Installation Engineering Handbook 61, 62, 63, 65, 67, 69C, 69SP, 267, 267A, 290, and 290A
Western Electric Company, Incorporated
Columbus Works

Section 0.3
10-12-72
Replaces: Section 0.3
Dated 9-20-71

SPECIAL TEST PRECAUTIONS FOR ELECTRONIC DEVICES

CONTENTS

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1. GENERAL

1.1 This section contains precautions and instructions for handling and testing either individually, or in circuits containing the following devices:

Integrated Circuits
Transistors
Diodes
Varistors
Thermistors
Dry Reed Relays
SCR (Silicon Controlled Rectifier)

1.2 Transistors, diodes, varistors, thermistors, SCR's and IC's are solid state devices. Precautions in testing, handling and continuity testing equipment for these devices and circuits containing these devices are covered in Paragraph 2.

1.3 Dry reed relays are covered in Paragraph 3 with respect to precautions in testing handling and continuity testing either individually or in circuits where these devices are present.

1.4 Paragraphs 2 and 3 are to be followed unless the handbook sections contain specific requirements to the contrary which obviates the need for a particular precatuion.

1.5 In general, all of the devices mentioned in Paragraph 1.1 are particularly sensitive and may easily be damaged by:

Heat
Mechanical Shock or Strain
Transient Currents

All of the precautions outlined in this section are aimed to prevent damage to the devices by the three factors named above.

1.6 Printed Wiring and Amplas Assemblies: Obtain Special Method No. 45 where modifications on printed wiring boards or amplas assemblies are authorized. A modification Tool Set R-3640 is listed in the method.

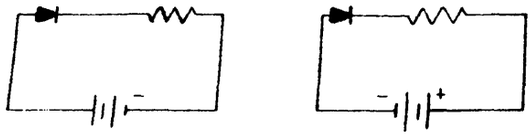
2. SEMICONDUCTOR DEVICES

2.1 Basic Diode, Varistor, Transistor, SCR, and IC Facts

2.11 Diodes

2.111 Diodes are semiconductor devices which have a low resistance to the flow of current when a voltage of one polarity is applied across the terminals and a high resistance when the polarily is reversed. Figure 1 shows battery connections for low and high resistance conditions.

2.112 Diodes are made with various voltage and current limits. Excessive reverse voltage will cause the diode to break down and permanent damage will result. Excessive forward voltage may cause too much current to flow and may result in damage.



LOW RESISTANCE (FORWARD VOLTAGE) HIGH RESISTANCE (REVERSE VOLTAGE)

FIG. 1 - DIODE CIRCUIT FUNCTIONS

2.12 Varistors

2.121 Varistors are semiconductor devices having a resistance that varies with changes in voltage. In general, an increase in voltage will result in a decrease in resistance.

2.122 Varistors are made with various voltage and current limits. Exceeding these limits may result in permanent damage.

2.123 A varistor can be thought of as two diodes connected together as shown in Figure 2.

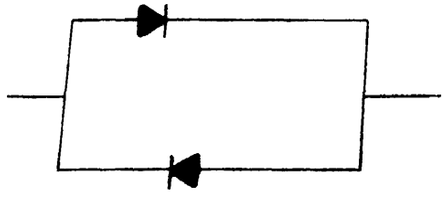


FIGURE 2

2.13 Transistors

2.131 Transistors are semiconductor devices that have characteristics which can be compared to those of electron tubes. They are used in applications such as amplifiers, oscillators, and electronic switches.

2.132 In its simplest form, a transistor has three leads which are designated emitter, base, and collector, which can be compared to the electron tubes cathode, grid, and plate terminals, respectively.

2.133 Figure 3 shows an example of a simplified amplifier circuit containing a transistor, and Figure 4 shows a comparable circuit containing an electron tube.

2.134 The bias voltage in both circuits determines the amount of collector or plate current flowing when there is no input. Variations in bias voltage caused by an input such as voice currents will result in an amplified collector or plate current variation.

2.135 Transistors are made with various voltage and current limits which if exceeded will result in damage to the transistor. The polarity of the voltages applied is also very important; for example, reversing the bias voltage will result in excessive collector current.

2.14 SCR's

2.141 SCR's are semiconductor devices that have characteristics which can be compared to a switch and a diode as shown in Figure 5.

2.142 The SCR has three leads which are designated anode, cathode, and gate. Figure 6 shows an example of a simple circuit containing an SCR.

2.143 The switch is open until the gate voltage and current exceed specified limits known as the trigger voltage and current respectively. The switch is closed until the gate current and voltage fall below the turn off level. Usually the turn off level is less than the trigger level.

2.144 The construction of SCR's usually allows higher currents and voltages but the gate current and voltage limits are much lower. The limits must not be exceeded or the SCR will be damaged.

2.15 Integrated Circuits

2.151 Integrated Circuits are semiconductor devices which contain many transistors, diodes, resistors, and capacitors. They are used in amplifiers, oscillators, and electronic switches.

2.152 The same precautions which are used for diodes, varistors, and transistors must be used on the IC's. If the voltage or current limits are exceeded damage will result.

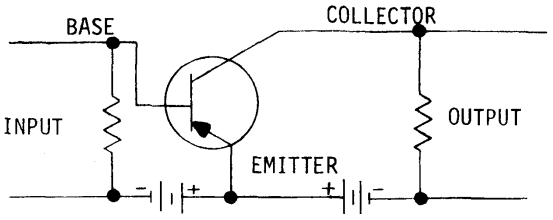


FIGURE 3 - TRANSISTOR AMPLIFIER

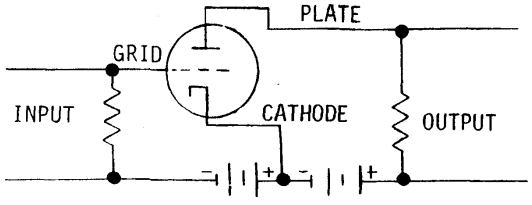


FIGURE 4 - ELECTRON TUBE AMPLIFIER

FIGURE 5

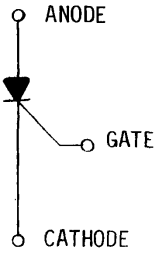


FIGURE 6

2.2 Mechanical Precautions

2.21 Cutting of Leads: Diagonal cutters shall not be used to cut the leads of semiconductor devices. The shock wave created along the lead is sufficient to damage or destroy the internal crystal. Use a cutting tool which has a shearing action (such as a pair of scissors): Where a cutting tool with a shear action is not available, nick the semiconductor lead with a diagonal cutter and then hold the semiconductor lead with a pair of long nose pliers between the device and the place where lead was nicked. Twist the lead back and forth until it breaks off.

2.22 Wire Wrapping of Leads: Wire wrapping of semiconductor device leads may cause injurious residual stresses. Therefore avoid wire wrapping unless specifically authorized.

2.23 Bending of Leads: When placing pigtail apparatus, particular care should be exercised in the bending of leads to prevent rupturing the glass seal. Always seize the lead with the tip of a long nose pliers between the bending point and the device. See Section 333, Handbook 9 for details.

2.24 Inspection for Mechanical Damage: Before replacing a semiconductor device examine the new device carefully for dents in the can, nicks in the tubulation or cracks in the glass seal. Reject all devices exhibiting these defects.

2.25 Handling: Handle semiconductor devices individually. Do not dump together since this may cause mechanical damage. Dropping or jarring these devices is prohibited. Limit handling because residual body oils increase soldering difficulties.

2.3 Electrical Precautions

2.31 Currents: The primary precaution during test is the prevention of the generation of currents which may harm the device. Under test conditions, voltages and ground will be provided to the device by the circuit of which it is a part. Voltage or groung applied to any other part of the circuit may cause excessive currents to pass thru the device causing it to be damaged.

2.311 Shorts: Exercise caution in dressing leads and taking measurements with a test probe to avoid shorting any part of the circuit or connecting leads. A fiber spudger or orange stick should always be used to check contacts, soldered connections, leads etc. The test receiver, of course, shall not be used.

2.312 Test Probe: Ground the test probe on metal framework before taking each measurement. The charge retained by the test probe after measuring a voltage may be sufficient to damage a semiconductor device.

2.313 Electrostatic Discharge: The static charge which the human body may accumulate, such as by the rubbing of leather shoes on a rug, may be sufficient to damage a semiconductor device. Therefore, before touching such a device ground your body by touching metal framework to dissipate any static charge.

2.314 Soldering Tip Voltage: Check the soldering copper per Section 321. Handbook 9 to verify the absence of voltage leaks. The leak test per these requirements will not verify the absence of voltages which may damage these devices.

NOTE: Inorder to verify that no more than 5VAC exist on the soldering copper, repeat the voltage leakage tests using the lower voltage ranges.

2.315 Component Replacement: Check the replacement component as specified in Paragraph 5 before placing in the circuit.

2.32 Continuity Test Sets to be Used: Only the following continuity test sets may be used:

Continuity Test Set	ITE NO.	
Tone Buzzer	4002	
Volt-Ohmmeter	*4442 or 4442A*	
Tone Buzzer	4525	Electronic Switching Only

The ITE-4442 or ITE 4442A Volt-Ohm-meter is to be used on its Rx100 or Rx1000 scale. The Rx10,000 scale is not to be used because the internal battery voltage for the meter is too high on this scale.

2.4 Heat Precautions

2.41 Semiconductor devices are especially sensitive to heat. Low wattage soldering irons (R-3007), heat sinks and low melting point solder (RM728226) are used for soldering operations on semiconductor devices, or circuits where these devices are present to reduce the heat absorbed.

2.42 Heat Sink: Where the length of the pigtail lead is less than 1/2 inch use the R-3367 tool or grasp with a long nose pliers between the soldering point and the device. See Section 333 of Handbook 9 for details.

2.5 In-Service Semiconductor Circuits

2.51 Where the semiconductor device cannot be removed from circuit voltages and grounds, unplug the soldering iron before preforming soldering operations. When wire wrapping is required use the manual wire wrapping tool. The power-operated gun cannot be used since the casing is grounded. See Section 333, Handbook 9 for details.

3. CIRCUIT PACKS

3.1 Precautions

3.11 Electrostatic Discharge: In general, circuit packs are sensitive to static charges, which the human body may accumulate. These static charges should be discharged from the body before handling a circuit pack by touching the metal framework.

3.12 The power should be turned off before inserting or removing a plug in circuit pack, unless otherwise specified by test requirements. All terminals on the connector should be checked for false potentials before replacing a circuit pack.

3.13 Avoid unnecessary removal of circuit packs.

3.14 When removing a circuit pack in an operating system, the extracting tool should not be permitted to come in contact with active components or connections which could ground or short components on the circuit pack.

3.15 Premature wear of circuit packs can occur from dirt or other contaminants on the gold contacts. Once the gold plating has been worn off or scratched, an insulating film will form on the exposed copper. This film will cause electrical noise and eventually an open circuit. To avoid the above, do not allow the circuit pack to come in contact with dirt, abrasives, or dirty hands.

3.16 Before replacing a circuit pack, check the identification code to insure the proper pack is being used.

3.17 When inserting a circuit pack, observe the following precautions:

a) Circuit pack should line up with guide.
b) Never force the circuit pack.
c) If unusual resistance is felt, determine and correct the cause before inserting the pack.
d) Avoid letting any components of a circuit pack scrape the adjacent packs.

3.2 Testing: All testing of circuit packs should only be performed following specific procedures, such as given on the SD or in a handbook test section.

4. DRY REED RELAYS

4.1 Test Sets

4.11 Whistler Transistorized (ITE-4511): This probe type whistler may be used for continuity tests on dry reed relays, if the function switch is retained in the REC position. It may not be used when the LR switch is operated since this action shunts out a 10,000 ohm series resistor. The probe may not be used on semiconductor devices.

4.12 Dry Reed Relay Test Fixture: The operate and nonoperate condition to the relay contacts of the 293 type relay may be determined by means of ITE-4546. This test fixture contains five carbon filament lamps (2Y type) in series with a resistor. It connects to the five test terminals on the 293 relay. The 2Y carbon filament lamp will limit the current across the contacts to less than 0.05 amperes. Therefore, it may be used to indicate operation of the contacts on dry reed relays when applied in a fashion similar to that of the ITE-4546 fixture. Only the 2Y type carbon filament lamp should be used.

4.2 Mechanical Shock: The same mechanical precautions of Paragraph 2.2 apply to dry reed relays.

5. TEST OF TRANSISTORS, VARISTORS, DIODES, AND SCR'S

5.1 General

5.11 Use of other than recommended test equipment or procedure may cause the voltage or current limits to be exceeded, and damage to the diode, varistor, or transistor will result.

5.12 A test receiver should not be used in circuits containing transistors, varistors, and diodes.

5.13 The P-N junction of diodes and transistors can be verified by using the ITE-4442 Volt-Ohmmeter. This tests whether the junction is opened or shorted and in some instances may show junctions that have excessive leakage. The Volt-Ohmmeter test is by no means complete. The test can only spot transistors which are defective and cannot give any quantitative information about the good transistors, i.e., gain, amount of leakage, etc.

5.14 If the test is to be made on an in-circuit basis, the associated circuitry must be analyzed to see what effect the surrounding components have on the ohmmeter reading. If similar circuits are available and at least one of them is known to be good, a comparison test between them may be helpful.

5.2 Diode Test

5.21 *Set the ITE-4442 or ITE-4442A Volt-Ohmmeter to the Rx1000 scale. Make the connections of Figure 7A or 7B.*

NOTE: *ITE-4442-The polarity stamping on the terminals of the V-O-M indicate the polarity of the voltmeter. The polarity of the ohmmeter is opposite to that of the voltmeter. The ohmmeter polarity, therefore, is the reverse of the stamped polarity. Figure 7A and the instructions of the following paragraphs take this into account.*

ITE-4442A - The polarity of the ohmmeter is the same as the polarity stamping on the terminals. Figure 7B and the instructions of the following paragraphs take this into account.

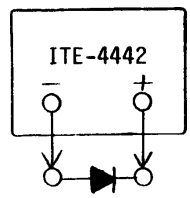


FIGURE 7A

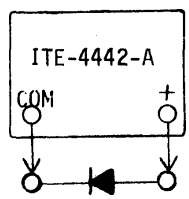


FIGURE 7B

5.22 The meter should read on the low end of the resistance scale (about 10 or lower note that this is not an ohm reading, but rather a scale reading).

5.23 Reverse the connection shown in Figure 7.

5.24 The meter should read in the high portion of the scale.

NOTE: Generally a defective diode will show either a high reading in both directions (open diode) or a low reading in both directions (shorted diode). This is the most common sign of a defective PN junction.

5.3 Varistor Test

5.31 *Set the ITE-4442 or ITE-4442A volt-*ohmmeter to the Rx1000 scale.

5.32 Take scale readings for the varistor in both directions, by connecting *the probes of the ITE-4442 or ITE-4442A* to the leads of the varistor then reversing the probe connections.

5.33 Both readings should be approximately equal (about 10 or lower, note that this is not an ohm reading but rather a scale reading.)

NOTE: Generally a defective varistor will show one of the following combinations of scale readings.

One direction	Other direction
10 or lower	high reading
10 or lower	low reading
high reading	high reading
high reading	low reading
Excessively low reading	Excessively low reading

5.4 Transistor Test

5.41 Voltage measurements should only be made using a vacuum tube voltmeter (VTVM), such as an ITE-4509.

5.42 Resistance measurements should only *be made using an ITE-4442, ITE-4442A* or VTVM such as an ITE-4509. These types of meters are satisfactory since they limit the voltage applied to the test probes to 3 volts on the higher ohms scales. Use only the Rx1000 scale.

5.43 The test of a transistor is similar to that of a diode in that most of the transistors consist of two PN junctions and each of the junctions is tested as if it were a diode. Two junction transistors are of two types: PNP and NPN. The test of a PNP transistor will be explained here, for the NPN transistor the test is the same except the leads connecting the volt-ohmmeter to the transistor are to be reversed in each connection.

5.44 *Set the ohmmeter to the Rx1000 scale. Connect the positive probe of the ITE-4442 or the negative probe of the ITE-4442A to the base lead of the transistor taking care not to touch the case of the transistor. Connect the other ohmmeter lead to the collector and emitter leads in turn. Meter should read on low end of the resistance scale. See figure 9 for lead arrangements and the difference in symbols between NPN and PNP transistors.*

NOTE: This is not a good qualitative test of the PN junctions; however, this test will indicate a shorted PN junction (zero reading) and an open PN junction (infinite reading).

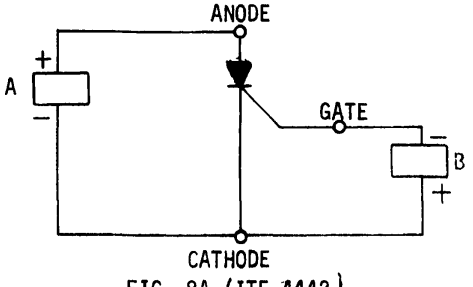


FIG. 8A (ITE-4442)

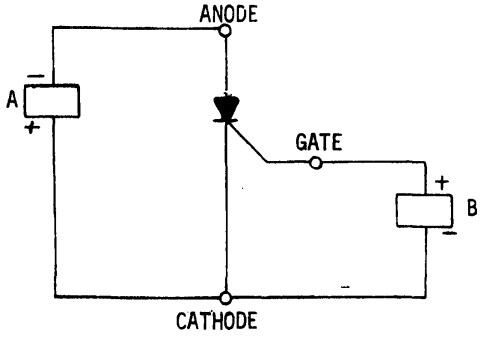


FIG. 8B (ITE-4442A)

5.5 SCR Test

5.51 Set up the circuit as shown in Figure 8. The meters should be ITE-4442 or equivalent.

5.52 Set meter A on the Rx100 resistance scale. Check between the gate and cathode, a high resistance in one direction and a low resistance in the other direction.

5.53 *Set meter A on the RX1000 resistance scale and meter B on the RX1 resistance scale. The polarity stampings on the meter case are for the voltmeter. The ohmmeter polarity may be different. The arrangement of figure 8A or 8B takes this into account. Meter B is used to provide an approximate one volt positive gate. Meter A should indicate a low resistance.*

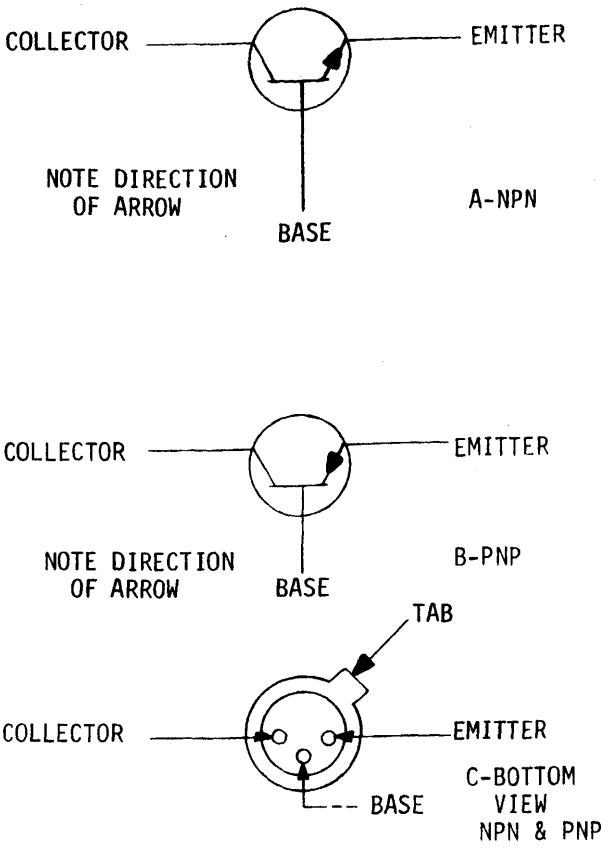


FIGURE 9

Lines presented in Script indicate new or changed information.

Manager, Crossbar Product Engineering
Control Center

Reason for Reissue:
To include reference to ITE-4442A in Test Section.