

Publication: 210352

Issue Date: July 1994

TECHNICAL MANUAL

for

MF/HF Multi-Antenna Coupler

Model MAC-8

THE TECHNICAL MATERIEL CORPORATION
COMMUNICATIONS ENGINEERS

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All inquiries should be directed to the following:

THE TECHNICAL MATERIEL CORPORATION

700 Fenimore Road

Mamaroneck, New York 10543 U.S.A.

Telephone 914-698-4800 * Facsimile (FAX) 914-698-4805

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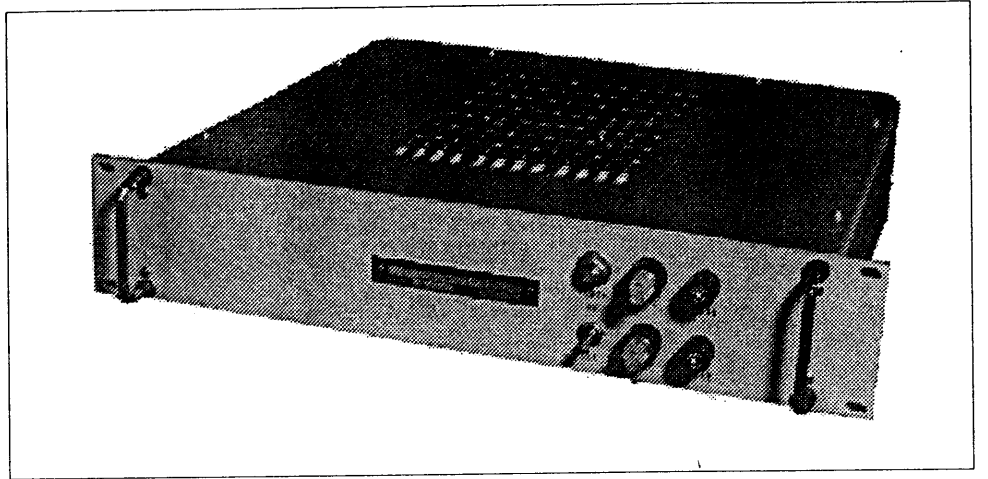
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Model MAC-8 Eight-Input Multi-Antenna Coupler

Section 1 - General Description

1.1 Functional Description

1.1.1 Overview

The MAC-8 multi-antenna coupler is a broadband coupling unit, used for coupling up to eight antennas to one common communications receiver, simultaneously. In addition, the coupler may be used as an RF combiner when the RF signals from multiple sources are required for test or analysis. The coupler provides a nominal 2dB gain from each antenna to the receiver, with a wide dynamic range and low noise characteristic over the frequency range of 2 to 30MHz. The equipment is designed to provide excellent isolation from antenna to antenna and from each antenna to the receiver. The coupler is fully solid state, including power supply components.

1.1.2 Major Assemblies

The coupler consists of eight input preamplifiers, one output buffer amplifier and a regulated power supply. The input preamplifiers are connected to the output amplifier through an RF combining network.

1.1.3 Input/Output Characteristics

The input and output characteristic impedance is 50 ohms, with a VSWR better than 1.5-to-1. Optionally, 70 ohms impedance can be provided. Isolation is maintained to a minimum of -40dB between each antenna terminal and -55dB from each antenna terminal to the receiver input. Phase correlation of input signals appearing at the output is kept within two (2) degrees over the operating range of 2 to 30MHz.

1.1.4 RF Outputs

The number of input ports available with the MAC-8 is fixed at eight. Input/output connectors, are normally the BNC-type but may be replaced depending on the interconnect required at the receiving site.

1.2 Physical Description

1.2.1 Equipment Mounting

The MAC-8 is designed for mounting in a standard 19-inch rack. The operating controls are located on the front panel. The input connectors, output connector and primary power socket are mounted on the rear panel. The amplifiers and power supply regulator are mounted on printed circuit boards which are in turn bolted to the coupler chassis.

1.2.2 Semiconductor Complement

A list of a semiconductors used in the MAC-8 are listed in Table 1.1.

Table 1.1 - Semiconductor and Integrated Circuit Complement

Power Supply and Regulator	
Rectifier Bridge	NW10005
Bias Regulator	1N758A
Bias Regulator	1N914B
Current Regulator	TX10001
Voltage Regulator	2N5086
Voltage Regulator	2N3055
Preamplifier and Output Circuits	
Bias Regulator	1N914B
Buffer	2N3866
Current Amplifier	2N5160

1.3 MAC-8 Technical Specifications

Frequency Range 2-32MHz

Number of Inputs Eight input ports

Input/Output Impedance Nominal 50 ohms, unbalanced. 70 ohms is available. BNC-type connectors. N-type and others are available.

Insertion Gain Nominal +2dB over operating range.

Frequency Response +/-1.0dB, 100kHz-32MHz

Offband Rejection Greater than -60dB, 10-100kHz. Greater than -30dB, 46-1000MHz.

Noise Figure Nominal +7dB.

Input/Input Isolation Greater than -40dB

Output/Input Isolation Greater than -55dB

Phase Differential +/-2 degree maximum, input-input

Desensitization 100 microvolt signal is compressed less than 3dB maximum when a 7-volt peak-to-peak signal between 2 and 6MHz is applied at the same time.

1.3 Technical Specifications (Continued)

Intermodulation Distortion For 50-ohm units: Second order is greater than -60dB for a 0.4-volt input; Third order is greater than -65dB.

VSWR Output/Input is better than 1.5-to-1.

Mean-Time-Between-Failure Nominally 20,000 hours.

Operating Features

Cooling Convection, no fans or moving parts

Ambient Conditions 0°C to +50°C; Up to 95% R.H. Storage -30°C to +80°C

Primary Power 115VAC standard/230VAC optional, 48-400Hz, single phase.

Power Consumption 25 watts maximum.

Size and Weight 3.5H x 19W x 14D inches, 12.5lbs (5.7kg)

Line Filters Greater than 40dB attenuation, 14kHz-150MHz.

Special Features

Monitoring Indicating fuseholders display status of primary power circuits

Safety Fuse and front-end overload protection, preventing circuit failure from high RF voltages at the input. High voltage points are covered and labelled.

Components and Construction Totally solid state circuits mounted to an aluminum alloy chassis. External hardware is stainless steel. Track slides are optional and due to weight distribution, are usually not required.

2.1 Initial Inspection

2.1.1 General

Every MAC-8 undergoes a thorough testing and calibration prior to shipment. Upon receipt of the unit, check the packing case and its contents for obvious damage. Unpack the equipment carefully to reduce the risk of damage and to avoid misplacing any parts shipped as loose items. See Table 2.1 for a list of the loose items.

2.1.2 Damage By Carrier

With respect to equipment damage for which the carrier is liable, TMC will assist in describing methods of repair as well as furnishing replacement parts.

2.2 Electrical Installation

2.2.1 Primary Power

The MAC-8 operates from a 115VAC, 48 to 400Hz power source. Optionally, the MAC-8 may be wired for 230VAC, which will be noted by a decal on the rear panel adjacent to the input power connector.

2.2.2 External Connections

The following external connections must be made to the MAC-8 after it has been installed in an equipment rack:

Antenna

The antenna cables must be fitted with a connector that mates with the MAC-8 connectors provided. Normally, this is a BNC-type connector, although such connectors as type N are also available. The antenna cables are then connected to ANTENNA INPUT jacks J1..J8 on the rear panel of the MAC-8.

Power

Connect primary power to the unit by plugging the supplied power cable assembly into POWER connector on the rear panel. Ensure that the plug lines up properly with the socket using the keyway as a guide.

Outputs

Connect the output of the MAC-8 to the associated receiver via the OUTPUT connector mounted to the rear panel. RF coaxial cable, terminated with the proper mating connector, is required for this connection.

2.2.3 Clearance Requirements

The MAC-8 equipment should be located in such a way that sufficient clearance is obtained at the rear of the unit for making all RF connections. The front panel controls should also be within easy reach of an operator. The solid state design of the MAC-8 reduces heat problems, allowing "stacking" of up to five MAC-8 units, one above the other, in the same rack. If more than five units are stacked, heat-related problems may occur after prolonged use of the multicouplers. To reduce the possibility of this happening, the equipment cabinet should be fitted for forced air cooling or the couplers should be separated vertically by at least one panel height, sufficient space for dissipating heat into the operating area.

2.3 Performance Check

2.3.1 General

When the appropriate power connections have been made to the MAC-8, turn the POWER switch S1 to the ON position. The POWER lamp DS1/LP1 will light, indicating that the MAC-8 is ready for use. No further checks are required.

Table 2.1 - Loose Items Supplied

CA10505	Power Cable Assembly	1 each
TM210352	Technical Manual	1 each
UGxx	Mating Connectors	Optional extra

Section 3 - Operation

3.1 General

3.1.1 Controls

Table 3.1 contains a list of the operating controls and indicators that are located on the front panel of the MAC-8.

3.1.2 Procedures

After connecting the antennas, communication receiver and power supply, and turning on the POWER switch, no further operating procedures are required. The MAC-8 is now fully operational without further adjustment.

Table 3.1 Controls and Indicators

Power ON/OFF switch S1	Controls primary power application
POWER lamps DS1/LP1	Lights when primary power is applied and switch S1 is turned ON.
FUSE holder/indicator F1,F2	Indicates failure of fuse by illumination of the fuseholder.
SPARE fuse	Two spare fuses are contained in spare fuseholders located on the front panel.

Section 4 - Principles of Operation

4.1 General

4.1.1 Capabilities

The Model MAC-8 Multi-antenna Coupler is a broadband antenna combining system, designed to couple RF signals from up to eight antennas to the input of one communication receiver.

4.1.2 Input/Output

Both the input and output impedance of the MAC-8 coupler is nominally 50 ohms, and optionally 70 ohms. The standing wave ratio characteristic is better than 1.5-to-1 over the frequency range of 2MHz to 30MHz.

4.1.3 Salient Performance Features

The MAC-8 coupler provides a nominal insertion gain of 2dB from each antenna input to the connected receiver. The coupler is designed to ensure minimum noise generation, and to provide a high degree of intermodulation rejection and isolation between the connected antennas. The rejection and isolation figures for this equipment are stated in the Technical Specifications section of this manual (See Section 1.3).

4.1.4 Equipment Structure

The MAC-8 coupler consists of three major sections as shown in the Block Diagram Schematic (Figure 4.1) and as described in the following paragraphs. These sections consist of the input preamplifier assemblies (A2..A9); the output buffer amplifier assembly (A10); and the regulated power supply (A1).

4.2 Input Preamplifiers

4.2.1 Location and Features

Eight preamplifiers are each mounted on printed circuit boards designated A2..A9. Each is a low-noise, wide-band amplifier having a 50-ohm impedance and a nominal voltage gain of 8.5dB. Figure 4.2 depicts their locations on the chassis, while Figure 7.1 can be used to locate components and troubleshoot with the schematic diagram.

4.2.2 Power Distribution

Power for the preamplifier is obtained from the -28VDC regulated supply A1. This DC voltage is heavily decoupled to prevent distortion from the rectified power supply.

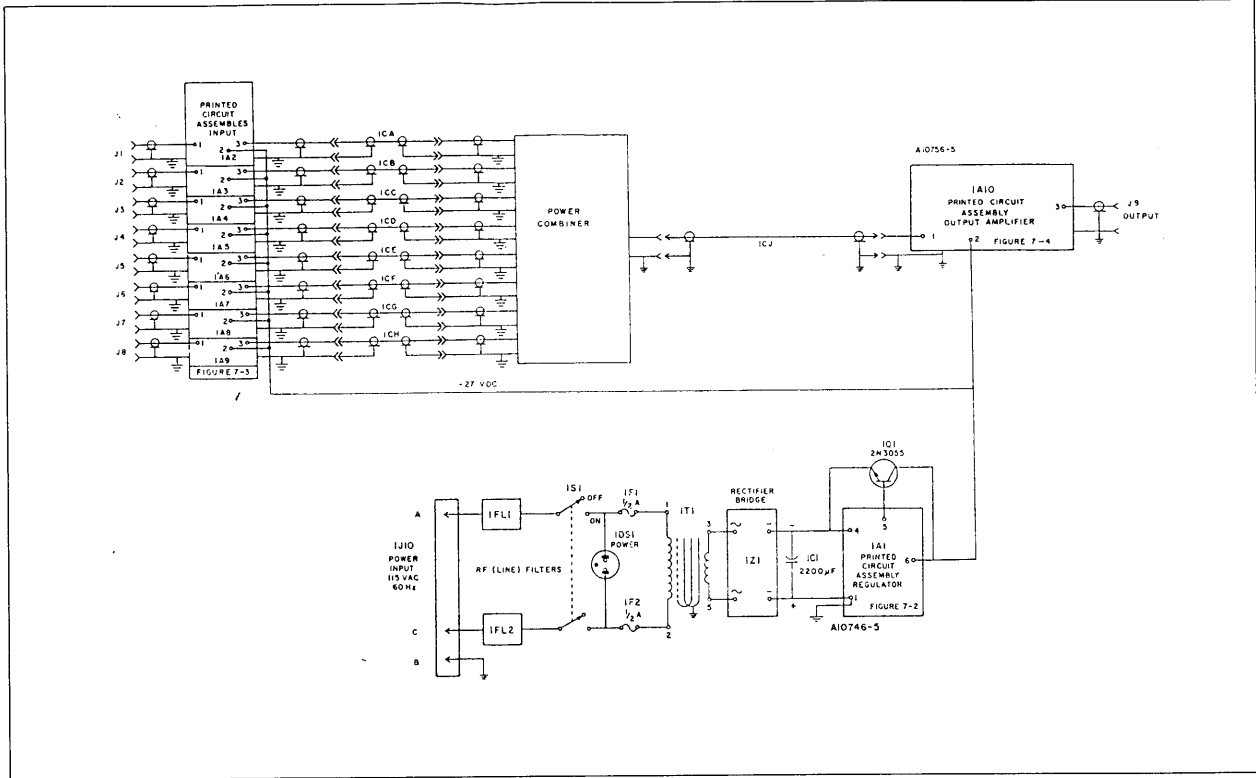


Figure 4.1 Block Diagram Schematic (overall)

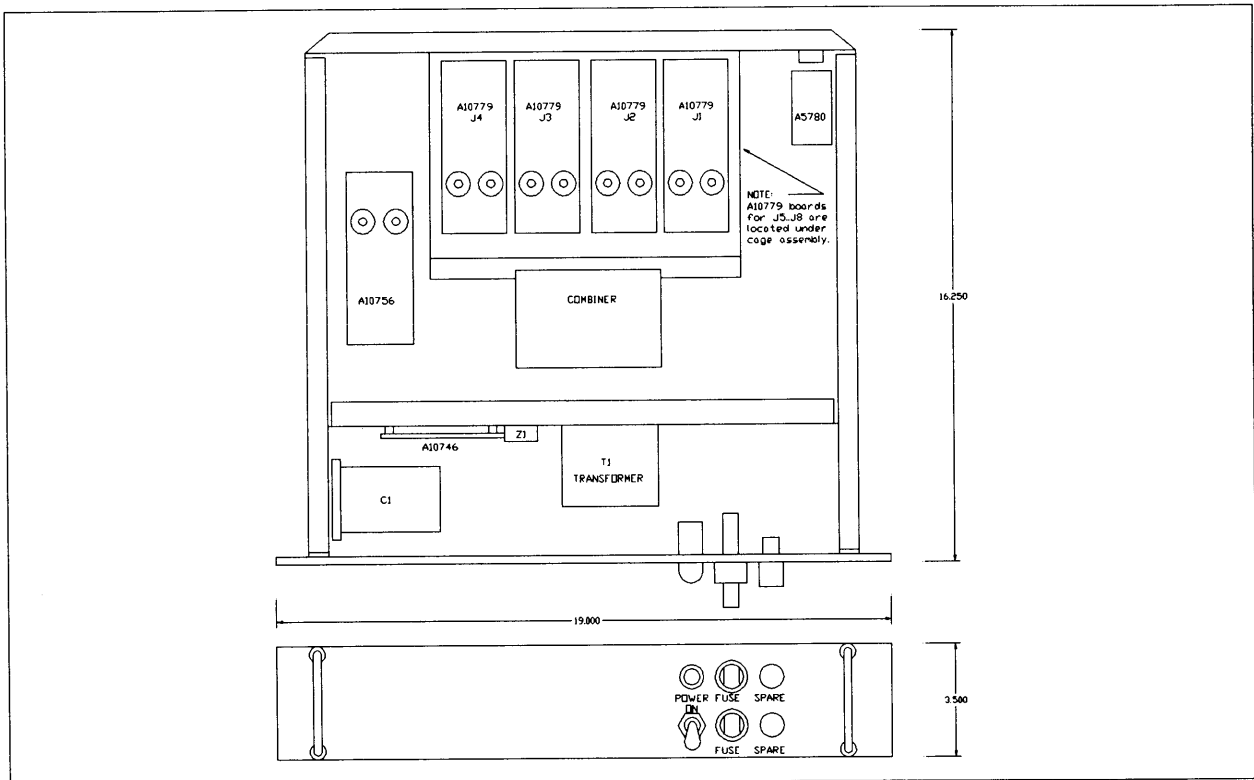


Figure 4.2 Outline Drawing w/Assembly Location

4.3 Output Buffer Amplifier

4.3.1 Location and Features

The RF from each input preamplifier is parallel-fed to a passive combining network. The output of this network is connected directly to the output buffer amplifier assembly, as shown in Figures 4.1 and 7.2. This amplifier assembly consists of an emitter-follower amplifier, with an output impedance of 50 ohms and an attenuation of 6.5dB. This results in an overall nominal coupler insertion gain from each antenna to the receiver of +2dB.

4.3.2 Circuit Analysis (?)

The input from the RF distribution line is RC-coupled through R11/C11 to the base of emitter-follower Q11. Bias is obtained with R12/R13. The output from the emitter-follower is applied to the output terminal through a matched 50-ohm load circuit consisting of R15/C13.

4.3.3 Power Distribution (?)

The -28VDC power is obtained from the regulated power supply A1 and is filtered through C1, C2 and L11 to the decoupling capacitor C12 and load compensator L12 to the 2N3866 transistor via R14.

4.4 Power Supply and Regulator

4.4.1 Location and Features

The components comprising the power supply are all chassis mounted except for the regulator circuit which is mounted on circuit assembly A1. The latter is described in the following paragraphs (See Figures 4.1 and 7.3).

4.4.2 Circuit Analysis (?)

Primary power is supplied through AC line filter FL1 to the ON/OFF switch S1. When S1 is in the ON position, power is supplied through the two fuses F1/F2 to the power transformer T1 and the front panel indicator lamp DS1. The secondary of transformer T1 produces 29VAC, which is rectified by bridge rectifier Z1, and filtered by 2900 umfd capacitor C1.

4.4.3 Current and Voltage Regulation (?)

The regulator board and transistor Q1 provide the voltage and current regulation required for the -29V supply. All components in this section, with the exception of transistor Q1, are mounted on printed circuit assembly A1. Potentiometer R7 is used to set up the initial -28V required by the AMC. Transistor Q1 and diodes CR1 and CR2 form a voltage reference circuit (sensitive to temperature and load changes) which in turn control Darlington-connected transistors Q2/Q1. In addition to providing short-circuit protection, this also provides the necessary voltage and current regulation for the power supply. The -29VAC output from Pin 6 of the regulator board is filtered through L1 and C1 of the preamplifier board A2 and then fed to the buffer amplifier board.

5.1 General

5.1.1 Test Equipment Requirements

This section describes preventive maintenance, trouble-shooting and repair procedures for the MAC-8. The following equipment is suggested in order to perform these procedures properly:

- RF Signal Generator, H/P Model 651B or equivalent
- Oscilloscope, Tektronix Model 545 or equivalent
- Standard Volt-Ohmmeter

5.1.2 Component Location

For aid in the location of components, refer to Figures 4.2 and 7.1 thru 7.8.

5.2 Preventive Maintenance

5.2.1 General Cleaning Methods

Preventive maintenance for the MAC-8 consists of routine functions such as visual inspection and cleaning. Periodic cleaning is recommended as dust may build up on components, reducing the efficiency of the coupler unit and possibly causing circuit failure. To facilitate cleaning the unit, use a vacuum cleaner or a low-pressure filtered compressed-air supply.

5.2.2 Visual Check and Adjustment

A simple visual check of the unit when it is opened up for servicing or cleaning will often reveal potential trouble spots and thereby reduce downtime due to component failure. Signs of trouble may be found in discoloration, warped printed circuit boards and damaged wiring or cables. Any deteriorating component should be replaced immediately. All hardware should be checked for tightness during preventive maintenance inspections.

5.3 Troubleshooting

5.3.1 General Failure Symptoms

During operation of the MAC-8, the following failure symptoms may be observed:

- No signal output to the receiver.
- Weak or noisy signals in the receiver.

5.3.2 Fault Localization

The primary objective of the troubleshooting procedure is to localize the fault to a particular section of the coupler unit. Table 5.1 provides a guide to locating and correcting the possible failures.

Table 5.1 - Troubleshooting Procedures

Symptom: No signal output from the receiver

Possible Cause:	Receiver failure
Remedial Action:	Refer to receiver manual
Possible Cause:	Interconnection, coupler to receiver
Remedial Action:	Check the RF cable between the receiver and coupler
Possible Cause:	Power supply failure in the coupler
Remedial Action:	If POWER ON lamp DS1 is not illuminated, check for power input failure or defective input filter FL1. If POWER ON lamp is on, check indicating type fuses F1/F2 and replace with spare if necessary. If both fuses are intact, proceed to check the transformer T1, bridge rectifier Z1 and voltage regulator A1. -28VDC should be available at terminal 6 of the regulator board.
Possible Cause:	Output buffer amplifier failure in the coupler
Remedial Action:	If DC voltage is present at the output of the regulator and at the output buffer amplifier, possible failure of a component in the output amplifier is indicated. Replacement or removal, testing and repair of the module is necessary.
Possible Cause:	Failure of input preamplifier (One input affected)
Remedial Action:	If DC voltage is present at the output of the regulator and at the preamplifier, possible failure of a component in the preamplifier or failure in the input antenna circuit is indicated. For repair of the preamplifier, removal and testing of one module A2..A9 will be necessary.

Symptom: Weak or noisy signals from the receiver

Possible Cause:	Antenna fault
Remedial Action:	Connect the antenna lead-in directly to the antenna input of the receiver. If the symptom persists, check for a fault in the antenna system.
Possible Cause:	Faulty output buffer amplifier
Remedial Action:	If the cause is not attributable to the antenna, possible failure of a component in the buffer amplifier is indicated. Removal, testing and repair of module A10 will be necessary.

Table 5 - Troubleshooting (Continued)

Symptom: Weak or noisy signals in the receiver

Possible Cause:	Receiver noise
Remedial Action:	Refer to receiver manual
Possible Cause:	Interconnection, coupler to receiver
Remedial Action:	Check the RF cable between the coupler and receiver.
Possible Cause:	Faulty input preamplifier
Remedial Action:	Connect the receiver to another output terminal of the same module (A10). If the symptom persists, the probable cause will be found in the power supply circuit of the module. If the symptom is no longer present, the fault will be found in the directly-associated buffer amplifier circuit or output connection. Removal, testing and repair of the module will be necessary if the fault is not located in the output connection.

5.4 Repair

5.4.1 General Method

Repair work generally consists of replacing the defective component. The following cautions should be observed:

- Make sure the replacement component is an exact duplicate of the defective one. This is particularly important in the amplifier modules.
- Place any new component in the same location as the component it replaces. The dressing of any wire runs should not be altered.
- Observe standard practice when replacing semiconductor components by using a low-wattage soldering iron and appropriate heat-sink tools.
- Avoid damage to the printed circuit wiring when handling or repairing amplifier and regulator modules.

5.5 Adjustments

5.5.1 Output Voltage Trim

Only one adjustment may be required in the MAC-8 coupler. Power supply regulator A1 contains a screwdriver-adjustable potentiometer (R7) that was pre-set, prior to shipment, to provide a -28VDC. If the output voltage is found to require adjustment, use an accurate voltmeter and re-set the voltage to -28VDC by rotating the potentiometer control clockwise to reduce voltage or counter-clockwise to raise voltage.

5.5.2 Amplifier Trim

The amplifiers do not require any adjustment since all components are of fixed values.

Section 6 - Parts Lists

A10739	Front Panel, Rear Panel and Main Chassis Assembly
A10746-()	Power Supply/Regulator Assembly (A1)
A10779-()	Input Preamplifier Assembly (A2..A9)
A10756-()	Output Buffer Amplifier Assembly (A10)

Section 7 - Schematic Diagrams

- Figure 7.1** Major Assembly Location, MAC-8
- Figure 7.2** Schematic, Power Supply/Regulator Assembly (A1/A10746)
- Figure 7.3** Schematic, Input Preamplifier Assembly (A2..A9/A10779)
- Figure 7.4** Schematic, Output Amplifier Assembly (A10/A10756)
- Figure 7.5** Schematic, AC Line Filter Assembly (A5780)

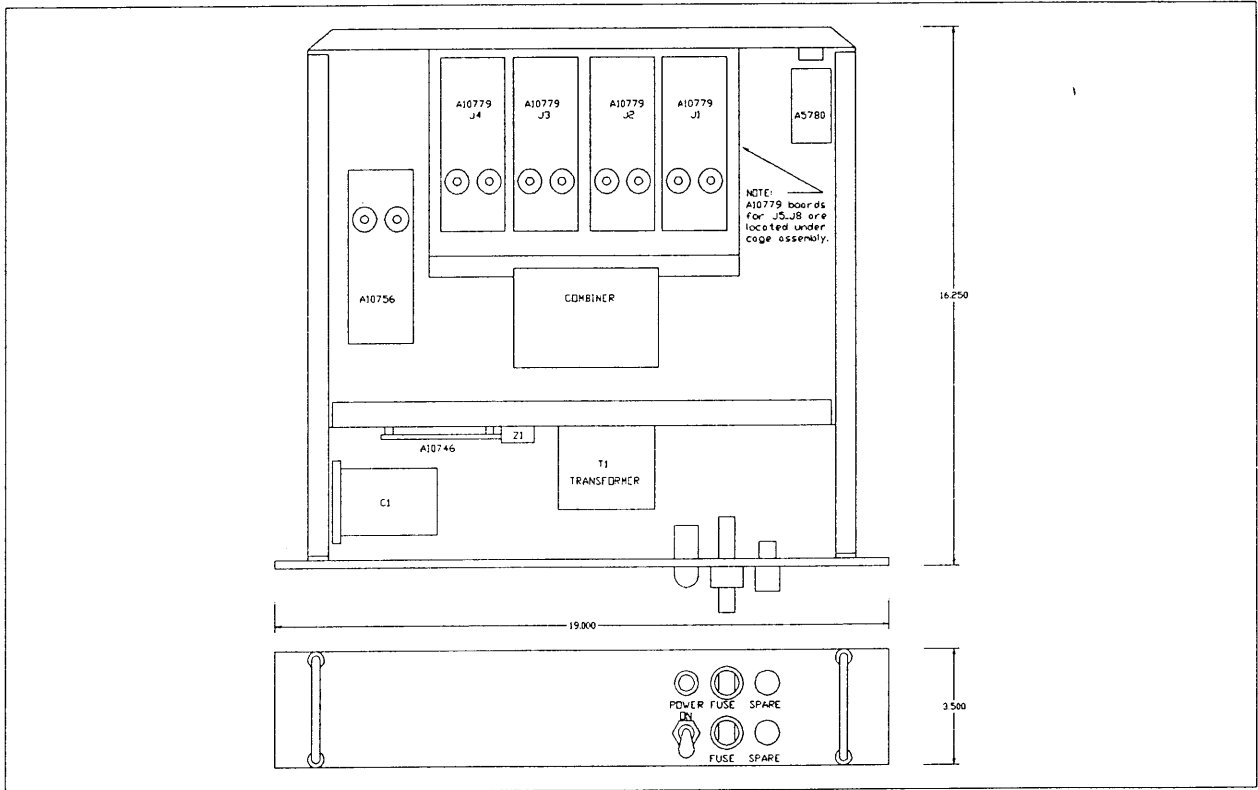


Figure 7.1 Major Assembly Location, MAC-8

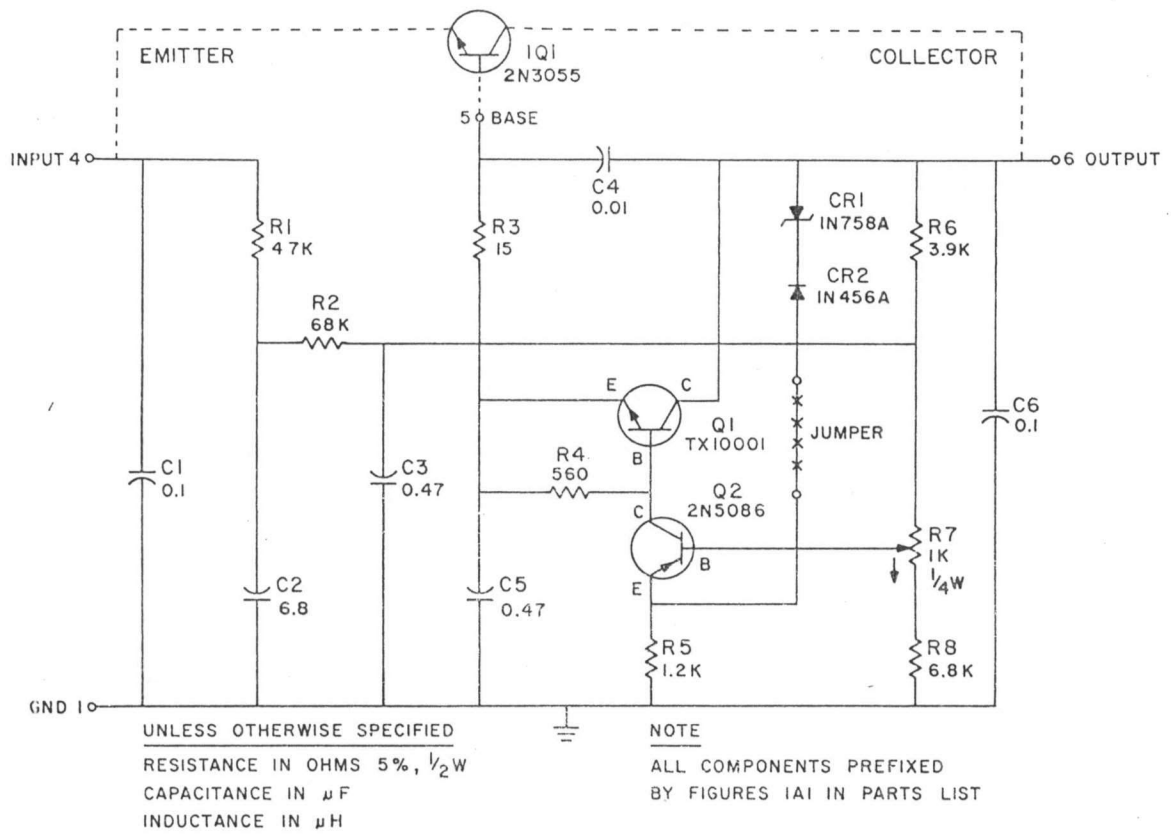
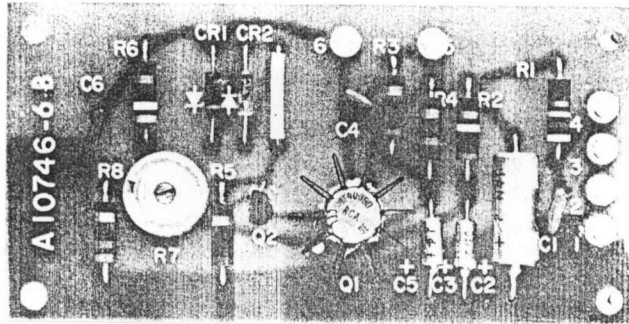


Figure 7.2 Schematic, Power Supply/Regulator Assembly (A1/A10746)

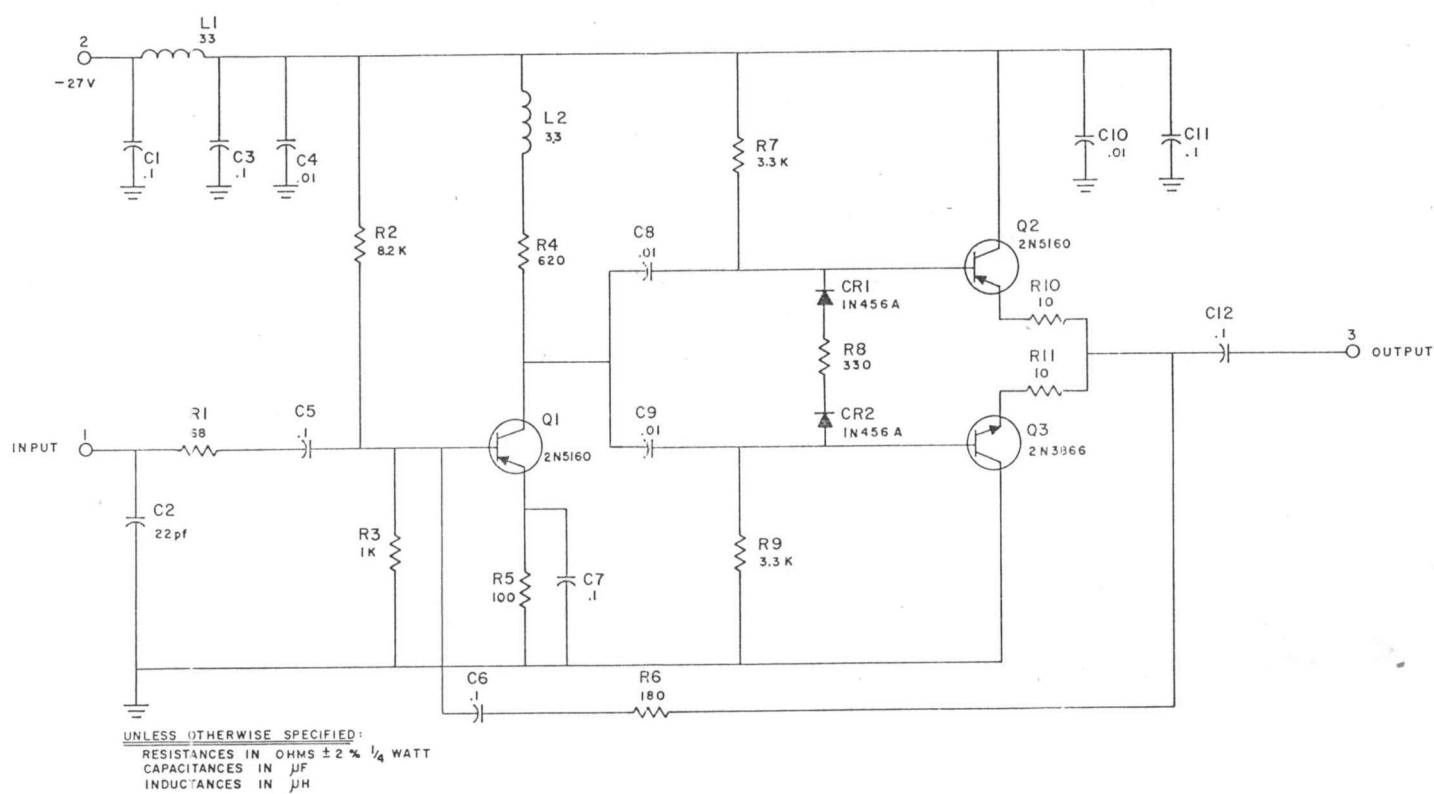
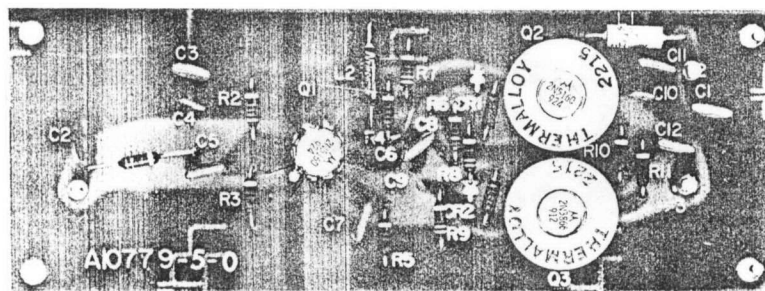


Figure 7.3 Schematic, Input Preamplifier Assembly (A2..A9/A10779)

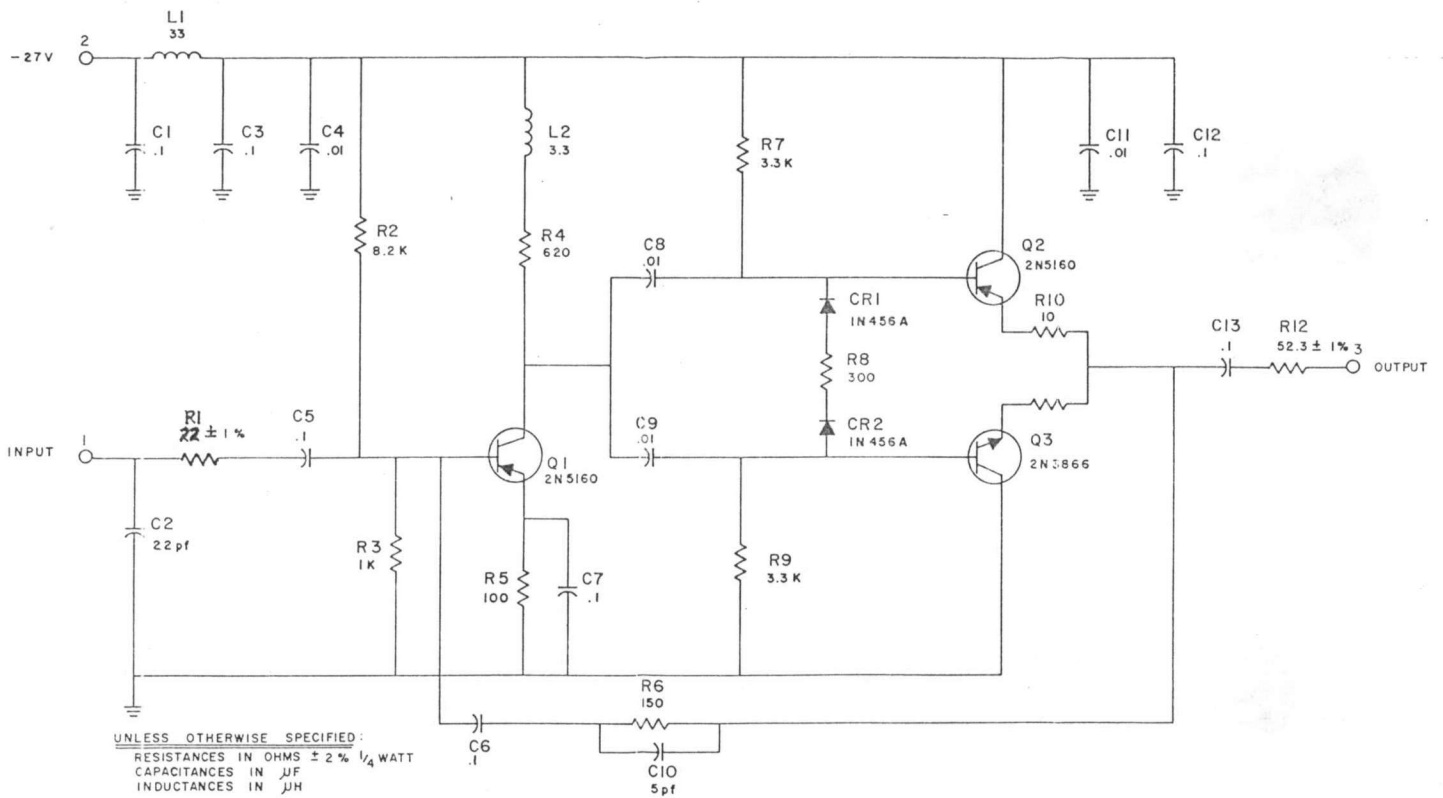
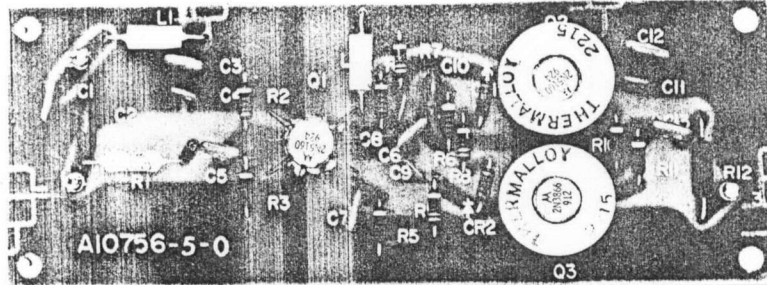


Figure 7.4 Schematic, Output Amplifier Assembly (A10/A10756)

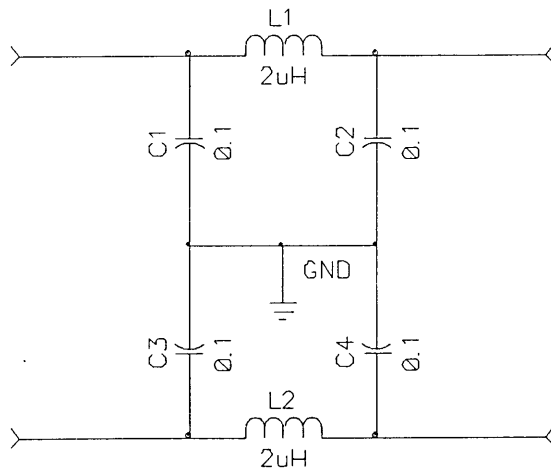


Figure 7.5 Schematic, AC Line Filter Assembly (A5780)



Please Read

Dear TMC Product User:

Thank you for purchasing the TMC Model MAC-8 Multi-Antenna Coupler. The MAC-8 provides the capability of coupling eight antennas to a single receiver, each with a nominal gain from antenna to receiver of 2dB. The MAC-8 operates from 2MHz to 30MHz

The coupler is described in detail in the enclosed technical manual. Application notes, as appropriate to the MAC-8, are included. These publications provide important information about using TMC equipment. Please read them.

Since the MAC-8 requires mating connectors and coaxial cables to operate properly, bulletins on TMC's connector products is included. If you need additional data or some specific technical information, please give our Customer Service a call at (914) 698-4800 or return the business reply card provided in this package. Our FAX (facsimilie) number is (914) 698-4805.

If you are missing any items, please contact TMC directly or through your local sales office.

Thank you for selecting the TMC Model MAC-8 active multi-antenna coupler.

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