

MODEL 203A DISTRIBUTION AMPLIFIER

INDEX TAB	TITLE	TITLE BLOCK INDEX NO.
SECTION IV - MODULE MAINTENANCE		
IV	The following module subsections, 4-1 through 4-7, contain a theory of operation, an alignment procedure and a parts list for a particular module. The schematic for each module is located on the first page of the subsection.	
4-1	THE POWER SUPPLY MODULE	203-16-408
4-2	THE 100 kHz PREAMPLIFIER MODULE	203- 2-401
4-3	THE 100 kHz AMPLIFIER MODULE	203-16-403
4-4	THE 1 MHz PREAMPLIFIER MODULE	203- 2-402
4-5	THE 1 MHz AMPLIFIER MODULE	203-16-404
4-6	THE 5 MHz PREAMPLIFIER MODULE	203- 2-405
4-7	THE 5 MHz AMPLIFIER MODULE	203-16-406
SECTION V - APPENDIX		
V	ILLUSTRATED PARTS LIST INFORMATION	50007
	TABLE OF ABBREVIATIONS	50022
	FEDERAL SUPPLY CODE FOR MANUFACTURERS - CODE TO NAME	50043
	MONTRONICS INSTRUMENT WARRANTY	

INTRODUCTION AND SPECIFICATIONS FOR THE MODEL 203A DISTRIBUTION AMPLIFIER

INTRODUCTION

The Model 203A is an all solid-state, rack mounting distribution amplifier. The unit accepts three input frequencies and provides 12 output signals, four signals at each input frequency. The Model 203A is completely modular in construction. All preamplifiers and amplifiers are contained on plug-in printed circuit boards. Each printed circuit board may be easily removed and exchanged for rapid servicing. Further, printed circuit boards bearing the same part number are electrically and physically interchangeable.

ELECTRICAL SPECIFICATIONS

INPUT FREQUENCIES

The distribution amplifier operates with sinewave inputs of 100 kHz, 1 MHz, and 5 MHz. Each input frequency must be within 1% of nominal value.

INPUT LEVELS

0.5 to 5.0 volts rms for each input. A level adjustment for each input is provided on the rear panel.

INPUT IMPEDANCE

Nominally 50 ohms with any number of amplifier modules connected.

OUTPUTS

There are usually four output channels at each of the three input frequencies. However, other output configurations are possible up to 12 outputs of one desired frequency; 100 kHz, 1 MHz or 5 MHz.

OUTPUT LEVELS

Each channel is continuously adjustable over the range of 0.5 to 4.0 volts rms into 50 ohms. Level controls for individual amplifiers are accessible through the top cover.

STABILITY

Typically better than 1×10^{-11} standard deviation for a one second averaging time at 1 MHz.

BANDWIDTH

Less than 3% of input frequency for 3 db down and 15% for 30 db down.

ISOLATION

Under all conditions of system loading, isolation of the 100 kHz and 1 MHz signals from adjacent channels is 80 db below full output. Isolation of the 5 MHz signal from adjacent channels is at least 65 db below full output.

OUTPUT VARIATIONS

A change in load conditions on any channel from open-circuit to short-circuit causes less than 3% change in the signal level of any other channel.

METERING

Front panel meter and switch provides indication of intermediate and output signal levels, and power supply voltage.

SPURIOUS

All non-harmonically related signals generated by the amplifier are 80 db below the output level of any channel.

HARMONIC DISTORTION

Harmonic distortion generated by the distribution system is 60 db below the output level of any channel.

DUTY CYCLE

The distribution amplifier is designed for continuous operation throughout its service life without degradation of specified performance.

POWER REQUIREMENTS

115/230 volts ac $\pm 10\%$, 50 to 400 Hz, approximately 35 watts.

A separate connector on the rear panel may be used to connect standby dc power from 22 to 30 vdc. Internal circuitry detects loss of primary power and automatically cuts over to the external standby dc power.

MECHANICAL SPECIFICATIONS

SIZE

Front panel 3-1/2 inches by 19 inches.
9 inches behind front panel.

WEIGHT

13 pounds.

CONSTRUCTION

Construction is modular. Each preamplifier and each power amplifier is built on a single plug-in printed circuit board. All parts with the same part number are mechanically and electrically interchangeable.

MOUNTING

The distribution amplifier is capable of being mounted in a standard 19-inch EIA relay rack. Side panels are drilled and tapped for the attachment of chassis slides.

CONNECTORS

All input and output connectors are mounted on the rear panel and are of the BNC type. Input connectors are isolated from chassis ground. Output connectors can be individually isolated from chassis ground if desired by a simple modification.

SHOCK AND VIBRATION

The distribution amplifier will withstand any shock and vibration that is normally encountered during surface and air transportation, installation, maintenance, and testing without any degradation in the specified performance.

ENVIRONMENTAL SPECIFICATIONS

OPERATING

Temperature:	0° to 50° C.
Relative Humidity:	0 to 85%.
Altitude:	0 to 10,000 feet.

STORAGE

Temperature:	-40° C to +75° C.
Relative Humidity:	0 to 95%.
Altitude:	0 to 10,000 feet.

SECTION II
**OPERATING
INSTRUCTIONS**

203A

Revision

Page 1 of 3

OPERATING INSTRUCTIONS FOR THE MODEL 203A DISTRIBUTION AMPLIFIER

PREPARATION FOR USE

Before initially placing the instrument in operation, carefully examine for any signs of physical damage. If any damage is discovered, follow the directions given on the warranty page in the rear of this manual. If no physical damage is found, follow the instructions given in the following paragraphs to place the Model 203A in operation. If any difficulty is encountered, contact your John Fluke Sales Representative for assistance or write directly to the John Fluke Manufacturing Company, Inc.

INSTALLATION

The Model 203A is intended primarily for mounting in a standard EIA relay rack although nylon feet are provided to permit bench use. It may be mounted in the rack directly by the front panel or it may be mounted on chassis slides. The side panels of the instrument are drilled and tapped for attachment of standard chassis slides.

INPUT POWER

The Model 203A is equipped with a dual primary power transformer. The primary windings are connected in parallel at the factory for operation on 115 volts ac. Figure 1 illustrates the transformer base wiring for 115 volt operation and 230 volt operation. To modify the instrument for operation on 230 volts ac, remove the two bus wires from pins 1 to 2 and 3 to 4. Then solder a bus wire from pin 2 to pin 3. It is not necessary to relocate any of the wires connected to these pins.

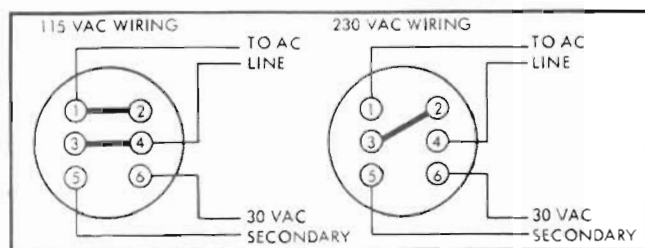


Figure 1. POWER TRANSFORMER BASE WIRING
FOR 115 VAC AND 230 VAC

The instrument is supplied with ac line power through a three-wire line cord. Two of the three leads carry ac line power and the third provides an earth ground. Where three-wire outlets are not available, a two-prong adapter plug should be used. If the adapter is used, connect the ground lead to a suitable earth ground.

ISOLATED OUTPUTS

The output connectors are mounted on a sheet of dielectric material set into the rear panel to permit output isolation. However, as the instrument is furnished

from the factory, the output connector shells are all bussed to chassis ground through the module connectors. The outputs may be isolated by locating the ground bus (attached to pin 9 of the module connectors) and cutting it between the connectors of the 12 amplifier modules.

CONTROLS, CONNECTORS AND INDICATORS

A brief functional description of the controls, connectors, and indicators of the Model 203A is given in Figure 2.

INPUT AND OUTPUT CONNECTIONS

After mounting the instrument, connect the line cord to a grounded ac outlet. Connect the kHz, 1 MHz, and 5 MHz input frequencies (at a level of 0.5 to 5 volts rms) to the 100 kHz, 1 MHz, and 5 MHz input connectors on the rear panel. Connect the output distribution lines to the output connectors on the rear panel.

CAUTION!

Terminate all unused outputs in 50-ohm loads. All outputs are adjusted to deliver more than 4 volts rms into 50 ohms at the factory. An output level over 5 volts rms may damage an amplifier module. If the load on a channel is less than 50 ohms, the amplifier module should be adjusted to keep the output level below 5 volts rms.

Throw the POWER switch to ON and observe that the POWER indicator lights. Verify correct operation of the instrument as follows:

- Turn the INPUT LEVEL ADJUST controls fully counterclockwise.
- Turn the LEVEL CHECK switch to the POWER SUPPLY position. The meter should indicate approximately 4 representing +20 volts dc.
- Turn the LEVEL CHECK switch to output channel 1 and adjust the 5 MHz INPUT LEVEL ADJUST control to obtain an indication of 4 volts rms. Channels 2, 3, and 4 should read 4 ± 0.5 volts rms, providing all outputs are terminated in 50 ohms.
- Turn the LEVEL CHECK switch to output channel 5 and adjust the 1 MHz INPUT LEVEL ADJUST control to obtain an indication of 4 volts rms. Channels 6, 7, and 8 should read 4 ± 0.5 volts rms providing all outputs are terminated in 50-ohms.
- Turn the level check switch to output channel 9 and adjust the 100 kHz INPUT LEVEL ADJUST control to obtain an indication of 4 volts rms. Channels 10, 11, and 12 should read 4 ± 0.5 volts rms providing all outputs are terminated in 50 ohms.

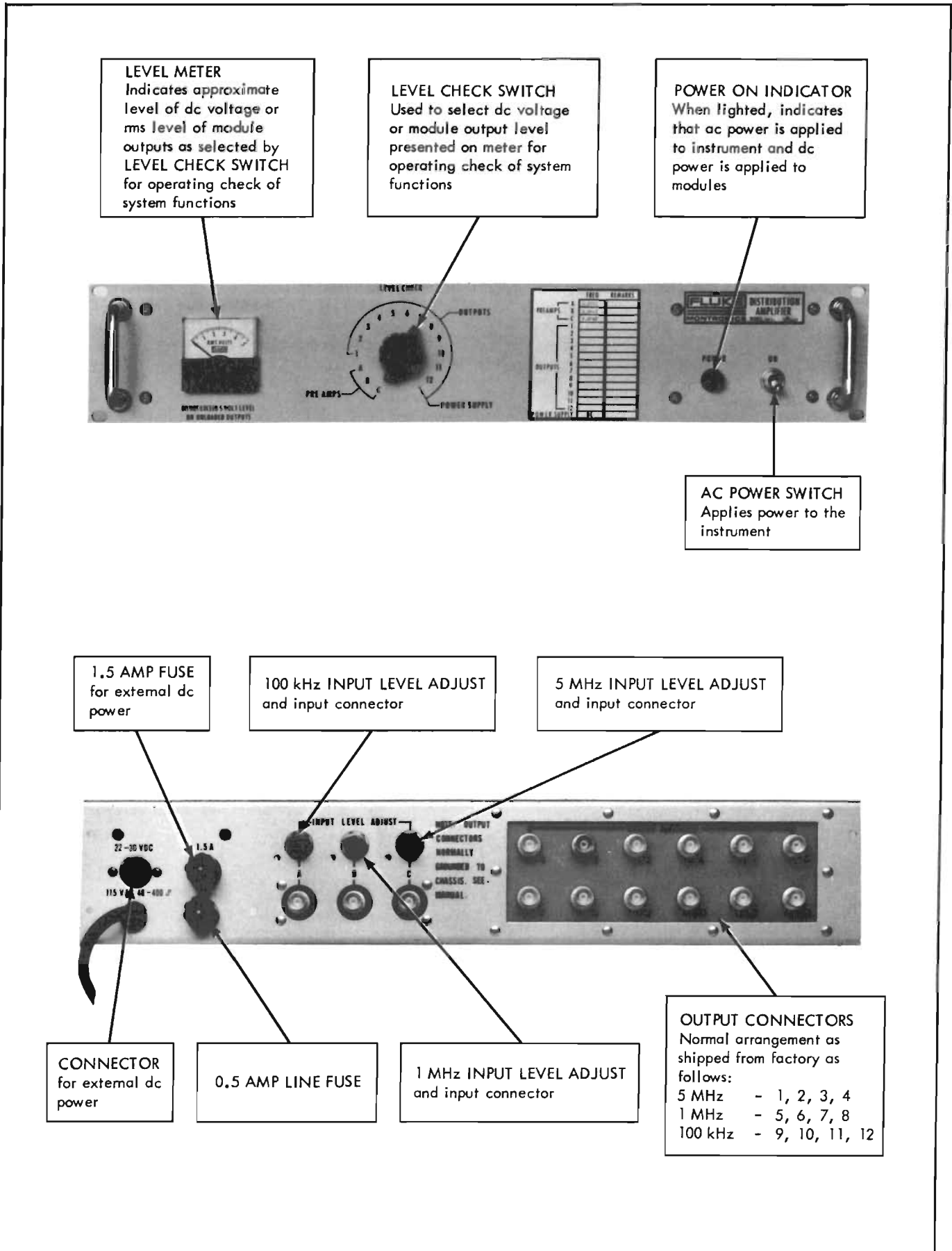


Figure 2. MODEL 203A CONTROLS, CONNECTORS, AND INDICATORS

- f. Turn the LEVEL CHECK switch to each of the pre-amplifier positions and observe the meter. It should indicate 1 to 3 volts rms.

OUTPUT LEVELS

The Model 203A has been adjusted at the factory to deliver more than 4.0 volts rms into a 50-ohm load when 0.5 volts rms is applied to the input connector and the input LEVEL control is turned fully clockwise. The 4-volt level is sufficient to provide 1.6 volts into 50 ohms at the end of 1000 feet of RG-58/U at 5 MHz. Lower attenuation will be experienced if lower loss coaxial cable is used and also at lower frequencies. Figure 3 is a graph showing the signal attenuation at 100 kHz, 1 MHz, and 5 MHz, in lengths of terminated RG-58/U up to 1400 feet.

To set all output channels at one frequency to the same output level simultaneously, adjust the corresponding INPUT LEVEL ADJUST control. Required output levels usually will be different because of differences in transmission lines and loads on the channels. The output level of any channel may be adjusted individually by adjusting the module level adjustments accessible through the top cover.

Note!

Usually, it will be preferred to monitor the level at the load end of the transmission line. Assuming negligible transmission line loss, the level meter will indicate correct load voltage only when the transmission line is terminated in a load equal to its characteristic impedance.

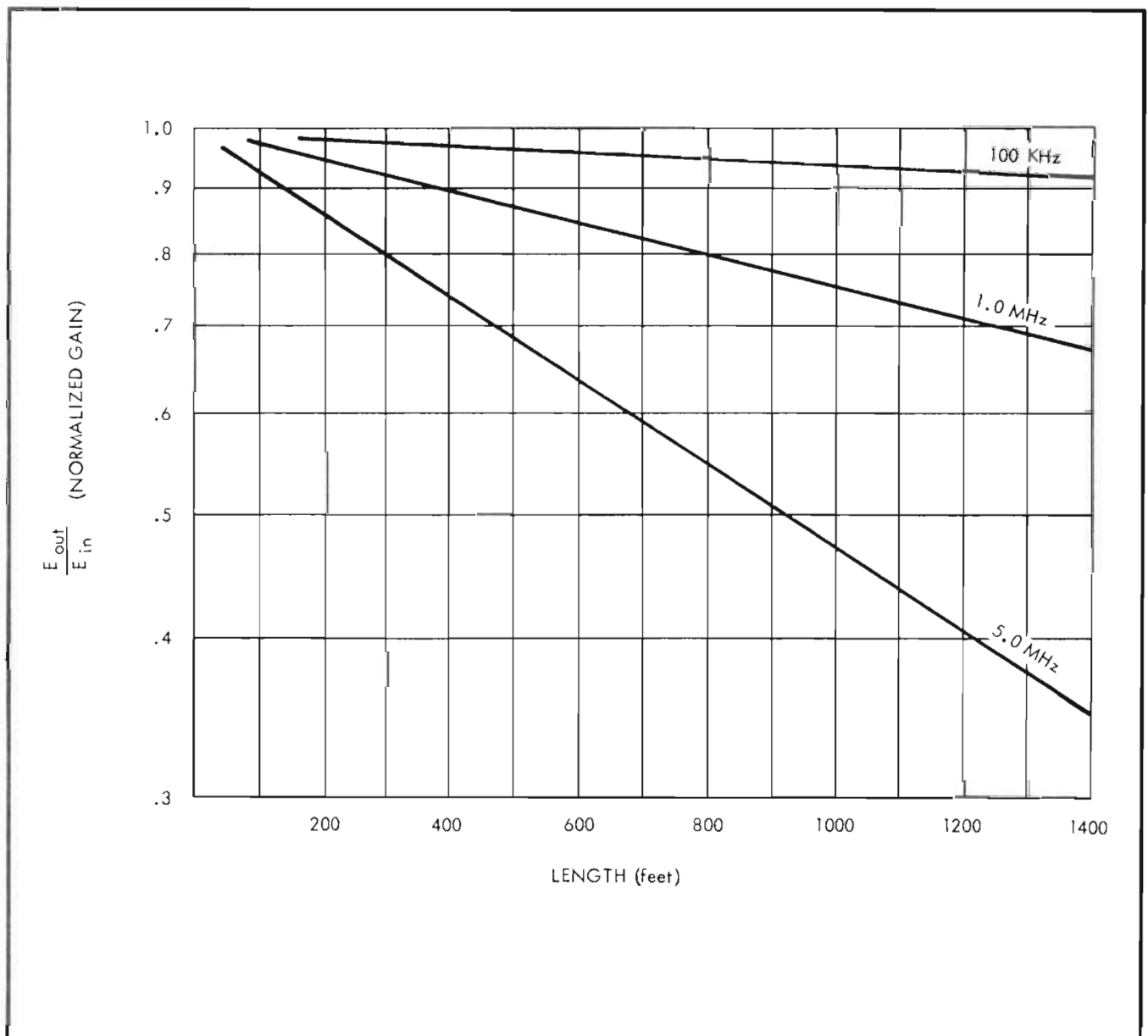


Figure 3. GAIN CHARACTERISTICS OF TERMINATED RG-58/U

SOLDERING TECHNIQUES

INTRODUCTION

Throughout our factory certain soldering techniques are used extensively to insure the finest quality soldering connections in our instruments. The following information is an attempt to illustrate some of these simple techniques that you can use to rapidly and accurately maintain and repair your instrument. Figure 1 illustrates some of the soldering tools and aids used by our assemblers and technicians.

TINNING THE IRON

Before heating the iron be sure to file all surfaces of the iron which will be tinned. A smooth surface will prevent the solder from building up on the rough spots and burrs where it can rapidly oxidize. Plug the cord

of the iron into a suitable power source and allow it to heat. One method of determining when the iron is at the right temperature to tin is to support a small piece of solder on the tip. When the right temperature for tinning is reached the solder will start to melt. Be sure that the soldering iron does not get too hot before applying the tinning solder, as an extremely hot iron will oxidize the solder and the tip will not be properly tinned. It is only necessary to tin the wedge portion of the tip.

REMOVING SOLDER FROM A CONNECTION

In most cases a solder connection is constructed of a terminal to which a wire or electrical component is to be soldered. Generally, the wire or component is wrapped around or over the terminal to assure a good mechanical joint as well as a good solder joint. When

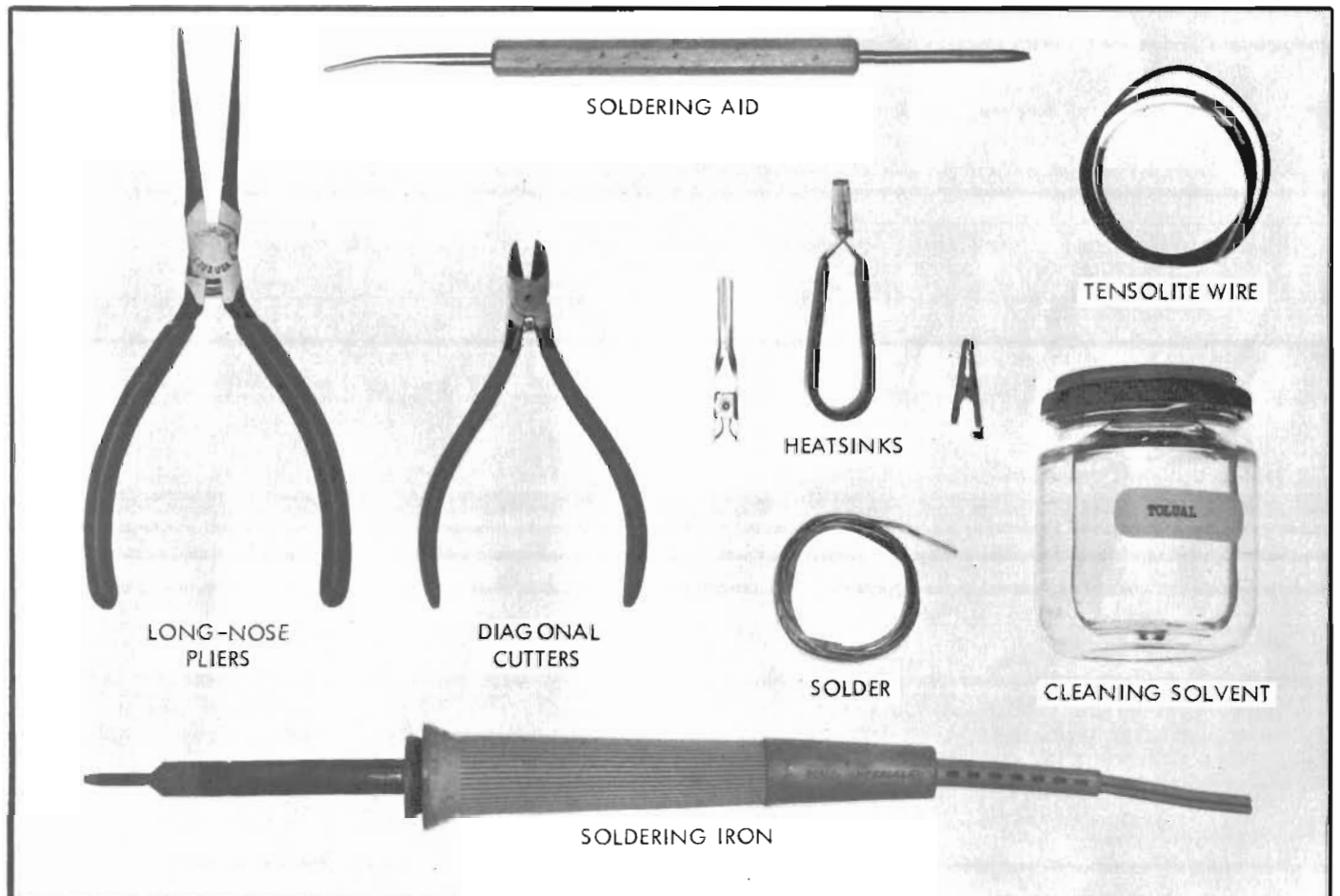


Figure 4-25. TOOLS REQUIRED FOR SOLDERING

removal of the wire or component is required, the mechanical construction of the solder joint presents a unique problem. That is, it is extremely difficult to free the wire or component from the terminal without resorting to a pair of wire clippers. This is especially true in the case of printed circuit boards where applying excessive heat or mechanical stress will break the land pattern away from the laminated epoxy. Thus, it would seem that a method of removing the solder from the connection is necessary. Many different methods have been devised for the removal of solder but one method used in our factory is relatively inexpensive and highly successful. Through the use of a soldering iron and a special type of wire the solder can be easily removed from a connection. Figure 2 illustrates this technique.

The wire can be a braided wire shield, stripped from small unusable pieces of shielded coax or a special #22 wire produced by Tensolite Inc. The tensolite wire is constructed from 105 strands of #40 tinned copper wire and is covered with a type of silicon rubber. Because of the numerous strands of wire the solder is drawn up the wire by capillary action. When the end becomes saturated with solder it can be clipped off and more insulation stripped off to form a clean end. The silicon rubber covering is convenient as it prevents the operator from being scorched by the heat transferred up the wire.

Many of our printed circuit boards have been treated with a special coating to inhibit fungus growth and moisture absorption. The special coating is composed of a polyurethane resin and is called epeccaste. It is not necessary to remove the coating from the area to be soldered, as the heat from the soldering iron decomposes the coating into carbon dioxide and water. After the soldering operation has been completed, the disturbed area can be cleaned with a suitable solvent, such as tolual and recoated. If Tolual is used care should be taken to avoid inhalation of the vapors and excessive contact with the skin. This solvent should also be kept away from open flames.

THE USE OF HEATSINKS

Certain components such as diodes, transistors and integrated circuits, can be damaged if excessive heat is applied to their leads. Thus, when removing these components it is recommended that a heatsink of some type be inserted between the soldering iron and where the lead enters the body of the component. Figure 3 illustrates the use of long-nose pliers as a heatsink. Other types of heatsinks are available on the market today and some of the more popular ones are shown in Figure 1. A common alligator clip which can be found in almost any service installation, serves quite well as a component heatsink.

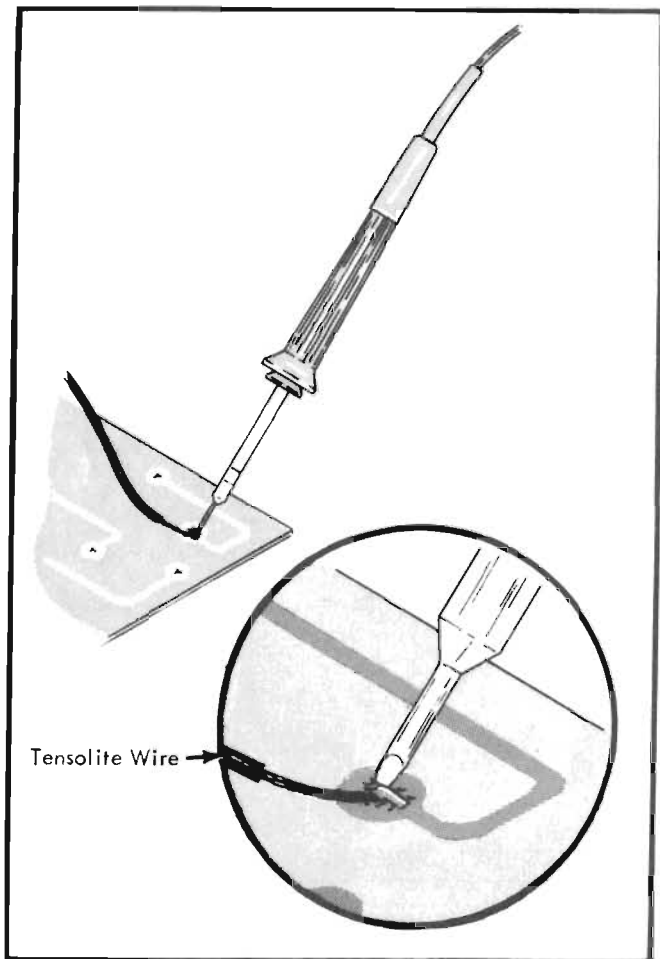


Figure 4-26. REMOVING SOLDER FROM A CONNECTION

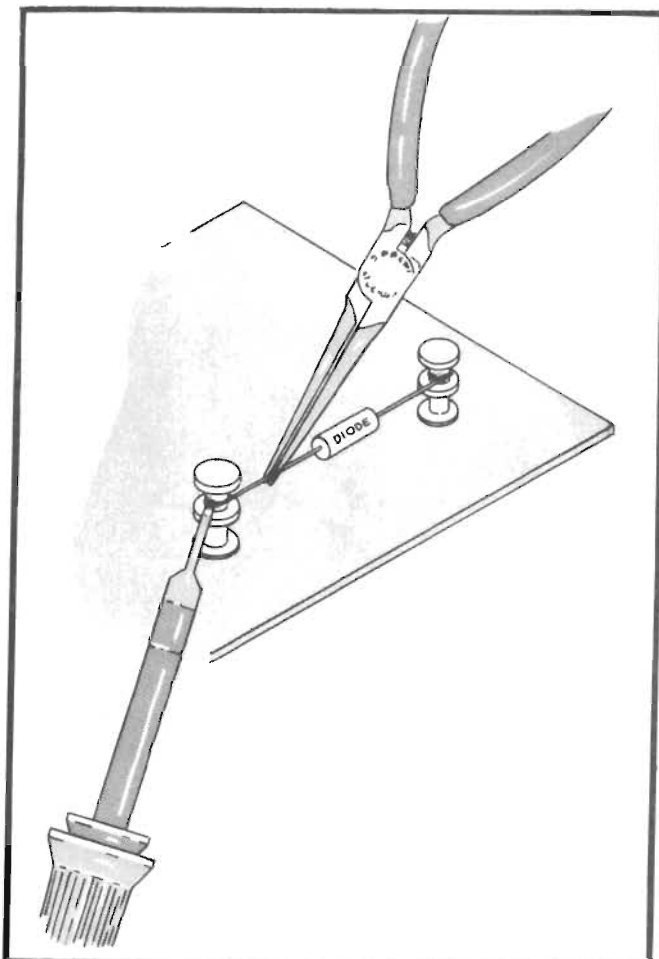


Figure 4-27. LONG-NOSE PLIERS USED AS A HEATSINK

MAINTENANCE INFORMATION FOR THE MODEL 203A DISTRIBUTION AMPLIFIER

INTRODUCTION

This section of the manual contains information that will allow you to completely maintain your Model 203A Distribution Amplifier. The section is composed of an overall theory of operation, general maintenance procedures, and instrument alignment procedure, troubleshooting instructions, and a parts list for the chassis. The parts list for the modules can be found in Sections 4-1 through 4-7.

It is recommended that you thoroughly understand the theory of operation of the instrument before attempting any of the maintenance procedures.

THEORY OF OPERATION

Figure 1 is a block diagram of the Model 203A Distribution Amplifier. Note that it is composed of three separate amplifier systems differing only in operating frequency. Each system consists of an input attenuator, a preamplifier module, and four output amplifier modules. Because the systems are identical except for frequency, only the system operating at 100 kHz will be discussed. The general layout of the instrument and location of modules is illustrated in Figure 2.

The 100 kHz input connector accepts a 100 kHz sinewave input signal at a level of 0.5 to 5.0 volts rms. This signal is applied to the 100 kHz LEVEL control, on the rear panel, which feeds the 100 kHz Preamplifier Module. The LEVEL control is a bridged-tee attenuator network. Its function is to maintain constant input impedance throughout the 30 db range of adjustment. For a schematic representation of the LEVEL control, see the wiring diagram (Drawing No. 203-2-100) at the end of this section.

The 100 kHz Preamplifier Module is a class B push-pull amplifier. Its primary function is to provide sufficient power gain to drive the four amplifier modules. It also provides load isolation between the input and the amplifiers. The preamplifiers, (100 kHz, 1 MHz, and 5 MHz) are described in Sections 4-2, 4-4, and 4-6, respectively.

The 100 kHz Preamplifier Module drives four 100 kHz Amplifier Modules. Each amplifier consists of a class B push-pull amplifier and differs from the preamplifier in that the output is double-tuned. The double-tuned output provides greater rejection of harmonics and a high degree of interchannel isolation. Each amplifier output is adjustable from 0.5 to 5.0 volts rms into a 50-ohm load by means of a variable resistor. The variable resistor attenuates the level of the input signal to the amplifier. The amplifiers (100 kHz, 1 MHz and 5 MHz) are described in Sections 4-3, 4-5, and 4-7, respectively.

The LEVEL CHECK switch selects the input to the meter circuit. The output of any preamplifier or amplifier module or the output of the power supply module may be selected. When the output of the power supply module is selected, the dc voltage is fed through a series resistor directly to the meter rectifier causing the meter to read normally 4 volts for +20 volts dc. When any of the signal levels are selected, the ac voltage is fed to the same meter rectifier and meter. This circuit is shown schematically on the chassis wiring diagram.

The Model 203A is provided with a solid-state circuit to switch the power supply voltage from the internal +20 volt dc power supply to an externally connected +22 -30 volt dc power supply in the event of failure of the input ac power or failure of the internal power supply. The dc switching circuit (203-16-415) consists of a diode switch and a regulator circuit that regulates the externally connected +22 -30 volts dc to approximately 20 volts dc. The regulating circuit is composed of two PNP transistors Q1 and Q2 and a zener diode CR1. The schematic for this circuit is illustrated in the Chassis Wiring Diagram, Drawing No. 203-2-100, located at the end of this section. Transistor Q2 is the basic regulating element and, for example, if the output voltage goes more positive, the voltage at the base of Q2 also goes more positive reverse biasing Q2; this action causes less current to flow in the output load and consequently lowering the output voltage.

Q1 is used primarily as a temperature regulating element. With a temperature increase, transistor Q2 increases conduction. Q1 also increases in conduction causing the voltage at the base of Q2 to go more positive, thus decreasing the conduction of Q2.

Diode, CR2 is used as the actual switch. The internal power supply is adjusted such that CR2 is forward biased by approximately 0.5 volts when the Model 203A is operating on ac line power and the external dc supply is connected. Then, should the ac line power fail, CR2 is forward biased and the external supply is allowed to power the internal circuits. This permits a smooth transition from operation on the internal power supply to operation on the external dc supply.

DESCRIPTIVE NOMENCLATURE

The following reference numbers are used as an example, to identify the 100 kHz Preamplifier Module. All printed circuit boards in the Model 203A are identified in this manner. These numbers are used in various places in the manual and on the printed circuit board itself. Under each number is an explanation of where and why it is used.

a. 203-2-401

This 400-series number is a manufacturing part number used to identify the printed circuit board complete with

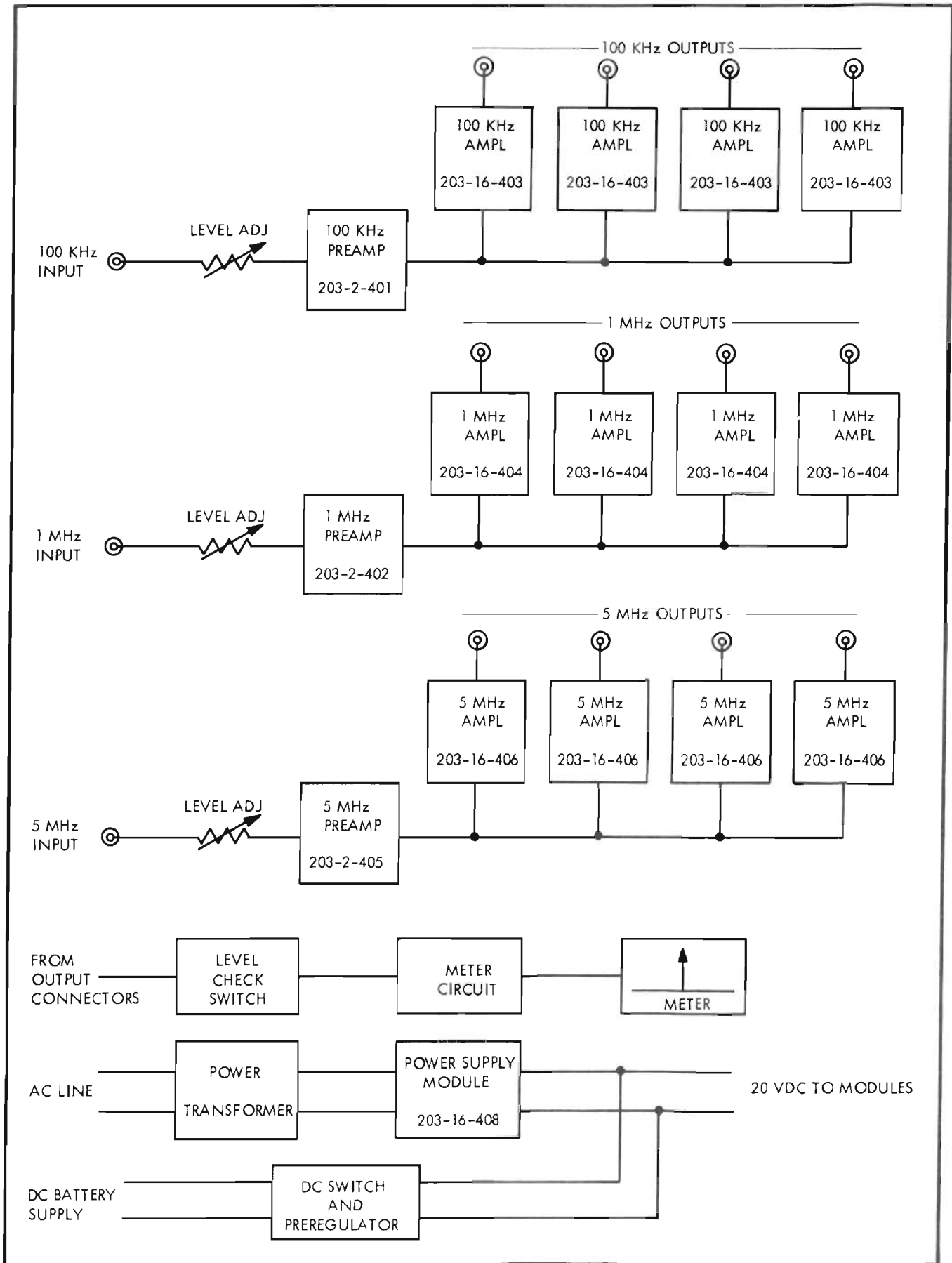


Figure 1. MODEL 203A DISTRIBUTION AMPLIFIER BLOCK DIAGRAM

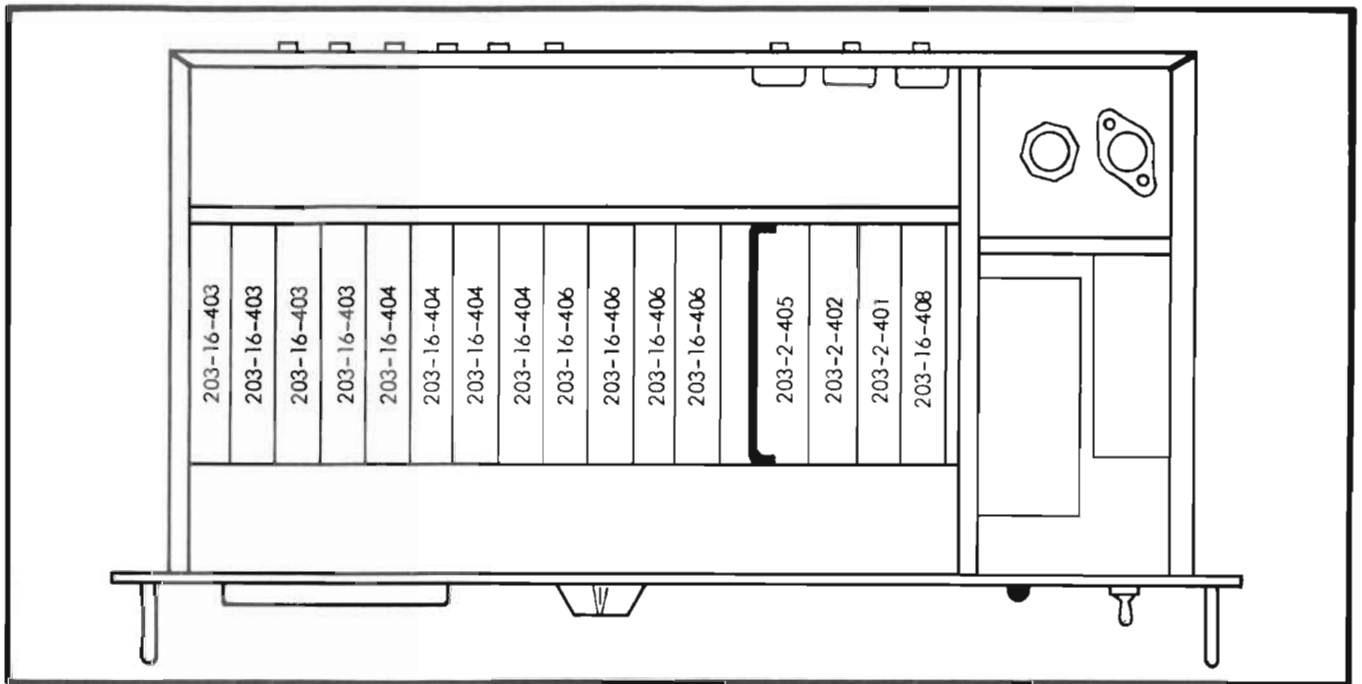


Figure 2. MODEL 203A TOP VIEW LAYOUT

all components. The number is usually found silk-screened on the component side of the printed circuit board.

b. 203-2-301

This 300-series number is a manufacturing part number used to identify the printed circuit board without components. It is used for manufacturing identification only. This number can be found on the land pattern side of the printed circuit board.

c. 1702-181578

This 10-digit part number is also used to identify the complete 100 kHz Preamplifier Module. It can be found in the parts list only and is used primarily for ordering parts.

d. A5

The letter-number combination A5 is a reference designation for the 100 kHz Preamplifier Module just as R1 is a reference designation for a resistor on the module. This reference designation appears only in this manual.

GENERAL MAINTENANCE

PERIODIC CLEANING

The Model 203A is completely enclosed and will seldom require cleaning unless subjected to an extreme dust or dirt atmosphere. To clean the exterior surfaces of the distribution amplifier, use a cloth moistened with anhydrous ethyl alcohol or use an aerosol can of Freon TF degreasing agent (MS Y80, Miller-Stephenson Chemical Co.). Dust may be removed from interior surfaces with a vacuum cleaner or it may be blown away with clean dry air at a pressure of 15 pounds per square inch or less.

Grease may be removed by spraying the internal surfaces with an aerosol can of Freon TF degreasing agent.

MAINTENANCE ACCESSORIES AND TEST EQUIPMENT

INSTRUMENT ACCESSORIES

A complete accessory kit shown in Figure 3 is furnished with each Model 203A Distribution Amplifier. These accessories are necessary to properly maintain and align the instrument.

The riser card in the accessory kit is used to raise the level of the printed circuit modules for easy access during maintenance. The card puller is used to remove printed circuit boards from their chassis connectors. The tuning tools are designed specifically for use with the variable transformers and coils in the Model 203A.

Note!

The powdered-iron transformer tuning cores are fragile. Use only the tuning tools supplied with the instrument to prevent damaging them. Care should be exercised in beginning any adjustment.

The shorting plug is used when aligning the double tuned output stages of the amplifier modules. It is also used when measuring the effect of an open-circuit load change on output channels.

USE OF TEST EQUIPMENT

Test equipment should be used in accordance with the manufacturer's instructions; no special techniques are required. However, the probe used with the rf voltmeter for checking amplifier modules should be of the high-impedance, low-capacitance type. If a low-im-

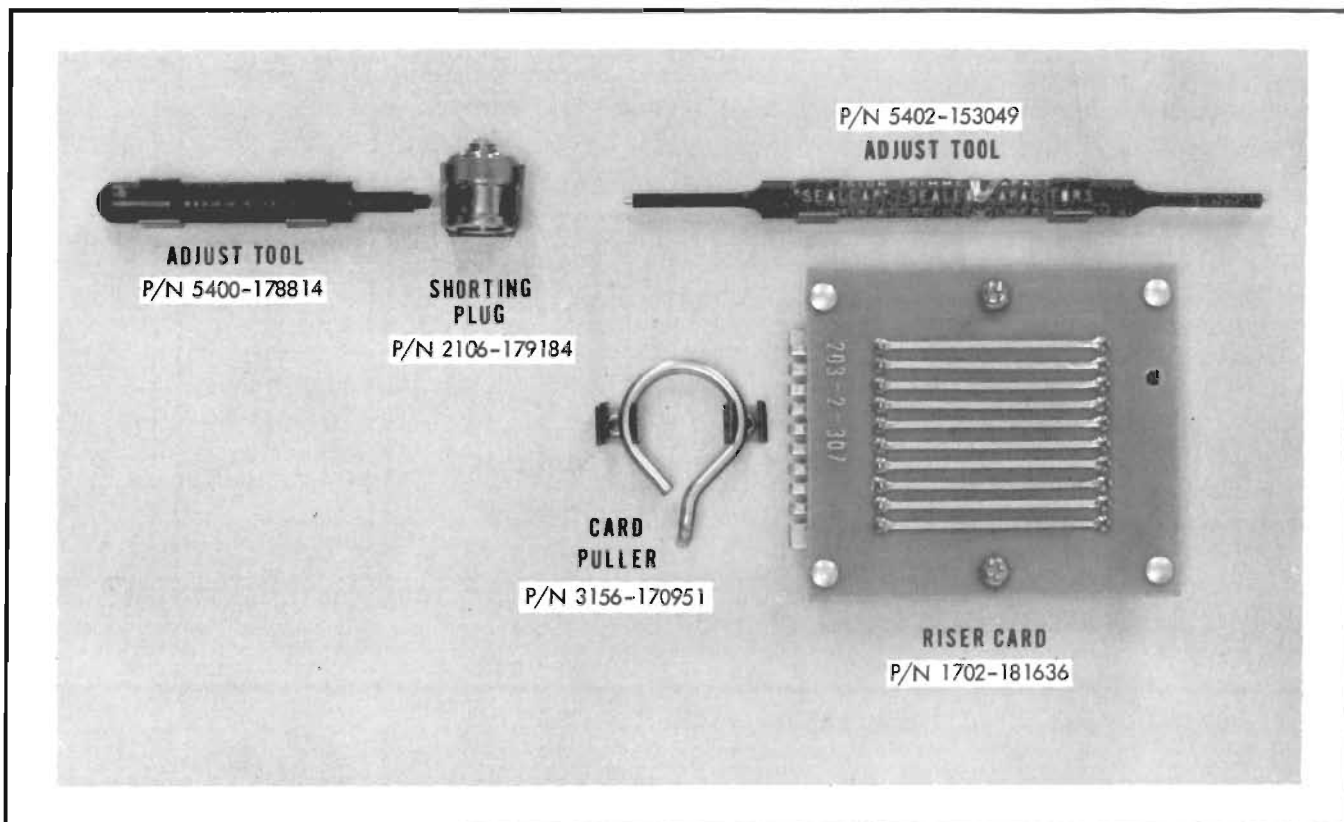


Figure 3. MODEL 203A ACCESSORY KIT

pedance probe is used, excessive loading will detune the double-tuned output circuits of the amplifier module.

TEST EQUIPMENT REQUIRED

Figure 4 lists all of the test equipment necessary for alignment and troubleshooting both of the instrument and of the individual modules. If the recommended equipment is not available, other equipment having the required specifications may be used.

INSTRUMENT ALIGNMENT

The alignment procedure presented in the following paragraphs consists of step-by-step instructions for aligning the Model 203A Distribution Amplifier. Each module must be aligned in accordance with the individual module alignment procedures given in Section IV before this procedure is begun. Figure 5 shows the location of adjustment access ports in the top cover.

POWER SUPPLY ADJUSTMENT WHEN USING AN EXTERNAL DC SUPPLY

In an external dc supply is being used with the Model 203A, this procedure should be used to align the Power Supply Module. This alignment requires the use of a voltohmmeter, an rms voltmeter, a riser card, twelve 50-ohm loads, and 100 kHz, 1 MHz, and 5 MHz signal sources (0.5-5v rms). The recommended voltmeters are listed in Figure 4.

a. Set the POWER switch of the distribution amplifier to OFF.

- b. Remove the top and bottom dust covers.
- c. Remove the Power Supply Module from its chassis connector, install it on the riser card, then install the riser card in the chassis connector for the Power Supply Module.

CAUTION!

The Power Supply Module can only be installed on the riser card one way. However, the riser card can be installed on the chassis connector either way. When installing the riser card in the chassis connector be sure that the Power Supply Module is facing in the same direction as it is when mounted without the riser card.

- d. Connect the 3 input signals to their appropriate input connectors and terminate all outputs into 50 ohms.
- e. Turn the distribution amplifier on its side to gain access to the external dc switch assembly through the bottom of the instrument.
- f. Connect the voltohmmeter to measure the forward drop across CR2.
- g. Set the POWER switch of the distribution amplifier to ON.
- h. Adjust R7 on the Power Supply Module to obtain an indication of 0.5 ± 0.05 volt on the voltohmmeter.

INSTRUMENT TYPE	MANUFACTURER	MODEL NUMBER	REQUIRED SPECIFICATIONS
rf voltmeter and BNC probe	Hewlett-Packard	Model 411, probe, model 11022A	to 10 MHz with full scale sensitivity to 0.01 volts rms.
rms voltmeter	John Fluke Mfg., Co., Inc.	Model 910A	to 7 MHz with full scale sensitivity to 0.001 volts rms.
spectrum analyzer	Panoramic	Model SPA-3/25a	to 25 MHz.
vacuum tube voltmeter	RCA	Sr. Voltohmmist	dc measurement to 25 volts dc.
voltohmmeter	Simpson	Model 260	dc measurement to 0.5v, isolated input.
100 kHz frequency source 1 MHz frequency source 5 MHz frequency source	Any frequency standard having an accuracy of 1% and the capability of delivering .5-5v rms to a 50-ohm load, is sufficient.		
ACCESSORIES			
BNC 50-ohm coaxial termination		(12 each)	
BNC coaxial tee		(1 each)	
BNC shorting connector*		(1 each)	
Riser card*		(1 each)	
Card puller*		(1 each)	
Tuning tool*		(1 each)	
* Included in instrument accessory kit.			

Figure 4. RECOMMENDED TEST EQUIPMENT AND ACCESSORIES FOR INSTRUMENT ALIGNMENT

- At the same time set all output voltage levels to the amplitudes at which you will normally operate.
- i. To perform ripple measurements, see the alignment procedure in Section 4-1.
 - j. Disconnect all test equipment and replace the Power Supply Module in its connector.
- OUTPUT LEVEL AND GAIN TESTS.** The following tests require an rf voltmeter with probe, three frequency sources at 100 kHz, 1 MHz, and 5 MHz, 50-ohm coaxial terminations and a BNC coaxial tee. The recommended rf voltmeter is listed in Figure 4.
- a. Rotate all input LEVEL controls on the rear panel fully clockwise. Connect the 100 kHz, 1 MHz, and 5 MHz signals to the proper input connectors on the rear panel. Adjust the output of each signal source to obtain a signal level of 0.5 volts rms at the input connectors on the rear panel.
 - b. Terminate all 12 output channels with 50-ohm coaxial terminations. Throw the POWER switch to on.
 - c. Beginning with channel 1, remove the 50-ohm coaxial termination from the output coaxial connector of the channel (labeled "1" on the rear panel for channel 1). Connect the 50-ohm termination and the rf voltmeter to a coaxial tee and connect to the output connector. Insert either adjustment tool into the output level adjustment port (labeled "1" for channel 1) in the top cover. Rotate the adjustment to obtain an indication of 4.0 volts rms on the rf voltmeter.
 - d. Repeat step c for each of the 12 output channels. It may be necessary to repeat several times on all outputs at the same frequency because of loading effects.
 - e. Set the level of each input to the distribution amplifier to 2.0 volts rms.
 - f. Check to see that the input LEVEL adjustment controls are capable of reducing the output levels to less than 2.0 volts rms terminated in 50 ohms. It is only necessary to perform this test on one output channel at each frequency.

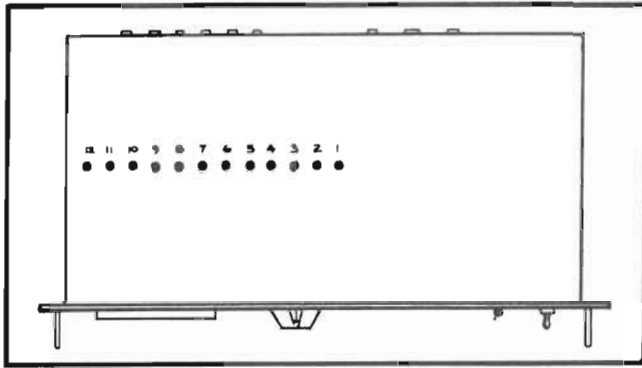


Figure 5. LOCATION OF ADJUSTMENT PORTS
IN TOP COVER

DISTORTION TESTS. The distortion tests require an rf voltmeter with probe, a spectrum analyzer, a BNC coaxial tee, twelve 50-ohm coaxial terminations, and frequency sources at 100 kHz, 1 MHz, and 5 MHz. The recommended rf voltmeter and spectrum analyzer are listed in Figure 4 of this section.

- a. Connect the 100 kHz, 1 MHz, and 5 MHz signals to the proper input connectors on the rear panel. Rotate all input LEVEL controls fully clockwise. Throw the POWER switch to ON. Adjust the output of each signal source to obtain a level of 1.0 volts rms at the rear panel input connector.
- b. Terminate all 12 output channels with 50-ohm coaxial terminations. Remove the 50-ohm coaxial terminations from channel 1, connect it and the rf voltmeter to a coaxial tee, and connect the tee to the channel 1 output connector. Adjust the 5 MHz input LEVEL control to obtain an indication of 4.0 volts rms on the rf voltmeter. Repeat this procedure for output channels number 5 and 9 adjusting the 1 MHz and 100 kHz input LEVEL controls respectively. The preceding adjustments set all output channels to a level of 4.0 volts rms.
- c. Connect the spectrum analyzer to any output channel. Set the spectrum analyzer to the frequency of the channel and adjust the spectrum analyzer attenuation to obtain a zero db reference level. Scan the spectrum starting at dc and continuing through the range of the spectrum analyzer. Check that all harmonics are more than 60 db down from the fundamental and that all spurious signals are more than 80 db down from the fundamental.
- d. Repeat this test for two output channels at each frequency.

OUTPUT VARIATIONS. This test requires an rf voltmeter with probe, three frequency sources at 100 kHz, 1 MHz, and 5 MHz, a BNC coaxial tee, twelve 50-ohm coaxial terminations, and a BNC coaxial shorting connector. The recommended rf voltmeter is listed in Figure 4 of this section.

- a. Connect the 100 kHz, 1 MHz, and 5 MHz signals to the proper input connectors on the rear panel. Adjust the output of each signal source to obtain a level of 1.0 volts rms at the rear panel input connector.

- b. Terminate all 12 output connectors with 50-ohm coaxial terminations. Set the POWER switch of the distribution amplifier to ON. Remove the 50-ohm coaxial termination from channel 1, connect it and the rf voltmeter to a coaxial tee, and connect the coaxial tee to the channel 1 output connector. Adjust the 5 MHz input LEVEL control on the rear panel to obtain an indication of 4.0 volts rms on the rf voltmeter. Repeat this procedure for output channels number 5 and 9 adjusting the 1 MHz and 100 kHz input LEVEL controls respectively. The preceding adjustments set all output channels to 4.0 volts rms.
- c. Remove the 50-ohm coaxial termination from any output channel, connect it and the rf voltmeter to a coaxial tee, and connect the coaxial tee to the output connector. Observe the rf voltmeter while removing the 50-ohm termination from either adjacent output channel and shorting the output with the BNC shorting connector. The indication should change less than 0.12 volts rms from open to shorted condition.
- d. Repeat this test for two channels at each frequency.

METER CALIBRATION. The meter calibration requires an rf voltmeter with probe, a coaxial tee, and twelve 50-ohm coaxial terminations.

- a. Connect the 100 kHz, 1 MHz, and 5 MHz signals to the proper input connectors on the rear panel.
- b. Terminate all 12 output connectors with 50-ohm coaxial terminations. Set the POWER switch of the distribution amplifier to ON. Remove the 50-ohm coaxial termination from channel 1, connect it and the rf voltmeter to a coaxial tee, and connect the coaxial tee to the channel 1 output connector. Adjust the 5 MHz input LEVEL control on the rear panel to obtain an indication of 4.0 volts rms on the rf voltmeter.
- c. Turn the LEVEL CHECK switch to channel 1.
- d. Adjust R2 on the meter circuit board to obtain an indication of 4.0 volts rms on the front panel meter.
- e. Connect the rf voltmeter terminated into a 50-ohm load through a coaxial tee to channel 5. Adjust the 1 MHz input LEVEL control on the rear panel to obtain an indication of 4.0 volts rms on the rf voltmeter.
- f. Turn the LEVEL CHECK switch to channel 5.
- g. The front panel meter should read 4.0 volts rms ± 0.5 volts rms.
- h. Repeat steps e through g for channel 9 (100 kHz).
- i. Provided all amplifier levels have been adjusted (see section titled OUTPUT LEVEL AND GAIN TESTS), positions 1-12 of the LEVEL CHECK switch will read 4.0 volts rms ± 0.5 volts rms.
- j. Rotate the LEVEL CHECK switch through the pre-amplifier positions. The meter should indicate

between 1 and 4 volts rms for each preamplifier level.

- k. Turn the LEVEL CHECK switch to POWER SUPPLY position. The meter should indicate 4.0 ± 0.5 volts.

LOCATING A FAULTY MODULE

Locating a faulty module in the Model 203A Distribution Amplifier is a relatively easy task. A defective module may be found by tracing the signal from input to output of the system. For example, if all output channels of one system only were at or near zero volts rms, it would be reasonable to suspect that the trouble was located in the preamplifier module. On the other hand, if only one channel output was at zero volts, the trouble would probably be found in the amplifier module for that channel. Any defect in the Power Supply Module would probably affect all output channels in the same manner. A defective output can also be caused by troubles in the chassis wiring or components mounted on the chassis. Depending on the nature of the particular fault, it may cause substandard performance or failure of the entire distribution amplifier or it may affect only one section.

TROUBLESHOOTING A FAULTY AMPLIFIER OR PRE-AMPLIFIER

The technique for finding the source of trouble in an amplifier or preamplifier module is similar to that for locating a faulty module. The input signal should be traced through the module with an rf voltmeter or an oscilloscope.

To further assist in troubleshooting, nominal values of pertinent dc voltages have been included on the schematic diagrams in Section IV for the preamplifier, amplifier and power supply modules. These voltages were measured with a vacuum tube voltmeter having an input resistance of 11 megohms. The following conditions were met before making these measurements:

- All modules in place and aligned per the module alignment procedures in Section IV.
- No signals present at all 3 inputs.
- The power supply voltage set at 20.0 volts dc.

TROUBLESHOOTING THE POWER SUPPLY CIRCUIT

If the power supply circuit is maintaining 20 ± 0.5 volts dc and the ripple is less than 10 millivolts rms under normal load conditions, it can be assumed that the power supply is operating properly. The tests for power supply voltage and ripple levels are given in the module alignment procedure in Section 4-1.

PARTS LIST

The following illustrated parts list contains all the electrical components that are a part of the final assembly. Information on column entries and ordering replaceable parts can be found on the first page of the Appendix section.

REF DESIG	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
	DISTRIBUTION AMPLIFIER - Figure 6	203A					
A1	Chassis Assembly (See Section III, Figure 7)						
A2	Front Panel Assembly (See Section III, Figure 8)						
A3	Rear Panel Assembly (See Section III, Figure 9)						
A4	Power Supply Module (See Section 4-1, Figure 2)	1702-212720 (203-16-408)	19429	1702-212720	1		
A5	100 kHz Preamplifier Module (See Section 4-2, Figure 2)	1702-181578 (203-2-401)	19429	1702-181578	1		
A6 thru A9	100 kHz Amplifier Module (See Section 4-3, Figure 2)	1702-195321 (203-16-403)	19429	1702-195321	4		
A10	1 MHz Preamplifier Module (See Section 4-4, Figure 2)	1702-181586 (203-2-402)	19429	1702-181586	1		
A11 thru A14	1 MHz Amplifier Module (See Section 4-5, Figure 2)	1702-195339 (203-16-404)	19429	1702-195339	4		

REF DESIG	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
A15	5 MHz Preamplifier Module (See Section 4-6, Figure 2)	1702-181610 (203-2-405)	19429	1702-181610	1		
A16 thru A19	5 MHz Amplifier Module (See Section 4-7, Figure 2)	1702-195347 (203-16-406)	19429	1702-195347	4		

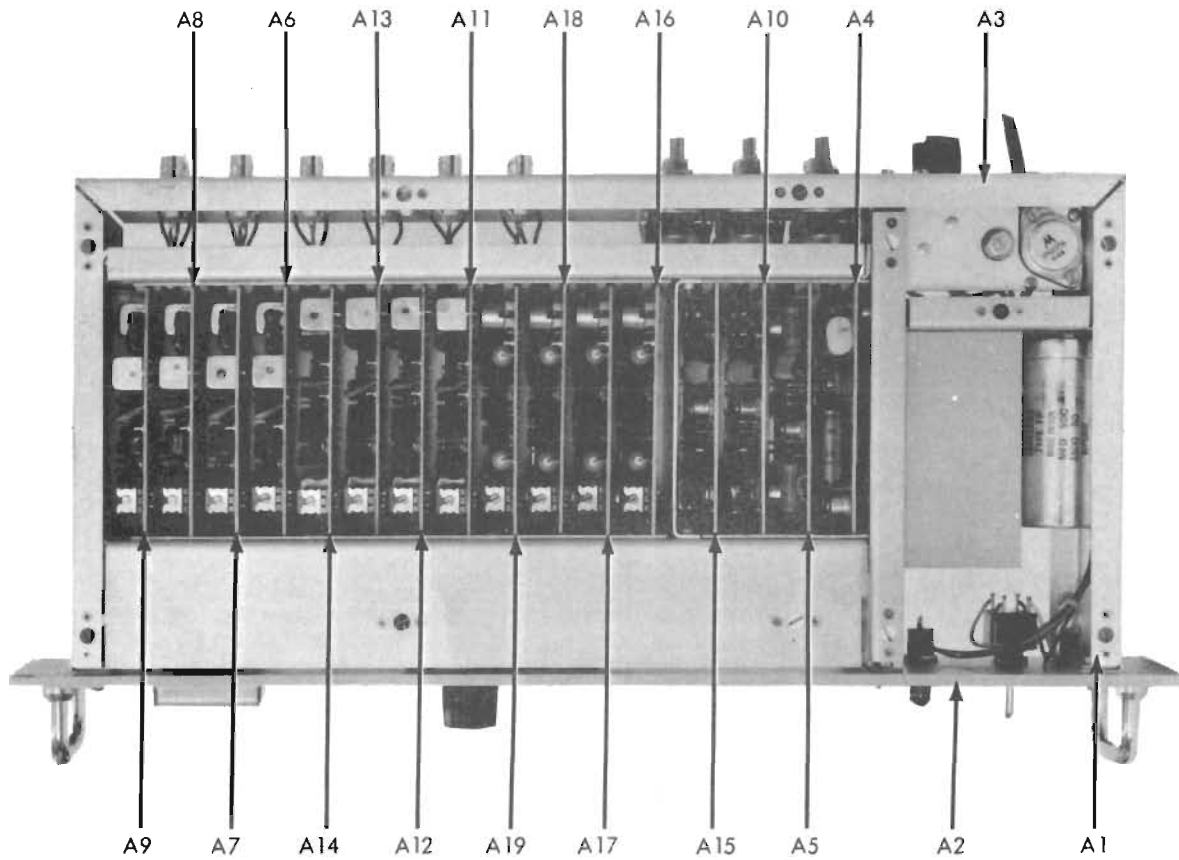


Figure 6. DISTRIBUTION AMPLIFIER

REF DESIG	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
A1	CHASSIS ASSEMBLY - Figure 7						
C1	Cap, elect, 1,500 uf +250/-10%, 50v	1502-154831	37942	WP-068	1		
C2, C3	Cap, cer, 0.05 uf +80/-20%, 500v (mounted on T1)	1501-105676	56289	33C58B	2		
C4	Cap, cer, 0.002 uf, gm, 1,000v	1501-105569	71590	DA140-139CB	1		
J1 thru J16	Connector, female, 10 contact	2107-149401	95354	91-6010-1100-00	16		
Q1	Transistor, Type 2N297A	4805-180315	04713	2N297A	1		
R10	Res, comp, 100k ±5%, 1/4w	4704-148189	01121	CB1045	1		
T1	Transformer, power	5602-180711	19429	5602-180711	1		
1	Foot, nylon (not illustrated)	2819-102921	19429	2819-102921	4		

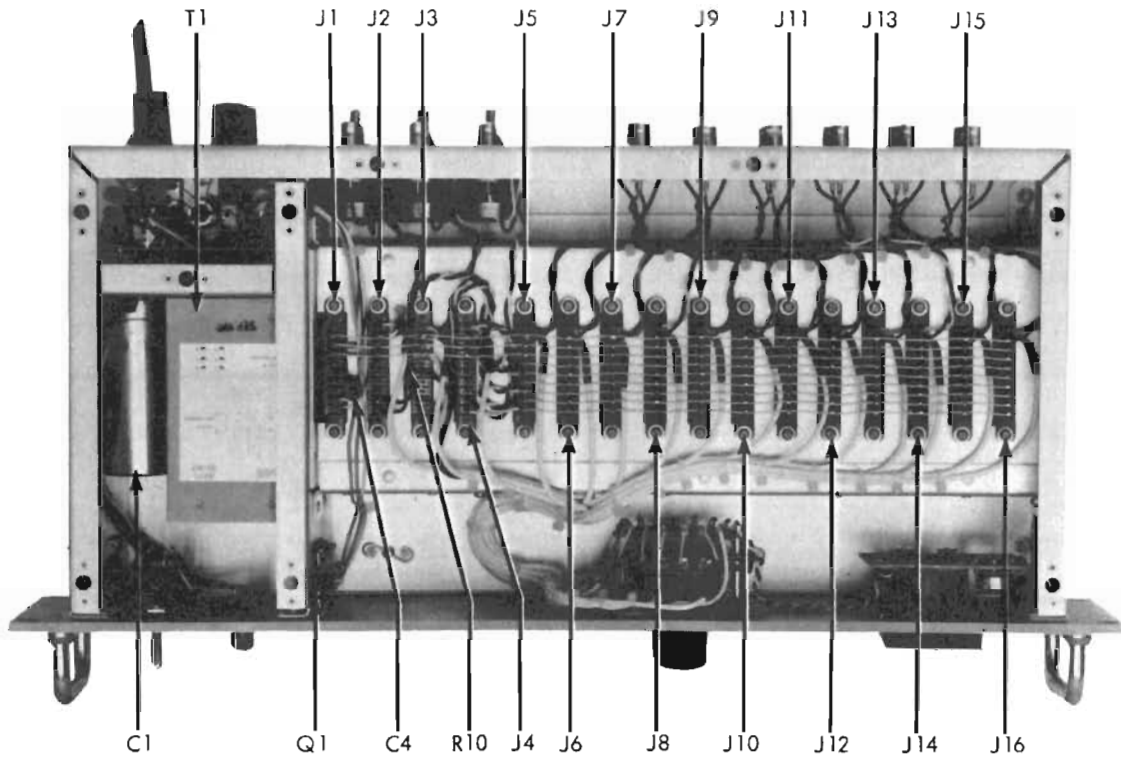


Figure 7. CHASSIS ASSEMBLY

REF DESIG	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
A2	FRONT PANEL ASSEMBLY - Figure 8						
A2A1	Meter P/C Assembly (See Figure 8)	1702-181651 (203-2-409)	19429	1702-181651	1		
DS1	Lamp, incandescent, 28v	3901-153106	71744	327	1		
M1	Meter, 0-200 ua, 225Ω	2901-184317	19429	2901-184317	1		
S1	Switch, POWER, toggle, dpst	5106-114835	04009	81024-GB	1		
S2	Switch, LEVEL CHECK, rotary, 2p, 17 pos	5105-180356	19429	5105-180356	1		
XDS1	Holder, lamp	3903-153114	13812	162-8430-931	1		
2	Handle, chrome-plated brass	2404-100412	05704	825	2		
3	Knob, LEVEL CHECK	2405-170035	19429	2405-170035	1		
4	Panel, front (less decals)	1406-181230	19429	1406-181230	1		
A2A1	METER P/C ASSEMBLY - Figure 8	1702-181651 (203-2-409)	19429	1702-181651	REF		
C1	Cap, mica, 10 pf ±10%, 500v	1504-175216	84419	CD15C0100K	1		
C2	Cap, cer, 0.05 uf ±20%, 100v	1501-149161	56289	55C23A7	2		
C3	Cap, cer, 0.05 uf ±20%, 100v	1501-149161	56289	55C23A7	REF		
CR1	Diode, Type IN270	4802-149187	93332	IN270	1		
R1	Res, comp, 4.7k ±5%, 1/4w	4704-148072	01121	CB4725	1		
R2	Res, var, comp, 50k ±20%, 1/4w	4701-163865	71450	Type UPE200	1		

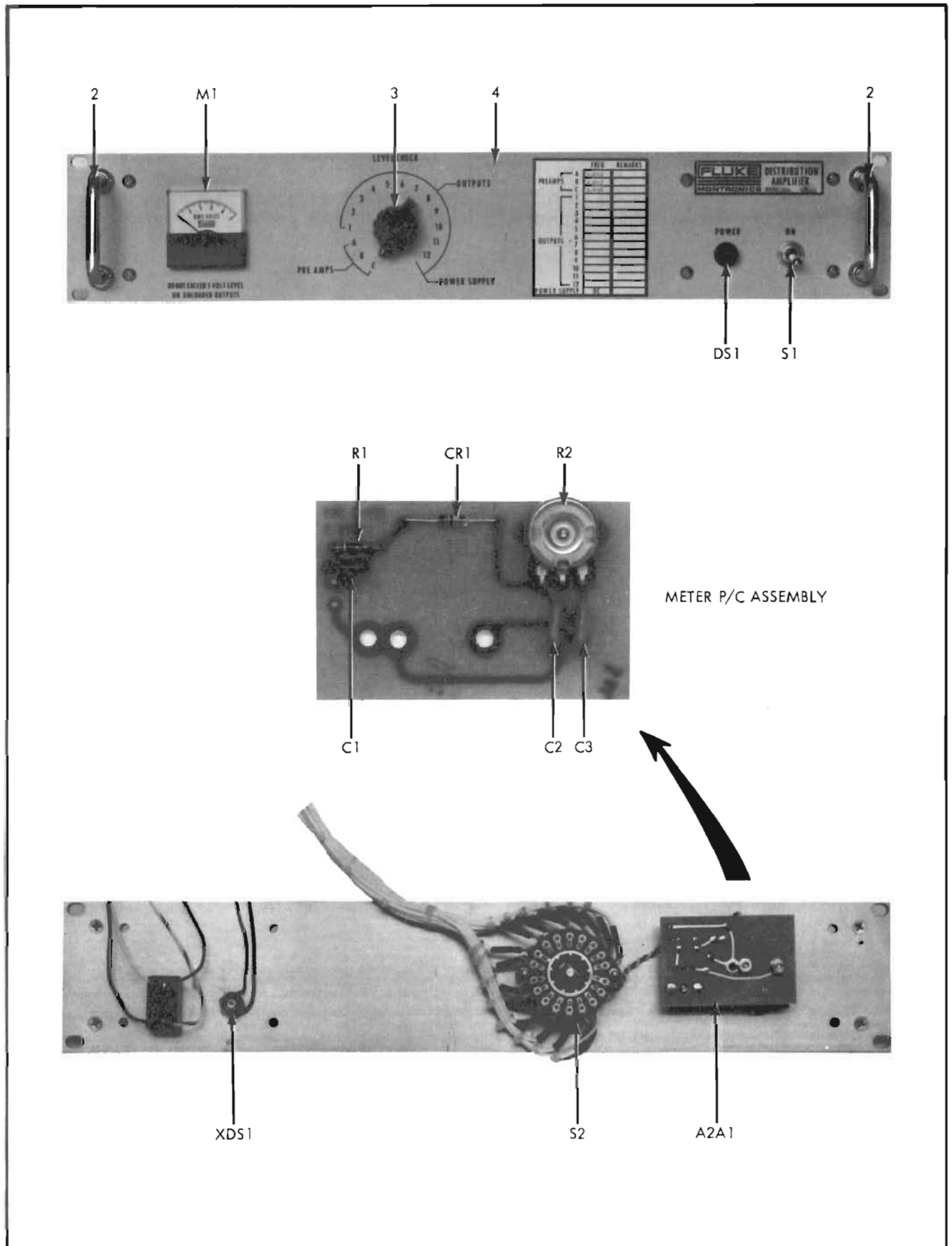


Figure 8. FRONT PANEL ASSEMBLY

REF DESIG	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
A3	REAR PANEL ASSEMBLY - Figure 9						
A3A1	DC Switchover Assembly (See Figure 9)	3158-209650 (203-2-415)	19429	3158-209650	1		
F1	Fuse, Type AGC, fast acting, 1/2 amp, 250v (for 115v operation) (not illustrated)	5101-153858	71400	Type AGC	1		
F1	Fuse, Type AGC, Fast acting, 1/4 amp, 250v (for 230v operation) (not illustrated)	5101-109314	71400	Type AGC	1		
F2	Fuse, Type AGC, Fast acting, 1-1/2 amp, 250v (not illustrated)	5101-109330	71400	Type AGC	1		
J17 thru J31	Connector, female, coaxial, BNC	2106-152033	02660	UG1094A/U	15		
J32	Connector, male, 2 contact	2105-215137	71785	P302AB	1		
R1 thru R3	Res, var, comp, 50Ω Bridged "T" Network, ±20%, 5w, dual	4701-174920	01121	Type JJ	3		
R4 thru R9	Res, comp, 47Ω ±5%, 1/4w	4704-147892	01121	CB4705	6		
W1	Line cord	6005-102822	19429	6005-102822	1		
XF1, XF2	Holder, fuse	2102-160846	75915	342004	2		
5	Panel, rear	1406-181438	19429	1406-181438	1		
A3A1	DC SWITCHOVER ASSEMBLY Figure 9	3158-209650 (203-2-415)	19429	3158-209650	REF		
CR1	Diode, zener, 20v, Type IN968B	4803-180463	07910	IN968B	1		
CR2	Diode, Type IN4817	4802-116111	05277	IN4817	1		
Q1	Transistor, Type 2N2553	4805-152447	01295	2N2553	1		
Q2	Transistor, Type 2N297A	4805-180315	04713	2N297A	1		
R1	Res, comp, 560Ω ±10%, 1w	4704-209692	01121	GB5611	1		
R2	Res, comp, 680Ω ±10%, 1w	4704-109611	01121	GB6811	1		

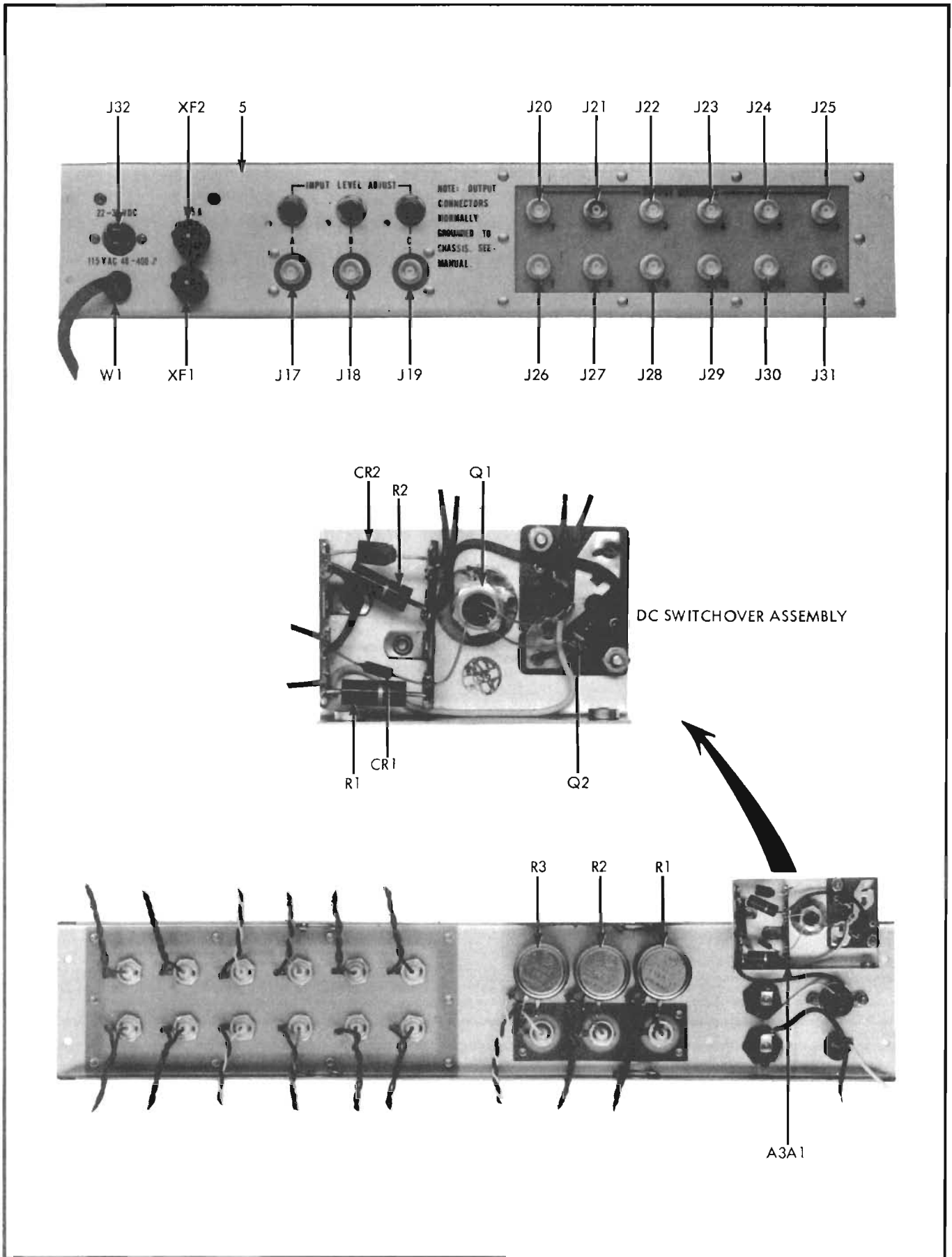
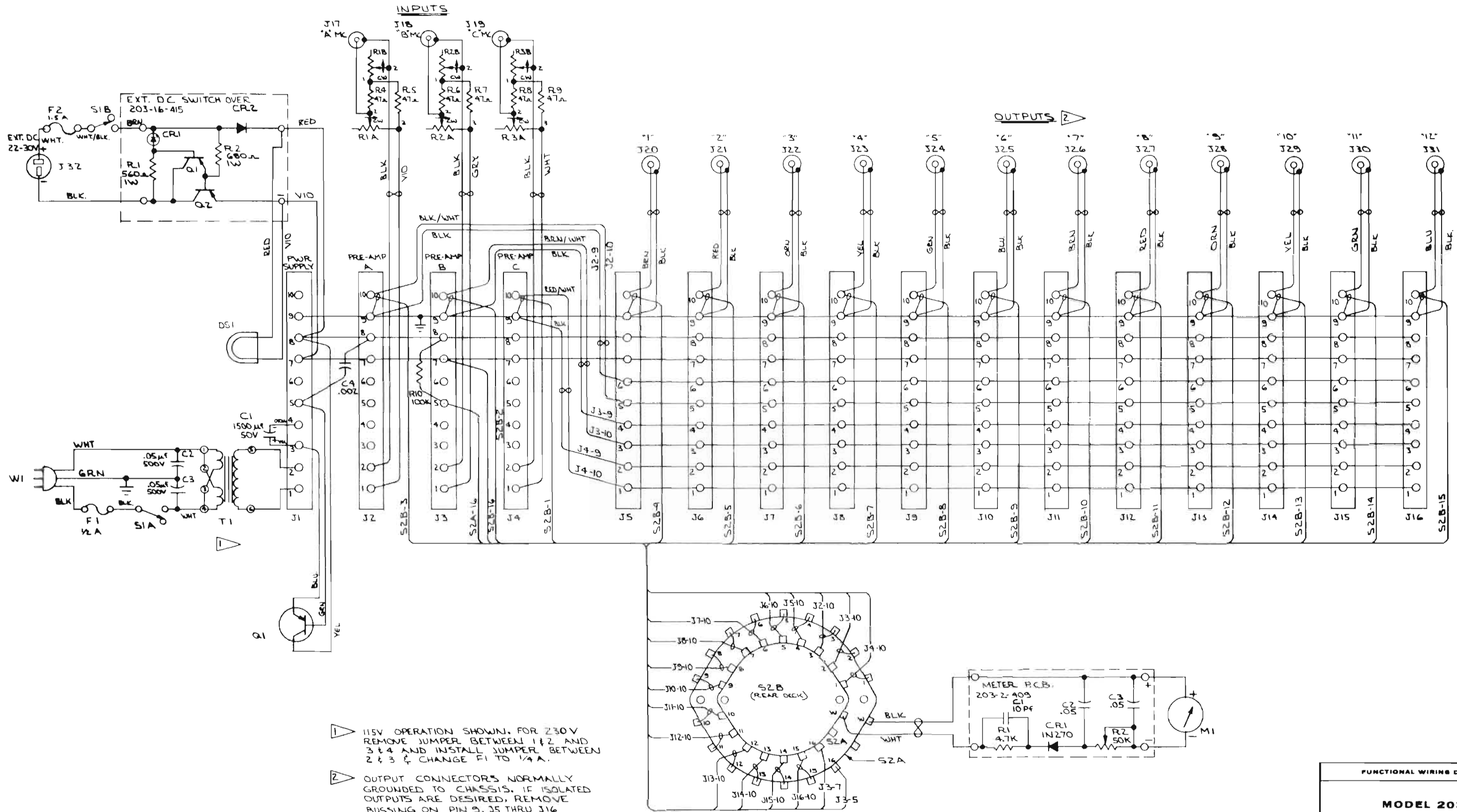


Figure 9. REAR PANEL ASSEMBLY



1 115V OPERATION SHOWN. FOR 230V REMOVE JUMPER BETWEEN 1 & 2 AND 3 & 4 AND INSTALL JUMPER BETWEEN 2 & 3 & CHANGE F1 TO 1/4 A.

2 OUTPUT CONNECTORS NORMALLY GROUNDED TO CHASSIS. IF ISOLATED OUTPUTS ARE DESIRED, REMOVE BUSSING ON PIN 9, 35 THRU 316

FUNCTIONAL WIRING DIAGRAM

MODEL 203A
(Serial No. 961 & on)

DRAWING NO. 203A-100

REVISION	ORIG	1	2	3	4	5	6	7	8
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MONTRONICS, INC.
P.O. Box 7428 Seattle, Washington 98133

conducting. As the conduction of Q1 increases, the base currents of both Q2 and the pass transistor are reduced. This reduces the conduction of the pass transistor. The decrease in series pass current causes a corresponding decrease in output voltage. Output voltage will continue to decrease until the circuit reaches equilibrium at an output of approximately 2.5 amperes.

ALIGNMENT PROCEDURE

The alignment of the Power Supply Module requires the distribution amplifier of which it is a part, a vacuum tube voltmeter, an rms voltmeter and the riser card from the accessory kit. The recommended voltmeters are listed in Section III.

- a. Set the POWER switch of the distribution amplifier to off.
- b. Remove the Power Supply Module from its chassis connector, install it on the riser card, then install the riser card into the Power Supply Module chassis connector.

CAUTION!

The Power Supply Module can only be installed on the riser card one way. However, the riser card can be installed on the chassis

connector either way. When installing the riser card in the chassis connector be sure that the Power Supply Module is facing in the same direction as it is when mounted without the riser card.

- c. Connect the positive lead of the vtm to pin 8 of the Power Supply Module connector and the ground lead to pin 7. Set the power switch of the distribution amplifier to ON. The vtm should indicate between 16 and 28 volts dc. Adjust R7 on the Power Supply Module for 20.0 volts dc, ± 0.5 volts.
- d. Remove the vtm connections and connect the signal lead of the rms voltmeter to pin 8 of the Power Supply Module connector and the ground lead to pin 7. The ripple indicated on the rms voltmeter should be less than 0.01 volts rms.
- e. Remove all test equipment connections.

PARTS LIST

The following illustrated parts list contains all the electrical components that are a part of the Power Supply Module. Further information on column entries and ordering replaceable parts can be found on the first page of the Appendix section.

REF DESIG	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
	POWER SUPPLY MODULE - Figure 2	1702-212720 (203-16-408)	19429	1702-212720	REF		
C1	Cap, elect, 160 uf +50/-10%, 64v	1502-170274	73445	C437ARH160	1		
C2	Cap, cer, 0.05 uf $\pm 20\%$, 100v	1501-149161	56289	55C23A7	1		
C3	Cap, mylar, 2 uf $\pm 20\%$, 100v	1507-106963	84411	Type X663FR	1		
C4	Cap, elect, 100 uf +75/-10%, 25v	1502-106518	56289	30D107G025DH4	1		
C5, C6	Cap, cer, 0.68 uf +80/-20%, 25v	1501-179077	56289	5C023684D8250-B3	2		
CR1 thru CR4	Diode, Motorola Type MR1032B	4802-187716	04713	MR1032B	4		
CR5	Diode, zener, 6.8v, Type IN754	4803-166199	07910	IN754	1		
P1	Connector, male, 10 contact	2107-149369	95354	61-6010-5700-00	1		
Q1 thru Q3	Transistor, C. D. Type CDQ10656	4805-203489	07910	CDQ10656	3		
R1	Res, comp, $33\Omega \pm 5\%$, 1/4w	4704-175034	01121	CB3305	1		
R2	Res, comp, $680\Omega \pm 5\%$, 1/4w	4704-148007	01121	CB6815	1		
R3	Res, comp, 3.3k $\pm 5\%$, 1/4w	4704-148056	01121	CB3325	2		
R4	Res, ww, $0.27\Omega \pm 5\%$, 5w	4706-183137	75042	AS-5	1		
R5	Res, comp, 1.5k $\pm 5\%$, 1/4w	4704-148031	01121	CB1525	2		
R6	Res, comp, 3.3k $\pm 5\%$, 1/4w	4704-148056	01121	CB3325	REF		
R7	Res, var, ww, 1k $\pm 5\%$, 1w	4702-149278	75042	Type 100-1	1		

REF DESIG	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
R8	Res, comp, 1.5k \pm 5%, 1/4w	4704-148031	01121	CB1525	REF		
R9	Res, comp, 1.10 Ω \pm 5%, 1/2w	4704-163717	01121	EB11G5	1		
R10	Res, comp, 4.7k \pm 5%, 1/4w	4704-148072	01121	CB4725	1		
	Transipad for Transistor TO-5 (not illustrated)	3155-152207	17069	88000	3		

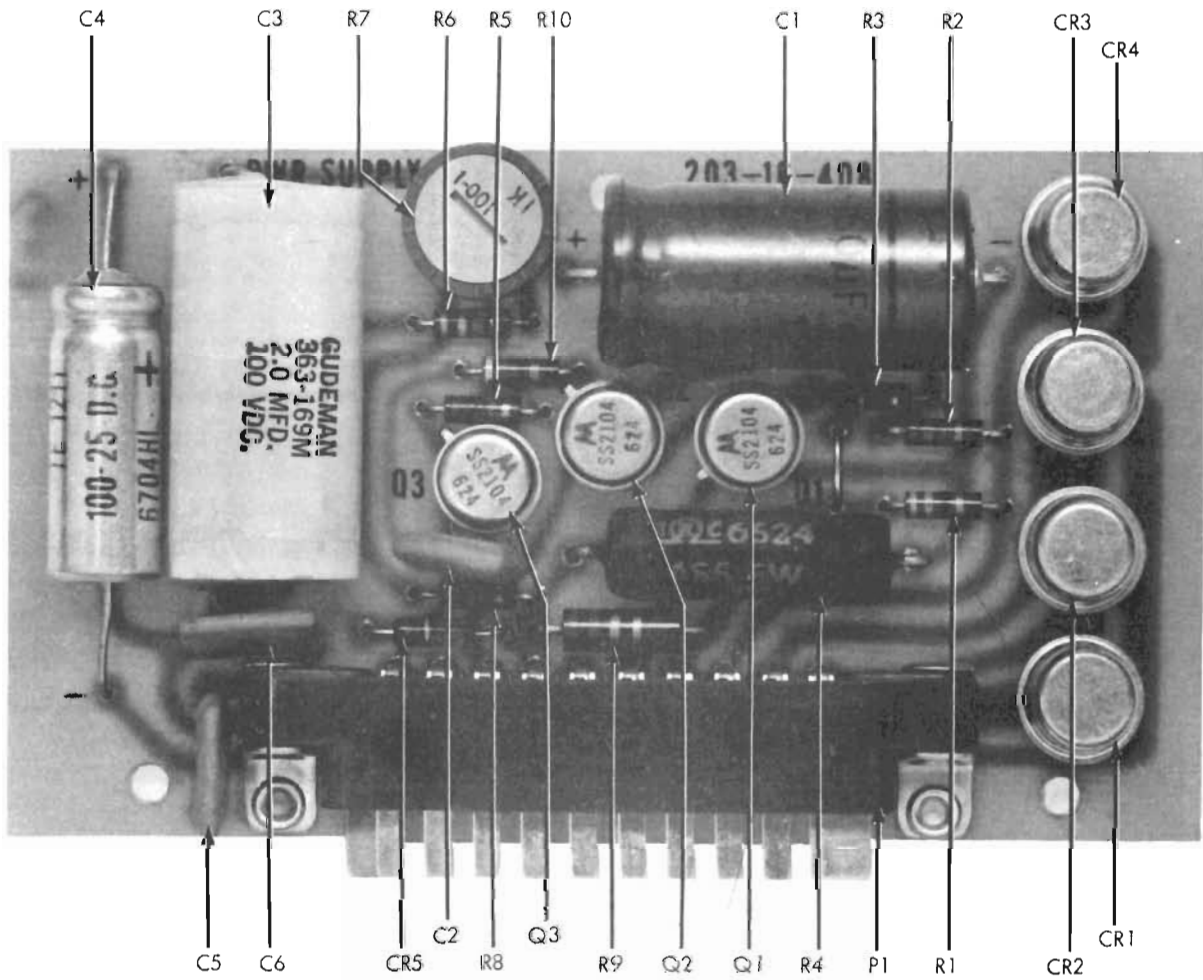


Figure 2. POWER SUPPLY MODULE

THE 100 KHz PREAMPLIFIER MODULE

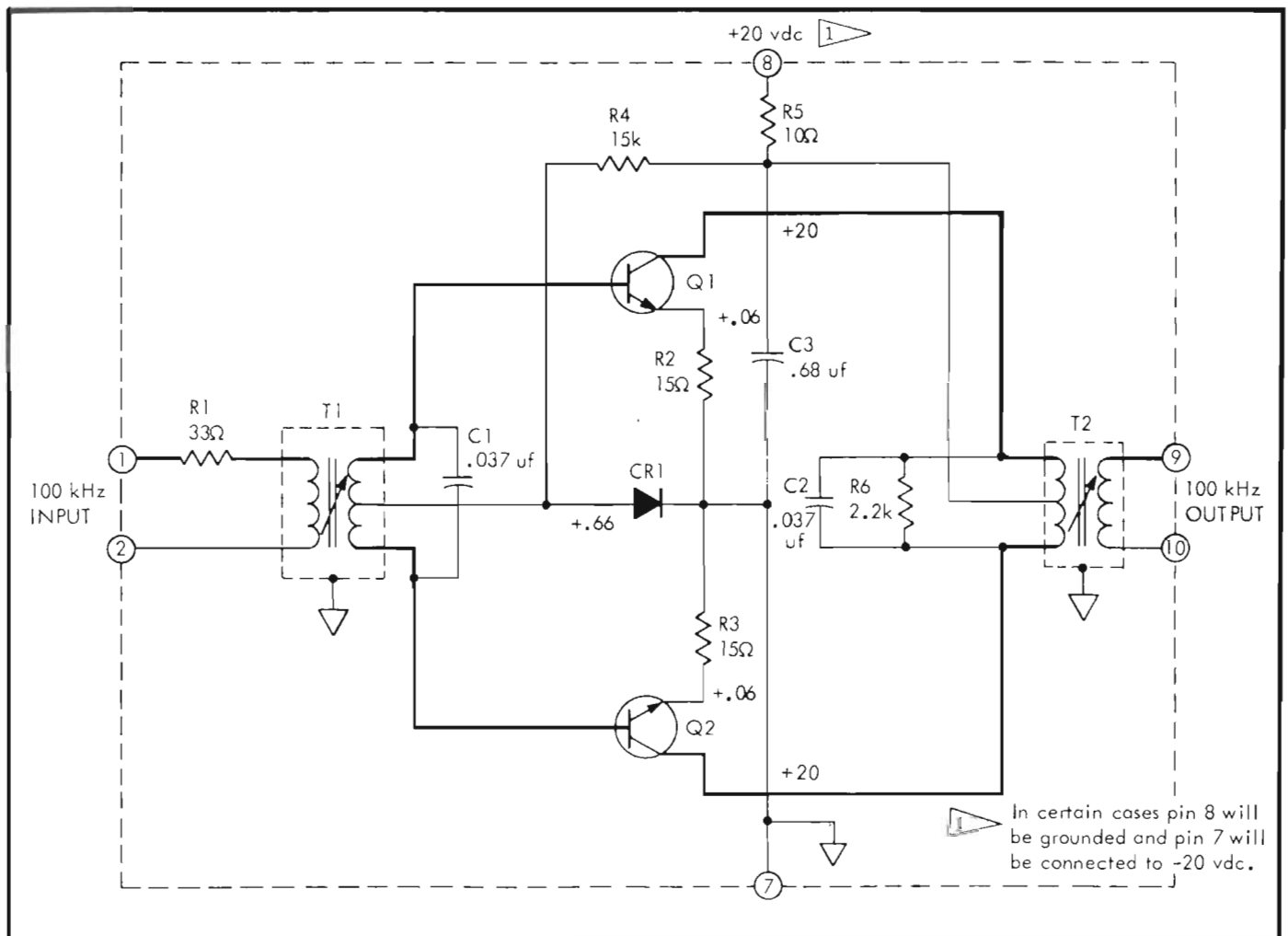


Figure 1. THE 100 KHz PREAMPLIFIER SCHEMATIC

THEORY OF OPERATION

The 100 kHz Preamplifier schematic is illustrated in Figure 1. The preamplifier is of the push-pull type, operated in the class B mode. As can be seen from the schematic, the circuit consists primarily of an input transformer, two transistors and an output transformer.

The input transformer, T1, accepts a 100 kHz sinewave signal. This signal is phase-split with respect to circuit common, by the center-tapped secondary of T1. Thus,

the signal is applied to the bases of Q1 and Q2 out of phase. An out-of-phase signal at the bases of Q1 and Q2 causes each transistor to alternately conduct. Consequently, each transistor amplifies one-half of each cycle of the input signal. The two amplified halves are then added in the center-tapped secondary of T2 to produce the complete waveform. If Q1 and Q2 are approximately matched transistors, even harmonics of the input signal are appreciably reduced in the output. Resistor R4 and diode CR1 provide a slight forward bias to the push-pull transistors to minimize crossover distortion.

ALIGNMENT PROCEDURE

The alignment of the 100 kHz Preamplifier requires the distribution amplifier of which this module is a part, an rf voltmeter and the accessory kit riser card, card pullers and adjustment tools. The recommended voltmeter model is listed in Section III.

- a. Set the power switch on the front panel of the distribution amplifier to off.
- b. Remove the 100 kHz Preamplifier Module from its chassis connector, install on the riser card, then install the riser card into the 100 kHz Preamplifier chassis connector.

CAUTION!

The module can only be installed on the riser card one way. However, the riser card can be installed on the chassis connector either way. When installing the riser card in the chassis connector be sure that the module on the riser card is facing in the same direction as it was when mounted without the riser card.

- c. Connect a 100 kHz input standard to the 100 kHz input connector on the distribution amplifier. Set the distribution amplifier power switch to ON.

- d. Connect the rf voltmeter to pins 1 and 2 of the module connector. Adjust either the 100 kHz input standard level control or the distribution amplifier 100 kHz level control, if provided, for 0.1 volts rms as indicated on the rf voltmeter.
- e. Connect the rf voltmeter to pins 9 and 10 of the module connector. Adjust T1 and T2 for maximum deflection of the rf voltmeter. It may be necessary to adjust each adjustment several times before arriving at the maximum point. With 0.1 volts rms at pins 1 and 2 of the module connector, the peaked output at pins 9 and 10 should be greater than 0.75 volts rms.
- f. Disconnect the 100 kHz input standard from the 100 kHz input connector of the distribution amplifier. The rf voltmeter reading should decrease to less than 0.01 volts rms.
- g. Set the distribution amplifier power switch to off. Remove the voltmeter connections. Reinstall the 100 kHz Preamplifier Module on its chassis connector.

PARTS LIST

The following illustrated parts list contains all the electrical components that are a part of the 100 kHz Preamplifier Module. Further information on column entries and ordering replaceable parts can be found on the first page of the Appendix section.

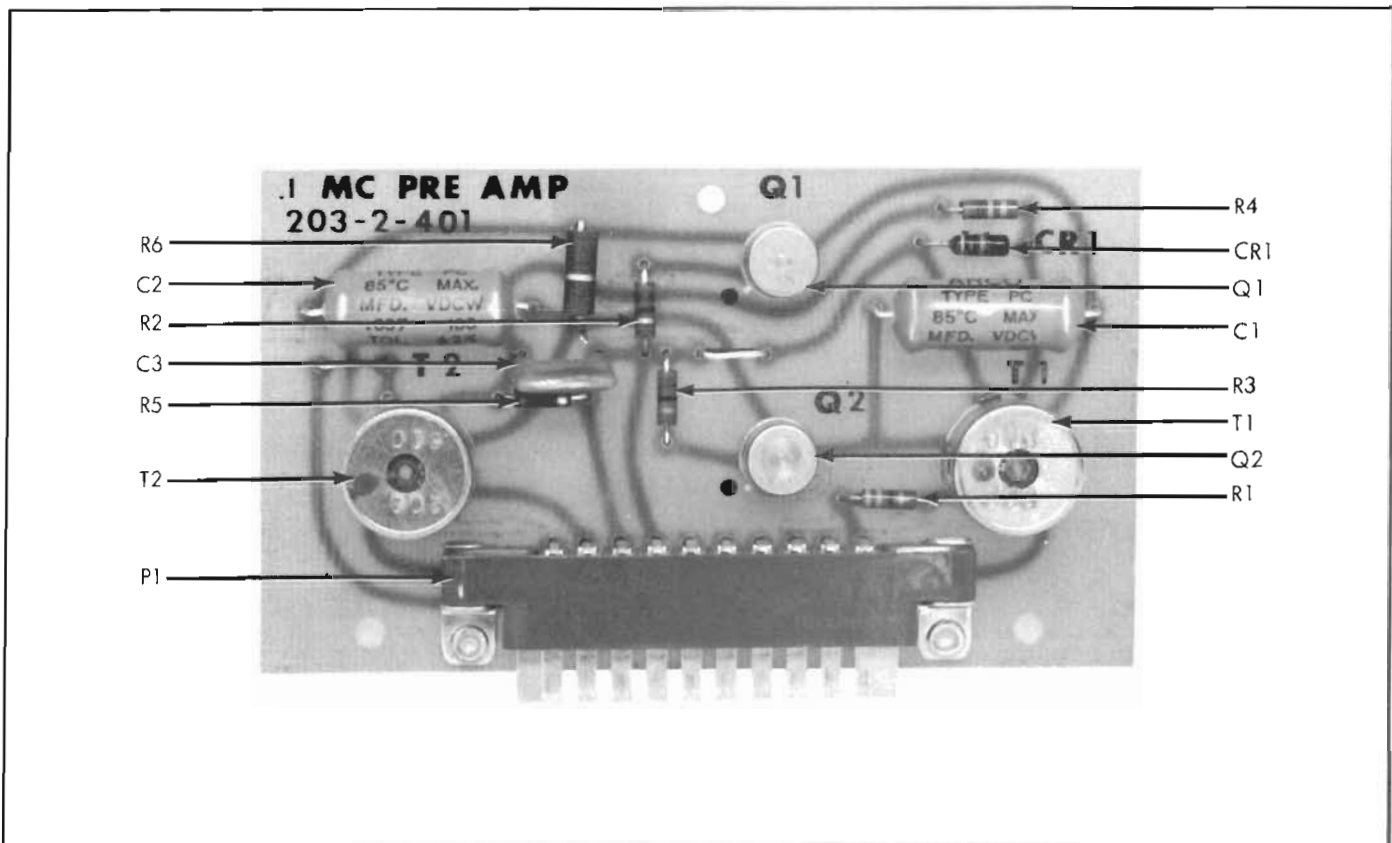


Figure 2. THE 100 KHz PREAMPLIFIER MODULE

REF DESIG	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
	100 KHz PREAMPLIFIER MODULE Figure 2	1702-181578	19429	1702-181578	REF		
C1, C2	Cap, plstc, 0.037 uf $\pm 2\%$, 100v	1507-179101	84171	1PC373G	2		
C3	Cap, cer, 0.68 uf +80/-20%, 25v	1501-179077	56289	5CO23684D- 8250B3	1		
CR1	Diode, Type 1N483B	4802-154799	84411	IN483B	1		
P1	Connector, male, 10 contact	2107-149369	95354	61-6010- 5700-00	1		
Q1, Q2	Transistor, Type 2N2218	4805-179374	04713	2N2218	2		
R1	Res, comp, $33\Omega \pm 5\%$, 1/4w	4704-175034	01121	CB3305	1		
R2, R3	Res, comp, $15\Omega \pm 5\%$, 1/4w	4704-147876	01121	CB1505	2		
R4	Res, comp, $15k \pm 5\%$, 1/4w	4704-148114	01121	CB1535	1		
R5	Res, comp, $10\Omega \pm 5\%$, 1/4w	4704-147868	01121	CB1005	1		
R6	Res, comp, $2.2k \pm 5\%$, 1/2w	4704-108506	01121	EB2225	1		
T1, T2	Transformer, var, 69.3 uh nominal	1800-181156	19429	1800-181156	2		
	Transipad for Transistor T0-5 (not illustrated)	3155-152207	17069	88000	2		

THE 100 KHz AMPLIFIER MODULE

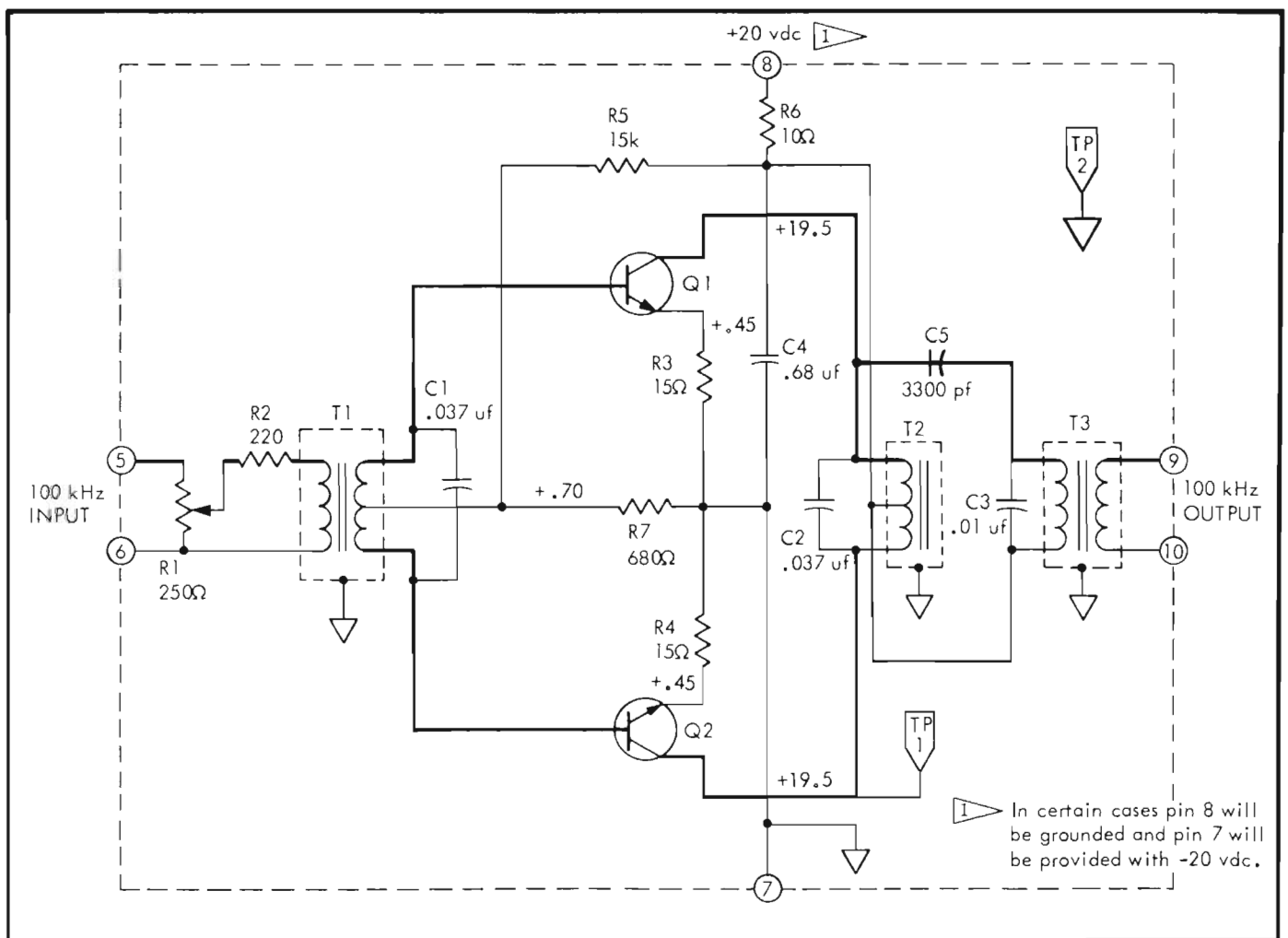


Figure 1. THE 100 KHz AMPLIFIER SCHEMATIC

THEORY OF OPERATION

The 100 kHz Amplifier schematic is illustrated in Figure 1. The amplifier is of the push-pull type, operated in the class B mode. As can be seen from the schematic the circuit consists primarily, of an input transformer,

two transistors, a transistor collector load transformer and an output transformer.

The input transformer, T1, accepts a 100 kHz sinewave signal. This signal is phase-split with respect to circuit common, by the center-tapped secondary of T1.

Thus, the signal is applied to the bases of Q1 and Q2 out of phase. An out-of-phase signal at the bases of Q1 and Q2 causes each transistor to alternately conduct. Consequently, each transistor amplifies one-half of each cycle of the input signal. The two amplified halves are then added in the center-tapped winding of T2. Transformers T2 and T3 operate together to form a double tuned circuit with mutual coupling impedance provided by C5. The double tuned output stage is under critically coupled and hence has a single-humped response curve (gain versus frequency). This characteristic provides a high degree of selectivity.

When the amplifier output is loaded into 50 ohms, most of the power is delivered to the load with very little loss in the tuned circuits. When the output is open-circuited, T3 absorbs most of the ac signal power from the collector circuit. If the output is shorted, T2 absorbs most of the ac signal power. Consequently, the dc power input to the stage remains essentially constant regardless of load.

If Q1 and Q2 are approximately matched transistors, even harmonics of the input signal are appreciably reduced in the output. Resistors, R5 and R7 provide a slight forward bias to the push-pull transistors, to minimize crossover distortion.

ALIGNMENT PROCEDURE

The alignment of 100 kHz Amplifier Module requires the distribution amplifier of which it is a part, and rf voltmeter with probe, the accessory kit riser card, card pullers, shorting connector and adjustment tools, a 50-ohm coaxial load, a BNC coaxial tee and a female BNC-to-test-clips adaptor. The recommended rf voltmeter and probe models are listed in Section III.

- a. Set the power switch of the distribution amplifier to off.
 - b. Remove the 100 kHz Amplifier Module from its chassis connector, install on the riser card, then install the riser card into the 100 kHz Amplifier Module chassis connector.
- CAUTION!**
- The module can only be installed on the riser card one way. However, the riser card can be installed on the chassis connector either way. When installing the riser card in the chassis connector be sure that the module on the riser card is facing in the same direction as it was when mounted without the riser card.
- c. Connect a 100 kHz input standard to the 100 kHz input connector on the distribution amplifier. Using a coaxial tee, connect a 50-ohm load to the channel output connector on the distribution amplifier associated with the 100 kHz Amplifier Module under test. Leave the open end of the coaxial tee unterminated.
 - d. Connect the signal lead of the rf voltmeter probe to pin 5 and the ground lead to pin 6 of the module

connector. Set the level potentiometer (R1) on the 100 kHz Amplifier Module, to maximum clockwise. Adjust either the 100 kHz input standard level control or the distribution amplifier 100 kHz level control, whichever is provided, for 0.1 volts rms, as indicated on the rf voltmeter.

- e. Connect the signal lead of the rf voltmeter probe to TP1 and the ground lead to TP2. Connect the shorting connector to the open end of the coaxial tee that is connected to the channel output connector. Adjust T1 and T2 for maximum deflection on the rf voltmeter. It may be necessary to adjust T1 and T2 several times, before arriving at the maximum level.
- f. Remove the shorting connector from the coaxial tee. Adjust T3 for minimum deflection on the rf voltmeter.
- g. Connect the rf voltmeter to the open end of the coaxial tee. Adjust T1 for maximum deflection of the rf voltmeter.
- h. Remove the rf voltmeter from the coaxial tee and once again connect the signal lead of the rf voltmeter probe to TP1 and the ground lead to TP2. Terminate the open end of the coaxial tee with the shorting connector. Adjust T2 for maximum deflection of the rf voltmeter.
- i. Remove the shorting connector from the coaxial tee. Adjust T3 for minimum deflection of the voltmeter.
- j. Connect the rf voltmeter to the open end of the coaxial tee. Remove the 100 kHz input standard from the 100 kHz input connector on the distribution amplifier. The rf voltmeter should indicate less than 0.01 volts rms.
- k. Connect the signal lead of the rf voltmeter probe to pin 5 and the ground lead to pin 6 of the 100 kHz Amplifier Module. Reconnect the 100 kHz input standard to the 100 kHz input connector on the distribution amplifier. Carefully adjust the input level to the 100 kHz Amplifier Module for 0.1 volts rms. Now reconnect the rf voltmeter to the coaxial tee located on the channel output connector associated with the module under test. The output level, as indicated on the rf voltmeter, should be greater than 0.26 volts rms.
- l. Set the distribution amplifier power switch to off. Remove all input-output and test equipment connections from the module under test and the distribution amplifier. Replace the 100 kHz Amplifier Module on its chassis connector.

PARTS LIST

The following illustrated parts list contains all the electrical components that are a part of the 100 kHz Amplifier Module. Further information on column entries and ordering replaceable parts can be found on the first page of the Appendix section.

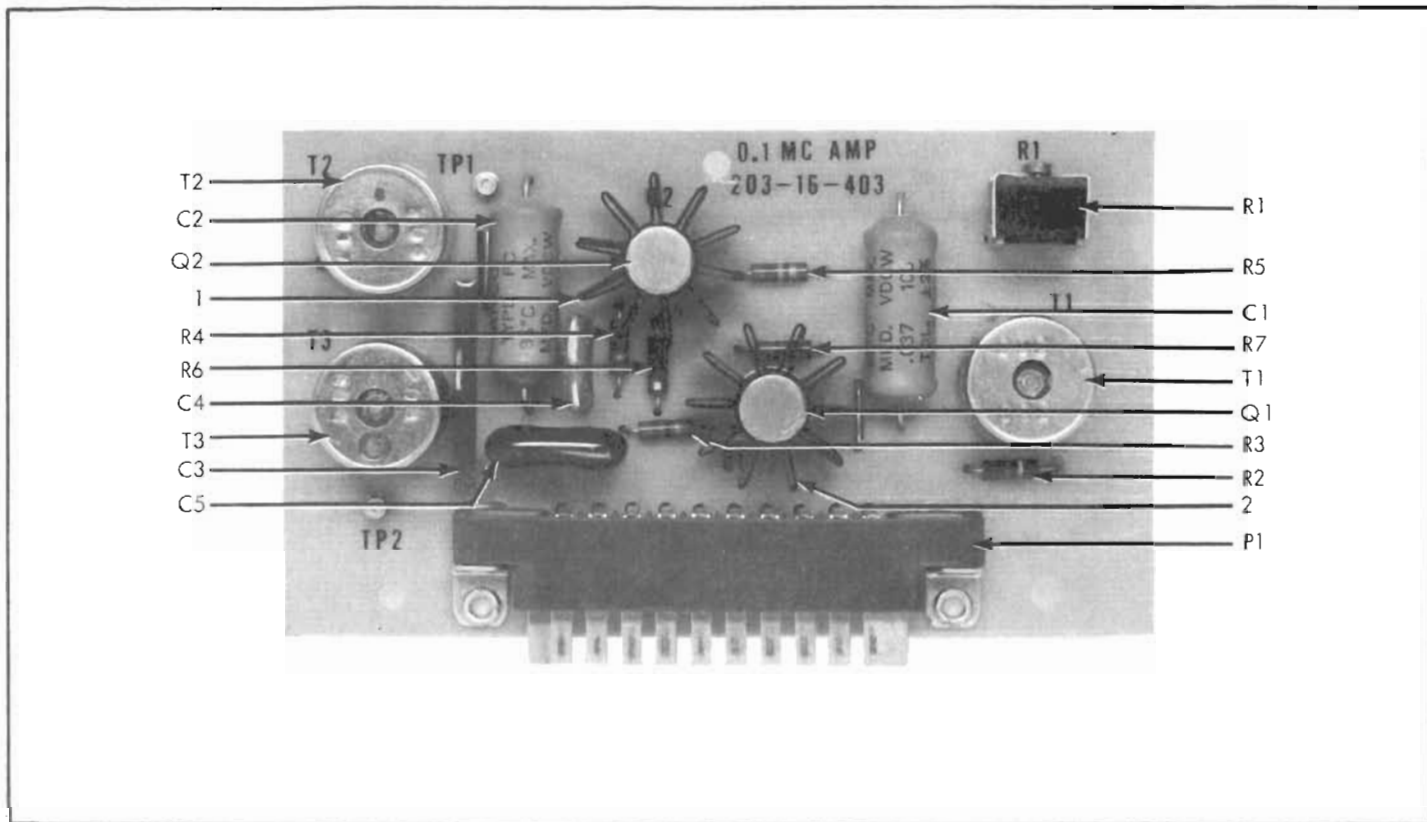


Figure 2. THE 100 KHz AMPLIFIER MODULE

REF DESIG	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
	100 KHz AMPLIFIER MODULE - Figure 2	1702-195321 (203-16-403)	19429	1702-195321	REF		
C1, C2	Cap, plstc, 0.037 uf ±2%, 100v	1507-179101	84171	1PC373G	20		
C3	Cap, plstc, 0.01 uf ±2%, 100v	1507-168385	84171	PE-103-G	10		
C4	Cap, cer, 0.68 uf +80/-20%, 25v	1501-179077	56289	5CO23684D-8250B3	10		
C5	Cap, mica, 3,300 pf ±5%, 500v	1504-148320	88419	CD19F332J	10		
P1	Connector, male, 10 contact	2107-149369	95354	61-6010-5700-00	1		
Q1, Q2	Transistor, Type 2N2218	4805-179374	04713	2N2218	20		
R1	Res, var, 250Ω ±20%, 1/8w	4701-194977	71450	2202251B	10		
R2	Res, comp, 220Ω ±5%, 1/4w	4704-147959	01121	CB2215	10		
R3, R4	Res, comp, 15Ω ±5%, 1/4w	4704-147876	01121	CB1505	20		
R6	Res, comp, 10Ω ±5%, 1/4w	4704-147868	01121	CB1005	10		
R7	Res, comp, 680Ω ±5%, 1/4w	4704-148007	01121	CB6815	10		
T1	Transformer, var 69.3 uh nominal	1800-181156	19429	1800-181156	10		
T2	Transformer, var 65 uh nominal	1800-181172	19429	1800-181172	10		
T3	Transformer, var 180 uh nominal	1800-181164	19420	1800-181164	10		
I. 2	Heat sink	4805-104646	05820	NF207	2		
	Transipad for Transistor T0-5 (not illustrated)	3155-152207	17069	88000	2		

THE 1 MHz PREAMPLIFIER MODULE

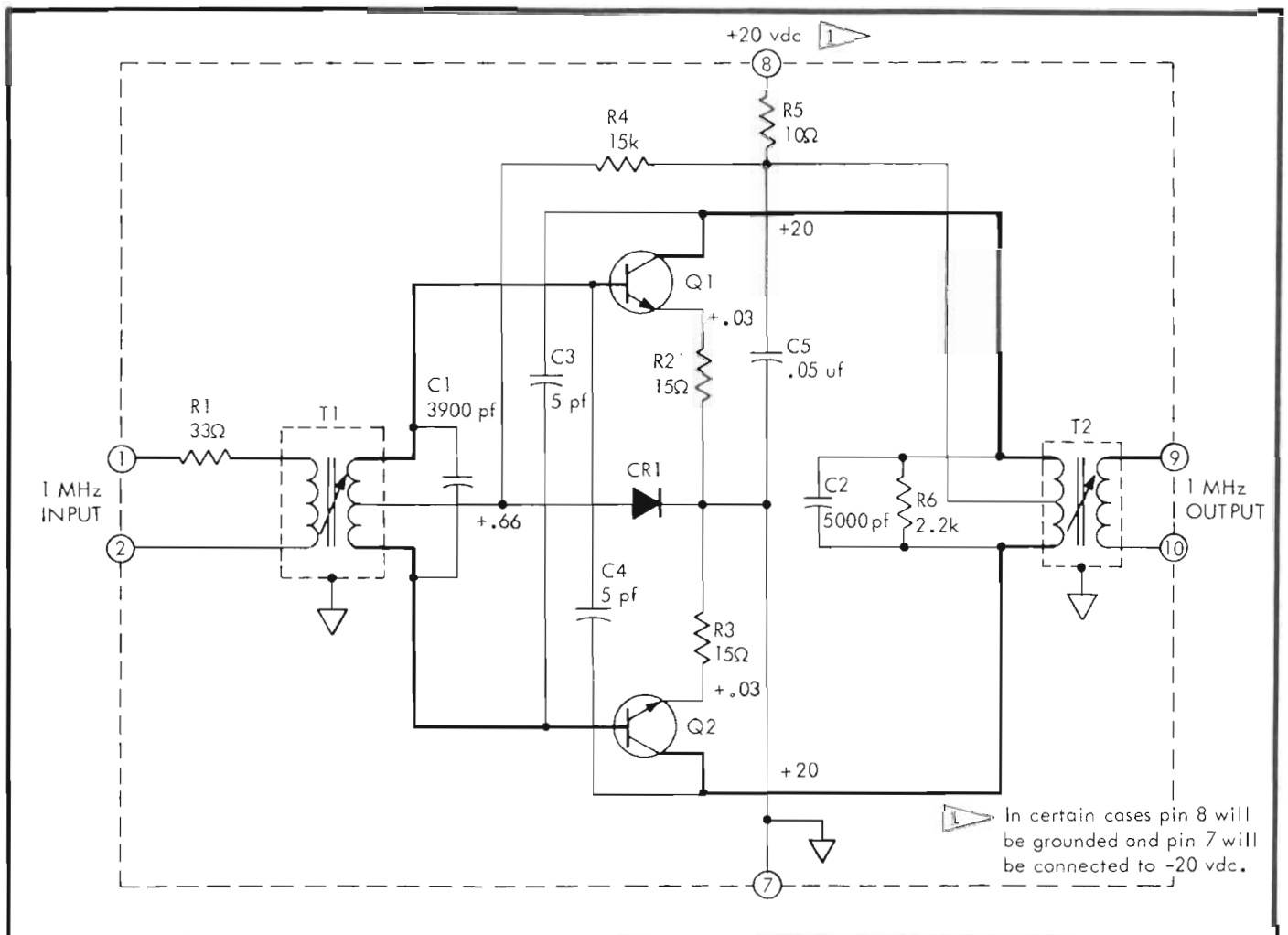


Figure 1. THE 1 MHz PREAMPLIFIER SCHEMATIC

THEORY OF OPERATION

The 1 MHz Preamplifier schematic is illustrated in Figure 1. The preamplifier is of the push-pull type, operated in the class B mode. As can be seen from the schematic, the circuit consists primarily, of an input transformer, two transistors and an output transformer.

The input transformer, T1, accepts a 1 MHz sinewave signal. This signal is phase-split with respect to circuit common, by the center-tapped secondary of T1.

Thus, the signal is applied to the bases of Q1 and Q2 out of phase. An out-of-phase signal at the bases of Q1 and Q2 causes each transistor to alternately conduct. Consequently, each transistor amplifies one-half of each cycle of the input signal. The two amplified halves are then added in the center-tapped secondary of T2 to produce the complete waveform. If Q1 and Q2 are approximately matched transistors, even harmonics of the input signal are appreciably reduced in the output. Resistor R4 and diode CR1 provide a slight forward bias to the push-pull transistors to minimize crossover distortion.

ALIGNMENT PROCEDURE

The alignment of the 1 MHz Preamplifier Module requires the distribution amplifier of which it is a part, an rf voltmeter and the accessory kit riser card, card pullers and adjustment tools. The recommended voltmeter is listed in Section III.

- a. Set the power switch on the front panel of the distribution amplifier to off.
 - b. Remove the 1 MHz Preamplifier Module from its chassis connector, install on the riser card, then install the riser card into the 1 MHz Preamplifier chassis connector.
- CAUTION!**
- The module can only be installed on the riser card one way. However, the riser card can be installed on the chassis connector either way. When installing the riser card in the chassis connector be sure that the module on the riser card is facing in the same direction as it was when mounted without the riser card.
- c. Connect a 1 MHz input standard to the 1 MHz input connector on the distribution amplifier. Set the distribution amplifier power switch to ON.

- d. Connect the rf voltmeter to pins 1 and 2 of the module connector. Adjust either the 1 MHz input standard level control or the distribution amplifier 1 MHz level control, if provided, for 0.1 volts rms as read on the rf voltmeter.
- e. Connect the rf voltmeter to pins 9 and 10 of the module connector. Adjust T1 and T2 for maximum deflection of the rf voltmeter. It may be necessary to adjust each adjustment several times before arriving at the maximum point. With 0.1 volts rms at pins 1 and 2 of the module connector, the peaked output at pins 9 and 10 should be greater than 0.52 volts rms.
- f. Disconnect the 1 MHz input standard from the 1 MHz input connector of the distribution amplifier. The rf voltmeter reading should decrease to less than 0.01 volts rms.
- g. Set the distribution amplifier power switch to off. Remove the voltmeter connections. Reinstall the 1 MHz Preamplifier Module on its chassis connector.

PARTS LIST

The following illustrated parts list contains all the electrical components that are a part of the 1 MHz Preamplifier Module. Further information on column entries and ordering replaceable parts can be found on the first page of the Appendix section.

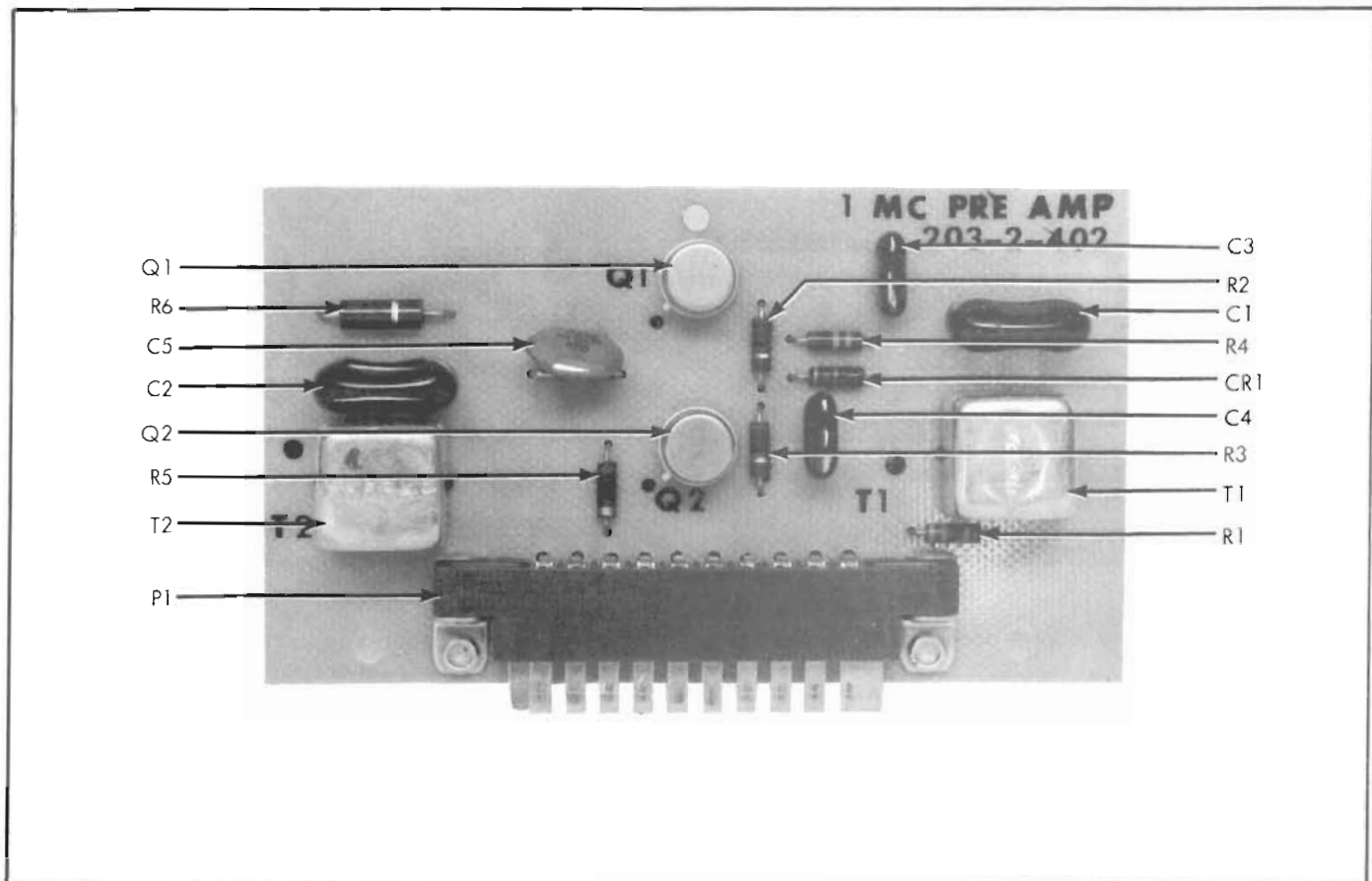


Figure 2. THE 1 MHz PREAMPLIFIER MODULE

REF DESIG	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
	1MHz PREAMPLIFIER MODULE Figure 2	1702-181586 (203-2-402)	19429	1702-181586	REF		
C1	Cap, mica, 3,900 pf $\pm 5\%$, 500v	1504-160325	88419	CD19F392J	1		
C2	Cap, mica, 5,000 pf $\pm 5\%$, 500v	1504-181065	88419	CD10F502J	1		
C3, C4	Cap, mica, 5 pf $\pm 10\%$, 500v	1504-148577	88419	CD15C050K	2		
C5	Cap, cer, 0.05 uf $\pm 20\%$, 100v	1501-149161	56289	55C23A7	1		
CR1	Diode, Type 1N483B	4802-154799	84411	IN483B	1		
P1	Connector, male, 10 contact	2107-149369	95354	61-6010-5700-00	1		
Q1, Q2	Transistor, Type 2N2218	4805-179374	04713	2N2218	2		
R1	Res, comp, $33\Omega \pm 5\%$, 1/4w	4704-175034	01121	CB3305	1		
R2, R3	Res, comp, $15\Omega \pm 5\%$, 1/4w	4704-147876	01121	CB1505	2		
R4	Res, comp, $15k \pm 5\%$, 1/4w	4704-148114	01121	CB1535	1		
R5	Res, comp, $10\Omega \pm 5\%$, 1/4w	4704-147868	01121	CB1005	1		
R6	Res, comp, $2.2k \pm 5\%$, 1/2w	4704-108506	01121	EB2225	1		
T1, T2	Transformer, var, 7.5 uh nominal	1800-181115	19429	1800-181115	2		
	Transipad for Transistor T0-5 (not illustrated)	3155-152207	17069	88000	2		

THE 1 MHz AMPLIFIER MODULE

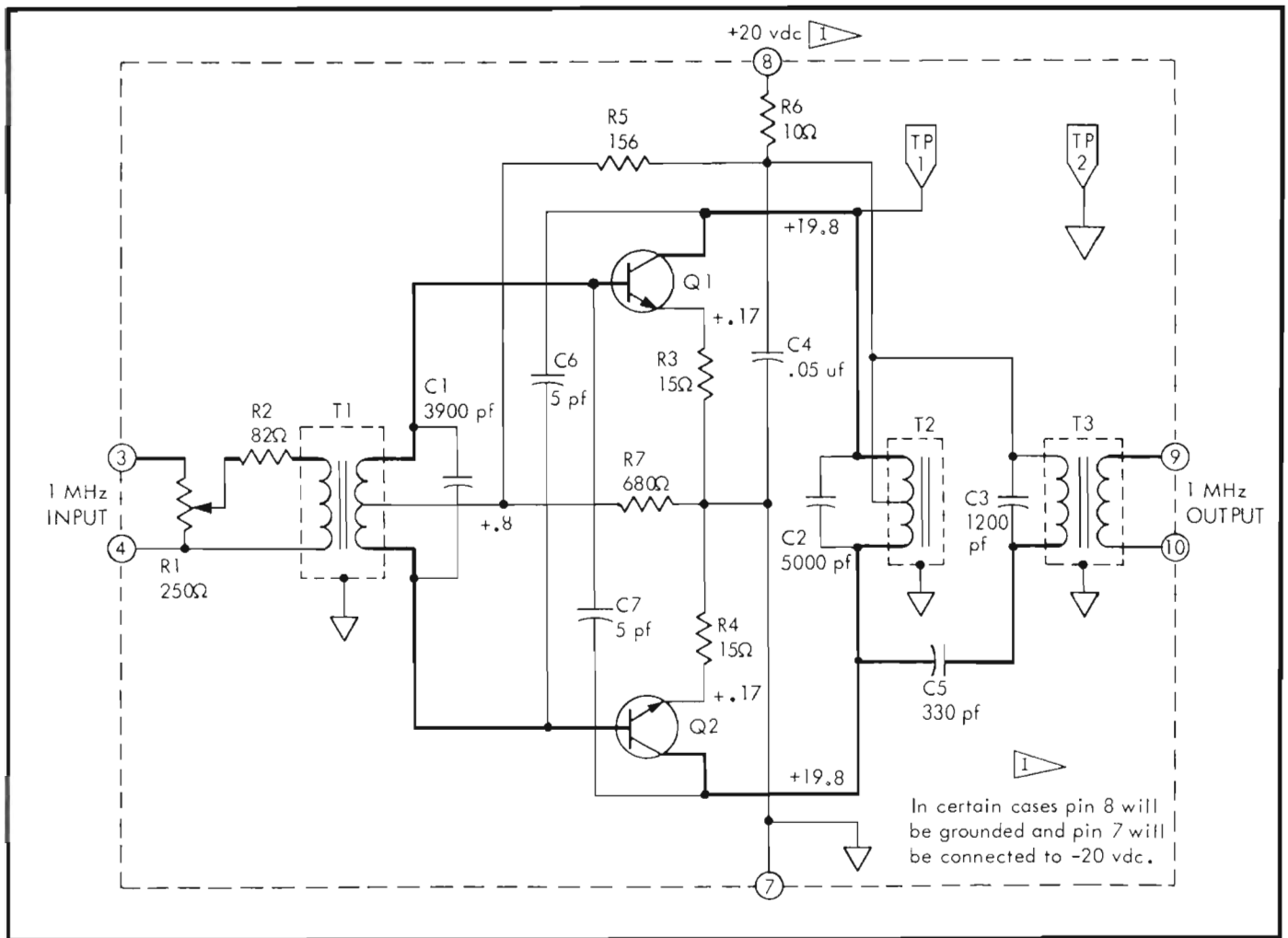


Figure 1. THE 1 MHz AMPLIFIER SCHEMATIC

THEORY OF OPERATION

The 1 MHz Amplifier schematic is illustrated in Figure 1. The amplifier is of the push-pull type, operated in the class B mode. As can be seen from the schematic the circuit consists primarily, of an input transformer,

two transistors, a transistor collector load transformer and an output transformer.

The input transformer, T1, accepts a 1 MHz sinewave signal. This signal is phase-split with respect to circuit common, by the center-tapped secondary of T1.

Thus, the signal is applied to the bases of Q1 and Q2 out of phase. An out-of-phase signal at the bases of Q1 and Q2 causes each transistor to alternately conduct. Consequently, each transistor amplifies one-half of each cycle of the input signal. The two amplified halves are then added in the center-tapped winding of T2. Transformers T2 and T3 operate together to form a double-tuned circuit with mutual coupling impedance provided by C5. The double-tuned output stage is under critically coupled and hence has a single-humped response curve (gain versus frequency). This characteristic provides a high degree of selectivity.

When the amplifier output is loaded into 50 ohms, most of the power is delivered to the load with very little loss in the tuned circuits. When the output is open-circuited, T3 absorbs most of the ac signal power from the collector circuit. If the output is shorted, T2 absorbs most of the ac signal power. Consequently, the dc power input to the stage remains essentially constant regardless of load.

If Q1 and Q2 are approximately matched transistors, even harmonics of the input signal are appreciably reduced in the output. Resistors, R5 and R7 provide a slight forward bias to the push-pull transistors, to minimize crossover distortion.

ALIGNMENT PROCEDURE

The alignment of the 1 MHz Amplifier Module requires the distribution amplifier of which it is a part, an rf voltmeter with probe, the accessory kit the riser card, card pullers, shorting connector and adjustment tools, a 50-ohm coaxial load, a BNC coaxial tee and a female BNC to test clips. The recommended rf voltmeter and probe models are listed in Section III.

- a. Set the power switch of the distribution amplifier to off.
- b. Remove the 1 MHz Amplifier Module from its chassis connector, install on the riser card, then install the riser card into the 1 MHz Amplifier Module chassis connector.

CAUTION!

The module can only be installed on the riser card one way. However, the riser card can be installed on the chassis connector either way. When installing the riser card in the chassis connector be sure that the module on the riser card is facing in the same direction as it was when mounted without riser card.

- c. Connect a 1 MHz input standard to the 1 MHz input connector on the distribution amplifier. Using a coaxial tee, connect a 50-ohm load to the channel output connector on the distribution amplifier associated with the 1 MHz Amplifier Module under test. Leave the open end of the coaxial tee unterminated.
- d. Connect the signal lead of the rf voltmeter probe to pin 3 and the ground lead to pin 4 of the module con-

ductor. Set the level potentiometer (R1) on the 1 MHz Amplifier Module, to maximum clockwise. Adjust either the 1 MHz input standard level control or the distribution amplifier 1 MHz level control, whichever is provided, for 0.1 volts rms, as indicated on the rf voltmeter.

- e. Connect the signal lead of the rf voltmeter probe to TP1 and the ground lead to TP2. Connect the shorting connector to the open end of the coaxial tee that is connected to the channel output connector. Adjust T1 and T2 for maximum deflection on the rf voltmeter. It may be necessary to adjust T1 and T2 several times, before arriving at the maximum level.
- f. Remove the shorting connector from the coaxial tee. Adjust T3 for minimum deflection on the rf voltmeter.
- g. Connect the rf voltmeter to the open end of the coaxial tee. Adjust T1 for maximum deflection of the rf voltmeter.
- h. Remove the rf voltmeter from the coaxial tee and once again connect the signal lead of the rf voltmeter probe to TP1 and the ground lead to TP2. Terminate the open end of the coaxial tee with the shorting connector. Adjust T2 for maximum deflection of the rf voltmeter.
- i. Remove the shorting connector from the coaxial tee. Adjust T3 for minimum deflection of the rf voltmeter.
- j. Connect the rf voltmeter to the open end of the coaxial tee. Remove the 1 MHz input standard from the 1 MHz input connector on the distribution amplifier. The rf voltmeter should indicate less than 0.01 volts rms.
- k. Connect the signal lead of the rf voltmeter probe to pin 3 and the ground lead to pin 4 of the 1 MHz Amplifier Module. Reconnect the 1 MHz input standard to the 1 MHz input connector on the distribution amplifier. Carefully adjust the input level to the 1 MHz Amplifier Module for 0.1 volts rms. Now reconnect the rf voltmeter to the coaxial tee located on the channel output connector associated with the module under test. The output level, as indicated on the rf voltmeter, should be greater than 0.26 volts rms.
- l. Set the distribution amplifier power switch to off. Remove all input-output and test equipment connections from the module under test and the distribution amplifier. Replace the 1 MHz Amplifier Module on its chassis connector.

PARTS LIST

The following illustrated parts list contains all the electrical components that are a part of the 1 MHz Amplifier Module. Further information on column entries and ordering replaceable parts can be found on the first page of the Appendix section.

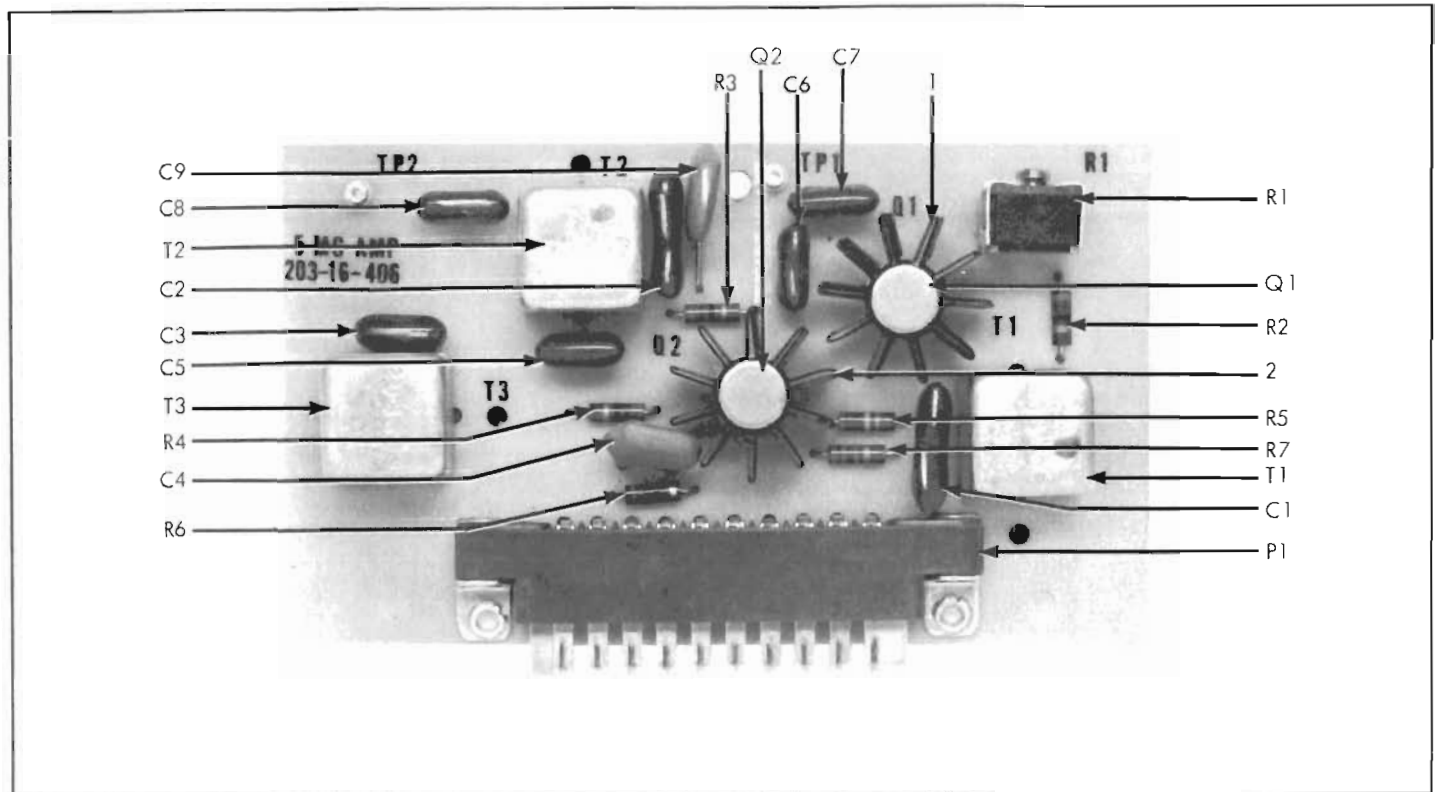


Figure 2. THE 5 MHz AMPLIFIER MODULE

REF DESIG	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
	5 MHz AMPLIFIER MODULE - Figure 2	1702-195347 (203-16-406)	19429	1702-195347	REF		
C1, C2	Cap, mica, 1,000 pf $\pm 5\%$, 500v	1504-147387	88419	CD19F102J	20		
C3	Cap, mica, 270 pf $\pm 5\%$, 500v	1504-148452	88419	CD15F271J	10		
C4	Cap, cer, 0.05 uf $\pm 20\%$, 100v	1501-149161	56289	55C23A7	20		
C5	Cap, mica, 82 pf $\pm 5\%$, 500v	1504-148502	88419	CD15F820J	20		
C6, C7	Cap, mica, 5 pf $\pm 10\%$, 500v	1504-148577	88419	CD15C050K	20		
C8	Cap, mica, 82 pf $\pm 5\%$, 500v	1504-148502	88419	CD15F820J	REF		
C9	Cap, cer, 0.05 uf $\pm 20\%$, 100v	1501-149161	56289	55C23A7	REF		
P1	Connector, male, 10 contact	2107-149369	95354	61-6010-5700-00	10		
Q1, Q2	Transistor, Type 2N2218	4805-179374	95303	2N2218	20		
R1	Res, var, 250 Ω $\pm 20\%$, 1/8w	4701-194977	71450	2202251B	10		
R2	Res, comp, 82 Ω $\pm 5\%$, 1/4w	4704-149484	01121	CB3205	10		
R3, R4	Res, comp, 15 Ω $\pm 5\%$, 1/4w	4704-147876	01121	CB1505	20		
R5	Res, comp, 15k $\pm 5\%$, 1/4w	4704-148114	01121	CB1535	10		
R6	Res, comp, 10 Ω $\pm 5\%$, 1/4w	4704-147868	01121	CB1095	10		
R7	Res, comp, 680 Ω $\pm 5\%$, 1/4w	4704-148007	01121	CB6815	10		
T1, T2	Transformer, var, 1.2 uh nominal	1800-181131	19429	1800-181131	20		
T3	Transformer, var, 3.7 uh nominal	1800-181149	19429	1800-181149	10		
1, 2	Heat sink	4806-104646	05820	NF207	20		
	Transipad for Transistor T0-5 (not illustrated)	3155-152207	17039	88000	20		

THE 5 MHz PREAMPLIFIER MODULE

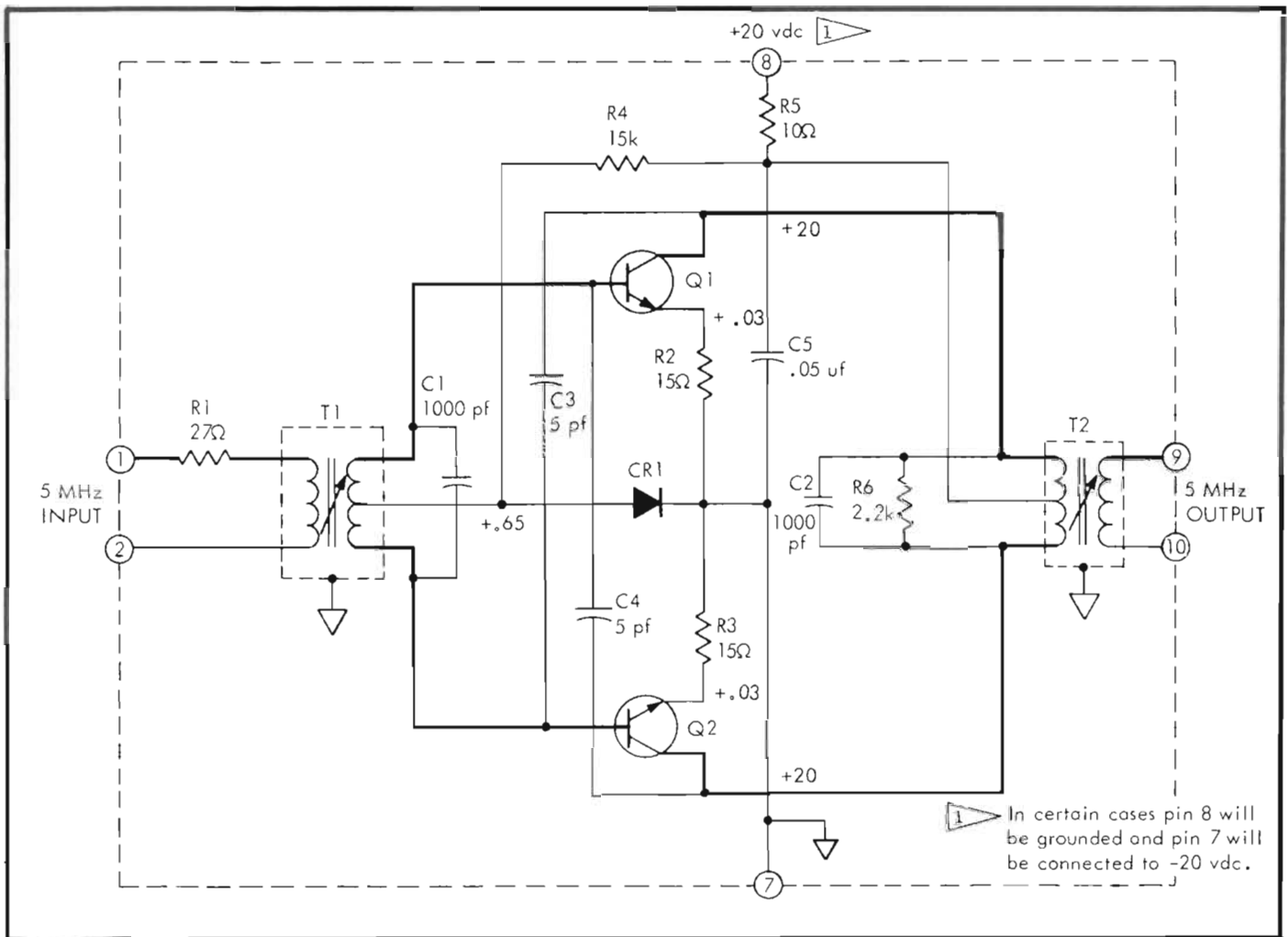


Figure 1. THE 5 MHz PREAMPLIFIER SCHEMATIC

THEORY OF OPERATION

The 5 MHz Preamplifier schematic is illustrated in Figure 1. The preamplifier is of the push-pull type, operated in the class B mode. As can be seen from the schematic, the circuit consists primarily, of an input transformer, two transistors and an output transformer.

The input transformer, T1, accepts a 5 MHz sinewave signal. This signal is phase-split with respect to circuit common, by the center-tapped secondary of T1.

Thus, the signal is applied to the bases of Q1 and Q2 out of phase. An out-of-phase signal at the bases of Q1 and Q2 causes each transistor to alternately conduct. Consequently, each transistor amplifies one-half of each cycle of the input signal. The two amplified halves are then added in the center-tapped secondary of T2 to produce the complete waveform. If Q1 and Q2 are approximately matched transistors, even harmonics of the input signal are appreciably reduced in the output. Resistor R4 and diode CR1 provide a slight forward bias to the push-pull transistors to minimize crossover distortion.

ALIGNMENT PROCEDURE

The alignment of the 5 MHz Preamplifier Module requires the distribution amplifier of which it is a part, an rf voltmeter and the accessory kit riser card, card pullers and adjustment tools. The recommended voltmeter model is listed in Section III.

- a. Set the power switch on the front panel of the distribution amplifier to off.
- b. Remove the 5 MHz Preamplifier Module from its chassis connector, install on the riser card, then install the riser card into the 5 MHz Preamplifier chassis connector.

CAUTION!

The module can only be installed on the riser card one way. However, the riser card can be installed on the chassis connector either way. When installing the riser card in the chassis connector be sure that the module on the riser card is facing in the same direction as it was when mounted without the riser card.

- c. Connect a 5 MHz input standard to the 5 MHz input connector on the distribution amplifier. Set the distribution amplifier power switch to ON,

- d. Connect the rf voltmeter to pins 1 and 2 of the module connector. Adjust either the 5 MHz input standard level control or the distribution amplifier 5 MHz level control, if provided, for 0.1 volts rms as read on the rf voltmeter.
- e. Connect the rf voltmeter to pins 9 and 10 of the module connector. Adjust T1 and T2 for maximum deflection of the rf voltmeter. It may be necessary to adjust each adjustment several times before arriving at the maximum point. With 0.1 volts rms at pins 1 and 2 of the module connector, the peaked output at pins 9 and 10 should be greater than 0.60 volts rms.
- f. Disconnect the 5 MHz input standard from the 5 MHz input standard from the 5 MHz input connector of the distribution amplifier. The rf voltmeter reading should decrease to less than 0.01 volts rms.
- g. Set the distribution amplifier power switch to off. Remove the voltmeter connections. Reinstall the 5 MHz Preamplifier Module on its chassis connector.

PARTS LIST

The following illustrated parts list contains all the electrical components that are a part of the 5 MHz Preamplifier Module. Further information on column entries and ordering replaceable parts can be found on the first page of the Appendix section.

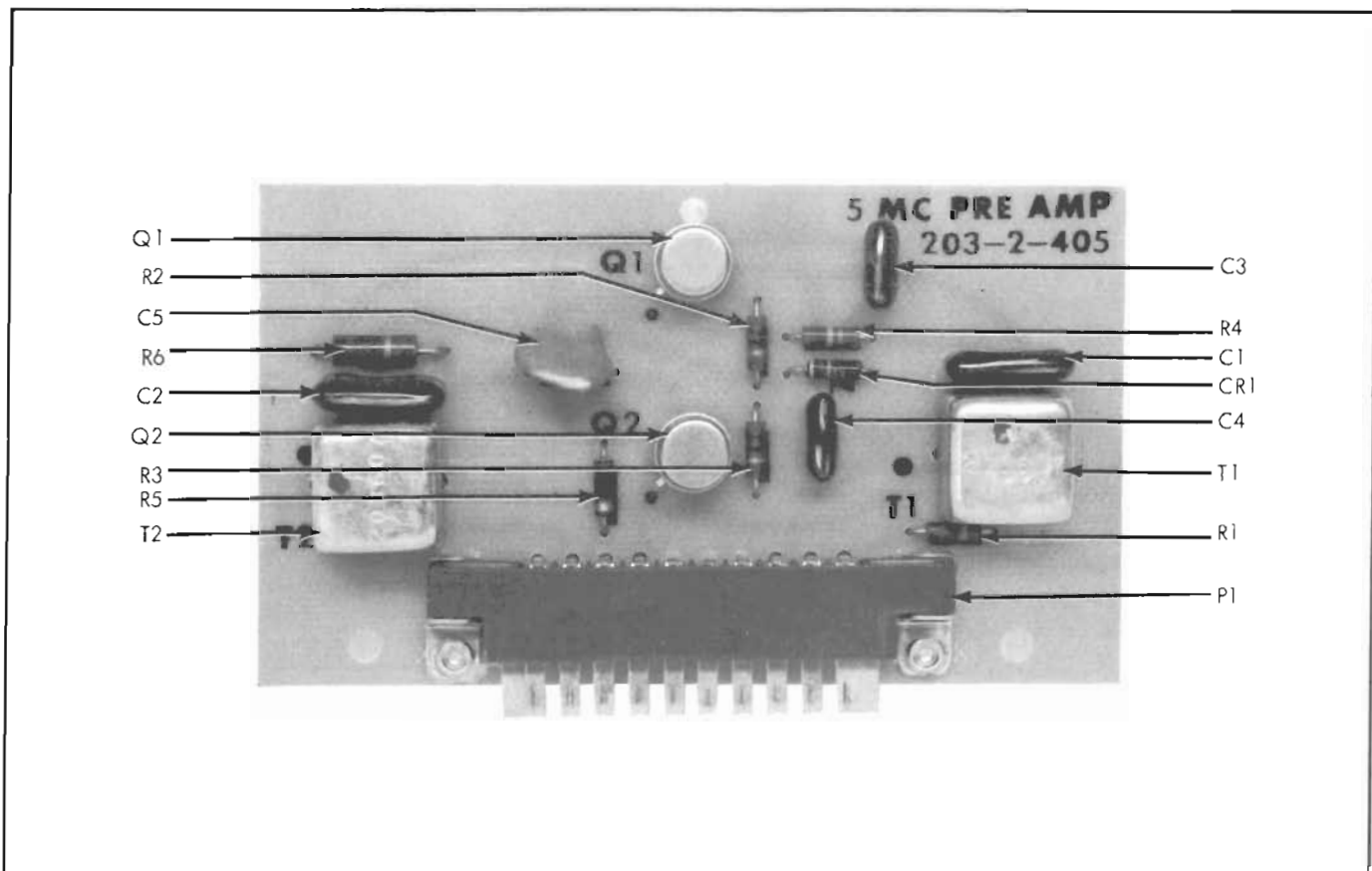


Figure 2. THE 5 MHz PREAMPLIFIER MODULE

REF DESIG	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
	5 MHz PREAMPLIFIER MODULE Figure 2	1702-181610 (203-2-405)	19429	1702-181610	REF		
C1, C2	Cap, mica, 1,000 pf $\pm 5\%$, 500v	1504-148387	88419	CD19F102J	2		
C3, C4	Cap, mica, 5 pf $\pm 10\%$, 500v	1504-148577	88419	CD15C050K	2		
C5	Cap, cer, 0.05 uf $\pm 20\%$, 100v	1504-149161	56289	55C23A7	1		
CR1	Diode, Type 1N483B	4802-154799	84411	1N483B	1		
P1	Connector, male, 10 contact	2107-149369	95354	61-6010-5700-00	1		
Q1, Q2	Transistor, Type 2N2218	4805-179374	04713	2N2218	2		
R1	Res, comp, $27\Omega \pm 5\%$, 1/4w	4704-160812	01121	CB2705	1		
R2, R3	Res, comp, $15\Omega \pm 5\%$, 1/4w	4704-147876	01121	CB1505	2		
R4	Res, comp, $15k \pm 5\%$, 1/4w	4704-148114	01121	CB1535	1		
R5	Res, comp, $10\Omega \pm 5\%$, 1/4w	4704-147868	01121	CB1005	1		
R6	Res, comp, $2.2k \pm 5\%$, 1/2w	4704-108506	01121	EB2225	1		
T1, T2	Transformer, var, 1.2 uh nominal	1800-181131	19429	1800-181131	2		
	Transipad for Transistor T0-5 (not illustrated)	3155-152207	17069	88000	2		

THE 5 MHz AMPLIFIER MODULE

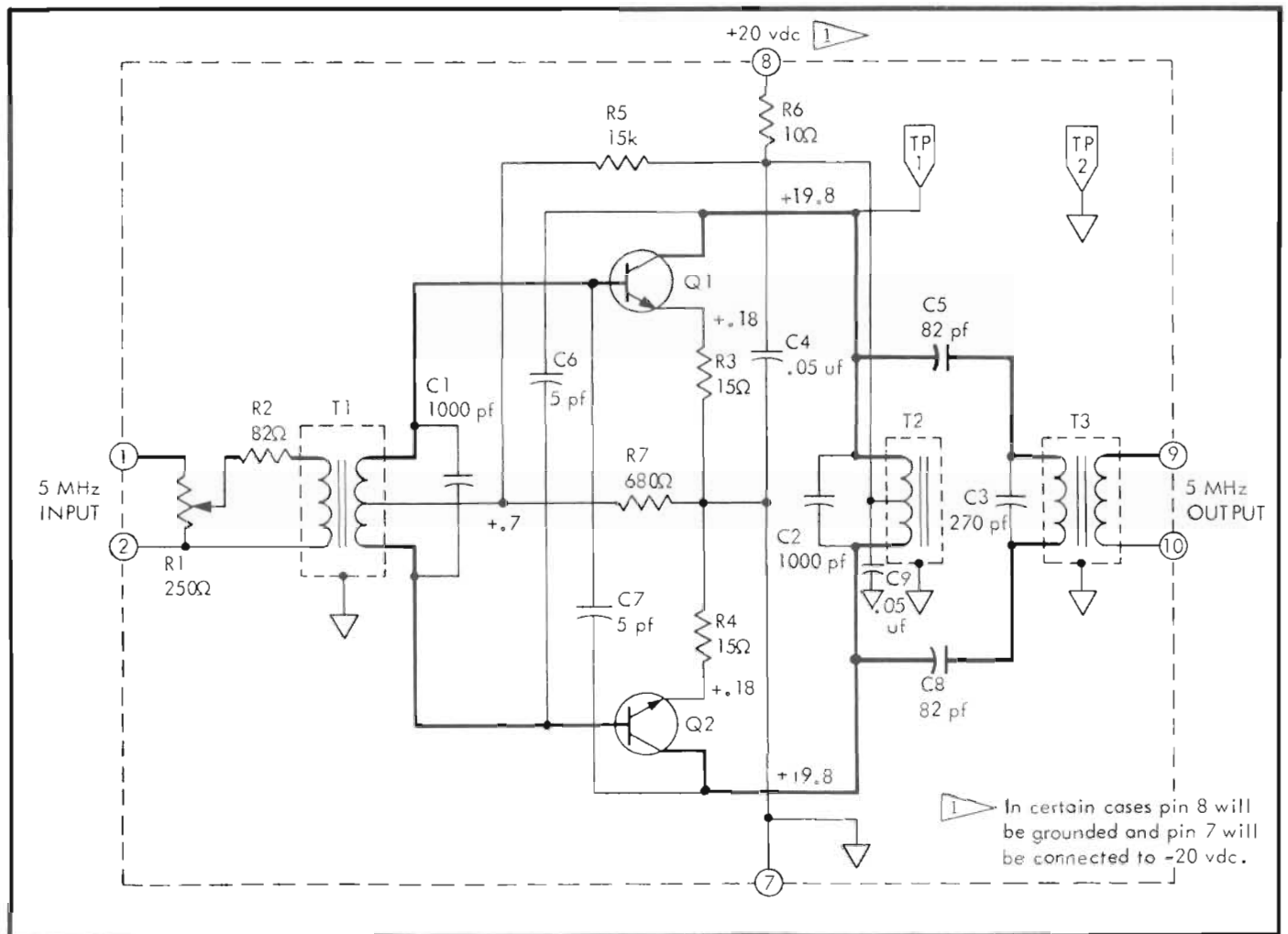


Figure 1. THE 5 MHz AMPLIFIER SCHEMATIC

THEORY OF OPERATION

The 5 MHz Amplifier schematic is illustrated in Figure 1. The amplifier is of the push-pull type, operated in the class B mode. As can be seen from the schematic the circuit consists primarily, of an input transformer,

two transistors, a transistor collector load transformer and an output transformer.

The input transformer, T1, accepts a 5 MHz sinewave signal. This signal is phase-split with respect to circuit common, by the center-tapped secondary of T1.

Thus, the signal is applied to the bases of Q1 and Q2 out of phase. An out-of-phase signal at the bases of Q1 and Q2 causes each transistor to alternately conduct. Consequently, each transistor amplifies one-half of each cycle of the input signal. The two amplified halves are then added in the center-tapped winding of T2. Transformers T2 and T3 operate together to form a double-tuned circuit with mutual coupling impedance provided by C5 and C8. The double-tuned output stage is under critically coupled and hence has a single-humped response curve (gain versus frequency). This characteristic provides a high degree of selectivity.

When the amplifier output is loaded into 50 ohms, most of the power is delivered to the load with very little loss in the tuned circuits. When the output is open-circuited, T3 absorbs most of the ac signal power from the collector circuit. If the output is shorted, T2 absorbs most of the ac signal power. Consequently, the dc power input to the stage remains essentially constant regardless of load.

If Q1 and Q2 are approximately matched transistors, even harmonics of the input signal are appreciably reduced in the output. Resistors, R5 and R7 provide a slight forward bias to the push-pull transistor, to minimize crossover distortion.

ALIGNMENT PROCEDURE

The alignment of the 5 MHz Amplifier Module requires the distribution amplifier of which it is a part, an rf voltmeter with probe, the accessory kit riser card, card pullers, shorting connector and adjustment tools, a 50-ohm coaxial load, a BNC coaxial tee and a female BNC-to-test-clips adaptor. The recommended rf voltmeter and probe models are listed in Section III.

- a. Set the power switch of the distribution amplifier to off.
- b. Remove the 5 MHz Amplifier Module from its chassis connector, install on the riser card, then install the riser card into the 5 MHz Amplifier Module chassis connector.

CAUTION!

The module can only be installed on the riser card one way. However, the riser card can be installed on the chassis connector either way. When installing the riser card in the chassis connector be sure that the module on the riser card is facing in the same direction as it was when mounted without the riser card.

- c. Connect a 5 MHz input standard to the 5 MHz input connector on the distribution amplifier. Using a coaxial tee, connect a 50-ohm load to the channel output connector on the distribution amplifier associated with the 5 MHz Amplifier Module under test. Leave the open end of the coaxial tee unterminated.

- d. Connect the signal lead of the rf voltmeter probe to pin 1 and the ground lead to pin 2 of the module connector. Set the level potentiometer (R1) on the 5 MHz Amplifier Module, to maximum clockwise. Adjust either the 5 MHz input standard level control or the distribution amplifier 5 MHz level control, whichever is provided, for 0.1 volts rms, as indicated on the rf voltmeter.
- e. Connect the signal lead of the rf voltmeter probe to TP1 and the ground lead to TP2. Connect the shorting connector to the open end of the coaxial tee that is connected to the channel output connector. Adjust T1 and T2 for maximum deflection on the rf voltmeter. It may be necessary to adjust T1 and T2 several times, before arriving at the maximum level.
- f. Remove the shorting connector from the coaxial tee. Adjust T3 for minimum deflection on the rf voltmeter.
- g. Connect the rf voltmeter to the open end of the coaxial tee. Adjust T1 for maximum deflection of the rf voltmeter.
- h. Remove the rf voltmeter from the coaxial tee and once again connect the signal lead of the rf voltmeter probe to TP1 and the ground lead to TP2. Terminate the open end of the coaxial tee with the shorting connector. Adjust T2 for maximum deflection of the rf voltmeter.
- i. Remove the shorting connector from the coaxial tee. Adjust T3 for minimum deflection of the rf voltmeter.
- j. Connect the rf voltmeter to the open end of the coaxial tee. Remove the 5 MHz input standard from the 5 MHz input connector on the distribution amplifier. The rf voltmeter should indicate less than 0.01 volts rms.
- k. Connect the signal lead of the rf voltmeter probe to pin 1 and the ground lead to pin 2 of the 5 MHz Amplifier Module. Reconnect the 5 MHz input standard to the 5 MHz input connector on the distribution amplifier. Carefully adjust the input level to the 5 MHz Amplifier Module for 0.1 volts rms. Now reconnect the rf voltmeter to the coaxial tee located on the channel output connector associated with the module under test. The output level, as indicated on the rf voltmeter, should be greater than 0.36 volts rms.
- l. Set the distribution amplifier power switch to off. Remove all input-output and test equipment connections from the module under test and the distribution amplifier. Replace the 5 MHz Amplifier Module on its chassis connector.

PARTS LIST

The following illustrated parts list contains all the electrical components that are a part of the 5 MHz Amplifier Module. Further information on column entries and ordering replaceable parts can be found on the first page of the Appendix section.

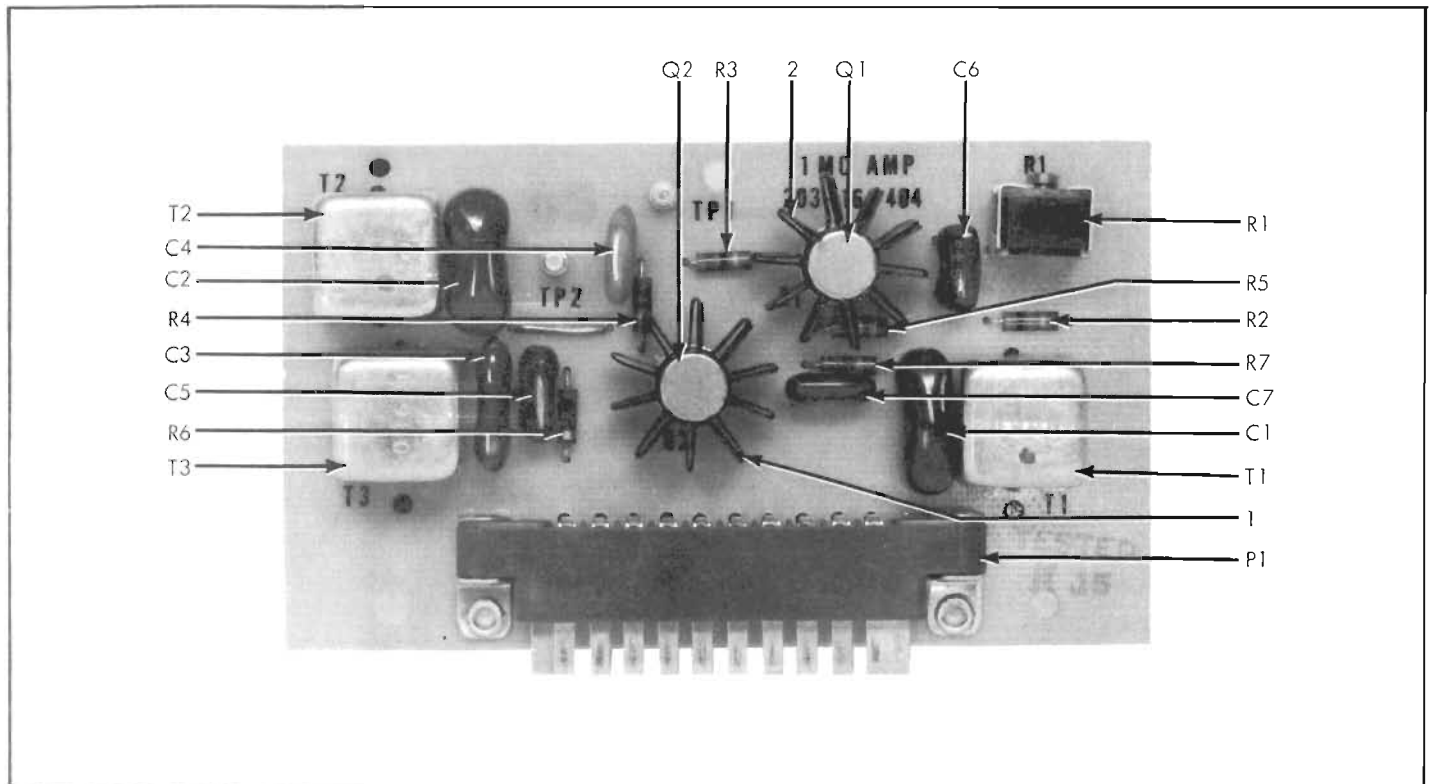


Figure 2. THE 1 MHz AMPLIFIER MODULE

REF DESIG	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
	1 MHz AMPLIFIER MODULE - Figure 2	1702-195339 (203-16-404)	19429	1702-195339	REF		
C1	Cap, mica, 3,900 pf $\pm 5\%$, 500v	1504-160325	88419	CD19F392J	10		
C2	Cap, mica, 5,000 pf $\pm 5\%$, 500v	1504-181065	88419	CD10F502J	10		
C3	Cap, mica, 1,200 pf $\pm 5\%$, 500v	1504-148379	88419	CD19F122J	10		
C4	Cap, cer, 0.05 uf $\pm 20\%$, 100v	1501-149161	56289	55C23A7	10		
C5	Cap, mica, 330 pf $\pm 5\%$, 500v	1504-148445	88419	CD15F331J	10		
C6, C7	Cap, mica, 5 pf $\pm 10\%$, 500v	1504-148577	88419	CD15C050K	20		
P1	Connector, male, 10 contact	2107-149369	95354	61-6010-5700-00	10		
Q1, Q2	Transistor Type 2N2218	4805-179374	04713	2N2218	20		
R1	Res, var, 250 Ω $\pm 20\%$, 1/8w	4701-194977	71450	2202251B	10		
R2	Res, comp, 82 Ω $\pm 5\%$, 1/4w	4704-149484	01121	CB8205	10		
R3, R4	Res, comp, 15 Ω $\pm 5\%$, 1/4w	4704-147876	01121	CB1505	20		
R5	Res, comp, 15k $\pm 5\%$, 1/4w	4704-148114	01121	CB1535	10		
R6	Res, comp, 10 Ω $\pm 5\%$, 1/4w	4704-147868	01121	CB1005	10		
R7	Res, comp, 680 Ω $\pm 5\%$, 1/4w	4704-148007	01121	CB6815	10		
T1, T2	Transformer, var, 7.5 uh nominal	1800-181115	19429	1800-181115	20		
T3	Transformer, var, 21 uh nominal	1800-181123	19429	1800-181123	10		
1, 2	Heat sink	4806-104646	05820	NF207	20		
	Transipad for Transistor T0-5 (not illustrated)	4805-152207	17069	88000	20		

ILLUSTRATED PARTS LIST INFORMATION

INTRODUCTION

This page contains introductory information pertaining to the illustrated parts list. Final assembly components are listed in Section III. Module components are listed in Section IV. Each list has a corresponding illustration on which the items of that list are identified. Parts are identified in the parts list by reference designation and are indexed to the illustration either by arrow call-outs or by a location code referenced to a grid overlay. Each list includes the following information for each part:

- a. The REF DESIG column indicates the reference designation used on the schematic diagram.
- b. The INDEX NO column lists coordinates which locate the designated part on the associated illustration. This column is only used when the grid overlay system is used for locating components.
- c. The DESCRIPTION column describes the part in words, along with any applicable values, tolerances, etc. Indentation is used to show assembly, subassembly, and parts relationship. Abbreviations are explained in Appendix 50022.
- d. The STOCK NO column indicates the number by which we stock the part. This number should be used when ordering parts from our factory or from our authorized representative.
- e. Entries in the MFR column indicate a typical manufacturer of the part by the Federal Manufacturers Code. A list of manufacturers codes is contained in Appendix 50043.
- f. The MFR PART NO column indicates the part number assigned by the manufacturer indicated in the MFR column.
- g. Entries in the TOT QTY column indicate the total quantity of parts used. The totals given in parts lists for the module are totals for that module; totals given in the final assembly list are totals for the final assembly. The total quantity of each part is listed the first time the part appears. REF indicates that the total quantity of the part has been listed previously.
- h. There are no entries in the REC QTY column in this manual. This parts list format is used in another type of manual where the REC QTY column indicates the recommended spare parts quantity. The recommended spares quantity for this instrument can be found on a separate sheet in Section III.
- i. The USE CODE column identifies certain parts which have been added, deleted, or modified during production of the instrument. Each part for which a use code has been assigned may be identified with a particular instrument serial number by consulting the Serial Number Effectivity List in Section III. The serial number listed indicates the instruments in which that particular part was used. The symbol ~ is used to indicate an approximate serial number.

HOW TO OBTAIN PARTS

Standard components have been used whenever possible. Thus, most parts can be obtained locally. However, parts may be ordered directly from the manufacturer using the manufacturer's part number, or from JOHN FLUKE or MONTRONICS using our stock number. In addition, the most commonly replaced parts that cannot be obtained locally may be obtained from our authorized representative in your area. If a part you have ordered has been replaced by a new or improved part, you will normally receive the new part along with an explanation. When ordering parts, always include the following:

- a. Reference designation, description, and stock number.
- b. Instrument model and serial number.
- c. Description, function, and location for all structural or mechanical parts.

TABLE OF ABBREVIATIONS

ac	alternating current	mw	milliwatt
Al	Aluminum	na	nanoampere
amp	ampere	nsec	nanosecond
assy	assembly	nv	nanovolt
cap	capacitor	Ω	ohm
car film	carbon film	ppm	parts per million
C	centigrade	piv	peak inverse voltage
cer	ceramic	p-p	peak to peak
comp	composition	pf	picofarad
conn	connector	plstc	plastic
db	decibel	p	pole
dc	direct current	pos	position
dpdt	double-pole, double-throw	P/C	printed circuit
dpst	double-pole, single-throw	rf	radio frequency
elect	electrolytic	rfi	radio frequency interference
F	fahrenheit	res	resistor
Ge	germanium	rms	root mean square
gmV	guaranteed minimum value	rtry	rotary
h	henry	sec	second
Hz	hertz	sect	section
hf	high frequency	S/N	serial number
IC	integrated circuit	Si	silicon
if	intermediate frequency	scr	silicon controlled rectifier
k	kilohm	spdt	single-pole, double-throw
kHz	kilohertz	spst	single-pole, single-throw
kV	kilovolt	sw	switch
lf	low frequency	Ta	tantalum
MHz	megahertz	tstr	transistor
M	megohm	tvm	transistor voltmeter
met film	metal film	uhf	ultrahigh frequency
ua	microampere	vtvm	vacuum tube voltmeter
uf	microfarad	var	variable
uh	microhenry	vhf	very high frequency
usec	microsecond	vlf	very low frequency
uv	microvolt	v	volt
ma	milliampere	va	voltampere
mh	millihenry	vac	volts, alternating current
m	milliohm	vdc	volts, direct current
msec	millisecond	w	watt
mv	millivolt	ww	wire wound

SECTION V
APPENDIX

50043

Revision

Page 1 of 2

FEDERAL SUPPLY CODE FOR
MANUFACTURERS - CODE TO NAME

The following code numbers, listed in numerical sequence, indicate the manufacturer's name and address for which the code has been assigned. The following list has been extracted from Cataloging Handbook H 4-2,

Federal Supply Code for Manufacturers - Code to Name. Those suppliers not assigned a Federal Supply Code are identified by an arbitrary code.

00213 Sage Electronics Corp. Rochester, New York	06555 Beede Electrical Inst. Co. Penacook, New Hampshire	18083 Clevite Corp. Translator Division Palo Alto, California	72259 Mytronics, Inc. Berkeley Heights, New Jersey
00327 Welwyn International, Inc. Cleveland, Ohio	06751 Nuclear Corporation of America, Inc. U. S. Sencor Div. Phoenix, Arizona	18429 Montronics, Inc. Seattle, Washington	72354 Fast, John E. Company Div. of Victrola Instr. Co. Chicago, Illinois
00656 Aerovox Corp. New Bedford, Massachusetts	06860 Gould National Batteries Inc. La Puente, California	19701 Electra Mfg. Company Independence, Kansas	72559 Essex Electronics Inc. Berkeley Heights, New Jersey
01121 Allen-Bradley Company Milwaukee, Wisconsin	07115 Corning Glass Works Electronic Components Dept. Bradford, Pennsylvania	24655 General Radio Company West Concord, Massachusetts	72619 Dnlight Corp. Brooklyn, New York
01281 Pacific Semiconductors Inc. Lawndale, California	07263 Fairchild Semiconductor Div. of Fairchild Camera and Instrument Corp. Mountain View, California	28520 Heyman Mfg. Company Kentlworth, New Jersey	72623 General Cement Div. of Tironics Inc. Packard, Illinois
01295 Texas Instruments, Inc. Semiconductor Components Div. Houston, Texas	07344 Bircher Co., Inc. Rochester, New York	31713 General Electric Co. Tube Dept. Owensboro, Kentucky	72685 Malloy Battery Company Cleveland, Ohio
01730 Circle Mfg. Co., Inc. Little Falls, New Jersey	07792 Lerma Engineering Corp. Northampton, Massachusetts	37942 P. R. Malory and Co., Inc. Indianapolis, Indiana	72983 Erie Tech. Products Inc. Erie, Pennsylvania
01884 Dearborn Electronic Lab Inc. Orlando, Florida	07910 Continental Device Corp. Hawthorne, California	38315 Honeywell Inc. Precision Meter Division Manchester, New Hampshire	73138 Beckman Instruments Inc. Heiphot Division Fullerton, California
01963 Cherry Electrical Products Corp Highland Park, Illinois	08530 Reliance Mica Corp. Brooklyn, New York	42498 National Company, Inc. Malden, Massachusetts	73293 Hughes Products Div. of Hughes Aircraft Company Newport Beach, California
02660 Amphenol-Borg Elect. Corp Chicago, Illinois	08863 Nylomatic Corp. Morristown, Pennsylvania	44655 Ohmite Mfg. Company Skokie, Illinois	73445 Amperex Electronic Co. Div. of North American Phillips Co., Inc. Hicksville, New York
02606 Fenwal Laboratories Inc. Framington, Massachusetts	08988 Skottle Electronics Inc. Jacksville, Pennsylvania	49671 Radio Corp. of America New York, New York	73550 Carling Electric Inc. Hartford, Connecticut
02799 Arco Capacitors, Inc. Los Angeles, California	11237 Chicago Telephone of Calif Inc. South Pasadena, California	53021 Sangamo Electric Co. Springfield, Illinois	73586 Circis F Mfg. Co. Trenton, New Jersey
03614 Bussman Mfg. Div. of McGraw-Edison Co. Los Angeles, California	11503 Keystone Mfg. Co. Warren, Michigan	55020 Simpson Electric Company Chicago, Illinois	73899 JFS Electronics Corp. Brooklyn, New York
03825 Ohmite Mfg. Company Los Angeles, California	12090 National Semiconductor, Inc. Danbury, Connecticut	55229 Sprague Electric Co. North Adams, Massachusetts	73949 Guardian Electric Mfg. Co. Chicago, Illinois
10077 Transatron Electronic Corp. Wassfield, Massachusetts	13060 Diodes, Inc. Chatsworth, California	58474 Superior Electric Co. Bristol, Connecticut	74217 Radio Switch Corp. Marbleton, New Jersey
03911 Clairtex Corp. New York, New York	12138 Philadelphia Handle Co. Camden, New Jersey	60399 Torrington Mfg. Company Torrington, Connecticut	74276 Signalite, Inc. Nepton, New Jersey
03930 Muirhead Instruments, Inc. Mountainside, New Jersey	12400 International Resistance Co. Control Components Division Philadelphia, Pennsylvania	61460 USHCO Mfg. Co., Inc. Buffalo, New York	74306 Piezo Crystal Company Carlisle, Pennsylvania
04009 Arrow Bart and Hegeman Electronic Company Hartford, Connecticut	12617 Hamlin Inc. Lake Mills, Wisconsin	64834 West Mfg. Company San Francisco, California	74542 Hoyt Elect. Instr. Works Penacook, New Hampshire
04062 Elmenco Products Company New York, New York	12697 Cifarostat Mfg. Company Dover, New Hampshire	65993 Weston Instruments Div. of Daystrom, Inc. Newark, New Jersey	74979 Johnson, E. F., Company Wausau, Wisconsin
04202 Winchester Electronics Co. New Milford, Connecticut	13606 Sprague Electric Company Translator Division Concord, New Hampshire	70563 Amperite Company Union City, New Jersey	75042 International Resolance Co. Philadelphia, Pennsylvania
04223 Telex-Aerco Division of Telex Corp. Mankato, Minnesota	13812 Dialco Electric Corp. Brooklyn, New York	70903 Belden Mfg. Co. Chicago, Illinois	75945 Littelfuse Inc. Tow Plaines, Illinois
04645 Kurz-Kaech, Inc. Chicago, Illinois	13839 Shlizer Lax, Inc. Bethesda, Maryland	71406 Bussman Manufacturing Division of McGraw Edison Co. St. Louis, Missouri	76854 Oak Mfg. Company Crystal Lake, Illinois
04713 Motorola Inc. Semiconductor Products Div. Phoenix, Arizona	14008 Bentech Corp. Newbury Park, California	71450 CTS Corp. Elkhart, Indiana	77342 American Machine and Foundry Company Potter & Brumfield Div. Princeton, Indiana
05082 Tung-Sol Electric Inc. Melrose Park, Illinois	14193 California Resistor Corp. Santa Monica, California	71468 Gunnon Electric Company Los Angeles, California	77889 Runkercraft Corp. of California Ltd. Torrance, California
05277 Westinghouse Electric Corp. Semiconductor Dept. Youngwood, Pennsylvania	14298 American Components Inc. Conshohocken, Pennsylvania	73482 Clare, C. P., and Company Chicago, Illinois	78277 Sigma Instruments, Inc. South Braintree, Mass.
05278 Penn-East Engrg. Corp. Kutztown, Pennsylvania	14792 Electro Cude Inc. South Pasadena, California	71590 Centralab Div of Globe Union, Inc. Milwaukee, Wisconsin	79136 Waldes Kohinor Inc. Long Island City, New York
05397 Union Cascade Corp. Kaiser Dept. Linde Div. Cleveland, Ohio	15818 Ameko Inc. Mountain View, California	71707 Coto Co. Co., Inc. Providence, Rhode Island	79467 Western Rubber Company Goshen, Indiana
05417 Farwest Mfg. Div. Inc. Seattle, Washington	15849 USECO Inc. Mt. Vernon, New York	71744 Chicago Miniature Lamp Works Chicago, Illinois	80031 Mepco Division of Sensone Clock Co. Marlinton, New Jersey
05704 Alac, Inc. Glendale, California	15909 Zareb Division Thomas A. Edison Ind. McGraw Edison Co. Livingston, New Jersey	71785 Cinch Mfg. Co. and Howard B. Jones Div. Chicago, Illinois	80194 Biorins Laboratories, Inc. Riverside, California
05820 Wakefield Engineering, Inc. Wakefield, Massachusetts	16332 Milwaukee Helix Inc. Cedarburg, Wisconsin	72005 Driner, Walter B., Co. Newark, New Jersey	80543 Hammarlund Company, Inc. New York, New York
06001 General Electric Company Capacitor Department Irmo, South Carolina	16473 Cambridge Scientific Industries Inc. Cambridge, Maryland	72082 Eltel-McCullough, Inc. San Bruno, California	80640 Stevens, Arnold Co., Inc. Boston, Massachusetts
06136 Ward Leonard Electric Co. Los Angeles, California	17069 Circuit Structures Lab Santa Ana, California	72185 Electro Motive Mfg. Co. Wilmington, Connecticut	81073 Grayhill Company 54 Orange, Illinois
06873 Amphenol Space and Missile Sys Chatsworth, California	17856 Silticon Inc. Sunnyvale, California		

81439	Therm-O-Disc, Inc. Mansfield, Ohio	84171	Arco Electronics, Inc. Great Neck, New York	91662	Elco Corp. Willow Grove, Penn.	95712	Dage Electric Co., Inc. Franklin, Indiana
81483	International Rectifier Corp. El Segundo, California	84411	Good All Electric Mfg. Co. (TRW) Ogallala, Nebraska	91737	Gremar Mfg. Co., Inc. Wakefield, Massachusetts	96733	San Fernando Electric Mfg. Co. San Fernando, California
81590	Korry Mfg. Company Seattle, Washington	86689	R. M. B. Corp. Los Angeles, California	91802	Industrial Devices, Inc. Edgewater, New Jersey	98881	Thomson Industries, Inc. New Hyde Park Long Island, New York
82375	Astrom Division Renwell Industries Inc. East Newark, New Jersey	88419	Cornell-Dubilier Elec. Corp. Electro-Mechanical Division Fuquay Springs, North Carolina	91929	Minneapolis Honeywell Regulator Company Micro Switch Division Freeport, Illinois	97945	S. S. White Dental Mfg. Co. Plastics Division New York, New York
82389	Switchcraft Inc. Chicago, Illinois	88890	Essex Wire Corp. R. B. M. Division Detroit, Michigan	91934	Miller Electric Co., Inc. Pawtucket, Rhode Island	97966	CBS Electronics Div. of Columbia Broadcasting Systems Inc. Danvers, Massachusetts
82415	Price Electric, Corp. Frederick, Maryland	89536	Fluke, John, Mfg. Co., Inc. Seattle, Washington	93332	Sylvania Electric Products Inc. Semiconductor Products Division Woburn, Massachusetts	98094	Penta Laboratories, Inc. Santa Barbara, California
82872	Roanwell Corp. Brooklyn, New York	89730	General Electric Company Newark Lamp Works of Lamp Division of Consumer Products Group GECO Newark, New Jersey	94145	Raytheon Company Semiconductor Division California Street Plant Newton, Massachusetts	98388	Accurate Sales Company Culver City, California
82877	Rotron Mfg. Co., Inc. Woodstock, New York	90205	Best Stamp and Mfg. Co. Kansas City, Missouri	95146	Alco Electronics Mfg. Co. Lawrence, Massachusetts	98743	James Vibrapower Corp. Chicago, Illinois
82879	Royal Electric Corp. Pawtucket, Rhode Island	90211	Square D. Company Chicago, Illinois	95264	Lerco Electronics Inc. Burbank, California	98925	Clevite Corp. Semiconductor Division Waltham, Massachusetts
83003	Varo Mfg. Co., Inc. Garland, Texas	90303	Mallory Battery Company North Tarrytown, New York	95303	Radio Corp. of America Comm. Receiving Tube & Semiconductor Division Cincinnati, Ohio	99120	Plastic Capacitors, Inc. Chicago, Illinois
83298	Bendix Corp. Red Bank Division Red Bank, Eatontown, New Jersey	91293	Johanson Mfg. Company Boonton, New Jersey	95354	Method Mfg. Co. Chicago, Illinois	99217	Southern Electronics Corp. Burbank, California
83330	Smith, Herman H., Inc. Brooklyn, New York					99515	Marshall Industries Electron Prod. Div. Pasadena, California
83478	Rubbercraft Corp of America New Haven, Connecticut						

Section 7

General Information

7-1. This section of the manual contains generalized user information as well as supplemental information to the List of Replaceable parts contained in Section 5. The following information is presented in this section:

List of Abbreviations

Federal Supply Codes for Manufacturers

Fluke Technical Service Centers — U.S. and Canada

Sales and Service Locations — International

Sales Representatives — U.S. and Canada

List of Abbreviations and Symbols

A or amp	ampere	H	henry	pF	picofarad
ac	alternating current	hd	heavy duty	pn	part number
af	audio frequency	hf	high frequency	(+) or pos	positive
a/d	analog-to-digital	Hz	hertz	pot	potentiometer
assy	assembly	IC	integrated circuit	p-p	peak-to-peak
AWG	american wire gauge	if	intermediate frequency	ppm	parts per million
B	bel	in	inch(es)	PROM	programmable read-only memory
bcd	binary coded decimal	intl	internal	psi	pound-force per square inch
°C	Celsius	I/O	input/output	RAM	random-access memory
cap	capacitor	k	kilo (10 ³)	rf	radio frequency
ccw	counterclockwise	kHz	kilohertz	rms	root mean square
cer	ceramic	kΩ	kilohm(s)	ROM	read-only memory
cermet	ceramic to metal (seal)	kV	kilovolt(s)	s or sec	second (time)
ckt	circuit	lf	low frequency	scope	oscilloscope
cm	centimeter	LED	light-emitting diode	SH	shield
cmrr	common mode rejection ratio	LSB	least significant bit	Si	silicon
comp	composition	LSD	least significant digit	serno	serial number
cont	continue	M	mega (10 ⁶)	sr	shift register
crt	cathode-ray tube	m	milli (10 ⁻³)	Ta	tantalum
cw	clockwise	mA	milliampere(s)	tb	terminal board
d/a	digital-to-analog	max	maximum	tc	temperature coefficient or temperature compensating
dac	digital-to-analog converter	mf	metal film	tcxo	temperature compensated crystal oscillator
dB	decibel	MHz	megahertz	tp	test point
dc	direct current	min	minimum	u or μ	micro (10 ⁻⁶)
dmm	digital multimeter	mm	millimeter	uhf	ultra high frequency
dvm	digital voltmeter	ms	millisecond	us or μs	microsecond(s) (10 ⁻⁶)
elect	electrolytic	MSB	most significant bit	uut	unit under test
ext	external	MSD	most significant digit	V	volt
F	farad	MTBF	mean time between failures	v	voltage
°F	Fahrenheit	MTTR	mean time to repair	var	variable
FET	Field-effect transistor	mV	millivolt(s)	vco	voltage controlled oscillator
ff	flip-flop	mv	multivibrator	vhf	very high frequency
freq	frequency	MΩ	megohm(s)	vlf	very low frequency
FSN	federal stock number	n	nano (10 ⁻⁹)	W	watt(s)
g	gram	na	not applicable	ww	wire wound
G	giga (10 ⁹)	NC	normally closed	xfmr	transformer
gd	guard	(-) or neg	negative	xstr	transistor
Ge	germanium	NO	normally open	xtal	crystal
GHz	gigahertz	ns	nanosecond	xtlo	crystal oscillator
gmv	guaranteed minimum value	opnl ampl	operational amplifier	Ω	ohm(s)
gnd	ground	p	pico (10 ⁻¹²)	μ	micro (10 ⁻⁶)
		para	paragraph		
		pcb	printed circuit board		

Federal Supply Codes for Manufacturers (Continued)

00213 Nytronics Comp. Group Inc. Subsidiary of Nytronics Inc. Formerly Sage Electronics Rochester, New York	03797 Eldema Div. Genisco Technology Corp. Compton, California	05574 Viking Industries Chatsworth, California	07597 Burndy Corp. Tape/Cable Div. Rochester, New York
00327 Welwyn International, Inc. Westlake, Ohio	03877 Transistron Electronic Corp. Wakefield, Massachusetts	05704 Replaced by 16258	07792 Lerma Engineering Corp. Northampton, Massachusetts
00656 Aerovox Corp. New Bedford, Massachusetts	03888 KDI Pyrofilm Corp. Whippany, New Jersey	05820 Wakefield Engineering Inc. Wakefield, Massachusetts	07910 Teledyne Semiconductor Formerly Continental Device Hawthorne, California
00686 Film Capacitors, Inc. Passaic, New Jersey	03911 Clairex Electronics Div. Clairex Corp. Mt. Vernon, New York	06001 General Electric Co. Electronic Capacitor & Battery Products Dept. Columbia, South Carolina	07933 - use 49956 Raytheon Co. Semiconductor Div. HQ Mountain View, California
00779 AMP Inc. Harrisburg, Pennsylvania	03980 Muirhead Inc. Mountainside, New Jersey	06136 Replaced by 63743	08225 Industro Transistor Corp. Long Island City, New York
01121 Allen-Bradley Co. Milwaukee, Wisconsin	04009 Arrow Hart Inc. Hartford, Connecticut	06383 Panduit Corp. Tinley Park, Illinois	08261 Spectra Strip Corp. Garden Grove, California
01281 TRW Electronic Comp. Semiconductor Operations Lombard, California	04062 Replaced by 72136	06473 Bunker Ramo Corp. Amphenol SAMS Div. Chatsworth, California	08530 Reliance Mica Corp. Brooklyn, New York
01295 Texas Instruments, Inc. Semiconductor Group Dallas, Texas	04202 Replaced by 81312	06555 Beede Electrical Instrument Co. Penacook, New Hampshire	08806 General Electric Co. Miniature Lamp Products Dept. Cleveland, Ohio
01537 Motorola Communications & Electronics Inc. Franklin Park, Illinois	04217 Essex International Inc. Wire & Cable Div. Anaheim, California	06739 Electron Corp. Littleton, Colorado	08863 Nylomatic Corp. Norrisville, Pennsylvania
01686 RCL Electronics Inc. Manchester, New Hampshire	04221 Aemco, Div. of Midtex Inc. Mankato, Minnesota	06743 Clevite Corp. Cleveland, Ohio	08988 - use 53085 Skottie Electronics Inc. Archbald, Pennsylvania
01730 Replaced by 73586	04222 AVX Ceramics Div. AVX Corp. Myrtle Beach, Florida	06751 Components, Inc. Semcor Div. Phoenix, Arizona	09214 G.E. Co. Semi-Conductor Products Dept. Power Semi-Conductor Products OPN Sec. Auburn, New York
01884 - use 56289 Sprague Electric Co. Dearborn Electronic Div. Lockwood, Florida	04423 Telonic Industries Laguna Beach, California	06860 Gould Automotive Div. City of Industry, California	09353 C and K Components Watertown, Massachusetts
02114 Ferroxcube Corp. Saugerties, New York	04645 Replaced by 75376	06961 Vernitron Corp., Piezo Electric Div. Formerly Clevite Corp., Piezo Electric Div. Bedford, Ohio	09423 Scientific Components, Inc. Santa Barbara, California
02131 General Instrument Corp. Harris ASW Div. Westwood, Maine	04713 Motorola Inc. Semiconductor Products Phoenix, Arizona	06980 Eimac Div. Varian Associates San Carlos, California	09922 Burndy Corp. Norwalk, Connecticut
02395 Rason Mfg. Co. Brooklyn, New York	04946 Standard Wire & Cable Los Angeles, California	07047 Ross Milton, Co., The South Hampton, Pennsylvania	09969 Dale Electronics Inc. Yankton, S. Dakota
02533 Snelgrove, C.R. Co., Ltd. Don Mills, Ontario, Canada M3B 1M2	05082 Replaced by 94988	07115 Replaced by 14674	10059 Barker Engineering Corp. Formerly Amerace, Amerace ESNA Corp. Kenilworth, New Jersey
02606 Fenwal Labs Div. of Travenal Labs. Morton Grove, Illinois	05236 Jonathan Mfg. Co. Fullerton, California	07138 Westinghouse Electric Corp., Electronic Tube Division Horsehead, New York	11236 CTS of Berne Berne, Indiana
02660 Bunker Ramo Corp., Conn Div. Formerly Amphenol-Borg Electric Corp. Broadview, Illinois	05245 Components Corp. now Corcom, Inc. Chicago, Illinois	07233 TRW Electronic Components Cinch Graphic City of Industry, California	11237 CTS Keene Inc. Paso Robles, California
02799 Aero Capacitors, Inc. Chatsworth, California	05277 Westinghouse Electric Corp. Semiconductor Div. Youngwood, Pennsylvania	07256 Silicon Transistor Corp. Div. of BBF Group Inc. Chelmsford, MA	11358 CBS Electronic Div. Columbia Broadcasting System Newburyport, MN
03508 General Electric Co. Semiconductor Products Syracuse, New York	05278 Replaced by 43543	07261 Aumet Corp. Culver City, California	11403 Best Products Co. Chicago, Illinois
03614 Replaced by 71400	05279 Southwest Machine & Plastic Co. Glendora, California	07263 Fairchild Semiconductor Div. of Fairchild Camera & Instrument Corp. Mountain View, California	11503 Keystone Columbia Inc. Warren, Michigan
03651 Replaced by 44655	05397 Union Carbide Corp. Materials Systems Div. New York, New York	07344 Bircher Co., Inc. Rochester, New York	11532 Teledyne Relays Hawthorne, California
	05571 - use 56289 Sprague Electric Co. Pacific Div. Los Angeles, California		

Federal Supply Codes for Manufacturers (Continued)

11711 General Instrument Corp Rectifier Division Hickville, New York	14099 Semtech Corp. Newbury Park, California	17069 Circuit Structures Lab. Burbank, California	24655 General Radio Concord, Massachusetts
11726 Qualidyne Corp. Santa Clara, California	14140 Edison Electronic Div. Mc Gray-Edison Co. Manchester, New Hampshire	17338 High Pressure Eng. Co., Inc. Oklahoma City, Oklahoma	24759 Lenox-Fugle Electronics Inc. South Plainfield, New Jersey
12014 Chicago Rivet & Machine Co. Bellwood, Illinois	14193 Cal-R-Inc. formerly California Resistor, Corp. Santa Monica, California	17545 Atlantic Semiconductors, Inc. Asbury Park, New Jersey	25088 Siemen Corp. Isilen, New Jersey
12040 National Semiconductor Corp. Danbury, Connecticut	14298 American Components, Inc. an Insilco Co. Conshohocken, Pennsylvania	17856 Siliconix, Inc. Santa Clara, California	25403 Amperex Electronic Corp. Semiconductor & Micro-Circuits Div. Statersville, Rhode Island
12060 Diodes, Inc. Chatsworth, California	14655 Cornell-Dublier Electronics Division of Federal Pacific Electric Co. Govt. Control Dept. Newark, New Jersey	17870 Replaced by 14140	27014 National Semiconductor Corp. Santa Clara, California
12136 Philadelphia Handle Co. Camden, New Jersey	14752 Electro Cube Inc. San Gabriel, California	18178 Vactec Inc. Maryland Heights, Missouri	27264 Molex Products Downers Grove, Illinois
12300 Potter-Brumfield Division AMF Canada LTD. Guelph, Onatrio, Canada	14869 Replaced by 96853	18324 Signetics Corp. Sunnyvale, California	28213 Minnesota Mining & Mfg. Co. Consumer Products Div. St. Paul, Minnesota
12323 Presin Co., Inc. Shelton, Connecticut	14936 General Instrument Corp. Semi Conductor Products Group Hicksville, New York	18736 Voltronics Corp. Hanover, New Jersey	28425 Serv-/Link formerly Bohannon Industries Fort Worth, Texas
12327 Freeway Corp. formerly Freeway Washer & Stamping Co. Cleveland, Ohio	15636 Elec-Trol Inc. Saugus, California	18927 G T E Sylvania Inc. Precision Material Group Parts Division Titusville, Pennsylvania	28478 Deltrol Controls Div. Deltrol Corporation Milwaukee, Wisconsin
12443 Budd Co. The, Polychem Products Plastic Products Div. Bridgeport, PA	15801 Fenwal Electronics Inc. Div. of Kidde Walter and Co., Inc. Framingham, Massachusetts	19451 Perine Machinery & Supply Co. Seattle, Washington	28480 Hewlett Packard Co. Corporate H.O. Palo Alto, California
12615 U.S. Terminals Inc. Cincinnati, Ohio	15818 Teledyne Semiconductors, formerly Amelco Semiconductor Mountain View, California	19701 Electro-Midland Corp. Mepco-Electra Inc. Mineral Wells, Texas	28520 Heyman Mfg. Co. Kenilworth, New Jersey
12617 Hamlin Inc. Lake Mills, Wisconsin	15849 Litton Systems Inc. Useco Div. formerly Useco Inc. Van Nuys, California	20584 Enochs Mfg. Inc. Indianapolis, Indiana	29083 Monsanto, Co., Inc. Santa Clara, California
12697 Clarostat Mfg. Co. Dover, New Hampshire	15898 International Business Machines Corp. Essex Junction, Vermont	20891 Self-Organizing Systems, Inc. Dallas, Texas	29604 Stackpole Components Co. Raleigh, North Carolina
12749 James Electronics Chicago, Illinois	15909 Replaced by 14140	21604 Buckeye Stamping Co. Columbus, Ohio	30148 A B Enterprise Inc. Ahoskie, North Carolina
12856 Micrometals Sierra Madre, California	16258 Space-Lok Inc. Burbank, California	21845 Solitron Devices Inc. Transistor Division Riveria Beach, Florida	30323 Illinois Tool Works, Inc. Chicago, Illinois
12954 Dickson Electronics Corp. Scottsdale, Arizona	16299 Corning Glass Electronic Components Div. Raleigh, North Carolina	22767 ITT Semiconductors Palo Alto, California	31091 Optimax Inc. Colmar, Pennsylvania
12969 Unitrode Corp. Watertown, Massachusetts	16332 Replaced by 28478	23050 Product Comp. Corp. Mount Vernon, New York	32539 Mura Corp. Great Neck, New York
13103 Thermalloy Co., Inc. Dallas, Texas	16473 Cambridge Scientific Ind. Div. of Chemed Corporation Cambridge, Maryland	23732 Tracor Inc. Rockville, Maryland	32767 Griffith Plastic Corp. Burlingame, California
13327 Solitron Devices Inc. Tappan, New York	16742 Paramount Plastics Fabricators, Inc. Downey, California	23880 Stanford Applied Engrng. Santa Clara, California	32879 Advanced Mechanical Components Northridge, California
13511 Amphenol Cadre Div. Bunker-Ramo Corp. Los Gatos, California	16758 Delco Electronics Div. of General Motors Corp. Kokomo, Indiana	23936 Pamotor Div., Wm. J. Purdy Co. Burlingame, California	32897 Erie Technological Products, Inc. Frequency Control Div. Carlisle, Pennsylvania
13606 - use 56289 Sprague Electric Co. Transistor Div. Concord, New Hampshire	17001 Replaced by 71468	24248 Replaced by 94222	32997 Bourns Inc. Trimpot Products Division Riverside, California
13839 Replaced by 23732		24355 Analog Devices Inc. Nerwood, Massachusetts	33173 General Electric Co. Products Dept. Owensboro, Kentucky

Federal Supply Codes for Manufacturers (Continued)

34333 Silicon General Westminister, California	70563 Amperite Company Union City, New Jersey	73293 Hughes Aircraft Co. Electron Dynamics Div. Torrence, California	77969 Rubbercraft Corp. of CA. LTD. Torrance, California
34335 Advanced Micro Devices Sunnyvale, California	70903 Belden Corp. Geneva, Illinois	73445 Amperex Electronic Corp. Hicksville, LI, New York	78189 Shakeproof Div. of Illinois Tool Works Inc. Elgin, Illinois
34802 Electromotive Inc. Kenilworth, New Jersey	71002 Birnback Radio Co., Inc. Freeport, LI New York	73559 Carling Electric Inc. West Hartford, Connecticut	78277 Sigma Instruments, Inc. South Braintree, Massachusetts
37942 Mallory, P.R. & Co., Inc. Indianapolis, Indiana	71400 Bussmann Mfg. Div. of McGraw-Edison Co. Saint Louis, Missouri	73588 Circle F Industries Trenton, New Jersey	78488 Stackpole Carbon Co. Saint Marys, Pennsylvania
42498 National Radio Melrose, Massachusetts	71450 CTS Corp. Elkhart, Indiana	73734 Federal Screw Products, Inc. Chicago, Illinois	78553 Eaton Corp. Engineered Fastener Div. Tinnerman Plant Cleveland, Ohio
43543 Nytronics Inc. Transformer Co. Div. Geneva, New York	71468 ITT Cannon Electric Inc. Santa Ana, California	73743 Fischer Special Mfg. Co. Cincinnati, Ohio	79136 Waldes Kohinor Inc. Long Island City, New York
44655 Ohmite Mfg. Co. Skokie, Illinois	71482 Clare, C.P. & Co. Chicago, Illinois	73899 JFD Electronics Co. Components Corp Brooklyn, New York	79497 Western Rubber Company Goshen, Indiana
49671 RCA Corp. New York, New York	71590 Centrelab Electronics Div. of Globe Union Inc. Milwaukee, Wisconsin	73949 Guardian Electric Mfg. Co. Chicago, Illinois	79963 Zierick Mfg. Corp. Mt. Kisco, New York
49956 Raytheon Company Lexington, Massachusetts	71707 Coto Coil Co., Inc. Providence, Rhode Island	74199 Ouan Nichols Co. Chicago, Illinois	80031 Electro-Midland Corp., Mepeco Div. A North American Phillips Co. Morristown, New Jersey
50088 Mostek Corp. Carrollton, Texas	71744 Chicago Miniature Lamp Works Chicago, Illinois	74217 Radio Switch Corp. Marlboro, New Jersey	80145 LFE Corp., Process Control Div. formerly API Instrument Co. Chesterland, Ohio
50579 Litronix Inc. Cupertino, California	71785 TRW Electronics Components Cinch Connector Operations Div. Elk Grove Village, Chicago, Illinois	74276 Signalite Div. General Instrument Corp. Neptune, New Jersey	80183 - use 56289 Sprague Products North Adams, Massachusetts
51605 Scientific Components Inc. Linden, New Jersey	72005 Driver, Wilber B., Co. Newark, New Jersey	74306 Piezo Crystal Co. Carlisle, Pennsylvania	80294 Bourne Inc., Instrument Div. Riverside, California
53021 Sangamo Electric Co. Springfield, Illinois	72092 Replaced by 06980	74542 Hoyt Elect. Instr. Works Penacook, New Hampshire	80583 Hammarlund Mfg. Co., Inc. Red Bank, New Jersey
54294 Cutler-Hammer Inc. formerly Shallicross, A Cutter-Hammer Co. Selma, North Carolina	72136 Electro Motive Mfg. Co. Williamantic, Connecticut	74970 Johnson E.F., Co. Waseca, Minnesota	80640 Stevens, Arnold Inc. South Boston, Massachusetts
55026 Simpson Electric Co. Div. of Am. Gage and Mach. Co. Elgin, Illinois	72259 Nytronics Inc. Palham Manor, New Jersey	75042 TRW Electronics Components IRC Fixed Resistors Philadelphia, Pennsylvania	81073 Grayhill, Inc. La Grange, Illinois
56289 Sprague Electric Co. North Adams, Massachusetts	72619 Dialight Div. Amperex Electronic Corp. Brooklyn, New York	75376 Kurz-Kasch Inc. Dayton, Ohio	81312 Winchester Electronics Div. of Litton Industries Inc. Oakville, Connecticut
58474 Superior Electric Co. Bristol, Connecticut	72653 G.C. Electronics Div. of Hydrometals, Inc. Brooklyn, New York	75378 CTS Knights Inc. Sandwich, Illinois	81439 Therm-O-Disc Inc. Mansfield, Ohio
60399 Terin Corp. formerly Torrington Mfg. Co. Torrington, Connecticut	72665 Replaced by 90303	75382 Kufka Electric Corp. Mount Vernon, New York	81483 International Rectifier Corp. Los Angeles, California
63743 Ward Leonard Electric Co., Inc. Mount Vernon, New York	72794 Dzus Fastener Co., Inc. West Islip, New York	75915 Littlefuse Inc. Des Plaines, Illinois	81590 Kerry Mfg. Co. Seattle, Washington
64834 West Mfg. Co. San Francisco, California	72928 Gulton Ind., Inc. Guderman Div. Chicago, Illinois	76854 Oak Industries Inc. Switch Div. Crystal Lake, Illinois	81741 Chicago Lock Co. Chicago, Illinois
65092 Weston Instruments Inc. Newark, New Jersey	72982 Erie Tech. Products Inc. Erie, Pennsylvania	77342 AMF Inc. Potter & Brumfield Div. Princeton, Indiana	82303 Palmer Electronics Corp. South Gate, California
66150 Winslow Tele-Tronics Inc. Eaton Town, New Jersey	73138 Beckman Instruments Inc. Helipot Division Fullerton, California	77638 General Instrument Corp. Rectifier Division Brooklyn, New York	82389 Switchcraft Inc. Chicago, Illinois
70485 Atlantic India Rubber Works Chicago, Illinois			

Federal Supply Codes for Manufacturers (Concluded)

82415
North American Phillips
Controls Corp.
Frederick, Maryland

82872
Roanwell Corp.
New York, New York

82877
Rotron Inc.
Woodstock, New York

82879
ITT Royal Electric Div.
Pawtucket, Rhode Island

83003
Varo Inc.
Garland, Texas

83058
Carr Co., The United Can Div.
of TRW
Cambridge, Massachusetts

83298
Bendix Corp.
Electric Power Division
Eatontown, New Jersey

83330
Smith, Herman H., Inc.
Brooklyn, New York

83478
Rubbercraft Corp. of America, Inc.
West Haven, Connecticut

83594
Burroughs Corp.
Electronic Components Div.
Plainfield, New Jersey

83740
Union Carbide Corp.
Battery Products Div.
formerly Consumer Products Div.
New York, New York

84171
Arco Electronics
Great Neck, New York

84411
TRW Electronic Components
TRW Capacitors
Ogallala, Nebraska

84513
Fuse Indicator Corp.
Rockville, Maryland

84682
Essex International Inc.
Industrial Wire Div.
Peabody, Massachusetts

86577
Precision Metal Products,
of Malden Inc.
Stoneham, Massachusetts

86684
Radio Corp. of America
Electronic Components Div.
Harrison, New Jersey

86928
Seastrom Mfg. Co., Inc.
Glendale, California

87034
Illuminated Products Inc.
Subsidiary of Oak Industries Inc.
Anshiem, California

88219
Gould Inc.
Industrial Div.
Trenton, New Jersey

88245
Litton Systems Inc.
Useco Div.
Van Nuys, California

88419
Cornell-Dubilier Electronic Div.
Federal Pacific Co.
Fuquay-Varian, North Carolina

88486
Plastic Wire & Cable
Jewitt City, Connecticut

88690
Replaced by 04217

89536
Fluke, John Mfg. Co., Inc.
Seattle, Washington

89730
G.E. Co., Newark Lamp Works
Newark, New Jersey

90201
Mallory Capacitor Co. Div of
P.R. Mallory Co., Inc.
Indianapolis, Indiana

90211 - use 56365
Square D Co.
Chicago, Illinois

90215
Best Stamp & Mfg. Co.
Kansas City, Missouri

90303
Mallory Battery Co.
Div. of Mallory Co., Inc.
Tarrytown, New York

91094
Essex International Inc.
Suglex/IWP Div.
Newmarket, New Hampshire

91293
Johanson Mfg. Co.
Boonton, New Jersey

91407
Replaced by 58474

91502
Associated Machine
Santa Clara, California

91506
Augat Inc.
Attleboro, Massachusetts

91637
Dale Electronics Inc.
Columbus, Nebraska

91662
Elco Corp.
Willow Grove, Pennsylvania

91737 - use 71468
Gremar Mfg. Co., Inc.
ITT Cannon/Gremar
Santa Ana, California

91802
Industrial Devices, Inc.
Edgewater, New Jersey

91833
Keystone Electronics Corp.
New York, New York

91836
King's Electronics Co., Inc.
Tuckahoe, New York

91929
Honeywell Inc.
Micro Switch Div.
Freeport, Illinois

91934
Miller Electric Co., Inc.
Div of Aunet
Woonsocket, Rhode Island

92194
Alpha Wire Corp.
Elizabeth, New Jersey

93332
Sylvania Electric Products
Semiconductor Products Div.
Woburn, Massachusetts

94145
Replaced by 49956

94154 - use 94988
Wagner Electric Corp.
Tung-Sol Div.
Newark, New Jersey

94222
Southco Inc. formerly
South Chester Corp.
Lester, Pennsylvania

95146
Alco Electronic Products Inc.
Lawrence, Massachusetts

95263
Leecraft Mfg. Co.
Long Island City, New York

95264
Replaced by 98278

95275
Vitramon Inc.
Bridgeport, Connecticut

95303
RCA Corp.
Receiving Tube Div.
Cincinnati, Ohio

95348
Gordo's Corp.
Bloomfield, New Jersey

95354
Methode Mfg. Corp.
Rolling Meadows, Illinois

95712
Bendix Corp.
Electrical Components Div.
Microwave Devices Plant
Franklin, Indiana

95987
Weckesser Co. Inc.
Chicago, Illinois

96733
San Fernando Electric Mfg. Co.
San Fernando, California

96853
Gulton Industries Inc.
Measurement and Controls Div.
formerly Rustrak Instruments Co.
Manchester, New Hampshire

96881
Thomson Industries, Inc.
Manhasset, New York

97540
Master Mobile Mounts
Div. of Whitehall Electronics Corp.
Ft. Meyers, Florida

97913
Industrial Electronic Hardware Corp.
New York, New York

97945
Penwalt Corp.
S.S. White Industrial Products Div.
Piscataway, New Jersey

97966
Replaced by 11358
98094
Replaced by 49956

98159
Rubber-Teck, Inc.
Gardena, California

98278
Malco A Microdet Co., Inc.
Connector & Cable Div.
Pasadena, California

98291
Sealectro Corp.
Mamaroneck, New York

98388
Royal Industries
Products Div.
San Diego, California

98743
Replaced by 12749

98925
Replaced by 14433

99120
Plastic Capacitors, Inc.
Chicago, Illinois

99217
Bell Industries Elect. Comp. Div.
formerly Southern Elect. Div.
Burbank, California

99392
STM
Oakland, California

99515
ITT Jennings Monrovia Plant
Div. of ITT Jennings formerly
Marshall Industries Capacitor Div.
Monrovia, California

99779 - use 29587
Bunker-Ramo Corp.
Barnes Div.
Landsdowne, Pennsylvania

99800
American Precision Industries Inc.
Delevan Division
East Aurora, New York

99942
Centrelab Semiconductor
Centrelab Electronics Div. of
Globe-Union Inc.
El Monte, California

Toyo Electronics
(R-Ohm Corp.)
Irvine, California

National Connector
Minneapolis, Minnesota

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345 Girard
Madison Heights, MI 48071
Tel. (313) 588-2300

MINNESOTA

Minneapolis
Cozzens & Cudahy
Sales Group
John Fluke Mfg. Co., Inc.
10800 Lyndale Ave. S.
Zip: 55420
Tel. (612) 884-4336

MISSOURI

Kansas City
Cozzens & Cudahy
Sales Group
John Fluke Mfg. Co., Inc.
4406 Chouteau Traffic Way
Zip: 64117
Tel. (816) 454-5836

St. Louis

Cozzens & Cudahy
Sales Group
John Fluke Mfg. Co., Inc.
P.O. Box 10013
Zip: 63145
Tel. (314) 423-1234

NEW JERSEY

Newark
SBM Representatives
Sales Group
John Fluke Mfg. Co., Inc.
1519A Stuyvesant Ave.
Union, NJ 07083
Tel. (201) 687-8737

NEW MEXICO

Albuquerque
Barnhill Associates, Inc.
1410-D Wyoming N.E.
Zip: 87112
Tel. (505) 299-7658

NEW YORK

New York
SBM Representatives
Sales Group
John Fluke Mfg. Co., Inc.
460 Colfax Avenue
Clifton, N.J.
Zip: 07013
Tel. (201) 778-4040

Rochester

SBM Representatives
Sales Group
John Fluke Mfg. Co., Inc.
4515 Culver Road
Zip: 14622
Tel. (716) 266-1400

NORTH CAROLINA

Greensboro
BCS Associates, Inc.
P.O. Box 9619
1310 Beaman Place
Zip: 27408
Tel. (919) 273-1918

OHIO

Cleveland
WKM Associates, Inc.
16141 Puritas Ave.
Zip: 44135
Tel. (216) 267-0445

Dayton

WKM Associates, Inc.
7913 S. Suburban Road
Zip: 45459
Tel. (513) 434-7500

OREGON

Beaverton
Showalter Instruments Inc.
3800 S.W. Cedar Hills Blvd.
Suite 160
Zip: 97005
Tel. (503) 646-5196

PENNSYLVANIA

Philadelphia
Mid-Atlantic Sales Group
John Fluke Mfg. Co., Inc.
Suite H
1010 West 8th Avenue
King of Prussia, PA 19406
Tel. (215) 265-4040

Pittsburgh

WKM Associates, Inc.
90 Clairton Blvd.
Zip: 15236
Tel. (412) 892-2953

TEXAS

Austin
Barnhill Associates, Inc.
1200 Barton Hill, No. 197
Zip: 78704
Tel. (512) 444-2377

Dallas

Barnhill Associates, Inc.
908 Business Parkway
Richardson, TX 75080
Tel. (214) 231-2573

Houston

Barnhill Associates, Inc.
10606 Hempstead Highway
Suite 132
Zip: 77092
Tel. (713) 688-9971

VIRGINIA

Williamsburg
BCS Associates, Inc.
107 Rich Neck Road
Zip: 23185
Tel. (804) 877-4053

WASHINGTON

Benton City
Showalter Instruments, Inc.
P.O. Box 828
Zip: 99320
Tel. (509) 588-3472

Seattle

Showalter Instruments, Inc.
1521 - 130th N.E.
Bellevue, WA 98005
Tel. (206) 455-4922

WASHINGTON, D.C.

Baltimore
John Fluke Mfg. Co., Inc.
11501 Huff Court
Kensington, MD 20795
Tel. (301) 881-3370

For U.S. areas not listed, contact the regional office nearest you or John Fluke Mfg. Co., Inc., Mountlake Terrace, WA.

Canada

ALBERTA

Calgary
Allan Crawford Assoc., Ltd.
3829 - 12th Street N.E.
Zip: T2E 6M5
Tel. (403) 276-9658

BRITISH COLUMBIA

North Vancouver
Allan Crawford Assoc., Ltd.
116 E. Third St., Suite 203
Zip: V7L 1E6
Tel. (604) 980-4831

NOVA SCOTIA

Halifax
Allan Crawford Assoc., Ltd.
Suite 291, Townsend Pl.
800 Windmill Rd.
Burnside Industrial Park
Dartmouth, NS
Zip: B3B 1L1
Tel. (902) 469-7865

ONTARIO

Toronto
Allan Crawford Assoc., Ltd.
6427 Northam Drive
Mississauga, Ont L4V 1J5
Tel. (416) 678-1500

Ottawa

Allan Crawford Assoc., Ltd.
1299 Richmond Road
Zip: K2B 7Y4
Tel. (613) 829-9651

QUEBEC

Montreal
Allan Crawford Assoc., Ltd.
1330 Marie Victorie Blvd. E.
Longueuil, P.Q. J4G 1A2
Tel. (514) 670-1212

For Canadian areas not listed, contact the regional office nearest you or Allan Crawford Assoc., Ltd., Mississauga, Ontario.

All of the above Fluke Sales Offices carry local stocks of low-cost Digital Multimeters (Models 8000A, 8030A, 8040A), Counters (Model 1900A), Digital Thermometers (Models

2160A, 2170A, 2165A, 2175A) and the Universal Temperature Probe (Model 80T-150). These same products are available from the following distributors:

Brownell Electronics

Atlanta, GA (404) 762-5181
Charlotte, NC (704) 394-4341
Memphis, TN (901) 323-8554
Nashville, TN (615) 889-8230
Orlando, FL (305) 843-6770
Mobile, AL (205) 479-5405

The Mancib Company

Boston, MA (617) 272-9450
Middletown, CT (203) 346-6646

Elmar Electronics

San Francisco, CA (415) 961-3611
Denver, CO (303) 287-9611

Pioneer-Standard

Cleveland, OH (216) 587-3600
Dayton, OH (513) 236-9900
Indianapolis, IN (317) 849-7300
Pittsburgh, PA (412) 782-2300
Detroit, MI (313) 525-1800

Liberty Electronics

El Segundo, CA (213) 322-8100
San Diego, CA (714) 565-9171
Phoenix, AZ (602) 257-1272
Seattle, WA (206) 763-8200
Albuquerque, NM (505) 299-8293
Beaverton, OR (503) 644-4783