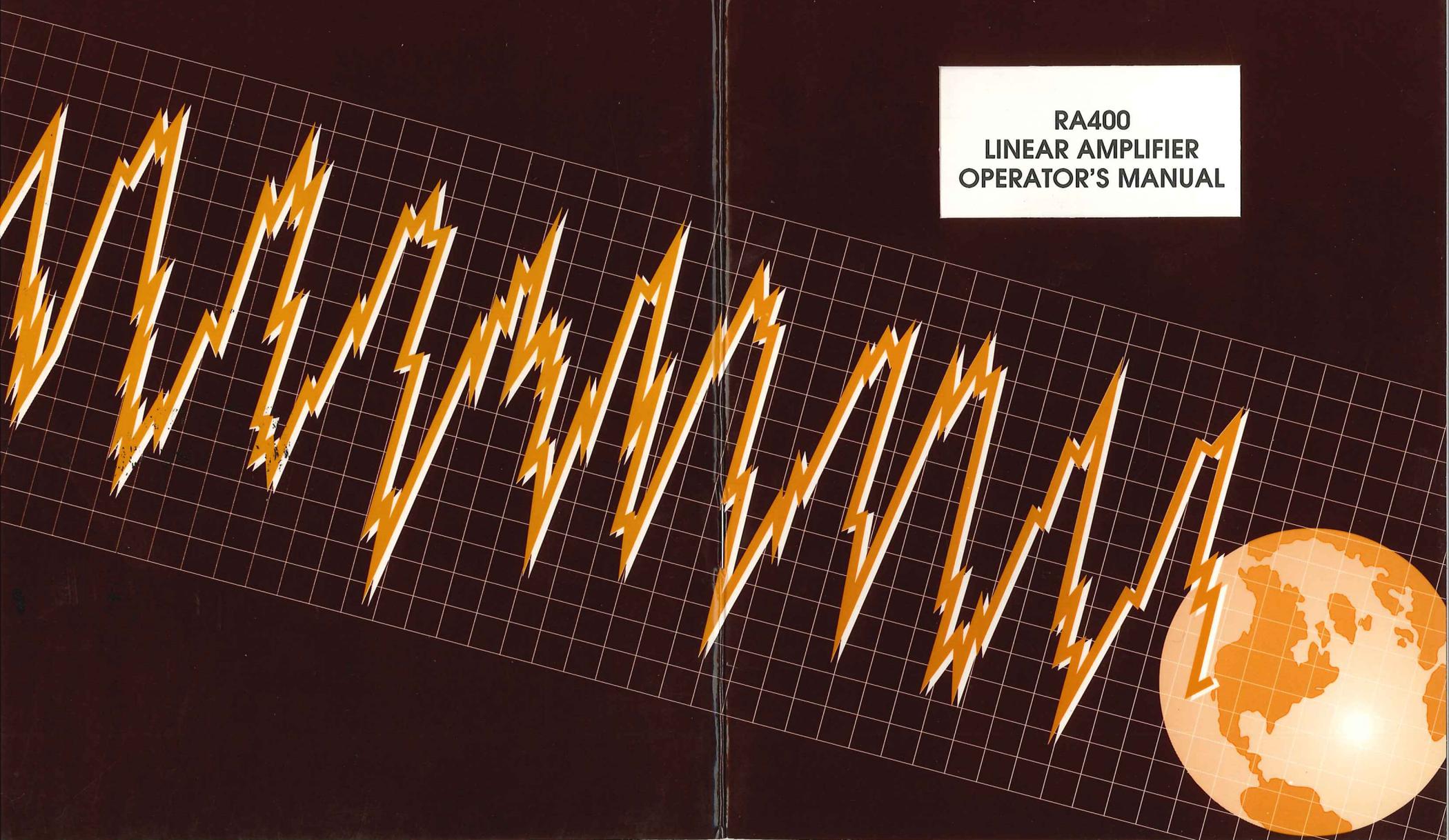


TRANSWORLDTM
for communications

**RA400
LINEAR AMPLIFIER
OPERATOR'S MANUAL**





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TRANSWORLDTM
for communications

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304 Enterprise Street
Escondido, CA 92029
Phone: (619) 747-1079 Telex: 695-433
Fax (619) 741-1658

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.

Safety Considerations

General

This product and manual must be thoroughly understood before attempting installation and operation. To do so without proper knowledge can result in equipment failure and bodily injury.

CAUTION!

Before applying dc power, be sure that the external power supply is configured to provide the correct voltage at the required current levels. Attempted operation at the wrong voltage can result in damage and voids the warranty. See the manual section on installation.

Earth Ground

DO NOT operate any equipment until a suitable ground has been established. Consult the manual section on grounding.

Servicing

Servicing should only be carried out by trained personnel. To avoid electric shock, do not open the case unless qualified to do so.

To protect against fire hazard, always replace line fuses with ones of the same current rating and type (normal delay, slow-blow, etc.). **DO NOT** use higher value replacements in an attempt to prevent fuse failure. If fuses are failing repeatedly, this indicates a probable defect in the equipment that needs attention.

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Introduction



FIGURE 1-1.
RA400 Linear Amplifier.

1.1

General Information

The RA400 linear amplifier is designed for use with the RT100/MP series of synthesized HF transceivers to form a high-power, 2- to 30-MHz communications system. The power output is 400 W. With the correct choice of power source, the amplifier is rated for continuous service in all operational modes. The amplifier has a power gain of 10-12 dB and can be used with any transmitter or transceiver with a power output of 100 W. The amplifier is used to increase the signal strength, range, and reliability of the HF communications system. With the correct choice of antennas and operating frequencies, the system will provide worldwide coverage.

1.2

Applications

The amplifier has been designed for tactical applications. The amplifier operates direct from a 28-Vdc supply and may be operated from a heavy-duty, vehicular generating system or from the standard military 28-V power systems in a shelter. The UPS500 power supply is available for operating the amplifier in base applications where 115- or 230-V, 50- or 60-Hz ac power is available. The amplifier is constructed in a rugged aluminum casting that may be desk mounted or fitted to the heavy-duty shock mount. The case has been designed to withstand severe handling and shock without damage and is fully submersible.

1.3

Interfacing With Exciter

The amplifier is designed for simple interfacing with the RT100/MP series of transmitters and receivers. Plugging in the control cable between the amplifier and the transceiver provides automatic selection of the harmonic filters, control of the drive level, and operation through the microphone PTT switch. Since the control circuitry is simple, interfacing with other types of equipment is usually not difficult, and appropriate instructions can be obtained from the factory.

1.4 High-Speed Switching

The amplifier uses a high-speed switching circuit for applications such as ARQ (SITOR).

1.5 Power Supplies

The amplifier may be operated on SSB from a 28-V, 40-A (peak) supply source. This same supply may be used for FSK operation at 400-W output. For operation at 400-W (AVG) in FSK service or similar modes, the power supply source should be rated at 28 V 40 A continuous.

The UPS500 is a heavy-duty 40-A (50-A peak) power supply that will power both the transceiver and the amplifier for continuous SSB operation at 400-W PEP and for FSK operation at 400 W (50 % transmit/receive duty cycle).

This power supply uses a CVT (constant voltage transformer) to provide good regulation without electronic circuitry. The reliability of the CVT is outstanding, and it provides almost complete protection against line transients. The supply is also short circuit proof. Internal connections are provided to operate from 115/230 V, 50/60 Hz.

1.6 Mounting

The amplifier is provided with rubber feet for desktop mounting. There are mounting clamps on the side of the amplifier for quick installation in the heavy-duty shock mount. The RT100/MP transceiver is normally mounted on the bottom of the amplifier using a stacking kit with quick removal clamps.

1.7 Technical Specifications

Table 1-1 lists the technical specifications of the RA400 linear amplifier.

TABLE 1-1.
RA400 Technical Specifications.

Power Output:	400-W PEP SSB, 400 W Average, FSK/CW.
Duty Cycle:	Continuous, transmit.
Tuning:	Broadband design— instantaneous.
Frequency Range:	2-30 MHz broadband (1.6-2 MHz at reduced harmonic specifications).
Intermodulation Distortion:	-30 dB typical.
Harmonics and Spurious:	-43 dB.
Harmonic Filters:	2-3, 3-5, 5-8, 8-13, 13-20, 20-30 MHz.
Drive Level:	Approximately 30 W.
Input Impedance:	50 ohms, less than 2:1 VSWR.
ALC Output:	Compatible with TWC transceivers and exciters. Open-collector transistor with conductive level proportional to the output. Selectable for peak or average output.
Power Requirements:	SSB—28 V 15-20 A, typical. FSK—28 V 30-40 A.
Overcurrent Protection:	50-A thermal breaker.
Environmental:	Fully sealed and submersible. Meets MIL810C for shock and vibration with optional shock mount.
Temperature Range:	-30° C to +60° C.
Size (W x H x D):	14.38 in x 6 in x 16.38 in, (36.5 cm x 15.2 cm x 41.6 cm).
Weight:	45 lbs (20.4 kg).

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Installation

2.1 Unpacking

Remove the amplifier from the shipping carton. Inspect carefully for any shipping damage. If the amplifier has been damaged, a claim should immediately be lodged with the shipping company. Retain the shipping carton and the packing material in case the amplifier has to be reshipped.

2.2 Mounting

The following is a description of the possible methods of mounting the RA400.

2.2.1 Bench Mounting

The amplifier is provided with rubber feet and may be placed on a tabletop for operation. Make sure that the sides are not obstructed so that there is free airflow to the cooling fan. The air exhausts from the left side of the amplifier, and it is important to ensure the sides of the amplifier are unobstructed.

2.2.2 Shock Mounting

The shock mount should be located in the position desired. The four shock mounts are then secured in place. The amplifier stands in the shock mount and is retained in place by rotating the six locking clips. Make sure that the airflow to the amplifier is unobstructed.

2.2.3 Transceiver Mounting

The transceiver is mounted on the bottom of the amplifier. The mounting plates should be first bolted onto the two top flanges of the transceiver. The amplifier is then secured in place by rotating the six locking clips.

2.2.4 Power-Supply Mounting

The power supply is normally used in base installations and will not require fixing in place. The power supply may be placed under the operating table, beside the amplifier, or stacking plates may be used to mount the amplifier and transceiver on top of the power supply. If the power supply is used in a shelter or portable installation, it is recommended that the amplifier and transceiver be installed separately on shock mounts. The power supply should be placed on a separate shock mount and bolted securely in place.

2.3 Ground Connections

It is important to make a good ground connection to the amplifier. Without a good ground connection, circulating currents may cause feedback in the amplifier and transceiver. The entire equipment may be at a high RF potential, which causes RF burns when touched. The ground is particularly important when an antenna tuner or unbalanced antenna is used. Use a heavy-gauge copper strap for the ground connection and keep the ground strap as short as possible.

2.4 Cable Connections

The 400-W amplifier is designed to be interfaced with a transceiver and an antenna tuner. The amplifier can interface with most transceivers and antenna tuners under special system considerations. However, this section will only discuss connections between the RA400 and companion Transworld transceivers and automatic antenna tuners.

2.4.1 System Interfacing

If the equipment is ordered as a system, all interconnecting cables will be supplied fully assembled. This section describes standard system configurations using the RA400 with other Transworld equipment. The control, RF and power cables are connected between the amplifier, the transceiver and the antenna tuner as discussed in the following paragraphs.

2.4.1.1 RT100/RA400/RAT400 Fixed Or Portable Systems

The block diagram of the system is shown in Figure 2-1. All major equipment and interconnecting cables are illustrated. Tables 2-1 through 2-5 describe the cable connector pin-outs. The cables used in the system are listed below.

1. C991510 - RT100/MP to RA400 RF cable.
2. C991633 - RT100/MP to RA400 tuner control cable.
3. C991509 - RT100/MP to RA400 control cable.
4. C991511 - RT100/MP to RA400 power cable.
5. C991552 - RA400 to RAT400 control cable.
6. C991505 - RA400 to RAT400 RF cable.
7. C991557 - UPS500 to RA400 power cable.

Standard configuration includes an RT100/MP with +28-Vdc option and power obtained from the RA400.

TABLE 2-1.
RA400 (J2) Connector Pin-outs and System Equipment Connections.

<u>Pins on RA400 (J2)</u>	<u>Description</u>	<u>Pins on UPS500 (PL1)</u>
A	+28 Vdc	A
B	Ground	B
C	Ground	C
D	+28 Vdc	D

TABLE 2-2.
RA400 (J3) Connector Pin-outs and System Equipment Connections.

<u>Pins on RA400 (J3)</u>	<u>Description</u>	<u>Pins on on RT100/MP (J4)</u>
A	+28 Vdc	A
B	Ground	B

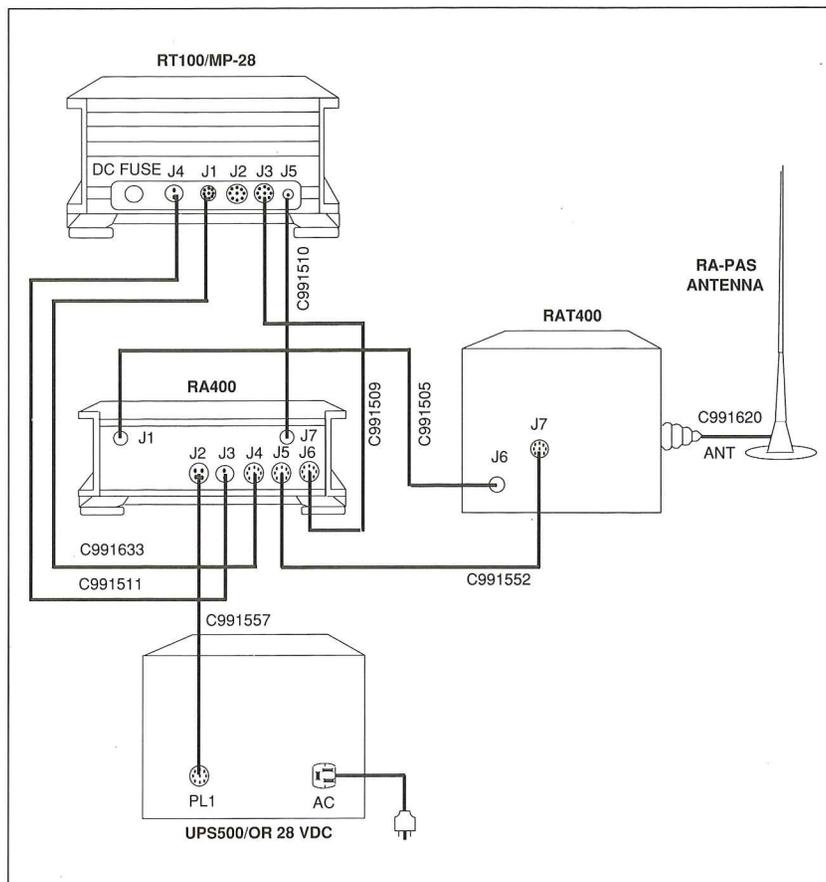


FIGURE 2-1.
RT100/RA400/RAT400 Configuration for Fixed
or Portable Systems.

NOTES

1. 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.
2. In the standard configuration, the RAT400 obtains its +28-Vdc primary power from the UPS500 in this fashion: raw 28 volts comes into the RA400, J2 and is routed to the RT100/MP-28 via RA400, J3; the raw 28 volts enters the radio, is switched through the on/off radio power switch, and is then routed back into the amplifier at

TABLE 2-3.
RA400 (J4) Connector Pin-outs and System
Equipment Connections.

<u>Pins on RA400 (J4)</u>	<u>Description</u>	<u>Pins on RT100/MP (J1)</u>
A	Key	A
B	—	—
C	Ground	C
D	Tune Initiate	D
E*	Data	E
F*	CHK TUNE	F
G*	Clock	G
H*	Strobe	H
J	+28 Vdc	J

* Used in memory option only.

RA400, J4-J; this switched 28 volts is connected directly between J4-J and J5-J inside the RA400, and then routed to the RAT400 tuner via RA400, J5. This configuration is used to allow the tuner to be used in both high-power mode (RA400 on) and low-power mode (RA400 off). It also provides for turning the tuner off **without** turning off the main power supply (or disconnecting the battery cable, in the case of a mobile system).

If a 12-V transceiver is used in place of an RT100/MP-28, not only will provision have to be made to find a separate 12-V power source for the radio, but *care must be taken to disconnect (or turn off) the main power source when the equipment is not in use*. This is because the tuner is being run in this configuration from the RAW 28 volts which, if left connected or turned on, will continually be subject to a current drain.

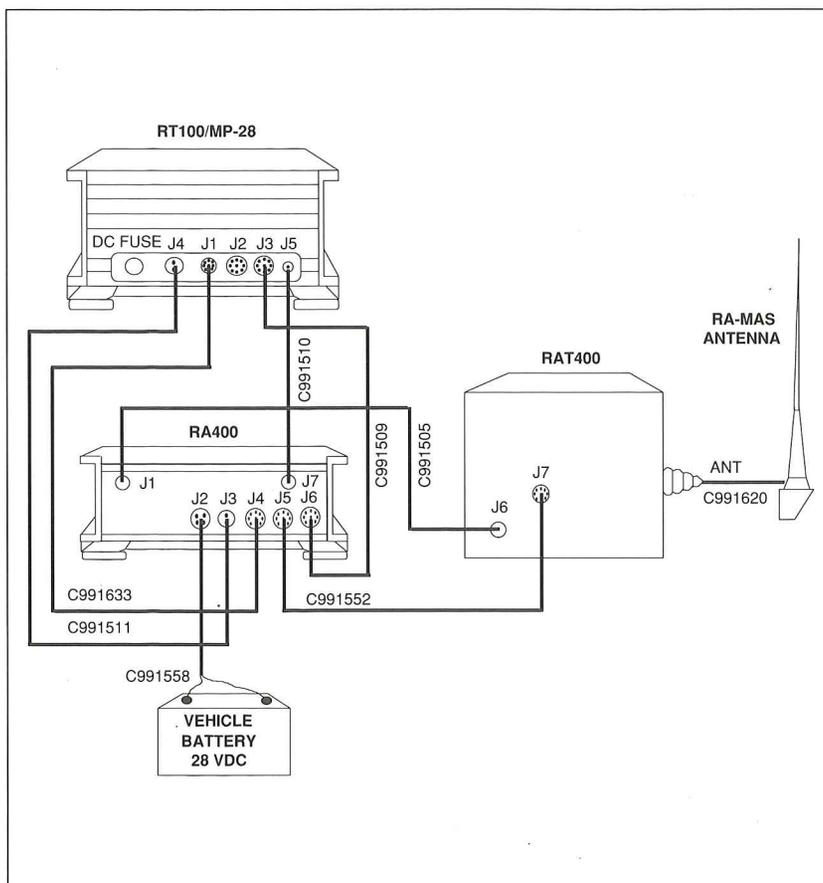


FIGURE 2-2.
RT100/RA400/RAT400 Configuration for Mobile Systems.

2.4.1.2 RT100/RA400/RAT400 Mobile Systems

The block diagram of the system is shown in Figure 2-2. Tables 2-1 through 2-5 describe the cable connector pin-outs. The cables used are as follows:

1. C991510 - RT100/MP to RA400 RF cable.
2. C991633 - RT100/MP to RA400 tuner control cable.
3. C991509 - RT100/MP to RA400 control cable.
4. C991511 - RT100/MP to RA400 power cable.
5. C991552 - RA400 to RAT400 control cable.

TABLE 2-4.
RA400 (J5) Connector Pin-outs and System
Equipment Connections.

<u>Pins on RA400 (J5)</u>	<u>Description</u>	<u>Pins on RAT1000 (J7)</u>
A	Key	A
B	—	B
C	Ground	C
D	Tune Initiate	D
E*	Data	E
F*	CHK TUNE	F
G*	Clock	G
H*	Strobe	H
I	—	I
J	+28 Vdc	J
K	—	K

* Used in memory option only.

6. C991505 - RA400 to RAT400 RF cable.
7. C991558 - RA400 dc power cable.

Standard configuration includes an RT100/MP with +28-Vdc option and power obtained from the RA400.

2.4.1.3 RT100/RA400 Fixed System With Broadband Antenna

The block diagram of the system is shown in Figure 2-3. Tables 2-1 through 2-5 describe the cable connector pin-outs. The cables used are as follows:

1. C991509 - RT100/MP to RA400 control cable.
2. C991510 - RT100/MP to RA400 RF cable.
3. C991511 - RT100/MP to RA400 power cable.
4. C991557 - UPS500 to RA400 power cable.

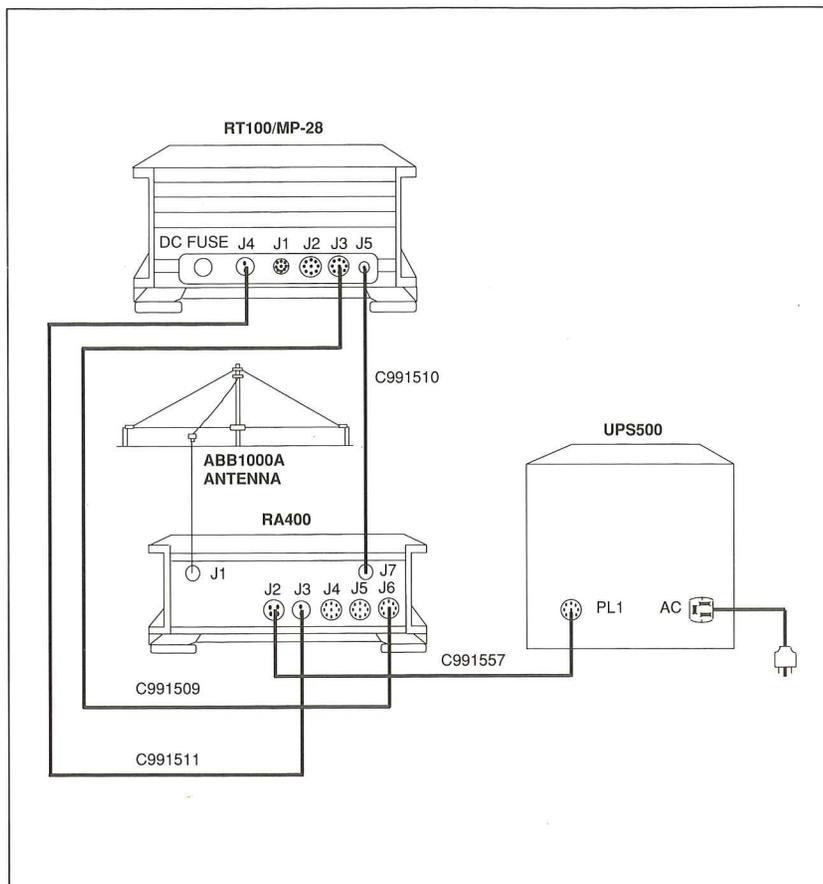


FIGURE 2-3.
RT100/MP Fixed System with Broadband Antenna.

Standard configuration includes an RT100/MP with the +28-Vdc option and power obtained from the RA400.

2.5

Power Connections

The amplifier and transceiver may draw peak currents as high as 40 A. This means that low-resistance connections are essential. The power-supply connection uses two contacts each for the positive and negative leads. A 4-wire, 10-AWG cable must be used for the power cable. The maximum length of the power cable must not exceed 1.25 m (4 ft). If

TABLE 2-5.
RA400 (J6) Connector Pin-outs and System
Equipment Connections.

Pins on RA400 (J6)	Description	Pins on RT100/MP (J3)
A	2-3 MHz	A
B	3-5 MHz	B
C	5-8 MHz	C
D	8-13 MHz	D
E	13-20 MHz	E
F	20-30 MHz	F
G	+28 Vdc	G
H	AMP PTT	H
I	AMP ALC	I
J	Ground	J

the power source is located some distance from the amplifier, terminate the power cable at a heavy-duty junction box as close as possible to the transceiver. The junction box is then connected to the power source using heavy-duty cable capable of carrying the heavy current with negligible loss. Heavy-duty starter cable is ideal. Remember, a cable resistance of 0.1 ohm would cause a voltage drop of 10 V.

2.6

Antenna Connection

The output impedance of the amplifier is 50 ohms. Use a heavy-duty coaxial cable of the RG8/U type for the connection to the antenna or the antenna tuner. Only use heavy-duty coaxial cable and make sure the connections are securely soldered and tightened as the peak RF currents exceed 5 A.

2.7

Antenna Matching

For best efficiency, the amplifier must operate into a correctly matched antenna system. If the VSWR exceeds 1.5:1, the

automatic protection circuits will progressively reduce the power output and the performance of the system will be reduced. Use a Bird Model 43 with a 1000-H element. The reflected power should not exceed 30 % of the forward power.

2.8

Antennas

The antenna system should have a minimum power capability of 400 W. The antenna will normally be fed with 50-ohm coaxial line, and the antenna matching should be adjusted for the lowest possible VSWR (preferably less than 1.5:1). The choice of antenna(s) will depend on the frequencies and the distances to be covered. If the amplifier is to be used on specific bands or channels, resonant dipoles or multiple dipoles are an excellent choice. The amplifier will provide continuous coverage from 2-30 MHz. When used with excitors covering the 2- to 30-MHz range, it is necessary to use an antenna tuner or a broadband antenna system. Best results will be obtained with the broadband antenna systems such as the discone type of construction of the log periodic beams. Many excellent proprietary brands of broadband antenna covering every frequency range in both omnidirectional and directional forms are available. When there is insufficient space for a broadband antenna, an antenna tuner may be used with a tower or long-wire antenna. Tuners are available for manual adjustment, or, for maximum flexibility, automatic tuners that tune for minimum VSWR can be used.

2.9

Adjustments

The amplifier is fully broadband and requires no tuning or adjustment for operation at any frequency. If the equipment is ordered as a system, the ALC system will have been set for the correct power output. The following adjustment procedure should be followed if the power output level is not correct.

2.9.1

Power-Output Adjustment

Two separate controls provide a control voltage which is proportional to either the peak or average value of the power output. See Figure 2-4.

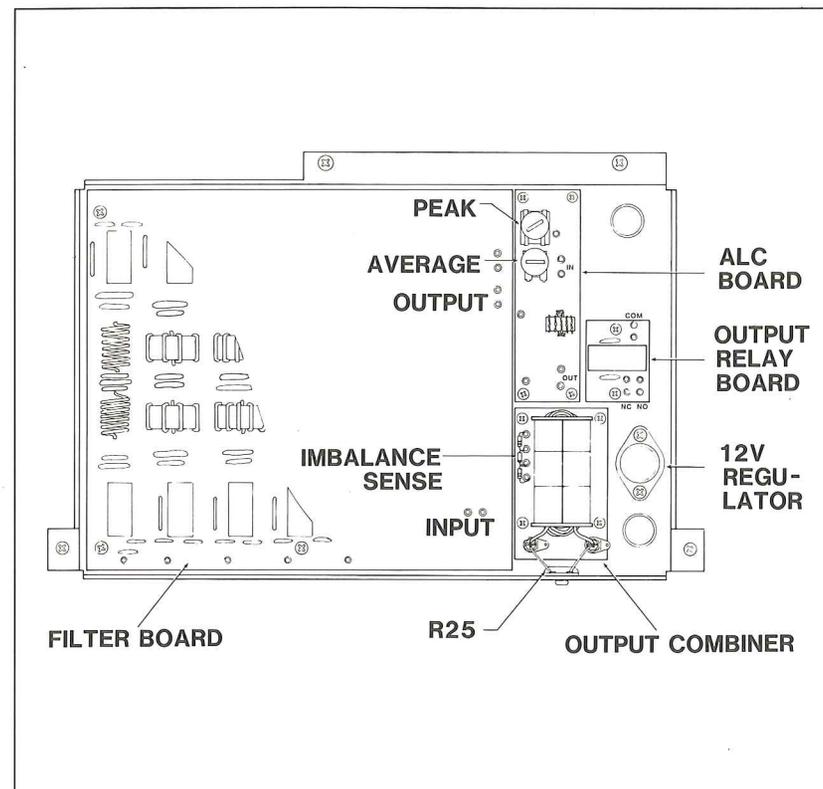


FIGURE 2-4.
Upper Tray Assembly.

NOTE

When operation is planned for more than one mode (e.g. SSB and CW operation), and a large change in the peak-to-average power ratio will occur, it is necessary to adjust BOTH of these controls. Adjusting both controls is also necessary in any condition that will result in amplifier or power supply overload. Initially, the "AVERAGE" control should be advanced to the maximum power setting, (fully counterclockwise). After the "PEAK" control has been set, the "AVERAGE" control may then be set to restrict power levels if a mode change will result in overload. It should be noted that there may be some small interaction between controls. Also, it is not possible for either control circuit to increase the power level if the other is already the controlling circuit. It will be necessary to provide test signals in both

modes to correctly set both controls. If only one control is in use, the OTHER must be advanced to its fully clockwise (maximum power) position.

2.10 Power Supplies

Refer to the separate instruction manual for the power supply. It is very important to ensure that the power supply has been connected for the correct mains supply voltage and frequency.

2.11 Operation With Other Exciters

If the amplifier is to be used with other types of exciters or transceivers, contact the factory for appropriate interfacing information.

2.12 Rear-Panel Connectors

Figure 2-5 shows the rear-panel connectors for the RA400. The connector pin designations are described in Tables 2-1 through 2-5.

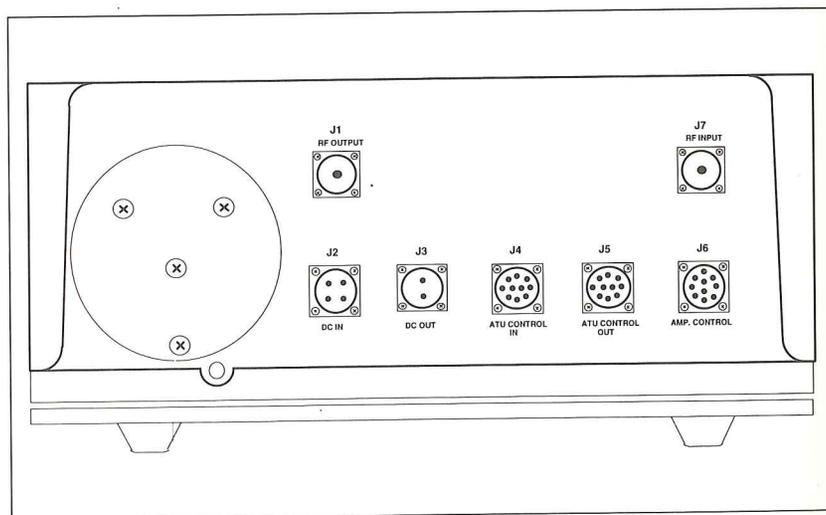


FIGURE 2-5.
Amplifier Rear Panel.

Operation

3.1 General

The amplifier requires no tuning adjustments. If the antenna is correctly matched at the operating frequency, the amplifier will deliver full output power.

3.2 Controls - ON/OFF

When the amplifier is used with exciters providing automatic filter selection, there is only one operating control—the ON/OFF switch. In the OFF position, the amplifier is bypassed and the exciter delivers the normal power output direct to the antenna. Turning the switch on brings the amplifier on line, and no further adjustments are required. The ON/OFF switch can also be considered the high-low power switch. The switch is a thermal circuit breaker and will trip if there is a fault in the amplifier, which causes excessive current drain.

3.3 Metering

The following is a description of RA400 metering.

3.3.1 Power Output

This meter measures the power output to the antenna. On FSK or CW transmissions, the meter should give a steady reading at approximately 400 W. On SSB voice transmissions, the meter will kick up on voice peaks towards the 400-W mark. If the meter does not indicate normal power output, the antenna is probably not correctly matched. The protective circuitry automatically reduces the output power when the antenna does not provide a correct match.

3.3.2 Collector Current

Each module is provided with a 25-mV shunt to measure the collector current. Monitoring the collector currents to each module provides a very good indication of correct

operation. The collector current to each module should be approximately equal. Any large imbalance in collector current indicates a fault in one of the modules.

3.4

Cooling Fan

The operation of the cooling fan is automatic. It is controlled by a thermostat on the heat sink. When the heat-sink temperature reaches 60°C , the cooling fan will come on. The fan will not switch on for short voice transmissions unless the ambient temperature is very high.

A second heat-sink-mounted thermostat switches the RA400 to the "straight-through" mode if the heat-sink temperature exceeds 85°C .

