TW1000A

LINEAR AMPLIFIER

TECHNICAL MANUAL

DATRON WORLD COMMUNICATIONS INC.

Manual Part No. TW1000A-MS
Publication # 991009
Printed: August 1993
Revision: F

304 Enterprise Street
Escondido, CA 92029, U.S.A.
Phone: (760) 747-1079 Fax: (760) 741-1658
EMail: datronw@powergrid.electriciti.com

SECTION 2
TECHNICAL SPECIFICATIONS

2.1 TECHNICAL SPECIFICATIONS

The technical specifications for the linear amplifier are defined in Table 2-1.

2.2 SEMICONDUCTORS

The semiconductors are defined in Table 2-2.

TABLE 2-1.
Technical Specifications.

POWER OUTPUT:	1000 W PEP or Avg ± 1dB.
FREQUENCY RANGE:	2-30 MHz (1.6-2 MHz at reduced harmonic specification).
INTERMODULATION DISTORTION*:	2-24 MHz 30 dB 3rd order. 36 dB 5th order. 24-30 MHz 26 dB 3rd order. 30 dB 5th order. Measured relative to PEP output.
SPURIOUS PRODUCTS:	-60 dB.
HARMONIC FILTERS:	7-Pole elliptic function.
Ranges:	2-3 MHz 8-13 MHz 3-5 MHz 13-20 MHz 5-8 MHz 20-30 MHz The filters are selected by grounding each filter control line.
DUTY CYCLE:	Rated for continuous services all modes.
DRIVE LEVEL:	100 W nominal.
INPUT IMPEDANCE:	50 ohm VSWR less than 1.5:1.
OUTPUT IMPEDANCE:	50 ohm.
POWER REQUIREMENTS:	28 Vdc negative ground. SSB 30-A avg. voice. FSK 70 A typical.
COOLING:	Dual fans controlled by 60^{o}-C thermostats. (Over-temperature shutoff at 85^{o} C).
CIRCUIT BREAKER:	100 A magnetic.
SIZE (WHD):	48.3 cm x 22.3 cm x 38.9 cm.
WEIGHT:	23.6 kg.
CONTROLS:	Amplifier ON/OFF.
METERING:	Module collector current 50 A (2x). Power output 0-1500 W.

TABLE 2-1.
Technical Specifications, Continued.

CONNECTORS:	RF input UHF. RF output UHF. Control 10 pin. Aux 28 V 2 pin. Dc power 4 pin.

*The intermodulation distortion and spurious products are also a function of the excitation source. The distortion products and spurious output are measured using two high-power RF signal generators as the two-tone test source. The generators are coupled through a combiner adjusted for maximum isolation between input ports. The output is coupled to the amplifier through low-pass harmonic filters. To ensure compliance with the published specifications, the excitation sources should have a minimum distortion figure at least 3 dB greater than the amplifier at the required drive level, the spurious products should not exceed -60 dB and the harmonic level should not exceed -40 dB. Spurious products in the exciter, below the cutoff frequency of the TW1000A amplifier low-pass filter, will be amplified without attenuation. Spurious products and harmonics above the amplifier filter cutoff frequency will be attenuated by the amplifier, however, excessive harmonic or spurious output from the exciter may increase the distortion products.

Table 2-2.
Semiconductors.

DESIGNATOR	FUNCTION	DESCRIPTION
MAINFRAME:		
Q1	ALC Control Amp.	2N5306
Q2	Meter Amp.	2N5306
Q3	PTT Control Amp.	2N5306
Q4	Relay Driver	TIP120
Q5	Relay Driver	TIP120
Q6	Stop Switch	EC103Y
U2	Voltage Regulator	UA7812KC
AMP MODULES:		
Q1A, Q2A, Q1B, Q2B	150-W RF Amp.	310050
Q3, Q3B	Bias Driver	TIP33B
Q4, Q4B	Bias Compensation	TIP29A

SECTION 5
TECHNICAL DESCRIPTION

GENERAL

amplifier consists of two 500-W plug-in modules with t and output impedances of 50 Ω. The two modules combined using 2:1 combining transformers at the t and output. See Figure 5-1, Plug Module Assembly. input is fed through a gain-leveling network providing ⌐Ω input and substantial level gain throughout the fre- ıcy range. The output of the amplifier is coupled to the nna through a series of six low-pass filters. Each lifier module uses two 250-W push-pull amplifiers 100-Ω inputs and outputs. These amplifiers are com- d to give 50-Ω input and output.

28 V, 250-W RF AMPLIFIERS

broa^d^and, push-pull, 250-W amplifiers use modern, -pow linear power transistors. These transistors use ter-ballasted chief design to control impedance and over a bandwidth of more than a decade.

schematic diagram, Figure 6-1, shows the transistors and Q2 connected in a conventional transformer-)led push-pull circuit. In order to provide uniform per- ıance over nearly four octaves, it is essential to use -performance input and output transformers. The out- transformer T2 must not only be capable of providing correct impedance transformation over the 2- to 30- z range, it must also operate at high efficiency at the current levels and at a power level of 250 W. The ially designed transformers use ferrite-loaded brass s as the base and collector windings with teflon insu- l wires wound inside the tubes to form the 100-Ω input output windings. The center taps of the transformers ate at RF ground potential. Extensive bypassing vides a very low impedance at audio frequencies and hrough the RF operating range.

ative dback is essential to prevent spurious opera- s and to reduce the gain variations through the range. istive feedback is used directly from the collector to base. The dc blocking capacitor provides a low im- ınce down into the audio range. While it is necessary issipate substantial power in the feedback resistor, this em ensures feedback independent of the characteristics ıe input and output transformers.

maximum efficiency and good linearity, the amplifiers operated in class AB. It is essential to provide a stable, -impedance bias source for the bases of the transistors. emitters of the transistors are grounded and the base edance changes as the transistors heat, which leads to a ntially unstable bias condition. This means that apart ı providing a low-impedance bias source, it is essential rovide thermal compensation with temperature sensing ely coupled to the high-power RF transistors.

The bias circuit uses the two transistors Q3 and Q4. The bias voltage at the center tap of the transformer is equal to the sum of the voltage across the adjustable resistor R3, and the emitter base voltage of Q4. This means that the emitter base voltage of Q4 must be lower than the voltage required to produce the forward bias current for Q1 and Q2. R3 may then be adjusted to provide the correct bias current. Q3 is an emitter follower with the base of Q4 connected to the emitter of Q3. The circuit provides the low-impedance bias source required by the high-power RF transistors. The diode D1 effectively shunts the bases of Q1 and Q2 and provides backup to the primary bias circuit. In the event of any defect in the bias circuit, D1 prevents catastrophic damage to the RF transistor. Q4 is mounted on the copper heat sink immediately adjacent to the RF power transistors. The tight thermal coupling ensures that Q4 will compensate the 2 mV/° C emitter-base voltage change of the output transistors. The circuit provides excellent thermal tracking with the desirable attribute of a small negative-temperature characteristic. This means a small reduction of the amplifier quiescent current at elevated temperatures.

Each of the four amplifiers uses identical circuitry. Individual bias regulators for each amplifier ensure uniform control of the quiescent current even if there are variations between the transistors used in each amplifier.

5.3 500-W MODULES

Each 500-W module uses two amplifiers mounted on individual heat sinks. The heat sinks are mounted so that the fins face in and form a tunnel, with a +28-Vdc Hall-effect brushless fan mounted at the end of the heatsinks. This ensures an excellent flow of cooling air through the module while retaining very good accessibility to the amplifiers. A 60°-C thermostat is mounted on one heatsink. This activates the fan when the heating temperature rises above 60° C. A second, 85°-C thermostat, mounted on the other heat sink, switches the amplifier to the bypass mode if, for any reason the cooling system fails.

The modules contain plugs on the rear frame for the RF input and output connections and the 28-Vdc supply. A tapered guide pin ensures correct alignment of the connectors. Each module is provided with a 50-A panel meter. The modules are held in the amplifier frame using four retaining screws on the front panel.

The input and output impedance of each amplifier is 100 Ω. The connections to each amplifier are made through 100-Ω coaxial cables cut to exactly the same lengths to maintain phase symmetry. The outputs and inputs are combined to provide the module with 50-Ω inputs and outputs.

The 100-Ω inputs and outputs are each combined in separate hybrids to provide a nominal impedance of 50 Ω in each case. The input impedance of the transistor pairs varies considerably with frequency, as does the gain. Compensation of these effects is provided in the amplifier mainframe.

5.4 INPUT CIRCUIT

The input circuits of the two modules are combined in the input combiner T1. The transformer is a 2:1 "Christmas-tree" design which combines the two 50-Ω inputs to the modules to provide a 50-Ω impedance to the amplifier.

The gain-leveling network uses capacitive, resistive and inductive elements to compensate for the lower gain of the amplifiers at the upper end of the frequency range. The network has been designed to maintain a constant input impedance with a VSWR of less than 1.5:1 over the entire frequency range.

5.5 OUTPUT CIRCUIT

The outputs of the two modules are 50 Ω. They are combined in the output combiner T2 which uses a 2:1 "Christmas-tree" design to provide an output impedance of 50 Ω with good port-to-port isolation. When the two modules are in balance, the voltages are equal at both ends of the primary winding of the combiner, and no power is dissipated in the resistors R25 and R26. In the event of unbalance or failure of either module, power is dissipated in R25 and R26. In the case of complete failure of one module, 50 % of the remaining power is dissipated in the resistors, but the amplifier will continue to operate. R25 and R26 are high-wattage non-inductive designs that use the chassis as a heat sink.

5.6 OUTPUT FILTERS

A broadband transistor amplifier has a high level of harmonic output. As the amplifier operates in push pull, the even-order harmonics tend to cancel but there is less suppression of odd-order harmonics. On the lower channel frequencies the second harmonic level is typically -30 dB, while the third harmonic may be as much as -15 dB. This means that the filters must have an ultimate attenuation of at least 50 dB to meet the amplifier design specification. The filter design selected is a seven-pole elliptic function with reflection coefficient of 5 %. A low-reflection coefficient is essential to prevent excessive VSWR between the amplifier and the filter.

The frequency range has been divided into six bands. The cut-off frequency of each filter is just above the highest frequency in each band. The characteristics of the filter ensure a minimum attenuation of -50 dB at the third harmonics of the signal frequency when operating at the lowest frequency in the band. For example, the attenuation of the 2- to 4-MHz filter is a minimum of -50 dB at 6 MHz. This is the third harmonic of 2 MHz. Designing for this "worst-case" situation ensures high harmonic attenuation throughout the operational range.

The filters are selected by the relays K3 to K14. Separate relays are used at the input and output of each filter. The unused filters are shorted at the inputs and outputs.

The design of satisfactory filters, capable of operating at continuous power levels of 1000 W, does pose a considerable design problem. Transmitting-grade mica capacitors are bulky, prohibitively expensive and exhibit excessive inductance for satisfactory operation on the higher frequencies. The final solution was the use of multiple high-voltage, ceramic disc capacitors. Each capacitor in the filter is made up from two or three disc capacitors selected so that the current is distributed between the individual capacitors.

In order to keep the filters compact, toroidal inductors were selected for the five lower frequency filters. These inductors have the further advantage of a restricted external field and eliminate the necessity to assemble the filters in individually shielded compartments. In examining the physical construction of the filter, the liberal use of ferrite sleeves, extensive bypassing of the dc control wiring, and the careful selection of ground points will be noted. It is important not to change any of the wiring or grounds, as unwanted loops will frequently bypass the filter, which causes a major reduction in the harmonic attenuation.

The filters are selected by grounding the control wire to each pair of relays. Diode isolation from the control switching in the transceiver is provided by D1-D6. If manual switching is provided, the filter-select switch grounds the relays for each filter in turn.

5.7 DIRECTIONAL COUPLER

The directional coupler is used to measure the forward power, to provide the ALC control voltage, and to reduce the amplifier power when the VSWR increases.

T4 is a toroidal pickup transformer which senses the magnitude and phase of the current. The inner conductor of the output coaxial cable passes through the center of the toroid to form a single-turn primary winding. L3 provides a dc center tap to the secondary of T4. C90 and C91 form a capacitive divider which provides a sample of the voltage on the coaxial line. When the amplifier is terminated in a 50-Ω load, the bridge balances and there is no output from the reverse arm of the bridge.

The forward arm of the bridge is rectified by D10 and D12. R30 and C98 provide a filter network that gives output corresponding to the average power output from the amplifier. C97 connects directly to D12 and provides a peak-reading circuit. The potentiometer R31 sets the peak power output. The average and peak power control voltages are combined with the output from the reverse arm of the bridge. Diodes D11, D13 and D14 provide isolation of the three outputs.

5.8 ALC CONTROL

The three outputs from the directional coupler are applied

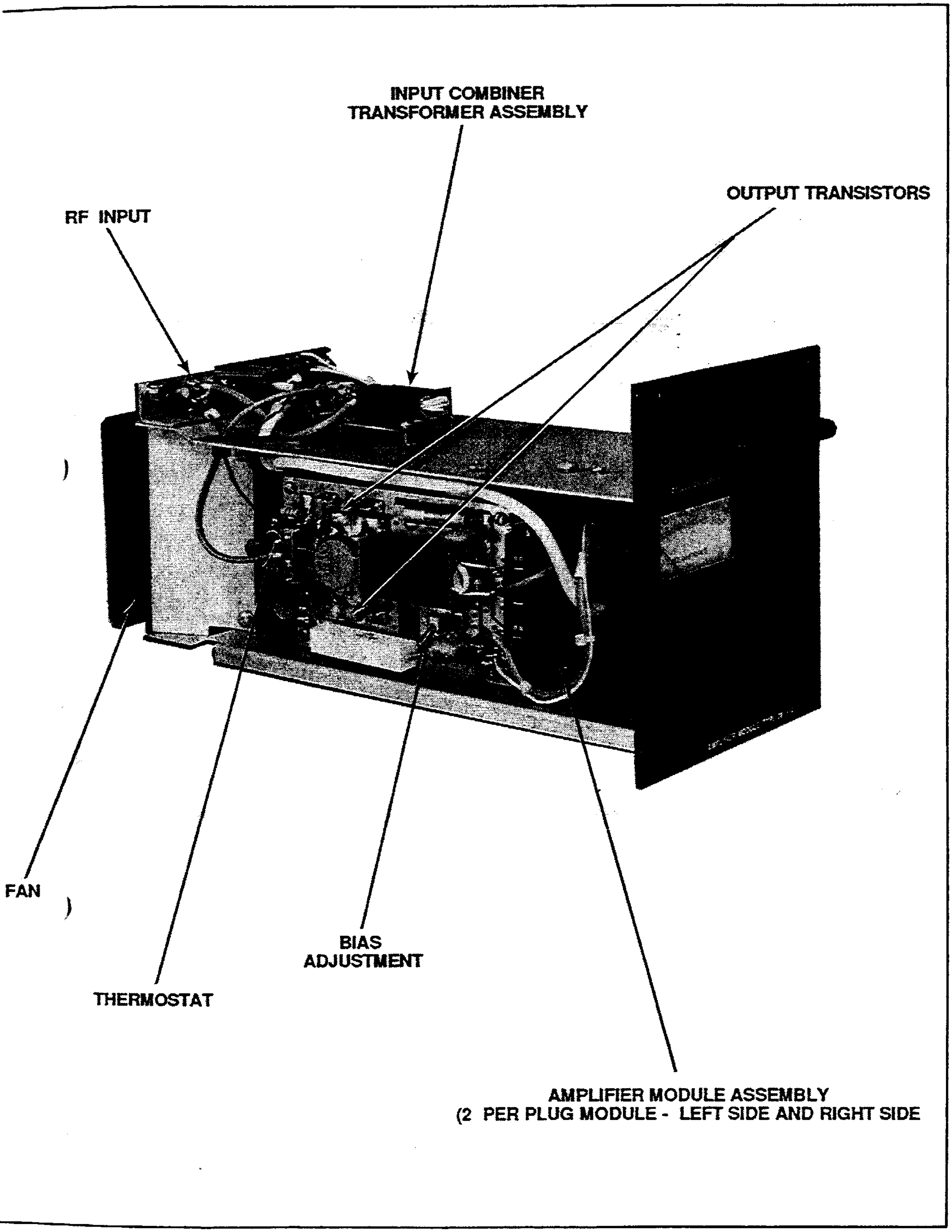

FIGURE 5-1.
Plug-Module Assembly.

to the base of the Darlington transistor Q1. In the TRANSWORLD transceivers, the gain is controlled by reducing the voltage on the high-impedance control line. The collector of Q1 is connected to the control line, and as the forward bias increases on Q1, the collector voltage is reduced until the system gain reaches the preset level.

The peak- and average-reading outputs from the bridge are adjusted to give the correct output in the SSB and FSK or CW modes. There is no output from the reverse arm of the bridge when the amplifier is operating into a correctly matched load. This output increases as the VSWR rises and progressively reduces the power output. This protects the RF transistors in the amplifier against mismatches.

As mentioned above, two separate ALC controls are provided. They are labelled "average" and "peak". In general it is intended that the peak control only should be used with full 1-kW average systems using the 80-A supply and that the average control should only be used with the smaller system using the 40-A supply. In either case, the control not in use should be rotated clockwise to its maximum power position.

5.9 POWER-OUTPUT METER

The output power is measured at the peak detector D12. The Darlington transistor Q2 drives the meter. R11 is the calibration control. (See Figure 5-2.)

5.10 ON/OFF SWITCHING - HIGH SPEED

In line with the requirements of modern ARQ teletype systems, the modular amplifiers have special circuitry enabling them to cycle from receive to transmit and back in much shorter times than was customary in older equipment. Typically switch times are of the order of 10 milliseconds or less.

The PTT line is a low-current-drain (typically less than 1 mA) circuit, which enables it to be switched by almost any normal transceiver PTT line or any logic system, without interfering with the system operation. It is internally diode isolated so that voltage differences will be ignored. To switch to the transmit condition, pin "H" of the interface socket must be pulled down to around 0.6 V or less, from its normal level of approximately 3.6 V.

The circuit action is as follows. Q3, a low-power Darlington transistor, is normally held in conduction by the divider chain composed of R9, R13, and R8. The collector of Q3 is directly connected to the base Q4, which in turn drives the output relay, K2. Although the output relay is nominally a 12-V device, it is supplied from the 28-V supply via R15. R15 limits the current flowing in K2 to its normal value. This has the effect of supplying the relay from a substantially constant current source, and hastens the relay closure. The current flowing in the coil of K2 is sensed by R10, in the emitter of Q4. When the current has built up to a value sufficient to close K2, Q5 is switched on via R12, which in turn closes K1, the input relay. K1 uses the same supply system as K2, via R16. The overall effect of this circuitry, on PTT closure, is to ensure tha the input relay closes AFTER the output relay, so that the amplifier can not be driven until the load is applied. When the PTT line is opened the reverse must take place. The sequence is as follows: When the PTT line is allowed to rise in voltage, Q3 again conducts, which switches off Q4 The current in K2 is prevented from collapsing instantly by D7 and R14, and consequently K2 does not open immediately. Q5 however switches off without delay and opens the input relay. Thus the output relay always switches on first when going from receive to transmit, and always switches off last when switching in the opposite direction. The protection circuitry is also incorporated in the PTT circuitry, and is described in Section 5.11.

5.11 PROTECTIVE CIRCUITRY

The protective circuits described below refer only to the high SWR circuitry.The amplifier does have the inheren protection provided by the ferroresonant power supply discussed under that section.

Although no protective system can provide ABSOLUTE immunity to incorrect operation, particularly the conditions which occur when an amplifier is heavily driven while in a totally unloaded or shorted condition, it is possible to build in a reasonable tolerance to the circumstances likely to be encountered in the field. The approach taken in this case is to provide a dual response system based on the measurement of SWR at the output terminal.

It must be emphasized that no protection against wrong filter selection is provided.

The two control systems activated by excess SWR are:

1. The transceiver ALC system. (High SWR provides an open collector ground, via a 2.2-kΩ resistor, R4, at pin I of the control socket). This control will normally keep the transceiver from supplying normal drive to the amplifier and is not subject to adjustment by either of the amplifier ALC controls.

NOTE

If a transceiver not made by this company is used, it may be necessary to provide a different ALC interface.

2. An internal "trip" system, which disables the PTT line which causes the amplifier to switch to the receive or bypass condition. This system automatically resets when the PTT line is returned to the "high" state, by the external control. Some versions of the amplifier will have a "reset" button on the front panel to reset the system without having to drop the PTT line. In any case, repeated tripping of this protective system should be taken as a signal that a problem may exist.

Also included under the heading of "protective circuitry," is an unbalance detector system, which detects the un-

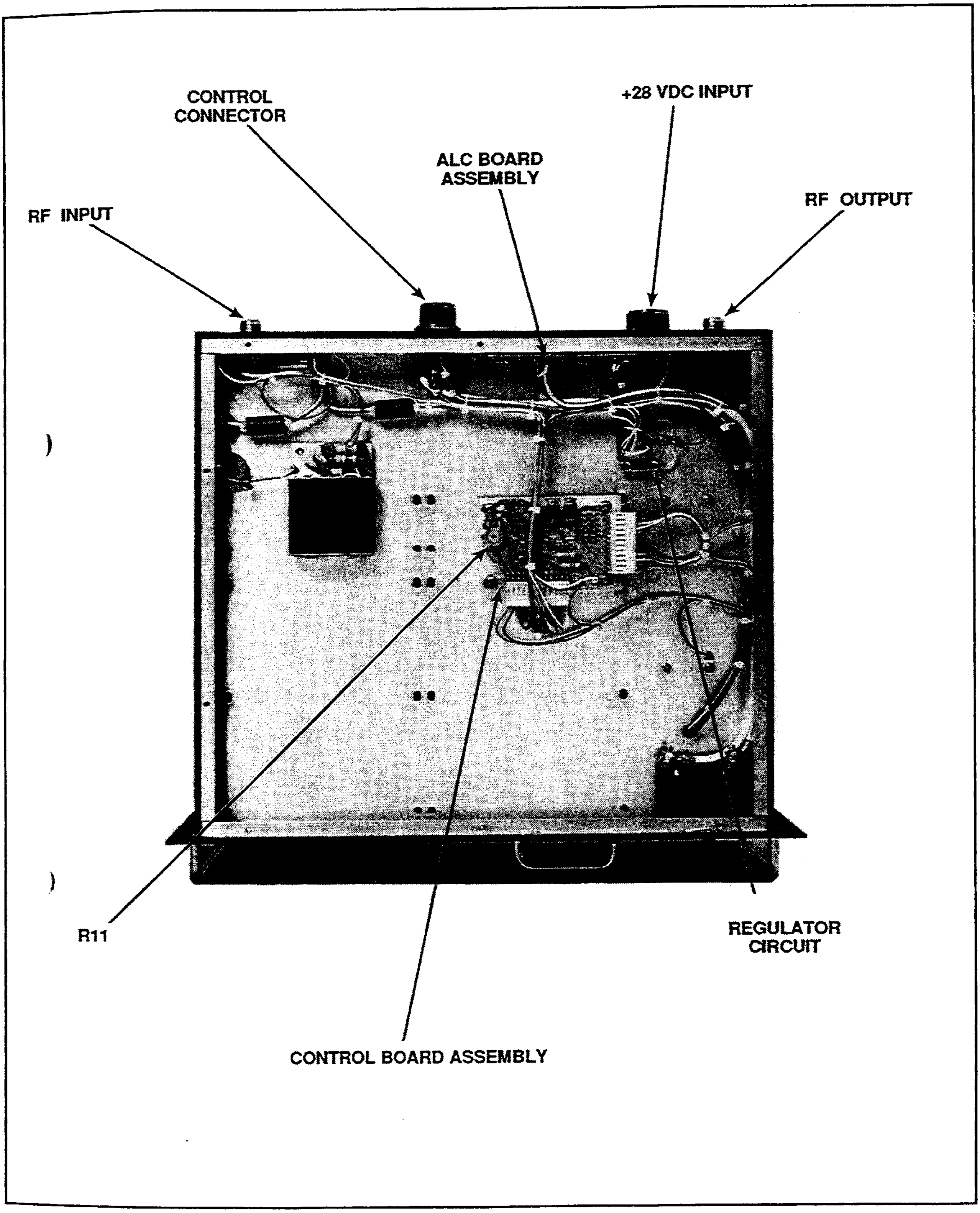

FIGURE 5-2.
Amplifier, Bottom View.

balance which occurs when for any reason a module shuts down or fails. A sensor which is located on the rear of the main output combiner detects this condition and trips the amplifier into the "straight-through" condition. If this precaution was not taken, the transceiver—when it senses lower output from the amplifier—would attempt to increase its output to compensate, which results in heavy peak flattening and distortion.

NOTE

The trip circuitry resets every time the PTT line returns to the receive condition.

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SECTION 1
INTRODUCTION

1.1 GENERAL INFORMATION

The TW1000A linear amplifier is designed for use with the TW100 series of synthesized HF transceivers to form a high-power 2- to 30-MHz communication system. The power output is 1000 W and 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 communication system. With the correct choice of antennas and operating frequencies, the systems will provide worldwide coverage.

1.2 GENERAL DESCRIPTION

The amplifier is entirely solid state and operates from a high-current 28-Vdc supply source. The amplifier uses two 500-W plug-in amplifier modules. Each module uses two push-pull 250-W amplifiers combined for an output of 500 W. The amplifiers are completely broadband in design and cover the frequency range 2-30 MHz without adjustment. The amplifier is constructed in a compact aluminum case designed for mounting in a standard 19-inch rack.

1.3 APPLICATIONS

The amplifier has been designed for continuous-duty commercial requirements where high performance and reliability are essential. The amplifier will normally be mounted in a 19-inch rack with the companion exciter and receiver or transceiver together with the FSK modem and any other ancillary equipment. The amplifier will normally be operated with the PS1000 power supply runs on the 115- or 230-V, 50- or 60-Hz ac power mains. The amplifier does operate from a high-current 28-Vdc supply source for shipboard or emergency applications.

1.4 MODES

The amplifier operates in linear service and is normally operated in single-sideband or FSK service. The amplifier is suitable for almost any relatively narrow-band mode including CW, AM and NBFM. The peak or average power output should not exceed 1000 W.

1.5 DUTY CYCLE

The amplifier is rated for continuous operation at a maximum power output of 1000 W (AVG). The power supply must be capable of continuous operation at the rated supply current which will be approximately 70 A for FSK service and 30 A for SSB service.

1.6 MODULES

The amplifier uses two 500-W modules. These modules are provided with individual metering and cooling fans. The modules plug in to the front panel and may be changed by removing four screws and withdrawing the module. If a module should fail, the amplifier will continue working at reduced efficiency. The plug-in modules are a great advantage for simplicity of service and maintenance.

1.7 COOLING SYSTEM

Each module is provided with a 28-Vdc (Hall-Effect) cooling fan mounted directly on the heatsinks. The fan blows air through the fins in the center of the module and provides efficient cooling. The fans are controlled by 60°-C thermostats mounted on the heats sinks and will only operate when the heat sink temperature reaches 60° C. In typical SSB service, the fans will seldom operate and will switch off soon after the amplifier FSK transmit cycle is ended. A second thermostat on each module switches the amplifier to the straight-through mode, if heat-sink temperature exceeds 85° C.

1.8 BYPASS MODE

Switching the dc power off switches the exciter through to the antenna. This feature is useful for providing lower power operation or as a fail-safe method of providing communications in the event of an amplifier fault condition.

1.9 HARMONIC FILTERS

The amplifier uses six seven-pole elliptic function filters covering the frequency range in six bands. The filters provide excellent suppression of all harmonics. The filters are normally selected automatically by the exciter or transceiver. An optional manual switch for filter selection is available. When this manual switch is used, a VSWR bridge is used between the amplifier and the filters. This bridge detects selection of the wrong filter and prevents damage to the amplifier by switching it off.

1.10 METERING

The collector current to each amplifier module is measured separately. The collector current in both modules should be approximately equal. Fault conditions are immediately indicated by unbalances in the collector currents between modules. A third meter is used to measure the power output.

1.11 FUSES

Current limiting is provided by a 100-A magnetic circuit breaker that is also used as the amplifier ON/OFF switch. The circuit breaker is reset from the front panel.

1.12 ALC ANTENNA-MISMATCH PROTECTION

A VSWR bridge is used to provide the ALC control voltage. The reverse arm of the bridge is used to reduce the power output as the VSWR rises and protects the amplifier against all conditions of mismatch.

1.13 INTERFACING WITH EXCITER

The amplifier is designed for simple interfacing with the TW100 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. The control circuit is simple, and interfacing with other types of equipment is usually not difficult. Contact the factory for appropriate information.

1.14 HIGH-SPEED SWITCHING

The amplifier uses a high-speed switching circuit for applications such as ARQ (SITOR). Provision is made to control an external high-speed vacuum relay for antenna switching.

1.15 POWER SUPPLIES

The amplifier may be operated on SSB from a 28-V, 50-A (peak) supply source. This same supply may be used for FSK operation at 500-W output. For operation at 1000 W (AVG) in FSK service or similar modes, the power supply source should be rated at 28 V 70 A (min.) continuous.

The PS1000 is a heavy-duty 80-A power supply rated for continuous operation. With this power supply, both the transceiver and amplifier may be operated continuously in any mode at 1000-W output.

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

TABLE 2-2.
28 Volt DC Pin-Out.

Pin	Description
A	+28 VDC
B	RETURN
C	RETURN
D	+28 VDC

TABLE 2-3.
13.8 Volt DC Pin-Out.

Pin	Description
A	+13.8 VDC
B	RETURN
C	RETURN
D	+13.8 VDC

2.4.4 13.8 VOLT DC OUTPUT

The 13.8 volt output is from the smaller 4-pin MIL-C circular connector. The mating plug is (Transworld P/N 614012). The standard cable used between the power supply and the TW7000 transceiver is C991907. The DC connection between the power supply and the transceiver should always be as short as possible. If other cables are used make sure that the wire gauge is capable of the current draw.

NOTE

The supply can put out up to 25 amps of current. This connector may be left unused in systems where the transceiver is powered by another source.

2.5 GROUNDING

A ground post at the rear panel of the supply is provided and should be used in the system grounding.

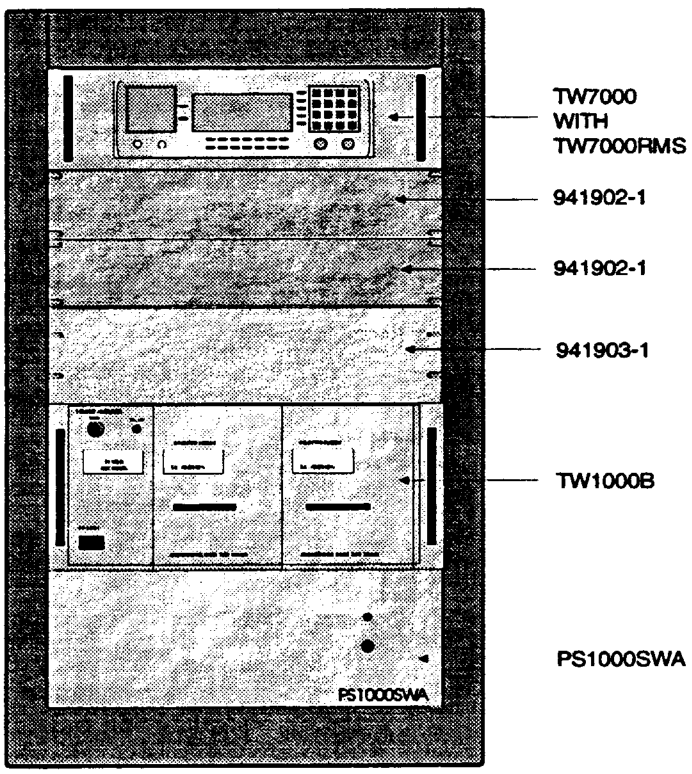


FIGURE 2-1.

TW7500.

SECTION 3
INSTALLATION

3.1 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.

3.2 MOUNTING

The amplifier should be mounted in the 19-inch rack using the mounting screws on each side of the panel. It is important to ensure that the back panel of the amplifier is completely unobstructed to ensure free airflow to the amplifier. We recommend installing the power supply at the bottom of the rack and the amplifier above. If there is spare rack space available, the blank panels may be inserted between the power supply and the amplifier so that the meters and controls are at a convenient height.

CAUTION!

The amplifier should never be installed in a closed rack unless forced air circulation is provided through the cabinet.

3.3 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.

3.4 INTERCONNECTIONS

Figure 3-1 shows the interconnections between the amplifier and the transceiver in a Transworld TW1500 rack-mount system. Other system configurations are available. If the equipment is ordered as a system, all interconnecting cables will be supplied and assembled. It is then simply a matter of connecting the RF control and power cables between the amplifier and the transceiver.

External cables needed to interface the TW1000A with the equipment shown in Figure 3-1 are listed below.

1. TW1000A to TW100 power cable: C991537
2. TW1000A to TW100 control cable: C991538
3. TW1000A to TW100 RF cable: C991539
4. TW1000A to PS1000 power cable: C991541

PL1 is the connector that receives primary dc power from the PS1000 power supply. Table 3-1 shows the pin-outs for PL1. PL2 is the connector that provides dc input to the TW100 transceiver. Table 3-2 shows the pin-outs for PL2.

PL3 is the connector that provides control information between the TW1000A and the TW100 transceiver. Table 3-3 shows the pin-outs for PL3.

For transceivers other than those manufactured by this company, it will be necessary to arrange that the appropriate filter is enabled by the transceiver itself. To achieve this, the transceiver must ground the control line of the correct filter-selection relay pair. As mentioned elsewhere, the filter ranges are as follows: 2-3 MHz, 3-5 MHz, 5-8 MHz, 8-13 MHz, 13-20 MHz, and 20-30 MHz. In some cases it may be necessary to interface with synthesizer arithmetic logic to enable the entire action to take place automatically.

Where absolutely necessary, a version of the amplifier with a manual front-panel switch for filter selection can be supplied, but in view of the danger of amplifier damage due to wrong filter selection, this is not a recommended technique.

3.5 POWER CONNECTIONS

The amplifier and transceiver may draw peak currents as high as 100 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 8-AWG cable must be used for the power cable. The maximum length of the power cable must not exceed 1.25 meters (4 feet). If 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.

3.6 ANTENNA CONNECTION

The output impedance of the amplifier is 50 Ω. 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.

3.7 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.

3.8 ANTENNAS

The antenna system should have a minimum power capability of 1 kilowatt. The antenna will normally be fed with 50-Ω coaxial line, and the antenna matching should be adjusted for the lowest 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 exciters 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 omni-directional 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. For maximum flexibility, the automatic tuner with motor driven elements that tune for minimum VSWR is used.

3.9 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.

3.9.1 POWER-OUTPUT ADJUSTMENT

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

NOTE

When operation is planned for more than one mode (e.g. SSB and CW operation), and a large change in 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. For example, if the PS1000 power supply is in use, the "PEAK" control would provide the correct power level for all modes.

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, this **OTHER** must be advanced to its fully clockwise (Maximum Power) position.

3.10 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.

3.11 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.

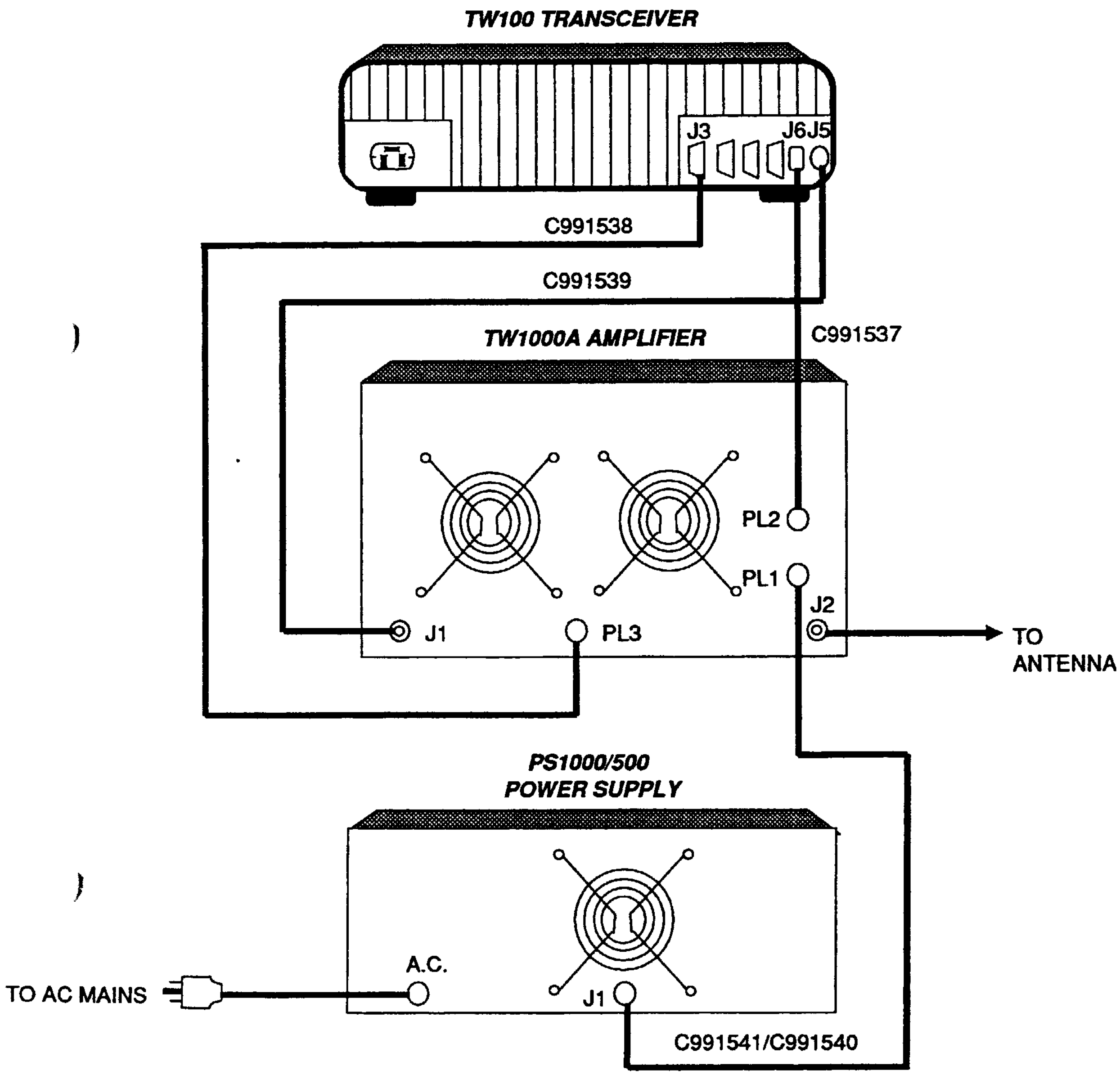


FIGURE 3-1.
TW1500 System Diagram.

TABLE 3-1.
TW1000A (PL1) Connector Pin-outs and System Equipment Connections.

Pins on TW1000A (PL1)	Description	Pins on PS500/1000 (J1)
A	+28 Vdc	A
B	Ground	B
C	Ground	C
D	+28 Vdc	D

TABLE 3-2.
TW1000A (PL2) Connector Pin-outs and System Equipment Connections.

Pins on TW1000A (PL2)	Description	Pins on TW100 (J6)
A	+28 Vdc	A
B	Ground	B

TABLE 3-3.
TW1000A (PL3) Connector Pin-outs and System Equipment Connections.

Pins on TW1000A (PL3)	Description	Pins on TW100 (J3)
A	2-3 MHz	4
B	3-5 MHz	5
C	5-8 MHz	6
D	8-13 MHz	7
E	13-20 MHz	8
F	20-30 MHz	9
H	PTT	3
I	Amp ALC	2
J	Ground	1

SECTION 4
OPERATION

GENERAL

amplifier requires no tuning adjustments. If the anten-
s correctly matched at the operating frequency, the
lifier will deliver full output power.

CONTROLS - ON/OFF

ɜn the amplifier is used with exciters providing auto-
ic filter selection, there is only one operating control—
ON/OFF switch. In the OFF position, the amplifier is
assed and the exciter delivers the normal power output
ct to the antenna. Turning the switch on brings the
ılifier on line, and no further adjustments are required.
ON/OFF switch can also be considered the high-low
'er switch. The switch is a magnetic circuit breaker and
trip if there is a fault in the amplifier which is causing
ɜssive current drain.

OF NAL CONTROLS - FILTER SELECTION

se controls are only required when the exciter does not
ɜ provision for automatic selection of the output filters.
switch should be turned to the filter range correspond-
with the operating frequency.

CAUTION!

not switch filters when the amplifier is operating.

METERING

.1 POWER OUTPUT

s meter measures the power output to the antenna. On FSK or CW transmissions, the meter should give a steady reading at approximately 1000 W. On SSB voice transmissions, the meter will kick up on voice peaks towards the 1000-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.

4.4.2 COLLECTOR CURRENT

Each module is provided with a meter 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.

4.5 COOLING FANS

The operation of the cooling fans is automatic. They are controlled by individual thermostats on the modules. When the heat-sink temperature reaches 60° C, the cooling fan will come on. It is normal for the fans in each module to switch on and off at slightly different times due to small variations in the thermostat operating temperatures. The fans will not switch on for short voice transmissions unless the ambient temperature is very high. A second thermostat on each power module in the amplifier switches the TW1000A to the "straight-through" mode if the heat-sink temperature exceeds 85° C.

SECTION 6
SERVICE AND MAINTENANCE

6.1 INTRODUCTION

The amplifier requires no routine maintenance. The power transistors are rated for an extended service life. It is important to ensure that the ALC is adjusted correctly. If the ALC is set for too high a power output, interference will be caused on adjacent channels and there is a possibility of damage to the amplifiers.

6.2 CLEANING

If the amplifier is operated in a dusty atmosphere, it is desirable to clean the interior of the amplifier regularly. Use a soft brush and compressed air to clean the interior. Take particular care to see that all air passages and the cooling fins are clean.

6.? AMPLIFIER MODULES

6.3.1 CHANGING MODULES

The amplifier uses field-replaceable modules. To remove a module, unscrew the four retaining screws on the front panel and withdraw the module from the amplifier. To replace the module, make sure that it is in the plastic guide rails, slide it back until the connectors engage and replace the four retaining screws.

6.3.2 FAULT DETECTION

The collector current in each module is monitored independently by the front-panel meters. A fault in a module is nearly always indicated by an imbalance in the collector current between the two modules and a decrease in the power output. It is normal for there to be small differences in the collector currents between the different transistors and variations up to 10 % are acceptable.

Check the quiescent current in each module. The bias has been set for a quiescent collector current of 200-300 mA fc [illegible]e module. The panel meter reads 50-A full scale and it will not be possible to measure the quiescent current accurately. Check that there is a small deflection of the meter when the amplifier is keyed. No meter movement or a substantial meter movement in one module indicates a fault in the bias circuit.

The operation of each module may be checked by removing the suspect module and operating the amplifier with only one module in place. The power output will be approximately 25 % of normal as 50 % of the power is dissipated in the balance resistors in the combining network. If both modules deliver equal power when operated alone, the fault is not in the modules.

The best possible check for correct operation is to check the modules by replacement with a known good module.

6.3.3 MODULE REPAIR

The most probable fault in a module is the failure of an RF power transistor. A defective transistor is located by the following procedure.

If it is suspected that a power transistor is at fault, as evidenced by a markedly lower collector current for the module, combined with a substantial drop in maximum output power for the entire amplifier, remove the module and perform the following checks.

Terminate the output connector of the module (R.H. connector viewed from the front of the module) in a 50-Ω, 500-W dummy load or high-power attenuator. Connect a suitable source of 28-30 Vdc to the power connector of the module, and jumper this voltage to the bias supply connector which is immediately adjacent to the output coaxial connector. Ensure that the negative lead of the power source is firmly grounded to the dc power source.

Bias Check

Measure the dc voltage between the base of the power transistors and ground on each amplifier block. It should be in the range +0.6 V to +0.7 V. If it is not, a thorough check of the bias circuitry should be made. (See Section 5.2 for a description of this circuitry.)

Functional Check

Connect a source of two-tone RF power at about 15 MHz (maximum power 10-15 W) to the input coaxial connector. Adjust the power level until a collector current of 3-5 A is indicated. With an oscilloscope observe the amplitude of the RF envelope at the output terminal of each amplifier block. If either block shows a markedly low output, further examine the particular transistor pair as follows:

Remove the RF drive source and disconnect the dc power. Carefully remove the solder from the base and collector leads of each transistor with a "solder sucker" or other solder removing means. With a suitable metal probe or other tool, applying further heat if necessary, GENTLY pry up the base and collector leads of both transistors so as to isolate them from the printed circuitry. With a conventional multimeter set on a low-resistance measuring scale (1000-Ω full scale or so), perform the following test: Connect the multimeter positive terminal (check which terminal actually has a positive voltage relative to the other) to the base of the transistor under test and leave it there for the following tests. Connect the other multimeter lead to the PC board ground. The meter should read a typical "diode-drop" value (10-20 Ω). A similar reading should be obtained on connecting the test lead to the collector lead. If any doubt exists as to what the ohmmeter should read, a test performed on any general-purpose silicon diode will establish a normal reading. If either test results in other than a normal reading, the transistor involved should be replaced. Although this test is a very basic one, the nature of high-power transistor failure is such that almost all failed parts will be detected by this procedure.

6.3.4 RF TRANSISTOR REPLACEMENT

Remove the two mounting screws from the transistor mounting flange. Unsolder the four transistor leads. This operation will require some dexterity, and an assistant with a second soldering iron may prove very helpful. Remove as much solder as possible with a desoldering tool or one of the proprietary solder removal tapes. It will then be possible to unsolder each lead in turn. Remove the defective transistor.

NOTE

The replacement transistor must have the same color dot (Beta Code) on top of its package.

Coat the mounting flange of the replacement transistor with heat sink compound and inspect the mounting area for dirt, etc. Check to ensure that the leads are correctly aligned and mount the transistor on the heat sink. The screws should be tightened securely but not overtightened, as this will distort the mounting flange. Do not solder the leads until the mounting screws are tightened. Use a large-capacity soldering iron to solder the leads in place. Complete the joint as quickly as possible so that the leads are soldered in place before the heat has time to be conducted through to the transistor chip.

6.4 POWER SUPPLY

Measure the power source both at no load and full load. The voltage should not exceed 32 V without load and should be 28 V at full power output. The amplifier will continue to operate at lower supply voltages but will not deliver the rated power output.

6.5 FILTER SERVICE

A filter defect is usually only apparent on one filter range. If the defect is present on more than one range, check the filter wiring and check for contacts sticking in the ON position in one of the relays. If the fault is confined to one filter, check the relays for dc continuity through the filter. If a capacitor in the filter fails, the capacitor will probably have a burned appearance and can be visually identified. The inductors are unlikely to give any problems unless the toroidal cores are broken. A special procedure is used in the factory for filter alignment, and a sweep generator is essential. Fortunately, the replacement of a single capacitor, or even an inductor, will not cause sufficient change to require realignment. If the filters suffer substantial damage (only likely if there is severe physical damage to the amplifier), a replacement filter assembly should be installed, or the original filter should be returned to the factory for service.

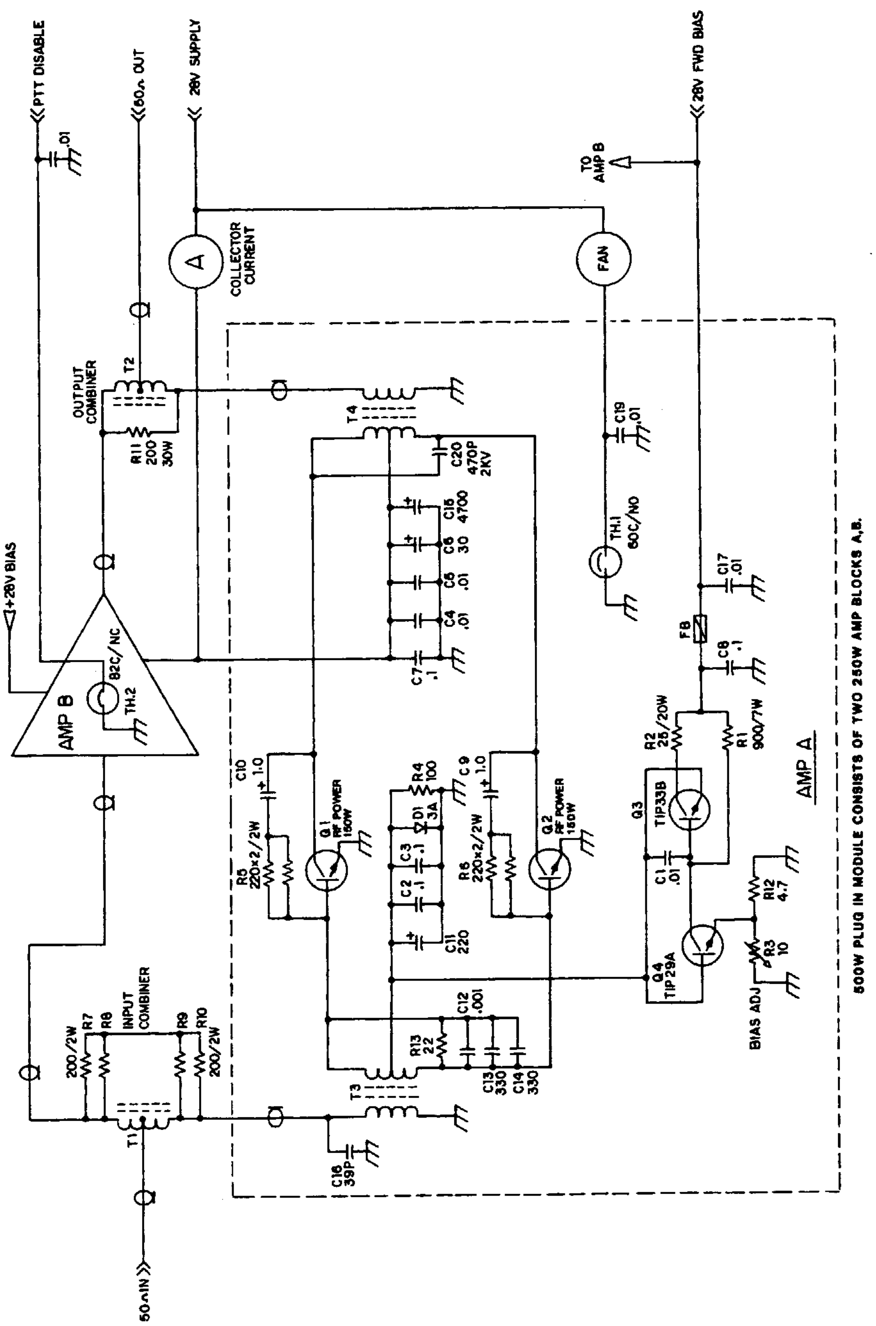


FIGURE 6-1.
Schematic Diagram, Amplifier Module.

TABLE 6-1.
Parts List, Amplifier Module.

C1	211103	Capacitor, Disc 500 V 0.01 µF
C2,C3	210104	Capacitor, Disc 25 V 0.1 µF
C4,C5	211103	Capacitor, Disc 500 V 0.01 µF
C6	230300	Capacitor, 100 V 30 µF
C7,C8	254104	Capacitor, Mylar 100 V 0.1 µF
C9,C10	240010	Capacitor, Tantalum 75 V 1 µF
C11	230201	Capacitor, Electrolytic 16 V 200 µF
C12	215102	Capacitor, Chip 100 V 0.001 µF
C13,C14	224331	Capacitor, Mica DM19 330 pF
C15	230502	Capacitor, Electrolytic 35 V 4700 µF
C16	220390	Capacitor, Mica DM15 39 pF
C17-C19*	211103	Capacitor, Disc 0.01 µF
C20	212471	Capacitor, Disc 2 kV 470 pF
D1	320103	Diode, 3 Amp 50 V 1N5400
FAN*	770003	Fan, 28 Vdc
FB	490201	Bead, Ferrite
Q1,Q2	310050	Transistor, Power RF 28 V
Q3	310025	Transistor, MJE3055K
Q4	310024	Transistor, MJE29A
R1	160901	Resistor, Wirewound 7 W 5 % 900 Ω
R2	160250	Resistor, Wirewound 20 W 5 % 25 Ω
R3	170212	Resistor, Trimmer 10 Ω
R4	144101	Resistor, Film 1 W 5% 100 Ω
R5,R6	153221	Resistor, Film Flameproof 2 W 5 % 220
R7-R10*	153201	Resistor, Film Flameproof 2 W 5 % 200
R11*	164201	Resistor, Film Power 30 W 10 % 200 Ω
R12	124047	Resistor, Film 1/4 W 5 % 4.7 Ω
R13	153220	Resistor, Film Flameproof 2 W 5 % 22 Ω
TH1*	560002	Thermostat 60° C N.O.
TH2*	560004	Thermostat 82° C N.O.

*Part is located on Plug Module (2 per unit).

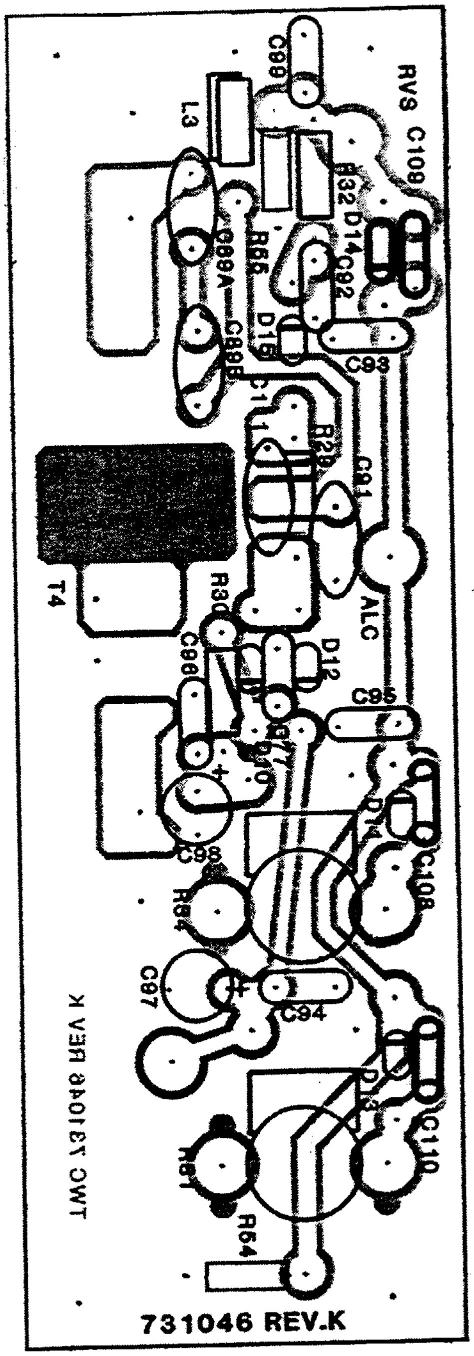


FIGURE 6-2.
Component Locations, ALC Board.

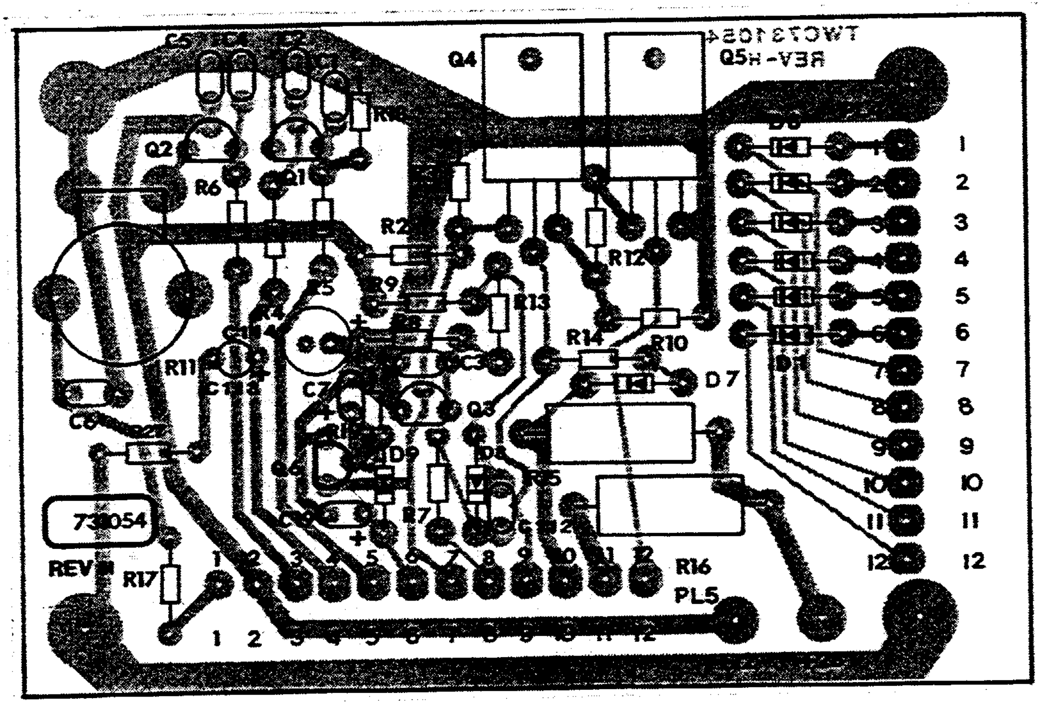
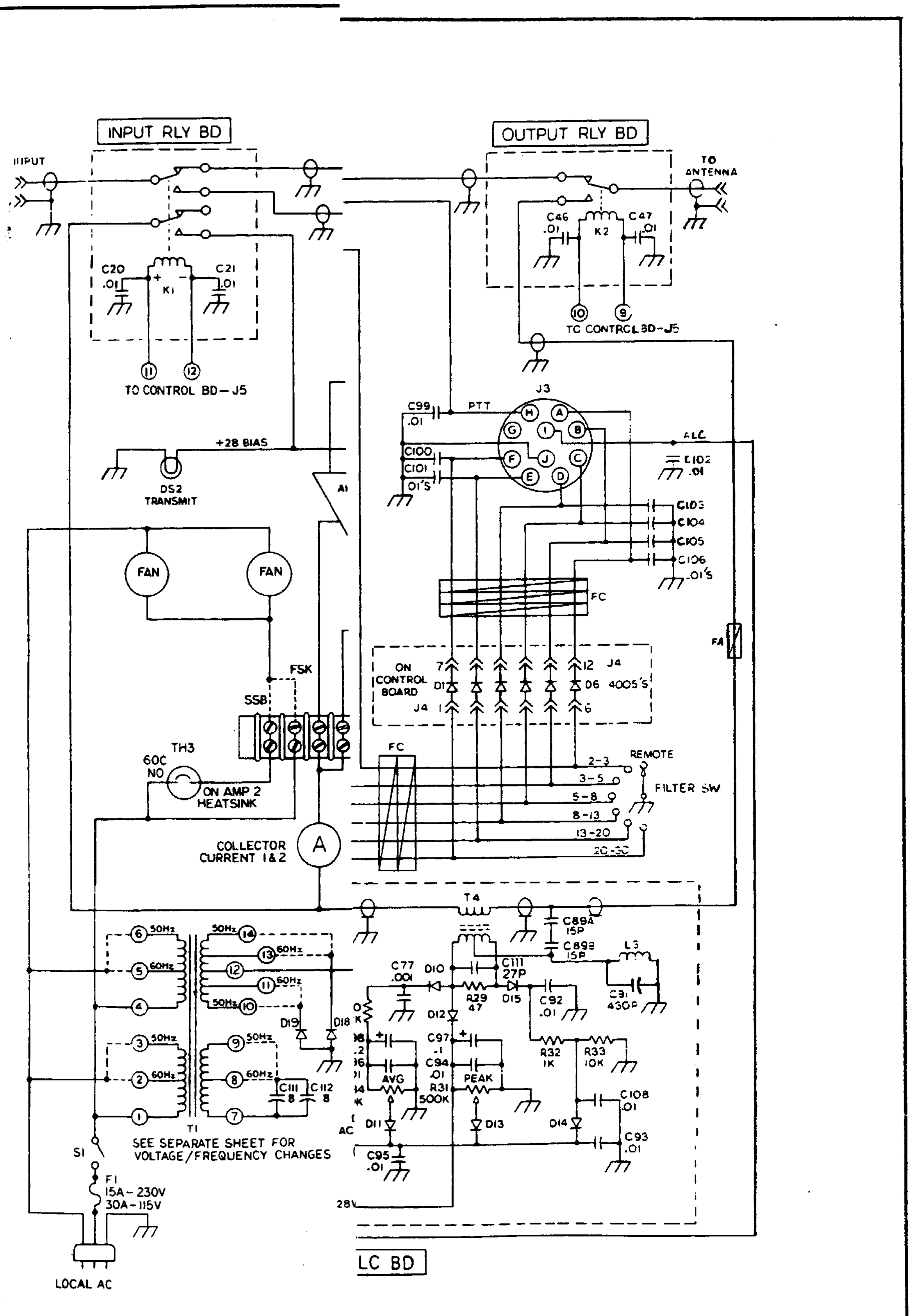


FIGURE 6-3.
Component Locations, Control Board.



Schematic Diagram, Linear Amplifier.

TABLE 6-2.
Parts List, Linear Amplifier.

[illegible]	210102	Control Board	Capacitor, Disc 25 V 0.001 μF
[illegible]	210103	Control Board	Capacitor, Disc 0.01 μF
[illegible]	241010	Control Board	Capacitor, Tantalum 1 μF
[illegible]	230201	Chassis	Capacitor, Electrolytic 16 V 200 μF
[illegible]	230300	Output Combiner	Capacitor, Disc 5 kV 39 pF
[illegible]	212560	Output Combiner	Capacitor, Disc 3 kV 56 pF
[illegible]	212391	Chassis	Capacitor, Disc 2k V 390 pF
…,C14	212751	Chassis	Capacitor, Disc 2k V 750 pF
…,C16	212470	Input Combiner	Capacitor, Disc 5k V 47 pF
…,C18	212560	Input Combiner	Capacitor, Disc 3 kV 56 pF
[illegible]	241010	Control Board	Capacitor, Tantalum 1 μF
…,C21	211103	Input Relay	Capacitor, Disc 500 V 0.01 μF
…,C45	211103	Filter Block	Capacitor, Disc 500 V 0.01 μF
…,C47	211103	Output Relay	Capacitor, Disc 500 V 0.01 μF
[illegible]	212560	Filter Block	Capacitor, Disc 3k V 56 pF
[illegible]	212470	Filter Block	Capacitor, Disc 5k V 47 pF
[illegible]	212560	Filter Block	Capacitor, Disc 3k V 56 pF
…B,C51	212680	Filter Block	Capacitor, Disc 5k V 68 pF
…2A	212560	Filter Block	Capacitor, Disc 3k V 56 pF
…2B	212820	Filter Block	Capacitor, Disc 5 kV 82 pF
[illegible]	212120	Filter Block	Capacitor, Disc 3 kV 12 pF
…4A,C54B	212390	Filter Block	Capacitor, Disc 5 kV 39 pF
…5A	212101	Filter Block	Capacitor, Disc 3 kV 100 pF
…5B	212271	Filter Block	Capacitor, Disc 2 kV 270 pF
…5C	212391	Filter Block	Capacitor, Disc 2 kV 390 pF
…6A,C56B	212470	Filter Block	Capacitor, Disc 5 kV 47 pF
…56C	212390	Filter Block	Capacitor, Disc 5 kV 39 pF
C57A-C57C	212471	Filter Block	Capacitor, Disc 2 kV 470 pF
C58A,C58B	212271	Filter Block	Capacitor, Disc 2 kV 270 pF
…59A	212121	Filter Block	Capacitor, Disc 3 kV 12 pF
…59B	212471	Filter Block	Capacitor, Disc 2 kV 470 pF
…60A	212391	Filter Block	Capacitor, Disc 2 kV 390 pF
…60B	212101	Filter Block	Capacitor, Disc 3 kV 100 pF
…61A	212391	Filter Block	Capacitor, Disc 2 kV 390 pF
…61B	212101	Filter Block	Capacitor, Disc 3 kV 100 pF
…62A-C62C	212151	Filter Block	Capacitor, Disc 4 kV 150 pF
…63A,C63B	212390	Filter Block	Capacitor, Disc 5 kV 39 pF
…64A,C64B	212391	Filter Block	Capacitor, Disc 2 kV 390 pF
…64C	212680	Filter Block	Capacitor, Disc 5 kV 68 pF
…65A	212271	Filter Block	Capacitor, Disc 2 kV 270 pF
…65B	212101	Filter Block	Capacitor, Disc 3 kV 100 pF
…6A	212391	Filter Block	Capacitor, Disc 2 kV 390 pF
…6B	212271	Filter Block	Capacitor, Disc 2 kV 270 pF
…6C	212101	Filter Block	Capacitor, Disc 3 kV 100 pF
…7A	212560	Filter Block	Capacitor, Disc 3 kV 56 pF
…7B,C67C	212121	Filter Block	Capacitor, Disc 3 kV 120 pF
…8A	212560	Filter Block	Capacitor, Disc 3 kV 56 pF
…8B,C68C	212121	Filter Block	Capacitor, Disc 3 kV 120 pF
…9A,C69B	212101	Filter Block	Capacitor, Disc 3 kV 100 pF
…9C	212820	Filter Block	Capacitor, Disc 5 kV 82 pF

TABLE 6-2.
Parts List, Linear Amplifier.

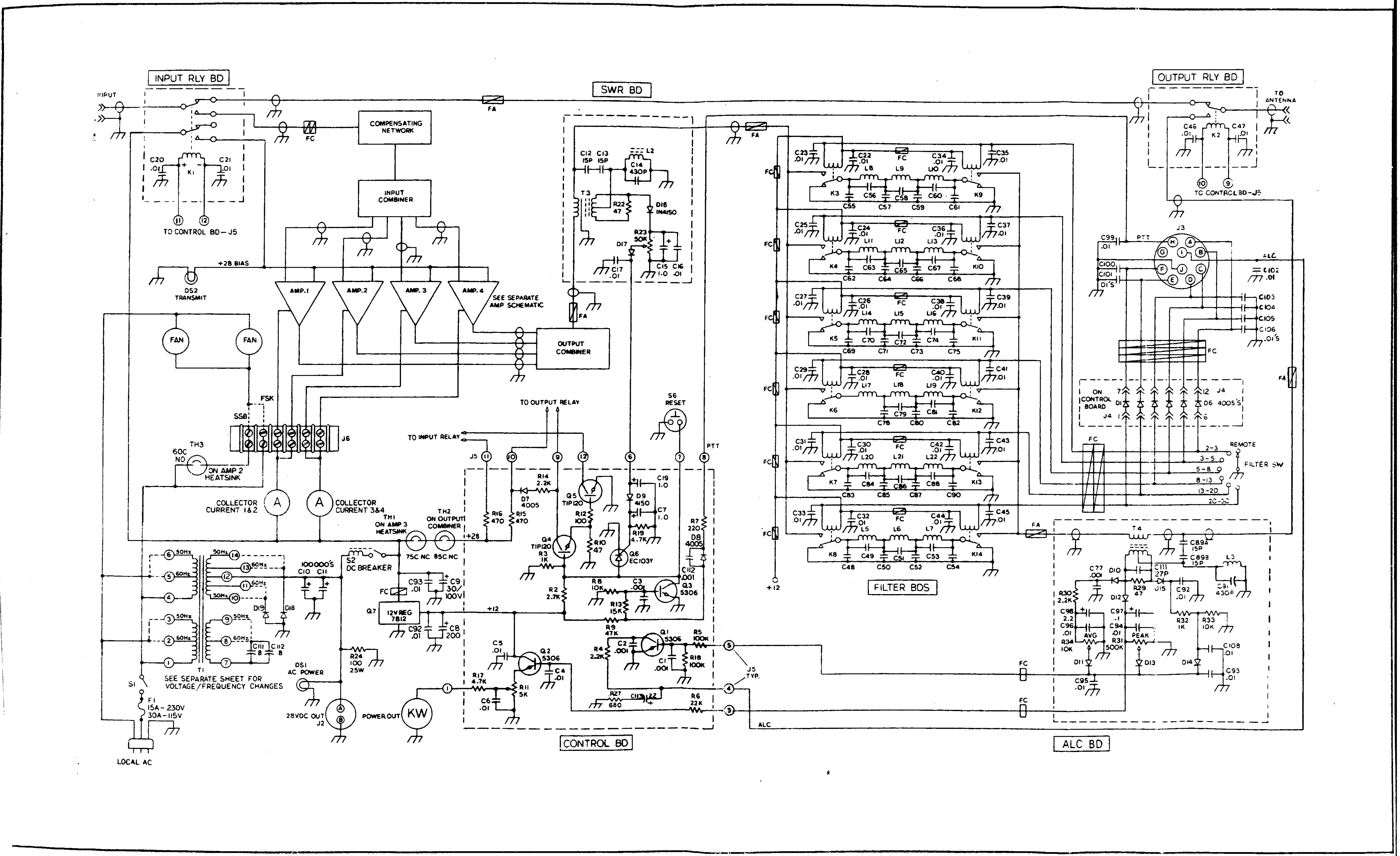
FB	490502	Various	Bead, Ferrite
FB	490302	Rear Panel	Bead, Ferrite Balun
K1	540008	Input Relay	Relay DPDT 12 V
K2	540013	Output Relay	Relay SPDT 12 Vdc 10A
K3- K14	540013	Filter Block	Relay SPDT 12 Vdc 10 A
L1	490008	Chassis	Inductor, Toroidal
L2			Not Used.
L3	490202	ALC Board	Inductor, Bead
L4			Not Used.
L5-L6	450411	Filter Block	Inductor, Air 20-30 MHz
L7	450412	Filter Block	Inductor, Air 20-30 MHz
L8	450501	Filter Block	Inductor, Toroidal 2-5 MHz
L10	450502	Filter Block	Inductor, Toroidal 2-5 MHz
L11	450503	Filter Block	Inductor, Toroidal 3-5 MHz
L12,L13	450504	Filter Block	Inductor, Toroidal 3-5 MHz
L14	450505	Filter Block	Inductor, Toroidal 5-8 MHz
L15,L16	450506	Filter Block	Inductor, Toroidal 5-8 MHz
L17	450508	Filter Block	Inductor, Toroidal 8-13 MHz
L18	450507	Filter Block	Inductor, Toroidal 8-13 MHz
L19	450509	Filter Block	Inductor, Toroidal 13-20 MHz
L20	450412	Filter Block	Inductor, Toroidal 13-20 MHz
L21	450510	Filter Block	Inductor, Toroidal 13-20 MHz
L22	450507	Filter Block	Inductor, Toroidal 8-13 MHz
M1	740010	Front Panel	Meter, RF Power
PL1	610060	Rear Panel	Plug, Chassis
PL2	613014	Rear Panel	Plug, Chassis Socket
PL3	610063	Rear Panel	Plug, Chassis
PL4,PL5	610147	Control Board	Plug, PC Mount 12 Pin Polar
Q1-Q3	310027	Control Board	Transistor, 2N5306
Q4,Q5	310053	Control Board	Transistor, NPN Darlington Tip 120
Q6	320602	Control Board	Transistor, SCR EC103Y
R1			Not Used.
R2	124272	Control Board	Resistor, Film 1/4 W 5 % 2.7 kΩ
R3	124102	Control Board	Resistor, Film 1/4 W 5 % 1 kΩ
R4	124222	Control Board	Resistor, Film 1/4 W 5 % 2.2 kΩ
R5	124104	Control Board	Resistor, Film 1/4 W 5 % 100 kΩ
R6	124223	Control Board	Resistor, Film 1/4 W 5 % 22 kΩ
R7	124221	Control Board	Resistor, Film 1/4 W 5 % 220 Ω
R8	124103	Control Board	Resistor, Film 1/4 W 5 % 10 kΩ
R9	124473	Control Board	Resistor, Film 1/4 W 5 % 47 kΩ
R10	124470	Control Board	Resistor, Film 1/4 W 5 % 47 Ω
R11	170103	Control Board	Resistor, Trimmer 5 kΩ
R12	124101	Control Board	Resistor, Film 1/4 W 5 % 100 Ω
R13	124153	Control Board	Resistor, Film 1/4 W 5 % 15 kΩ
R14	124222	Control Board	Resistor, Film 1/4 W 5 % 2.2 kΩ

TABLE 6-2.
Parts List, Linear Amplifier.

C70	212470	Filter Block	Capacitor, Disc 5 kV 47 pF
C71A	212271	Filter Block	Capacitor, Disc 2 kV 270 pF
C71B	212201	Filter Block	Capacitor, Disc 3 kV 200 pF
C71C	212560	Filter Block	Capacitor, Disc 3 kV 56 pF
C72A,C72B	212121	Filter Block	Capacitor, Disc 3 kV 120 pF
C73A	212271	Filter Block	Capacitor, Disc 2 kV 270 pF
C73B	212201	Filter Block	Capacitor, Disc 3 kV 200 pF
C74A,C74B	212560	Filter Block	Capacitor, Disc 3 kV 56 pF
C74C	212680	Filter Block	Capacitor, Disc 5 kV 68 pF
C75A,C75B	212560	Filter Block	Capacitor, Disc 3 kV 56 pF
C75C	212580	Filter Block	Capacitor, Disc 5 kV 68 pF
C76			Not Used.
C77	210102	ALC Board	Capacitor, Disc 25 V 0.001 µF
C78A	212101	Filter Block	Capacitor, Disc 3 kV 100 pF
C78B,C78C	212820	Filter Block	Capacitor, Disc 5 kV 82 pF
C79A	212390	Filter Block	Capacitor, Disc 5 kV 39 pF
C79B	212470	Filter Block	Capacitor, Disc 5 kV 47 pF
C80A,C80B	212121	Filter Block	Capacitor, Disc 3 kV 120 pF
C80C	212560	Filter Block	Capacitor, Disc 3 kV 56 pF
C81	212470	Filter Block	Capacitor, Disc 5 kV 47 pF
C82A,C82B	212470	Filter Block	Capacitor, Disc 5 kV 47 pF
C82C	212390	Filter Block	Capacitor, Disc 5 kV 39 pF
C83A-C83C	212390	Filter Block	Capacitor, Disc 5 kV 39 pF
C84A,C84B	212100	Filter Block	Capacitor, Disc 3 kV 10 pF
C85A,C85B	212820	Filter Block	Capacitor, Disc 5 kV 82 pF
C85C	212470	Filter Block	Capacitor, Disc 5 kV 47 pF
C86A,C86B	212470	Filter Block	Capacitor, Disc 5 kV 47 pF
C87A,C87B	212680	Filter Block	Capacitor, Disc 5 kV 68 pF
C87C	212560	Filter Block	Capacitor, Disc 3 kV 56 pF
C88	212390	Filter Block	Capacitor, Disc 5 kV 39 pF
C89A,C89B	220150	ALC Board	Capacitor, Mica DM15 15 pF
C90A,C90B	212390	Filter Block	Capacitor, Disc 5 kV 39 pF
C91	220431	ALC Board	Capacitor, Mica DM15 430 pF
C92-C96	210103	ALC Board	Capacitor, Disc 0.01 µF
C97	241001	ALC Board	Capacitor, Tantalum 0.1 µF
C98	241020	ALC Board	Capacitor, Tantalum 2.2 µF
C99-C106	211103	Rear Panel	Capacitor, Disc 500 V 0.01 µF
C107	210103	ALC Board	Capacitor, Disc 0.01 µF
C108	210103	Output Combiner	Capacitor, Disc 0.01 µF
C109,C110	211103	Chassis	Capacitor, Disc 500 V 0.01 µF
C111	220270	ALC Board	Capacitor, Mica DM15 27 pF
C112	210102	Control Board	Capacitor, Disc 25 V 0.001 µF
C113	241110	Control Board	Capacitor, Tantalum 10 µF
D1-D8	320101	Control Board	Diode, 1N4005
D9	320002	Control Board	Diode, 1N4148
D10-D13	320002	ALC Board	Diode, 1N4148
D14			Not Used.
D15	320002	ALC Board	Diode, 1N4148
D16	320002	Output Combiner	Diode, 1N4148

TABLE 6-2.
Parts List, Linear Amplifier.

R15			Not Used.
R16	144471	Control Board	Resistor, Film 1 W 5 % 470 Ω
R17	124472	Control Board	Resistor, Film 1/4 W 5 % 4.7 kΩ
R18	124104	Control Board	Resistor, Film 1/4 W 5 % 100 kΩ
R19	124472	Control Board	Resistor, Film 1/4 W 5 % 4.7 kΩ
R20-R22	164500	Chassis	Resistor, Film 30 W 50 Ω
R23,R24	153201	Input Combiner	Resistor, 2 W 5 % 200 Ω
R25,R26	164201	Side Panel	Resistor, Film Power 30 W 10 % 200 Ω
R27	124681	Control Board	Resistor, Film 1/4 W 5 % 680 Ω
R28			Not Used.
R29	134470	ALC Board	Resistor, Film 1/2 W 5 % 47 Ω
R30	124222	ALC Board	Resistor, Film 1/4 W 5 % 2.2 kΩ
R31	170106	ALC Board	Resistor, Trimmer 500 kΩ
R32	124102	ALC Board	Resistor, Film 1/4 W 5 % 1 kΩ
R33			Not Used.
R34	170101	ALC Board	Resistor, Variable 10 kΩ
R35	124221	Output Combiner	Resistor, Film 1/4 W 5 % 220 Ω
R36	124472	Output Combiner	Resistor, Film 1/4 W 5 % 4.7 kΩ
R37	124222	Output Combiner	Resistor, Film 1/4 W 5 % 2.2 kΩ
R38	124102	Output Combiner	Resistor, Film 1/4 W 5 % 1 kΩ
SW1	570005	Front Panel	Circuit Breaker, 100 A
SW2			Not Used.
SW3	530001	Front Panel	Switch, Push Button
T4	490401	ALC Board	Transformer, Toroidal
U1			Not Used.
U2	330132	Chassis	IC, UA7812KC



Schematic Diagram, Linear Amplifier.