TRANS WORLD ELECTRONICS

T1000
1000W Linear Amplifiers

T1000 Manual

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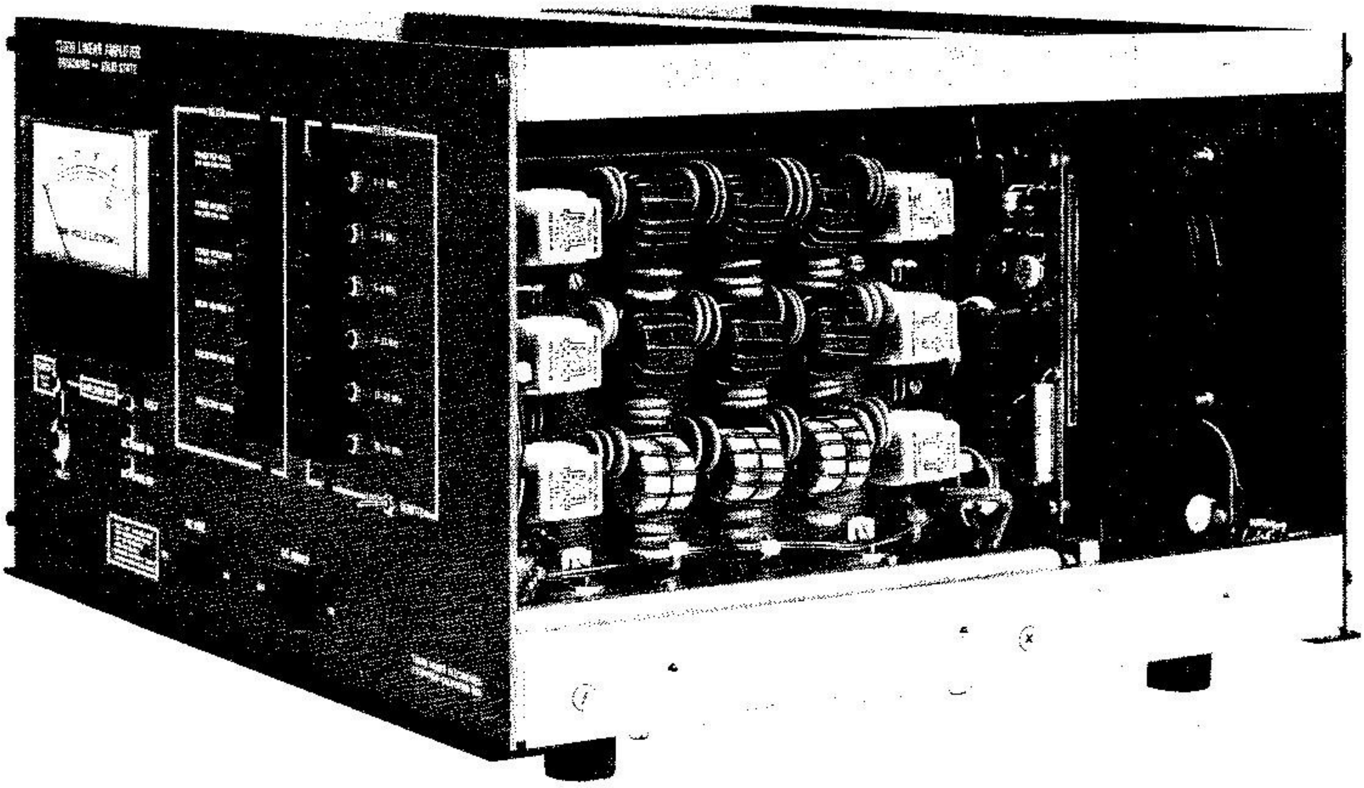
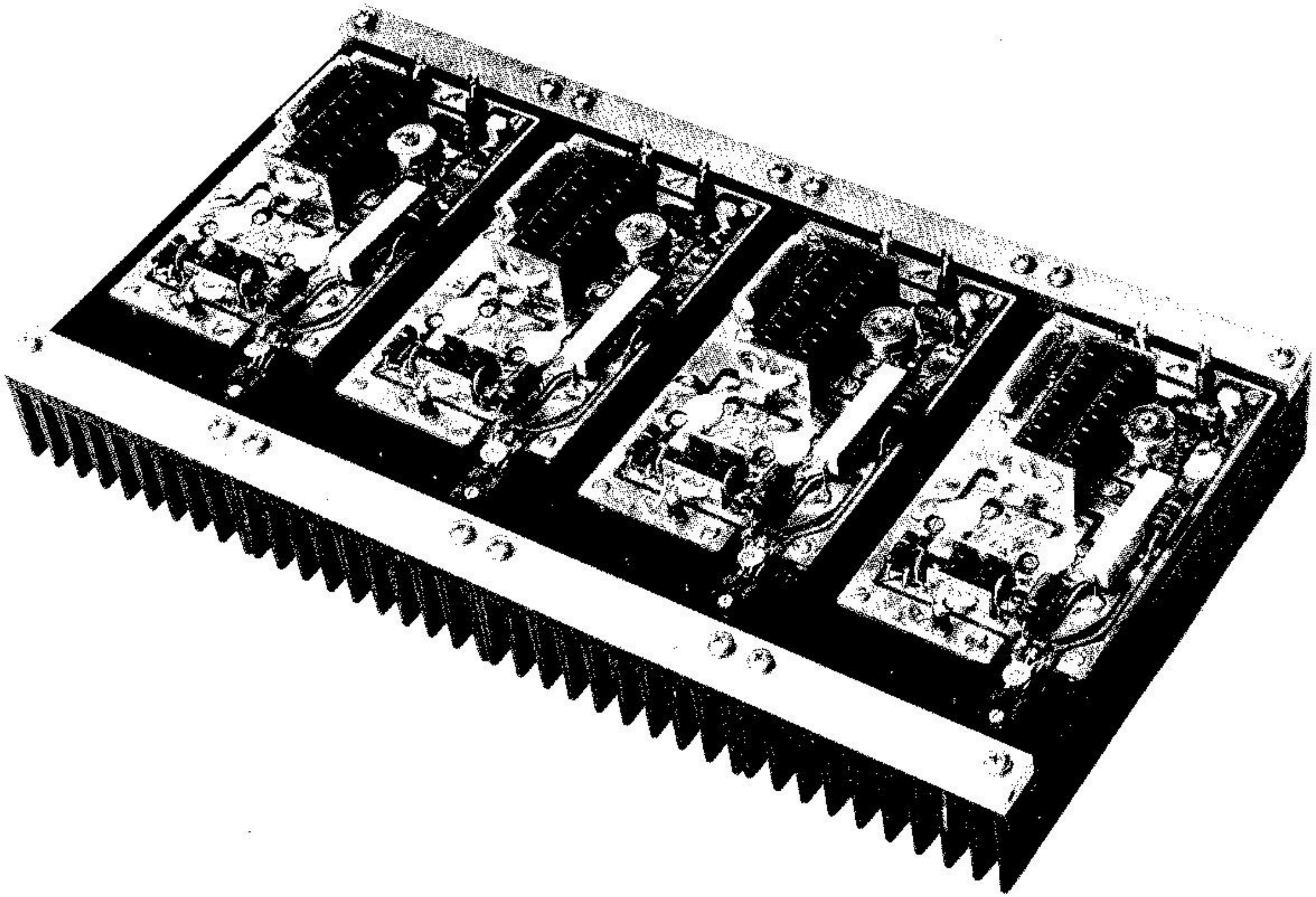
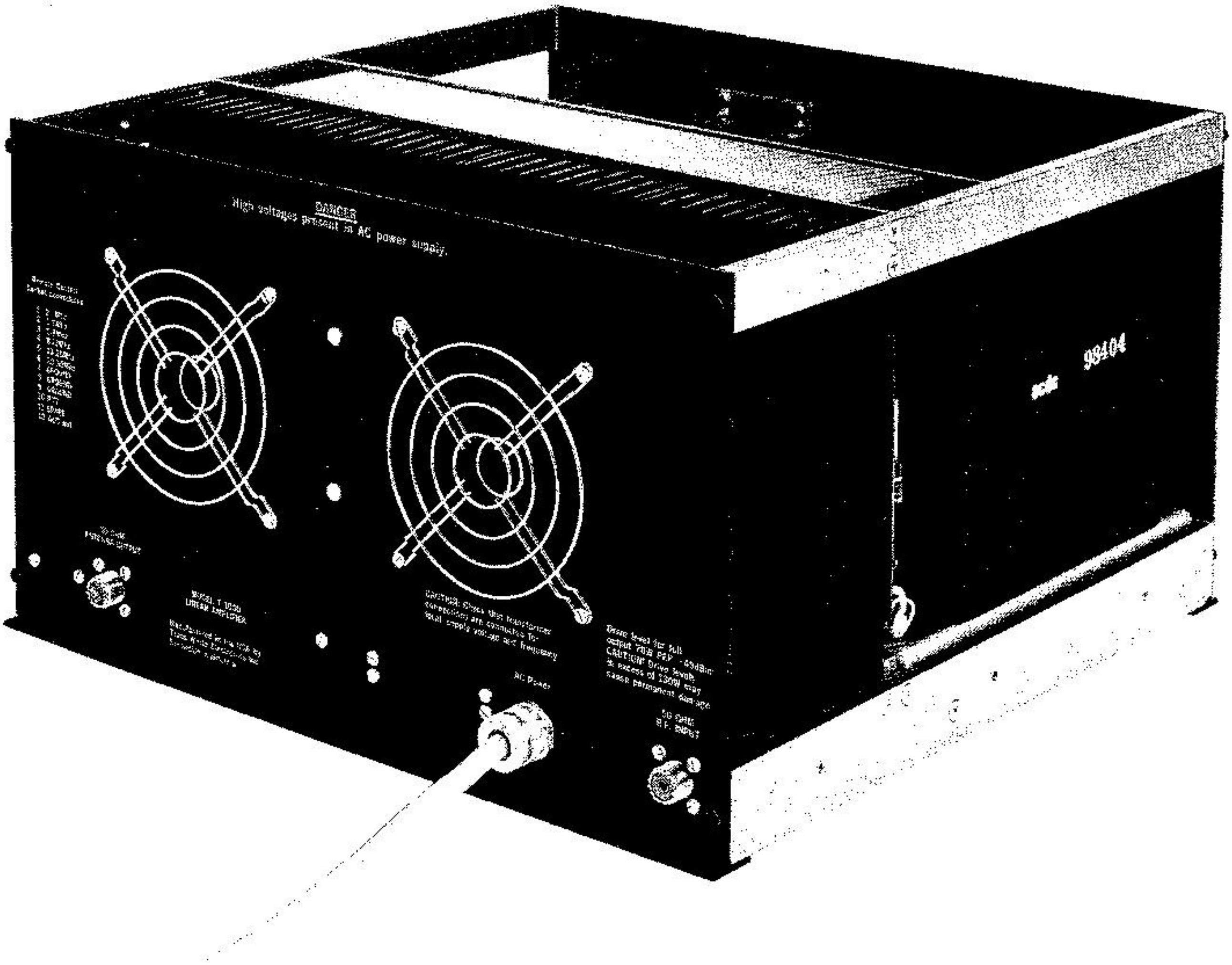


T1000 Side View - Filter Assembly



T 1000 RF Assembly



T 1000 Rear View

INTRODUCTION

Please note carefully the following important information about the T1000 Linear Amplifier.

1. The amplifier is broadband and has no tuning adjustments. This means that the amplifier will not operate correctly unless the antenna presents a 50 ohm non-inductive load to the amplifier. Do not expect the amplifier to operate correctly unless the VSMR is lower than 1.5:1. If it is not possible to obtain a good match it is essential to use a simple antenna tuner.

   Some users of the T1000 have expected results similar to those obtained with a tuned vacuum tube amplifier. This type of amplifier has an adjustable output network that enables the amplifier to be matched to incorrectly terminated lines.

   The protective circuitry in the amplifier is set to operate if the VSWR exceeds 3:1, and on some frequencies the protect circuit may operate at even lower VSWR's. This limit has been set, even although the transistors are rated to withstand limited operation at infinite VSWR, as the amplifier will simply not provide satisfactory output unless the load is correctly matched. If the VSWR protective circuit operates it will be necessary to improve the match to the antenna.

2. The amplifier uses a Constant Voltage Transformer in the power supply. The CVT uses a magnetic circuit to regulate the output voltage and the core operates at high flux densities. The following facts should be noted:

   a. The power dissipation in the CVT is high under no-load conditions. The core losses will reduce as the load increases, and the power dissipation will remain substantially constant. This means that it is normal for the transformer temperature to rise under no-load conditions. The transformer is rated for operation at a maximum temperature of 130°C.

   b. The high flux density in the core generates some lamination noise. This noise has been minimized in the T1000 by encapsulating the CVT in epoxy, however, some transformer "buzz" is normal.

   c. The CVT will generate a considerable external magnetic field and the amplifier should not be operated close to any device subject to magnetic disturbance.

3. The standard T1000 is supplied for SSB service. This model should not be used for FSK service except on an intermittent basis (5 minutes transmit duty cycle maximum). The FSK model may be used for both SSB and FSK service. The peak output power in the SSB model is slightly reduced. The SSB model can be modified for FSK operation. Conversion information is available at no charge from the factory.

WEIGHT

46 kilos (103 lbs.)

CONTROLS

AC Power ON/OFF
DC Power ON/OFF (Resettable Circuit Breaker)
Filter Range
Filter Selection -- Remote/Local
Meter Range
VSWR Reset

INDICATORS

Filter Range (6)
AC Power On
DC Power On
VSWR High
Fault Condition

METERING

Peak Power -- 1250W Full Scale
Average Power -- 750W Full Scale
Reflected Power (Relative)
Relay Voltage -- 50V Full Scale
Collector Voltage -- 50V Full Scale
Collector Current -- 50A Full Scale

CONTROL CIRCUITRY

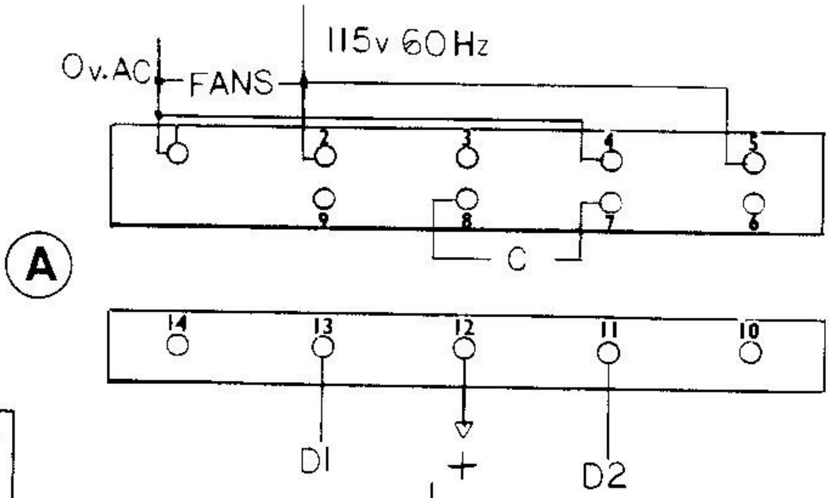
12 Pin Connector on rear panel.
Control voltage 14V nominal.
Actuation -- all functions, ground control line.
Functions -- Transmit/Receive
Filter Select (6 lines)
ALC -- DC voltage proportional to RF output.

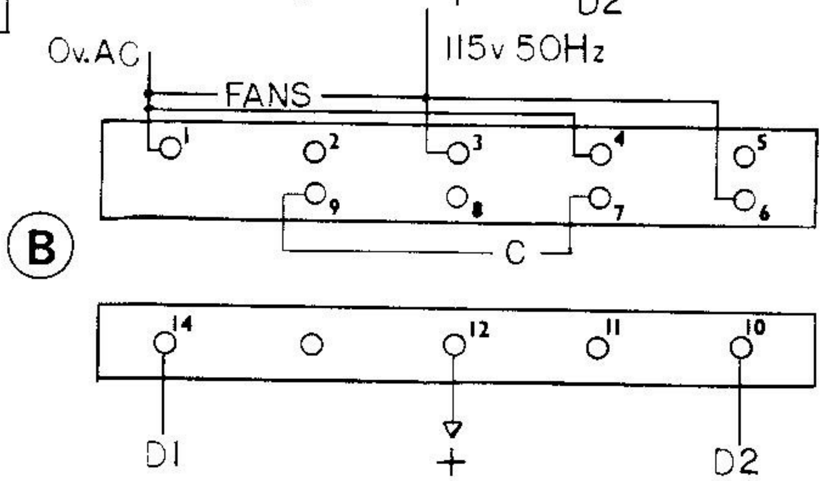
Specifications subject to change without notice.

*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 2-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 3dB greater than the T1000 at the required drive level, the spurious products should not exceed -60dB and the harmonic level should not exceed -40dB. Spurious products in the exciter, below the cutoff frequency of the T1000 amplifier low pass filter, will be amplified without attenuation. Spurious products and harmonics above the T1000 filter cutoff frequency will be attenuated by the amplifier, however, excessive harmonic or spurious output from the exciter may increase the distortion products.

3·2

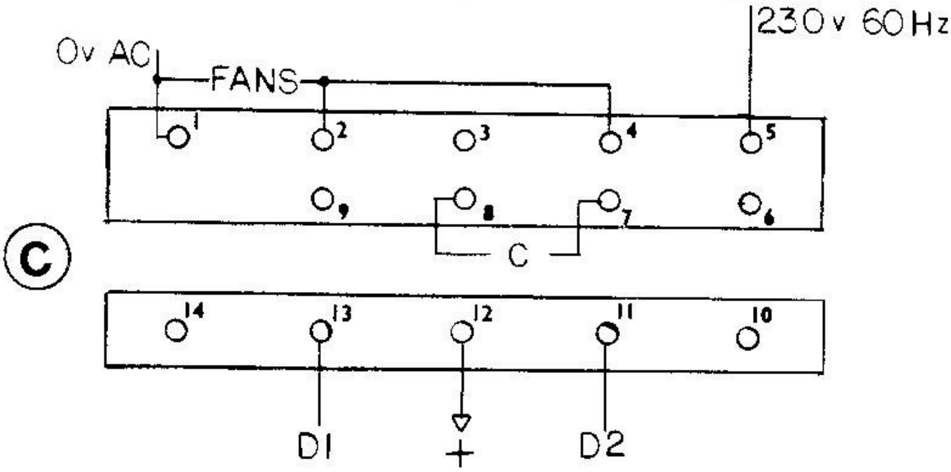
T1000 TRANSFORMER
CONNECTIONS-UNDERSIDE





POWER CABLE COLOR CODE:-

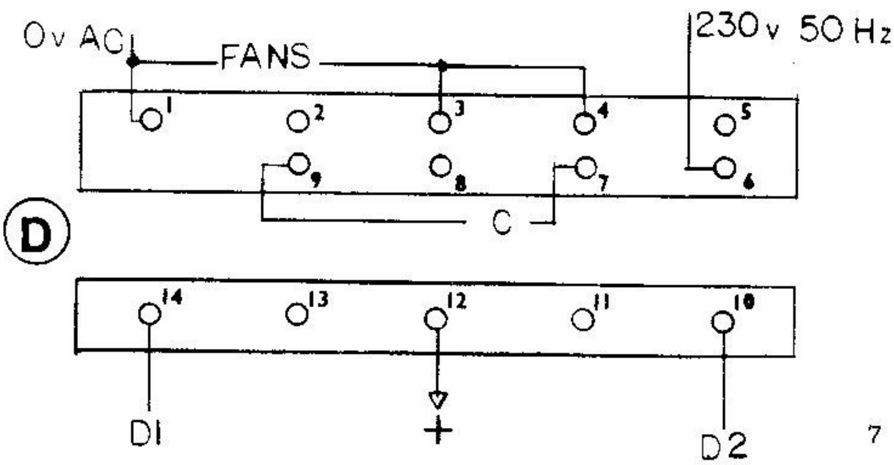
GREEN – GROUND
WHITE – NEUTRAL
BLACK – LIVE



LEGEND:-

D1, 2, MAIN RECTIFIER DIODES

C, 16μF AC CAP



SECTION 3

INSTALLATION

3.1 UNPACKING

The T1000 is packed with the base plate removed and the amplifier bolted to a wooden base. The mounting bolts are screwed into spacers on the transformer mounting bolts and directly support the transformer on the wooden base. Remove the four mounting bolts and carefully check the amplifier for damage. The power transformer connections are made in accordance with Paragraph 3.2. The base plate is then installed using six 8-32 binder head screws in the side bars. Retain the packing material and always use the wooden base if the amplifier is to be shipped or transported.

3.2 POWER CONNECTIONS

The T1000 may be operated from 115V or 230V, 50Hz or 60Hz power mains. Check the local supply voltage and frequency. It is important to make the connections for the correct supply frequency, as the T1000 uses a CVT (Constant Voltage Transformer). This type of transformer uses a ferro-resonant winding, and it is essential to make the correct frequency connections. If the transformer is correctly connected, the output will be substantially independent of mains supply variations. The connections are shown in the diagram. Unless otherwise specified the amplifier will be supplied connected for 110V 60Hz operation.

Fit the correct fuse in the holder located underneath the chassis to the rear. Use a type 3AB ceramic bodied fuse. Glass bodied fuses should not be used.

115V	Type 3AB	30 amps
230V	Type 3AB	15 amps

The power cable should be connected to a line connector in accordance with the requirements of the local power authority. The power outlet should be capable of supplying the following peak load current:

115V	20A
230V	10A

3.3 LOCATION & MOUNTING

The T1000 is normally placed on the operators desk adjacent to the exciter. The cooling ducts are located on the rear panel, the base plate and the top of the case. Make sure that there are no obstructions to the airflow, particularly if the amplifier is to be operated in the FSK mode. The exciter may be mounted anywhere close to the amplifier. It is frequently convenient to mount the exciter on top of the amplifier, as the cooling ducts on the top case can be used to provide additional forced cooling for the exciter. Place the exciter so that the heatsink radiating fins or the cooling inlet ducts are immediately above the amplifier outlet ducts.

3.4 GROUND CONNECTIONS

A separate ground connection is advisable to prevent RF currents circulating in the wiring and cases of the amplifier and exciter. This ground connection is essential if the equipment is operated with an unbalanced antenna located close to the amplifier. Without a good ground the high RF circulating currents may induce feedback and distortion in the exciter and cause RF burns when the equipment is touched. Use a heavy gauge copper wire or strap for the connection. This lead should be as short and direct as possible. A good ground can be made by driving a 2 meter rod into moist soil.

3.5 FUSES

The T1000 uses a 40A magnetic circuit breaker mounted on the front panel. This breaker is also used as the DC on-off switch. If the circuit breaker trips, the rocker switch turns to the "OFF" position. The circuit breaker is reset by turning the rocker switch to the on position. The primary circuit is protected by a fuse located underneath the chassis. The bottom plate should be removed to replace the fuse. The primary fuse will normally blow only if there is an extreme power-line surge, a defect in the transformer or wiring, or the amplifier is connected to a supply of the incorrect voltage.

Always replace the fuse with the correct type and rating.

Primary Fuse -- 115V Type 3AB 30A, 230V Type 3AB 15A.

3.6 ANTENNA CONNECTION

The amplifier output impedance is 50 ohms, and a heavy duty co-axial cable of the RG8/U type should be used for the connection to the antenna or the antenna tuner. The cable is fitted to the PL259 UHF connector. Make sure the connections are securely soldered and tightened, as the peak RF currents will exceed 5A at full output.

3.7 ANTENNA MATCHING

For best efficiency the T1000 amplifier should operate into a correctly matched antenna system. The automatic protect circuits will switch the amplifier off if the VSWR exceeds 2:1. For normal operation the VSWR should not exceed 1.5:1 and for full output, the VSWR should be 1:1. It is best to check the VSWR using a VSWR indicator connected in the line to the antenna. Alternatively, the VSWR can be checked by using the panel meter in the "Power Reflected" mode. This mode indicates relative reflected power, and the antenna should be adjusted for minimum meter reading. It should be noted that the VSWR bridge is connected between the amplifiers and the low-pass filters. The filters have a maximum reflection co-efficient of 5%. This means that on some frequencies the meter will indicate a small residual reading even when the amplifier is correctly terminated. On the lower frequencies the amplifier harmonics may also cause a residual reflected power indication. The residual meter readings may be disregarded, and the antenna should simply be adjusted for the lowest possible reflected power indication.

3.8 ANTENNAS

The antenna system should have a minimum power capability of 1 kilowatt. The antenna will normally be fed with 50 ohm co-axial 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 T1000 will provide continuous coverage from 2-30MHz and when used with exciters covering this 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 or 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, or for maximum flexibility, the automatic tuner, with motor driven elements that tune for minimum VSWR, is used.

3.9 FREQUENCY ADJUSTMENT

The T1000 is fully broadband and requires no adjustment or tuning for operation on any frequency.

3.10 FILTER SWITCHING

The correct low pass filter for the operating frequency must be selected. The front panel pushbutton switch may be used to select the correct filter or if automatic filter selection is desired the front panel switch is turned to the auto mode. The filter remote control circuits are wired through the 12 pin connector on the rear panel. Each filter is activated by grounding the appropriate control wire. The power is supplied by the amplifier, and the switching circuits should control approximately 14V at 200mA. The wiring connections are shown in the diagram, and suggested circuits are shown for a 4-channel transceiver, a 12-channel transceiver and a continuous coverage synthesized transceiver. Provided there is a bandswitch switching wafer available for external control, it is usually possible to devise a suitable switching system. In some complex systems it may be necessary to use a diode control matrix to provide correct filter selection, and Trans World Electronics will be pleased to provide engineering assistance with switching connections for specific exciters.

3.11 EXCITER INTERCONNECTIONS

The T1000 amplifier requires only two connections to the exciter. The input to the amplifier is connected through a 50 ohm co-axial cable (RG58/U type) terminated in a PL259 UHF connector. The T1000 is switched on by grounding the control line. The control line may be switched by the exciter control relay or by the microphone press-to-talk switch. The operating voltage is approximately 14 volts, and the switching current is 200mA. It is usually advisable to install a diode (1N4001 or equivalent) in the control lines from the exciter switching relay and the amplifier. The diodes form an OR gate and prevent the two control voltages from interacting in the OFF condition.

A separate short ground connection between the exciter and the amplifier should be provided. In all off conditions the exciter is connected to the antenna with only the 20 to 30MHz low pass filter in circuit. This means that the T1000 may be used with transceivers without any additional antenna switching requirements. To bypass the amplifier simply turn the AC power switch OFF. The suggested interconnecting wiring is shown in the diagram.

3.12 DRIVE LEVEL

The normal drive level for full output will not exceed 70W. The exciter ALC should be adjusted, so that the exciter does not overdrive the transmitter. A DC voltage, proportional to power output, is provided at pin 12 of the interconnection socket. The voltage may be used to control the exciter ALC system. The appropriate circuitry must be added to set the threshold level and to provide any voltage level shifts required by the exciter ALC system.

DO NOT OVERDRIVE

Drive levels in excess of 100W can destroy the expensive transistors in the final amplifier. If the exciter is capable of power outputs in excess of 100W it is essential to modify the exciter final amplifier, so that exessive drive power cannot be employed.

3.13 CAUTION

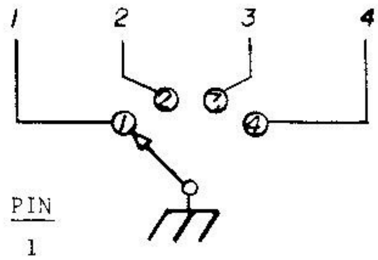
The only high voltages in the T1000 are at the primary and resonant windings of the power transformer. The usual lethal voltages used in a high power amplifier are not present, as the transistors operate at 40V. It is important to remember that RF voltages between 200-500V are present when the transmitter is operating at full power. These RF voltages can cause severe burns and extreme caution should be observed.

If the T1000 is to be used for teletype operation the model T1000-FSK* should be used and the fans should be connected for continuous full speed operation. The connections are shown in the diagram. It should be remembered that teletype operation makes much greater demand of the equipment than SSB or telegraphy. The transmitter must have a continuous CW power output compared with the lower duty cycle and much smaller average power requirements on SSB. The amplifiers in the T1000 have more than adequate cooling capacity, even at 1000W output on teletype operation and will cycle from low to high speed operation. The limiting factor is the power supply and to prevent excessive size and weight, the teletype rating is reduced to 600W output (CCS). Even at this level the power dissipation is high and to ensure maximum cooling, the fans should be reconnected as described. It is also recommended that the maximum transmit/receive duty cycle does not exceed 50% with a maximum continuous transmit time of 4 hours.

*The standard model T1000 may be modified for FSK operation very simply. Send for information on the changes required if FSK operation is required.

3·10 Remote Filter Switching — SO3 Pin Numbers

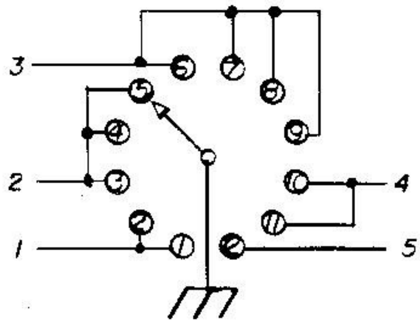
Examples:—



4 CH.

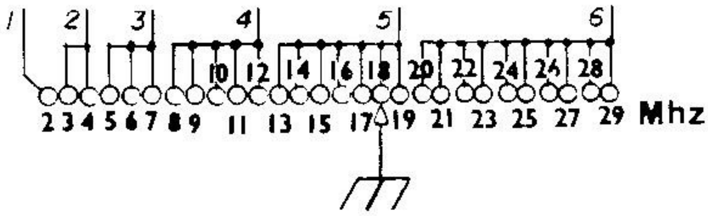
CHANNEL	FREQUENCY	PIN
1	2.6 MHz	1
2	4.7 MHz	2
3	6.33MHz	3
4	12.2 MHz	4

12 CH.



CHANNEL	FREQUENCY	PIN
1	2.2MHz	1
2	2.7MHz	1
3	3.1MHz	2
4	4.4MHz	2
5	4.9MHz	2
6	5.3MHz	3
7	5.7MHz	3
8	5.8MHz	3
9	7.9MHz	3
10	8.2MHz	4
11	12.7MHz	4
12	15.9MHz	5

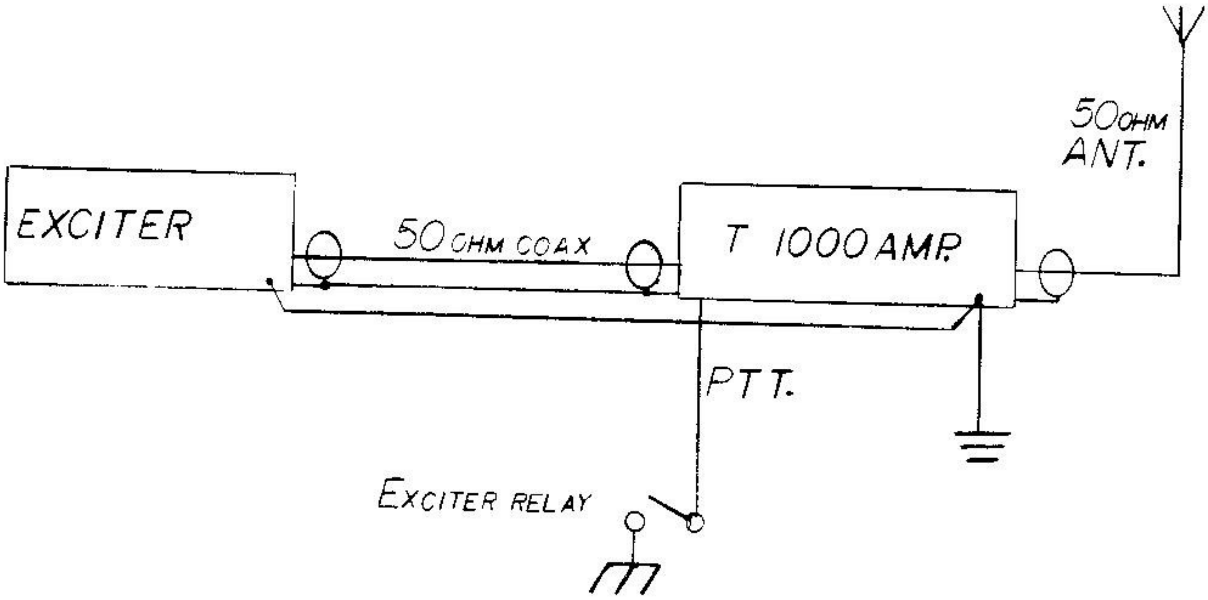
SYNTH. 2-30 MHz



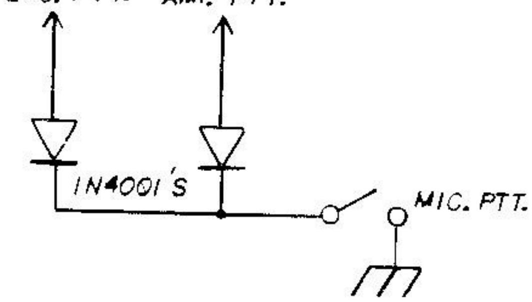
The above example will serve to indicate the general pattern which the filter selection logic must follow.

In practice it may be necessary to use diode gates to "AND" the "Tens" and "Ones" of MHz selectors. The appropriate diode matrix should be used if code conversion is necessary.

3·11 INTERCONNECTIONS



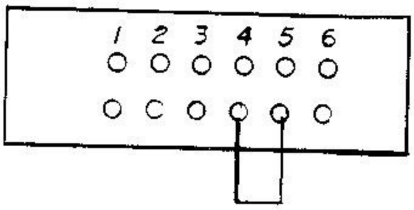
ALTERNATE :-



3·13

TELETYPE FAN CONNECTION

REAR PANEL CONNECTOR BLOCK



SECTION 4

OPERATION

4.1 GENERAL

The T1000 amplifier requires no tuning adjustments and provided the antenna is correctly terminated, the only operator attention required is checking the drive level and filter selection. If the exciter ALC level has been set correctly and remote filter selection is used the operation will be entirely automatic.

4.2 CONTROLS

AC Line--On/Off

The rocker switch controls the primary power to the amplifier. In the "Off" position the amplifier is completely switched off, and the exciter is connected directly to the antenna. The amplifier is all solid state and requires no warm up.

DC Power--On/Off

This switch is a 40A electro-magnetic circuit breaker in the main 40V DC supply line. The switch is normally left in the "On" position and the amplifier power controlled by the AC line switch. If the current exceeds 40A the circuit breaker will open and the switch will turn to the "Off" position. The circuit breaker is reset by turning the switch back to the "On" position. If the circuit breaker trips repeatedly the drive level is excessive and should be reduced. The circuit breaker will also trip if there is a short or fault in the amplifier.

Filters--Local/Remote

The switch is turned to the "Remote" position only if the exciter has been programmed for automatic filter selection. The switch is turned to the "Local" position for manual filter selection.

Filter Switch

The 6-position switch controls the selection of the filter when the Local/Remote switch is in the "Local" position. A separate pushbutton for each filter range is provided, and the button for the desired range should be pressed. The switch locks in place until another filter is selected. If a filter with a cut-off frequency below the operating frequency is chosen the amplifier switches off automatically.

Meter Switch

The 6-position switch controls the selection of the meter function. Refer to the more detailed metering information.

Reset Button

This momentary push switch resets the amplifier after a fault causing excess VSWR. If the amplifier switches off check the filter selection and the antenna, then press the reset button.

4.3 INDICATORS

Filter Range (6)

There are six indicators to show which filter is operational. The indicators operate in both the local and the remote modes. In the remote mode the filter pushbutton switch is disconnected and the pushbuttons do not indicate the operational filter.

AC Power On

This indicator operates only if the AC power is switched "On". If the indicator does not light check the mains supply and the primary fuse.

DC Power On

This indicator is operated by the main 40V DC supply. If this indicator does not light check the circuit breaker (DC Power On/Off switch).

Check Filter/VSWR

This indicator operates if the VSWR detector has measured a reflected voltage level equivalent to a VSWR of 2:1 at a power level of 1000W PEP. If the indicator lights, check the correct filter has been selected. Press the reset button and check that the reflected power indicated by the meter does not exceed a relative reading of 20. The antenna or tuner will require adjustment if the VSWR is excessive.

Fault Indication

The fault indicator is connected to thermostats on the output combiner and on the amplifier heatsink. One thermostat measures the thermal rise in the balance resistors in the combiner. Any internal faults, such as a change in power output from one of the four amplifier modules, will cause unbalance in the combiner, and the resulting power dissipation in the balance resistors operates the thermostat. The other thermostat operates if the heatsink temperature exceeds 75°C. This will only happen if the fans fail or the cooling vents are blocked. Both thermostats reset automatically when the temperature falls to a safe level.

4.4 METERING

Power -- PEP

The meter indicates peak envelope power output* (multiply scale reading by 25 for power in watts). The MAX PWR mark on the meter indicates the maximum rated PEP power of 1000W. The time constants have been chosen to indicate PEP, and the calibration has been set at 1000W PEP on a three-tone test signal.

Power -- Average

The meter indicates average power output*(multiply the scale reading by 15 for power in watts). The MAX PWR mark on the meter indicates the maximum rated continuous CW power output of 600W. Do not exceed this power output level for continuous FSK operation.

*The meter is calibrated to indicate maximum output at a VSWR of 1:1. The meter will not indicate correctly if there is any mismatch. The output reading is reduced as the mismatch is increased, and the indicated output at a VSWR of 2:1 will be approximately 600W PEP.

Reflected Power

The meter is not calibrated and indicates relative reflected power. For normal operation the meter reading should not exceed 5-10. The maximum reflected power indication should not exceed 25-30 at any time. At this level the protect circuitry will operate and switch the amplifier off. The reflected power bridge is connected between the amplifier and the low-pass filters. This means that the reflection co-efficient of the filter and harmonic energy will cause some measurement inaccuracies, and a small residual meter reading is normal even when the amplifier is correctly terminated. For accurated VSWR measurements use an external VSWR indicator in the line to the antenna.

Relay Voltage

The meter indicates the supply voltage to the transmit/receive relays. The normal relay voltage is approximately 14V (full scale 50V).

Collector Voltage

The meter reads the collector supply voltage and should indicate approximately 40V (full scale 50V).

Collector Current

This meter range indicates the collector current and provides accurate information on the operation of the amplifier. The meter will indicate 15-25A current on SSB voice operation and the maximum CW current must not exceed 35A* Do not exceed these current levels even if the meter does not indicate "MAX PWR" on the power ranges. The power readings will always read low unless the amplifier is correctly matched to the antenna. Monitoring the collector current ensure the transistors are operated within ratings.

*Model T1000-FSK

4.5 EXCITATION LEVEL

Apart from ensuring the antenna is correctly matched and selecting the correct filter range, the only operating adjustment is setting the drive to the correct level.

CW, FM, FSK Operation

Select the meter "Collector Current" range. Increase the drive level until the collector current reaches 35A. Check the power output in the "Power Average" range and if necessary reduce the output to 600W (MAX PWR). If the antenna is not correctly matched the indicated power will be less than 600W. Do not exceed 35A collector current at any time.

AM Operation

Select the meter "Collector Current" range. Adjust the drive level for a collector current of 25A. Check the modulated output on the "Power PEP" range . The maximum output should not exceed 1000W (MAX PWR) on voice peaks.

SSB Operation

The most accurate adjustment of drive level is made by monitoring the RF output on an oscilloscope. Speak into the microphone at a normal voice level and increase the drive level until there is an indication of peak flattening on voice peaks. Reduce the drive level slightly so there is no indication of peak flattening.

If an oscilloscope is not available select the "Collector Current" meter range and adjust the drive level for an average current of 15-25A with an absolute maximum of 30A on an occasional voice peak. Make sure that the collector does not exceed 30A at any time. The power output can be checked on the "Power PEP" range. If the amplifier is correctly terminated the maximum indicated output should be limited to 1000W (MAX PWR). The meter should indicate this output only on occasional voice peaks. The meter will not indicate full output if there is any mismatch to the antenna. Always use the collector current for the initial setting of drive level and regardless of the power output indication do not exceed a peak collector current of 30A.

4.6 MEASURING INPUT POWER

In amateur and some commercial applications the power input must be measured. The collector voltage is first measured and the meter then set to the "Collector Current" range. Multiply the collector voltage by collector current to read the power input. For a power input of 1000W the meter should indicate 25A collector current. This is the DC input on CW, and on SSB voice operation the peak power input will be approximately double the power input as indicated by the meter.

4.7 REDUCED POWER OPERATION

High power output is usually only required for long distance communications or under unfavorable conditions. Reduction of power to the minimum required for reliable communications will reduce interference to other users of the frequency. Remember, the T1000 is capable of worldwide coverage with good antenna systems. The amplifier will operate satisfactorily at reduced output power and by simply switching the amplifier off, the exciter will be coupled direct to the antenna.

4.8 AMPLIFIER SWITCH OFF

The amplifier is normally switched off by the AC Line switch. If the amplifier is switched off while operating, first switch the DC Power, then the AC Line. This prevents operating the exciter into an open circuit while the filter capacitors discharge.

4.9 CAUTION

Do not switch filters or AC power while amplifier is actually in the transmit condition.

(The above actions could result in momentary total unloading of the exciter or amplifier.)

4.10 NOTE

Some mechanical noise will be noticed from the constant voltage power transformer. This is mainly due to magnetostrictive effect and is quite normal. The transformer is rated for operation to 135°C and high case temperatures are normal.

SECTION 5

TECHNICAL DESCRIPTION

5.1 GENERAL

The T1000 amplifier consists of four 250W amplifier modules with input and output impedances of 200 ohms. The four amplifiers are paralleled through input and output combiners to give the composite amplifier a 50 ohm input and output impedance. The input from the exciter is fed through a matching network providing compensation and gain levelling through the frequency range. The output of the amplifier is coupled to the antenna through a series of six low pass filters. The internal regulated power supply is rated at 40V 40A.

5.2 250W AMPLIFIER MODULES

The 250W amplifiers are a simple push-pull design using two 150W broadband rated linear power transistors. These new generation transistors use a unique emitter ballasted chip design to control impedance and gain over a bandwidth of more than a decade.

The schematic diagram shows the transistors Q1 and Q2 connected in a conventional transformer coupled push-pull circuit. In order to provide uniform performance over nearly four octaves it is essential to use high performance input and output transformers. The output transformer T2 must not only be capable of providing the correct impedance transformation over the 2-30MHz range, it must also operate at high efficiency at high currents and at power levels of 250W. The TWE designed and manufactured transformers use ferrite loaded tubes as the base and collector windings with teflon insulated wires wound inside the tubes to form the 200 ohm input and output windings. The input transformer T1 uses a matching network, common to all input transformers, at the 50 ohm input to the amplifier. The output transformer has excellent transfer characteristics and requires minimal compensation to cancel the leakage characteristics. The center taps of the transformers T1 and T2 operate at RF ground potential. A very low impedance across the entire operating range and at audio frequencies is essential, and three paralleled capacitors are used at each of the transformer center taps.

For maximum efficiency and good linearity the amplifiers are operated in class AB. It is essential to provide a stable low impedance bias source for the bases of the transistors. The emitters of the transistors are grounded and the base impedance changes as the transistors heat causing a potentially unstable bias condition. This means that apart from providing a low impedance bias source, it is essential to provide thermal compensation with temperature sensing closely 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 T1 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 used to adjust the bias current. Q3 is an emitter follower with the base of Q4 connected to the emitter of Q3. This circuit provides the low impedance bias source required for the high power RF transistors. The diode D1 effectively shunts the bases of Q1 and Q2 and provides back up to the primary bias circuitry. In the event of any defect in the bias circuit, D1 prevents catastrophic damage to the RF transistors.

Q4 is mounted on the copper heatsink immediately adjacent to Q1 and Q2. The tight thermal coupling ensures that Q4 will compensate the 2mV/°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. Individual bias regulators for each of the four amplifiers ensure uniform control of the quiescent current in each amplifier.

5.3 INPUT CIRCUIT

The matching of the four amplifier inputs over nearly four octaves frequency range presents a complex design problem. The base impedance of the RF transistors varies substantially over the frequency range and changes sign from -j to +j. The variation of the real part of the input impedance changes by a factor of almost 10, and the gain of the devices changes by approximately 8dB. The design objective was to attain a 50 ohm input with a 1.5:1 maximum VSWR and maintain the amplifier gain within 2dB.

The input to each amplifier is 200 ohms. If each amplifier was identical in all respects it would be possible to simply parallel the four inputs for a combined input impedance of 50 ohms. In practice the mismatch between the amplifiers would prevent satisfactory operation. The solution is the use of the input combiner. The combiner is a TWE developed design using ferrite loading for compact size, low loss and effective port-to-port isolation. The amplifier inputs are effectively paralleled while each input is isolated from the other inputs. The unbalance components of the input are dissipated in non-inductive resistors incorporated in the combiner. Each amplifier is coupled to the combiner through a specially fabricated 200 ohm transmission line.

The excellent transfer characteristics of the input transformers and input combiner made it possible to use a single compensation network in the 50 ohm input instead of individual compensation at the bases of each of the four amplifiers. The complex computer designed input network uses a combination of inductors, resistors and capacitors to provide matching to the complex input impedance, and gain levelling across the 2-30MHz range. The elimination of individual input compensation networks for each transistor brings a substantial reduction in circuit complexity. The matching network fulfills the design requirements, and the amplifier has a low input VSWR with substantially level gain across the operating range.

5.4 OUTPUT CIRCUIT

The output of the four 250W amplifiers must be combined at an output impedance of 50 ohms. It is not possible to simply parallel the 200 ohm output, as this would result in interaction between the amplifiers with a resultant severe degradation of performance and increase in distortion. The TWE designed output combiner provides good port-to-port isolation and effectively parallels the outputs with low combination losses. The unbalance components are dissipated in the non-inductive loads in the combiner. In the event of a defect in an amplifier module, causing a severe unbalance in the combiners, the large unbalance components would cause excess dissipation in the loads and possible damage to the combiner. The thermostat TH2 is mounted on the combiner and will be activated if severe unbalance occurs. This turns off the amplifier, and the fault indicator on the panel lights.

5.5 OUTPUT FILTER

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 -30dB, while the third harmonic may be as much as -15dB. This means that the filters must have an ultimate attenuation of at least 50dB to meet the amplifier design specification. The filter design selected is a 7-pole elliptic function with a reflection co-efficient of 5%. A low reflection co-efficient 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 -50dB at the third harmonics of the signal frequency when operating at the lowest frequency in the band. For example, the attenuation of the 2-4MHz filter is a minimum of -50dB at 6MHz. This is the third harmonic of 2MHz. Designing for this "worst case" situation ensures high harmonic attenuation throughout the operational range.

The filters are selected by the relays RL3 to RL14. Separate relays are used at the input and output of each filter. The unused filters are shorted at the inputs and outputs. The 20-30MHz filter is permanently connected in circuit and on the lower frequencies operates in tandem with the operational filter. This results in additional attenuation of the harmonics in the VHF range. Relays RL8 and RL14 switch in a co-axial bypass, so that the amplifier is connected directly to the filter for the 20-30MHz range.

The design of satisfactory filters, capable of operating at continuous power levels of 1000 watts, 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 ground loops will frequently bypass the filter causing a major reduction in the harmonic attenuation.

The relays are selected by grounding the control wire to each pair of relays. These wires are connected to both the remote control socket S03 and to the front panel pushbuttons. The "Local/Remote" switch opens the ground return to the pushbuttons so that they will not operate in the remote mode. The indicators showing the operational filter are LED's. When the filter is selected by grounding the relay control line, by either the pushbutton switch, or the remote control wiring, the ground return to the LED is completed causing the indicator to light.

5.6 DIRECTIONAL COUPLER

The direction coupler is used to measure forward and reflected power in the co-axial line from the amplifier to the filter. L23 is the toroidal pick-up transformer, which senses the magnitude and phase of the line current. The "inner" of the co-axial cable passes through the center of the toroid, forming a one-turn primary. C17, C18 and C19 form a capacitive divider, providing a sample of the co-axial line voltage, whose amplitude is adjusted with variable capacitor C17, to balance the bridge formed with the center tapped L23.

D5 rectifies the forward voltage output of the bridge and has a long time constant reservoir formed by R37 and C11. The output of this rectified system feeds darlington voltage-to-current converter Q3 which in turn drives the meter via PEP power calibration potentiometer R15 when this meter position is selected. The time constant of this metering circuit has been carefully chosen to provide a good indication of peak envelope power under typical SSB speech conditions.

D6 rectifies the forward voltage output of the bridge. The D6 reservoir capacitor C12 and R19 form a short time constant, so that D6 measures average power. Variable R19 is used to calibrate the average power meter setting.

D7 rectifies the reflected voltage output of the bridge. It has virtually no reservoir capacitor and is used to trigger SCR Q2 if the SWR is excessive. Q2 controls the protect circuitry and immediately switches the amplifier into the "straight through" mode. Variable resistor R20 sets the point at which this occurs and is normally set to activate Q2 at a SWR of 2:1 at 1kW output.

D8 rectifies the reflected power and is used to provide the reflected power reading on the meter. It should be noted that the bridge is located before the filter and does not always indicate zero, even if the amplifier is correctly terminated. The harmonics and reflected power from the filter will give a residual meter reading on some frequencies. For exact antenna matching use a separate VSWR bridge in the antenna feed line.

5.7 POWER SUPPLY

The power supply uses a high grade epoxy encapsulated "Constant Voltage Transformer". The CVT is of conventional design using core saturation and the ferro resonance principle to maintain constant output voltage. C1 and C2 are the two capacitors used to resonate the winding at 50 or 60Hz.

The transformer has taps on the primary, the secondary and the resonant winding, so that it can be connected for 115 or 230V operation at a power line frequency of 50 or 60Hz. The CVT maintains constant output over a wide range of input voltages and under the varying secondary loads. This characteristic is particularly desirable in areas where the regulation of the supply mains is poor. The CVT also eliminates the problem of operation at 115V. With conventional transformers the mains voltage drop at high currents may limit peak output.

The output waveform from a CVT approaches a square wave. This substantially reduces the filtering requirements and the peak voltages. The rectifiers are two heavy duty 85A silicon power diodes D1 and D2 connected in a conventional full wave circuit. The anodes are grounded so that the diodes can be bolted direct to the chassis. The filter capacitors C7 and C8 are computer grade electrolytics.

A separate rectifier system, D3, is used to operate LD4, the "AC ON" LED indicator. The "DC ON" indicator LD3 is connected to the 40V supply line.

A fuse is located in the primary supply. This fuse will normally only operate if there is a severe mains surge or a defect in the transformer. The CVT has been designed for short circuit protection and will automatically current limit at approxiamtely 50A even if the supply is short circuited. The main supply protection is the fast acting 40A magnetic circuit breaker S2. The breaker prevents the amplifier from operating at excessive power output, and frequent tripping indicates an excessive drive level.

Two metering positions are provided to monitor the power supply output. The meter operates as a conventional voltmeter and ammeter. The current scale is calibrated by the potentiometer R17. The main current shunt is a loop in the DC wiring to the amplifiers.

5.8 COOLING SYSTEM

Two fans are used in the cooling system. The fans are mounted on the rear panel and direct the main airflow at the heatsinks and exhaust through the ducts in the base plate and top cover. A secondary airflow is provided through to the front of the chassis to cool the interior of the amplifier. The air ducts are arranged to provide convection cooling of the heatsinks, and in the rare event of failure of both fans, the amplifier may be safely operated in the SSB mode without forced cooling.

The fans are wired across one of the 115V transformer windings. The transformer primary acts as an auto transformer when connected for 230V operation and eliminates the need for dual voltage fans. The inductor L3 is connected in series with the fans and drops the voltage to approximately 60V. The fans then operate at low speed with negligible noise, yet provide adequate cooling for all operational modes except FSK. The thermostat TH3 is mounted on one of the amplifier heatsinks and is connected in parallel with L3, the fan series inductor. If the heatsink temperature reaches 60° the thermostat closes, shorting L3 so that the fans operate at full speed. A second 75° thermostat TH1 is mounted on the heatsinks. If the heatsink temperature reaches 75°, TH1 opens and switches the amplifier off. The fault indictor LD1 lights to indicate either a fan failure or blockage of the cooling ducts. TH1 should never open under normal operating conditions, as the available cooling is more than adequate, even for teletype service.

5.9 RELAY SUPPLY & PROTECT CIRCUITRY

The transmit/receive relays operate at a supply voltage of approximately 14V. This supply voltage is derived from the main 40V supply using the series regulator Q1 and the zener diode D11. The relay supply voltage can be checked by selecting the "Relay Supply" metering position.

A separate regulator, D14 and Q3, supply the filter selection relays, both in the "Remote" and "Local" positon of the remote/local switch. The regulator is identical with the one mentioned in the previous paragraph, but is not metered or deactivated by the protect circuitry.

The heatsink thermostat TH1 and the output combiner thermostat TH2 are connected in series with the amplifier TRANSMIT switching relays. If either thermostat opens, the relay supply is disconnected and the amplifier immediately switches off. The "Fault Indicator" LD1 is connected in parallel with the thermostats and has the supply voltage applied if either relay opens.

The VSWR protect circuitry is controlled by the thyristor Q2. The thyristor will switch when the reflected voltage applied by R14 exceeds the level preset by potentiometer R20. (Normally a VSWR of 2:1 at 1000W.) The thyristor shorts the base of Q1 to ground, and the pass transistor Q1 becomes an open circuit. This removes the transmit/receive relay supply voltage and the amplifier switches off. The VSWR indicator LD2 is connected between the 14V relay supply and a subsidiary 14V source across the zener diode D10. This means that the voltages across LD2 are approximately equal and the indicator does not light. When the relay supply voltage is removed LD2 conducts through R4 to ground, and the excess VSWR indicator lights. The thyristor continues to conduct until the supply voltage is interrupted by switching the amplifier power off or by pushing the "Reset" button S6. This places a momentary short across the thyristor and restores normal operation.

5.10 ON-OFF SWITCHING

The ON/OFF switching is controlled by switching the two relays RL1 and RL2. These relays are activated by grounding the control line. In the ON position RL1 connects the 50 ohm input from the exciter to the input combiner. The amplifier bias supply is connected through the second set of contacts. RL2 connects the output from the filters to the 20-30MHz filter which is connected directly to the 50 ohm antenna output. In the OFF position the 50 ohm input is connected through a 50 ohm co-axial cable to the output switching relay RL2 and thence to the 20-30MHz output filter and antenna output. The bias supply to the amplifier is switched off and the final transistors do not draw any collector current.

The ON/OFF or transmit/receive relays, RL1 and RL2, are provided with sequencing circuitry, consisting of D13, C94, D12, C92, R34 and R35. This circuitry operates in all ON/OFF switching operations, whether activated by the SWR protect circuitry or by normal transmit/receive switching. Its function is to ensure that the amplifier cannot be driven, before the load is connected, and that the load is not removed before the drive is disconnected. If this precaution is not taken severe arcing and subsequent premature relay or semiconductor failure will take place. The sequence delay is of the order of 10 milliseconds in each direction and will not normally be observable as an actual delay.

This switching system completely bypasses the amplifier in the off position, so that when the amplifier is used with a transceiver the transmit/receive antenna switching is automatic. The 20-30MHz filter does remain in circuit at all times but provides negligible attenuation in the 2-30MHz range.

The amplifier is normally controlled by the exciter transmit/receive switching. If the amplifier is turned off the relays return to the off position, and the exciter is connected directly to the antenna. If the amplifier is switched off by any of the protect circuits the same switching is used to connect the exciter to the antenna.

SECTION 6

SERVICE AND MAINTENANCE

6.1 INTRODUCTION

The T1000 amplifier requires no routine maintenance. The power transistors are rated for an extended service life and only need to be replaced in the event of a failure. The power transformer is encapsulated in epoxy and is rated for extreme reliability. The transistors operate at a DC collector voltage of 40V and no high voltages are present in the amplifier. This makes a major contribution to low service requirements. The extensive protect circuitry makes it difficult to damage the amplifier through incorrect operation. The only real precaution required is to ensure that the exciter cannot supply a drive level much in excess of 100W.

6.2 AMPLIFIER ACCESS

6.2.1 CASE REMOVAL

The case is removed by unscrewing the four truss head screws on each side of the amplifier. The case then lifts off the amplifier.

6.2.2 BOTTOM PANEL

The bottom panel is removed by unscrewing the six binder head screws. The panel may then be lifted off.

6.2.3 REAR PANEL

Remove the four socket head screws located in the corners of the panel. Unscrew the cap on the power cord feedthrough. This loosens the retaining grommet and permits the cable to slide through the feedthrough. The panel can then be tilted back to give good access to all panel components.

6.2.4 FRONT PANEL

Remove the four socket head screws located in the corners of the panel. Remove the six oval head screws at the bottom of the panel. Note four of these screws retain the DC and AC switches in place. The panel can be tilted forward for access to all panel components.

6.2.5 AMPLIFIER MODULES

Remove the rear panel retaining screws and tilt the panel back. Remove the rear flat head screw located in both side bars at the bottom of the amplifier. This is the screw that screws into the heatsink. Leave the front flat head screw in place. Remove the two socket head screws from the top corners of the front panel. The entire amplifier assembly can then be tilted back to give access to amplifiers.

6.2.6 VSWR CIRCUIT BOARD

To obtain access to the VSWR Circuit Board unscrew the four retaining screws. Remove the heavy co-axial cable from the two terminals. The remaining leads have sufficient length to give access to the underneath of the board so that components may be replaced.

6.2.7 FILTERS

Remove the VSWR circuit board retaining screws. Push the circuit board to one side to give access to the four filter assembly retaining screws. These screws thread into the four brackets on the bottom of the filter assembly. When the retaining screws are removed the filter assembly can be tilted clear of the amplifier for access to all components.

There is sufficient clearance to replace components located near the edge of the circuit board. The filter assembly may be taken apart to replace components located toward the center of the circuit boards. Remove the four screws from one of the circuit boards. These are the screws in four standoff posts joining the two circuit boards. Carefully unsolder one end of each of the two brass tubes joining the boards. Unsolder the center conductor inside of the tubes. The circuit boards may then be taken apart. Make sure that the two ferrite beads are replaced on each of the tubes when re-assembling the filter boards.

6.2.8 INPUT MATCHING NETWORK

The input matching network is installed inside the top channel on the amplifier assembly. Remove the cover by unfastening the screw and hex nut at each end of the cover. The cover then lifts off to give access to input network and input combiner.

6.3 FUSE REPLACEMENT

The primary fuse holder is located inside the chassis. Remove the bottom panel to gain access. Always replace the fuse with the correct type. DO NOT use glass bodied fuses.

230V Operation -- Fuse Type 3AB 15Amps rating
110V Operation -- Fuse Type 3AB 30Amps rating

6.4 GENERAL FAULT FINDING TECHNIQUES

An examination of the schematic diagrams indicates that the basic RF circuitry is simple. The high power levels usually mean that a defective component will suffer catastrophic failure and show external evidence of damage. If either transistor fails in one of the RF amplifiers that amplifier will have negligible output. The most complex part of the amplifier is the control and protect circuitry. The operation of the circuitry is simple and most faults can be located by resistance and continuity checks using a simple VOM. Use the information in the preceding section to find the general area of the fault, then use a systematic analytical procedure to localize the specific fault if the initial visual examination does not pinpoint the problem. The following sections give detailed information on the different parts of the amplifier.

6.5 FAULT LOCATION

The front panel meter and indicators will provide information to locate the approximate area of the fault.

T 1000 Interior View - Note Access to Amplifier Modules

6.5.1 POWER SUPPLY

Check the supply voltage is approximately 42V without load. The voltage drop should not exceed 3-4V at 40A collector current. If the no load and full load voltages vary substantially the power supply or AC mains regulation is faulty.

6.5.2 AMPLIFIER

If there is a defect in one of the amplifiers the unbalance currents will cause heating in the output combiner. This actuates the thermostat TH2 and the fault indicator LD2 lights. As a first quick check, switch the amplifier off and feel the top of each transistor. The transistors in a non-operatonal amplifier will usually be much cooler than the transistors in the other amplifiers. For a more accurate check measure the currents in the individual amplifiers. The amplifier currents may be measured by placing an ammeter (10A minimum) in the main supply lead to each amplifier. The supply leads are individually terminated on the large terminal block underneath the transformer as shown in the photograph and do not have to be unsoldered to make the current measurements. The defective amplifier will normally show a substantial variation in current drain compared with the other amplifiers. This measurement should be made at full output.

An alternate method of locating a defective amplifier module is to short the input of each amplifier to ground at the terminal at the top of the printed circuit board. The power output will drop substantially when the drive to each amplifier is shorted. No change in output or a smaller than normal change indicates a defective amplifier module.

6.5.3 INPUT CIRCUITS

Faults in the input matching circuits and combiner are indicated by low amplifier current at normal levels of drive. Check the exciter separately to ensure the drive level is adequate.

6.5.4 OUTPUT CIRCUITS & FILTER

Any defects in the output circuitry will cause the VSWR indicator LD2 to light. Check that the antenna matching is satisfactory by operating the amplifier into a 50 ohm dummy load or by using a separate VSWR indicator to the antenna. The dummy load must have an adequate power rating for the amplifier. If the antenna matching is satisfactory the fault is in the amplifier output circuitry. Check the operation on each filter. If the defect is on only one frequency range the fault is confined to that specific filter. If the fault is present on all filter positions the fault will be in the switching, the wiring, or the 20-30MHz filter which is permanently connected in circuit.

6.5.5 SWITCHING CIRCUITS

Check the relay supply voltage is approximately 14V. If the voltage is high there is a defect in the relay voltage regulator Q1. Low voltage may also indicate a regulator defect, or more likely there is a short circuit or the protect circuitry is operating.

6.6 AMPLIFIER SERVICE

6.6.1 GENERAL

A. Check the current or short the drive to each amplifier (Sec. 6.5.2). This will usually indicate the defective module.

B. Check the RF voltage at the collectors of each amplifier using an oscilloscope or RF voltmeter. The defective amplifier will show a lower voltage than the operating amplifiers.

C. If the RF output level is very low, and the collector current increases as the drive is increased, one of the transistors has failed.

D. The defective transistor can be located by placing bypass capacitors (.1µF) across each base and collector in turn. When the defective transistor is bypassed the RF output of the amplifier will show a substantial increase.

6.6.2 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. Coat the mounting flange of the replacement transistor with heatsink compound and inspect the mounting area for dirt, etc. Check the leads are correctly aligned and mount the transistor on the heatsink. The screws should be tightened securely but not over tightened, 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.

6.6.3 BIAS CIRCUIT

Check the quiescent collector current is set at 300mA. Measure the DC voltage at the center tap of the input transformer. Under quiescent conditions the voltage should be approximately .625V and should not decrease by more than around .01V at full drive. If the bias circuit does not appear to be operating correctly check that the emitter base voltage differential of Q3 and Q4 is approximately .8V. Any substantial variation indicates the transistor is defective. The quiescent current collector should be reset to 300mA by adjusting R3 after replacing any transistor in the amplifier module.

6.6.4 PASSIVE COMPONENTS

The input and output transformers are unlikely to give any problems. Check for broken ferrite cores and for shorts between the brass tubes and the input and output windings. The resistor values should be checked with an ohmmeter after temporarily disconnecting one end of the resistor from the circuit. The capacitors in the amplifier are all used as bypasses. Short circuits at the input will be indicated by zero base voltage. Shorts at the output will operate the main circuit breaker.

6.7 INPUT CIRCUIT SERVICE

Check the operation of Relay RL1. One set of contacts on RL1 switches the 40V supply voltage to the individual bias regulators in each amplifier. Check that the 40V appears at the bias regulators in the "ON" condition. Faults in the input circuit are likely to be confined to the relay. The wiring should also be checked for continuity with an ohmmeter. Defects in the input matching network are only likely to happen as a result of excess drive which will be evidenced by overheating. It is recommended that the entire network is replaced in the event of damage. The input combiner is electrically virtually indestructable and should only require replacement in the event of physical damage.

6.8 OUTPUT COMBINER SERVICE

The output combiner is wound with teflon insulated 16 AWG wire and is extremely unlikely to fail. The termination resistors on the combiner dissipate any unbalance currents between the amplifiers. The thermostat TH2 switches off the amplifier if there is excess dissipation in the resistors. If there is any evidence of severe overheating or failure check the operation of the thermostat.

6.9 VSWR INDICATION & PROTECT CIRCUIT SERVICE

The VSWR indicator should be checked by terminating the amplifier in a 50 ohm non-inductive load. The meter should indicate zero or very low reflected power. If there is an excessive reflected power reading, recheck using the next higher filter to ensure any reflected power reading is due to the reflection co-efficient of the filter. If the meter continues to indicate reflected power the bridge may require rebalancing as described in the adjustment procedure. Alternatively, there may be a defect in the bridge circuit. Check the diodes D5, D6, D7 and D8 for low forward resistance and high reverse resistance. The other bridge components are unlikely to fail.

If the protect circuit fails to operate check the DC voltage at the bridge end of R20 using a VTVM with an isolating resistor in the active test prod. This voltage should be approximately 1.2V at a reflected power reading of 30. If the voltage is incorrect check D7, C15, R20 and R14. If these components are satisfactory the protect circuit may require recalib ration If the voltage at the end of R20 is normal and the protect circuit does not operate replace Q2.

6.10 FILTER SERVICE

A filter defect is usually only apparent on one filter range. If the defect is presenton more than one range,check the filter wiring and 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.

6.11 . RELAY SUPPLY SERVICE

If either relay supply voltage is high, check the appropriate zener diode and pass transistor. If the transmit/receive relay supply is faulty, the active components are D11 and Q1. In the case of low output first check that the protect circuitry is not operating, then for a shorted D11, and open Q1, or a short in the relay circuit itself. Check the bypass capacitors C46, C47, C10 and check R15. If the filter select relay supply is faulty, the active components are D14 and Q3. High output of this supply (which is not metered) will be caused by an open D14 or a shorted Q3. Low output will be caused by a shorted D14 or an open Q3. Also check for a shorted C95, an open R36, or a short any where in the filter assembly. Select a different filter to check for a possible short location.

6.12 POWER SUPPLY SERVICE

The power supply service is very simple. First recheck the transformer connections are correct for both voltage and frequency. Check D1 and D2. A large voltage drop under load indicates a defective diode. Excessive power supply ripple indicates one or both of the electrolytic capacitors C7 and C8 are defective or have low capacity. If the rectifiers and filters appear normal check the CVT transformer and resonating capacitors C1 and C2. Problems in the high grade encapsulated transformer are most unlikely, and faults are more likely to occur with the capacitors, diodes or extremely poor mains voltage regulation.

6.13 ADJUSTMENTS

The only adjustments to be made in the amplifier are setting the bias for the correct quiescent current in the final transistors, adjusting the VSWR bridge, and setting the excess VSWR trip point. These adjustments will only require resetting if there has been a component change in the related circuitry.

6.13.1 BIAS ADJUSTMENT

Open the collector supply lead to the amplifier requiring adjustment and insert an ammeter in series with the supply lead. The supply leads terminate at individual connections on the terminal block underneath the transformer. Make sure there is no drive power present and adjust the control R3 on the amplifier module for a quiescent current of 300mA.

6.13.2 VSWR ADJUSTMENT

Terminate the amplifier in a 50 ohm non-inductive load capable of handling the full amplifier output for at least one minute. Set the filters to the 20-30MHz range. Drive the amplifier to full power at a frequency of approximately 15MHz. Adjust C17 for minimum reflected power reading on the panel meter.

6.13.3 VSWR PROTECT CIRCUIT ADJUSTMENT

This adjustment has been factory set and the potentiometer (R20) sealed.

If for any reason it is necessary to reset this adjustment the following procedure should be followed. Set R20 in the fully clockwise position. Terminate the amplifier in a 1kW 50 ohm load. Selecting the 13-20MHz filter range, drive the amplifier with a 15MHz CW signal and adjust the drive for a power output of 350W CW. Holding the reset button in, disconnect the load; release the button. The protect circuitry should operate immediately. Back off (anti-clockwise) R20 until the protect circuitry just operates, resetting with the reset button as necessary. When a satisfactory setting has been achieved, reconnect the load and seal the potentiometer rotor in place adjacent to the terminals.

6.14 METER CALIBRATION

For all adjustments terminate the amplifier in a 50 ohm non-inductive load.

6.14.1 CURRENT SCALE

Select the collector current meter range. Connect an accurate 50A ammeter across the terminals of the DC breaker and switch the breaker to the off position. Adjust the loaded amplifier for a current drain of 30A. Adjust R17 so the panel meter reads exactly the same current as the calibrating ammeter.

6.14.2 POWER MEASUREMENTS

CAUTION: Commercial wattmeters frequently have inaccuracies of 10% or greater. Unless good quality laboratory equipment is available, it is recommended that the power scales are not recalibrated. It is essential that an accurate non-inductive load is used.

6.14.3 AVERAGE POWER

Connect an average reading power meter to the output. Adjust the CW drive level for 600W output. Adjust the R19 so that the meter reads at the "MAX POWER" calibration mark. If an accurate RF voltmeter is used across the output load adjust for a voltage of 173V.

6.14.4 PEAK POWER

Preferably use an accurate peak reading RF voltmeter with RMS calibration. Alternatively use an average reading power meter. The excitation source should be a three-tone test signal. (An AM signal 100% modulated meets this requirement.) The three-tone test signal has been chosen to give accurate correspondence to the voice waveform as far as the panel meter time constants are concerned. Adjust the three-tone drive level for a reading of 223V on the peak reading RF voltmeter. Alternatively, adjust the three-tone drive level for an average power of 375W as indicated on the average reading power meter. Adjust R18 so that the meter reads at the "MAX POWER" calibration mark.

6.15 DUMMY LOADS

It is desirable to use a 50 ohm non-inductive lead when servicing the amplifier. It is essential that the load has at least an intermittent rating of 1 kilowatt. Do not use the amplifier with low wattage loads, as they may be permanently damaged. Laboratory standard 1 kilowatt loads are expensive and are usually not readily available. For all routine servicing requirements the Heathkit "Cantenna" is satisfactory. The load is inexpensive and is capable of dissipating the full kilowatt for several minutes. The "Cantenna" should not be used for precise performance measurements.

6.16 TEST MEASUREMENTS

Special care needs to be taken when making accurate measurements of spurious output and linearity. The high power levels mean that the test equipment is susceptible to ground loops and direct radiation. It is also important that the drive source be taken into consideration.

TWE tests are made using a Tektronix 7L13 spectrum analyzer for linearity and spurious measurements. The amplifier is operated into a precision 1 kilowatt attenuator.

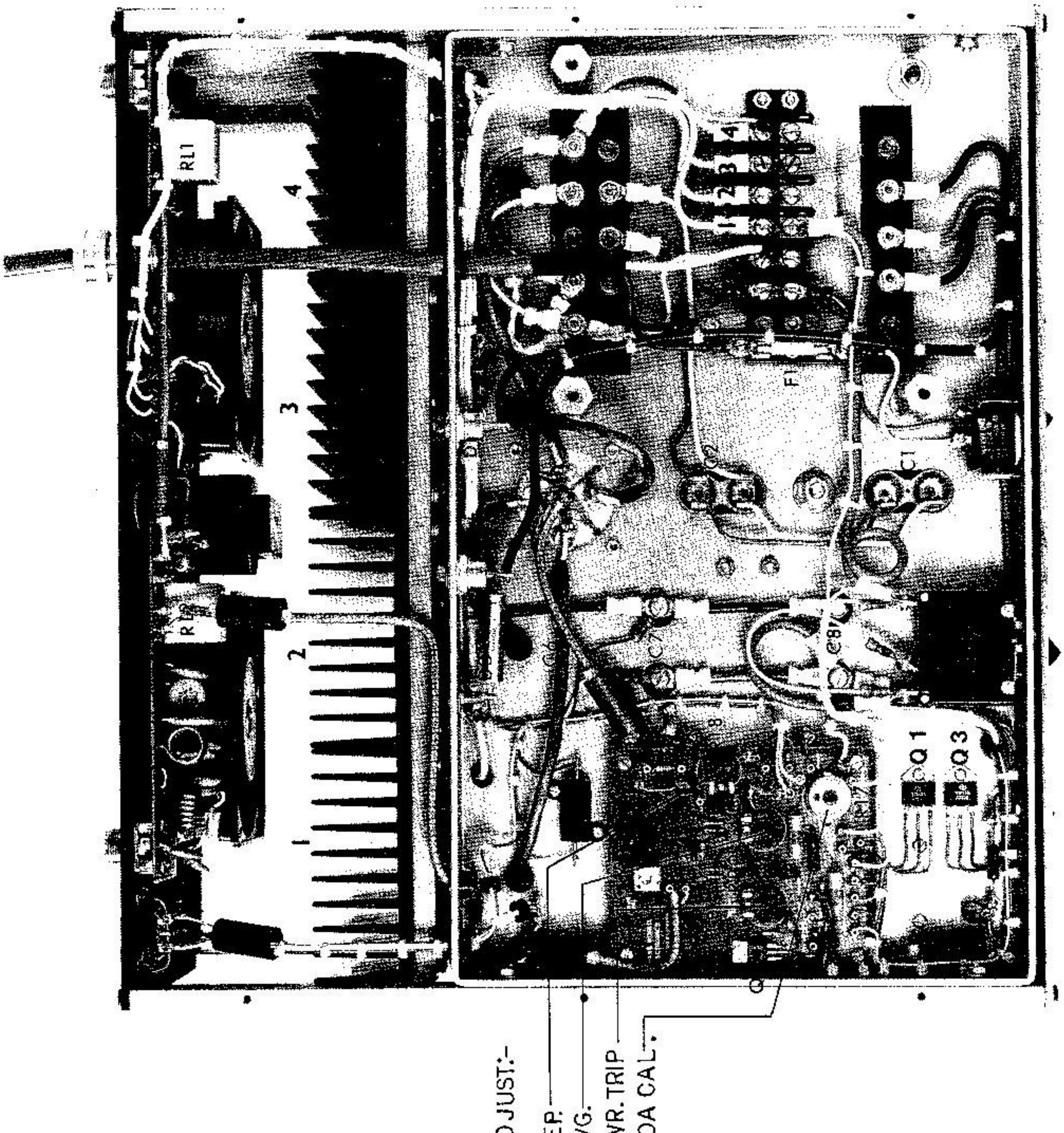
TWE tests are made using a Singer SSB4 high resolution spectrum analyzer for linearity measurements and a Hewlett Packard 85558B 0-1500MHz spectrum analyzer for spurious measurements. The amplifier is operated into a precision 1 kilowatt load with a 40dB sampling attenuator inserted in the line to the load. This sampling attenuation introduces negligible mismatch, and the attenuation is level within 1dB from 0-200MHz. (NOTE: Probe type attenuaators vary with frequency making them difficult to use for spurious measurements.)

The drive source consists of two separate 100W broadband amplifiers excited by HP606A signal generators. The amplifier outputs are coupled to the T1000 through a combiner and harmonic filter. The measured output of the driver is - distortion 3rd order -50dB and harmonics >-40dB. This system ensures that the driver is making negligible contribution to the performance of the amplifier.

To obtain accurate measurements it is essential to take extensive precautions. All connections are made through correctly terminated high quality co-axial cables. The connections between the amplifier and test equipment are extensively decoupled by using ferrite sleeves on all co-axial cables. The spectrum analyzer is physically separated from the other equipment by approximately 5 metres. Without these precautions accurate measurements are impossible. Common mode currents and even the smallest level of RF feedback causes highly inaccurate readings.

In real life the T1000 will not be operated under the laboratory conditions, and practical test measurements should be made with the exciter that will be used in the system. It should be remembered that any exciter spurious products will not be attenuated by the T1000 unless they are above the cut-off frequency of the operational filter. Exciter harmonics will be attenuated by the T1000 low pass filters, however, there may be some degradation of harmonic suppression and an increase of distortion if the exciter harmonics are not suppressed 35-40dB. It is desirable that the intermodulation distortion in the exciter be as low as possible, although distortion levels 6dB below the amplifier distortion level will make a negligible contribution to the over all distortion level. In practice we have found that the linearity characteristics of modern solid state exciters are such that frequently there is no increase in distortion, even if the distortion levels of the exciter and amplifier are similar. In fact, in many instances the exciter and amplifier distortion characteristics are such that the over all linearity is improved.

It will be noted that there is a small increase in the distortion products at the high end of the frequency range. At the high frequency end of the range transistors are getting toward the limits of their frequency capability at full power. The distortion and harmonic measurements listed in the specifications represent the worst case conditions. Over most of the frequency range the performance will be substantially better than the published specification.



Bottom View Part Identification T1000

T1000 PARTS LIST

(Except Amplifier Module)

Ref.	Part Number	Location	Description
C1	280001D	Chas.	Capacitor, Oil 8µF 660V AC
C2	280001D	Chas.	Capacitor, Oil 8µF 660V AC
C3	268000	Comp. Network	Capacitor, Comp. Trimmer 80pF
C4	212391D	Comp. Network	Capacitor, Disc 390pF
C5	210104	Swr. Brd.	Capacitor, Disc .1µF 25V
C6	230300D	Chas.	Capacitor, Electrolytic 30µF 100V
C7	230603D	Chas.	Capacitor, Electrolytic 69,000µF 50V
C8	230603D	Chas.	Capacitor, Electrolytic 69,000µF 50V
C9	211103	Fr. Panel	Capacitor, Disc .01µF 500V
C10	210103	Swr. Brd.	Capacitor, Disc .01µF 25V
C11	210104	Swr. Brd.	Capacitor, Disc .1µF 25V
C12	210102	Swr. Brd.	Capacitor, Disc .001µF 25V
* C13	210103	Rear Panel	Capacitor, Disc .01µF 500V
C14	210104	Swr. Brd.	Capacitor, Disc .1µF 25V
C15	241020	Swr. Brd.	Capacitor, Tantalum 2.2µF
* C16	210103	Rear Panel	Capacitor, Disc .01µF 500V
C17	260110D	Swr. Brd.	Capacitor, Trimmer Air 11pF
C18	220270	Swr. Brd.	Capacitor, Mica 27pF
C19	220431D	Swr. Brd.	Capacitor, Mica 430pF
C20	211103	Rear Panel	Capacitor, Disc .01µF 500V
C21	211103	Rear Panel	Capacitor, Disc .01µF 500V
C22	211103	Filter Assy.	Capacitor, Disc .01µF 500V
C23	211103	Filter Assy.	Capacitor, Disc .01µF 500V
C24	211103	Filter Assy.	Capacitor, Disc .01µF 500V
C25	211103	Filter Assy.	Capacitor, Disc .01µF 500V
C26	211103	Filter Assy.	Capacitor, Disc .01µF 500V
C27	211103	Filter Assy.	Capacitor, Disc .01µF 500V
C28	211103	Filter Assy.	Capacitor, Disc .01µF 500V
C29	211103	Filter Assy.	Capacitor, Disc .01µF 500V
C30	211103	Filter Assy.	Capacitor, Disc .01µF 500V
C31	211103	Filter Assy.	Capacitor, Disc .01µF 500V
C32	211103	Filter Assy.	Capacitor, Disc .01µF 500V
C33	211103	Filter Assy.	Capacitor, Disc .01µF 500V
C34	211103	Filter Assy.	Capacitor, Disc .01µF 500V
C35	211103	Filter Assy.	Capacitor, Disc .01µF 500V
C36	211103	Filter Assy.	Capacitor, Disc .01µF 500V
C37	211103	Filter Assy.	Capacitor, Disc .01µF 500V
C38	211103	Filter Assy.	Capacitor, Disc .01µF 500V
C39	211103	Filter Assy.	Capacitor, Disc .01µF 500V
C40	211103	Filter Assy.	Capacitor, Disc .01µF 500V
C41	211103	Filter Assy.	Capacitor, Disc .01µF 500V
C42	211103	Filter Assy.	Capacitor, Disc .01µF 500V
C43	211103	Filter Assy.	Capacitor, Disc .01µF 500V
C44	211103	Filter Assy.	Capacitor, Disc .01µF 500V
C45	211103	Filter Assy.	Capacitor, Disc .01µF 500V

*may not be used in some units

T1000 Parts List
(Except Amplifier Module)

Ref.	Part Number	Location	Description
C46	211103	Rear Panel	Capacitor, Disc .01μF 500V
C47	211103	Rear Panel	Capacitor, Disc .01μF 500V
C48	212560D	Rear Panel	Capacitor, Disc 56pF 3kV
C49	212470D	Rear Panel	Capacitor, Disc 47pF 3kV
C50*	212560D	Rear Panel	Capacitor, Disc 56pF 3kV
C50*	212680D	Rear Panel	Capacitor, Disc 68pF 3kV
C51	212680D	Rear Panel	Capacitor, Disc 68pF 3kV
C52*	212560D	Rear Panel	Capacitor, Disc 56pF 3kV
C52*	212820D	Rear Panel	Capacitor, Disc 82pF 5kV
C53	212120D	Rear Panel	Capacitor, Disc 12pF 3kV
C54*	212390D	Rear Panel	Capacitor, Disc 39pF 3kV
C54*	212390D	Rear Panel	Capacitor, Disc 39pF 3kV
C55*	212101D	Filter Assy.	Capacitor, Disc 100pF 3kV
C55*	212271D	Filter Assy.	Capacitor, Disc 270pF 2kV
C55*	212391D	Filter Assy.	Capacitor, Disc 390pF 2kV
C56*	212470D	Filter Assy.	Capacitor, Disc 47pF 5kV
C56*	212470D	Filter Assy.	Capacitor, Disc 47pF 5kV
C56*	212390D	Filter Assy.	Capacitor, Disc 39pF 5kV
C57*	212471D	Filter Assy.	Capacitor, Disc 470pF 2kV
C57*	212471D	Filter Assy.	Capacitor, Disc 470pF 2kV
C57*	212471D	Filter Assy.	Capacitor, Disc 470pF 2kV
C58*	212271D	Filter Assy.	Capacitor, Disc 270pF 2kV
C58*	212271D	Filter Assy.	Capacitor, Disc 270pF 2kV
C58*	212820D	Filter Assy.	Capacitor, Disc 82pF 5kV
C59*	212121D	Filter Assy.	Capacitor, Disc 120pF 3kV
C59*	212471D	Filter Assy.	Capacitor, Disc 470pF 2kV
C59*	212681D	Filter Assy.	Capacitor, Disc 680pF 2kV
C60*	212391D	Filter Assy.	Capacitor, Disc 390pF 2kV
C60*	212101D	Filter Assy.	Capacitor, Disc 100pF 3kV
C61*	212391D	Filter Assy.	Capacitor, Disc 390pF 2kV
C61*	212101D	Filter Assy.	Capacitor, Disc 100pF 3kV
C62*	212151D	Filter Assy.	Capacitor, Disc 150pF 4kV
C62*	212151D	Filter Assy.	Capacitor, Disc 150pF 4kV
C62*	212151D	Filter Assy.	Capacitor, Disc 150pF 4kV
C63*	212390D	Filter Assy.	Capacitor, Disc 39pF 5kV
C63*	212390D	Filter Assy.	Capacitor, Disc 39pF 5kV
C64*	212391D	Filter Assy.	Capacitor, Disc 390pF 2kV
C64*	212391D	Filter Assy.	Capacitor, Disc 390pF 3kV
C64*	212680D	Filter Assy.	Capacitor, Disc 68pF 5kV
C65*	212271D	Filter Assy.	Capacitor, Disc 270pF 2kV
C65*	212101D	Filter Assy.	Capacitor, Disc 100pF 3kV
C66*	212391D	Filter Assy.	Capacitor, Disc 390pF 2kV
C66*	212271D	Filter Assy.	Capacitor, Disc 270pF 2kV
C66*	212101D	Filter Assy.	Capacitor, Disc 100pF 3kV
C67*	212560D	Filter Assy.	Capacitor, Disc 56pF 3kV
C67*	212121D	Filter Assy.	Capacitor, Disc 120pF 3kV
C67*	212121D	Filter Assy.	Capacitor, Disc 120pF 3kV
C68*	212560D	Filter Assy.	Capacitor, Disc 56pF 3kV
C68*	212121D	Filter Assy.	Capacitor, Disc 120pF 3kV

T1000 Parts List
(Except Amplifier Module)

Ref.	Part Number	Location	Description
C68*	212121D	Filter Assy.	Capacitor, Disc 120pF 3kV
C69*	212101D	Filter Assy.	Capacitor, Disc 100pF 3kV
C69*	212101D	Filter Assy.	Capacitor, Disc 100pF 3kV
C69*	212820D	Filter Assy.	Capacitor, Disc 82pF 5kV
C70	212470D	Filter Assy.	Capacitor, Disc 47pF 3kV
C71*	212271D	Filter Assy.	Capacitor, Disc 270pF 2kV
C71*	212201D	Filter Assy.	Capacitor, Disc 200pF 3kV
C71*	212560D	Filter Assy.	Capacitor, Disc 56pF 3kV
C72*	212151D	Filter Assy.	Capacitor, Disc 150pF 4kV
C72*	212820D	Filter Assy.	Capacitor, Disc 82pF 5kV
C73*	212271D	Filter Assy.	Capacitor, Disc 270pF 2kV
C73*	212201D	Filter Assy.	Capacitor, Disc. 200pF 3kV
C74*	212560D	Filter Assy.	Capacitor, Disc 56pF 3kV
C74*	212560D	Filter Assy.	Capacitor, Disc 56pF 3kV
C74*	212680D	Filter Assy.	Capacitor, Disc 68pF 5kV
C75*	212560D	Filter Assy.	Capacitor, Disc 56pF 3kV
C75*	212560D	Filter Assy.	Capacitor, Disc 56pF 3kV
C75*	212680D	Filter Assy.	Capacitor, Disc 68pF 5kV
* C76	210103	Rear Panel	Capacitor, Disc .01µF 500V
* C77	210103	Rear Panel	Capacitor, Disc .01µF 500V
C78*	212101D	Filter Assy.	Capacitor, Disc 100pF 3kV
C78*	212820D	Filter Assy.	Capacitor, Disc 82pF 5kV
C78*	212820D	Filter Assy.	Capacitor, Disc 82pF 5kV
C79*	212390D	Filter Assy.	Capacitor, Disc 39pF 5kV
C79*	212470D	Filter Assy.	Capacitor, Disc 47pF 5kV
C80*	212121D	Filter Assy.	Capacitor, Disc 120pF 3kV
C80*	212121D	Filter Assy.	Capacitor, Disc 120pF 3kV
C80*	212560D	Filter Assy.	Capacitor, Disc 56pF 3kV
C81	212470D	Filter Assy.	Capacitor, Disc 47pF 5kV
C82*	212470D	Filter Assy.	Capacitor, Disc 47pF 5kV
C82*	212470D	Filter Assy.	Capacitor, Disc 47pF 5kV
C82*	212390D	Filter Assy.	Capacitor, Disc 39pF 5kV
C83*	212390D	Filter Assy.	Capacitor, Disc 39pF 5kV
C83*	212390D	Filter Assy.	Capacitor, Disc 39pF 5kV
C83*	212390D	Filter Assy.	Capacitor, Disc 39pF 5kV
C84*	212100D	Filter Assy.	Capacitor, Disc 10pF 3kV
C84*	212100D	Filter Assy.	Capacitor, Disc 10pF 3kV
C85*	212820D	Filter Assy.	Capacitor, Disc 82pF 5kV
C85*	212820D	Filter Assy.	Capacitor, Disc 82pF 5kV
C85*	212470D	Filter Assy.	Capacitor, Disc 47pF 5kV
C86*	212470D	Filter Assy.	Capacitor, Disc 47pF 5kV
C87*	212680D	Filter Assy.	Capacitor, Disc 68pF 5kV
C87*	212680D	Filter Assy.	Capacitor, Disc 68pF 5kV
C87*	212560D	Filter Assy.	Capacitor, Disc 56pF 3kV
C88*	212390D	Filter Assy.	Capacitor, Disc 39pF 5kV
C88*	212390D	Filter Assy.	Capacitor, Disc 39pF 5kV
* C89	210103	Rear Panel	Capacitor, Disc .01µF 500V

* may not be used in some units

T1000 Parts List
(Except Amplifier Module)

Ref.	Part Number	Location	Description
C90*	212390C	Filter Assy.	Capacitor, Disc 39pF 5kV
C90*	212390D	Filter Assy.	Capacitor, Disc 39pF 5kV
C91	211103	Rear Panel	Capacitor, Disc .01µF 500V
C92	230251	Rear Panel	Capacitor, Electrolytic 250µF 25V
C93	210103	Swr. Brd.	Capacitor, Disc .01µF 25V
C94	230500	Rear Panel	Capacitor, Electrolytic 50µF 16V
C95	210104	Chas.	Capacitor, Disc .1µF 25V
C96	210104	Swr. Brd.	Capacitor, Disc .1µF 25V
C97	220101	Swr. Brd.	Capacitor, DM15, 100pF
C98	210103	Rear Panel	Capacitor, Disc .01µF 500V
C99	210103	Rear Panel	Capacitor, Disc .01µF 500V
D1	320104D	Chas.	Diode, 85 Amp 200 Piv Reverse Polarity
D2	320104D	Chas.	Diode, 85 Amp 200 Piv Reverse Polarity
D3	320102	Chas.	Diode, 1N4001
D4	320102	Rear Panel	Diode, 1N4001
D5	320001	Swr. Brd.	Diode, 1N4148
D6	320001	Swr. Brd.	Diode, 1N4148
D7	320001	Swr. Brd.	Diode, 1N4148
D8	320001	Swr. Brd.	Diode, 1N4148
D9	320001	Swr. Brd.	Diode, 1N4148
D10	320205D	Swr. Brd.	Diode, Zener 1N4744
D11	320205D	Swr. Brd.	Diode, Zener 1N4744
D12	320103	Rear Panel	Diode, 3 Amp 50V
D13	320103	Rear Panel	Diode, 3 Amp 50V
D14	320205D	Chas.	Diode, Zener 1N4744 15V
D15	Not Used	Standard Version	
D16	Not Used	Standard Version	
D17	Not Used	Standard Version	
D18	Not Used	Standard Version	
D19	Not Used	Standard Version	
D20	320102	Rear Panel	Diode, IN4001
D21	320103	Rear Panel	Diode, 3 Amp 50V
FAN	770001D	Rear Panel	Fan 110V
FA	490501D	Various	Sleeve, Ferrite .1" X 1.12"
FB	490302	Various	Bead, Ferrite .2" X .35"
FC	490202D	Various	Bead, Ferrite .2" X .45"
F1	550007D	Chas.	Fuse, 30 Amp for 110V
F1	550006D	Chas.	Fuse, 15 Amp for 220V
F1	630003D	Chas.	Block, Fuse Holder
LD1	320402D	Front Panel	LED, Red
LD2	320402D	Front Panel	LED, Red
LD3	320402D	Front Panel	LED, Red
LD4	320402D	Front Panel	LED, Red
LD5	320402D	Front Panel	LED, Red
LD6	320402D	Front Panel	LED, Red
LD7	320402D	Front Panel	LED, Red
LD8	320402D	Front Panel	LED, Red
LD9	320402D	Front Panel	LED, Red
LD10	320402D	Front Panel	LED, Red
L1	450105D	Comp. Network	Inductor, Special
L2	450106D	Comp. Network	Inductor, Special
L3	410007D	Rear Panel	Inductor, Fan Speed Reduction

T1000 Parts List
(Except Amplifier Module)

Ref.	Part Number	Location	Description
L4	450104D	Swr. Brd.	Inductor, Ferrite
L5	450401D	Rear Panel	Inductor, Air 20-30MHz
L6	450401D	Rear Panel	Inductor, Air 20-30MHz
L7	450402D	Rear Panel	Inductor, Air 20-30MHz
L8	450501D	Filter Assy.	Inductor, Toroidal 2-3MHz
L9	450502D	Filter Assy.	Inductor, Toroidal 2-3MHz
L10	450502D	Filter Assy.	Inductor, Toroidal 2-3MHz
L11	450503D	Filter Assy.	Inductor, Toroidal 3-5MHz
L12	450504D	Filter Assy.	Inductor, Toroidal 3-5MHz
L13	450504D	Filter Assy.	Inductor, Toroidal 3-5MHz
L14	450505D	Filter Assy.	Inductor, Toroidal 5-8MHz
L15	450506D	Filter Assy.	Inductor, Toroidal 5-8MHz
L16	450506D	Filter Assy.	Inductor, Toroidal 5-8MHz
L17	450508D	Filter Assy.	Inductor, Toroidal 8-13MHz
L18	450507D	Filter Assy.	Inductor, Toroidal 8-13MHz
L19	450509D	Filter Assy.	Inductor, Toroidal 13-20MHz
L20	450510D	Filter Assy.	Inductor, Toroidal 13-20MHz
L21	450510D	Filter Assy.	Inductor, Toroidal 13-20MHz
L22	450507D	Filter Assy.	Inductor, Toroidal 8-13MHz
L23	450306D	Swr. Brd.	Inductor, Current Transforming
L24	450140D	Comp. Network	Inductor, Special
M1	740020	Front Panel	Meter, Special
Q1	310025D	Chas.	Transistor, MJE3055K
Q2	320601D	Swr. Brd.	SCR S2003LS2
Q3	310025D	Chas.	Transistor MJE3055K
Q4	310027D	Swr. Brd.	Transistor, 2N5306
R1	153201D	Comp. Network	Resistor, Flameproof 200Ω 2W
R1	153201D	Comp. Network	Resistor, Flameproof 200Ω 2W
R1	153021D	Comp. Network	Resistor, Flameproof 200Ω 2W
R1	153201D	Comp. Network	Resistor, Flameproof 200Ω 2W
R1	153201D	Comp. Network	Resistor, Flameproof 200Ω 2W
R2	153221D	Comp. Network	Resistor, Flameproof 220Ω 2W
R2	153221D	Comp. Network	Resistor, Flameproof 220Ω 2W
R2	153221D	Comp. Network	Resistor, Flameproof 220Ω 2W
R2	153221D	Comp. Network	Resistor, Flameproof 220Ω 2W
R3	124222	Swr. Brd.	Resistor, 2.2k ¼W 5%
R4	124102	Swr. Brd.	Resistor, 1k ¼W 5%
R5	124682	Chas.	Resistor, 6.8k ¼W 5%
R6	124562	Swr. Brd.	Resistor, 5.6k ¼W 5%
R7	144101	Input Comb.	Resistor, 100Ω 1W 5%
R8	144101	Input Comb.	Resistor, 100Ω 1W 5%
R9	144101	Input Comb.	Resistor, 100Ω 1W 5%

T1000 Parts List
(Except Amplifier Module)

Ref.	Part Number	Location	Description
R10	144101	Input Comb.	Resistor, 100Ω 1W
R11	141492D	Swr. Brd.	Resistor, 49.9k 1%
R12	124562	Swr. Brd.	Resistor, 5.6k ¼W
R13	124562	Swr. Brd.	Resistor, 5.6k ¼W
R14	124102	Swr. Brd.	Resistor, 1k ¼W
R15	154182D	Swr. Brd.	Resistor, 1.8k 2W
R16	141492D	Swr. Brd.	Resistor, 49.9k 1%
R17	170301D	Swr. Brd.	Resistor, Variable WW 5Ω
R18	170101	Swr. Brd.	Resistor, Variable 10k
R19	170101	Swr. Brd.	Resistor, Variable 10k
R20	170102D	Swr. Brd.	Resistor, Variable 1k
R21	124102	Swr. Brd.	Resistor, 1k ¼W
R22	124470	Swr. Brd.	Resistor, 47Ω ¼W
R23	153201D	Output Comb.	Resistor, Flameproof 200Ω 2W
R23	153201D	Output Comb.	Resistor, Flameproof 200Ω 2W
R24	153201D	Output Comb.	Resistor, Flameproof 200Ω 2W
R24	153201D	Output Comb.	Resistor, Flameproof 200Ω 2W
R25	153201D	Output Comb.	Resistor, Flameproof 200Ω 2W
R25	153201D	Output Comb.	Resistor, Flameproof 200Ω 2W
R26	153201D	Output Comb.	Resistor, Flameproof 200Ω 2W
R26	153201D	Output Comb.	Resistor, Flameproof 200Ω 2W
R27	124102	Swr. Brd.	Resistor, 1k ¼W
R28	124102	Pushbutton Assy.	Resistor, 1k ¼W
R29	124102	Pushbutton Assy.	Resistor, 1k ¼W
R30	124102	Pushbutton Assy.	Resistor, 1k ¼W
R31	124102	Pushbutton Assy.	Resistor, 1k ¼W
R32	124102	Pushbutton Assy.	Resistor, 1k ¼W
R33	124102	Pushbutton Assy.	Resistor, 1k ¼W
R34	134471	Rear Panel	Resistor, 470Ω ½W
R35	144470	Rear Panel	Resistor, 47Ω 1W
R36	154182D	Chas.	Resistor, 1.8k 2W
R37	123205	Swr. Brd.	Resistor, 2MEG ¼W
R38	154182D	Comp. Network	Resistor, 1.8kΩ 1W
R39	154182D	Comp. Network	Resistor, 1.8kΩ 1W
R40	153220D	Comp. Network	Resistor, 22Ω 2W
R41	144471	Rear Panel	Resistor 470Ω 1W
R42	161101D	Chassis	Resistor 100Ω 25W
RL1	540005	Rear Panel	Relay, DPDT 12V
RL2	540005	Rear Panel	Relay, DPDT 12V
RL3	540005	Rear Panel	Relay, DPDT 12V
RL4	540005	Rear Panel	Relay, DPDT 12V
RL5	540005	Rear Panel	Relay, DPDT 12V
RL6	540005	Rear Panel	Relay, DPDT 12V
RL7	540005	Rear Panel	Relay, DPDT 12V
RL8	540005	Rear Panel	Relay, DPDT 12V
RL9	540005	Rear Panel	Relay, DPDT 12V
RL10	540005	Rear Panel	Relay, DPDT 12V
RL11	540005	Rear Panel	Relay, DPDT 12V
RL12	540005	Rear Panel	Relay, DPDT 12V
RL13	540005	Rear Panel	Relay, DPDT 12V
RL14	540005	Rear Panel	Relay, DPDT 12V

T1000 Parts List
(Except Amplifier Module)

Ref.	Part Number	Location	Description
S1	530201D	Front Panel	Switch, Rocker Power
S2	570004D	Front Panel	Circuit Breaker 40A
S3)Part of Assy. S4)530301D		Front Panel	Assembly, Pushbutton
S5	520001	Front Panel	Switch, Toggle SPDT
S6	530001D	Front Panel	Switch, Pushbutton Mom. Cl.
S01	610003	Rear Panel	Socket, Coax S0239
S02	610003	Rear Panel	Socket, Coax S0239
S03	610014D	Rear Panel	Socket, 12 Pin
TH1	560001	Heatsink	Thermostat N/C 75°C
TH2	560003	Output Comb.	Thermostat N/C 85° C
TH3	560002D	Heatsink	Thermostat N/O 60°C
CVT	410008D	Chas.	Transformer C/V 1.2kVA
	630101D	Front Panel	Socket LED
	870005D	Various	Terminal Insulated Bifurcated
	700101D	Combiner Assy.,	Input
	700102D	Combiner Assy.,	Output
	530301D	Pushbutton Assy.	(Consists of 2x pushbutton switches, 2x P.C. Boards and mounting plates.)
	731004D	Filter Assy.	Printed Circuit Board
	731008D	Swr./Metering	Printed Circuit Board
	731009D	Compensating Network	Printed Circuit Board

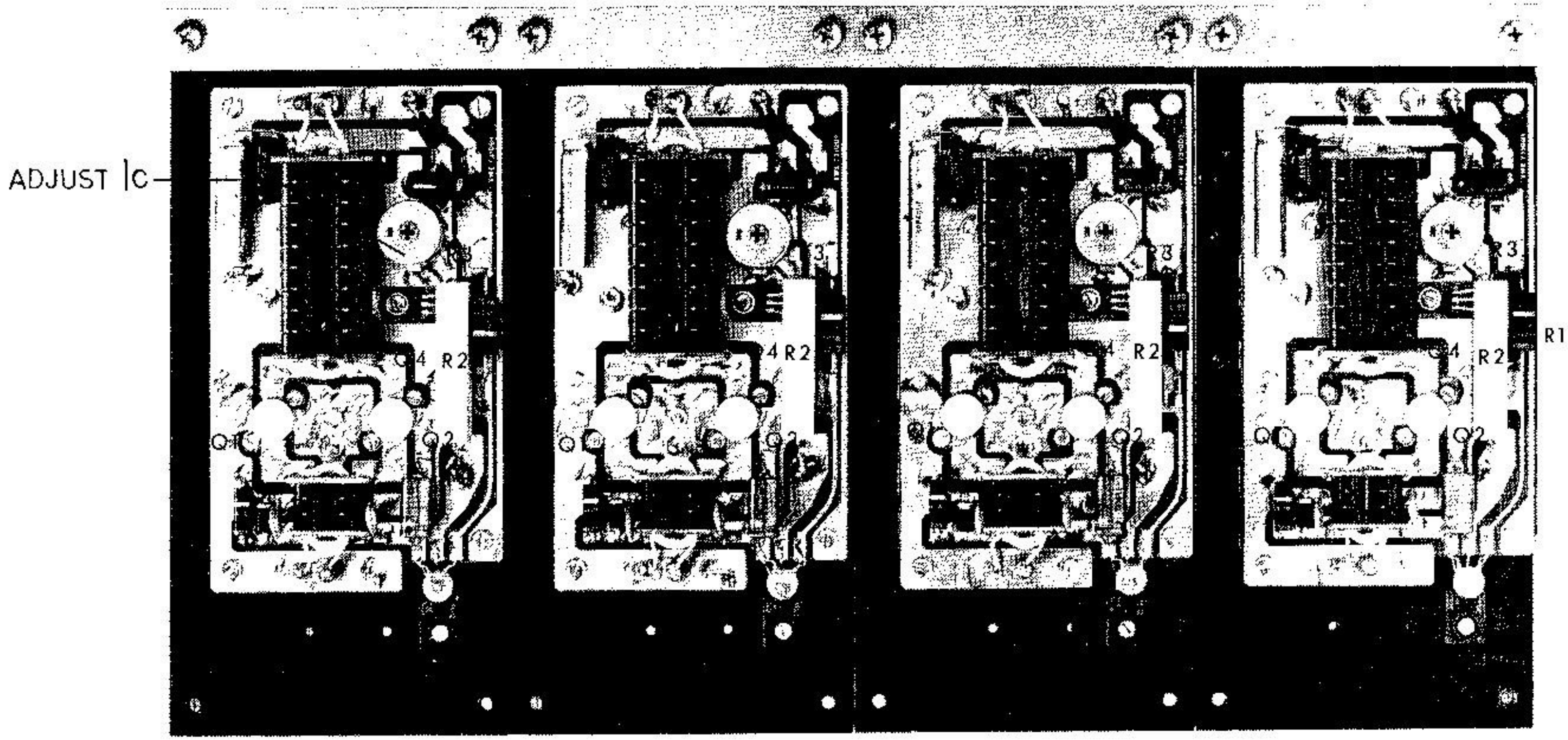
T1000 AMPLIFIER MODULE

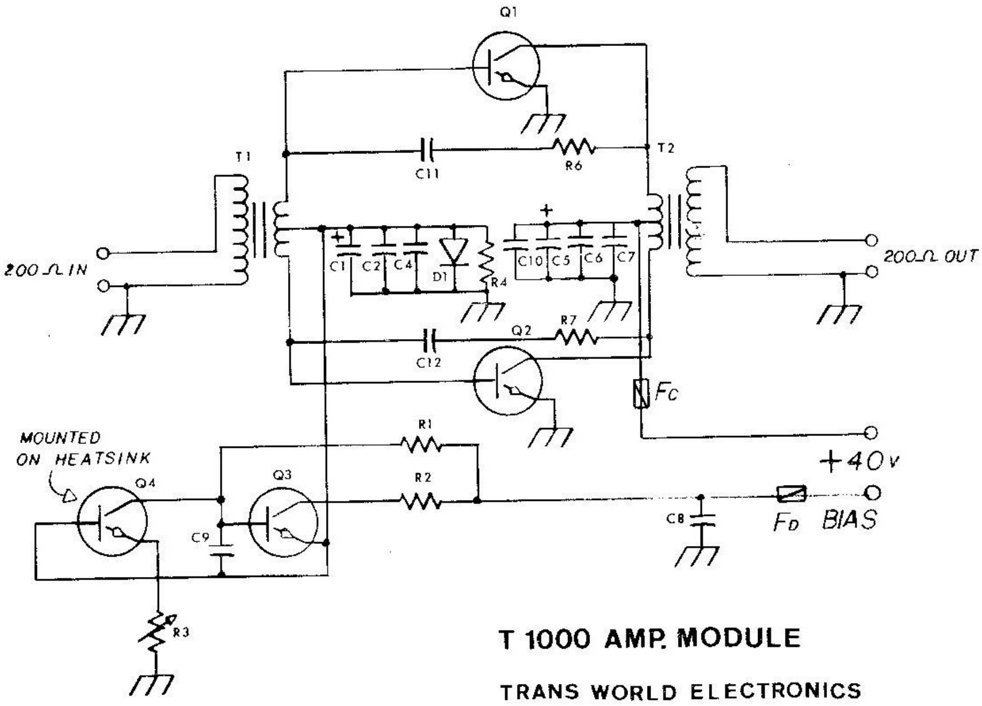
PARTS LIST

(4 PER UNIT)

Ref.	Part Number	Description
C1	230201	Capacitor, Electrolytic 200µF 16V
C2	210104	Capacitor, Ceramic Disc .1µF 25V
C3	Not used.	
C4	210104	Capacitor, Ceramic Disc .1µF 25V
C5	230300D	Capacitor, Electrolytic 30µF 100V
C6	211103	Capacitor, Ceramic Disc .01µF 500V
C7	254104D	Capacitor, Mylar .1µF 100V
C8	254104D	Capacitor, Mylar .1µF 100V
C9	211103	Capacitor, Ceramic Disc .01µF 500V
C10	211103	Capacitor, Ceramic Disc .01µF 500V
C11	211103	Capacitor, Ceramic Disc .01µF 500V
C12	211103	Capacitor, Ceramic Disc .01µF 500V
D1	320103	Diode, Silicon 3 Amp
FC	490201	Bead, Ferrite
FD	490202D	Bead, Ferrite
Q1	310026D	Transistor, Power RF 150W
Q2	310026D	Transistor, Power RF 150W
Q3	310025D	Transistor, MJE3055K
Q4	310024D	Transistor, MJE29A
R1	154182D	Resistor, Carbon 1800Ω 2W
R1	154182D	Resistor, Carbon 1800Ω 2W
R2	160500D	Resistor, WW 50Ω 10W
R2	160500D	Resistor, WW 50Ω 10W
R3	170301D	Resistor, WW Variable 5Ω 2W
R4	144101	Resistor, Carbon 100Ω 1W
R5	Not Used.	
R6	153201D	Resistor, Flameproof 200Ω 2W
R7	153201D	Resistor, Flameproof 200Ω 2W
	731001D	Printed Circuit Board
	870005D	Terminal, Insulated Bifurcated

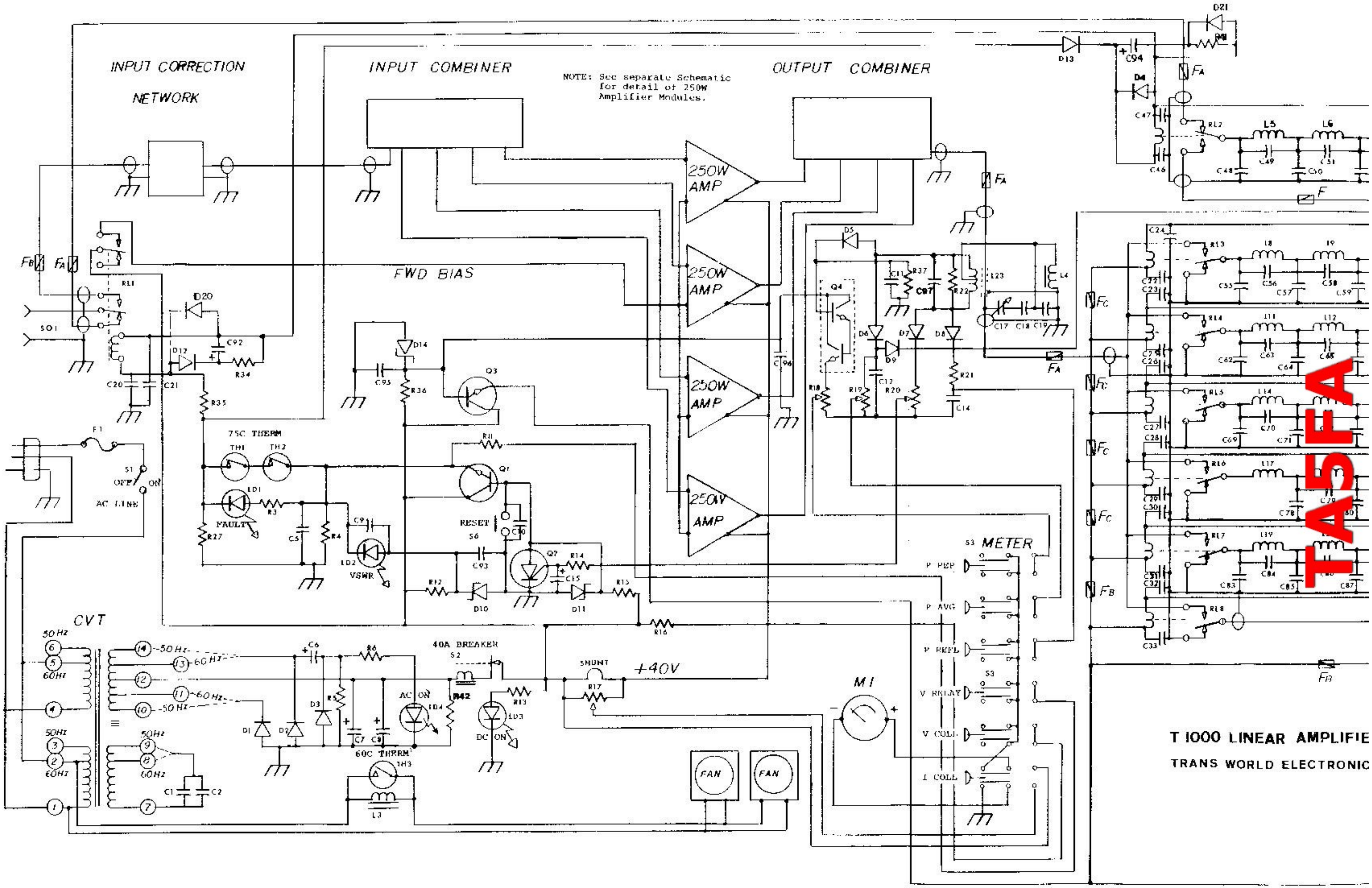
Amp. Assy. Part Identification T1000





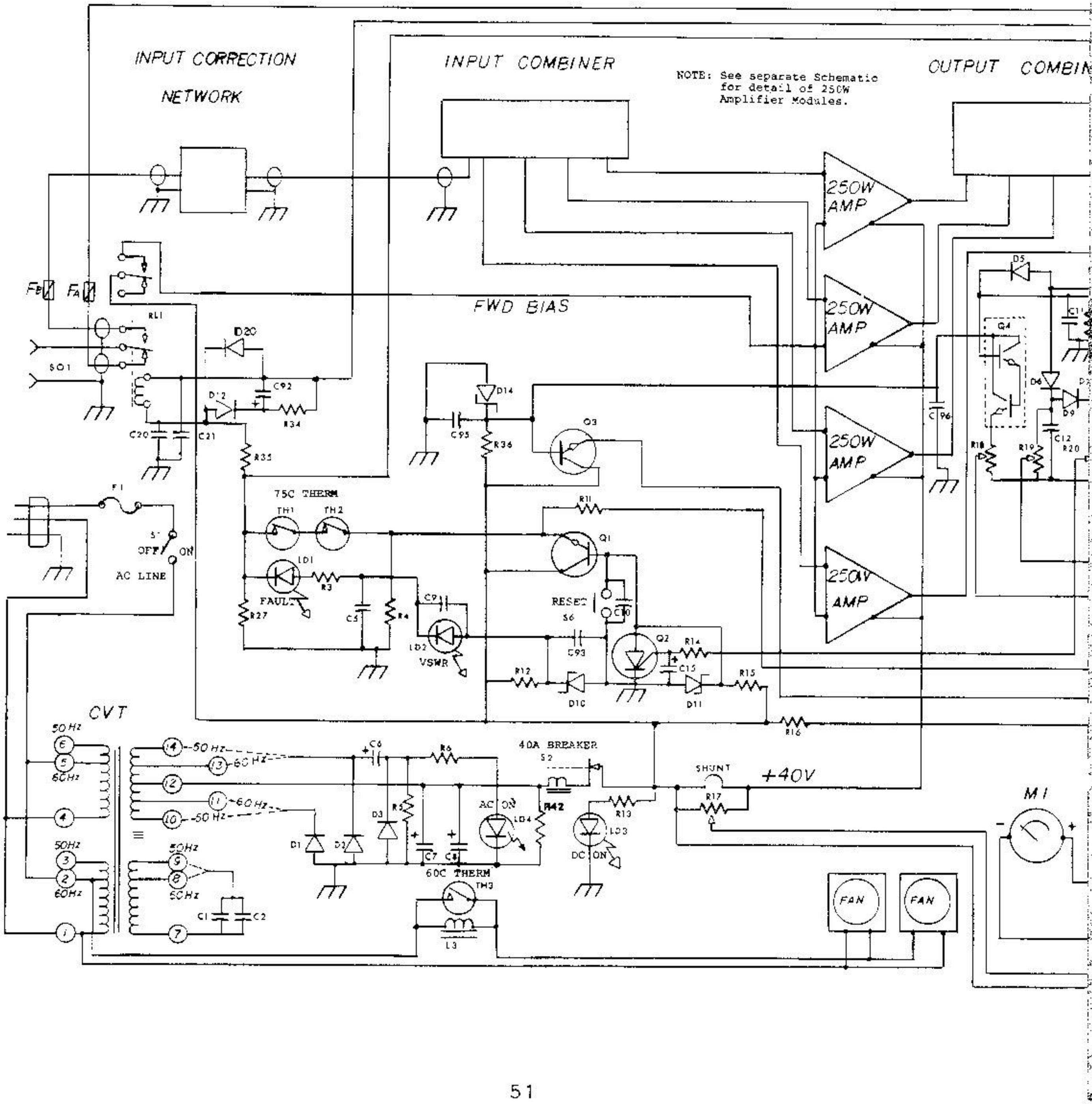
T 1000 AMP. MODULE

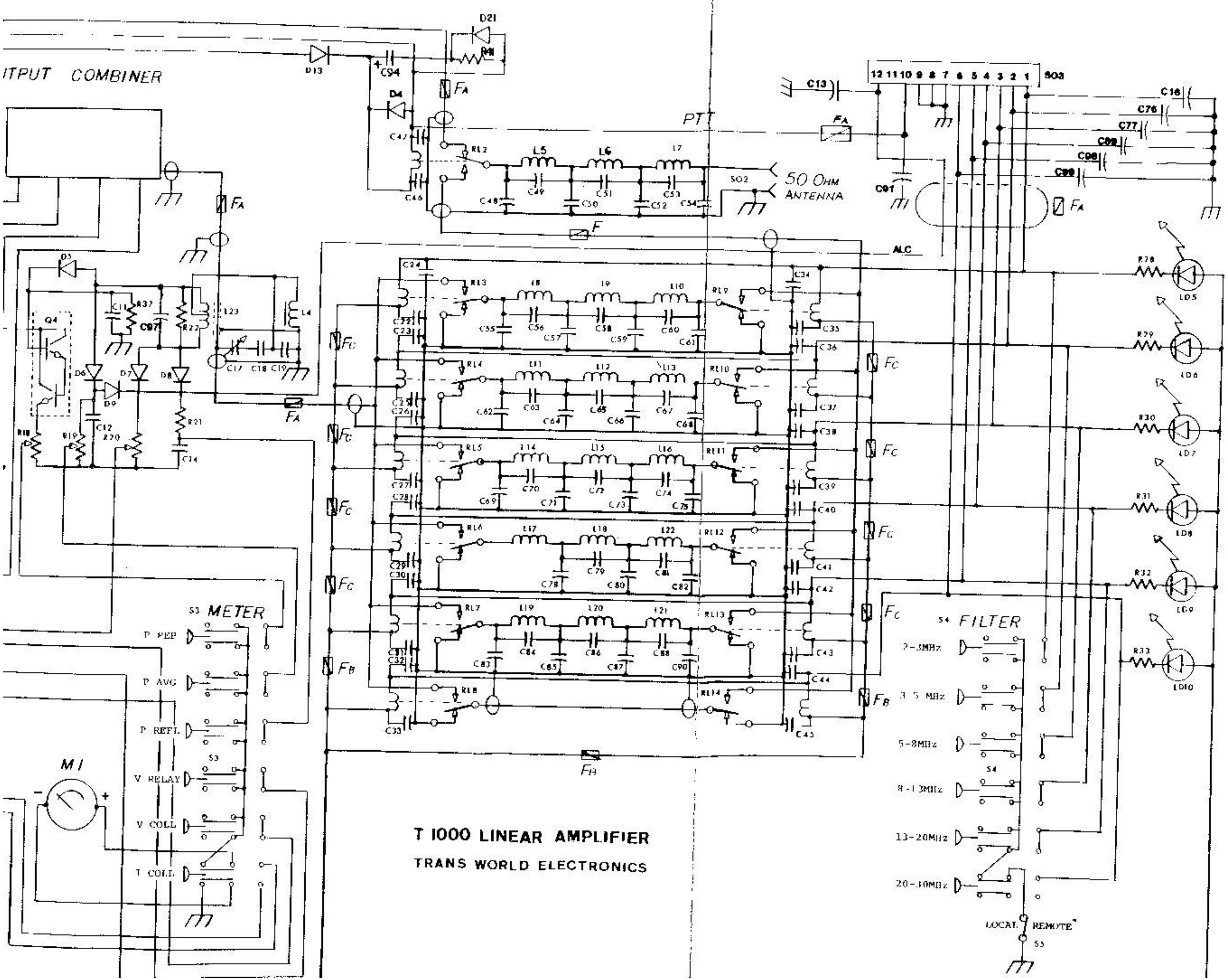
TRANS WORLD ELECTRONICS



T 1000 LINEAR AMPLIFIE

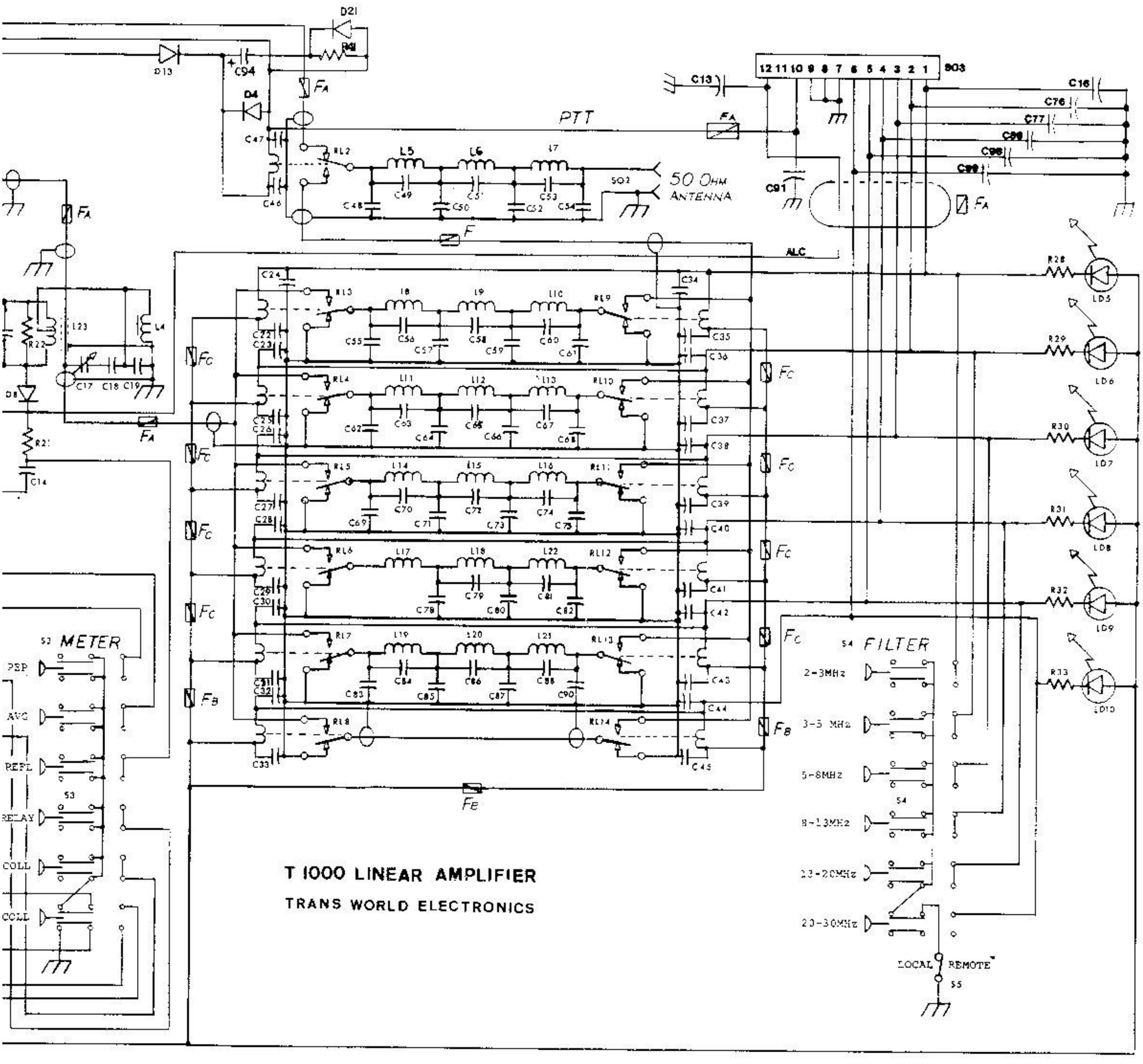
TRANS WORLD ELECTRONIC


INPUT CORRECTION NETWORK
INPUT COMBINER
NOTE: See separate Schematic for detail of 250W Amplifier Modules.
OUTPUT COMBIN
250W AMP
250W AMP
250W AMP
250W AMP
FWD BIAS
75C THERM
FAULT
VSWR
RESET
AC LINE
CVT
40A BREAKER
SHUNT
+40V
M1
60C THERM
AC ON
DC ON
FAN
FAN



T 1000 LINEAR AMPLIFIER

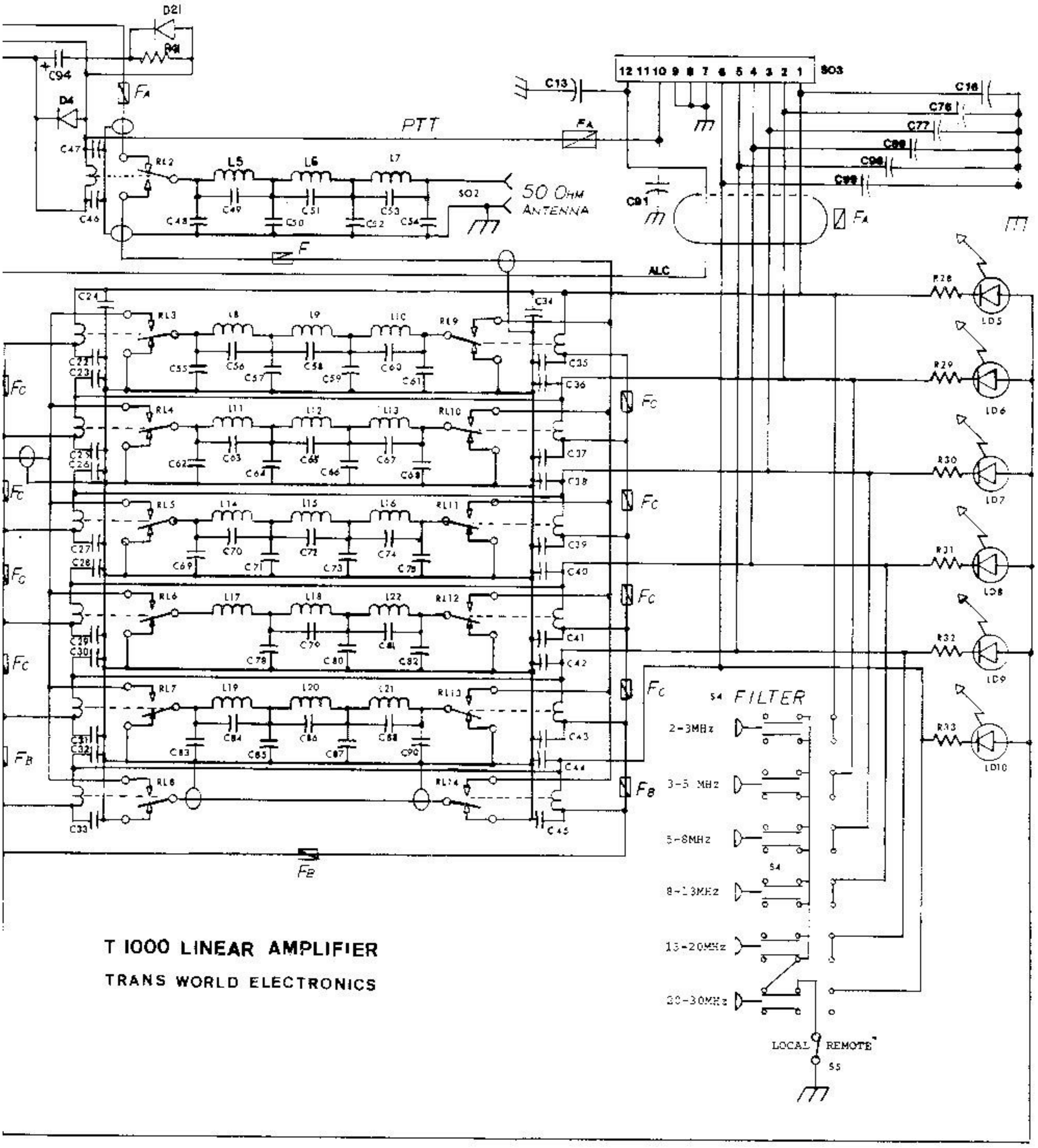
TRANS WORLD ELECTRONICS



T 1000 LINEAR AMPLIFIER

TRANS WORLD ELECTRONICS

TA5FA



T 1000 LINEAR AMPLIFIER

TRANS WORLD ELECTRONICS