TRANS WORLD COMMUNICATIONS, INC. ■ A EMTRON COMPANY

RAT1000
AUTOMATIC ANTENNA TUNER
OPERATOR'S MANUAL

TRANSWORLD™
for communications

Manual No. RAT1000-MSOP
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*** WARNING ***

RAT1000 Memory Option - Software

If the RAT1000 memory option is to be used in a system with either Transcall or Transcall/R, the correct version of Transcall software must be used or DAMAGE TO THE TUNER WILL RESULT. The software revision levels to be used with the RAT1000 memory option are:

- Transcall: -77 or higher (used in the TW100 or RT100/MP transceivers)
- Transcall/R: -79 or higher (used in the TW5201 or RT5201 remote controls)

When the channel is changed on the transceiver, it may take as much as 200 milliseconds for the relays in the tuner to settle to their new tuning positions. The original software for both Transcall configurations used a 50-ms delay before the onset of RF output following the channel change. This would have resulted in "hot switching" of the tuner relays, which causes arcing and temporary mismatch.

The new software revisions will increase the delay to a value which will prevent "hot switching." Systems with either Transcall configuration which are shipped after 3-26-87 will already have the new software installed. If you are retrofitting a RAT1000 memory tuner to your Transcall system, please indicate to us that you require the new version of software and it will be sent to you free of additional charge.

Note that this "hot switching" problem is not evident in the RAT100 memory option, as the switching time in that tuner is already less than 50 milliseconds. Also note that the new revisions are completely compatible with existing systems in every other way.

Warranty

Trans World Communications, Inc. (TWC) warrants that new TWC equipment has been manufactured free of defects in design, material and workmanship. If the equipment does not give satisfactory service due to defects covered by this warranty, TWC will, at its option, replace or repair the equipment free of charge.

The warranty is for a period of 90 days from the date of installation. In the event that the equipment is not installed within 90 days of factory shipment, satisfactory evidence of the installation date must be submitted.

Limitations:

This warranty does not cover physical damage caused by impact, liquids or gases. Defects caused by lightning, static discharge, voltage transients, or application of incorrect supply voltages are specifically excluded from this warranty.

Return Of Equipment - USA:

The equipment shall be returned freight prepaid to the Service Department, Trans World Communications, Inc., 304 Enterprise Street, Escondido, California 92029. The equipment should be packed securely, as TWC will not be responsible for damage incurred in transit. Please include a letter containing the following information:

- Model, serial number, and date of installation.
- Name of dealer or supplier of equipment.
- Detailed explanation of problem.
- Return shipping instructions.

TWC will return the equipment prepaid by United Parcel Service, Parcel Post or truck. If alternate shipping is specified, freight charges will be made collect.

Return Of Equipment - Foreign:

Write for specific instructions. Do not return equipment without authorization. It is usually not possible to clear equipment through U.S. Customs without the correct documentation. If equipment is returned without authorization, the sender is responsible for all taxes, customs duties and clearance charges.

Limited Parts Warranty:

This warranty shall cover all parts in the equipment for a period of 12 months from the date of installation, subject to the previous conditions and limitations. The parts will be replaced free of cost. The labor charges will be made at the current TWC hourly service rate.

Parts Replacement:

If it is not practical, or the purchaser does not want to return the equipment to the factory, this warranty is limited to the supply of replacement parts for a period of 12 months from the date of equipment installation. The following instructions for the supply of replacement parts should be followed:

- Return defective parts prepaid to: Parts Replacement, Trans World Communications, Inc., 304 Enterprise Street, Escondido, California 92029.

- Include a letter with the following information:

  Part number(s).

  Serial number and model of equipment.

  Date of installation.

Parts returned without this information will not be replaced. In the event of a dispute over the age of the replacement part, components date coded over 24 months prior will be considered out of warranty.

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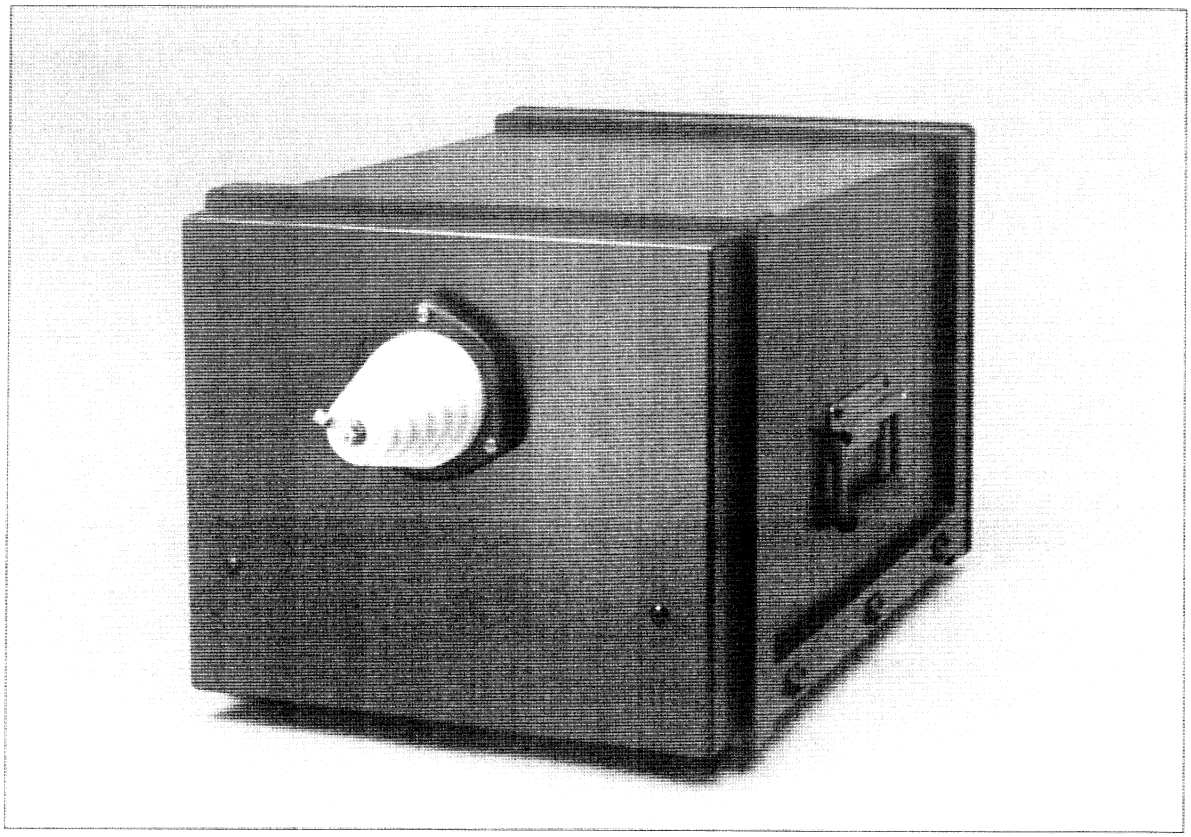

FIGURE 1-1.
RAT1000 1000-W Automatic Antenna Tuner.

General Information

1.1 Introduction

This manual contains the information required for the installation and operation of the automatic antenna tuner. Refer to the RAT1000-MS technical manual for detailed technical and servicing information.

1.2 General Description

The automatic antenna tuner is designed to automatically match the 50-ohm output of the transceiver into a variety of antennas for mobile and base-station applications over the frequency range of 2-30 MHz. All operation, including network tuning and VSWR monitoring, is fully automatic and microprocessor controlled. Tuning time is typically three seconds.

The automatic antenna tuner is designed to provide tactical security by permitting remote location of the antenna up to 200 feet from the associated transceiver. Since a radiating antenna is always a potential target under combat conditions, the transceiver and operator can be protected at a safe distance from the antenna.

1.3 Physical Description

The automatic antenna tuner is designed for continuous operation under the most severe environmental conditions. It is contained in a rugged, waterproof, metal case which should be mounted as close as possible to the radiating part of the antenna.

1.4 Technical Specifications

Table 1-1 lists the technical specifications of the automatic antenna tuner.

1.5 Minimum Antenna Length

The following minimum antenna lengths should be used:

Frequency Range	Antenna Length
2-30 MHz	40 ft. (32 ft. with external loading coil)
3-30 MHz	16 ft.

1.6 FSK Operation (Continuous Transmit Duty)

The following condition regarding ambient temperature must be observed when operating in the FSK mode:

Sun Loading
The tuner is rated for operation to 55° C ambient. This temperature can be exceeded if the case is exposed to direct sunlight. For FSK operation it is important that the tuner is installed so that the case is not exposed to direct sunlight.

1.7 Memory Option

Memory or automatic-tune options are available for the RAT1000. These options are described in detail in Section 4 of this manual.

TABLE 1-1.
RAT1000 Technical Specifications.

Frequency Range:	2-30 MHz.
Tuning Capability:	
Whips -	See Section 1.5 regarding minimum length.
Long Wires -	23-46 m (75-150 ft).
Rated RF Input Power:	1000 W PEP and continuous (see Section 1.6).
Tuning Mode:	Fully automatic.
Tuning Accuracy:	Typically greater than or equal to 1.5:1 VSWR referenced to 50 ohms; maximum VSWR of 3:1.
RF Efficiency:	Typically 50 to 90% depending on antenna type and frequency.
Tuning Time:	Typically 3 seconds.
RF Tune Power:	10-W forward power throughout tuning cycle.
Primary Power Requirements (J7-J):	28 Vdc @ 4.0 A peak, during tuning cycle, 1.8 A when tuned.
Operating Environment:	Waterproof (sealed), designed for exposed installations.
Temperature Range:	-30° C to +55° C.
Weight:	22 kg.
Size (W x H x D):	34 cm x 29.7 cm x 49 cm.
RF Connections:	
Input	UG-21C type-N.
Output	High-voltage ceramic insulator.
Ground Connection:	Ground lug.

TABLE 1-1.
RAT1000 Technical Specifications.

Input Control Connector:	CA3102R12SA10S.
Control Lines:	
ATU Initiate (J7-D):	Ground-going pulse from radio enables tune cycle.
Key (J7-A):	Ground from tuner during tune cycle to companion transceiver.
Data (J7-E):	Memory option only.
Check Tune (J7-F):	Memory option only.
Clock (J7-G):	Memory option only.
Strobe (J7-H):	Memory option only.

Installation

2.1 General

System installation is a three-part process covering the following steps:

a. Installing the antenna.
b. Mounting the antenna tuner.
c. Connecting the appropriate interface cables between the tuner and the transceiver.

This manual section will discuss the above-mentioned three steps in detail. This should provide sufficient information to enable the user to confidently install a complete system in the proper manner.

2.2 Antenna Installation

The antenna system is a key part of the communication system, and for satisfactory operation the system must be installed correctly. The unbalanced antennas used with the automatic antenna tuner use the ground as half of the antenna system. The ground forms an "image" antenna and is a critical part of the system. This makes it essential to consider both the ground and the antenna when designing the system.

2.2.1 Antenna Location

The following points should be carefully considered when designing the antenna system.

a. The antenna should be located in a position free of obstructions, particularly in the desired direction of communication.

b. The antenna should be kept as far away as possible from buildings, trees and vegetation. If metallic masts or supports are used, arrange the insulators so that the antenna is spaced at least 2 m from the mast.

c. Remember that the radiating part of the antenna starts at the tuner, and therefore, the lead-in cable from the tuner to the antenna should be as short as possible.

d. Vertical antennas have an omni-directional radiation pattern and will provide equal performance in all directions.

e. Horizontal wire antennas have maximum radiation broadside to the antenna when the frequency is less than 1/4 wavelength. As the frequency increases beyond 1/4 wavelength, lobes will appear in the radiation pattern with the principal lobes becoming closer to the plane of the antenna as the length increases. At all times, radiation will be minimum at the end of the antenna, and it should be located so that the ends point in directions where communications are not required.

f. The "VEE" construction minimizes the directivity of the horizontal antenna and is recommended for all-around coverage. In addition, the "VEE" antenna is a compromise between vertical and horizontal polarization and will give good results for communications with land or marine mobiles using vertical whip antennas.

g. High voltages (sometimes exceeding 15,000 V) are present on the antenna. All parts of the antenna and tuner must be located or protected so that there is no possibility of accidental contact.

h. Do not locate the antenna close to other antenna systems.

i. Make sure that the antenna is rigidly supported. The antenna will detune if it sags or sways.

j. The connection from the tuner to the ground must be a small percentage of the total length of the antenna. Do not let the length of the ground strap exceed 1-1.5 m. Use heavy-gauge wire or strap for ground connection.

k. Whip antennas should be connected with the minimum length of wire. (Do not exceed 0.6 m.)

l. Do not locate the tuner farther from the transceiver than necessary. If the distance exceeds 35 m, it is recommended that low-loss coaxial cable be used.

2.2.2 Ground System

The ground system is a key part of the overall antenna system and is the primary cause of poor performance and difficulty in adjusting the tuner. There is no point in installing the antenna unless a good ground can be provided.

2.2.2.1 Vehicle Grounds

Connect the tuner directly to the frame of the vehicle. Ensure that a heavy strap is used from the tuner ground lug and that the connections are cleared of all paint and dirt so that the shiny metal is exposed. Make sure that the grounding point is not insulated from other parts of the vehicle by nonmetallic couplings, brushings, fiberglass panels, etc.

2.2.2.2 Base-station Grounds

In areas of high ground conductivity, an effective ground can be made through a grounding rod. The rod should be approximately 3 m in length and should be installed as close as possible to the tuner. It may be necessary to use several ground rods bonded together to improve the ground contact. Water pipes are sometimes recommended as grounds and may be used provided the following conditions are met.

a. The water pipe is close to the tuner.
b. The water pipe enters the ground very close to the tuner bonding point.
c. There are no joints or couplings in the pipe that will increase the resistance path to ground.
d. The water pipe enters soil with good conductivity.
e. A low-resistance contact is made to the water pipe.

Frequently the ground conductivity will not be sufficient to provide satisfactory operation of the tuner. This is almost certainly the case with well-drained sandy, rocky or loamy soils, and a counterpoise must be used as the ground system. This is also very important in a roof-top installation where there is no existing ground plate. The ideal ground would be a conducting surface extending several wavelengths in all directions around the antenna. On a rooftop this situation may be approximated by placing a screen of chicken mesh or similar material over the roof of the build-

ing. More frequently, a counterpoise system of radial wires must be used. We recommend the use of at least 8-10 radials bonded together. If the antenna is at ground level, the radials should be buried a few inches below the surface.

2.2.2.3 Corrosion

The ground connections are subject to corrosion and oxidation. All joints must be clean and the hardware adequately tightened. The joints may be protected by an application of silicon grease and, under severe conditions, covered with electrical tape and waterproof varnish.

2.3 Antenna-Tuner Mounting

The tuner is mounted using the proper mounting brackets on the case. Choose a location immediately adjacent to the antenna feed point. High-voltage connecting cable must be used. (RG8U cable with solid insulation may be used if the outer shielding is removed.)

2.3.1 Antenna Connection

The antenna lead is connected to the high-voltage insulator. Use two wrenches when tightening the nut to prevent the stud from rotating. Potentials of several thousand volts may be present at the antenna terminal, and adequate protection must be made against accidental contact. It is also necessary to ensure that the antenna is spaced at least 3 cm from the conducting surface. Sharp points should be avoided to prevent corona discharges.

2.4 Cable Connections

The 1-kW antenna tuner is designed to be interfaced with a transceiver and high-power amplifier. The tuner can interface with most transceivers and amplifiers under special system considerations, however, this section will discuss connections between the TWC tuner and TWC transceivers and amplifiers.

2.4.1 RF Coaxial Cable To Tuner

The RF connection between the high-power amplifier and tuner should be made with a good grade of RG213/U-type, 50-ohm coaxial cable. The tuner end of the cable should be terminated with a UG-21C type-N connector.

J6 is the RF input connector on the RAT1000. The following RF cables are used with Transworld amplifiers.

1. RAT1000 (J6) to TW500A/TW1000,TW1000A
   RF Cable: C991526
2. RAT1000 (J6) to RA400/RA1000
   RF Cable: C991505

2.4.2 Control Cable To Tuner

The tuner uses a 10-pin control connector on the end of the control cable. Standard pin connections are as follows:

PIN	DESCRIPTION
A	Key Keys the transceiver into transmit mode for low-level (10-W) carrier tune power. An open-collector transistor is switched "on" during the tune cycle.
J	+28 Vdc The tuner needs +28 volts at 4.0 amps peak. (Dc voltage is supplied from the high-power amplifier—the amplifier can be turned off and dc power still provided to the tuner from the power supply.)
C	Ground
D	Tune Initiate A momentary ground from the transceiver starts the tune cycle (the ground on this line comes from the ATU button on the transceiver).

NOTE

The data, clock, check tune, and strobe lines are only used when the control cable is configured for the memory option (see Section 4). Refer to Table 2-1 for the pin-outs of J7, the control/dc input connector on the RAT1000.

2.4.3 System Interfacing

This section describes the standard system configurations using the RAT1000 with other Transworld equipment.

2.4.3.1 TW100/TW500A/RAT1000

The block diagram of the standard system is shown in Figure 2-1. All major equipment and interconnecting cables are illustrated. The list that follows describes the cables used in the system.

1. C991536 — TW500A to TW100 control cable.
2. C991539 — TW100 to amplifier RF cable.
3. C991551 — TW100 tuner control cable.
4. C991552 — RAT1000 control cable.
5. C991526 — RAT100 to TW100 RF cable.

NOTE

A special interface box (RAT1000P) is required to provide +28 Vdc to the RAT1000; this box also takes control-line data from the TW100 and routes it (together with the +28 Vdc) to the RAT1000. The RAT1000P also has: 1) Coupler Input Connector — 613051, 2) Coupler Output Connector -613003, and 3) Ac Power Cord. See Section 5 for a detailed description of the RAT1000P.

2.4.3.2 TW100/TW1000A/RAT1000

The standard configuration has a TW100 with a +28-Vdc option and power obtained from the TW1000A (Figure 2-2). Interconnecting cables are described in the following list.

1. C991537 — TW100 to amplifier power cable.
2. C991539 — TW100 to amplifier RF cable.
3. C991538 — TW100 to amplifier control cable.
4. C991551 — TW100 to RAT1000 control cable.

5. C991526 — RAT1000 to amplifier RF cable.
6. C991541 — TW1000A to PS1000 power cable.

NOTE

A jumper must be connected inside the TW100 transceiver from connector J4-9 to the input of the M8A module; this connects +28 Vdc to the C991551 cable to provide primary power to the RAT1000. This allows power to the tuner to be controlled by the TW100 power switch (see Figure 2-3).

2.4.3.3 RT100/RA400/RAT1000

The standard configuration has an RT100/MP with the +28-Vdc option and power obtained from the RA400. See Figure 2-4.

Figure 2-5 shows the primary power routing. The RT100/MP-28 power switch controls the +28 V to the RAT1000.

NOTE

A +12-Vdc RT100/MP can also be used. In this case, cable C991511 is not used and the RT100/MP must obtain primary power from another source. In this case the +28 V for the RAT1000 must be picked up inside the RA400.

Cables used are as follows:

1. C991511 — RT100/MP to amplifier power cable.
2. C991509 — RT100/MP to amplifier control cable.
3. C991552 — RAT1000 control cable. (-552 is 16 ft (C991633) in length while -663 is 2 ft.)
4. C991510 — RT100/MP to amplifier RF cable.
5. C991505 — RAT1000 to amplifier RF cable.

2.4.3.4 RT100/RA1000/RAT1000

The standard configuration has an RT100/MP with the +28-Vdc option and power received from the RA1000. See Figure 2-6.

1. To provide +28 Vdc to the RAT1000, a jumper must be connected inside the RT100/MP from J1-J to the input of the M8A module (see Figure 2-5). The RAT1000 +28 V is then controlled by the RT100/MP-28 power switch.

2. Interconnecting cables are the same as used in Section 2.4.3.3, except that C991508 (See Figure 2-6) must be used between the UPS1000 power supply and the RA1000 amplifier.

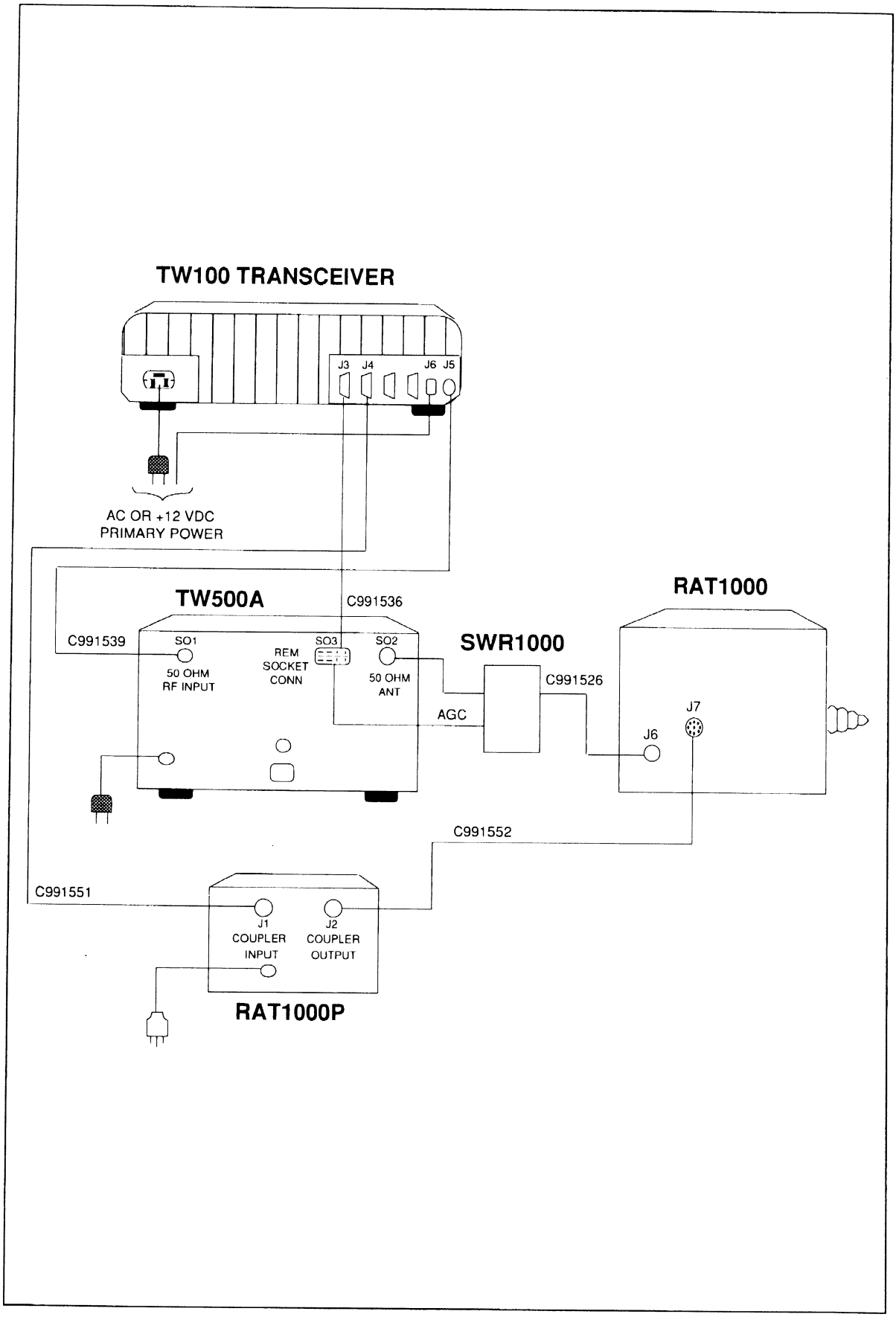

FIGURE 2-1.
TW100/TW500A/RAT1000 Block Diagram.

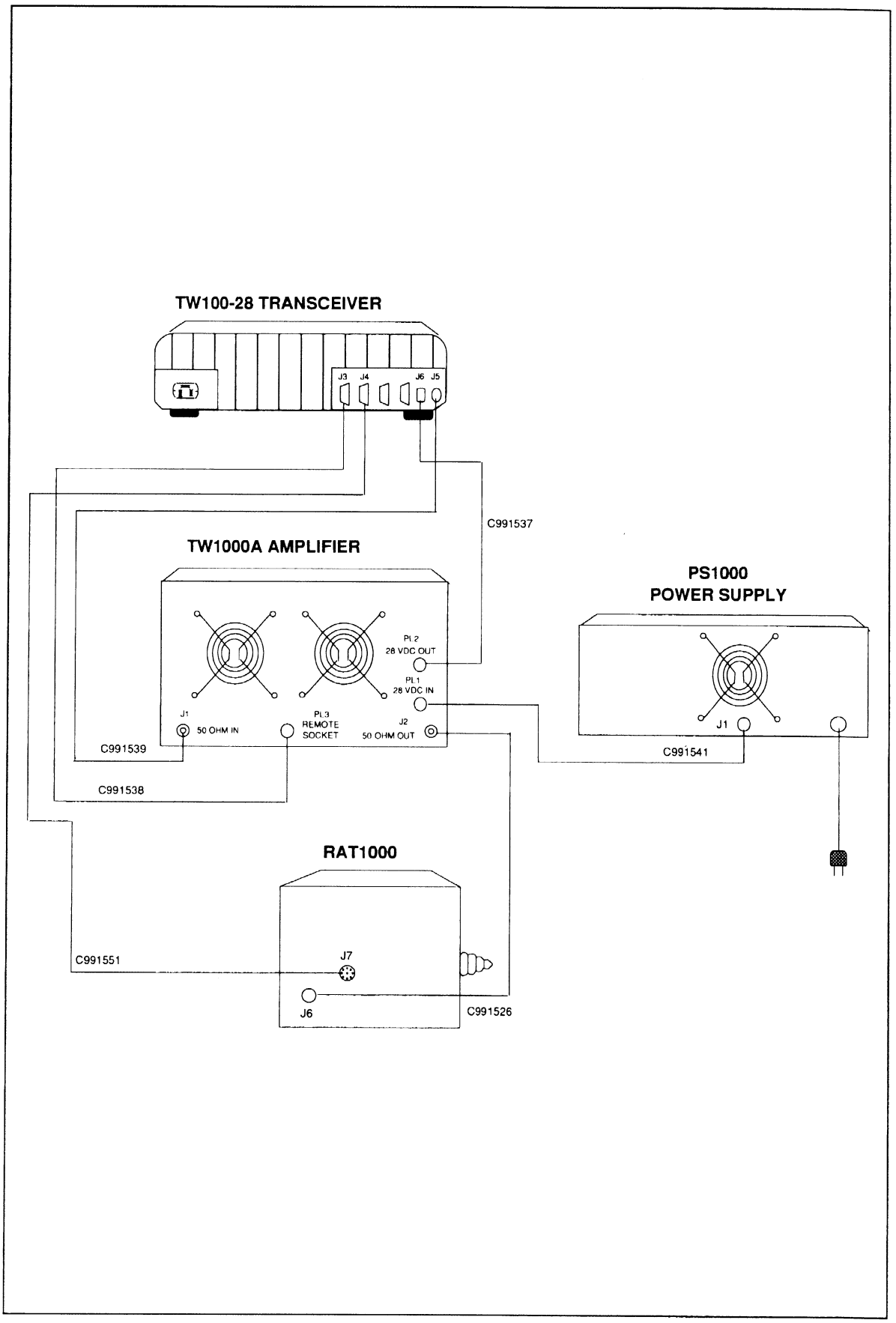

FIGURE 2-2.
TW100/TW1000A/RAT1000 Configuration.

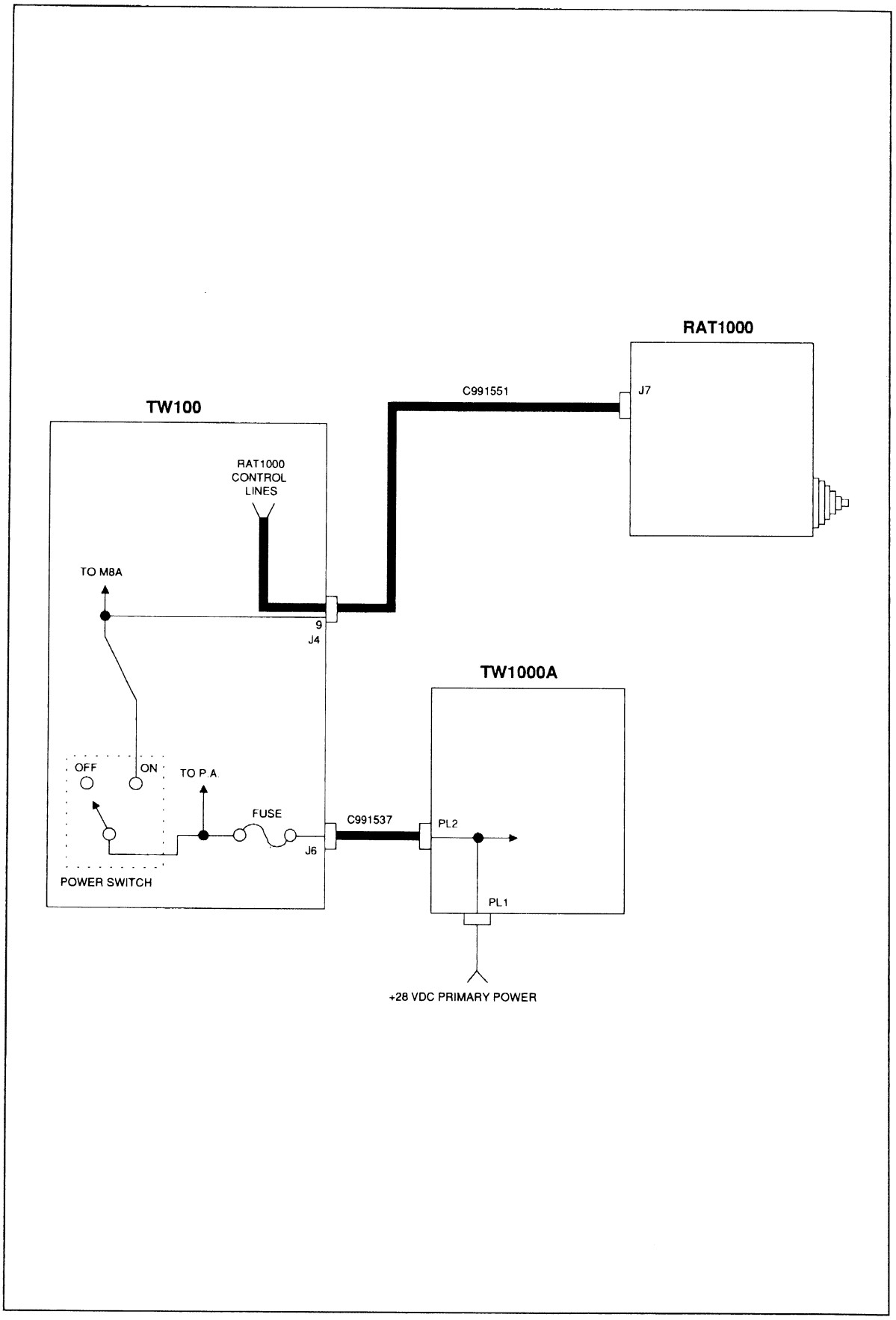

FIGURE 2-3.
Primary Power Routing for Standard TW100/TW1000A/RAT1000 System.

TABLE 2-1.
Connections - Control Cable to RAT1000.

Connector Pin (TW100, J4)	Connector Pin (RAT1000 or RT100/MP, J1)	Line Description
4	A	KEY - Keys the transmitter on for low-level carrier tuning. An open-collector NPN transistor capable of sinking 0.5 A to ground when activated.
1	C	Ground.
5	D	Initiate Tune - Starts tune cycle. Line is normally open. Pressing ATU button puts momentary ground on this line which activates coupler tune cycle.
7	E	Data* - Serial data from the transceiver provides channel number information.
8	F	Check Tune* - Negative-going pulse from transceiver tells the tuner to "read" the channel number and set itself to the setting stored in memory.
6	G	Clock* - Toggles to allow data to be shifted and read properly.
3	H	Strobe* - A high level on this line allows parallel loading of the BCD channel data into the serial-out shift register.
9	J	+28 Vdc - Primary Power.

* Used only in memory-option configuration.

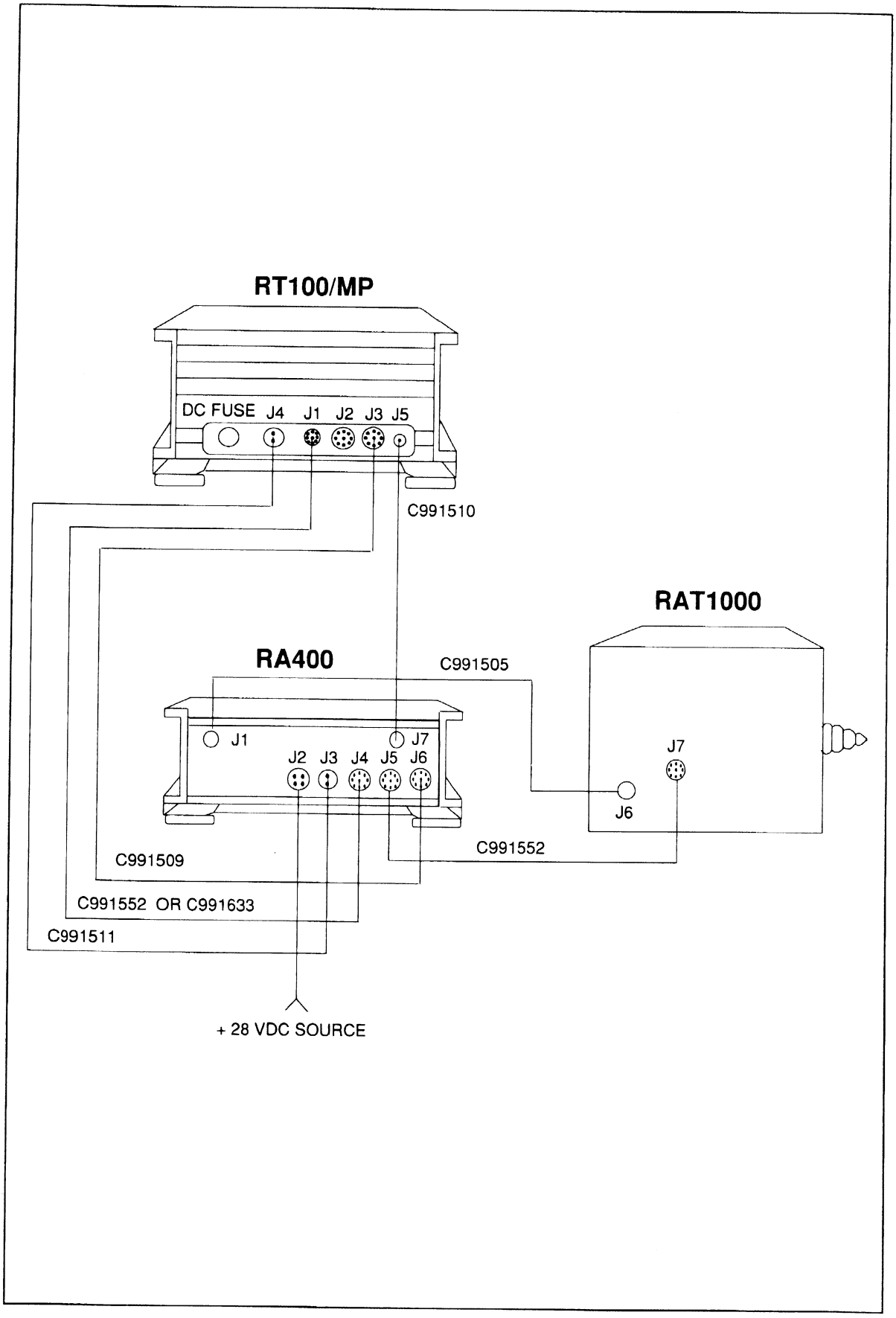

FIGURE 2-4.
RT100/RA400/RAT1000 Configuration.

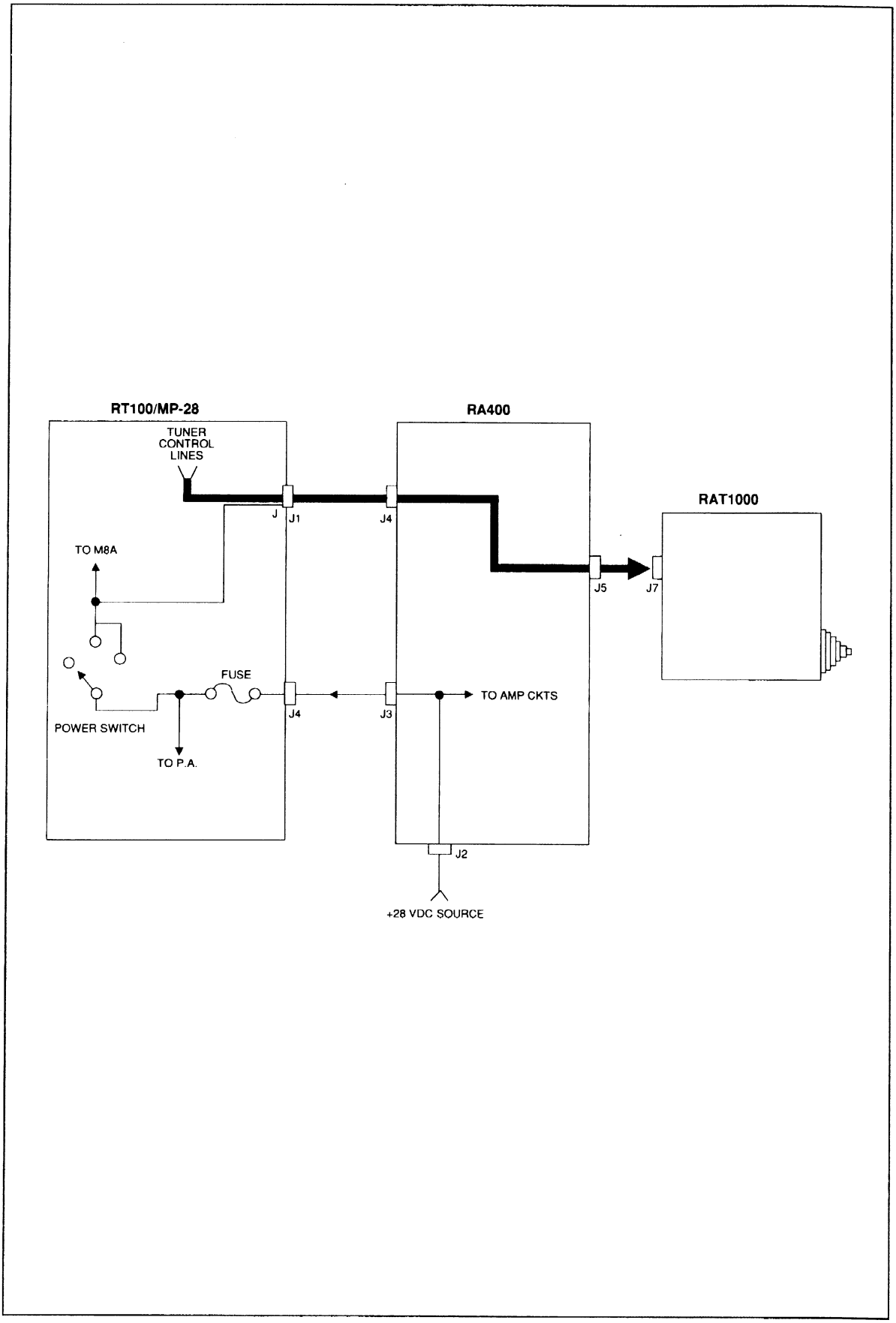

FIGURE 2-5.
Primary Power Routing for RT100/MP-28/RA400/RAT1000 System.

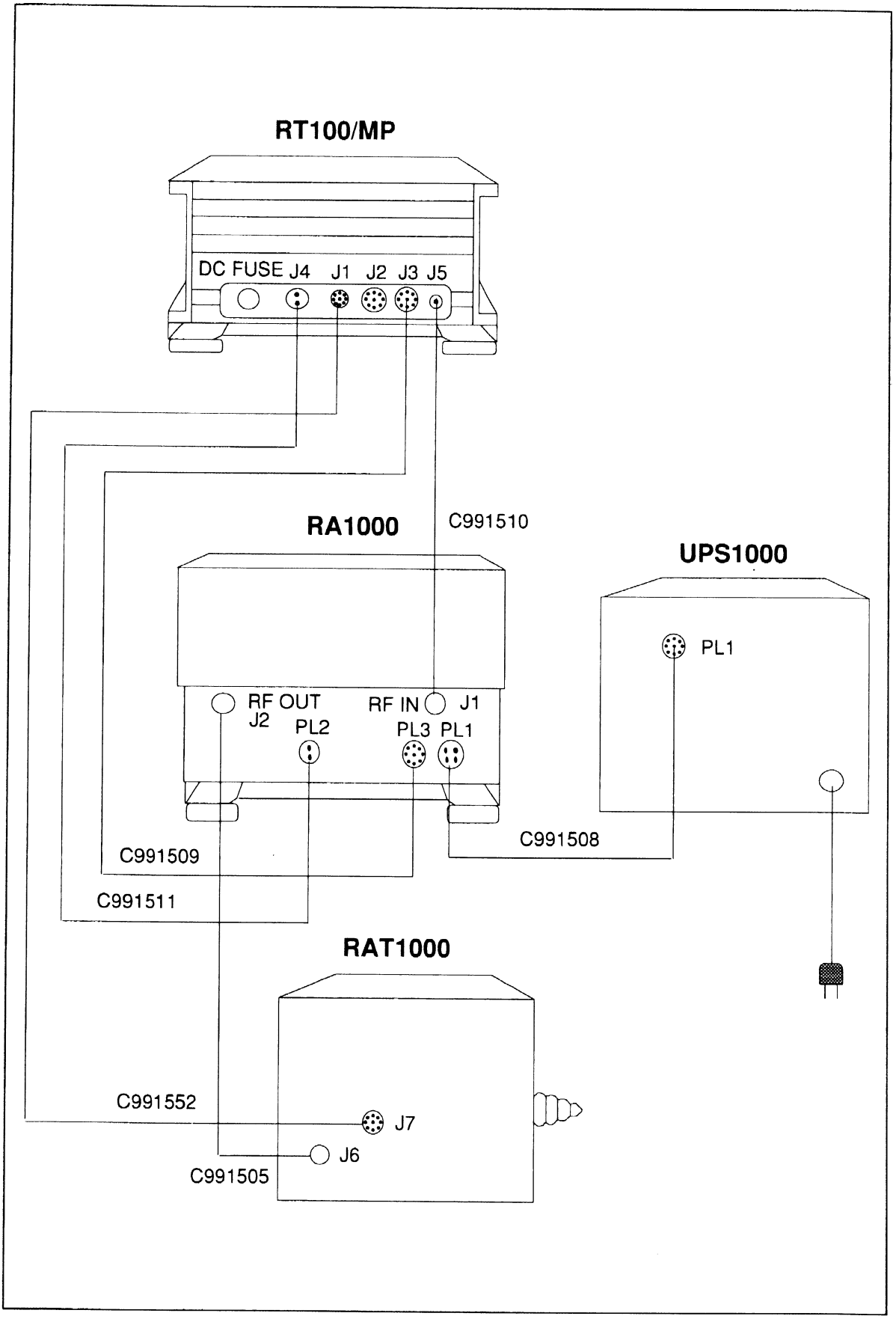

FIGURE 2-6.
RT100/RA1000/RAT1000 Configuration.

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Operation

3.1 General

The automatic antenna tuner is designed to operate with either the TW100 or RT100/MP series of transceivers, and companion high-power amplifiers. After installing the antenna and the tuner, it is only necessary to connect the tuner to the system using the multi-wire control cable and RF coaxial cable described in Section 2.4.

3.2 Operation with RT100/MP or TW100 Transceivers

The following procedure should be followed when operating the tuner with the RT100/MP or TW100 transceivers.

1. Select the operating mode of the RT100/MP or TW100, i.e., LSB, USB, AM or FSK.

2. Turn on the power using the front-panel switch. Note that there are no operator controls on the tuner.

3. Select the operating frequency or channel.

4. Press and then release the "ATU-initiate" button on the front panel.

After the ATU-INITIATE button is pressed, the TUNING TONE should come on, which indicates that a tune cycle is in progress (the transceiver internal tune tone is activated). During this period, the tuner holds the transceiver key line down (transmit mode) until the tune cycle is completed; it also disables the high-power amplifier PTT line during the tune cycle. Upon completion of the tune cycle, the TUNING TONE goes off and the key line is released. The system is ready for use when this occurs.

If the antenna tuner does not achieve satisfactory match, an interrupted tune tone will be heard at the end of the tuning cycle. The tuner will then be switched out of circuit, leaving a direct connection between the radio, amplifier and the antenna.

NOTE

If a match is not achieved, it may be due to a transient happening, and the tuning cycle should be repeated.

3.3 Low-Power Operation

The following is a discussion of system low-power operation.

3.3.1 RAT1000 with TW500A Amplifier

For normal high-power operation, turn both the ac power switch and the dc breaker switch on the amplifier to "ON." This enables the amplifier. In order to operate the system in a low-power mode (i.e., on the 100-W output of the transceiver only), keep the ac power switch on the amplifier "ON" and turn the dc breaker switch "OFF." This will turn primary power off to the amplifier and put it in a bypass mode; power will still be provided to the RAT1000.

3.3.2 RAT1000 with TW1000A, RA400 or RA1000 Amplifiers

For normal high-power operation, turn the amplifier on/off switch "ON" and the companion external power supply "ON." For low-power operation, keep the external power supply "ON" and turn the amplifier On/Off switch "OFF."

NOTES

The transceiver ***must*** be unkeyed when the ATU-INITIATE button is depressed in order to activate the tune cycle. The tuner will ***not*** go through a proper tune cycle if transmit power is present ***before*** the button is pressed.

If the transceiver is being operated using the remote control, then antenna tuning is accomplished by pressing the "ATU" key on the remote control (after operating mode and frequency have first been input per the procedure).

Auto-Tune Or Memory Option

4.1 General Description

The RT100/MP and TW100 series of transceivers can be configured to interface with the automatic antenna tuner to provide either an auto-tune or memory option. These options utilize the same hardware, but different software and are mutually exclusive. Neither option precludes the use of the transceiver front-panel "tune button" for manual tuning, which can be used anytime the operator desires. The options also affect only the "programmable" channels—channel 00 frequencies must still be tuned manually by depressing the tune button.

4.2 Description

The following are specific descriptions of the auto-tune and memory options.

4.2.1 Auto-Tune Option

The auto-tune option provides for automatic initiation of the coupler tune cycle under one of the following conditions:

1. After the channel has been changed, or

2. After the channel has been changed and the PTT has been engaged. It is possible to configure the option for either of the above conditions. See section 4.4 for instructions.

4.2.2 Memory-Tuner Option

The memory-tuner option provides for storage and retention of the antenna-tuner settings on up to ten preprogrammed channels when used with the microprocessor-controlled transceivers. A lithium cell is installed in the tuner's microprocessor module to achieve memory retention. The cell will not reach the end of its useful life in the service life of the tuner and should not require replacement.

4.3 Operation

Auto-Tune Option—When configured for condition 1 of paragraph 4.2.1 (automatic initiation of the coupler tune cycle after the channel has been changed), the tune sequence will be initiated whenever a channel number is entered at the transceiver. When configured for condition 2 of paragraph 4.2.1 (automatic initiation of the coupler tune cycle after the channel has been changed and the PTT has been engaged), the channel must be changed and then the PTT must be activated to start the tune cycle. In both cases, the operator must wait for the tune cycle to be completed before beginning the transmission of information. The tune cycle is indicated by the presence of an audible tone.

Memory-Tuner Option—The tune sequence must first be manually initiated on each of the channels 00-10 which are to be memorized. Thereafter, when any of those channels is selected, the tuner will set its network to the memorized setting. The time from the channel change until the tuner is set is approximately 30 ms. In the case of the 1000-W tuner, the large solenoids require a longer time to transit. That time is of the order of 150 ms. This retained setting may be changed at any time by manually initiating the tune sequence on that channel.

4.4 Installation Hardware Modifications

When configured for condition 1 of paragraph 4.2.1, install R11 (100 kΩ, P/N 113104) and remove jumper "A-B." When configured for condition 2 of paragraph 4.2.1, remove R11 and install jumper "A-B." For memory-tuner operation, install R11 and remove jumper "A-B."

RAT1000P Interface Box

5.1 Purpose

The RAT1000P interface box is designed for use in Transworld systems where +28 Vdc is not available, e.g. systems including the TW500A. Figure 5-1 shows the front and rear panels of the RAT1000P.

5.2 Block Diagram

Figure 5-2 is a block diagram of the RAT1000P.

5.3 Wiring

Figure 5-3 shows the wiring diagram of the RAT1000P. Refer to Figure 2-1 in Section 2, Installation, for a complete system interconnection diagram or specific system diagrams shipped with your equipment.

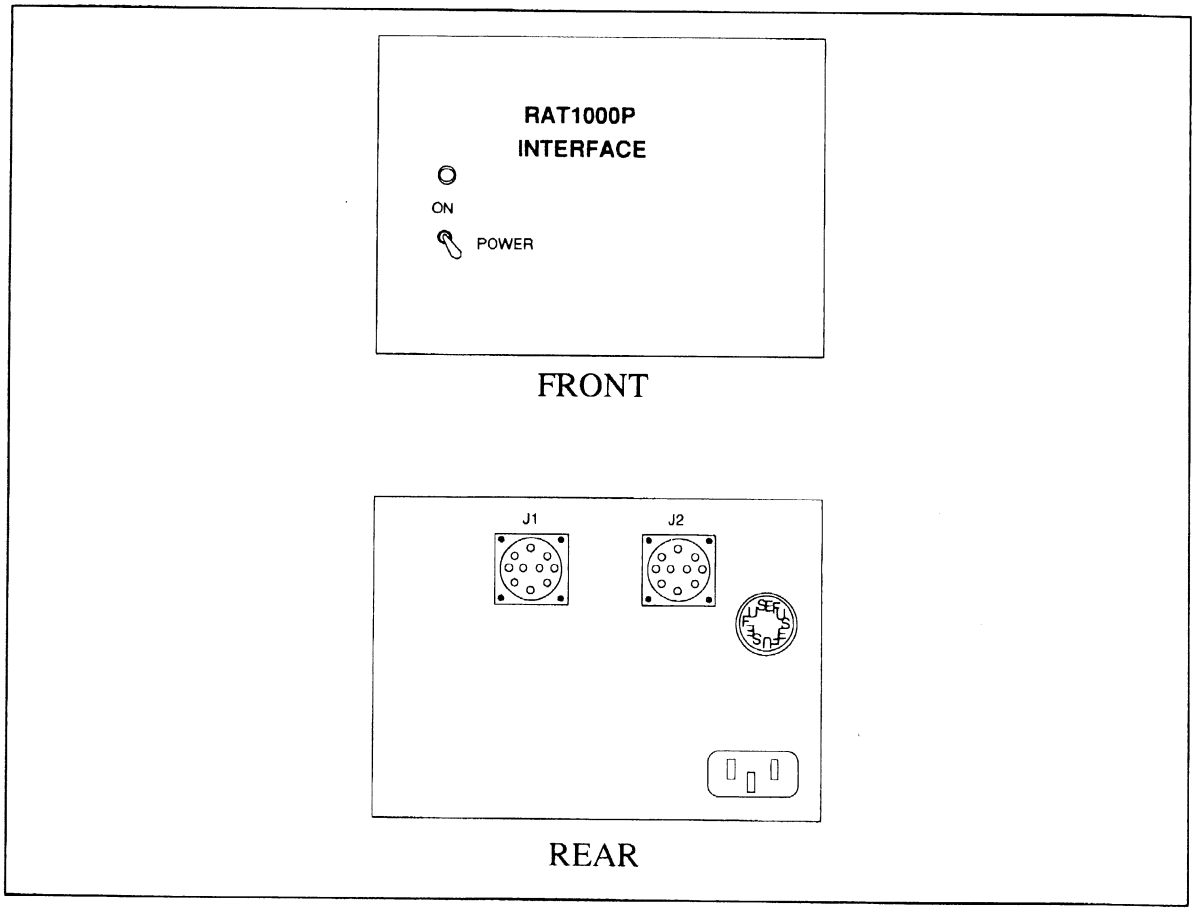

FIGURE 5-1.
RAT1000P Front and Rear-Panel Diagrams.

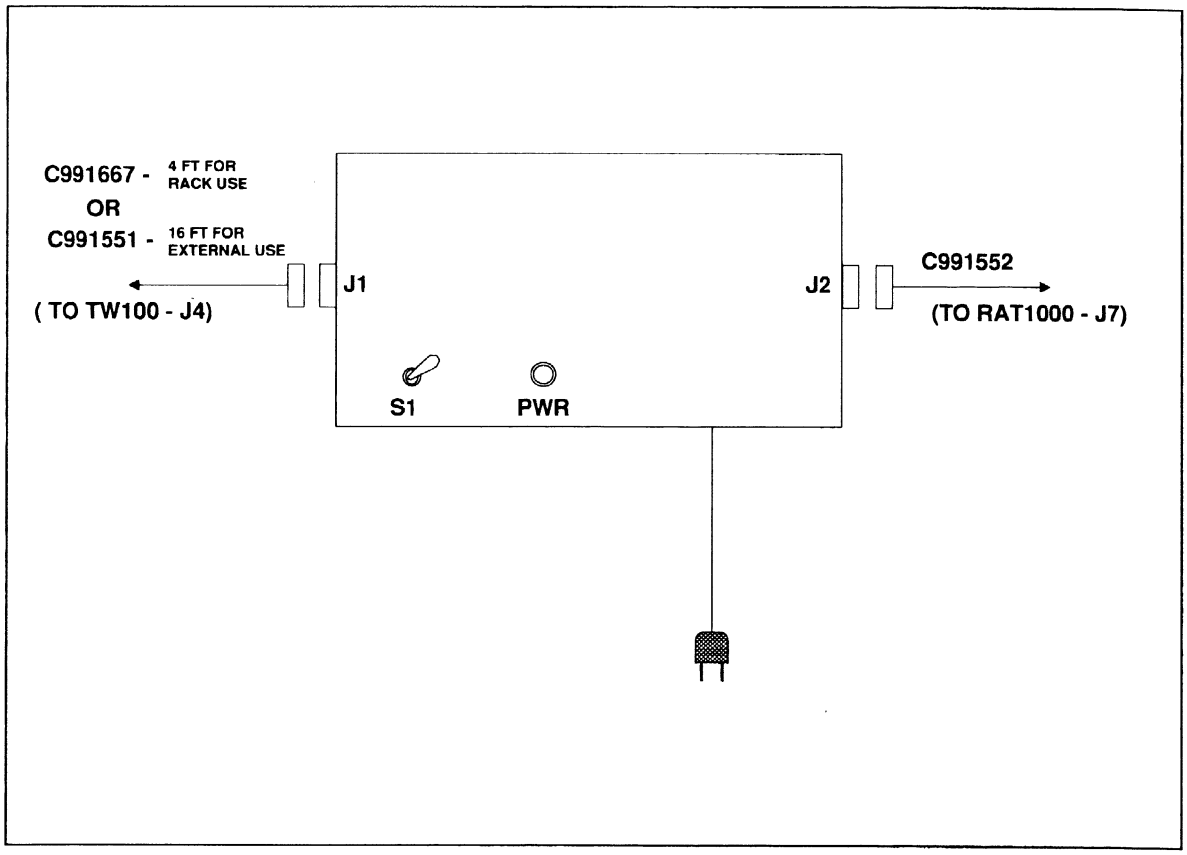

FIGURE 5-2.
Block Diagram.

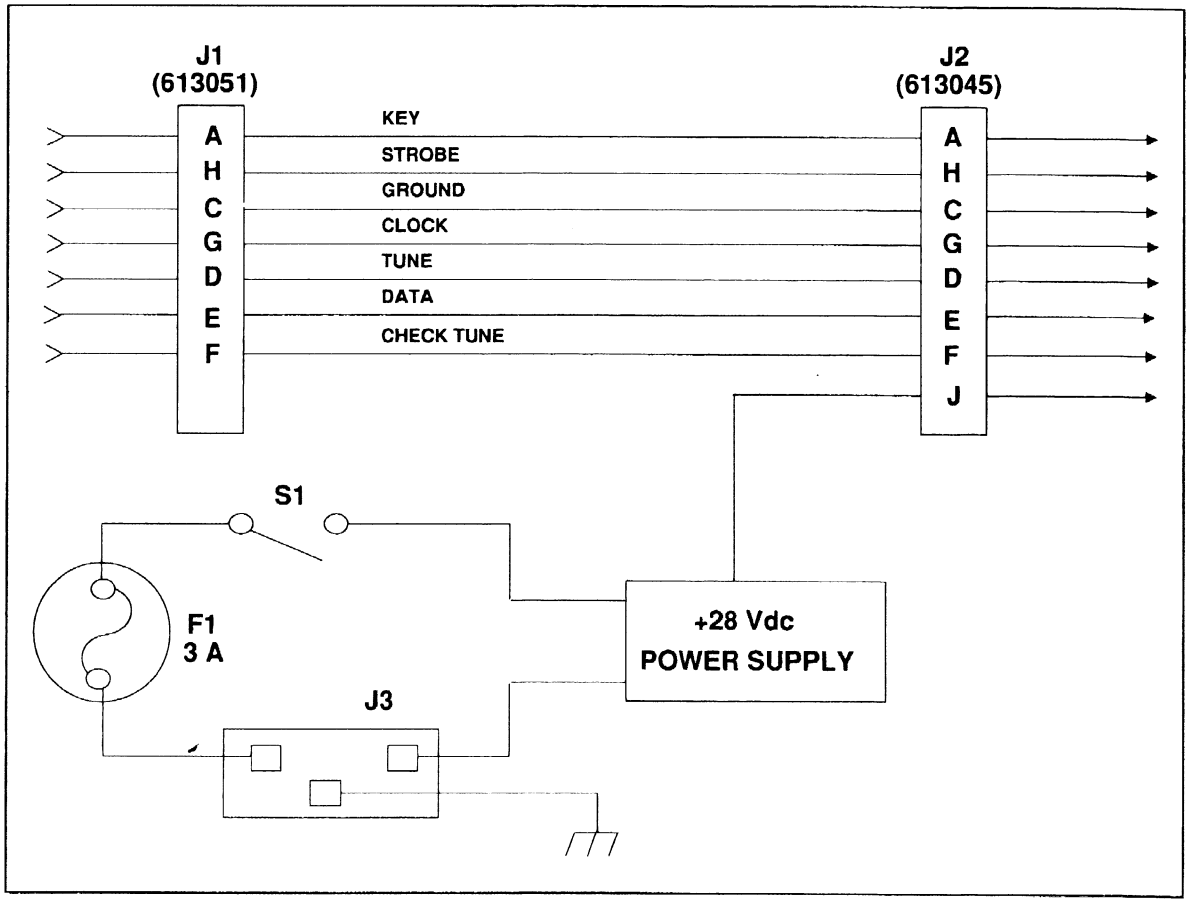

FIGURE 5-3.
RAT1000P Wiring.