FLUKE®

Instruction Manual

Models

203A

Distribution Amplifier

P/N 313387

SEPTEMBER 1968

LIMITED WARRANTY

The JOHN FLUKE MFG. CO., INC., warrants each instrument it manufactures to be free from defects in material and workmanship under normal use and service for the period of one year from date of purchase. This warranty extends only to the original purchaser. This warranty shall not apply to fuses, disposable batteries (rechargeable type batteries are warranted for 90 days), or any product or parts which have been subject to misuse, neglect, accident or abnormal conditions of operations.

In the event of failure of a product covered by this warranty, John Fluke Mfg. Co., Inc., will repair and calibrate an instrument returned to an authorized Service Facility within one year of the original purchase; provided the warrantor's examination discloses to its satisfaction that the product was defective. The warrantor may, at its option, replace the product in lieu of repair. With regard to any instrument returned within one year of the original purchase, said repairs or replacement will be made without charge. If the fault has been caused by misuse, neglect, accident or abnormal conditions of operations, repairs will be billed at a nominal cost. In such case, an estimate will be submitted before work is started, if requested.

> ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS SHALL BE LIMITED TO A PERIOD OF TWELVE MONTHS FROM THE DATE OF PURCHASE. THE FOREGOING WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OF MERCHANTABILITY, FITNESS OR ADEQUACY FOR ANY PARTICULAR PURPOSE OR USE. JOHN FLUKE MFG. CO., INC. SHALL NOT BE LIABLE FOR ANY SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES, WHETHER IN CONTRACT, TORT OR OTHERWISE.
>
> NOTE: Some states do not allow limitations on how long an implied warranty lasts, or the exclusion or limitation of incidental or consequential damages, so the above limitations or exclusion may not apply to you. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

If any fault develops, the following steps should be taken:

1. Notify the John Fluke Mfg. Co., Inc. or nearest Service facility, giving full details of the difficulty, and include the Model number, type number, and serial number. On receipt of this information, service data or shipping instructions will be forwarded to you.

2. On receipt of the shipping instructions, forward the instrument, transportation prepaid. Repairs will be made at the Service Facility and the instrument returned, transportation prepaid.

SHIPPING TO MANUFACTURER FOR REPAIR OR ADJUSTMENT

All shipments of John Fluke Mfg. Co., Inc., instruments should be made via United Parcel Service or "Best Way*" prepaid. The instrument should be shipped in the original packing carton; or if it is not available, use any suitable container that is rigid and of adequate size. If a substitute container is used, the instrument should be wrapped in paper and surrounded with at least four inches of excelsior or similar shock-absorbing material.

CLAIM FOR DAMAGE IN SHIPMENT TO ORIGINAL PURCHASER

The instrument should be thoroughly inspected immediately upon original delivery to purchaser. All material in the container should be checked against the enclosed packing list. The manufacturer will not be responsible for shortages against the packing sheet unless notified immediately. If the instrument is damaged in any way, a claim should be filed with the carrier immediately. (To obtain a quotation to repair shipment damage, contact the nearest Fluke Technical Center.) Final claim and negotiations with the carrier must be completed by the customer.

The John Fluke Mfg. Co., Inc. will be happy to answer all application or use questions, which will enhance your use of this instrument. Please address your requests or correspondence to: JOHN FLUKE MFG. CO., INC., P.O. Box 43210, MOUNTLAKE TERRACE, WASHINGTON 98043, Atten: Sales Dept. For European Customers: FLUKE (Nederland) B.V., Zevenheuvelenweg 53, Tilburg, The Netherlands.

* For European customers, Air Freight prepaid.

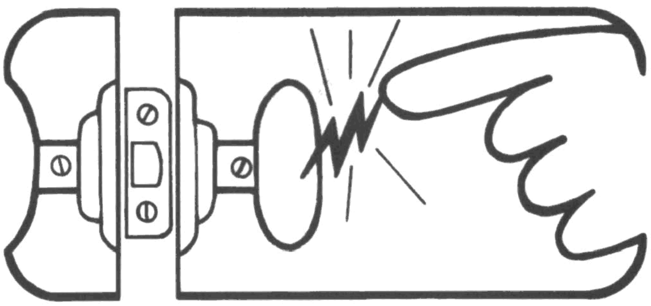
John Fluke Mfg. Co., Inc. • P.O. Box 43210 • Mountlake Terrace, Washington 98043

Rev. 12/77

static awareness

A Message From

John Fluke Mfg. Co., Inc.

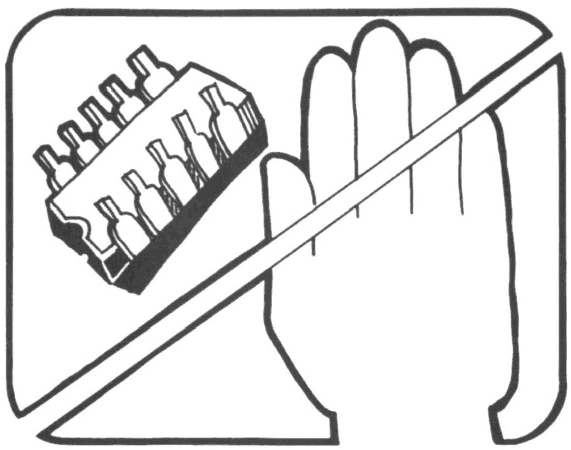


Some semiconductors and custom IC's can be damaged by electrostatic discharge during handling. This notice explains how you can minimize the chances of destroying such devices by:

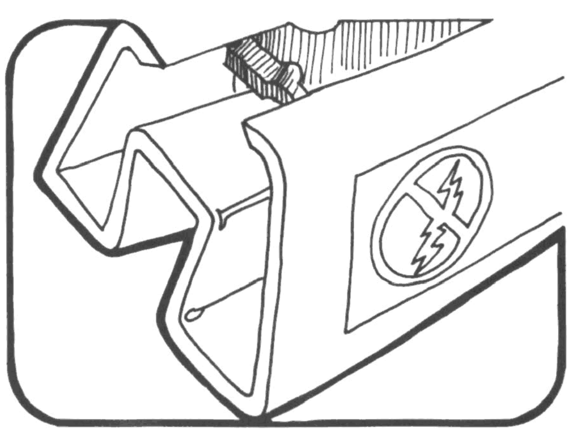
1. Knowing that there is a problem.
2. Learning the guidelines for handling them.
3. Using the procedures, and packaging and bench techniques that are recommended.

The Static Sensitive (S.S.) devices are identified in the Fluke technical manual parts list with the symbol “ ”.

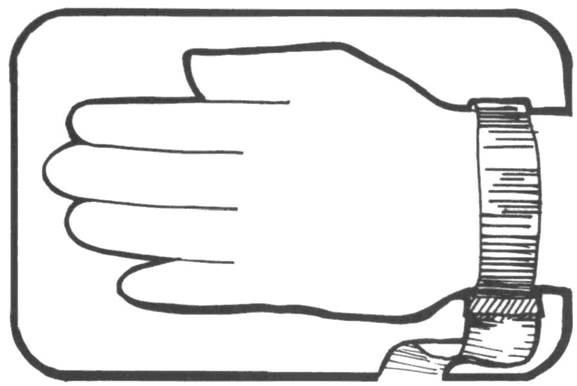
The following practices should be followed to minimize damage to S.S. devices.



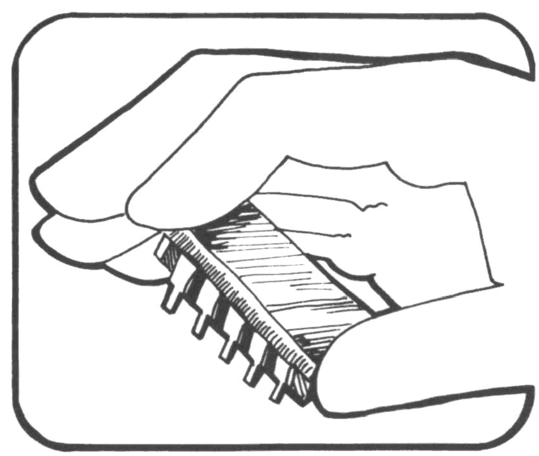
1. MINIMIZE HANDLING



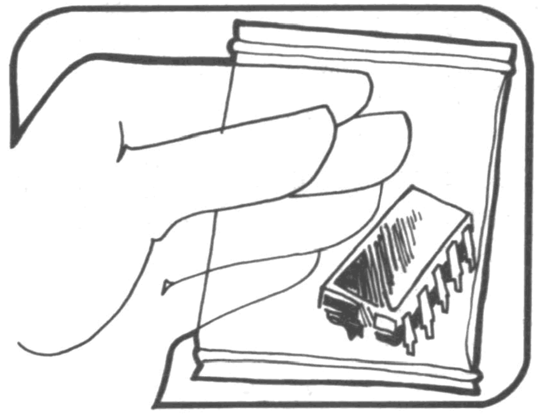
2. KEEP PARTS IN ORIGINAL CONTAINERS UNTIL READY FOR USE.



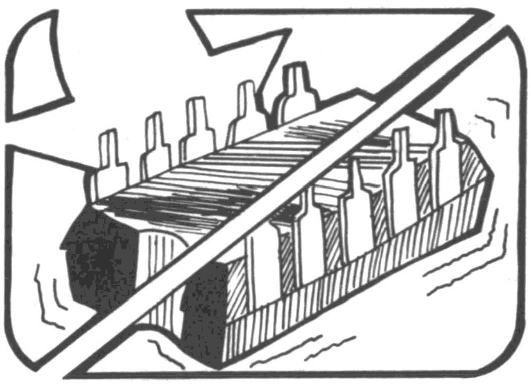
3. DISCHARGE PERSONAL STATIC BEFORE HANDLING DEVICES



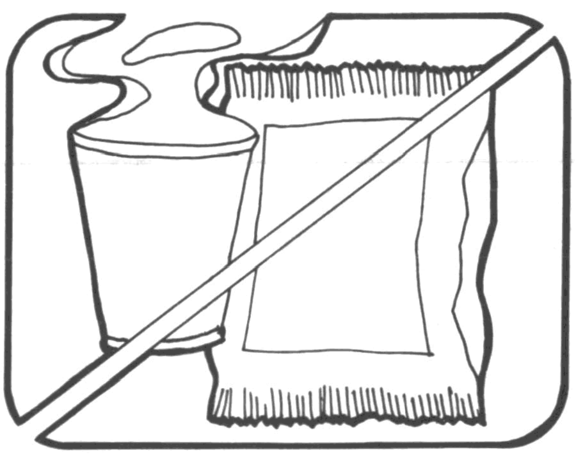
4. HANDLE S.S. DEVICES BY THE BODY



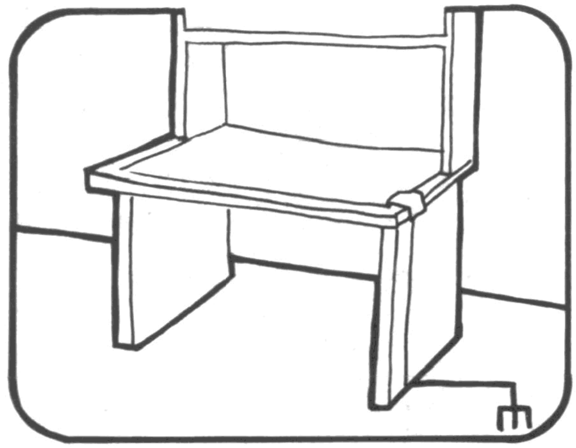
5. USE ANTI-STATIC CONTAINERS FOR HANDLING AND TRANSPORT



6. DO NOT SLIDE S.S. DEVICES OVER ANY SURFACE



7. AVOID PLASTIC, VINYL AND STYRAFOAM IN WORK AREA



8. HANDLE S.S. DEVICES ONLY AT A STATIC-FREE WORK STATION

9. ONLY ANTI-STATIC TYPE SOLDER-SUCKERS SHOULD BE USED.

10. ONLY GROUNDED TIP SOLDERING IRONS SHOULD BE USED.

Anti-static bags, for storing S.S. devices or pcbs with these devices on them, can be ordered from the John Fluke Mfg. Co., Inc.. See section 5 in any Fluke technical manual for ordering instructions. Use the following part numbers when ordering these special bags.

John Fluke Part No.	Bag Size
453522	6" x 8"
453530	8" x 12"
453548	16" x 24"
454025	12" x 15"

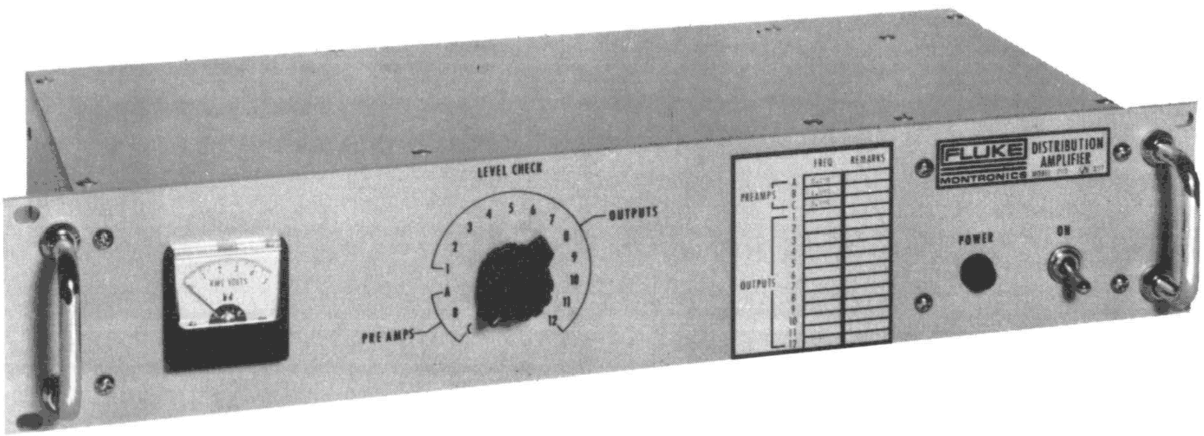
FOREWORD

This instruction manual has been especially designed to provide you with complete technical information at the time you receive your instrument. Because your instrument is a member of a family that is frequently modified for special applications, it sometimes happens that technical data isn't available until as little as a week before the instrument is shipped. These unusual circumstances dictate an unusual instruction manual.

The most significant departure from conventional instruction manuals is the elimination of consecutive page numbers. In this manual, each subsection is identified by a Title Block in the upper right-hand corner of the first page. In the title block, the manual section number and title are shown, along with an indexing number that identifies the subsection. The number of subsection pages is listed at the bottom of the title block.

Section I itemizes the instrument performance characteristics. In Section II, you'll find detailed instructions on how to operate the instrument. Sections III and IV contain maintenance and calibration information, circuit descriptions, parts lists, and schematic diagrams. The data in Section III pertains to the instrument. And that in Section IV relates to the individual modules. Section V is an appendix in which you'll find reference information. Here, for example, you may find a detailed description of a frequently used circuit or engineering data for an unusual application.

Sometimes, information about late design changes or special modifications must be added to the manual after it is printed. This information is printed on pages placed in front of the appropriate sub section and identified by the subsection indexing number. The word "Addendum" appears in the space normally reserved for the subsection revision letter.



MODEL 203A DISTRIBUTION AMPLIFIER

THE MODEL 203A DISTRIBUTION AMPLIFIER
TABLE OF CONTENTS

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 ±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.

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.

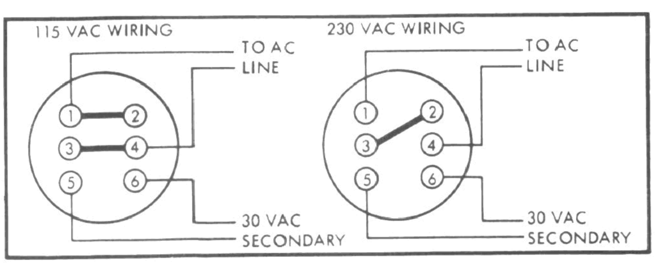


Figure 1. POWER TRANSFORMER BASE WIRING FOR 115 VAC AND 230 VAC

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:

a. Turn the INPUT LEVEL ADJUST controls fully counterclockwise.

b. Turn the LEVEL CHECK switch to the POWER SUPPLY position. The meter should indicate approximately 4 representing +20 volts dc.

c. 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.

d. 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.

e. 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.

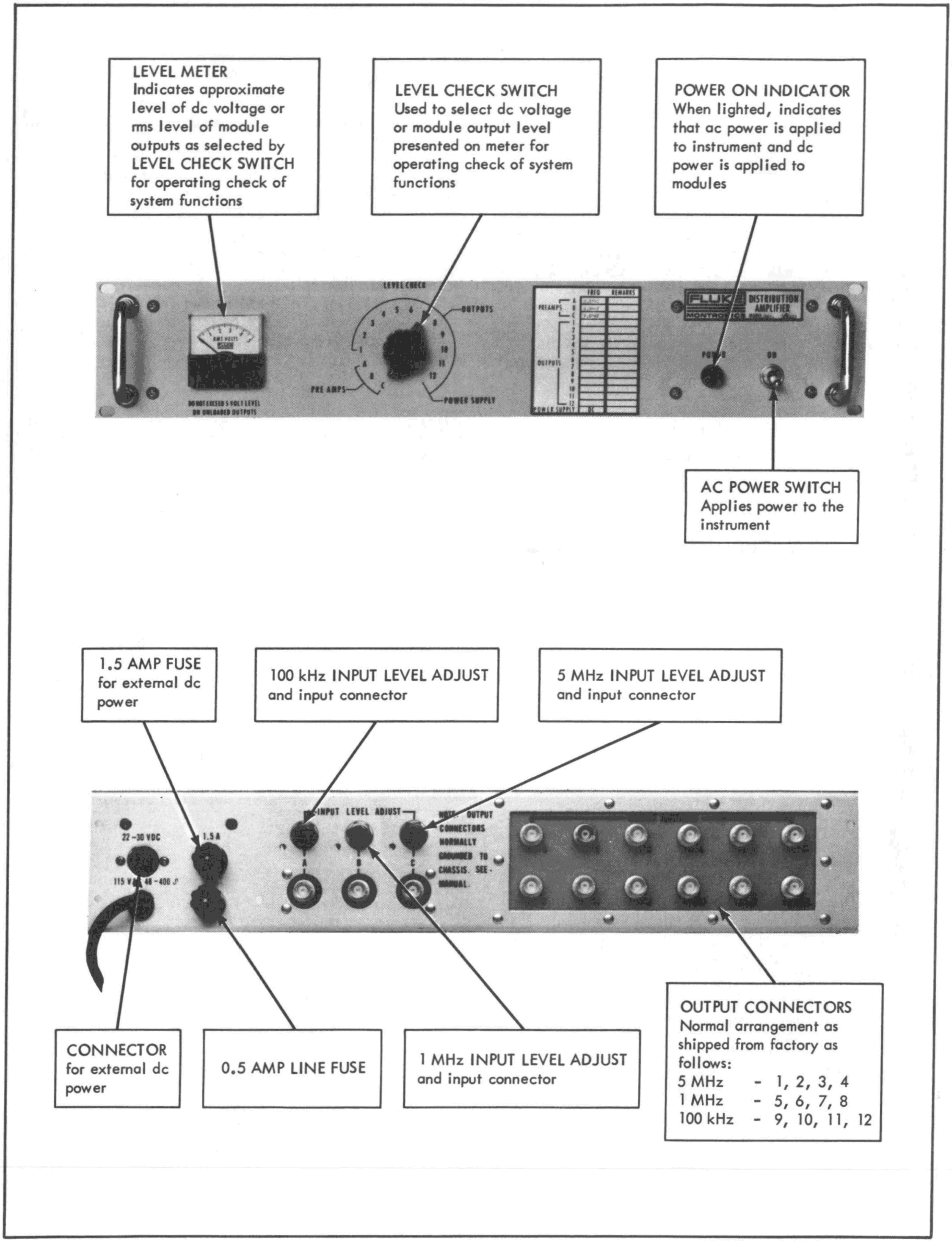


Figure 2. MODEL 203A CONTROLS, CONNECTORS, AND INDICATORS

f. Turn the **LEVEL CHECK** switch to each of the preamplifier 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.

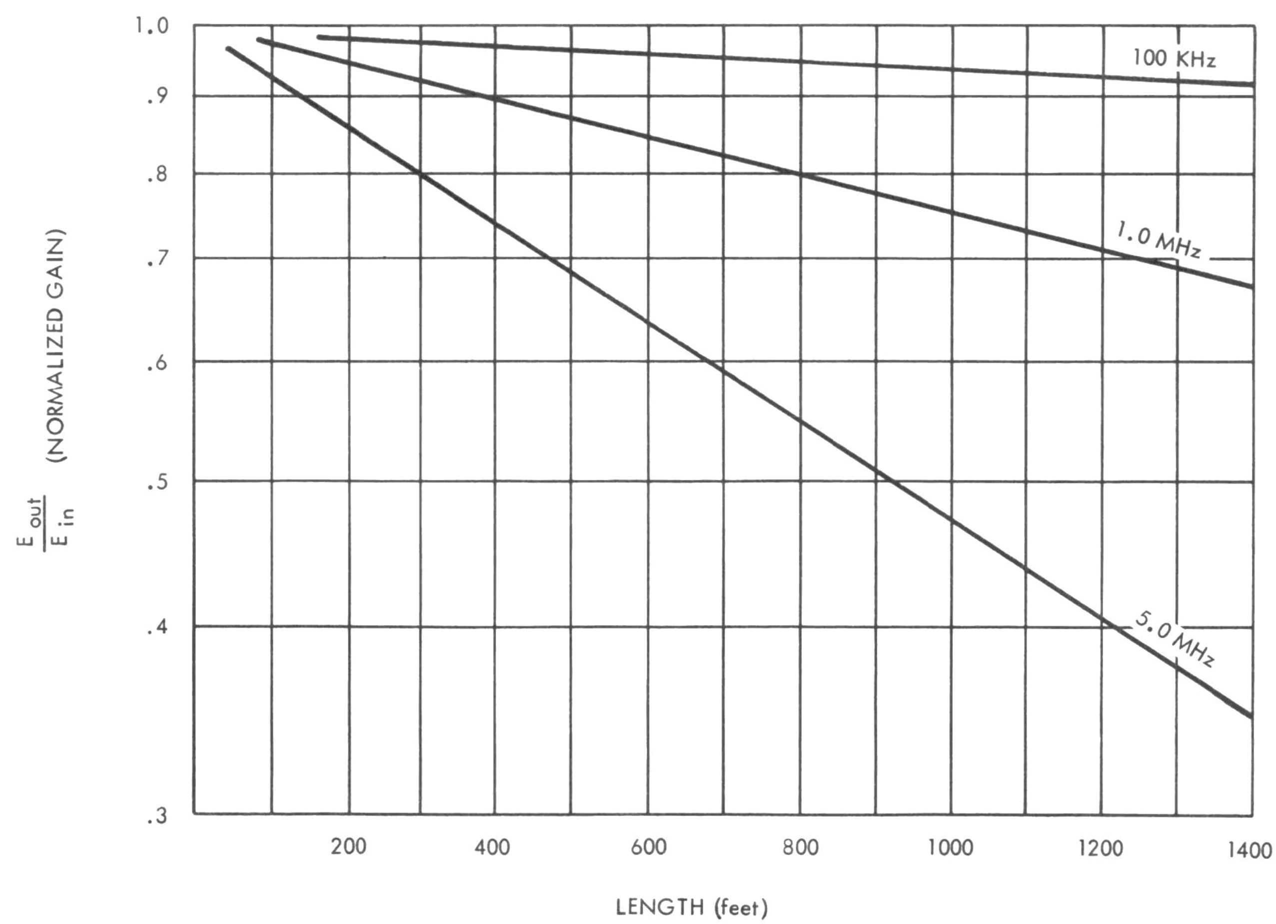


Figure 3. GAIN CHARACTERISTICS OF TERMINATED RG-58/U

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

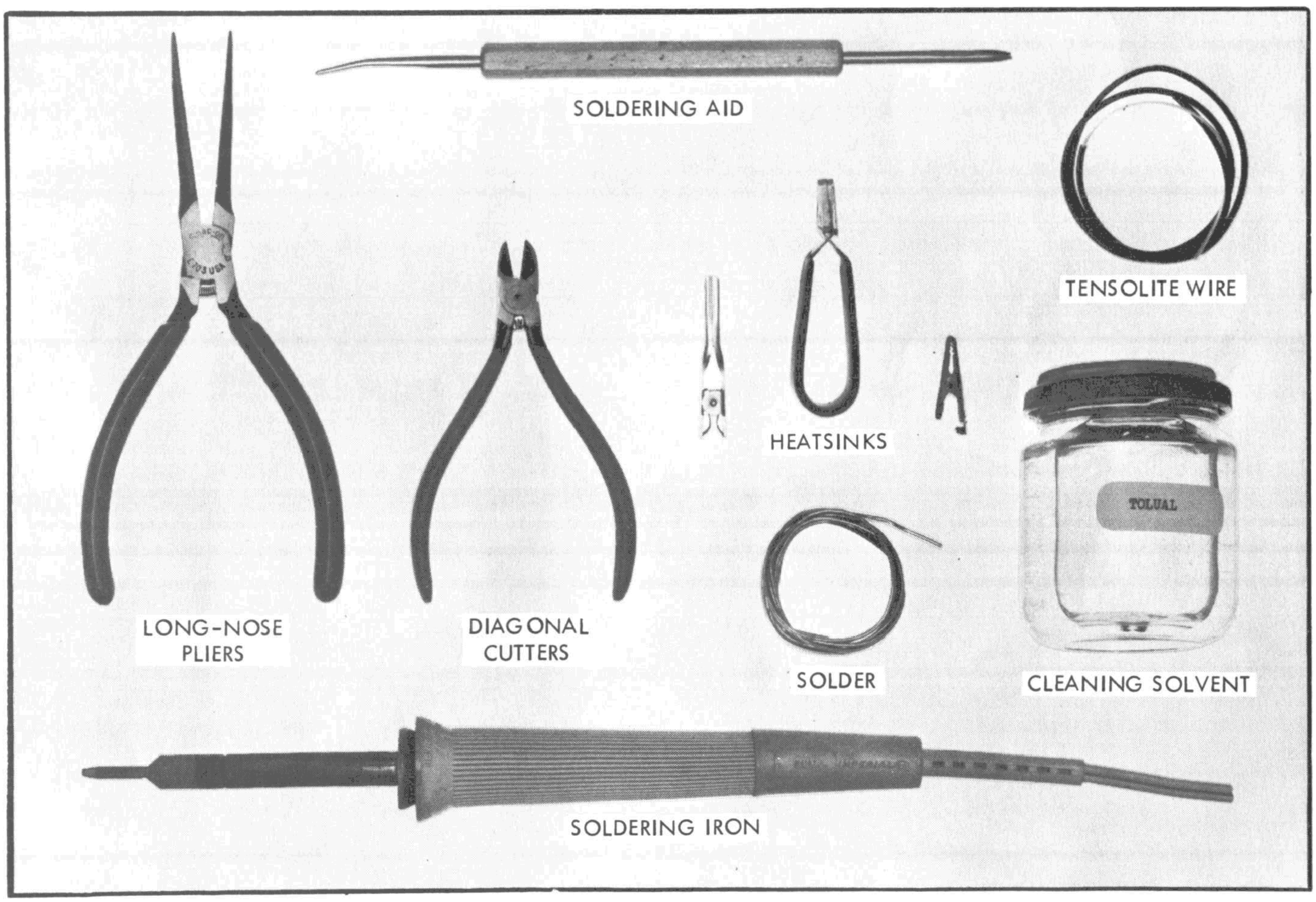


Figure 4-25. TOOLS REQUIRED FOR SOLDERING

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 tined 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 absorbtion. The special coating is composed of a polyurethane resin and is called epecaste. 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.

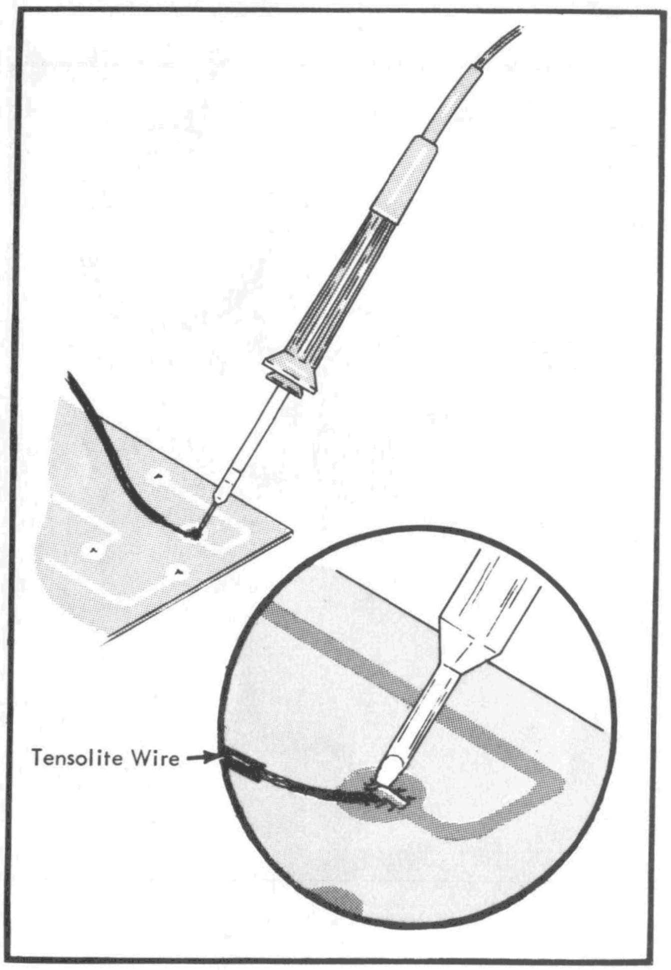


Figure 4-26. REMOVING SOLDER FROM A CONNECTION

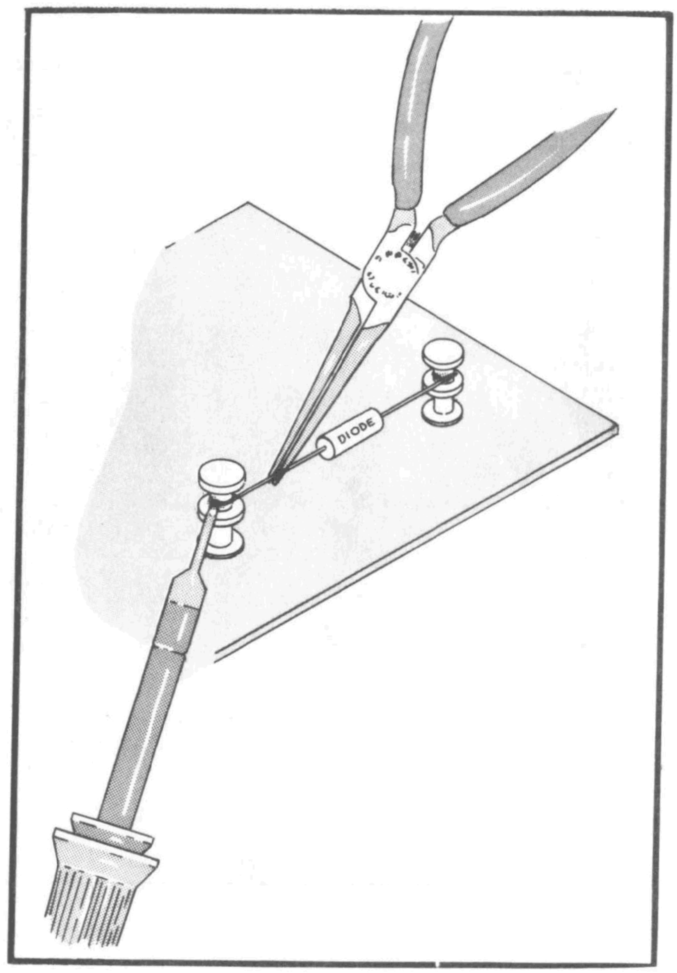


Figure 4-27. LONG-NOSE PLIERS USED AS A HEATSINK

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

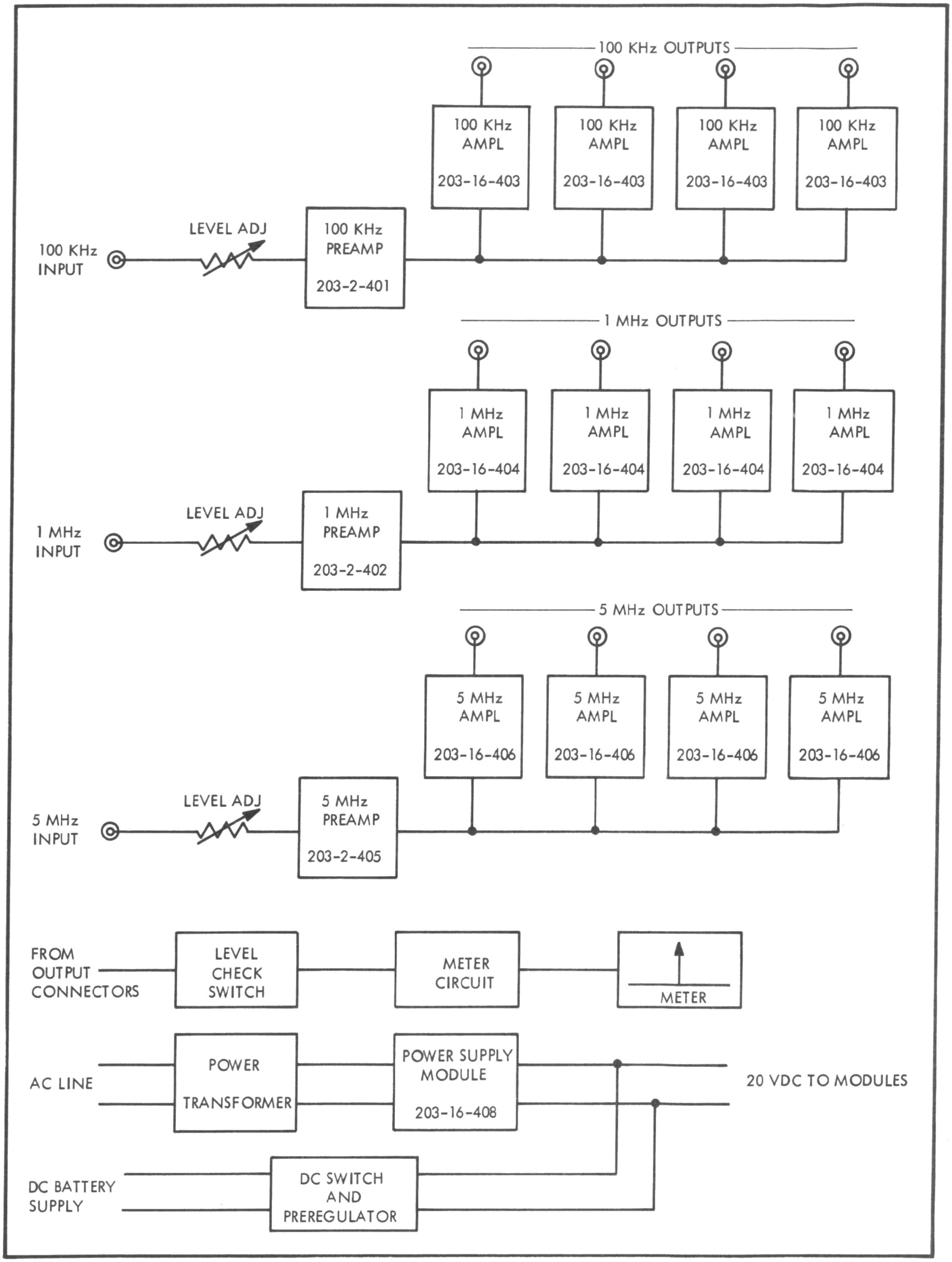


Figure 1. MODEL 203A DISTRIBUTION AMPLIFIER BLOCK DIAGRAM

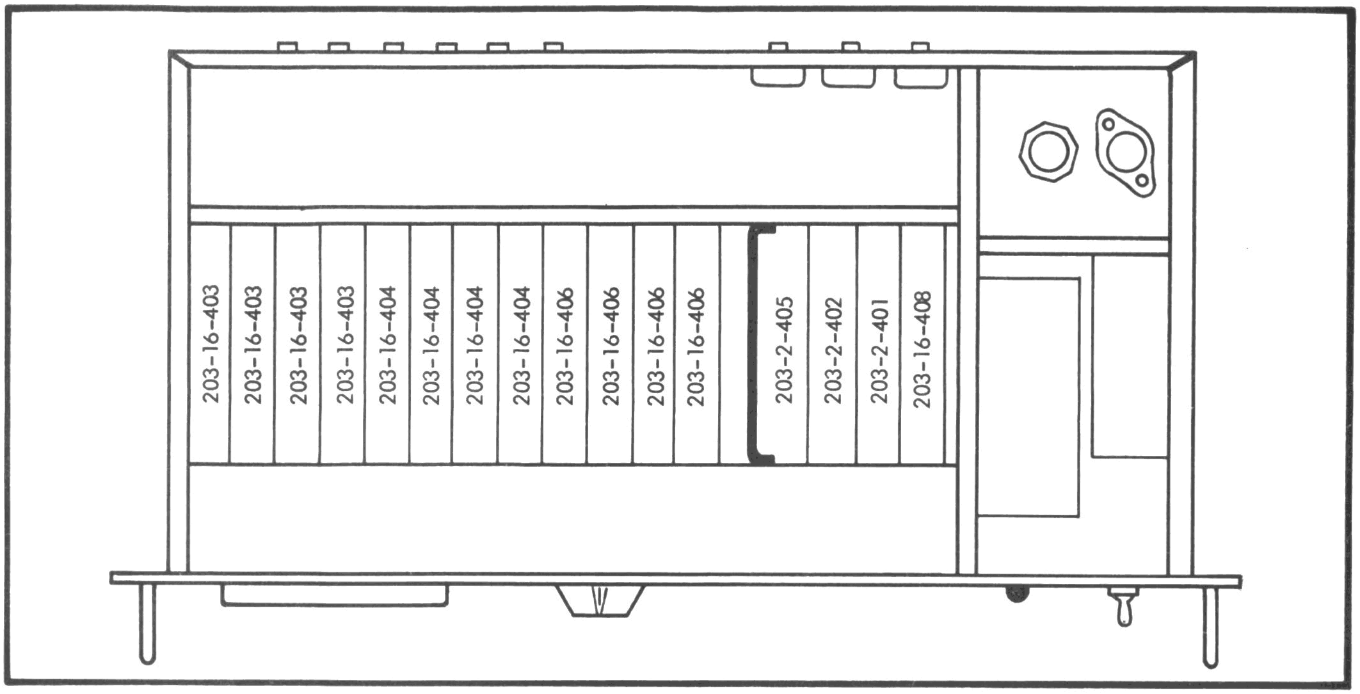


Figure 2. MODEL 203A TOP VIEW LAYOUT

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 180, 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 damageing 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-

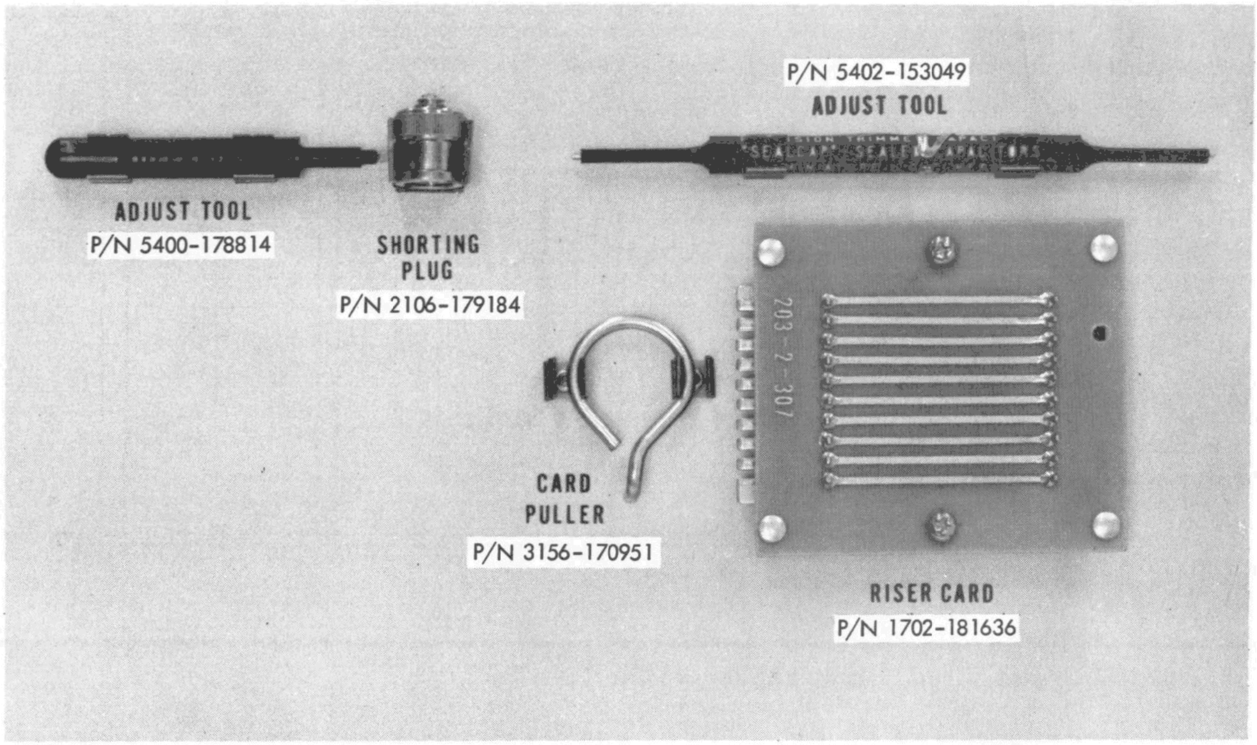


Figure 3. MODEL 203A ACCESSORY KIT

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. Voltohmist	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.

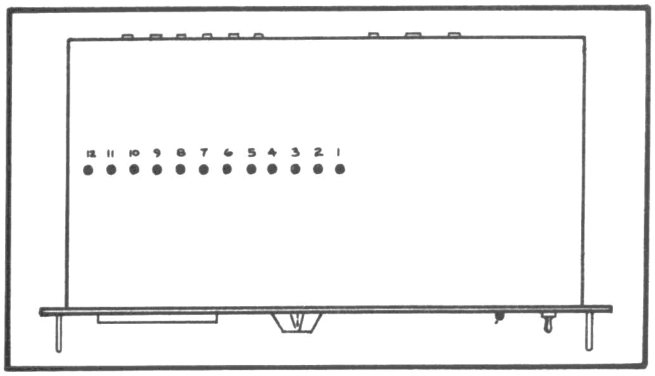


Figure 5. LOCATION OF ADJUSTMENT PORTS IN TOP COVER

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 preamplifier 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:

a. All modules in place and aligned per the module alignment procedures in Section IV.

b. No signals present at all 3 inputs.

c. 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		

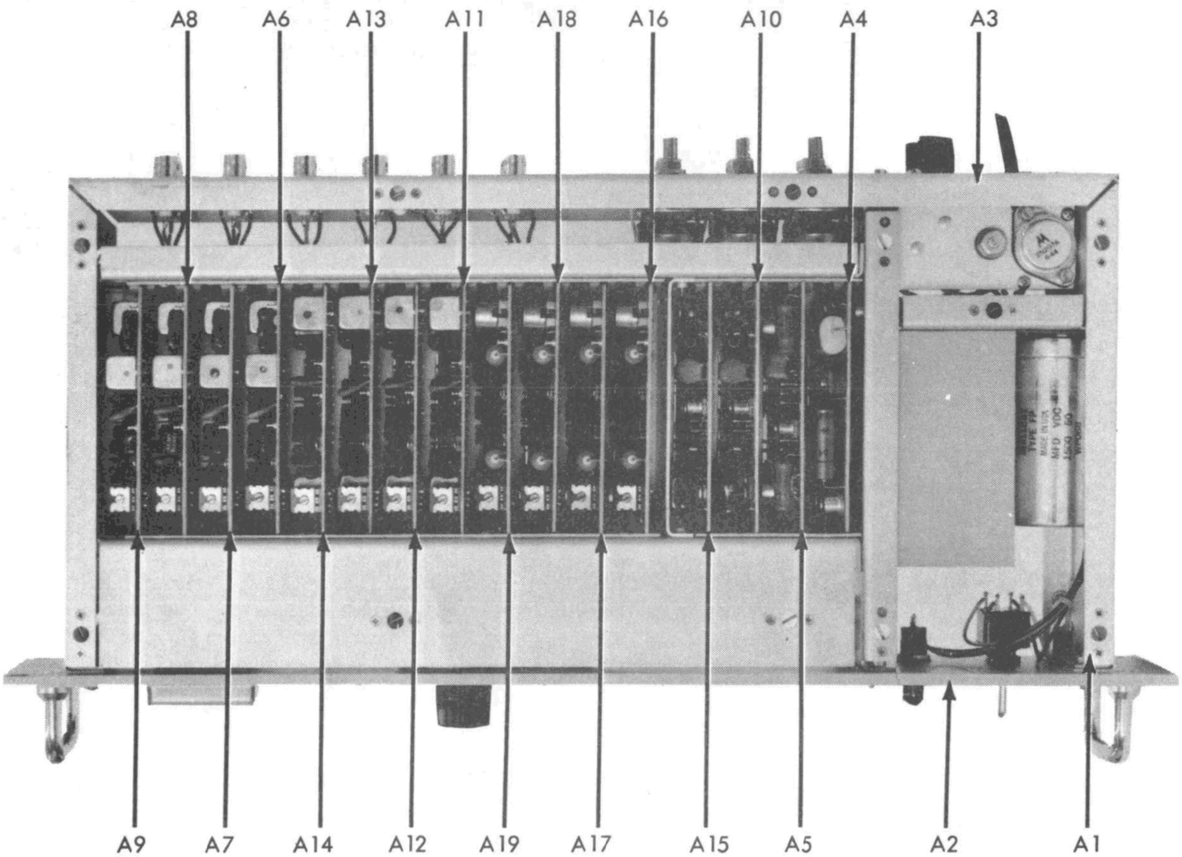


Figure 6. DISTRIBUTION AMPLIFIER

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, gmv, 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		

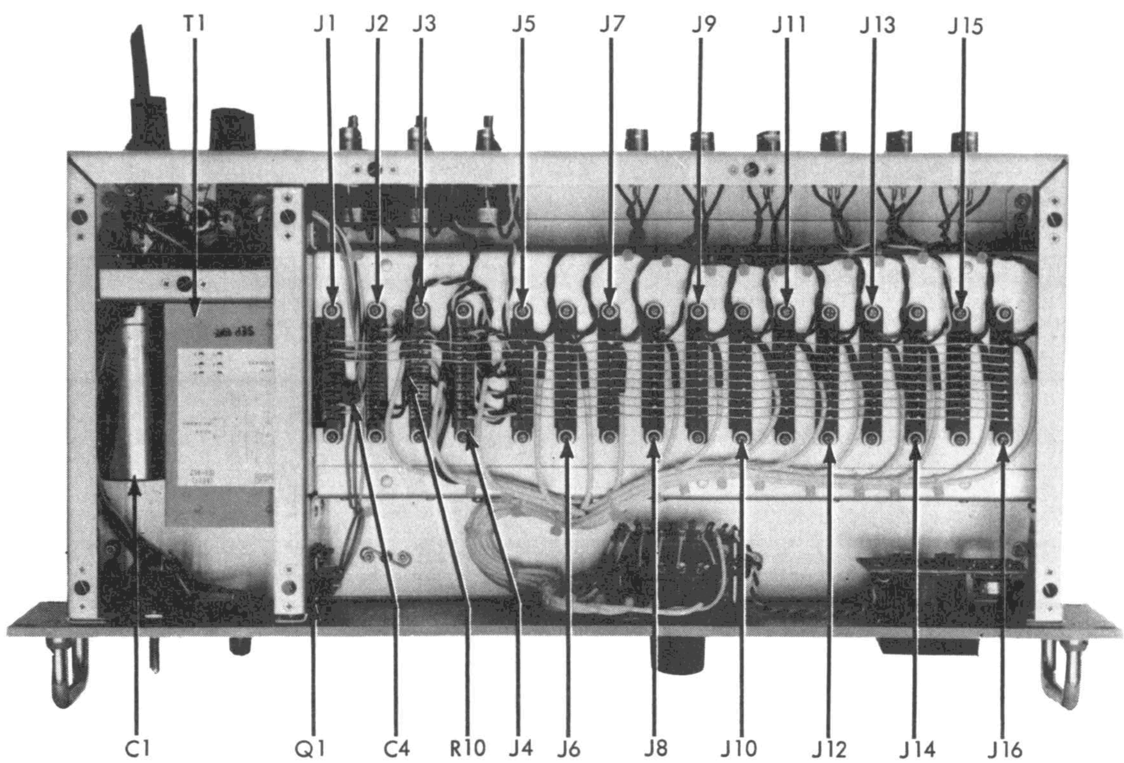


Figure 7. CHASSIS ASSEMBLY

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, incandescant, 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		

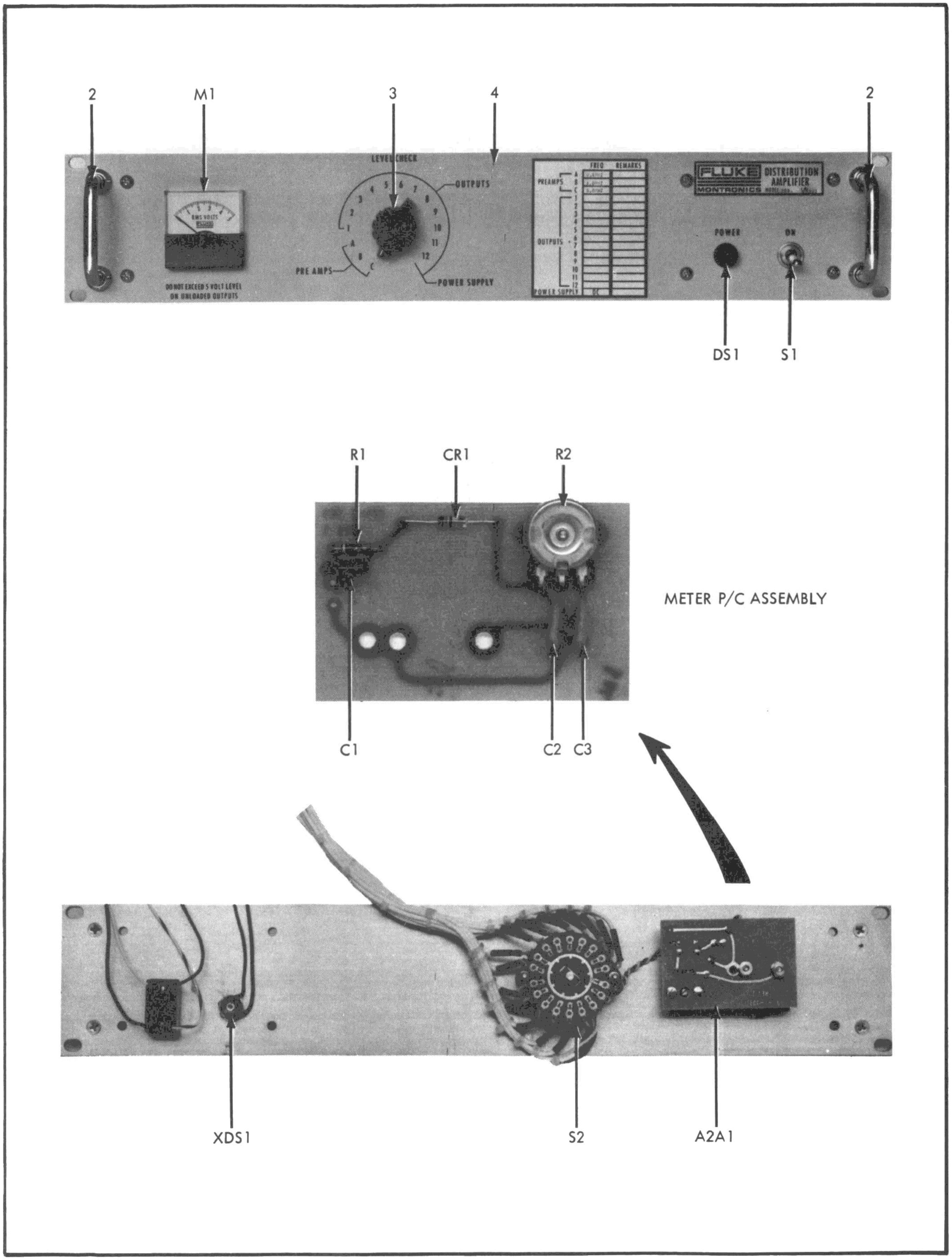


Figure 8. FRONT PANEL ASSEMBLY

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		

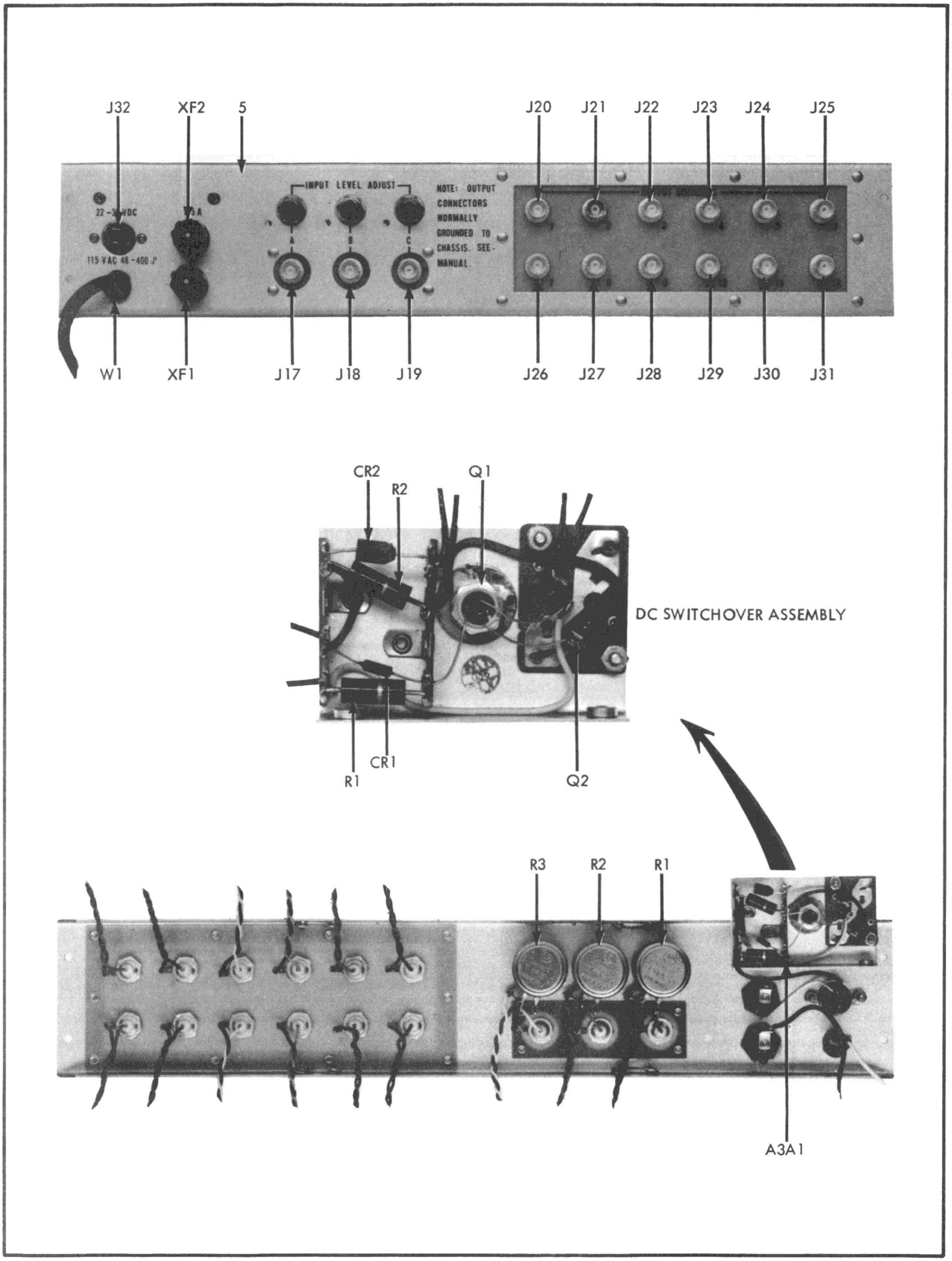
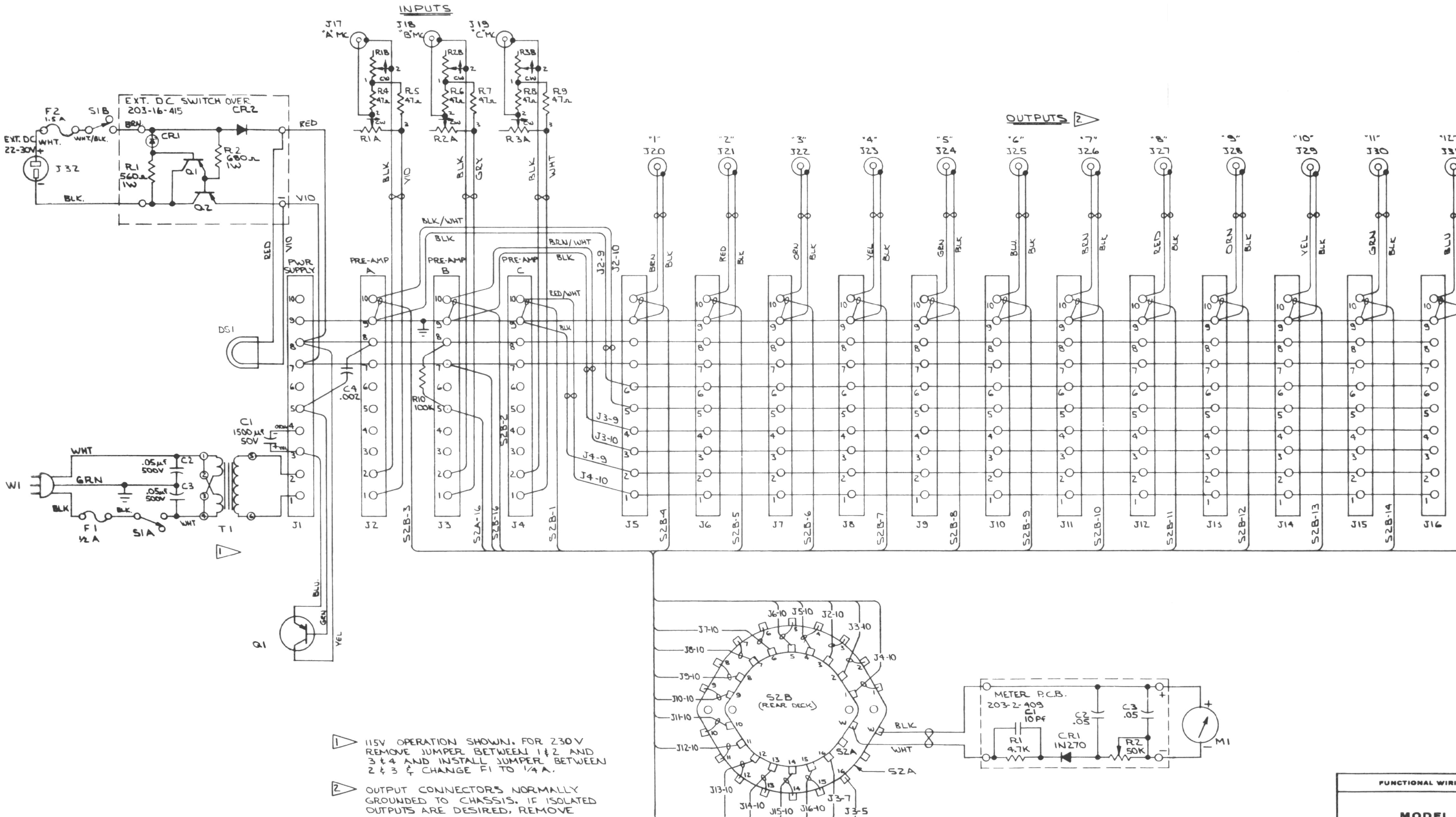


Figure 9. REAR PANEL ASSEMBLY



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, J5 THRU J16

FUNCTIONAL WIRING DIAGRAM

MODEL 203A

(Serial No. 961 & on)

DRAWING NO. 203A-100

REVISION	ORIG	1	2	3	4	5	6	7	8

FLUKE MONTRONICS

MONTRONICS, INC.

P.O. Box 7428 Seattle, Washington 98133

THE POWER SUPPLY MODULE

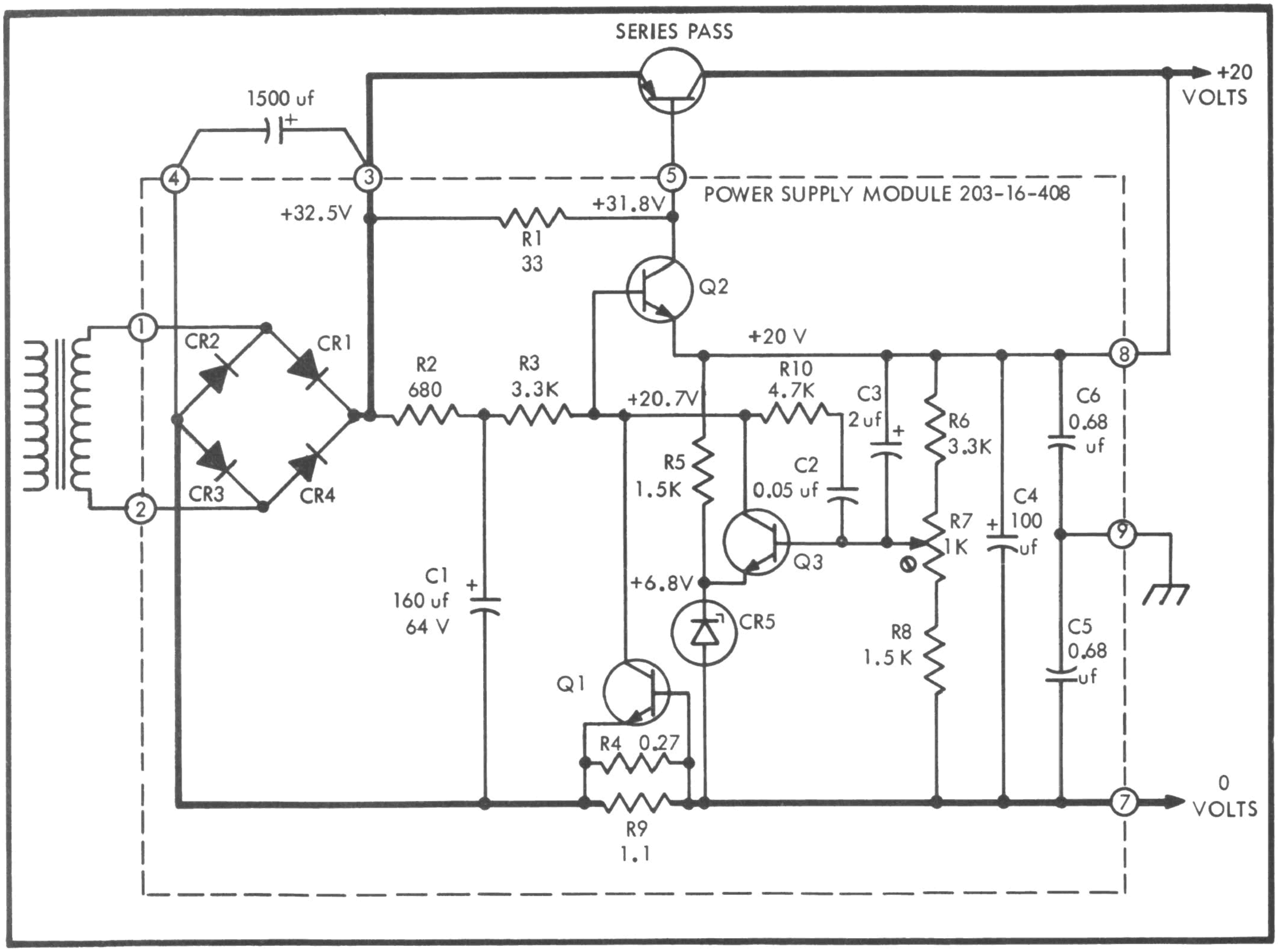


Figure 1. THE POWER SUPPLY MODULE SCHEMATIC

THEORY OF OPERATION

The power supply circuit consists of a step-down transformer, a full-wave bridge rectifier, a filter capacitor, a series pass regulator, and a regulator control circuit. The bridge rectifier and the regulator control circuit including the Zener reference are contained in the Power Supply Module.

The secondary voltage of T1 is converted to unregulated dc by a bridge rectifier and applied to the emitter of the pass transistor Q1 and to the regulator control circuit. Filter capacitor C1 smooths the rectified dc reducing ripple to an acceptable level of less than four volts peak-to-peak. The regulated output voltage at the collector of the series pass transistor is sensed by the regulator control circuit and used to develop a control signal to the base of the pass transistor.

Assume that a change tends to cause an increase in the output voltage of the pass transistor. This increase causes an increase in the base voltage of Q3. The base-emitter voltage of Q3 increases, increasing the conduction of Q3, because the emitter of Q3 is clamped at the zener voltage of CR5. The increasing collector current of Q3 robs some of the base current from Q2 and from the pass transistor, reducing the output. Thus, this feedback loop tends to resist any change in output voltage.

The power supply is protected against damage caused by an overload, by current limiting stage Q1. With a normal load applied to the power supply, the voltage drop across the base-to-emitter resistance (R4 and R9) or Q1 is too small to cause the transistor to conduct. When the current rises to approximately 2. 5 amperes, the voltage drop becomes sufficient to cause Q1 to start 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 vtvm 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 vtvm 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 vtvm 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 ±20%, 100v	1501-149161	56289	55C23A7	1		
C3	Cap, mylar, 2 uf ±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, 33Ω ±5%, 1/4w	4704-175034	01121	CB3305	1		
R2	Res, comp, 680Ω ±5%, 1/4w	4704-148007	01121	CB6815	1		
R3	Res, comp, 3.3k ±5%, 1/4w	4704-148056	01121	CB3325	2		
R4	Res, ww, 0.27Ω ±5%, 5w	4706-183137	75042	AS-5	1		
R5	Res, comp, 1.5k ±5%, 1/4w	4704-148031	01121	CB1525	2		
R6	Res, comp, 3.3k ±5%, 1/4w	4704-148056	01121	CB3325	REF		
R7	Res, var, ww, 1k ±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 ±5%, 1/4w	4704-148031	01121	CB1525	REF		
R9	Res, comp, 1.10Ω ±5%, 1/2w	4704-163717	01121	EB11G5	1		
R10	Res, comp, 4.7k ±5%, 1/4w	4704-148072	01121	CB4725	1		
	Transipad for Transistor TO-5 (not illustrated)	3155-152207	17069	88000	3		

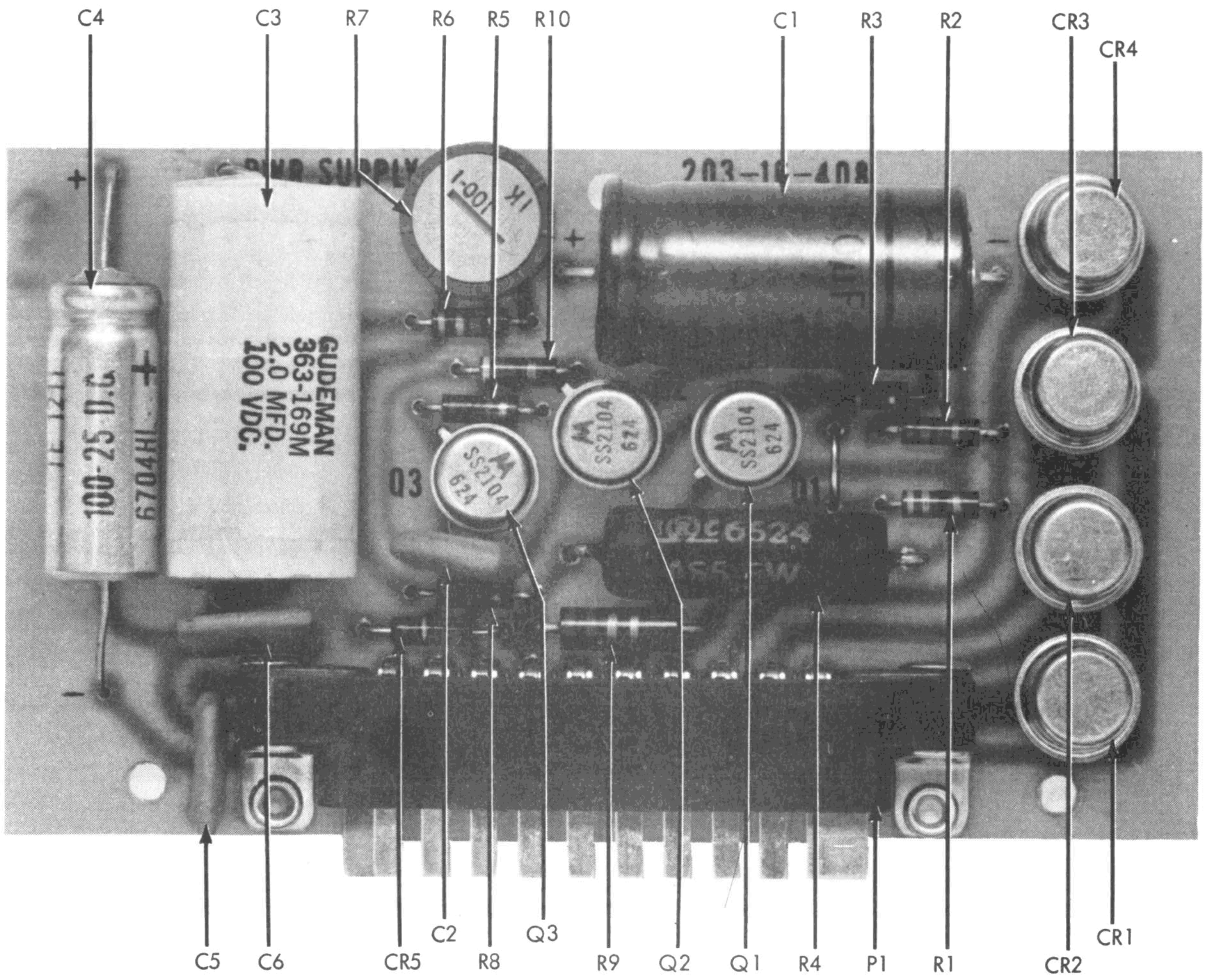


Figure 2. POWER SUPPLY MODULE

THE 100 KHz PREAMPLIFIER MODULE

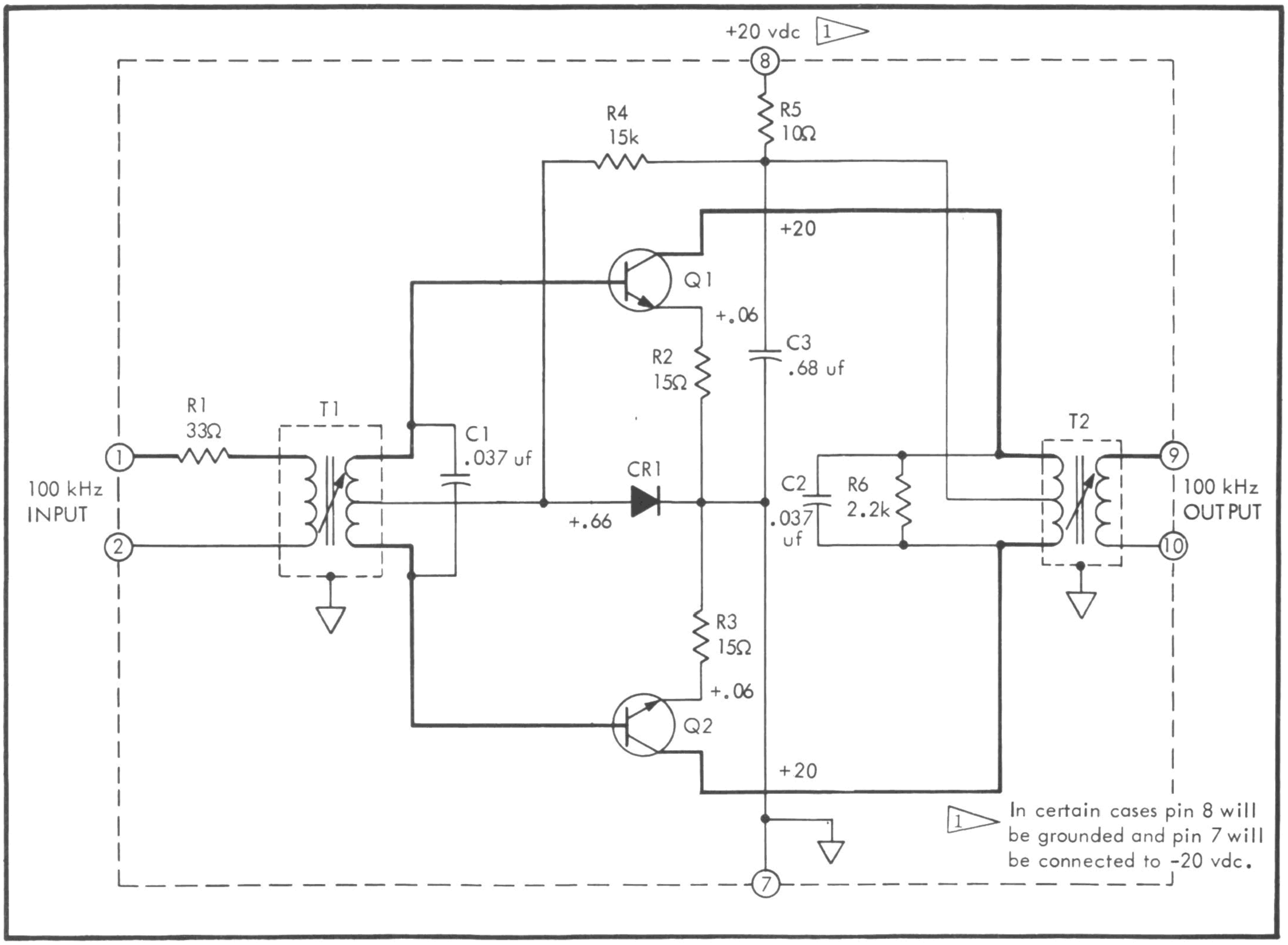


Figure 1. THE 100 KHz PREAMPLIFIER SCHEMATIC

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.

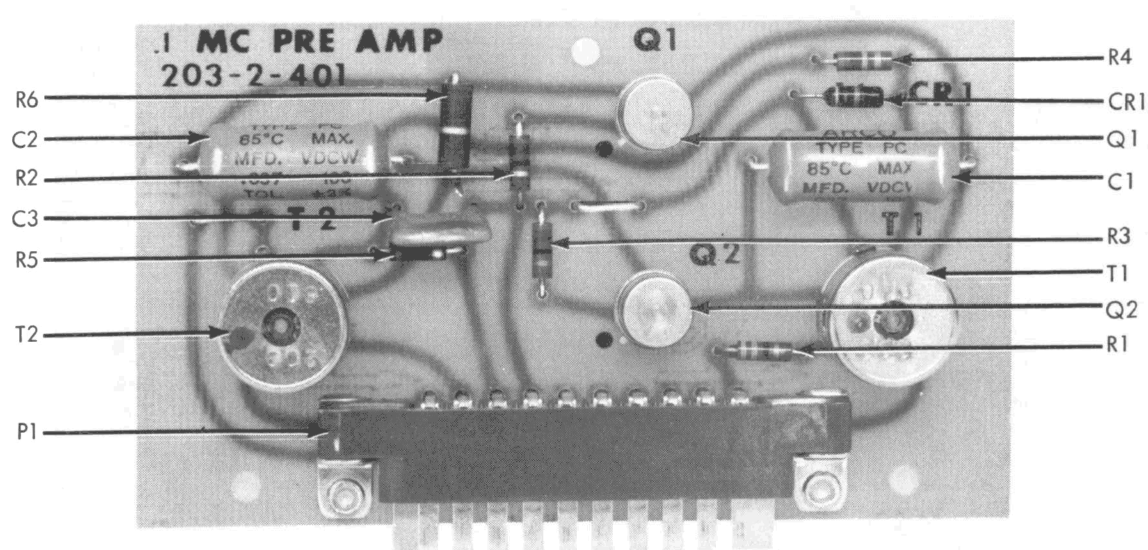


Figure 2. THE 100 KHz PREAMPLIFIER MODULE

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 ±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, 33Ω ±5%, 1/4w	4704-175034	01121	CB3305	1		
R2, R3	Res, comp, 15Ω ±5%, 1/4w	4704-147876	01121	CB1505	2		
R4	Res, comp, 15k ±5%, 1/4w	4704-148114	01121	CB1535	1		
R5	Res, comp, 10Ω ±5%, 1/4w	4704-147868	01121	CB1005	1		
R6	Res, comp, 2.2k ±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

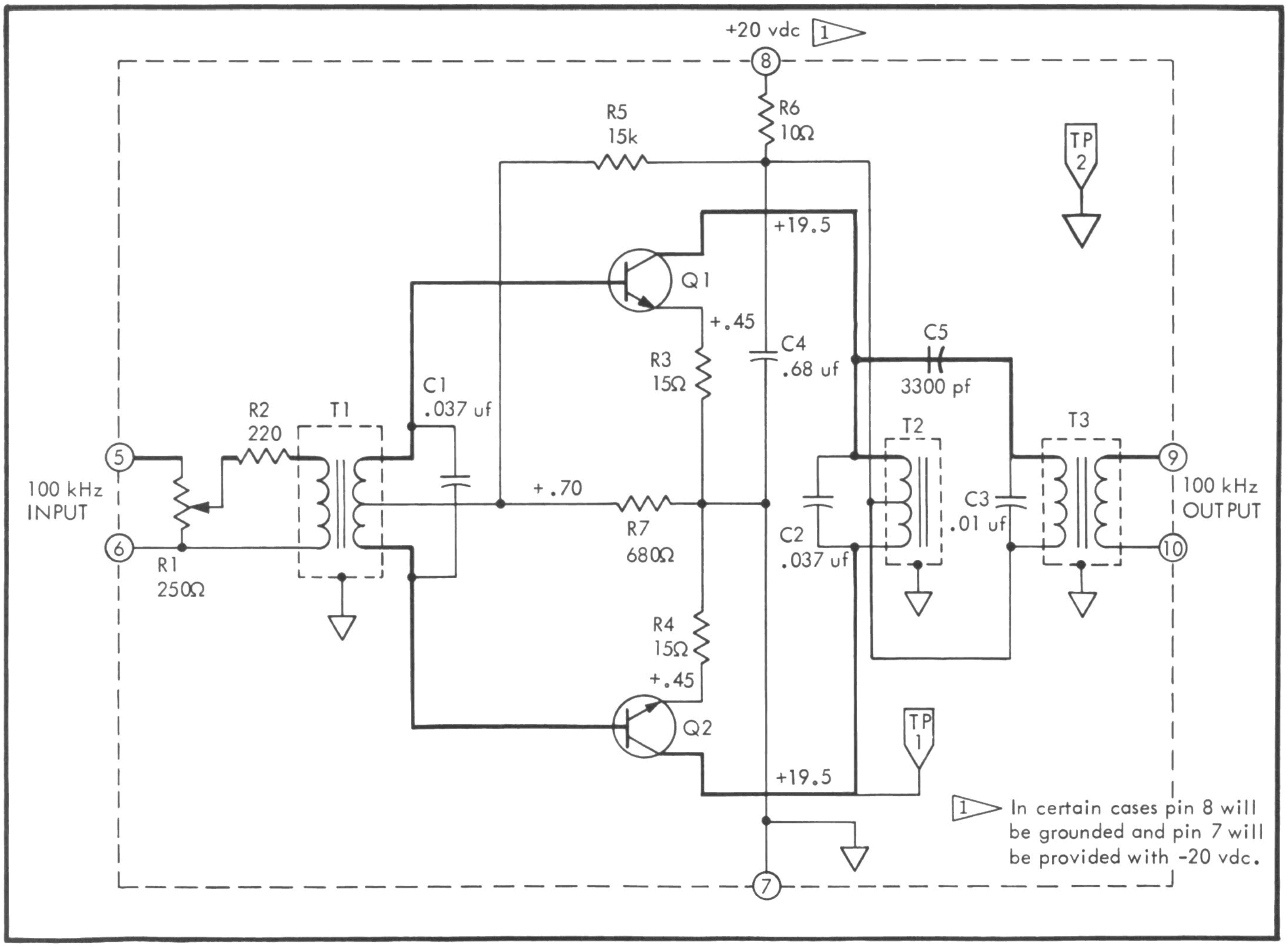


Figure 1. THE 100 KHz AMPLIFIER SCHEMATIC

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 crytically 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, which ever 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.

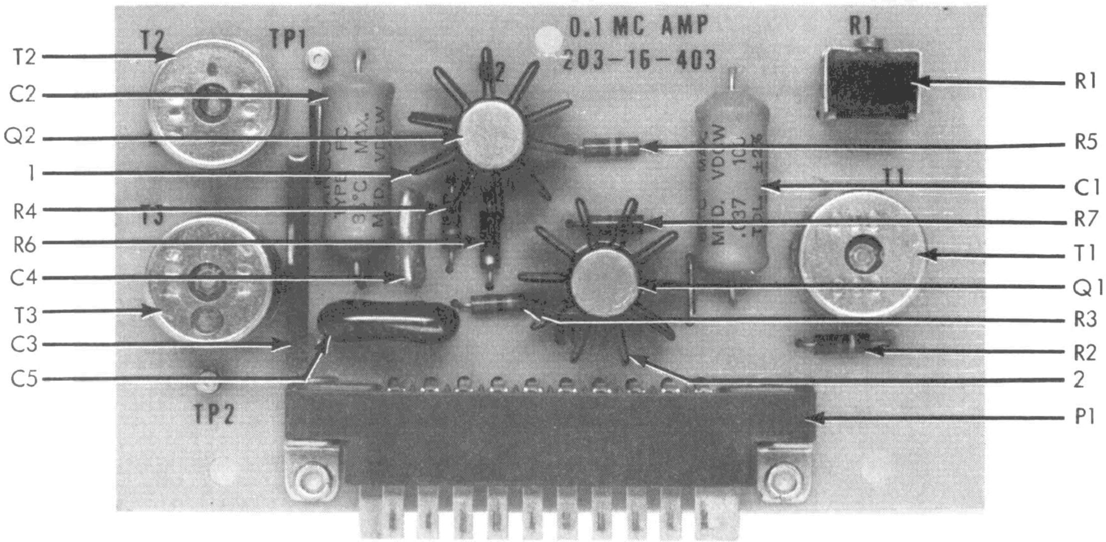


Figure 2. THE 100 KHz AMPLIFIER MODULE

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		
1, 2	Heat sink	4806-104646	05820	NF207	2		
	Transipad for Transistor T0-5 (not illustrated)	3155-152207	17069	88000	2		

THE 1 MHz PREAMPLIFIER MODULE

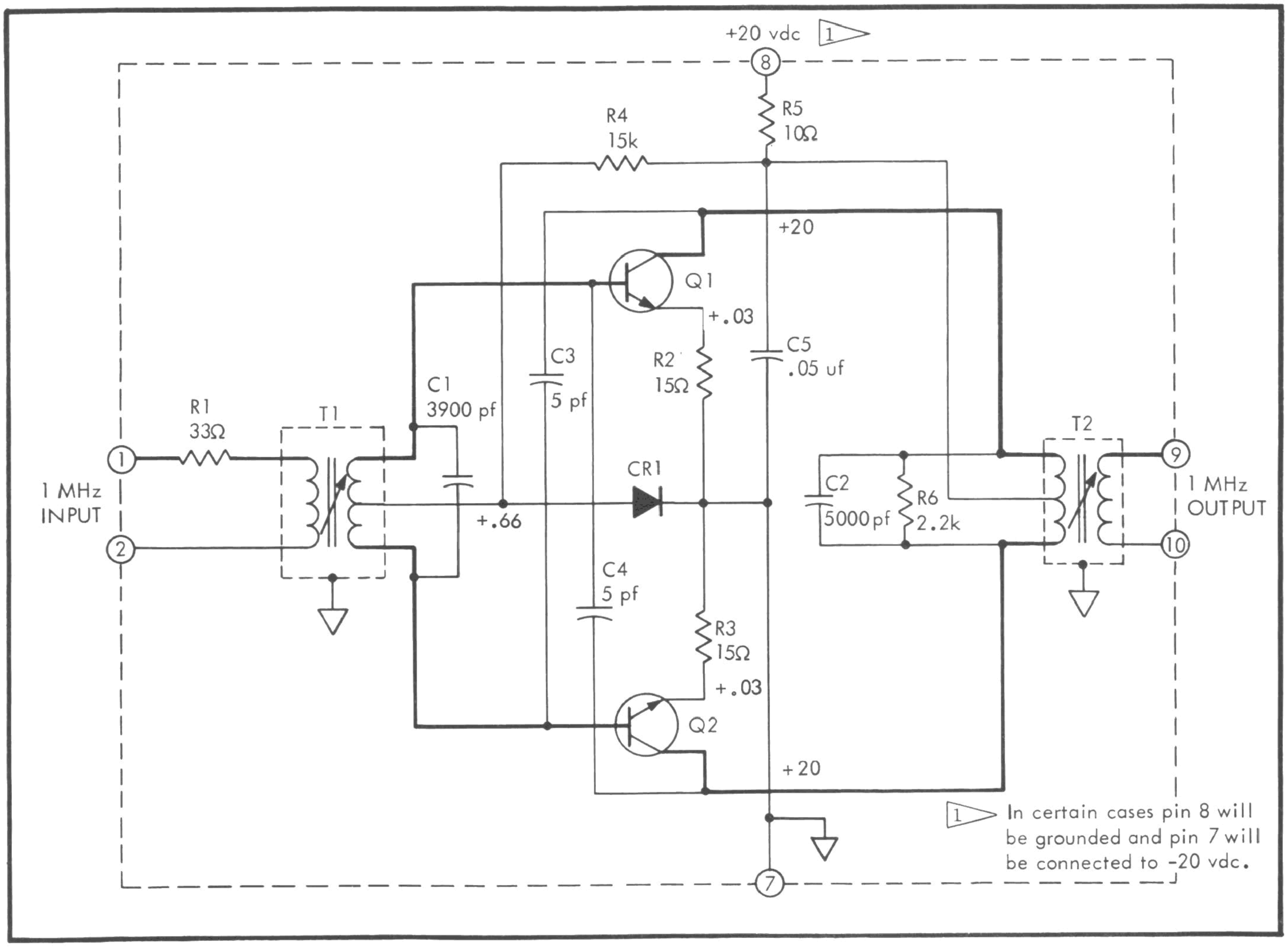


Figure 1. THE 1 MHz PREAMPLIFIER SCHEMATIC

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.

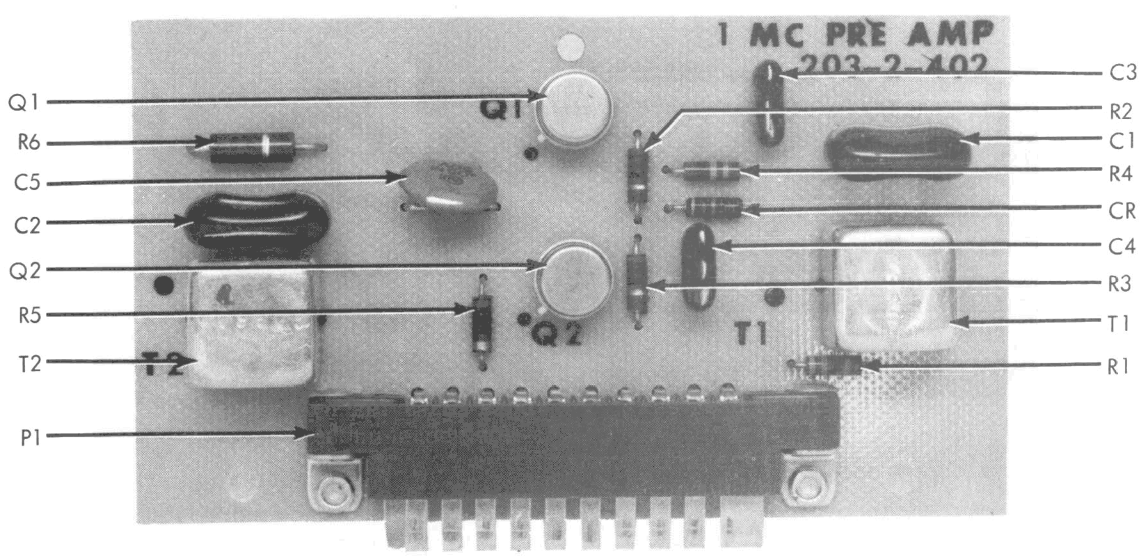


Figure 2. THE 1 MHz PREAMPLIFIER MODULE

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 ±5%, 500v	1504-160325	88419	CD19F392J	1		
C2	Cap, mica, 5,000 pf ±5%, 500v	1504-181065	88419	CD10F502J	1		
C3, C4	Cap, mica, 5 pf ±10%, 500v	1504-148577	88419	CD15C050K	2		
C5	Cap, cer, 0.05 uf ±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, 33Ω ±5%, 1/4w	4704-175034	01121	CB3305	1		
R2, R3	Res, comp, 15Ω ±5%, 1/4w	4704-147876	01121	CB1505	2		
R4	Res, comp, 15k ±5%, 1/4w	4704-148114	01121	CB1535	1		
R5	Res, comp, 10Ω ±5%, 1/4w	4704-147868	01121	CB1005	1		
R6	Res, comp, 2.2k ±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

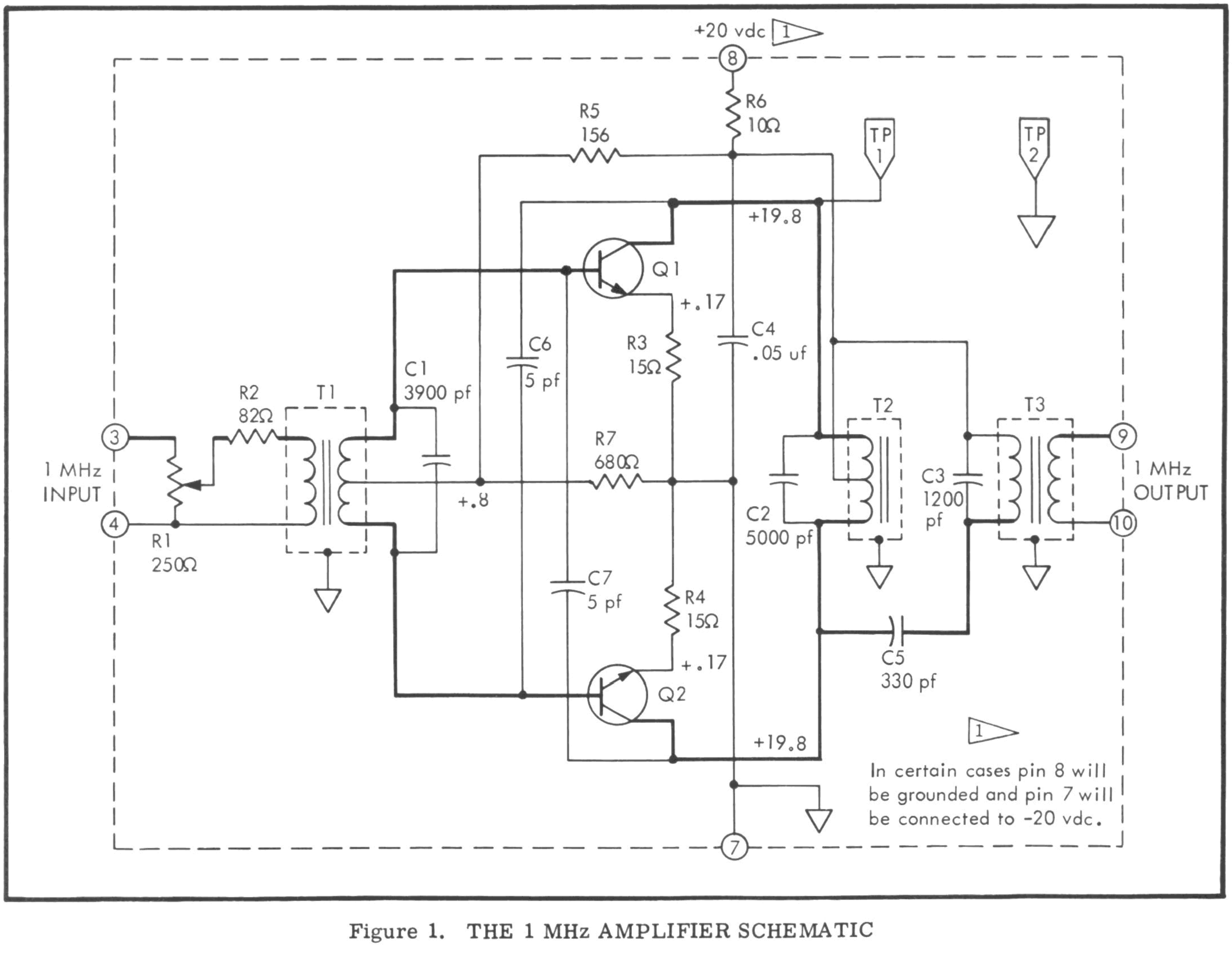


Figure 1. THE 1 MHz AMPLIFIER SCHEMATIC

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 than 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 crytically 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 connector. 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, which ever 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.

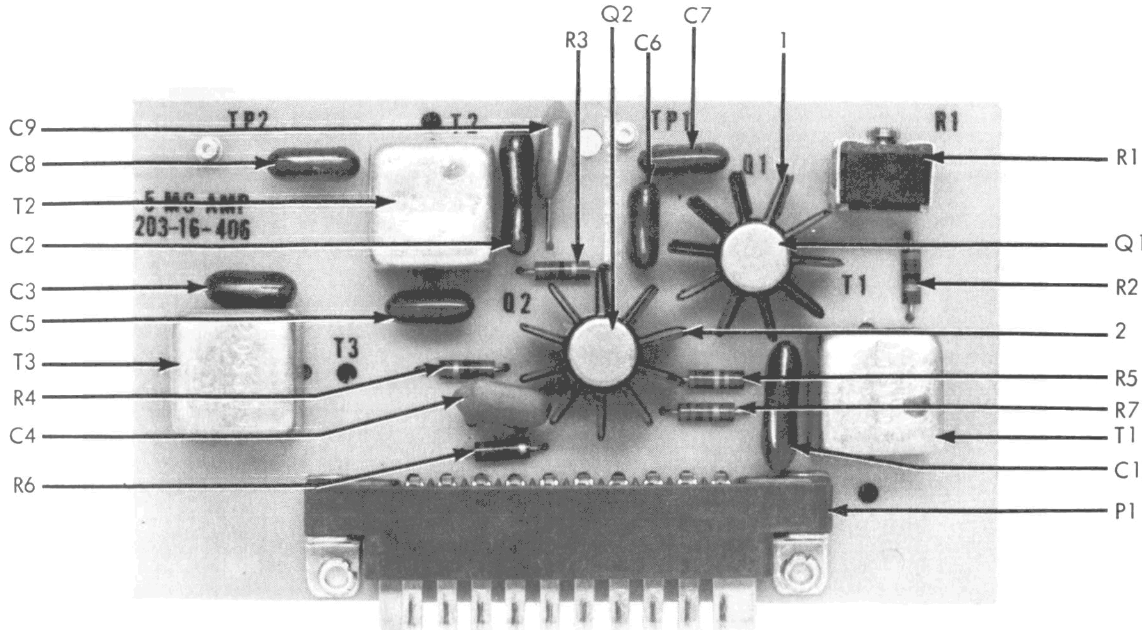


Figure 2. THE 5 MHz AMPLIFIER MODULE

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 ±5%, 500v	1504-147387	88419	CD19F102J	20		
C3	Cap, mica, 270 pf ±5%, 500v	1504-148452	88419	CD15F271J	10		
C4	Cap, cer, 0.05 uf ±20%, 100v	1501-149161	56289	55C23A7	20		
C5	Cap, mica, 82 pf ±5%, 500v	1504-148502	88419	CD15F820J	20		
C6, C7	Cap, mica, 5 pf ±10%, 500v	1504-148577	88419	CD15C050K	20		
C8	Cap, mica, 82 pf ±5%, 500v	1504-148502	88419	CD15F820J	REF		
C9	Cap, cer, 0.05 uf ±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, 250Ω ±20%, 1/8w	4701-194977	71450	2202251B	10		
R2	Res, comp, 82Ω ±5%, 1/4w	4704-149484	01121	CB8205	10		
R3, R4	Res, comp, 15Ω ±5%, 1/4w	4704-147876	01121	CB1505	20		
R5	Res, comp, 15k ±5%, 1/4w	4704-148114	01121	CB1535	10		
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, 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	17069	88000	20		

THE 5 MHz PREAMPLIFIER MODULE

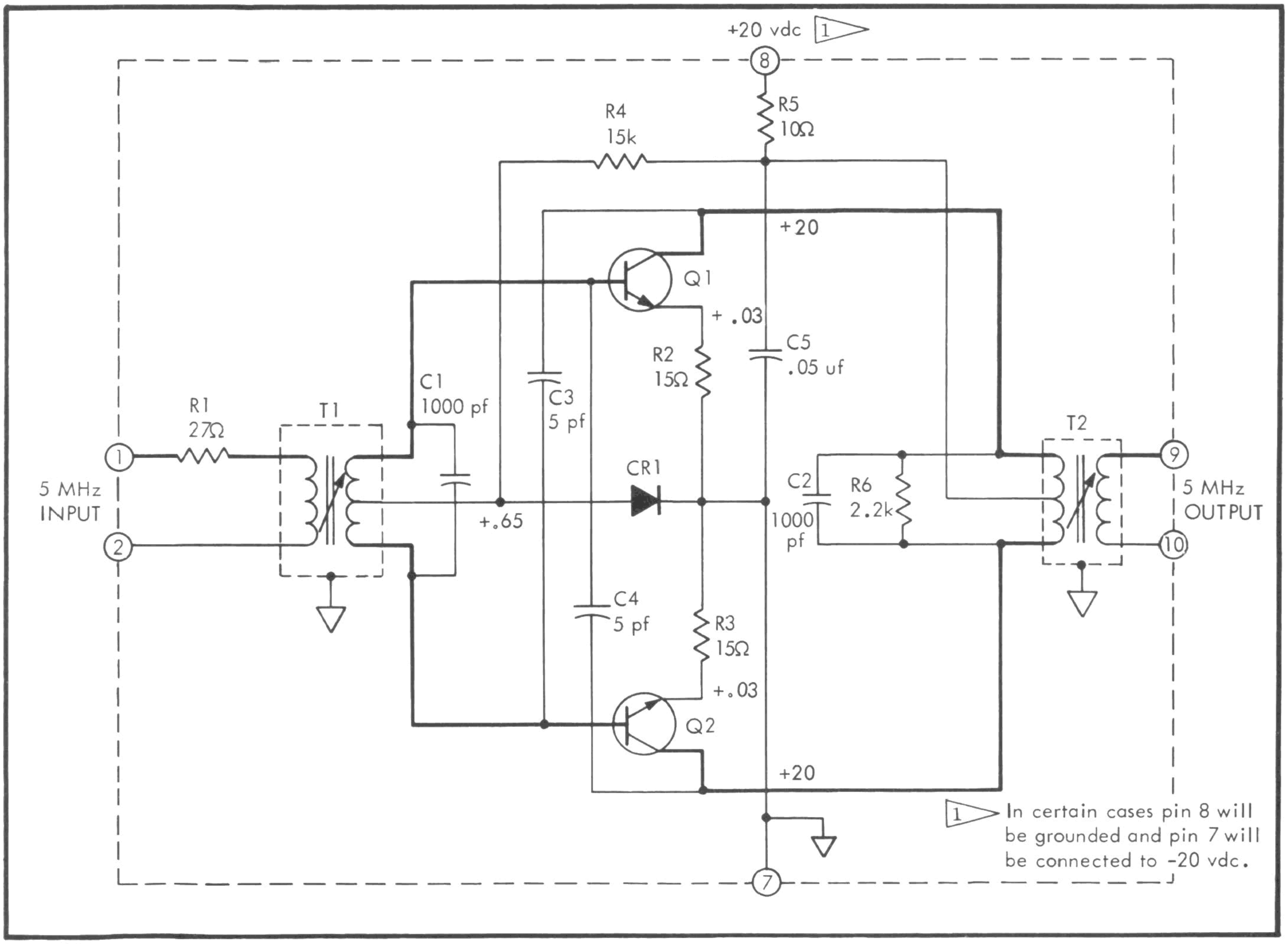


Figure 1. THE 5 MHz PREAMPLIFIER SCHEMATIC

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 than 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.

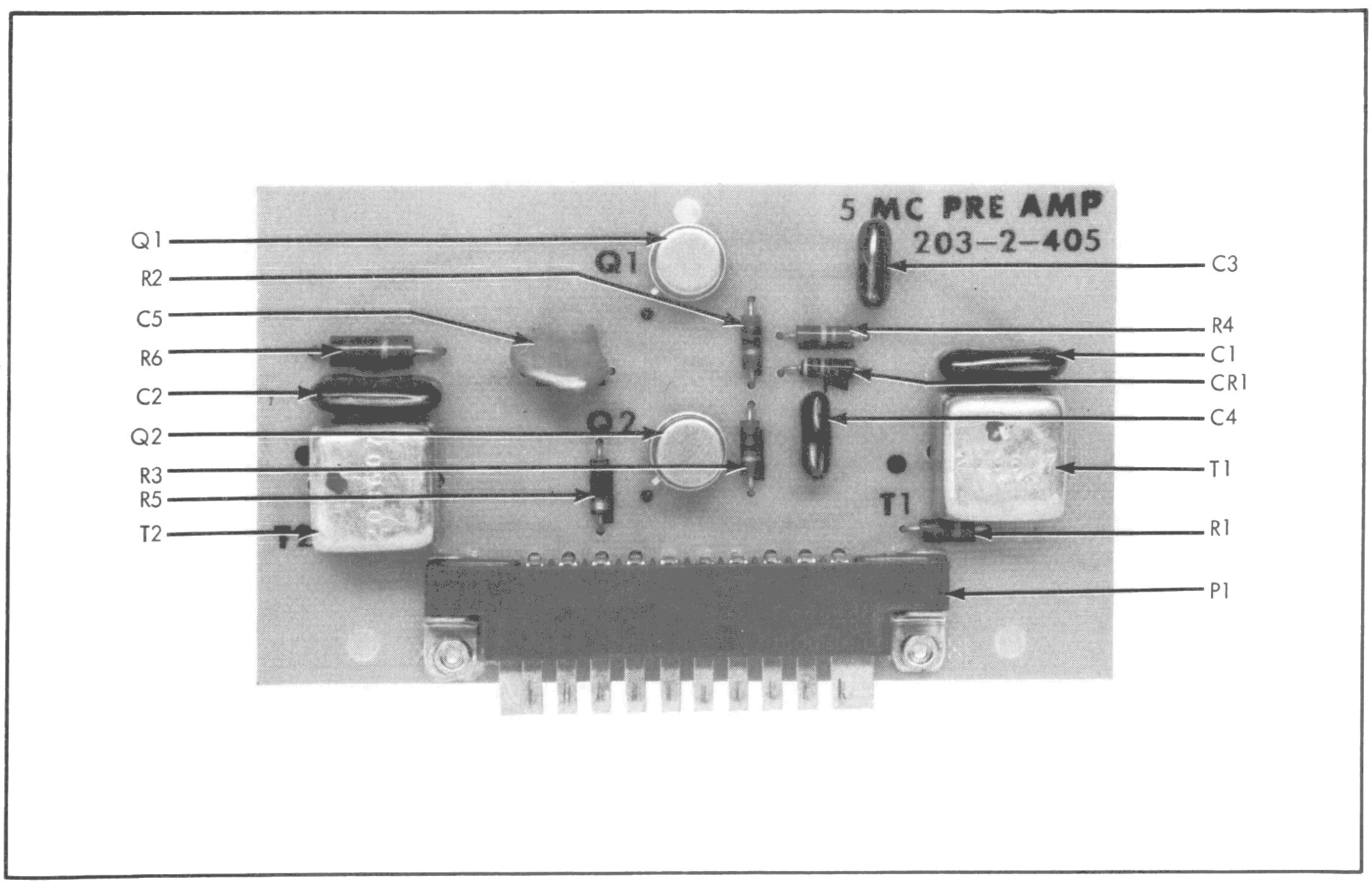


Figure 2. THE 5 MHz PREAMPLIFIER MODULE

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 ±5%, 500v	1504-148387	88419	CD19F102J	2		
C3, C4	Cap, mica, 5 pf ±10%, 500v	1504-148577	88419	CD15C050K	2		
C5	Cap, cer, 0.05 uf ±20%, 100v	1504-149161	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, 27Ω ±5%, 1/4w	4704-160812	01121	CB2705	1		
R2, R3	Res, comp, 15Ω ±5%, 1/4w	4704-147876	01121	CB1505	2		
R4	Res, comp, 15k ±5%, 1/4w	4704-148114	01121	CB1535	1		
R5	Res, comp, 10Ω ±5%, 1/4w	4704-147868	01121	CB1005	1		
R6	Res, comp, 2.2k ±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

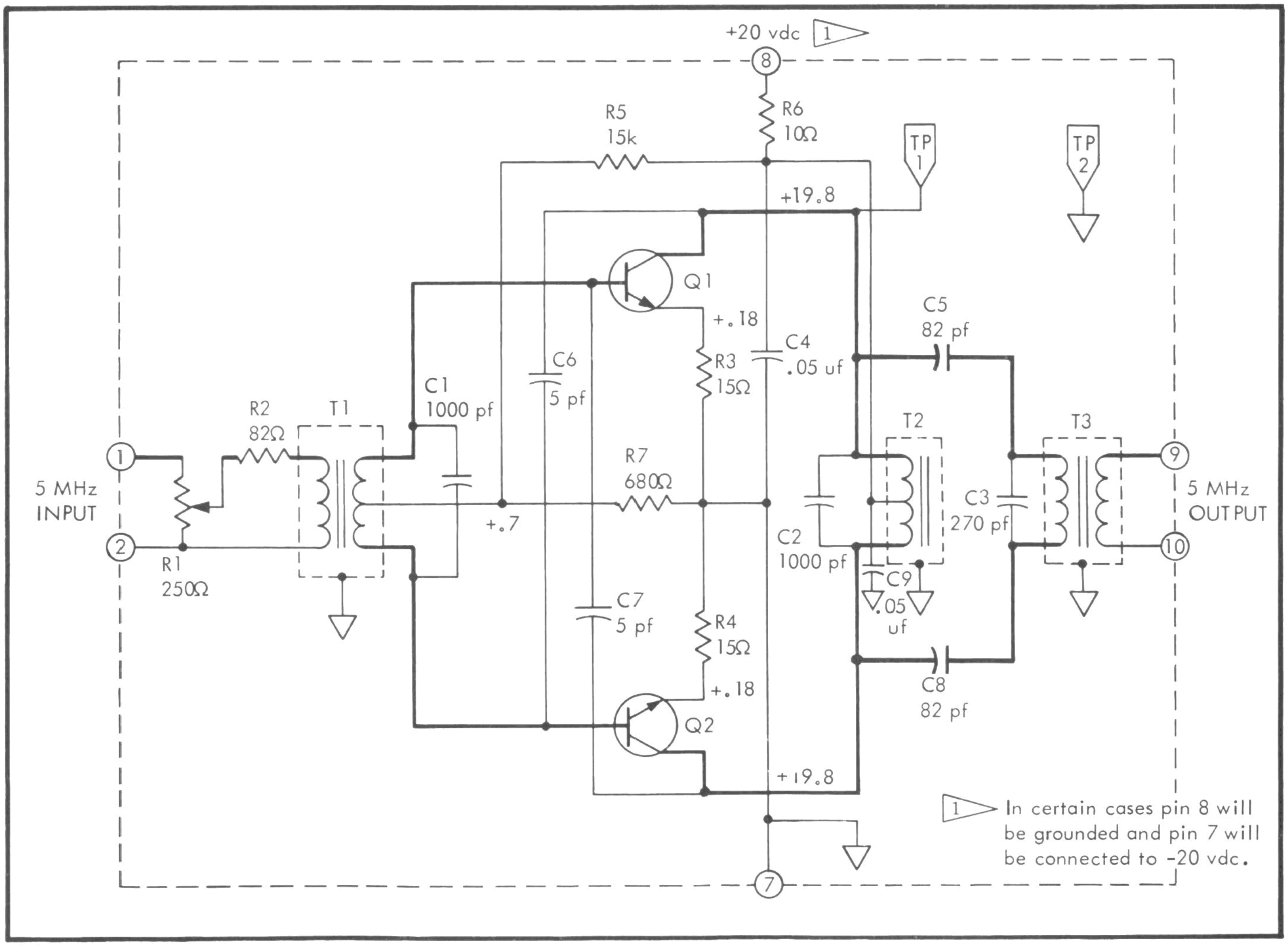


Figure 1. THE 5 MHz AMPLIFIER SCHEMATIC

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 crytically 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, which ever 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.

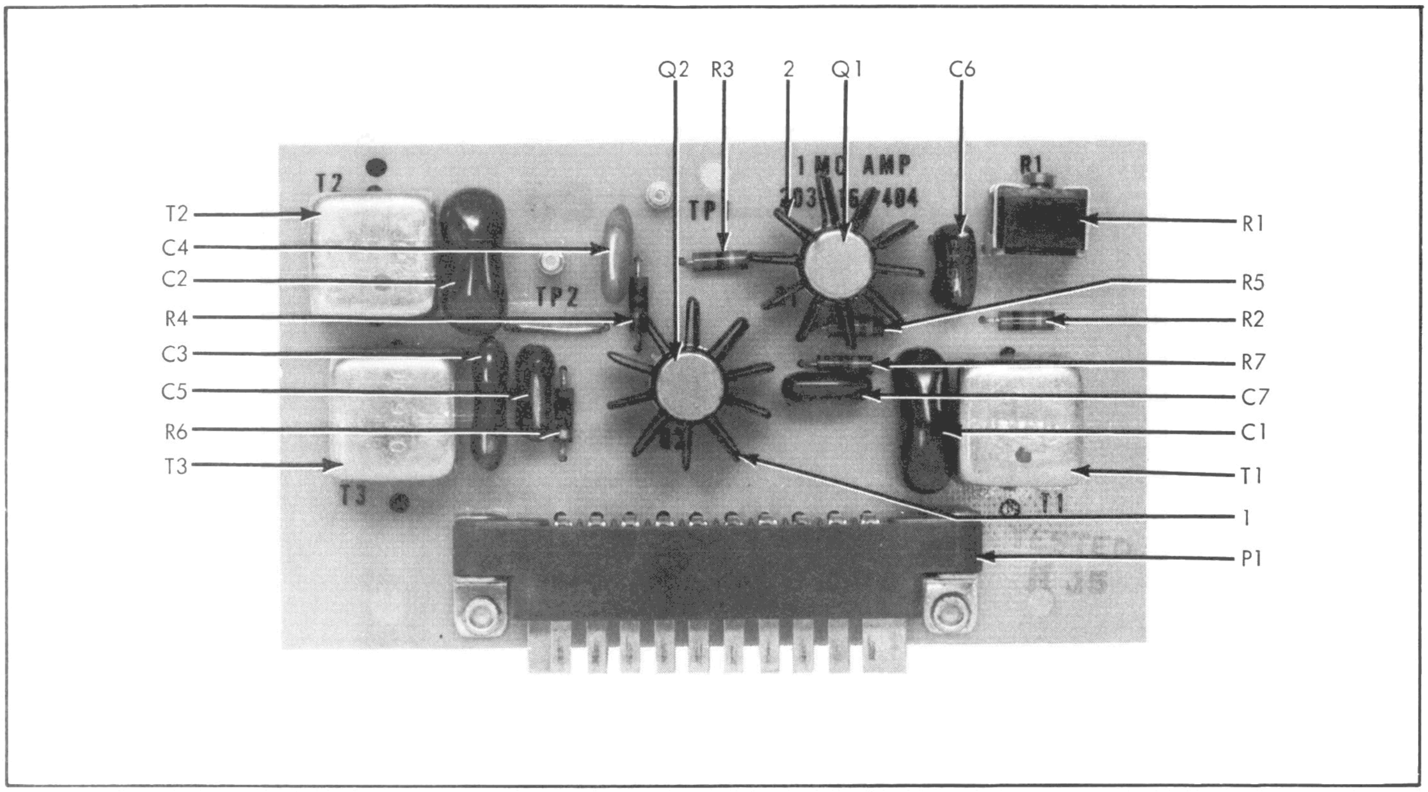


Figure 2. THE 1 MHz AMPLIFIER MODULE

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 ±5%, 500v	1504-160325	88419	CD19F392J	10		
C2	Cap, mica, 5,000 pf ±5%, 500v	1504-181065	88419	CD10F502J	10		
C3	Cap, mica, 1,200 pf ±5%, 500v	1504-148379	88419	CD19F122J	10		
C4	Cap, cer, 0.05 uf ±20%, 100v	1501-149161	56289	55C23A7	10		
C5	Cap, mica, 330 pf ±5%, 500v	1504-148445	88419	CD15F331J	10		
C6, C7	Cap, mica, 5 pf ±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, 250Ω ±20%, 1/8w	4701-194977	71450	2202251B	10		
R2	Res, comp, 82Ω ±5%, 1/4w	4704-149484	01121	CB8205	10		
R3, R4	Res, comp, 15Ω ±5%, 1/4w	4704-147876	01121	CB1505	20		
R5	Res, comp, 15k ±5%, 1/4w	4704-148114	01121	CB1535	10		
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, 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
Al	Aluminum
amp	ampere
assy	assembly
cap	capacitor
car flm	carbon film
C	centigrade
cer	ceramic
comp	composition
conn	connector
db	decibel
dc	direct current
dpdt	double-pole, double-throw
dpst	double-pole, single-throw
elect	electrolytic
F	fahrenheit
Ge	germanium
gmv	guaranteed minimum value
h	henry
Hz	hertz
hf	high frequency
IC	integrated circuit
if	intermediate frequency
k	kilohm
kHz	kilohertz
kv	kilovolt
lf	low frequency
MHz	megahertz
M	megohm
met flm	metal film
ua	microampere
uf	microfarad
uh	microhenry
usec	microsecond
uv	microvolt
ma	milliampere
mh	millihenry
m	millohms
msec	millisecond
mv	millivolt
mw	milliwatt
na	nanoampere
nsec	nanosecond
nv	nanovolt
Ω	ohm
ppm	parts per million
piv	peak inverse voltage
p-p	peak to peak
pf	picofarad
plstc	plastic
p	pole
pos	position
P/C	printed circuit
rf	radio frequency
rfi	radio frequency interference
res	resistor
rms	root mean square
rtry	rotary
sec	second
sect	section
S/N	serial number
Si	silicon
scr	silcon controlled rectifier
spdt	single-pole, double-throw
spst	single-pole, single-throw
sw	switch
Ta	tantalum
tstr	transistor
tvm	transistor voltmeter
uhf	ultr high frequency
vtvm	vacuum tube voltmeter
var	variable
vhf	very high frequency
vlf	very low frequency
v	volt
va	voltampere
vac	volts, alternating current
vdc	volts, direct current
w	watt
ww	wire wound

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.

Code	Manufacturer
00213	Sage Electronics Corp. Rochester, New York
00327	Welwyn International, Inc. Cleveland, Ohio
00656	Aerovox Corp. New Bedford, Massachusetts
01121	Allen-Bradley Company Milwaukee, Wisconsin
01281	Pacific Semiconductors Inc. Lawndale, California
01295	Texas Instruments, Inc. Semiconductor Components Div. Houston, Texas
01730	Circle Mfg. Co., Inc. Little Falls, New Jersey
01884	Dearborn Electronic Labs Inc. Orlando, Florida
01963	Cherry Electrical Products Corp. Highland Park, Illinois
02660	Amphenol-Borg Elect. Corp Chicago, Illinois
02606	Fenwal Laboratories Inc. Framington, Massachusetts
02799	Arco Capacitors, Inc. Los Angeles, California
03614	Bussmann Mfg. Div. of McGraw-Edison Co. Los Angeles, California
03615	Ohmite Mfg. Company Los Angeles, California
03877	Transitron Electronic Corp. Wakefield, Massachusetts
03911	Clairex Corp. New York, New York
03980	Muirhead Instruments, Inc. Mountainside, New Jersey
04009	Arrow Hart and Hegemen Electronic Company Hartford, Connecticut
04062	Elmenco Products Company New York, New York
04202	Winchester Electronics Co. New Milford, Connecticut
04221	Telex-Aemco Division of Telex Corp. Mankato, Minnesota
04645	Kurz-Kasch, Inc. Chicago, Illinois
04713	Motorola Inc. Semiconductor Products Div. Phoenix, Arizona
05082	Tung-Sol Electric Inc. Melrose Park, Illinois
05277	Westinghouse Electric Corp. Semiconductor Dept. Youngwood, Pennsylvania
05278	Penn-East Engrg. Corp. Kutztown, Pennsylvania
05397	Union Carbide Corp. Kemet Dept. Linde Div. Cleveland, Ohio
05617	Farwest Mfg. Div. Inc. Seattle, Washington
05704	Alac, Inc. Glendale, California
05820	Wakefield Engineering, Inc. Wakefield, Massachusetts
06001	General Electric Company Capacitor Department Irmo, South Carolina
06136	Ward Leonard Electric Co. Los Angeles, California
06473	Amphenol Space and Missile Sys Chatsworth, California
06555	Beede Electrical Inst. Co. Penacook, New Hampshire
06751	Nuclear Corporation of American, Inc. U.S. Semcor Div. Phoenix, Arizona
06860	Gould National Batteries Inc. La Puente, California
07115	Corning Glass Works Electronic Components Dept. Bradford, Pennsylvania
07263	Fairchild Semiconductor Div. of Fairchild Camera and Instrument Corp. Mountain View, California
07344	Bircher Co., Inc. Rochester, New York
07792	Lerma Engineering Corp. Northampton, Massachusetts
07910	Continental Device Corp. Hawthorne, California
08530	Reliance Mica Corp. Brooklyn, New York
08863	Nylomatic Corp. Morrisville, Pennsylvania
08988	Skottie Electronics Inc. Peckville, Pennsylvania
11237	Chicago Telephone of Calif Inc. South Pasadena, California
11503	Keystone Mfg. Co. Warren, Michigan
12040	National Semiconductor, Inc. Danburry, Connecticut
12060	Diodes, Inc. Chatsworth, California
12136	Philadelphia Handle Co. Camden, New Jersey
12400	International Resistance Co. Control Components Division Philadelphia, Pennsylvania
12617	Hamlin Inc. Lake Mills, Wisconsin
12697	Clarostat Mfg. Company Dover, New Hampshire
13606	Sprague Electric Company Transistor Division Concord, New Hampshire
13812	Dialco Electric Corp. Brooklyn, New York
13839	Sulzer Lab, Inc. Bethesda, Maryland
14099	Semtech Corp. Newbury Park, California
14193	California Resistor Corp. Santa Monica, California
14298	American Components Inc. Conshohocken, Pennsylvania
14752	Electro Cude Inc. South Pasadena, California
15818	Amelco Inc. Mountain View, California
15849	USECO Inc. Mt. Vernon, New York
15909	Daven Division Thomas A. Edison Ind. McGraw Edison Co. Livingston, New Jersey
16332	Milwaukee Relays Inc. Cedarburg, Wisconsin
16473	Cambridge Scientific Industries Inc. Cambridge, Maryland
17069	Circuit Structures Lab Santa Ana, California
17856	Siliconix Inc. Sunnyvale, California
18083	Clevite Corp. Transistor Division Palo Alto, California
19429	Montronics, Inc. Seattle, Washington
19701	Electra Mfg. Company Independence, Kansas
24655	General Radio Company West Concord, Massachusetts
28520	Heyman Mfg. Company Kenilworth, New Jersey
33173	General Electric Co. Tube Dept. Owensboro, Kentucky
37942	P. R. Mallory and Co., Inc. Indianapolis, Indiana
38315	Honeywell Inc. Precision Meter Division Manchester, New Hampshire
42498	National Company, Inc. Malden, Massachusetts
44655	Ohmite Mfg. Company Skokie, Illinois
49671	Radio Corp. of America New York, New York
53021	Sangamo Electric Co. Springfield, Illinois
55026	Simpson Electric Company Chicago, Illinois
56289	Sprague Electric Co. North Adams, Massachusetts
58474	Superior Electric Co. Bristol, Connecticut
60399	Torrington Mfg. Company Torrington, Connecticut
62460	USHCO Mfg. Co., Inc. Buffalo, New York
64834	West Mfg. Company San Francisco, California
65092	Weston Instruments Div. of Daystrom, Inc. Newark, New Jersey
66150	Winslow Tele-Tronics Inc. Asbury Park, New Jersey
70563	Amperite Company Union City, New Jersey
70903	Belden Mfg. Co. Chicago, Illinois
71400	Bussman Manufacturing Division of McGraw Edison Co. St. Louis, Missouri
71450	CTS Corp. Elkhart, Indiana
71468	Cannon Electric Company Los Angeles, California
71482	Clare, C. P. and Company Chicago, Illinois
71590	Centralab Div of Globe Union, Inc. Milwaukee, Wisconsin
71707	Coto Coil Co., Inc. Providence, Rhode Island
71744	Chicago Miniature Lamp Works Chicago, Illinois
71785	Cinch Mfg. Co. and Howard B. Jones Div. Chicago, Illinois
72005	Driver, Wiber B., Co. Newark, New Jersey
72092	Eitel-McCullough, Inc. San Bruno, California
72136	Electro Motive Mfg. Co. Willimantic, Connecticut
72259	Nytronics, Inc. Berkley Heights, New Jersey
72354	Fast, John E. Company Div. of Victoreen Instr. Co. Chicago, Illinois
72559	Essex Electronics Inc. Berkeley Heights, New Jersey
72619	Dialight Corp. Brooklyn, New York
72653	General Cement Div. of Titronics Inc. Packard, Illinois
72665	Mallory Battery Company Cleveland, Ohio
72982	Erie Tech. Products Inc. Erie, Pennsylvania
73138	Beckman Instruments Inc. Helipot Division Fullerton, California
73293	Hughes Products Div. of Hughes Aircraft Company Newport Beach, California
73445	Amperex Electronic Co. Div. of North American Philips Co., Inc. Hicksville, New York
73559	Carling Electric Inc. Hartford, Connecticut
73586	Circle F Mfg. Co. Trenton, New Jersey
73899	JFD Electronics Corp. Brooklyn, New York
73949	Guardian Electric Mfg. Co. Chicago, Illinois
74217	Radio Switch Corp. Marlboro, New Jersey
74276	Signalite, Inc. Neptune, New Jersey
74306	Piezo Crystal Company Carlisle, Pennsylvania
74542	Hoyt Elect. Instr. Works Penacook, New Hampshire
74970	Johnson, E. F., Company Waseca, Minnesota
75042	International Resistance Co. Philadelphia, Pennsylvania
75915	Littelfuse Inc. Des Plaines, Illinois
76854	Oak Mfg. Company Crystal Lake, Illinois
77342	American Machine and Foundry Company Potter & Brumfield Div. Princeton, Indiana
77969	Rubbercraft Corp. of California Ltd. Torrance, California
78277	Sigma Instruments, Inc. South Braintree, Mass.
79136	Waldes Kohinoor Inc. Long Island City, New York
79497	Western Rubber Company Goshen, Indiana
80031	Mepco Division of Sessions Clock Co. Morristown, New Jersey
80294	Bourns Laboratories, Inc. Riverside, California
80583	Hammarlund Company, Inc. New York, New York
80640	Stevens, Arnold Co., Inc. Boston, Massachusetts
81073	Grayhill Company La Grange, Illinois

81439 Therm-O-Disc. Inc.
Mansfield, Ohio

81483 International Rectifier Corp.
El Segundo, California

81590 Korry Mfg. Company
Seattle, Washington

82376 Astrom Division
Renwell Industries Inc.
East Newark, New Jersey

82389 Switchcraft Inc.
Chicago, Illinois

82415 Price Electric, Corp.
Frederick, Maryland

82872 Roanwell Corp.
Brooklyn, New York

82877 Rotron Mfg. Co., Inc.
Woodstock, New York

82879 Royal Electric Corp.
Pawtucket, Rhode Island

83003 Varo Mfg. Co., Inc.
Garland, Texas

83298 Bendix Corp.
Red Bank Division
Red Bank, Eatontown,
New Jersey

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

83478 Rubbercraft Corp of
America
New Haven, Connecticut

84171 Arco Electronics, Inc.
Great Neck, New York

84411 Good All Electric Mfg. Co.
(TRW)
Ogallala, Nebraska

86689 R. M. B. Corp.
Los Angeles, California

88419 Cornell-Dubilier Elec. Corp.
Electro-Mechanical Division
Fuquay Springs,
North Carolina

88690 Essex Wire Corp.
R. B. M. Division
Detroit, Mechigan

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

89730 General Electric Company
Newark Lamp Works of
Lamp Division of Consumer
Products Group
GECO
Newark, New Jersey

90205 Best Stamp and Mfg. Co.
Kansas City, Missouri

90211 Square D. Company
Chicago, Illinois

90303 Mallory Battery Company
North Tarrytown, New York

91293 Johanson Mfg. Company
Boonton, New Jersey

91662 Elco Corp.
Willow Grove, Penn.

91737 Gremar Mfg. Co., Inc.
Wakefield, Massachusetts

91802 Industrial Devices, Inc.
Edgewater, New Jersey

91929 Minneapolis Honeywell
Regulator Company
Micro Switch Division
Freeport, Illinois

91934 Miller Electric Co., Inc.
Pawtucket, Rhode Island

93332 Sylvania Electric Products Inc.
Semiconductor Products Division
Woburn, Massachusetts

94145 Raytheon Company
Semiconductor Division
California Street Plant
Newton, Massachusetts

95146 Alco Electronics Mfg. Co.
Lawrence, Massachusetts

95264 Lerco Electronics Inc.
Burbank, California

95303 Radio Corp. of America
Comm. Receiving Tube &
Semiconductor Division
Cincinnati, Ohio

95354 Methode Mfg. Co.
Chicago, Illinois

95712 Dage Electric Co., Inc.
Franklin, Indiana

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

96881 Thomson Industries, Inc.
New Hyde Park
Long Island, New York

97945 S. S. White Dental Mfg. Co.
Plastics Division
New York, New York

97966 CBS Electronics Div. of
Columbia Broadcasting
Systems Inc.
Danvers, Massachusetts

98094 Penta Laboratories, Inc.
Santa Barbara, California

98388 Accurate Sales Company
Culver City, California

98743 James Vibrapower Corp.
Chicago, Illinois

98925 Clevite Corp.
Semiconductor Division
Waltham, Massachusetts

99120 Plastic Capacitors, Inc.
Chicago, Illinois

99217 Southern Electronics Corp.
Burbank, California

99515 Marshall Industries
Electron Prod. Div.
Pasadena, California

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

Federal Supply Codes for Manufacturers (Continued)

00213
Nytronics Comp. Group Inc.
Subsidiary of Nytronics Inc.
Formerly Sage Electronics
Rochester, New York

00327
Welwyn International, Inc.
Westlake, Ohio

00656
Aerovox Corp.
New Bedford, Massachusetts

00686
Film Capacitors, Inc.
Passaic, New Jersey

00779
AMP Inc.
Harrisberg, Pennsylvania

01121
Allen-Bradley Co.
Milwaukee, Wisconsin

01281
TRW Electronic Comp.
Semiconductor Operations
Lawndale, California

01295
Texas Instruments, Inc.
Semiconductor Group
Dallas, Texas

01537
Motorola Communications &
Electronics Inc.
Franklin Park, Illinois

01686
RCL Electronics Inc.
Manchester, New Hampshire

01730
Replaced by 73586

01884 - use 56289
Sprague Electric Co.
Dearborn Electronic Div.
Lockwood, Florida

02114
Ferroxcube Corp.
Saugerties, New York

02131
General Instrument Corp.
Harris ASW Div.
Westwood, Maine

02395
Rason Mfg. Co.
Brooklyn, New York

02533
Snelgrove, C.R. Co., Ltd.
Don Mills, Ontario, Canada
M3B 1M2

02606
Fenwal Labs
Div. of Travenal Labs.
Morton Grove, Illinois

02660
Bunker Ramo Corp., Conn Div.
Formerly Amphenol-Borg
Electric Corp.
Broadview, Illinois

02799
Areo Capacitors, Inc.
Chatsworth, California

03508
General Electric Co.
Semiconductor Products
Syracuse, New York

03614
Replaced by 71400

03651
Replaced by 44655

03797
Eldema Div.
Genisco Technology Corp.
Compton, California

03877
Transistron Electronic Corp.
Wakefield, Massachusetts

03888
KDI Pyrofilm Corp.
Whippany, New Jersey

03911
Clairex Electronics Div.
Clairex Corp.
Mt. Vernon, New York

03980
Muirhead Inc.
Mountainside, New Jersey

04009
Arrow Hart Inc.
Hartford, Connecticut

04062
Replaced by 72136

04202
Replaced by 81312

04217
Essex International Inc.
Wire & Cable Div.
Anaheim, California

04221
Aemco, Div. of
Midtex Inc.
Mankato, Minnesota

04222
AVX Ceramics Div.
AVX Corp.
Myrtle Beach, Florida

04423
Telonic Industries
Laguna Beach, California

04645
Replaced by 75376

04713
Motorola Inc. Semiconductor
Products
Phoenix, Arizona

04946
Standard Wire & Cable
Los Angeles, California

05082
Replaced by 94988

05236
Jonathan Mfg. Co.
Fullerton, California

05245
Components Corp. now
Corcom, Inc.
Chicago, Illinois

05277
Westinghouse Electric Corp.
Semiconductor Div.
Youngwood, Pennsylvania

05278
Replaced by 43543

05279
Southwest Machine &
Plastic Co.
Glendora, California

05397
Union Carbide Corp.
Materials Systems Div.
New York, New York

05571 - use 56289
Sprague Electric Co.
Pacific Div.
Los Angeles, California

05574
Viking Industries
Chatsworth, California

05704
Replaced by 16258

05820
Wakefield Engineering Inc.
Wakefield, Massachusetts

06001
General Electric Co.
Electronic Capacitor &
Battery Products Dept.
Columbia, South Carolina

06136
Replaced by 63743

06383
Panduit Corp.
Tinley Park, Illinois

06473
Bunker Ramo Corp.
Amphenol SAMS Div.
Chatsworth, California

06555
Beede Electrical Instrument Co.
Penacook, New Hampshire

06739
Electron Corp.
Littleton, Colorado

06743
Clevite Corp.
Cleveland, Ohio

06751
Components, Inc. Semcor Div.
Phoenix, Arizona

06860
Gould Automotive Div.
City of Industry, California

06961
Vernitron Corp., Piezo
Electric Div.
Formerly Clevite Corp., Piezo
Electric Div.
Bedford, Ohio

06980
Eimac Div.
Varian Associates
San Carlos, California

07047
Ross Milton, Co., The
South Hampton, Pennsylvania

07115
Replaced by 14674

07138
Westinghouse Electric Corp.,
Electronic Tube Division
Horsehead, New York

07233
TRW Electronic Components
Cinch Graphic
City of Industry, California

07256
Silicon Transistor Corp.
Div. of BBF Group Inc.
Chelmsford, MA

07261
Aumet Corp.
Culver City, California

07263
Fairchild Semiconductor
Div. of Fairchild Camera
& Instrument Corp.
Mountain View, California

07344
Bircher Co., Inc.
Rochester, New York

07597
Burndy Corp.
Tape/Cable Div.
Rochester, New York

07792
Lerma Engineering Corp.
Northampton, Massachusetts

07910
Teledyne Semiconductor
Formerly Continental Device
Hawthorne, California

07933 - use 49956
Raytheon Co.
Semiconductor Div. HQ
Mountain View, California

08225
Industro Transistor Corp.
Long Island City, New York

08261
Spectra Strip Corp.
Garden Grove, California

08530
Reliance Mica Corp.
Brooklyn, New York

08806
General Electric Co.
Miniature Lamp Products Dept.
Cleveland, Ohio

08863
Nylomatic Corp.
Norrisville, Pennsylvania

08988 - use 53085
Skottie Electronics Inc.
Archbald, Pennsylvania

09214
G.E. Co. Semi-Conductor
Products Dept.
Power Semi-Conductor
Products OPN Sec.
Auburn, New York

09353
C and K Components
Watertown, Massachusetts

09423
Scientific Components, Inc.
Santa Barbara, California

09922
Burndy Corp.
Norwalk, Connecticut

09969
Dale Electronics Inc.
Yankton, S. Dakota

10059
Barker Engineering Corp.
Formerly Amerace, Amerace
ESNA Corp.
Kenilworth, New Jersey

11236
CTS of Berne
Berne, Indiana

11237
CTS Keene Inc.
Paso Robles, California

11358
CBS Electronic Div.
Columbia Broadcasting System
Newburyport, MN

11403
Best Products Co.
Chicago, Illinois

11503
Keystone Columbia Inc.
Warren, Michigan

11532
Teledyne Relays
Hawthorne, California

Federal Supply Codes for Manufacturers (Continued)

11711
General Instrument Corp
Rectifier Division
Hickville, New York

11726
Qualidyne Corp.
Santa Clara, California

12014
Chicago Rivet & Machine Co.
Bellwood, Illinois

12040
National Semiconductor Corp.
Danburry, Connecticut

12060
Diodes, Inc.
Chatsworth, California

12136
Philadelphia Handle Co.
Camden, New Jersey

12300
Potter-Brumfield Division
AMF Canada LTD.
Guelph, Onatrio, Canada

12323
Presin Co., Inc.
Shelton, Connecticut

12327
Freeway Corp. formerly
Freeway Washer & Stamping Co.
Cleveland, Ohio

12443
Budd Co. The, Polychem Products
Plastic Products Div.
Bridgeport, PA

12615
U.S. Terminals Inc.
Cincinnati, Ohio

12617
Hamlin Inc.
Lake Mills, Wisconsin

12697
Clarostat Mfg. Co.
Dover, New Hampshire

12749
James Electronics
Chicago, Illinois

12856
Micrometals
Sierra Madre, California

12954
Dickson Electronics Corp.
Scottsdale, Arizona

12969
Unitrode Corp.
Watertown, Massachusetts

13103
Thermalloy Co., Inc.
Dallas, Texas

13327
Solitron Devices Inc.
Tappan, New York

13511
Amphenol Cadre Div.
Bunker-Ramo Corp.
Los Gatos, California

13606 - use 56289
Sprague Electric Co.
Transistor Div.
Concord, New Hampshire

13839
Replaced by 23732

14099
Semtech Corp.
Newbury Park, California

14140
Edison Electronic Div.
Mc Gray-Edison Co.
Manchester, New Hampshire

14193
Cal-R-Inc. formerly
California Resistor, Corp.
Santa Monica, California

14298
American Components, Inc.
an Insilco Co.
Conshohocken, Pennsylvania

14655
Cornell-Dublier Electronics
Division of Federal Pacific
Electric Co. Govt. Control Dept.
Newark, New Jersey

14752
Electro Cube Inc.
San Gabriel, California

14869
Replaced by 96853

14936
General Instrument Corp.
Semi Conductor Products Group
Hicksville, New York

15636
Elec-Trol Inc.
Saugus, California

15801
Fenwal Electronics Inc.
Div. of Kidde Walter and Co., Inc.
Framingham, Massachusetts

15818
Teledyne Semiconductors, formerly
Amelco Semiconductor
Mountain View, California

15849
Litton Systems Inc. Useco Div.
formerly Useco Inc.
Van Nuys, California

15898
International Business
Machines Corp.
Essex Junction, Vermont

15909
Replaced by 14140

16258
Space-Lok Inc.
Burbank, California

16299
Corning Glass
Electronic Components Div.
Raleigh, North Carolina

16332
Replaced by 28478

16473
Cambridge Scientific Ind.
Div. of Chemed Corporation
Cambridge, Maryland

16742
Paramount Plastics Fabricators, Inc.
Downey, California

16758
Delco Electronics
Div. of General Motors Corp.
Kokomo, Indiana

17001
Replaced by 71468

17069
Circuit Structures Lab.
Burbank, California

17338
High Pressure Eng. Co., Inc.
Oklahoma City, Oklahoma

17545
Atlantic Semiconductors, Inc.
Asbury Park, New Jersey

17856
Siliconix, Inc.
Santa Clara, California

17870
Replaced by 14140

18178
Vactec Inc.
Maryland Heights, Missouri

18324
Signetics Corp.
Sunnyvale, California

18612
Vishay Resistor Products Div.
Vishay Intertechnology Inc.
Malvern, Pennsylvania

18736
Voltronics Corp.
Hanover, New Jersey

18927
G T E Sylvania Inc.
Precision Material Group
Parts Division
Titusville, Pennsylvania

19451
Perine Machinery & Supply Co.
Seattle, Washington

19701
Electro-Midland Corp.
Mepco-Electra Inc.
Mineral Wells, Texas

20584
Enochs Mfg. Inc.
Indianapolis, Indiana

20891
Self-Organizing Systems, Inc.
Dallas, Texas

21604
Buckeye Stamping Co.
Columbus, Ohio

21845
Solitron Devices Inc.
Transistor Division
Riveria Beach, Florida

22767
ITT Semiconductors
Palo Alto, California

23050
Product Comp. Corp.
Mount Vernon, New York

23732
Tracor Inc.
Rockville, Maryland

23880
Stanford Applied Engrng.
Santa Clara, California

23936
Pamotor Div., Wm. J. Purdy Co.
Burlingame, California

24248
Replaced by 94222

24355
Analog Devices Inc.
Norwood, Massachusetts

24655
General Radio
Concord, Massachusetts

24759
Lenox-Fugle Electronics Inc.
South Plainfield, New Jersey

25088
Siemen Corp.
Isilen, New Jersey

25403
Amperex Electronic Corp.
Semiconductor &
Micro-Circuits Div.
Slatersville, Rhode Island

27014
National Semiconductor Corp.
Santa Clara, California

27264
Molex Products
Downers Grove, Illinois

28213
Minnesota Mining & Mfg. Co.
Consumer Products Div.
St. Paul, Minnesota

28425
Serv-/-Link formerly
Bohannan Industries
Fort Worth, Texas

28478
Deltrol Controls Div.
Deltrol Corporation
Milwaukee, Wisconsin

28480
Hewlett Packard Co. Corporate H.Q.
Palo Alto, California

28520
Heyman Mfg. Co.
Kenilworth, New Jersey

29083
Monsanto, Co., Inc.
Santa Clara, California

29604
Stackpole Components Co.
Raleigh, North Carolina

30148
A B Enterprise Inc.
Ahoskie, North Carolina

30323
Illinois Tool Works, Inc.
Chicago, Illinois

31091
Optimax Inc.
Colmar, Pennsylvania

32539
Mura Corp.
Great Neck, New York

32767
Griffith Plastic Corp.
Burlingame, California

32879
Advanced Mechanical Components
Northridge, California

32897
Erie Technological Products, Inc.
Frequency Control Div.
Carlisle, Pennsylvania

32997
Bourns Inc.
Trimpot Products Division
Riverside, California

33173
General Electric Co.
Products Dept.
Owensboro, Kentucky

34333
Silicon General
Westminister, California

34335
Advanced Micro Devices
Sunnyvale, California

34802
Electromotive Inc.
Kenilworth, New Jersey

37942
Mallory, P.R. & Co., Inc.
Indianapolis, Indiana

42498
National Radio
Melrose, Massachusetts

43543
Nytronics Inc.
Transformer Co. Div.
Geneva, New York

44655
Ohmite Mfg. Co.
Skokie, Illinois

49671
RCA Corp.
New York, New York

49956
Raytheon Company
Lexington, Massachusetts

50088
Mostek Corp.
Carrollton, Texas

50579
Litronix Inc.
Cupertino, California

51605
Scientific Components Inc.
Linden, New Jersey

53021
Sangamo Electric Co.
Springfield, Illinois

54294
Cutler-Hammer Inc. formerly
Shallcross, A Cutter-Hammer Co.
Selma, North Carolina

55026
Simpson Electric Co.
Div. of Am. Gage and Mach. Co.
Elgin, Illinois

56289
Sprague Electric Co.
North Adams, Massachusetts

58474
Superior Electric Co.
Bristol, Connecticut

60399
Torin Corp, formerly
Torrington Mfg. Co.
Torrington, Connecticut

63743
Ward Leonard Electric Co., Inc.
Mount Vernon, New York

64834
West Mfg. Co.
San Francisco, Californai

65092
Weston Instruments Inc.
Newark, New Jersey

66150
Winslow Tele-Tronics Inc.
Eaton Town, New Jersey

70485
Atlantic India Rubber Works
Chicago, Illinois

70563
Amperite Company
Union City, New Jersey

70903
Belden Corp.
Geneva, Illinois

71002
Birnbach Radio Co., Inc.
Freeport, LI New York

71400
Bussmann Mfg.
Div. of McGraw-Edison Co.
Saint Louis, Missouri

71450
CTS Corp.
Elkhart, Indiana

71468
ITT Cannon Electric Inc.
Santa Ana, California

71482
Clare, C.P. & Co.
Chicago, Illinois

71590
Centrelab Electronics
Div. of Globe Union Inc.
Milwaukee, Wisconsin

71707
Coto Coil Co., Inc.
Providence, Rhode Island

71744
Chicago Miniature Lamp Works
Chicago, Illinois

71785
TRW Electronics Components
Cinch Connector Operations Div.
Elk Grove Village, Chicago, Illinois

72005
Driver, Wilber B., Co.
Newark, New Jersey

72092
Replaced by 06980

72136
Electro Motive Mfg. Co.
Williamantic, Connecticut

72259
Nytronics Inc.
Pelham Manor, New Jersey

72619
Dialight Div.
Amperex Electronic Corp.
Brooklyn, New York

72653
G.C. Electronics
Div. of Hydrometals, Inc.
Brooklyn, New York

72665
Replaced by 90303

72794
Dzus Fastener Co., Inc.
West Islip, New York

72928
Gulton Ind. Inc.
Gudeman Div.
Chicago, Illinois

72982
Erie Tech. Products Inc.
Erie, Pennsylvania

73138
Beckman Instruments Inc.
Helipot Division
Fullerton, California

73293
Hughes Aircraft Co.
Electron Dynamics Div.
Torrence, California

73445
Amperex Electronic Corp.
Hicksville, LI, New York

73559
Carling Electric Inc.
West Hartford, Connecticut

73586
Circle F Industries
Trenton, New Jersey

73734
Federal Screw Products, Inc.
Chicago, Illinois

73743
Fischer Special Mfg. Co.
Cincinnati, Ohio

73899
JFD Electronics Co.
Components Corp
Brooklyn, New York

73949
Guardian Electric Mfg. Co.
Chicago, Illinois

74199
Quan Nichols Co.
Chicago, Illinois

74217
Radio Switch Corp.
Marlboro, New Jersey

74276
Signalite Div.
General Instrument Corp.
Neptune, New Jersey

74306
Piezo Crystal Co.
Carlisle, Pennsylvania

74542
Hoyt Elect. Instr. Works
Penacook, New Hampshire

74970
Johnson E.F., Co.
Waseca, Minnesota

75042
TRW Electronics Components
IRC Fixed Resistors
Philadelphia, Pennsylvania

75376
Kurz-Kasch Inc.
Dayton, Ohio

75378
CTS Knights Inc.
Sandwich, Illinois

75382
Kulka Electric Corp.
Mount Vernon, New York

75915
Littlefuse Inc.
Des Plaines, Illinois

76854
Oak Industries Inc.
Switch Div.
Crystal Lake, Illinois

77342
AMF Inc.
Potter & Brumfield Div.
Princeton, Indiana

77638
General Instrument Corp.
Rectifier Division
Brooklyn, New York

77969
Rubbercraft Corp. of CA. LTD.
Torrance, California

78189
Shakeproof
Div. of Illinois Tool Works Inc.
Elgin, Illinois

78277
Sigma Instruments, Inc.
South Braintree, Massachusetts

78488
Stackpole Carbon Co.
Saint Marys, Pennsylvania

78553
Eaton Corp. Engineered
Fastener Div.
Tinnerman Plant
Cleveland, Ohio

79136
Waldes Kohinoor Inc.
Long Island City, New York

79497
Western Rubber Company
Goshen, Indiana

79963
Zierick Mfg. Corp.
Mt. Kisko, New York

80031
Electro-Midland Corp., Mepco Div.
A North American Phillips Co.
Morristown, New Jersey

80145
LFE Corp., Process Control Div.
formerly API Instrument Co.
Chesterland, Ohio

80183 - use 56289
Sprague Products
North Adams, Massachusetts

80294
Bourns Inc., Instrument Div.
Riverside, California

80583
Hammarlund Mfg. Co., Inc.
Red Bank, New Jersey

80640
Stevens, Arnold Inc.
South Boston, Massachusetts

81073
Grayhill, Inc.
La Grange, Illinois

81312
Winchester Electronics
Div. of Litton Industries Inc.
Oakville, Connecticut

81439
Therm-O-Disc Inc.
Mansfield, Ohio

81483
International Rectifier Corp.
Los Angeles, California

81590
Korry Mfg. Co.
Seattle, Washington

81741
Chicago Lock Co.
Chicago, Illinois

82305
Palmer Electronics Corp.
South Gate, California

82389
Switchcraft Inc.
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

84613
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.
Anahiem, 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
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Industrial Electronic Hdware Corp.
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97945
Penwalt Corp.
SS White Industrial Products Div.
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97966
Replaced by 11358

98094
Replaced by 49956

98159
Rubber-Teck, Inc.
Gardena, California

98278
Malco A Microdot Co., Inc.
Connector & Cable Div.
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98291
Sealectro Corp.
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98388
Royal Industries
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98743
Replaced by 12749

98925
Replaced by 14433

99120
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99217
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99392
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99515
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Monrovia, California

99779 - use 29587
Bunker-Ramo Corp.
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