section 5

maintenance

5.1 General.

Because the amplifier stages in this unit employ transistors in place of vacuum tubes, slightly different techniques are necessary in maintenance procedures. The impedances and resistances encountered are of much lower values than those encountered in vacuum tube amplifiers, therefore a few ohms discrepancy can make a big difference in the performance of the transistor-equipped unit. Likewise, the coupling capacitors and filter capacitors are of larger values and, in general, are of the electrolytic type. This means that when measuring resistances, an instrument very accurate in the low-resistance ranges must be used, and when measuring the value of the capacitors, an instrument very accurate in the high ranges must be used. Also, the polarity of the capacitors must be observed when taking resistance measurements.

To further complicate the picture, transistors have a low value of forward resistance and a high, but measurable, value of backward resistance. More satisfactory results are obtained if the transistors are removed or disconnected from the circuit when "bugging" individual circuit components.

Figure 5-4, the gain chart, is useful in diagnosing troubles.

5.2 Test Equipment.

The following test equipment is known to function satisfactorily and is recommended for use in testing the 212Z-1 equipment.

TABLE 5-1. LIST OF TEST EQUIPMENT

FUNCTION	TEST EQUIPMENT
Resistance measurements	BECO Impedance Bridge Model 250-C1
Voltage measurements (d-c)	Simpson Model 269 Meter
Voltage measurements (a-c)	Hewlett-Packard Model 400D AC-VTVM
Capacity measurements	BECO Impedance Bridge Model 250-C1
Audio output meter	Daven Power Output Meter Type OP-182
Audio signal generator	Hewlett-Packard Model 200CD Wide-Band Oscillator
Distortion	Hewlett-Packard Model 330D Distortion Analyzer
Oscilloscope	Dumont 208-B
Attenuation network	Daven T-693-R with various impedance pads

5.3 Transistor Replacement.

The transistors are mounted on the printed circuit boards. Remove the four screws holding the board containing the defective transistor and carefully turn the transistor over.

The transistors in this equipment are of the same general construction, especially insofar as the connection leads are concerned. The connection leads on a new transistor must be pruned to 1/4-inch length in order to fit the sockets properly. When replacing the transistors, see that the prongs are not bent, then align them with the holes in the socket and carefully press the transistor into position. Be sure the prongs do not bend.

CAUTION

The transistors should not be inserted into or withdrawn from the socket with the power on, because high transient currents may cause permanent damage to the transistor.

5.4 Resistance and Voltage Measurements. (Refer to figures 5-1, 5-2, and 5-3.)

5.4.1 GENERAL. Inspect the leads and test probes of the test equipment to be used. There must be no high resistance in these leads and the test probes must be clean and sharp. When using test probes, take measurements at points on the printed circuit where there is a large build-up of solder to prevent damaging any of the interconnecting printed wiring. Remember to observe polarity when checking with an ohmmeter any circuit across which there is an electrolytic capacitor.

Resistance measurements are made with the power plug pulled from the supply line and the battery plugs pulled from the batteries.

A chart of resistance measurements is not included in this book because of the use of high-capacity electrolytic capacitors in the filter and audio coupling circuits. In any circuit that includes an electrolytic capacitor, the charging time to charge the capacitor when the ohmmeter is attached makes a duplication of readings impossible. If resistance measurements are taken, take them directly across the component in question. Resistance values of resistors are given on the schematic diagram.

CAUTION

When making resistance measurements or at any other time, never reverse the polarity across any elements of a transistor to that existing in the normal operating circuit. Likewise, never apply more voltage to the transistor than that appearing in the normal circuit from which it was taken. Be sure that the circuit from which a transistor is extracted or into which it is being inserted has no voltage applied.

5.5 Fuse.

One fuse, F101, is used in this equipment. It is connected in the 115-volt supply line circuit only. The fuse is contained within the fuse post on the rear of the unit. To replace the fuse, press the cap of the holder and rotate it in the direction indicated on the cap. Pull the cap with the fuse attached from the holder. Pull the fuse from the cap and replace with a 1/16-amp, 3AG-type fuse. (A spare fuse is located in a clip on the carrying case.) Return the fuse and cap to the holder.

5.6 Component Parts Replacement.

5.6.1 GENERAL. In manufacturing the printed circuit assemblies, the "wires" are first copper plated on the insulation board, then the component parts are mounted on the board, then the bottom of the board is dipped into a pot of hot solder. All of the components are soldered at once and, at the same time, a coating of solder is deposited on the copper "wires." The leads of the resistors and condensers, after they come through the mounting holes, are slightly flattened and bent over and cannot safely be withdrawn from the same side of the board. The main problem with any printed circuit assembly when replacing parts is to prevent dislodging the copper "wires" from the board and causing an open circuit in the wiring. This copper "wire" can be disturbed by two means. One way is by applying too much heat, the other way is by accidentally pushing the copper away from the board when shoving the leads of the resistors or capacitor through the holes of the board. Extreme care is the only answer to either problem. The special tools listed below will make it easier to perform the soldering operations without damaging the wiring.

5.6.2 SPECIAL TOOLS.

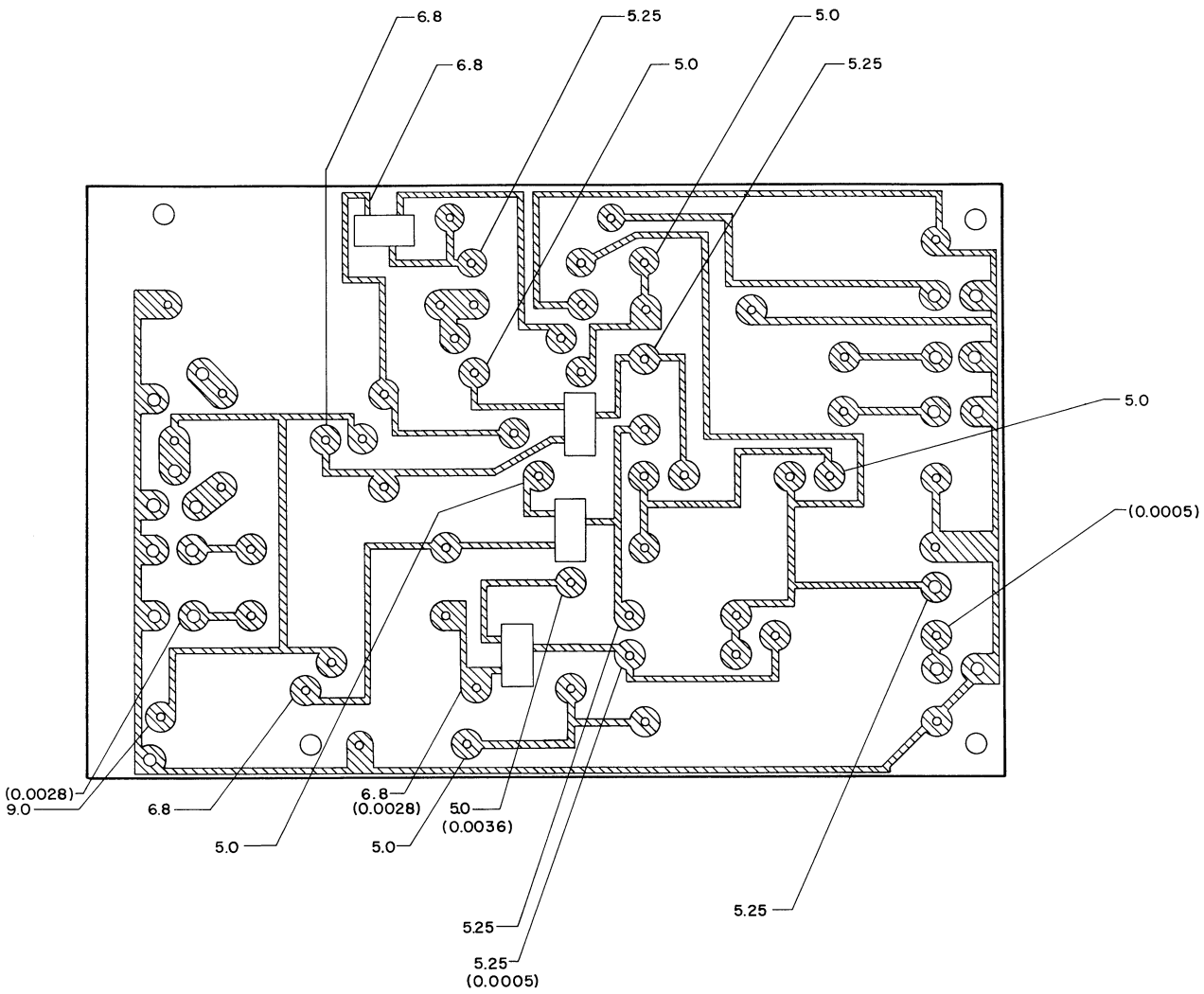
5.6.2.1 SOLDERING IRON. Select a soldering iron with a removable tip and of no more than 40 watts capacity. Flatten and dress the tip to a size of 3/16 inch across. With a file or saw, cut a 1/32-inch wide slot in the center of the tip, then put a slight bend in the tip close to the end. This tip will be used to hold the copper down around a hole through which a resistor or capacitor lead is being thrust (and melt the solder at the same time).

5.6.2.2 PIN-NOSED PLIERS. Pin- (or needle-) nosed pliers are used to grasp the protruding resistor or capacitor leads.

5.6.3 PROCEDURE. To remove a resistor or capacitor, cut the leads close to the ends of the component, then straighten them so that they protrude straight upward from the board. Using the soldering iron with the notched tip, quickly melt the solder at the solder spots and grasp the ends of the leads in the melted solder with pin-nosed pliers. Gently withdraw the leads through the board. To replace a resistor or capacitor, bend the leads so that they will exactly fit the spacing of the holes into which they are mounted. Prune the leads so that there will be only about 1/8-inch excess lead length. Carefully file the end of each lead to produce a point. Enter one lead into the mounting board and press the soldering iron against the associated soldering spot. When the tip of the lead comes through, allow it to come through the notch in the iron and press the iron firmly against the board. This will prevent the copper-plated wiring from coming loose from the board. Enter the other lead in its hole and repeat the process. Trim the excess lead.

CAUTION

If unreasonable resistance is met at any time when the lead is being thrust through the board into the melted solder, do not force the lead on through, because to do so may cause the copper "wiring" to be lifted from the board. The copper "wiring" can be lifted also if too much heat is applied during a soldering operation. Use only the minimum amount of heat and do the job quickly.



NOTES:
1. AC VOLTAGES WITH PARENTHESIS, DC VOLTAGES WITHOUT PARENTHESIS.
2. ALL DC VOLTAGES NEGATIVE WITH RESPECT TO GROUND.
3. DC VOLTAGES MEASURED WITH SIMPSON MODEL 269 METER. 100,000 OHMS PER VOLT INPUT IMPEDANCE.
4. AC VOLTAGES MEASURED WITH HEWELETT-PACKARD MODEL 400D VTVM WITH AN INPUT SIGNAL LEVEL OF -60DBM AND AN OUTPUT LEVEL OF +5DBM.

4.8 -

Figure 5-1. Voltage Measurements, Preamplifier Board

5.7 Servicing Transistor Circuits.

5.7.1 GENERAL. The servicing procedures and test equipments that have been used in the past with other types of electronic gear, for the most part, may be used with transistor circuits. The cases where special precautions must be used are listed below. If the equipment under test contains transistors, even though they may not be in the circuits under test, the precautions should be observed because of the possibility of accidentally cotacting a transistor circuit.

5.7.2 TEST EQUIPMENT. The damage to transistors by test equipment is usually the result of accidentally applying too much current or voltage to the transistor elements. The following are common sources of damage from test equipment.

5.7.2.1 TRANSFORMERLESS POWER SUPPLIES. One source of such current is from the power line when test gear with transformerless power supply is used. This type of test gear can be used by employing an isolation transformer in the power line.

5.7.2.2 LINE FILTER. It is still possible to damage transistors from line current, even though the test gear has a power transformer in the power supply, if the test gear is equipped with a line filter. This

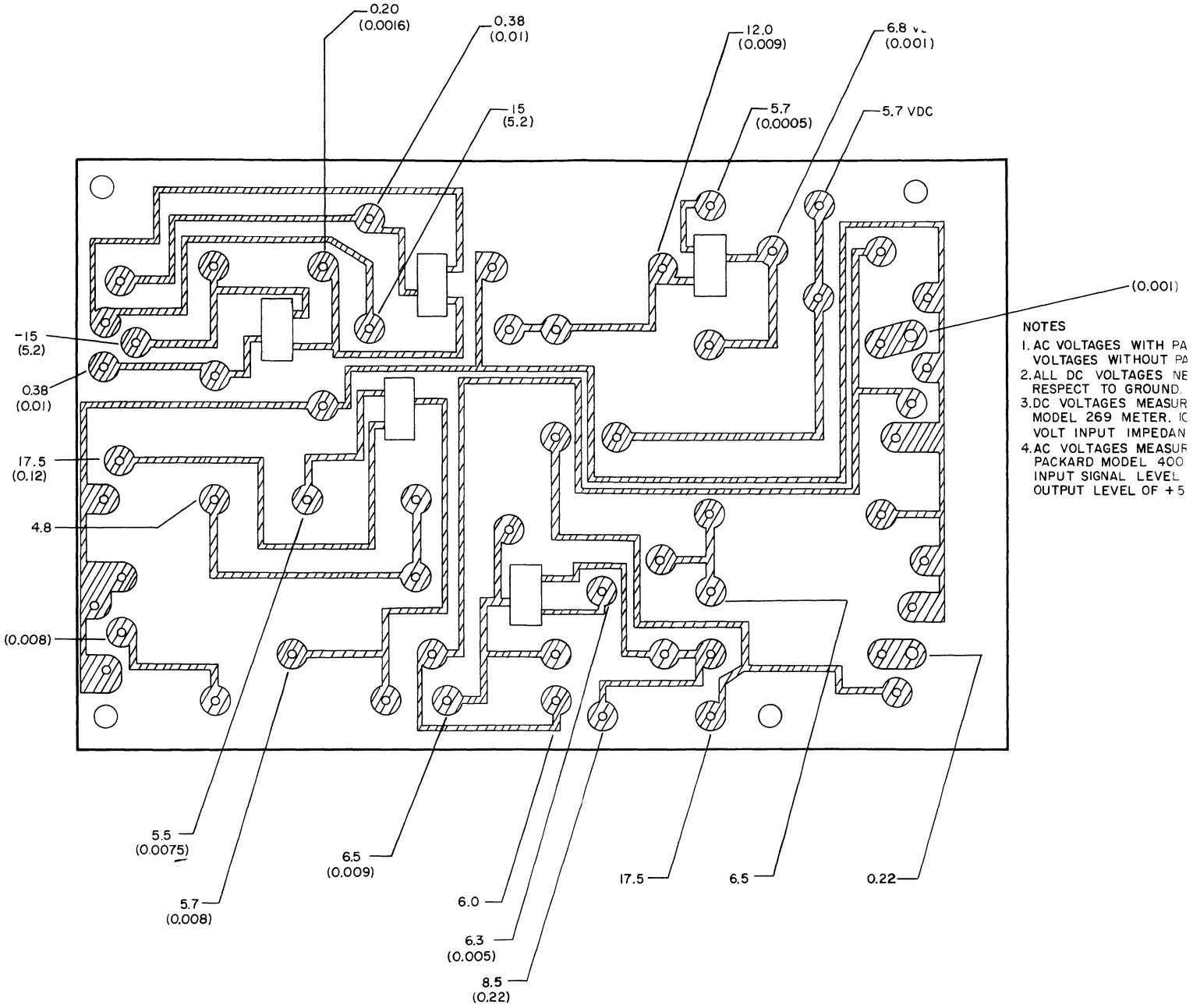
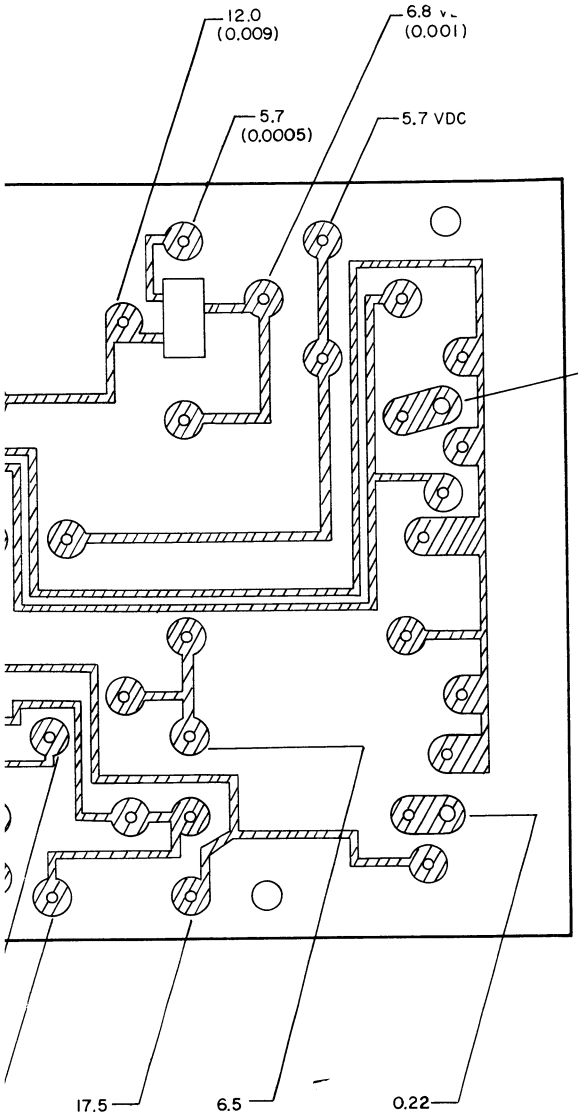


Figure 5-2. Voltage Measurements, Amplifier Board



NOTES

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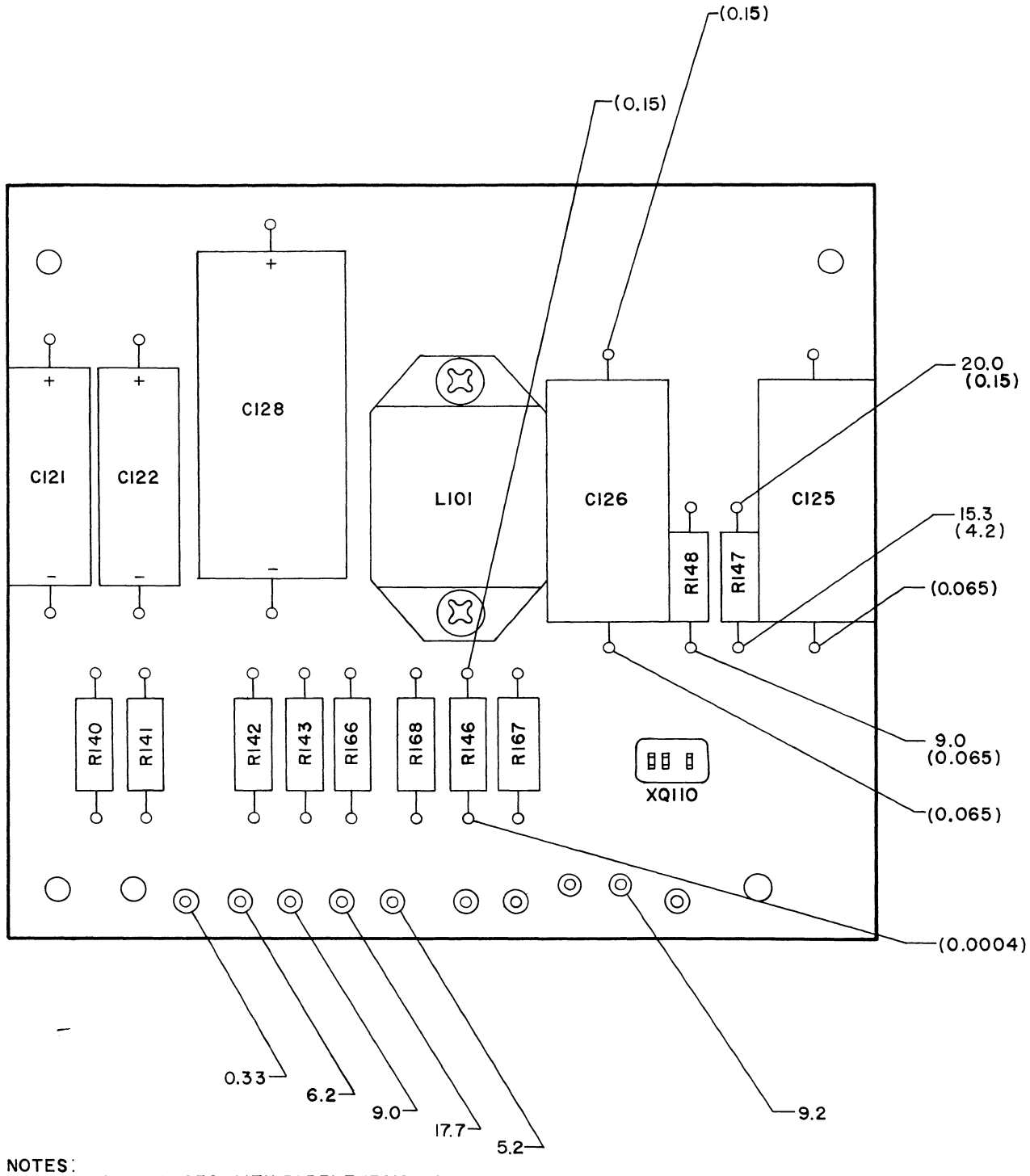
2. ALL DC VOLTAGES NEGATIVE WITH RESPECT TO GROUND.
3. DC VOLTAGES MEASURED WITH SIMPSON MODEL 269 METER. 100,000 OHMS PER VOLT INPUT IMPEDANCE.
4. AC VOLTAGES MEASURED WITH HEWELETT-PACKARD MODEL 400D VTVM WITH AN INPUT SIGNAL LEVEL OF 60DBM AND AN OUTPUT LEVEL OF +5DBM



NOTES:
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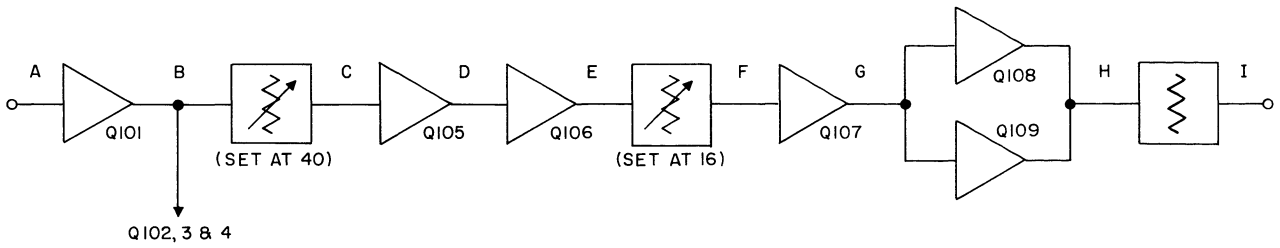
2. ALL DC VOLTAGES NEGATIVE WITH RESPECT TO GROUND.
3. DC VOLTAGES MEASURED WITH SIMPSON MODEL 269 METER. 100,000 OHMS PER VOLT INPUT IMPEDANCE.
4. AC VOLTAGES MEASURED WITH HEWELETT-PACKARD MODEL 400D VTVM WITH AN INPUT SIGNAL LEVEL OF -60DBM AND AN OUTPUT LEVEL OF +5DBM.

Figure 5-3. Voltage Measurements, Oscillator Board



LOCATION	VOLTAGE	LEVEL IN DBM
A		−60
B	.0045	$-47\frac{1}{2}$
C	.0019	$-59\frac{1}{4}$
D	.016	−35
E	.038	−3.15
F	.0155	−41.1
G	.025	−16.5
H	.5	+13.0
I	2.45	+10.

NOTES:

1. GAIN MEASURED AS FOLLOWS:
   600 OHMS 1000 CPS INPUT, INPUT FADER AT 40, MASTER AT 16.
2. ZERO DBM = 1 MW ACROSS 600 OHMS.

Figure 5-4. 212Z-1 Gain Chart

filter may act like a voltage divider and apply 55 volts a-c to the transistor. To eliminate trouble from this situation, connect a ground wire from the chassis of the test gear to the chassis of the equipment under test before any other connections are made.

5.7.2.3 LOW SENSITIVITY MULTIMETERS. Another source of transistor damage is a multimeter that requires excessive current for adequate indications. Multimeters that have sensitivities of less than 5000 ohms per volt should not be used. A multimeter with lower sensitivity will draw too much current through many types of transistors and damage them. Use of 20,000 ohms-per-volt meters or vacuum tube voltmeters is recommended. Check the ohmmeter circuits (even those in vtvms) on all scales with an external, low resistance milliammeter in series with the ohmmeter leads. If the ohmmeter draws more than one milliampere on any range, this range cannot be used safely on small transistors.

5.7.2.4 POWER SUPPLY. Always use fresh batteries of the proper value for the equipment under test in test power supplies. Never use battery eliminators because the regulation of these devices is poor at the current values drawn by transistor circuits. Be certain about identification of polarity before attaching the battery to the equipment under test; polarity reversal may damage the transistor.

5.7.3 ELECTRIC SOLDERING IRONS. The following are possible sources of transistor damage from soldering irons.

5.7.3.1 LEAKAGE CURRENT. Electric soldering irons may damage transistors through leakage current. To check a soldering iron for leakage current, connect an a-c voltmeter between the tip of the iron and a ground connection (water pipe or line ground), allow the iron to heat up, then check for a-c voltage with the meter. Reverse the plug in the a-c receptacle and again check for voltage. If there is any indication on the meter, isolate the iron from the line with a transformer. The iron may be used without the isolation transformer if the iron is plugged in and brought to temperature, then unplugged for the soldering operation. It is also possible to use a ground wire between the tip of the iron and the chassis of the equipment being repaired to prevent damage from leakage current.

5.7.3.2 IRON SIZE. Light duty soldering irons of 20 to 25 watts capacity are adequate for transistor work and should be used. If it is necessary to use a heavier duty iron, wrap a piece of about number 10 copper wire around the tip of the iron and make it extend beyond the tip of the iron. Tin the end of the piece of copper wire and use it as the soldering tip.

5.7.4 SERVICING PRACTICES.

5.7.4.1 HEAT SINK WHEN SOLDERING. When installing or removing a soldered-in transistor, grasp the lead to which heat is being applied, between the solder joint and the transistor, with long-nosed pliers to bleed off some of the heat that conducts into the transistor from the soldering iron. Make sure the wires being soldered to transistor terminals are properly pretinned so that the connection can be made quickly. Excessive heat will permanently damage a transistor.

5.7.4.2 REMOVAL OF TRANSISTORS FROM OPERATING CIRCUITS. Never remove a plug-in transistor or replace same when the supply voltage is turned on. Transients thus produced may damage the transistor or others remaining in the circuit. If a transistor is to be evaluated in an external test circuit, be sure that no more voltage is applied to the transistor than is normally used in the circuit from which it came.

5.7.4.3 PLUG-IN TRANSISTORS. When servicing equipment that uses plug-in transistors, it is good practice to remove the transistors from their sockets and reinsert them to break down any film of corrosion or dirt that may have formed.

5.7.4.4 RESISTANCE MEASUREMENTS IN TRANSISTOR CIRCUITS. When measuring resistances of circuits containing transistors or mineral diodes, remember that these components are polarity and voltage conscious; therefore, follow the directions of the notes given on the resistance tables or drawings to be sure that the correct polarity and range is applied to the circuit from the ohmmeter. Any capacitors used in transistor circuits are usually of large values (especially in audio, servo, or power circuits) and it takes time to charge these capacitors when an ohmmeter is connected to a circuit in which they appear; thus, any reading obtained is subject to error if the capacitor is not allowed time to fully charge. In some cases, it may be best to isolate the components in question and individually measure them.

5.7.4.5 POWER TRANSISTOR HEAT SINKS. In some cases, power transistors are mounted on heat sinks that are designed to carry heat away from them and in some power circuits, the transistor must also be insulated from ground. This insulating is done by means of insulating washers made of fiber and mica. When replacing transistors of this nature, be sure that the insulating washers are replaced in proper order. Before installing the mica washers, treat them with a film of silicone fluid, Collins part number 005-0273-00, or equivalent. This treatment helps in the transfer of heat. After the transistor is mounted and before making any connections to it, check from the case to ground with an ohmmeter to see that the insulation is effective.

5.7.4.6 TEST PRODS. Test prods should be clean and sharp. Because many of the resistors used in transistorized equipments are of low values, when checking resistance values any additional resistance produced by a dirty test prod will make a good resistor appear to be out of tolerance. In miniaturized equipment the clearance between socket terminals, wires, and other components is usually very small. Because of this, it is easy to cause accidental short circuits with a test prod using a long, exposed needle in the end. Short circuits can be very destructive to transistors, therefore it is a good practice to cover all of the exposed tip of the test prod, except about 1/8 inch, with plastic tape or other insulation.

5.7.5 TROUBLE SHOOTING. The usual trouble-shooting practices apply to transistors. Be sure the test equipment and tools meet the requirements outlined in the above paragraphs. It is recommended that transistor testers be used to evaluate the transistor.

5.7.5.1 OHMMETER TEST OF TRANSISTORS. If a transistor tester is not available, a good ohmmeter may be used for testing. Be sure the ohmmeter meets the requirements as set forth in the paragraph on test equipment, above. To check a PNP transistor, connect the positive lead of the ohmmeter to the base and the negative lead to the emitter. (The red lead is not necessarily the positive lead on all ohmmeters.) Generally, a resistance reading of 50,000 ohms or more should be obtained. Connect the negative lead to the collector; again a reading of 50,000 ohms or more should be obtained. Reconnect the circuit with the negative lead of the ohmmeter to the base. With the positive lead connected to the emitter, a value of resistance in the order of 500 ohms or less should be obtained. Likewise, with the positive lead connected to the collector, a value of 500 ohms or less should be obtained. Similar tests made on an NPN transistor produce results as follows: With the negative ohmmeter lead connected to the base, the value of resistance between the base and the emitter and between the base and the collector should be high. With the positive lead of the ohmmeter connected to the base, the value of resistance between the base and the emitter and between the base and collector should be low. If the readings do not check out as indicated, the transistor probably is defective and should be replaced.

CAUTION

If a defective transistor is found, make sure that the circuit is in good operating order before inserting the replacement transistor. If a short circuit exists in the circuit, plugging in another transistor will most likely result in another burned out transistor. Do not depend upon fuses to protect transistors.

Make sure that the bias resistors in series with the various transistor elements are correct. The transistor is very sensitive to improper bias voltages; therefore, a short or open circuit in the bias resistors may damage the transistor. For this reason, do not trouble-shoot by shorting various points in the circuit to ground and listening for clicks.