MA1000B-MS

OPERATION & SERVICE MANUAL

MA1000B LINEAR AMPLIFIER

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Revision 1.00
January 1988

Dear Magnus Customer:

Our experience to date, is that with a reasonably well matched antenna and an input of no more than 70 W PEP, the MA1000B is a rugged, tolerant workhorse. The worst you can do is trip the magnetic breaker, and this normally amounts to a minor inconvenience. But, please be advised of the need to limit drive to a reasonable level. We have seen many cases of people who increase mike gain until they read 70 watts on their average-reading wattmeters with a voice signal. That amounts to over 150 W PEP! Even our carefully balanced hybrid splitter may burn under those conditions.

Regards and 73's

MAGNUS ELECTRONICS, INC.

WARRANTY POLICY

I. Warranty

MAGNUS ELECTRONICS, INC. warrants that its equipment has been manufactured free of defects in design, material and workmanship. If the equipment does not give satisfactory service due to defects covered by this warranty, MAGNUS will replace or repair the equipment free of charge.

A. Time of Warranty

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

B. Limitations of Warranty.

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

C. Return of Equipment - U.S.A.

The equipment shall be returned freight prepaid to:

Service Department
MAGNUS ELECTRONICS, INC
7101 Ridgeway Avenue
Lincolnwood, Illinois 60645, U.S.A.

The equipment should be packed securely as MAGNUS will not be responsible for damage incurred in transit. Please include a letter containing the following information:

1. Model, Serial Number and date of installation.
2. Name of dealer or supplier of equipment.
3. Detailed explanation of problem.
4. Return shipping instructions.

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

D. Return of Equipment - Foreign

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

II. Limited Parts Warranty

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

A. Parts Replacement

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

1. Return parts prepaid to:

   Parts Replacement
   MAGNUS ELECTRONICS, INC.
   7101 Ridgeway Avenue
   Lincolnwood, Illinois 60645, U.S.A.

2. Include a letter with the following information:

   a. Part number.

   b. Serial Number and Model of Equipment.

   c. Date of installation.

   d. Return shipping instructions.

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

Magnus Electronics, Inc.
7101 Ridgeway Avenue
Lincolnwood, Illinois 60645
U.S.A.

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SECTION 1

GENERAL INFORMATION

1.1 GENERAL INFORMATION

The MA1000B Linear Amplifier is designed to amplify the output from medium power (60W PEP output minimum), transmitters and transceivers operating on any frequency in the range 1.8-22 MHz. The amplifier has a power gain of approximately 10 dB and is rated for a power input of 1000W PEP. The amplifier operates directly from a 12V power source and provides the rated output at 13.6V DC. The amplifier is suitable for mobile operation directly from a vehicle, ship or aircraft 12V system, or with a separate power source is an ideal base station amplifier.

1.2 THE MA1000B AMPLIFIER

The MA1000B Linear Amplifier is designed for reliable operation over the entire frequency range 1.8-22 MHz. The design is all solid state using 8 transistors in (4) push pull amplifiers. This means a major step forward in reliability, service life, simplicity of adjustment and maintenance. The amplifier is completely broadband and requires no tuning or adjustment during service and installation. Unlike vacuum tube amplifiers, there are no high voltages, and all circuitry operates at 12V giving the components an extended service life.

1.3 MOBILE OPERATION

The MA1000B Linear Amplifier operates directly from the 12V system and requires no power supply or voltage conversion. This gives much improved efficiency compared with vacuum tubes and there is no standby current drain or warmup time. The remote control facilities and the fact that there are no operating adjustments, make the amplifier ideal for trunk mounting in automobiles. The amplifier is extremely compact and installation should be simple in almost any mobile application.

1.4 BASE STATION OPERATION

The MA1000B is equally suited to fixed operation, if a suitable power source is provided. The PS75 power supply provides an economical 13.6V 75A peak power source for operation from 115V/230V, 50/60 Hz AC supplies. An alternate economical power source can be constructed at low cost using a standard vehicle 12V battery and a 15A battery charger. The mobile mount is constructed for simple removal so that the amplifier can be readily interchanged between mobile and fixed service.

1.5 OPERATION

The MA1000B has no tuning adjustments and requires no operator skills. Unlike tube amplifiers, the transistor amplifiers and combining networks are compensated for uniform output across the 1.8 MHz to 22 MHz range. Operation is simply a matter of selecting the correct harmonic filter, (either via the remote control socket and exciter bandswitch, or from the front panel bandswitch on the MA1000B). The only other adjustment required, is the setting of exciter ALC to provide the correct drive level.

1.6 FILTERS

The MA1000B uses five 5 pole Tchebycheff low pass filters with the cutoff frequency just above the top end of the 160, 75, 40, 20, and 15 meter Amateur Bands. The filters give maximum harmonic attenuation in the amateur bands. The harmonic attenuation will be lower at the low end of each range. Only the lowest frequency filter which includes the exciter frequency should be selected. This provides maximum amplifier fundamental output with minimum harmonic output. This is an important adjustment for correct operation. A six position switch on the front panel is used for filter selection. Five positions select filters and the sixth position (OFF/REMOTE) switches to remote control using either a separate five position switch or selection by the transceiver bandswitch. In this position, the power On/Off function is also remotely controlled.

1.7 METERING

A front panel meter (100A full scale) monitors the collector current. This provides an accurate monitor of amplifier performance, provided the amplifier is operated into a correctly matched load.

1.8 PROTECTIVE CIRCUITRY

A. A high speed 75A magnetic circuit breaker is provided on the positive supply line. This circuit breaker protects against short circuits, overdrive and mismatched antennas.

B. A protective diode keeps the amplifier from operating if the supply polarity is accidentally reversed.

C. A 75° thermostat is mounted on the transistor heatsink. If the heatsink temperature should become excessive, the amplifier will switch off and connect the exciter to the antenna. The amplifier will switch back on as soon as the heatsink cools.

1.9 OPERATING MODES

The amplifier is primarily designed for SSB operation, but is suitable for CW or brief FSK operation at a maximum collector current of 75A. In the FSK mode, the operating time will be limited by the heatsink temperature and may be extended by the use of an external cooling fan.

1.10 REMOTE CONTROL

The amplifier is fully remote controlled. The power is switched by a heavy duty relay and the filters are remotely selectable. All control functions are accomplished by grounding the appropriate control line.

1.11 TRANSMIT/RECEIVE SWITCHING

The amplifier is switched to the transmit mode by grounding the appropriate control line. Normally this line will be connected in parallel with the exciter microphone PTT switch. In the receive mode, the amplifier is bypassed for transceiver operation.

1.12 CONSTRUCTION

The amplifier is constructed on a large, finned aluminum heatsink which forms the main structural member of the amplifier. The heatsink is on the top of the amplifier and forms the top of the chassis which is constructed of .090 aluminum bolted to the heatsink. The baseplate serves as a cover for the amplifier and is removable for service. The entire amplifier and heatsink is finished in an attractive hard wearing black anodizing. The construction is very strong and the amplifier is suitable for use under the most severe environmental conditions.

1.13 EXCITERS

The amplifier has a 50 ohm input and provides a good match to transmitters designed for 50 ohm output. The drive level is within the capabilities of almost all modern equipment. The transmitter gain and/or ALC system should be set to limit the power output to 60W PEP (approximately 120W input). The amplifier faithfully reproduces the input signal. and if the input is distorted, the output will also be distorted. The harmonic output is determined by the output filters, however, it is desirable for the drive signal to have harmonics suppressed by at least 25 dB.

SECTION 2

TECHNICAL SPECIFICATIONS

POWER INPUT:	1000W (Output 600W PEP Typical)
INTERMODULATION DISTORTION:	1000W Input -24 dB 3rd Order 500W PEP Output 1.2-21.5 MHz -32 dB 3rd Order
FREQUENCY RANGE:	1.8-21.5 MHz
HARMONIC FILTERS:	5 pole Tchebycheff Low Pass

Ranges	160M	1.8 - 2	MHz
	75M	2 - 4	MHz
	40M	4 - 7.5	MHz
	30-20M	7.5 - 14.5	MHz
	17-15M	14.5 - 21.5	MHz

HARMONICS:	-50 dB (Amateur Bands)
DRIVE LEVEL:	60W PEP 50 Ohms (SO239 Connector)
OUTPUT IMPEDANCE:	50 Ohms (SO239 Connector)
POWER REQUIREMENTS:	11-13.6V DC negative ground 75A Maximum 40A Average Voice
FILTER SELECTION:	Remote - Ground control line for each filter. Local - Front Panel switch.
POWER SWITCHING:	Remote Controlled Relay - Ground control line
TRANSMIT - RECEIVE SWITCHING:	Ground control line
AMPLIFIER OFF:	Amplifier is bypassed when switched off.
COOLING:	Convection cooled heatsink protected by 75°C thermostat.
FUSES:	75A high speed magnetic circuit breaker.
SIZE:	10 cm H x 25 cm W x 47 cm L (4" x 10" x 18.5")
WEIGHT:	8 kilos (18 lbs)

NOTE: All performance specifications are with a supply voltage of 13.6V DC measured at the amplifier while under load.

SECTION 3

INSTALLATION

3.1 MOBILE INSTALLATION

The amplifier may be mounted in any location where it is not exposed to excessive heat and where the cooling fins will not be obstructed. The amplifier is designed for mounting on any flat surface. Temporarily place the mobile mount on the amplifier and set the amplifier in the chosen position. Mark the position of the base of the mount and then remove from the amplifier. Use the mount as a template and drill holes through the mounting surface. Bolt the mount securely in place. Replace the amplifier in the mount, then press the amplifier firmly down against the mounting feet and tighten the 2 retaining screws. This completes the amplifier mounting.

3.2 FIXED OPERATION

The amplifier may be placed on the desk top adjacent to the exciter or may be located in any convenient remote location. Make sure that the amplifier is kept out of direct sunlight and other sources of heat and ensure that the cooling fins are not obstructed.

3.3 POWER CONNECTIONS

The power connections to the amplifier are extremely important, as the amplifier draws instantaneous peak currents in excess of 100A. The amplifier will only deliver the rated power output when the voltage, at the amplifier at maximum current drain, is 13.6V. The ideal mobile installation is with the amplifier mounted very close to the battery so that the length of the connecting leads does not exceed 40 or 50 cm (15" to 20").

If the amplifier is mounted in the trunk of an automobile and the battery is in the front of the vehicle, it is essential to use very heavy gauge (#8 AWG) wiring to minimize the voltage drop in the connecting cables. The cables should be terminated directly on the battery terminals and the connections and must have negligible resistance. Take special care with the mounting of the cable to ensure there is no possibility of shorts to ground. Heavy gauge wiring will carry very high currents if there is a short circuit and may result in a fire.

Even when taking all possible precautions to minimuze the voltage drop, there will always be some loss in long power cable runs and the output of the amplifier will be less than with direct connections to the battery. An alternate method of installation is to mount a separate battery in the trunk adjacent to the amplifier. The power connections can then be made directly to the ancillary battery. The connecting cables to the vehicle power system will then only carry the battery charging current and a small voltage drop from the generator will not affect the amplifier power output. The average battery charging current will normally not exceed 15A and 14 AWG cables may be used between the battery and the charging system.

The cables should be terminated in the lugs provided with the amplifier. Use a large soldering iron to solder the cable into the lug, making sure the solder flows into the lug to make a low resistance connection. The lugs should be connected to the brass bolts on the amplifier and the wing nuts screwed down securely.

3.4 POWER SUPPLIES - BASE STATION

The amplifier may be used with any 13.6V DC power supply capable of peak currents of 75A and an average current of 35A. The supply should maintain good voltage regulation with low ripple. .

The PS75 is specially designed for use with MA1000B and provides a well regulated 13.6V supply source, when operating from 115/230V 50/60 Hz power mains. The voltage sensing leads terminate at the output terminals and compensate for any voltage drop in the internal power supply leads. This ensures that 13.6V is maintained at the output at maximum load.

An alternate low cost power supply can be constructed using a 12V auto battery and a 15A charger. Although the collector currents peak over 70A, the average current on voice operation is 30 - 40A. With a 50% transmit duty cycle, the 15A charger will keep the battery charged.

3.5 GROUND CONNECTIONS - MOBILE

The amplifier should be grounded directly to the body of the vehicle. Do not rely on the mobile mount for this connection. Make sure the ground wire makes a low resistance connection and is as short as possible.

NOTE: The vehicle body should not be used as the connection to the negative battery terminal. Always run a separate cable for the negative battery connection.

3.6 GROUND CONNECTIONS - BASE STATION

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.

3.7 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 reach 2-3A at full output.

3.8 ANTENNA MATCHING

Correct antenna matching is extremely important when using the MA1000B amplifier. The output transformers in the amplifier have been designed to provide a correct match to a 50 ohm resistive load and the amplifier is only capable of delivering the rated power output, if the load is very close to 50 ohms. A good example of this is if the amplifier operates into a 100 ohm load (or at a VSWR of 2:1). The voltage at the output of the amplifier will remain substantially constant, and with a power output of 600 watts into a 50 ohm load, the output voltage is 173V RMS. The same voltage across a 100 ohm load equals $300W = 173V^2/100$ ohms. If the load is less than 50 ohms, the amplifier will current limit and the output will similarly be reduced.

The output circuit in a tube type amplifier is tuned and it is normally possible to adjust the amplifier to provide correct matching over a limited range of output impedance. The MA1000B is completely broadband with no tuning adjustments of any kind and it is not possible to compensate for any mismatch in the antenna system. This difference in operation between the true broadband amplifier and the older tuned type tube amplifiers must be clearly understood if satisfactory results are to be achieved.

The antenna matching should be checked carefully using a VSWR indicator in the co-axial cable to the antenna. The antenna or tuner should be adjusted to the lowest possible VSWR. An exact match is desirable but the amplifier will operate satisfactorily up to a VSWR of 1.5:1. Operation at VSWRs exceeding 2:1 is not recommended and even at the 2:1 level, the amplifier output is substantially reduced.

3.9 ANTENNAS

The MA1000B amplifier is suitable for use with any antenna with a 50 ohm feed system and a power capability of at least 600W. If the antenna system cannot be adjusted to provide a 50 ohm match to the antenna it will be necessary to use a matching system such as an antenna tuner or a broadband impedance matching transformer.

The base impedance of the typical resonant mobile whip antenna will be in the range of 10-20 ohms. This will result in a VSWR in excess of 2:1 and the amplifier will not operate satisfactorily. A matching network can be placed at the base of the antenna to provide a 50 ohm match. Alternatively, use a broadband matching transformer and select the tap position providing the lowest SWR.

3.10 RF FEEDBACK

It is very important to prevent RF feedback into the exciter. RF feedback will be indicated by severe distortion and oscillation. In a mobile station, feedback can usually be prevented by grounding both the amplifier and the exciter directly to the body of the vehicle. In a fixed station, connect the exciter and amplifier together using a short heavy gauge ground wire. As a further precaution, ensure all control leads to the exciter are bypassed to ground where they enter the exciter.

3.11 FREQUENCY ADJUSTMENT

The MA1000B is fully broadband and requires no tuning or adjustment for operation on any frequency.

3.12 FILTER SELECTION

A front panel switch is provided for manual selection of the filters. When the switch is turned to the remote position, the filters may be selected by grounding the control line to the filter through the connector on the rear panel of the amplifier. A 5 position switch may be wired to the connector for remote manual filter selection. Many amateur transceivers can be modified to provide automatic filter selection when the bandswitch is turned. First check the bandswitch and see if there is an unused switch section. If one is not available, it may be possible to fit an additional switch section. The moving arm of the switch should be grounded and each switch contact should be wired to the appropriate filter contact on the connector.

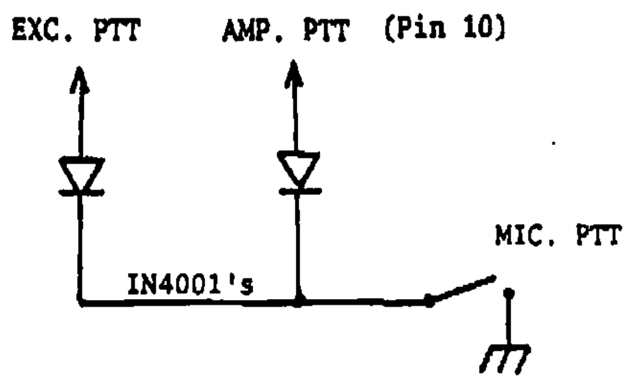
The switching power is provided by the amplifier and the switch contacts should be rated to control 12V at 140 mA.

Filter Connections

Pin 1	1.8 - 2.0 MHz
Pin 2	3.5 - 4.0 MHz
Pin 3	7.0 - 7.3 MHz
Pin 4	14.0 - 14.35 MHz
Pin 5	21.0 - 21.45 MHz
Pin 7, 8, 9	Ground

3.13 EXCITER INTERCONNECTIONS

The MA1000B 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 PL 259 UHF connector. The amplifier 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 12V at 140 mA. If there is any interaction between the exciter and amplifier, two diodes may be installed in the switching lines to form an OR gate as shown in the diagram.



3.14 ON/OFF SWITCHING

The amplifier may be switched off by using the circuit breaker on the front panel. For remote control, the amplifier is switched on by grounding the control line Pin No. 11 on the amplifier rear contact.

3.15 DRIVE LEVEL

The normal drive level for full output should not exceed 60W PEP. The gain of the transmitter and the ALC circuit should be adjusted so that the exciter cannot be overdriven. If the circuit breaker trips, it is a sure indication of overdrive, antenna mismatch, or incorrect filter selection.

CAUTION: Do not overdrive. Excessive drive levels can destroy the expensive power transistors. If the exciter is capable of power output in excess of 120W, it is recommended that a modification is made so that the maximum power output is restricted.

SECTION 4

OPERATION

4.1 GENERAL

The MA1000B amplifier requires no tuning adjustments. Provided the antenna is correctly matched and the drive level set correctly, operation is simply a matter of turning the power switch on, and selecting the correct band switch position. The transistors require no warmup and the amplifier is ready for immediate operation.

4.2 CONTROLS

ON-OFF CIRCUIT BREAKER

The amplifier can be switched on and off using the front panel rocker switch on the circuit breaker. If the collector current exceeds 75A, the circuit breaker will trip and is reset by the rocker switch. If the circuit breaker trips repeatedly, the drive level is excessive or the antenna is not matched correctly. The circuit breaker will also trip if there is a short circuit or fault in the amplifier.

ON-OFF REMOTE

If the amplifier is remote controlled the circuit breaker is left on. The relay in the amplifier is then used to switch the amplifier on and off via the remote switch.

FILTER SELECTION

The filter selection is made by turning the filter switch to the correct band. If the amplifier has been set up for remote or automatic operation, turn the filter switch to the remote position. When the exciter is wired for automatic operation, the correct filter will be selected when the band switch is turned. It is important to select the correct filter. For proper operation, and maximum harmonic attenuation, the filter cutoff frequency should lie just above the exciter channel frequency. If the filter has a cutoff frequency below the channel frequency, the circuit breaker will probably open. Although the transistors are rated for operation at infinite VSWR, the collector currents may be excessive if the wrong filter is selected, causing a possibility of transistor failures.

4.3 DRIVE ADJUSTMENT

Before setting the drive level, make sure that the amplifier is operating into a 50 ohm load.

SSB

Increase the drive level until the collector current reaches 70A on voice peaks. Do not increase the drive level beyond this point or peak flattening will occur. If the circuit breaker trips, it is an indication of severe overdrive. The meter reading is dependent on the voice characteristics and it is recommended that an oscilloscope is used to monitor the output waveform, particularly when setting the initial drive level. When using an oscilloscope, set the drive level so that there is no indication of peak flattening on voice peaks. If the exciter is provided with adjustable ALC, set the level to limit the drive to the maximum level required to drive the amplifier to full output.

CW/FSK

Adjust the drive level for maximum collector current of 70A. Do not hold the key down for long periods.

4.4 DUTY CYCLE-COOLING

The MA1000B is rated for a 50% transmit/receive duty cycle on SSB voice operation or on CW at a maximum ambient temperature of 25°C. At higher ambient temperatures, the transmit duty cycle must be reduced. The amplifier is not designed for FSK operation and if used in this mode, the duty cycle should be restricted. At ambient temperatures of not more than 25°C, a maximum transmit period of 5 minutes is recommended. Sufficient time between transmissions should be allowed for the heatsink temperature to drop. The duty cycle of the amplifier can be extended by directing a fan at the cooling fins.

The amplifier is protected by a 75°C thermostat mounted on the heatsink and should the duty cycle be exceeded, the thermostat will open, switching the amplifier off, and connecting the exciter to the antenna. This ensures that no damage can result from overheating.

4.5 MEASURING POWER

METHODS

The two most widely used methods of measuring power are input power and output power. It is simpler to measure input power and in the amateur service amplifiers are usually rated in terms of input power. In commercial service, it is normal to rate amplifiers according to their power output.

INPUT POWER

The MA1000B is rated at a power input of 1000W. At a supply voltage of 13.6V this represents a collector current of 73.5A. On CW setting, the input power is simply a matter of adjusting the drive for a collector current of 73.5A. On voice operation, it is usual to adjust the drive level so that the meter indicates the correct collector current on peaks. The ballistics (damping) of the meter are such that the input power will not exceed 1000W on normal voice operation. If the amplifier is operated from a battery, it is not possible for the supply voltage to exceed 13.6V under load. The PS75 AC power supply is fully regulated and apart from the initial adjustment of the output voltage, it is not necessary to measure the supply voltage. If an adjustable or unregulated power supply is used, it will be necessary to use a separate voltmeter in order to comply with some government regulations. (Required in the USA.)

OUTPUT POWER

The amplifier output power will vary according to the input power and the amplifier efficiency. The best method of measuring SSB output power is to use a peak reading RF voltmeter (calibrated RMS) connected across a non-reactive 50 ohm load. The output power is then $E^2/50$ = PEP Watts. (158V Peak = 500W, 141V Peak = 400W)

An oscilloscope is another peak reading instrument and a calibrated oscilloscope may be used to measure the peak-to-peak voltage across the load (500W = 448V P. to P., 400W = 399V P. to P.). The frequency response of oscilloscopes frequently falls off at the top end of the HF range and the oscilloscope must be calibrated at the operating frequency. The peak reading voltmeter or oscilloscope can be used to measure power output using voice waveforms, two tone test signals and CW.

The conventional wattmeter or directional coupler measures the average power output and is only accurate on a CW signal. PEP output should be measured using a 2 tone test signal. The wattmeter will indicate 50% of the PEP output (500W PEP = 250W Av., 400W PEP = 200W Av.). On a voice waveform, the average power is even lower and the indicated output power will depend on the meter characteristics. The reading may only be 20 to 40% of PEP and is not a very meaningful indication of output.

POWER SUPPLY VOLTAGE

To achieve rated output power, the amplifier must be operated at a supply voltage of 13.6V measured under load across the amplifier power input terminals. The PS75 AC power supply is rated to supply 13.6V at a supply current of 75A. When operating in a mobile installation, it is difficult to maintain the supply voltage at 13.6V under load. Even with the alternator operating at maximum charge and maintaining the battery voltage at 13.6V, it is inevitable that there will be some voltage drop in the supply leads at currents as high as 70A. For this reason, the power output measured on CW or on two tone test signals in mobile installations are likely to be disappointing. The problem is that we are reaching the limitations of a 12V supply system when operating at these power levels.

Fortunately, the SSB voice signal has lower energy requirements than the test tones, and on voice operation, the voltage drop to the amplifier will be much lower than is indicated on the test signals. An oscilloscope or peak reading voltmeter will show that on SSB voice operation, the output power is similar to that attained on the regulated power supply.

SECTION 5

TECHNICAL DESCRIPTION

5.1 GENERAL

The MA1000B amplifier consists of four push-pull amplifiers with input and output impedances of 200 ohms. The 4 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 compensastion and gain levelling through the frequency range. The output of the amplifier is coupled to the antenna through one of the 5 low pass filters.

5.2 AMPLIFIERS

Each of the 4 basic amplifiers use a simple push-pull design using two high power broadband linear power transistors. These newly developed transistors use an emitter ballasted chip design to control impedance and gain over a bandwidth of more than a decade.

The schematic diagram shows how each pair of transistors are connected in a conventional transformer coupled push-pull circuit. Special ferrite loaded broadband transformers provide the correct impedance transformation, with high efficiency over the range 1.8-21.5 MHz.

For maximum efficiency and good linearity, the amplifiers all operate in CLASS AB. The low impedance bias source is provided by the transistors Q1 and Q2. The thermal compensation for the 2mV/°C emitter/base voltage change of the output transistors is provided by Q1 which is mounted on the heatsink. The bias regulator provides a stiff current source with excellent thermal tracking.

5.3 INPUT CIRCUIT

Matching the 4 amplifier inputs over the frequency range of nearly four octaves provides a complex design problem. The base impedance of the RF transistor varies greatly 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 8 dB.

If each amplifier was identical in all respects, the four 200 ohm inputs could be paralleled to give a combined input impedance of 50 ohms. In practice, the mismatch between amplifiers would prevent satisfactory operation. The input combiner is used to parallel the inputs while providing good port to port isolation. The unbalance components in the inputs then appear across the non-inductive resistors used in the combiner and are dissipated as heat.

The excellent transfer characteristics of the input transformers and the combiner make it possible to use a single compensation network at the 50 ohm input instead of individually compensating at the bases of all 8 transistors. The computer designed input network uses a combination of inductors, resistors and capacitors to provide a low input VSWR and substantially level gain across the operating range.

5.4 OUTPUT CIRCUIT

The output circuit is similar to the input and it would not be possible to combine the outputs without considerable interaction between the amplifiers. The output combiner is similar in design to the input combiner and the unbalance components of the output are dissipated in the balance resistors.

5.5 OUTPUT FILTER

A broadband transistor amplifier has a relatively high level of harmonic output. The even order harmonics tend to balance in the push-pull output transformers, but the odd order (3rd, 5th, etc.) are not attenuated and a filter is essential to ensure satisfactory spectral purity. The filter design used is a low loss 5 pole Tchebycheff with a low reflection coefficient.

Five filters are used to cover the frequency range. Separate relays are used at the input and output of each filter so that the filters may be selected by remote control.

5.6 CONTROL CIRCUITRY

The amplifier transmit/receive switching is accomplished by the 2 relays, RLY 1 and RLY 14. In the receive or off position the input and output connectors are connected together so that the amplifier is completely bypassed. In the transmit mode, the relay RLY 1 connects the input terminal to the input combiner and also switches on the bias to the amplifiers. RLY 14 connects the amplifier output to the antenna connector.

The positive supply voltage passes through the circuit breaker and the on/off relay RLY 2. The circuit breaker is used for local ON/OFF switching and the RLY 2 for remote ON/OFF switching. The diode D3 prevents RLY 2 operating if the supply polarity is reversed. The thermostat is connected so that RLY's 1 and 14 open if the heatsink temperature exceeds 75°C.

SECTION 6

SERVICE-MAINTENANCE

6.1 INTRODUCTION

The MA1000B requires no routine maintenance. The power transistors are rated for an extended service life and replacement is recommended only in event of a failure. The entire amplifier operates directly from a 13.6V supply source and no high voltages are present in the amplifier. This low voltage operation makes a major contribution to low maintenance requirements. The only special precautions to take to ensure reliability and a long service life are to ensure that the amplifier is operated into a correctly terminated load and is not overdriven. It should be noted that although the transistors are rated for operation at infinite VSWR, prolonged operation when operating into mismatched loads causes excessive dissipation and early device failure.

6.2 AMPLIFIER ACCESS

6.2.1 COVER REMOVAL

The cover is removed by unscrewing the 6 retaining screws in the base and 3 on each side. This gives complete access to the entire amplifier.

6.2.2 FILTER BOARD REMOVAL

The filter board may be removed for relay or filter component replacement by unscrewing the 6 screws securing the board to the heatsink. The circuit board can usually be lifted sufficiently to give access to the components for replacement. If necessary, the appropriate cables can be temporarily disconnected to provide further clearance.

6.2.3 AMPLIFIER CIRCUIT BOARD

Most of the amplifier components can be replaced without removing the circuit board. If it is necessary to lift the circuit board, remove the two circuit breaker mounting screws and swing the breaker clear of the board. Remove the 6 retaining screws, the 16 RF power transistor retaining screws and the 2 bias transistor mounting screws. The circuit board can then be lifted. Take special care, when replacing the board, to ensure there is adequate heatsink compound under the transistors and that no strain is exerted on the transistor leads when the transistor mounting screws are tightened.

6.2.4 RF TRANSISTOR REPLACEMENT

The components in the feedback network above each transistor should be moved to one side by unsoldering the resistor from the output transformers and pushing to one side. Unsolder the transistor leads, taking care not to damage the circuit board foil. If will be helpful to use a desoldering tool to remove as much solder as possible and then lift the lead up from the board while the solder is molten. Unscrew the two mounting screws and remove the transistors. The replacement transistor should have the leads trimmed to fit the circuit board and the mounting base should be liberally coated with heatsink compound. Position the transistor carefully with the collector lead towards the output transformer. Replace the 2 mounting screws and tighten. Check that there is no strain on the transistor leads and solder in place. The soldering iron should have sufficient thermal capacity to melt the solder rapidly. If the iron is too small, a prolonged application will be required to melt the solder. This will give sufficient time for the heat to be conducted through the lead and cause damage to the transistor.

6.3 GENERAL

Fault location is relatively simple as the basic circuitry is simple and there are only 2 transistors in each of the four amplifiers. The high power levels usually mean that if a component fails, there will be heating and physical evidence of the damage. The operation of the switching circuitry is simple and can be checked by using a VOM to make continuity measurements.

6.4 AMPLIFIER SERVICE

The failure of one of the four amplifiers will cause the amplifier to run at half power even though 3 amplifiers are still operating. The unbalance in the combiners causes one of the amplifiers to dissipate its full output in the balance resistor on the combiners. Low power output and overheating of the balance resistor on the output combiner is a sure indication of a fault in one of the amplifiers.

The faulty amplifier can usually be located by measuring the collector currents in turn. The lead to the output transformer center-tap should be lifted and the collector currents should be measured while the amplifier is driven to a moderate output level. The faulty amplifier will show a substantial difference in collector current from the other 3 amplifiers.

Check the defective amplifier for any obvious fault such as broken or disconnected wires and defective input or output transformers. If everything appears normal, one or both of the transistors are defective. The amplifier will have very low output even if only one of the transistors is defective. The faulty transistor can be located by placing a .1 uF capacitor across the base and collector of each transistor to ground in turn. When the defective transistor is bypassed, the output will show a substantial increase.

When the defective amplifier is repaired check the balance resistors. The resistors will usually take moderate overload without damage, however, it is advisable to check the resistance of any balance resistors that show evidence of having been overheated.

6.5 BIAS CIRCUIT

Check that the total quiescent collector current is set at approximately 1.6 - 2A. (NOTE: The total quiescent current will include the bias currents, subtract the current in R5 from the total to get actual collector current.) If necessary adjust the bias potentiometer to set the collector current to the correct level. Under quiescent conditions, the bias voltage at the bases of the transistors should be approximately .625V and should not increase by more than a fraction of a volt at full drive. If the bias circuit does not appear to be operating correctly, check that the emitter/base voltage differential of the 2 bias transistors is approximately .7V. Any substantial variation indicates that the device is defective. The quiescent current should be reset after any transistor change.

6.6 FILTERS

A filter defect is usually only apparent on one filter range. If the defect is present on more than one range, check the filter switch wiring and for sticking relay contacts. If the fault is confined to one filter, check the input and output relays and the filter components.

CAUTION: Although the highest DC voltage in the amplifier should not exceed 13.6V, quite high RF voltages are present at full output. While the RF voltages are not lethal, they can cause unpleasant burns and care should be taken when servicing the amplifier. The amplifier power supply or the vehicle battery system are capable of very high currents and great care should be taken to avoid short circuits. Apart from the fire hazard, short circuits are likely to cause severe physical and electrical damage to the amplifier.

SECTION 7

PARTS LIST

Reference	Part Number	Description
C1	211103	Capacitor, Ceramic Disc .01uF 500V
C2	211103	Capacitor, Ceramic Disc .01uF 500V
C3	212390D	Capacitor, Ceramic Disc 39pF 3kV
C4	212201D	Capacitor, Ceramic Disc 20pF 3kV
C5	212560D	Capacitor, Ceramic Disc 56pF 3kV
C6	240020	Capacitor, Tantalum 2.2uF
C7	240020	Capacitor, Tantalum 2.2uF
C8	210104	Capacitor, Ceramic Disc .1uF 25V
C9	220821	Capacitor, DM15 820pF
C10	210104	Capacitor, Ceramic Disc .1uF 25V
C12	220821	Capacitor, DM15 820pF
C13	210104	Capacitor, Ceramic Disc .1uF 25V
C14	210104	Capacitor, Ceramic Disc .1uF 25V
C15	220821	Capacitor, DM15 820pF
C16	210104	Capacitor, Ceramic Disc .1uF 25V
C17	210104	Capacitor, Ceramic Disc .1uF 25V
C18	220821	Capacitor, DM15 820pF
C19	210104	Capacitor, Ceramic Disc .1uF 25V
C20	224122	Capacitor, DM19 1200pF
C21	224122	Capacitor, DM19 1200pF
C22	224122	Capacitor, DM19 1200pF
C23	224122	Capacitor, DM19 1200pF
C24	210104	Capacitor, Ceramic Disc .1uF 25V
C25	210104	Capacitor, Ceramic Disc .1uF 25V
C26	210104	Capacitor, Ceramic Disc .1uF 25V
C27	210104	Capacitor, Ceramic Disc .1uF 25V
C28	211103	Capacitor, Ceramic Disc .01uF 500V
C29	211103	Capacitor, Ceramic Disc .01uF 500V
C30	211103	Capacitor, Ceramic Disc .01uF 500V
C31	211103	Capacitor, Ceramic Disc .01uF 500V
C32	230202	Capacitor, Electrolytic 2000uF 16V
C33	230202	Capacitor, Electrolytic 2000uF 16V
C34	230202	Capacitor, Electrolytic 2000uF 16V
C35	211103	Capacitor, Ceramic Disc .01uF 500V
C36	211103	Capacitor, Ceramic Disc .01uF 500V
C37	211103	Capacitor, Ceramic Disc .01uF 500V
C38	211103	Capacitor, Ceramic Disc .01uF 500V
C39	211103	Capacitor, Ceramic Disc .01uF 500V
C40	211103	Capacitor, Ceramic Disc .01uF 500V
C41	211103	Capacitor, Ceramic Disc .01uF 500V
C42	211103	Capacitor, Ceramic Disc .01uF 500V
C43	211103	Capacitor, Ceramic Disc .01uF 500V
C44	211103	Capacitor, Ceramic Disc .01uF 500V
C45	211103	Capacitor, Ceramic Disc .01uF 500V

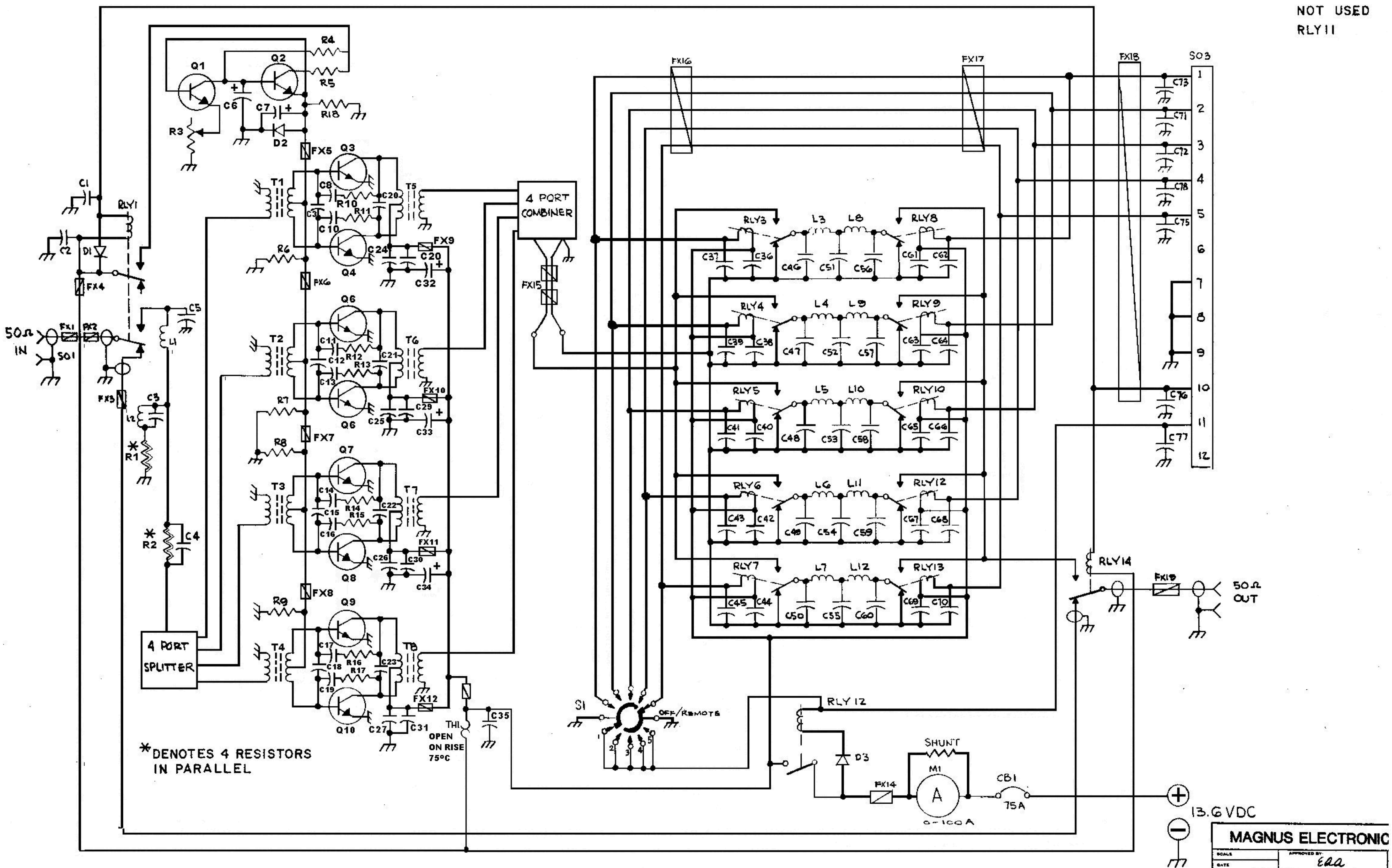
Reference	Part Number	Description
C46 C60	See Filter Parts List for Capacitors C46 thru C60.	
C61	211103	Capacitor, Ceramic Disc .01uF 500V
C62	211103	Capacitor, Ceramic Disc .01uF 500V
C63	211103	Capacitor, Ceramic Disc .01uF 500V
C64	211103	Capacitor, Ceramic Disc .01uF 500V
C65	211103	Capacitor, Ceramic Disc .01uF 500V
C66	211103	Capacitor, Ceramic Disc .01uF 500V
C67	211103	Capacitor, Ceramic Disc .01uF 500V
C68	211103	Capacitor, Ceramic Disc .01uF 500V
C69	211103	Capacitor, Ceramic Disc .01uF 500V
C70	211103	Capacitor, Ceramic Disc .01uF 500V
D1	320102	Diode, Silicon 1N4001
D2	320103	Diode, Silicon 3 amp
D3	320102	Diode, Silicon 1N4001
FX1	490501D	Sleeve Ferrite
FX2	490501D	Sleeve Ferrite
FX3	490501D	Sleeve Ferrite
FX4	490202D	Sleeve Ferrite
FX5	490202D	Sleeve Ferrite
FX6	490202D	Sleeve Ferrite
FX7	490202D	Sleeve Ferrite
FX8	490202D	Sleeve Ferrite
FX9	490202D	Sleeve Ferrite
FX10	490202D	Sleeve Ferrite
FX11	490202D	Sleeve Ferrite
FX12	490202D	Sleeve Ferrite
FX13	490202D	Sleeve Ferrite
FX14	490302	2X Bead, Ferrite
FX15	490302	2X Bead, Ferrite
FX16	490302	2X Bead, Ferrite
FX17	490302	2X Bead, Ferrite
FX18	490302	2X Bead, Ferrite

Reference	Part Number	Description
FX19	490501D	Sleeve, Ferrite
L1	430101D	Inductor Special
L2	430102D	Inductor Special
L3	For L3 thru L12 see appropriate filter	
L12	Parts List.	
M1	740003D	Meter 100 amp scale
Q1	310024D	Transistor, MJE29A
Q2	310025D	Transistor, MJE3055K
Q3	310030D	Transistor, Rf Power
Q4	310030D	Transistor, Rf Power
Q5	310030D	Transistor, Rf Power
Q6	310030D	Transistor, Rf Power
Q7	310030D	Transistor, Rf Power
Q8	310030D	Transistor, Rf Power
Q9	310030D	Transistor, Rf Power
Q10	310030D	Transistor, Rf Power
R1	4X 153201D	4X Resistor Metal Film 200 ohm 2W
R2	4X 153221D	4X Resistor Metal Film 200 ohm 2W
R3	170301D	Pot Preset 5 ohm W.W.
R4	144471	Resistor Carbon 470 ohm 1W
R5	160005	Resistor WW 5 ohm 10W
R6	133027	Resistor Carbon 2.7 ohm 1/2W
R7	133027	Resistor Carbon 2.7 ohm 1/2W
R8	133027	Resistor Carbon 2.7 ohm 1/2W
R9	133027	Resistor Carbon 2.7 ohm 1/2W
R10	154470	Resistor Carbon 47 ohm 2W
R11	154470	Resistor Carbon 47 ohm 2W
R12	154470	Resistor Carbon 47 ohm 2W
R13	154470	Resistor Carbon 47 ohm 2W
R14	154470	Resistor Carbon 47 ohm 2W
R15	154470	Resistor Carbon 47 ohm 2W
R16	154470	Resistor Carbon 47 ohm 2W
R17	154470	Resistor Carbon 47 ohm 2W
R18	154470	Resistor Carbon 47 ohm 2W
RLY1	540005	Relay DPDT 5 Amp 12V
RLY2	540006D	Relay SPDT 50 Amp

Reference	Part Number	Description
RLY3	540005	Relay DPDT 5 Amp 12V
RLY4	540005	Relay DPDT 5 Amp 12V
RLY5	540005	Relay DPDT 5 Amp 12V
RLY6	540005	Relay DPDT 5 Amp 12V
RLY7	540005	Relay DPDT 5 Amp 12V
RLY8	540005	Relay DPDT 5 Amp 12V
RLY9	540005	Relay DPDT 5 Amp 12V
RL10	540005	Relay DPDT 5 Amp 12V
RLY11	Not Used	
RLY12	540005	Relay DPDT 5 Amp 12V
RLY13	540005	Relay DPDT 5 Amp 12V
RLY14	540005	Relay DPDT 5 Amp 12V
S1	510004D	Switch 2 Pole, 6 Position Shorting
SO1	610003	Socket Coax SO239
SO2	610003	Socket Coax SO239
SO3	610014D	Socket Jones Type 12 Pin
	610015D	Plug Jones Type 12 Pin
T1	450306D	Transformer Ferrite Driver
T2	450306D	Transformer Ferrite Driver
T3	450306D	Transformer Ferrite Driver
T4	450306D	Transformer Ferrite Driver
T5	450307D	Transformer Ferrite Output
T6	450307D	Transformer Ferrite Output
T7	450307D	Transformer Ferrite Output
T8	450307D	Transformer Ferrite Output
TH1	560001	Thermostat N/C 75°C
	910020D	Heatsink
	910021D	Panel Front
	910022D	Panel Rear
	910023D	Cover
	910024D	Bracket Mounting
	570004D	Breaker Magnetic 75A
	731010D	Board, Circuit Amplifier
	731011D	Board, Circuit Filter
	700103D	Combiners (4)

FILTER COMPONENTS

Reference	Part Number	Description
C46	212431D	Capacitor, Disc 430pF 2kV
/56	212390D	Capacitor, Disc 390pF 2KV
C47	212431D	Capacitor, Disc 430pF 2kV
/57	212271D	Capacitor, Disc 270pF 2kV
C48	212121D	Capacitor, Disc 120pF 3kV
/58	212201D	Capacitor, Disc 200pF 3kV
C49	212121D	Capacitor, Disc 120pF 3kV
/59	212560D	Capacitor, Disc 56pF 3kV
C50	212560D	Capacitor, Disc 56pF 3kV
/60	212560D	Capacitor, Disc 56pF 3kV
C51	212751D	Capacitor, Disc 750pF 2kV
	212751D	Capacitor, Disc 750pF 2kV
	212680D	Capacitor, Disc 680pF 2kV
	212391D	Capacitor, Disc 390pF 2kV
C52	212431D	Capacitor, Disc 430pF 2kV
	212431D	Capacitor, Disc 430pF 2kV
	212431D	Capacitor, Disc 430pF 2kV
	212431D	Capacitor, Disc 430pF 2kV
C53	212431D	Capacitor, Disc 430pF 2kV
	212271D	Capacitor, Disc 270pF 2kV
C54	212151D	Capacitor, Disc 150pF 2kV
	212201D	Capacitor, Disc 200pF 3kV
C55	212121D	Capacitor, Disc 120pF 3kV
	212121D	Capacitor, Disc 120pF 3kV
L3/8	450605D	Inductor, 160M
L4/9	450601D	Inductor, 75M
L5/10	450602D	Inductor, 40M
L6/11	450603D	Inductor, 20M
L7/12	450604D	Inductor, 15M



MAGNUS ELECTRONIC

MA1000B LINEAR AMP

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