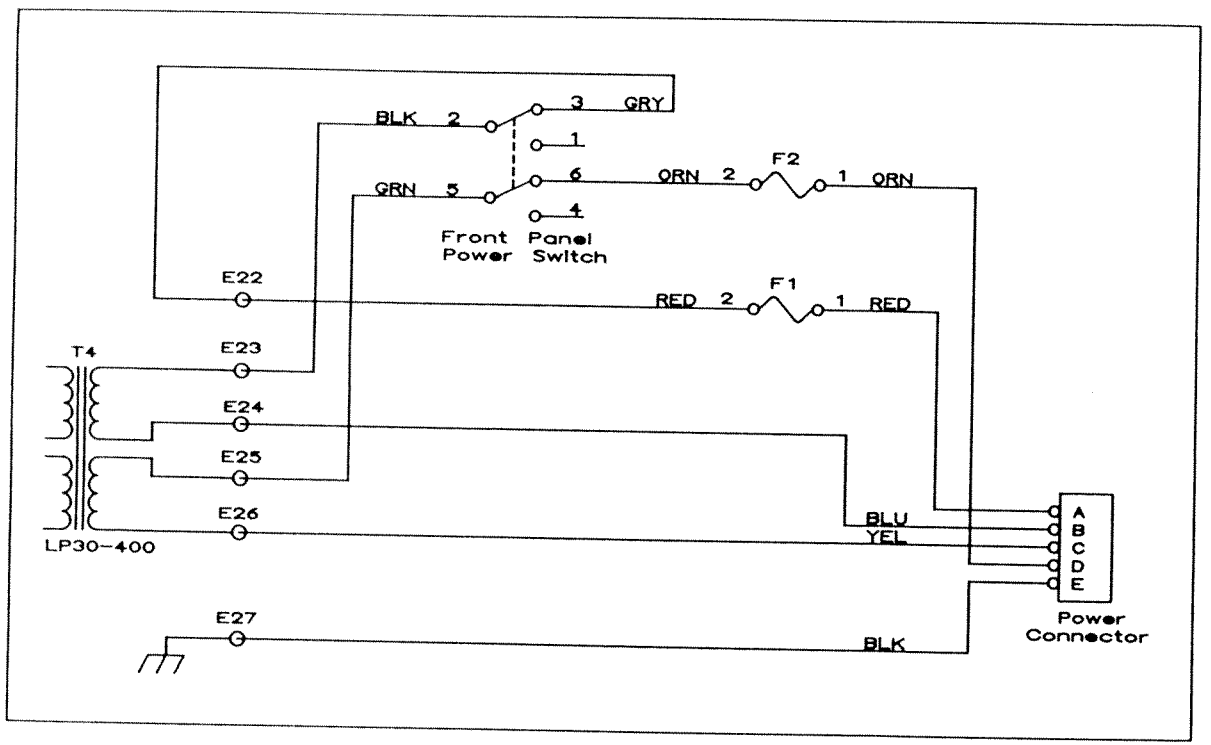
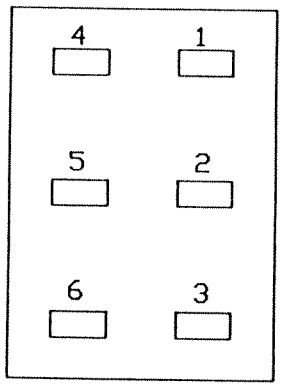


Figure 5.8 DC Supply Option

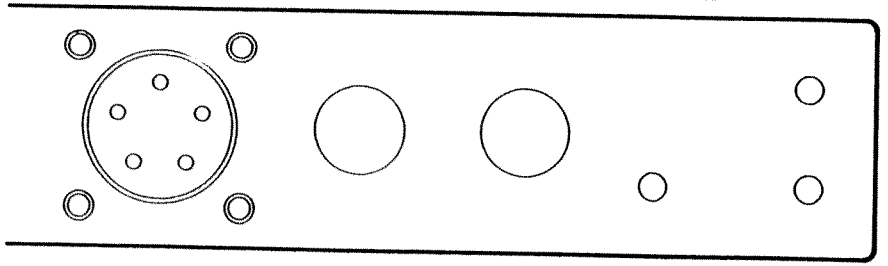
WIRING DIAGRAM SUNAIR RTU-200



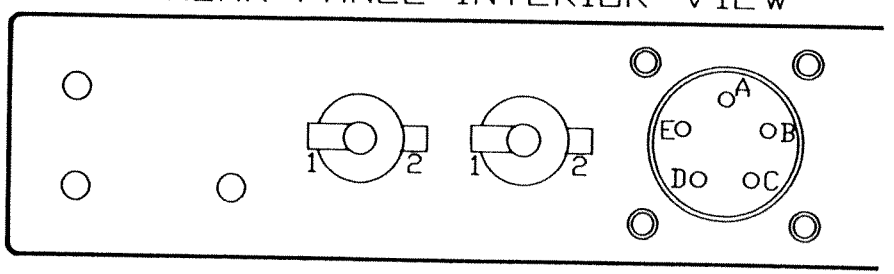


POWER SWITCH
INTERIOR VIEW

REAR PANEL EXTERIOR VIEW



REAR PANEL INTERIOR VIEW



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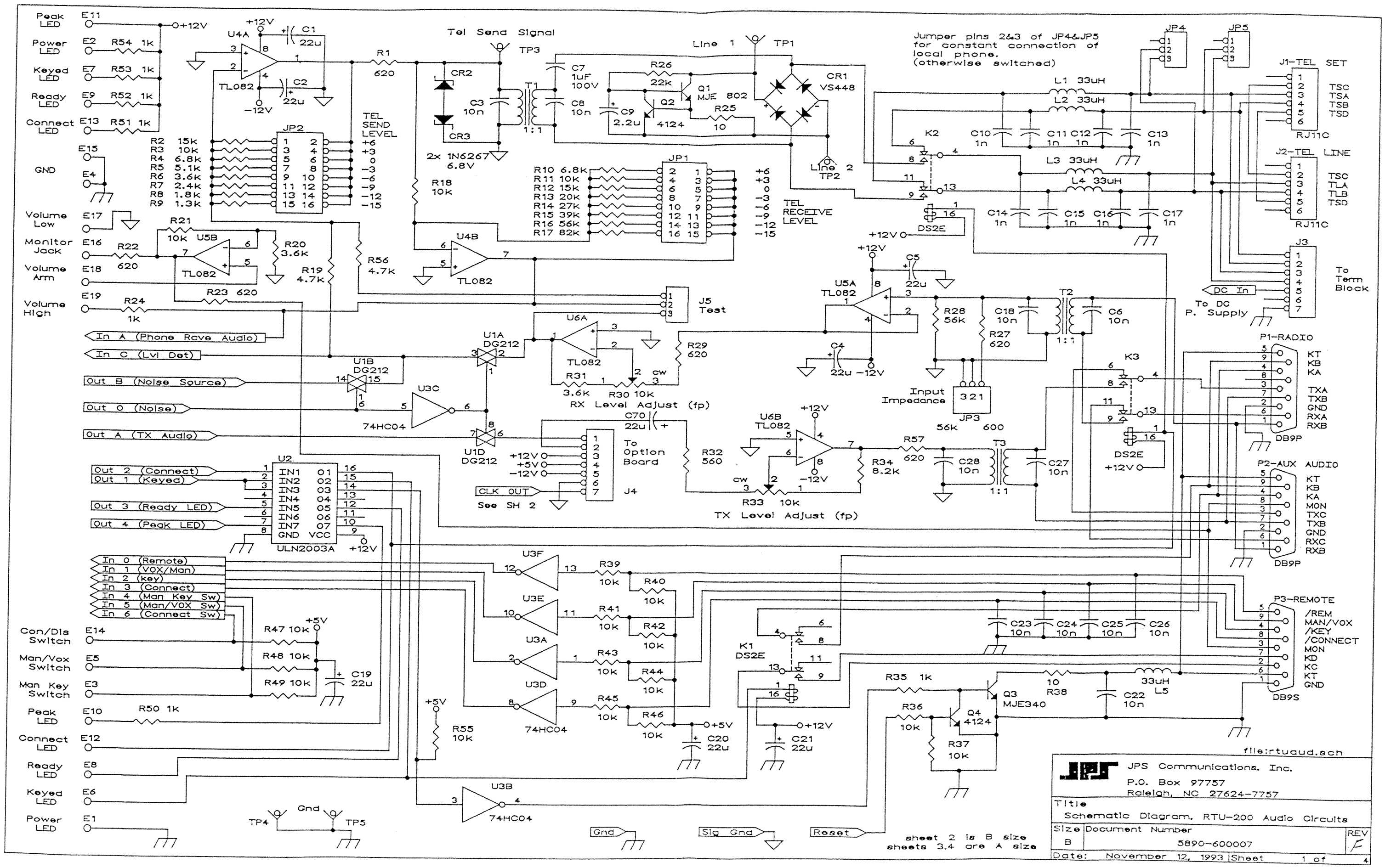

Figure 5.5 Audio Circuits

C30 10 pF
20.00MHz
Y1
C31 10 pF
R60 2.4k
C32 22u
U7 320E15
/RS X1 X2 /DEN A0 A1 A2 A3 A4 A5 A6 A7 A8 A9 A10 A11 D15 D14 D13 D12 D11 D10 D9 D8 D7 D6 D5 D4 D3 D2 D1 D0 /BIO /MEN /WE CLKOUT /INT
R61 2.4k
U19A U19D U19C U19B 74LS00
C71 330 pf
U8 U9 74HC299
R63 2.4k
U20A U20B 74ALS00
R62 2.4k
C33 22u
U10 32040
/RS /FSX DX SCLK WD/BYT /EODR REF /FSR DR NU MCLK /EODX VDD DGND NU AX AGND VCC+ VCC- OUT+ OUT-
In A
Out A
C37 10n
C35 22u
C36 22u
Sig Gnd
Gnd
U18A 74ALS00
CLK OUT
To J4 (Option Board)
U17 74HC374
Out 0 Out 1 Out 2 Out 3 Out 4 Out 5 Out 6 Out 7
R67 2.4k
U15A 74ALS74
U20C U20D 74ALS00
C38 100pF
U11 74HC374
In 0 In 1 In 2 In 3 In 4 In 5 In 6
R58 10k
JP6 Long Short Hangtime
R64 2.4k
C40 0.1
U13 U14 74HC299
U21B U21A U21D 74LS00
U18B 74ALS00
U21C 74LS00
R65 2.4k
R66 2.4k
U12 32040
In C
Out B
C44 10n
C42 22u
C43 22u
Reset
U16 TL7705A
REF RSI CT SNS VCC /RST GND
C47 0.1
C48 22u
C49 0.1
C50 0.1
C51 0.1
C52 0.1
C53 0.1

Reference Designators

Last Used	Not Used
R74	R59,68,69
C69	C27,29,34,39,41,45 C46,54-56,58,59
U25	—
Q4	—
CR5	—
L5	—
T4	—
K3	—
Y1	—
TP12	—
E25	—
P3	—
JP6	—
J5	—

Unused Gates: U18C, U18D
Unused Flip-flop: U15B

file:rtudsp.sch
sheet 1 is B size
sheets 3,4 are A size

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Date: November 12, 1993 | Sheet 2 of 4

Figure 5.6 DSP Circuits