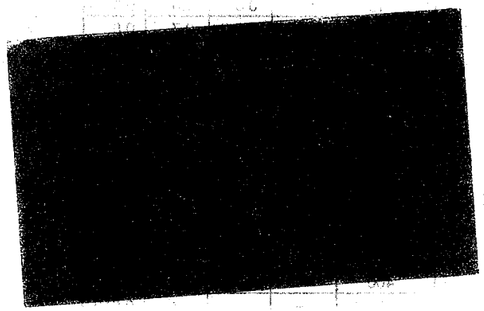
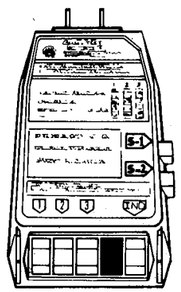


ecos

OPERATING INSTRUCTIONS
MODEL 7106

Accu-Test II™



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Form 7106I-1085-5M

CONTENTS

CONTENTS

Conventions used in this instruction set:

Note: Notes are used to provide additional explanations of tests, procedures or equipment. Notes require no additional action.

CAUTION! Cautions warn of possible equipment damage.

WARNING! WARNINGS ALERT YOU TO SITUATIONS THAT COULD CAUSE HARM TO PEOPLE. READ THEM CAREFULLY AND PROCEED WITH CARE.

Use Ecos Ground Impedance Test Instruments (1020 & 1023) for measuring specific values indicated in Table 1.

SUGGESTED MAXIMUM EQUIPMENT GROUND IMPEDANCE VALUES IN OHMS

O.C. Device Rating in Amperes	CIRCUIT VOLTAGE			
	120V	240V	277V	480V
10	1.6	1.6	—	—
15	1.0	0.8	1.0	0.6
[illegible]	[illegible]	[illegible]	0.7	0.6
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
400	[illegible]	[illegible]	[illegible]	[illegible]
500	—	—	—	0.016
600	—	—	—	0.013
800	—	—	—	0.010
1000	—	—	—	0.008

Table 1

GLOSSARY

250-51. Effective Grounding Path. The path to ground from circuits, equipment, and conductor enclosures shall: (1) be permanent and continuous; (2) have capacity to conduct safely any fault current likely to be imposed on it; and (3) have sufficiently low impedance to limit the voltage to ground and to facilitate the operation of the circuit protective devices in the circuit.

250-74. Connecting Receptacle Grounding Terminal to Box. An equipment bonding jumper shall be used to connect the grounding terminal of a grounding-type receptacle to a grounded box.

Exception No. 4: Where required for the reduction of electrical noise (electromagnetic interference) on the grounding circuit, a receptacle in which the grounding terminal is purposely insulated from the receptacle mounting means shall be permitted. The receptacle grounding terminal shall be grounded by an insulated equipment grounding conductor run with the circuit conductors. This grounding conductor shall be permitted to pass through one or more panelboards without connection to the panelboard grounding terminal as permitted in Section 384-27. Exception No. 1, so as to terminate directly at an equipment grounding conductor terminal of the applicable derived system or service.

(FPN): Use of an isolated equipment grounding conductor does not relieve the requirement for grounding the raceway system and outlet box.

WARRANTY and REPAIR SERVICES

All warranty services are performed at the Ecos factory.

Ecos warrants products of its own manufacture against defects in material and workmanship for a period of one year. The liability of Ecos under this warranty is limited solely to replacing, repairing, or issuing credit (at supplier's discretion) for any products which are proved to be defective during the warranty period and provided that:

(a) The defective unit(s) is (are) returned to Ecos, transportation prepaid by Buyer, and
(b) Ecos examination of such unit(s) shall disclose to its satisfaction that such defects have not been caused by misuse, neglect, repair, alteration, or accident.

In no case is Ecos liable for consequential or special damage arising from the use or misuse of our products. This warranty is in lieu of all other warranties expressed or implied.

All calibration and repair services are performed at Ecos factory.

INTRODUCTION

The Model 7106 Accu-Test™ is an accurate, durable and simple to operate instrument for testing grounded power systems, outlets, electrical and electronic equipment.

Read and follow these instructions carefully to learn what the different combinations of lamps mean and how to use your instrument properly.

The Model 7106 Accu-Test™ will test the following types of outlets, power systems or equipment:

A. 120 VAC, single phase grounded outlets (the most common). The instructions assume this type of wiring (Fig. 1).

B. 208 and 240 VAC, single phase, 4 wire outlets (twist-lock and straight blade outlets). You will need special NEMA adaptors, listed in the Accessories section of this Manual (Fig. 2).

C. Hardwired Equipment (no outlets). You will need the Model 7552 Hardwired Equipment Probe (Fig. 3).

For B and C above, you will need to follow some special instructions in addition to the basic instructions for each test. See the "Special Wiring Conditions" section in this manual on page 5.

Note: Check Instrument and Follow Test Sequence

To test instrument calibration and to verify that all lamps are working, follow the "Lamp Verification and Calibration Test Procedure" on page 35.

Do not go to the next test until the outlet or equipment you are testing passes the test you are performing.

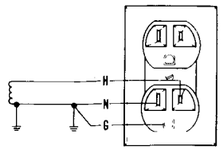


Figure 1

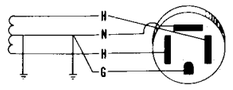


Figure 2

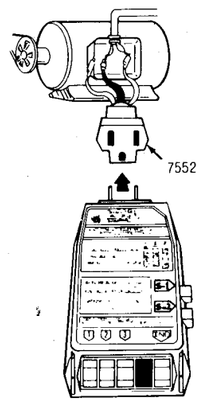


Figure 3

INTRODUCTION

If the instrument shows any of these conditions:

- Wiring Errors (Test #1)
- Low Voltage (Test #2)
- Neutral-Ground Short (Test #3)

DO NOT try any of the other tests until you correct these conditions and retest the outlet or equipment to be sure the wiring is now correct.

THIS INSTRUMENT IS A DIAGNOSTIC AID. *It does not repair wiring,* but only tells you about problems that need repair and may be safety hazards.

WARNING! THE WIRING PROBLEMS IDENTIFIED BY THIS INSTRUMENT SHOULD BE CORRECTED BY AN ELECTRICIAN OR OTHER QUALIFIED PERSON.

The instrument will accurately detect the wiring errors indicated, as well as the continuity and quality (impedance) of *all* paths leading to ground. It is *not* intended to indicate:

— the current-carrying capability (ampacity) of any electrical conductors in accordance with the prescribed wire sizes as required by the National Electrical Code (NEC), article 250-95.

— which grounding path is the intended path (in situations where parallel grounding paths exist), without further testing.

All wiring problems shown by this instrument are violations of the National Electrical Code or safe wiring practices. See Glossary for specific NEC references.

GLOSSARY

Ground Fault Protector (GFP) — A device designed to protect electrical service equipment from arcing ground faults. A GFP does not provide protection for people.

Main Service Entrance — The necessary equipment, usually consisting of main circuit breakers or fuses, a switch and branch circuit breakers or fuses, in a grounded enclosure (panel) connected directly to earth. Located in the building at the point of entrance of the supply conductors from the utility. Other panels in the building are referred to as branch, service or supply panels.

Short Circuit — An unintended connection between two supply conductors (ie: HOT and Neutral conductors). A short circuit will usually cause high current flow and will operate the over current protection (fuse or breakers) to interrupt the circuit.

Ground Fault — Any unintended connection between a supply conductor and ground (ie: hot conductor in contact with the metal case of a piece of equipment). A ground fault will cause a high current flow and should operate the overcurrent protection (fuse or breaker provided such devices are functionally adequate) *only* if the ground path impedance is sufficiently low (less than the specific ohmic value indicated in the table shown on page 45) but under no circumstances greater than 2 ohms.

N.E.C. — National Electrical Code. The National Electrical Standard published by National Fire Protection Association.

N.E.C. REFERENCES
NATIONAL ELECTRICAL CODE — 1984

110-4. Voltages. Throughout this Code the voltage considered shall be that at which the circuit operates.

200-11. Polarity of Connections. No grounded conductor shall be attached to any terminal or lead so as to reverse designated polarity.

250-23. Grounding Service-Supplied Alternating-Current Systems.

(a) System Grounding Connections... *A grounding connection shall not be made to any grounded circuit conductor on the load side of the service disconnecting means.*

GLOSSARY

Impedance — The total opposition (i.e. resistance and reactance) a circuit offers to the flow of alternating current. It is measured in ohms and the lower the ohmic value, the better the quality of the conductor. Low impedance will help provide safety and fire protection and a reduction in the severity of common and normal mode electrical noise and transient voltages (Table 1, page 45).

Ohm (Ω) — The unit of measurement of resistance or impedance (Z). One ohm is the value of resistance or impedance through which one volt will maintain a current of one ampere.

Volt (V) — The unit of measurement of electromotive force (V). Voltage is always expressed as the potential difference in available energy between two points. One volt is the force required to produce a current of one ampere through a resistance or impedance of one ohm.

Ampere (A) — The unit of measurement of electric current (I) or the flow of electrons. One volt of potential across a one ohm impedance causes a current flow of one ampere.

Amp: Abbreviation for ampere

Ampacity: Current-carrying capacity of a conductor or other electrical path expressed in Amperes.

Ohms Law — The relationship between voltage (V), current (I) and impedance (Z) as expressed by the equation: V = IZ.

Earth Ground — The connection of an electrical system to earth. This connection is necessary to provide lightning and static protection as well as establish the zero-voltage reference for the system.

Earth Grounding Electrode — The conducting body in contact with the earth. The grounding electrode may be a metallic cold water pipe when used in conjunction with a driven rod, a mat, a grid, etc. **(Use Ecos Model 2300 To Test)** Earth shall never be used as the equipment grounding conductor.

Ground Fault Circuit Interrupter (GFCI or GFI) — A device intended to interrupt the electrical circuit when the fault current to ground exceeds a predetermined value (usually 4 to 6 milliamps) that is less than that required to operate the overcurrent protection (fuse or breaker) for the circuit. This device is intended to protect people against electrocution. It does not protect against fire from circuit overload.

FOR YOUR SAFETY

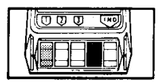
FOR YOUR SAFETY

Note: Sparks resulting from connecting the Model 7565 Remote Ground Probe clip lead, as a result of not following the procedure in the instruction manual, does not directly cause a shock or energy hazard to the operator.

OPEN GROUND

When testing electrical or electronic equipment:

If the wiring lamps (1,2,3) show "Open Ground," the ground path being tested is TOTALLY OPEN.



THIS IS A HAZARDOUS CONDITION!

The equipment or outlet being tested is *dangerous* and *should not be used until it is repaired.*

HAZARDOUS LOCATIONS

Do not use the instrument near combustible or flammable dust, liquids, gases or in other hazardous locations, as defined by the National Electrical Code.

Note: If the wiring has been properly installed in these locations, you will not be able to connect this instrument to the system or equipment. If connection is possible, notify the local authority having jurisdiction.

HANDY TIPS

HANDY TIPS TO PROLONG INSTRUMENT LIFE AND ACCURACY

Be sure both the black (S-1) and red (S-2) buttons are OUT before you plug in the instrument (Fig. 4).

Note: Black (S-1) will lock when pushed in. To unlock and move to "out" position, push in again.

Do not hold the red (S-2) button IN while you press the black (S-1) button. Doing this will eventually damage the instrument.

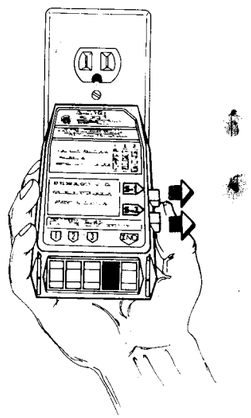


Figure 4

NOT A MONITOR

ALWAYS DISCONNECT THE INSTRUMENT FROM THE OUTLET AFTER TESTING IS COMPLETE. The instrument is not designed to be left in the outlet to monitor voltage or wiring conditions. See Ecos Model GMS series monitors for this application.

SPECIAL WIRING CONDITIONS

Reference B: Page 1 — For 208 and 240 VAC 1ϕ, 3 or 4 wire or 125 and 250 VAC power systems with twist-lock and straight blade (not 5-15 or 5-20 outlets).

You will need the specific NEMA adaptor to match the outlet you are testing (Fig. 5).

Check the accessory list on page 8 for the appropriate adaptor. See Fig. 9 for examples.

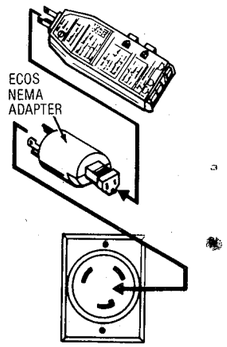


Figure 5

GLOSSARY

HOT and NEUTRAL Reversed (Reversed Polarity) — The correct connection of the HOT and NEUTRAL conductors is reversed. Dangers include increased leakage current, and damage to electronic equipment or motors and appliances requiring correct polarity.

Open GROUND, NEUTRAL or HOT — An "open" is a break, an extremely loose or an unconnected wire in any electrical path. Dangers of an "open" GROUND include serious shock and fire hazard and are life-threatening.

Caution: an "open" GROUND *will not* stop equipment from operating. However, it will stop a fuse or circuit breaker from operating should a ground fault occur.

HOT and GROUND Reversed — The correct connection of the HOT and GROUND wires is reversed. This is an extremely dangerous condition because the GROUND path will rise to 120 Volts and can present a lethal shock hazard to anyone in contact with equipment powered from this outlet or any outlet using the same ground path.

HOT on NEUTRAL, HOT Unwired — The HOT wire is connected to the NEUTRAL terminal of the outlet and the HOT terminal is UNWIRED. Dangers include shock hazard from excessive leakage current and fire hazard. Depending on other conditions, equipment may or may not operate.

Two HOTS in Outlet — More than one HOT conductor has been incorrectly connected to the terminals in the outlet being tested. Dangers include extreme fire hazard and/or major damage to equipment plugged into the outlet.

Low Voltage — A low voltage condition exists when less than 105 VAC is present at a 120 VAC outlet or HOT conductor.

IG (Isolated Ground) — A type of outlet characterized by the following features and uses:

- It may be orange and must have a "delta" (Δ) on the front of the outlet.
- It must be grounded by an insulated green wire.
- It must have an insulator between the ground terminal and the mounting bracket.
- It is used primarily to power electronic equipment because it reduces the incidence of electrical "noise" on the ground path.

GLOSSARY

A.C. Electrical Circuit — A standard 120 volt A.C. electrical circuit (may also be referred to as 110 volts, 115 volts, 117 volts or 125 volts) consists of two supply conductors (HOT and NEUTRAL) and a LOAD.

The HOT, energized or live conductor, is *ungrounded* and delivers energy to the LOAD. The HOT conductor is connected to the fuse or circuit breaker at the main service entrance.

The NEUTRAL or common conductor is *grounded* and completes the circuit from the LOAD back to the utility transformer.

The LOAD is any electric or electronic appliance plugged into an outlet. It completes the circuit from the transformer, through the HOT conductor, to the LOAD, through the NEUTRAL conductor and back to the transformer.

Standard 120 volt circuits also include an equipment GROUND conductor. This equipment GROUNDING conductor provides an intended path for fault current and is **NEVER INTENDED** to be a part of the LOAD circuit. (See definition of equipment ground below.)

Equipment Ground — The equipment grounding conductor is not intended to carry any load current under normal operating conditions. However, it serves three very important purposes:

1. Maintains metal appliance cases at zero volts, thus protecting people who touch the cases from receiving an electrical shock.

2. Provides an intentional fault path of low impedance path for current flow when the HOT conductor contacts equipment cases (ground fault). This current causes the fuse or circuit breaker to open the circuit to protect people from electric shock.

3. Any electronic equipment (not electrical) uses the equipment ground as a zero volt reference for logic circuits to provide proper equipment performance.

Correct Wiring — Wiring installed and connected as designed to provide safe, direct access to electrical energy for correctly-wired electrical appliances.

Wiring Errors — Any wiring condition that deviates from "Correct Wiring." Specific examples are described below.

HANDY TIPS

When performing tests (3A, 5A2-3-4-5, & 5B), where probes are necessary, first plug the instrument into the probe and then plug the probe into the special NEMA Adaptor.

CAUTION! Use ECOS NEMA Adaptors *ONLY* with ECOS test equipment.

Reference C: Hardwired Equipment
Page 1

Use the Model 7552 Hardwired Equipment Probe (Fig. 6).

Use this probe on hardwired equipment, terminal strips, panel boards, junction boxes or other power systems not accessible through an outlet, in order to assure safety and adequate performance of the equipment.

Note: This probe converts the instrument plug or the 7564 Neutral Impedance Probe into 3 color-coded leads with alligator clips for use on 240/120, 208/120 volt systems:

(1) Green lead = GROUND
(connect to metal cabinet, metal enclosure, or green wire terminal)

(2) White lead = NEUTRAL
(connect to solid or striped white or gray wire terminal)

(3) Black Lead = HOT
(connect to any other color wire-generally black, orange, red or brown)

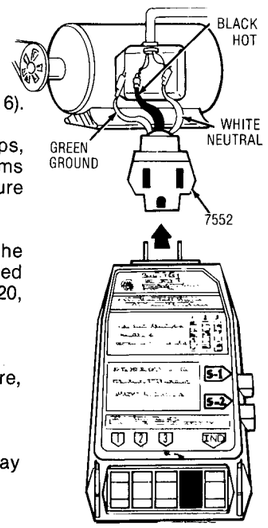


Figure 6

HANDY TIPS

Plug the instrument into the Model 7552 and connect the leads as follows (Fig. 7):

GREEN — GROUND (first)
WHITE — NEUTRAL (second)
BLACK — HOT (third)

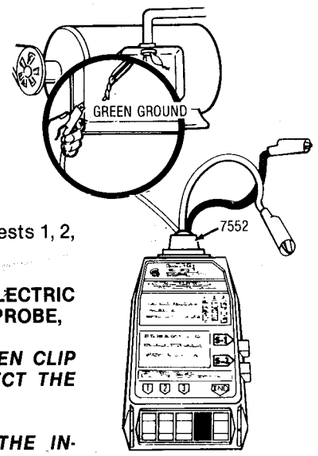


Figure 7

Note: You may use this probe for performing Tests 1, 2, 3 and 5.

WARNING! TO AVOID THE POSSIBILITY OF ELECTRIC SHOCK WHEN USING THE 7552 PROBE,

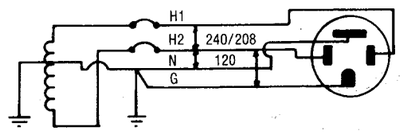
1. ***ALWAYS CONNECT THE GREEN CLIP LEAD FIRST AND DISCONNECT THE GREEN CLIP LEAD LAST.***

2. ***KEEP YOUR FINGERS ON THE INSULATED RUBBER COVERS OF THE CLIPS.*** **DO NOT TOUCH THE METAL PROBE TIPS OR METAL TERMINALS OF EQUIPMENT UNDER TEST.**

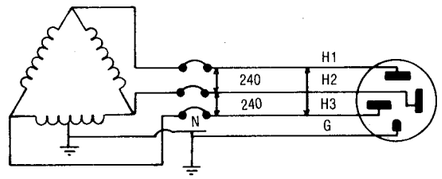
GLOSSARY

C) 120/240V 1ϕ 4-Wire (Delta)*

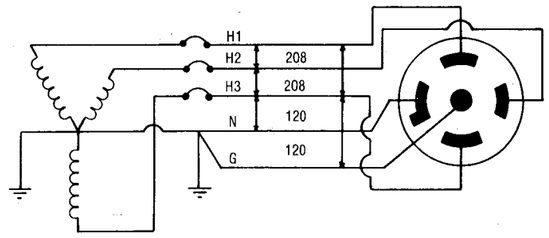
D) 120/208V 1ϕ 4-Wire (Wye)*



E) 240 3ϕ 4-Wire (Delta)*



F) 120/208 3ϕ 5-Wire (Wye)*



All receptacles shown are 20 Amp

GLOSSARY

GLOSSARY OF TERMS

A.C. Electrical System — Consists of two types of conductors:

1) Supply Conductors

   a. Ungrounded = Hot = Phase
   May be any of various colors, ex: red, black, orange, violet, blue, brown, etc.

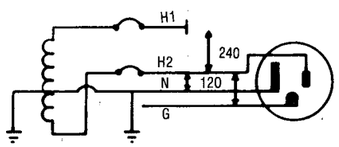
   b. Grounded = Neutral = Common = System Ground
   Must be white, gray or white with gray stripes.

2) Grounding Conductors
   Ground = Equipment Ground = Grounding Path = Conduit
   Must be green or green with a yellow stripe (Household: may be bare metallic (copper) wire)

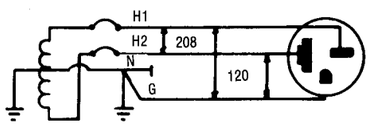
A.C. Electrical System Rating — Systems are rated by voltage supplied, number of phases and total number of supply conductors, plus ground. (It is common among trades, other than electrical, that they are also referred to by total number of conductors, including ground, that are wired to the outlet.)*

*Some common system configurations are shown below:

A) 120/240V 1Ø 3-Wire (Delta)*



B) 120/280V 1Ø 3-Wire (Wye)*



KITS/ACCESSORY PROBES

KITS and ACCESSORY PROBES

7106 AccuTest

Your 7106 AccuTest is designed to perform many important tests by using specially designed probes to extend the testing capability. These test probes are available in kits or individually as listed below:

Figure 8

MODEL	DESCRIPTION
SK-B	Service Kit-B includes 7106 AccuTest, all probes shown below and a 7706A case.
TP-2	Test Probe Kit-2 (Does not include 7106) includes all probes, and case shown below except 7566.
	PROBES
7552	12″ Power cord with clips for handwired equipment
7561	Neutral/Ground Reversal Test Probe
7562	Isolated (dedicated) Ground Short Test Probe
7563	36″ Mini-Extension Cord
7564	Neutral Impedance Probe
7565	Remote Ground Test Probe
7566	Calibration Reference and Lamp Verification Probe (specify 7566-1 for 1 ohm tester)
7706A	Soft-sided zipper case to carry 7106 AccuTest and all probes

KITS/ACCESSORY PROBES

NEMA Adaptors For Testing
Single Phase Systems Up To 240 Volts.

The adaptors shown below will allow you to test single phase power systems and equipment for correct wiring, and grounding and neutral conductor quality (impedance) shown in this instruction booklet.

WARNING! USE ECOS NEMA ADAPTORS *ONLY* WITH ECOS TEST EQUIPMENT.

NEMA Adaptors available for 7106 AccuTest are shown below:

For 3-Wire 120 Volt Systems

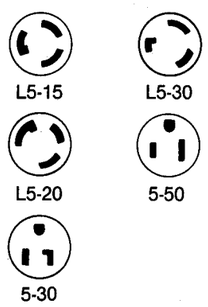
Model	**To test outlet type**
AL5-15	L5-15, 125V, 15A Twist Lock
AL5-20	L5-20, 125V, 20A Twist Lock
A5-30	5-30, 125V, 30A Straight Blade
AL5-30	L5-30, 125V, 30A Twist Lock
A5-50	5-50, 125V, 50A Straight Blade
AK-1	NEMA Adaptor Kit (Incl: AL5-15, AL5-20, A5-30, AL5-30 and 7706 Case)

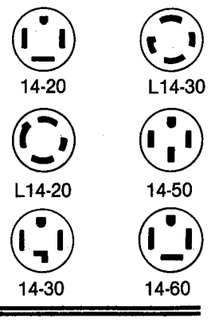
For 4-Wire 125/250 Volt Systems

NEMA Adaptors shown below are 4 wire, single phase and MUST be used with Adaptor Interface model 7552A.

Model	**To test outlet type**
A14-20	14-20, 125/250V, 20A Straight Blade
AL14-20	L14-20, 125/250V, 20A Twist Lock
A14-30	14-30, 125/250V, 30A Straight Blade
AL14-30	L14-30, 125/250V, 30A Twist Lock
A14-50	14-50, 125/250V, 50A Straight Blade
A14-60	14-60, 125/250V, 60A Straight Blade

Figure 9





CALIBRATION VERIFICATION

CALIBRATION VERIFICATION TEST:

Step 1. Be sure black (S-1) and red (S-2) buttons are out and that tests 1-5 have been passed on your reference outlet.

Step 2. Insert the instrument into the plug end of the 7566 Probe.

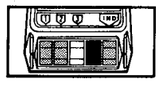
Step 3. Plug the other end of the 7566 Probe into a duplex outlet.

Step 4. Plug the instrument and 7566 Probe into the second outlet of the duplex receptacle.

Step 5. Check the Wiring Lamps (1, 2 & 3)
Remove and rotate the instrument as necessary until the Wiring Lamps look like this:

to indicate "Correct Wiring."

Step 6. Press and hold red (S-2) and watch IND lamp.



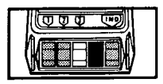
IND is ON
↓
Your instrument is out out of calibration and must be replaced.

OR

IND is OFF or FLASHING
↓
Your instrument is correctly calibrated.

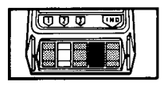
LAMP VERIFICATION

Step 5. Check the Wiring Lamps (1, 2 & 3).

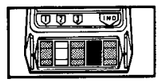


Lamps 1, 2 and IND are working.

Remove instrument, rotate 180° and plug into outlet again (Fig. 43).

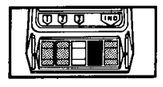


OR



Lamps 1, 3 and IND are working.

Remove instrument, rotate 180° and plug into outlet again (Fig. 43).



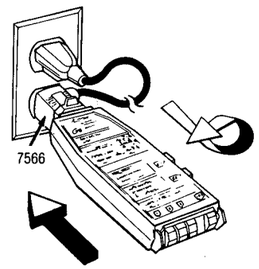


Figure 43

This procedure will have caused all four lamps to light — if any lamp does not light, the instrument must be replaced. Contact Factory.

TEST #1

Test #1. WIRING ERRORS TEST PROCEDURE

WIRING ERRORS ARE A SAFETY HAZARD AND MAY ALSO DAMAGE YOUR ELECTRICAL OR ELECTRONIC EQUIPMENT

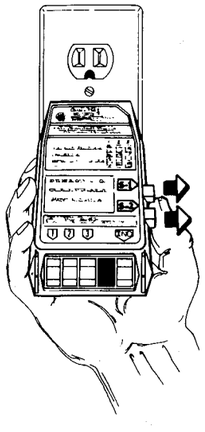
Reference N.E.C. Articles 200-11 and 250-51

Step 1. Be sure the black (S-1) button and red (S-2) button are *out* (Fig. 10).

Note: Black (S-1) will lock when pushed in. To unlock and move to the "out" position, push in again.

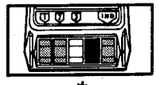
Step 2. Plug the instrument into the outlet to be tested.

Step 3. Watch the lamps 1, 2 and 3. See Fig. 11 for Wiring Errors.



Wiring Error (Any Other Combination) (See Fig. 11 at right)

OR



Correct Wiring

Go to Test #2

Repair and Retest

Note: You will notice that the IND lamp also lights up. See Test # 2.

CAUTION! If the Neutral wire and Ground paths are *both* open, the instrument will show a "dead circuit"—all lamps "OFF"—OPEN HOT.

Figure 10

1. WIRING ERRORS

Lamp ON ■ Lamp OFF □	1	2	3
Correct Wiring	■	■	□
Hot & Neut (Rev. Pol)	■	□	■
Open Ground	■	□	□
Open Neutral	□	■	□
Open Hot (see caution in instr.-Test 1)	□	□	□
Hot & Gnd Reversed	□	■	■
H on N, H Unwired	□	□	■
2 Hots in Outlet (>180V)	■	■	■

Figure 11

(continued on page 10)

TEST #1

To confirm this condition:

Step 1. Use the Model 7565 Remote Ground Test Probe.

Step 2. Plug the instrument into the receptacle end of the #7565.

Step 3. Connect the ground clip of the probe to any *KNOWN* grounded surface. (Example: Previously tested correctly wired outlet)

Step 4. Insert the probe and instrument into the outlet showing open hot.

WARNING! IF ANY LAMP LIGHTS UP, THE OUTLET IS LIVE, AND THE OPEN HOT CONDITION *DOES NOT EXIST.*

TEST #2

Test #2. LOW VOLTAGE TEST PROCEDURE

CONSISTENT LOW VOLTAGE IN A POWER SYSTEM MAY CAUSE ELECTRICAL OR ELECTRONIC EQUIPMENT TO OPERATE IMPROPERLY. IT MAY ALSO CAUSE FIRE OR OTHER DAMAGE.

Reference N.E.C. Article 110-4

POSSIBLE CAUSES:

- Overloading the circuit with too many appliances.
- Low voltage supplied by the electric utility.
- Excessive HOT conductor impedance.
- Excessive circuit breaker impedance.
- Improper use of aluminum wire.

LAMP VERIFICATION

LAMP VERIFICATION AND CALIBRATION TEST PROCEDURE

YOUR INSTRUMENT CAN TEST ITS OWN CONDITION AND CALIBRATION.

By following the test sequence outlined below, you can test all four (4) lamps and the instrument's calibration point.

You will need the Model 7566 Calibration Reference Probe, or Model 7566-1 if your instrument is calibrated at 1 ohm (Fig. 41).

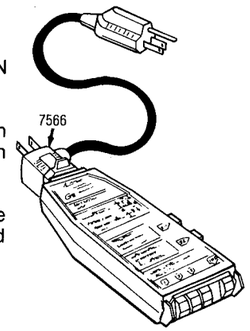


Figure 41

LAMP VERIFICATION TEST:

Step 1. Be sure black (S-1) and red (S-2) buttons are out and that tests 1-5 have been passed on your reference outlet.

Step 2. Insert the instrument into the plug end of the 7566 Probe (Fig. 41).

Step 3. Plug the other end of the 7566 Probe into a duplex outlet (Fig. 42).

Step 4. Plug the instrument and 7566 Probe into the second outlet of the duplex receptacle (Fig. 42).

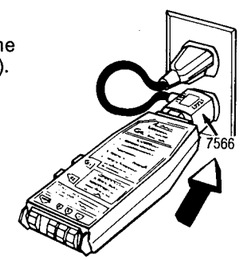


Figure 42

TEST #5B

Note: It is recommended that all equipment operating on the circuit under test be turned "OFF."

To test for neutral impedance, follow this preliminary procedure:

Step 1. Plug the instrument into the 7564 Probe (with NEMA adaptor, if required) (Fig. 40).

Step 2. Proceed with test #5 below:

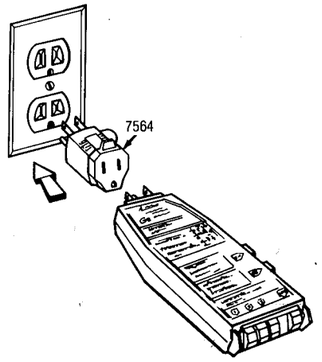


Figure 40

Test #5. Basic Impedance Test

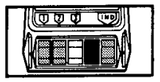
Step 1. Be sure the black (S-1) and red (S-2) buttons are OUT and that you have passed tests 1, 2, 3 & 4 before proceeding.

Step 2. Plug the instrument into the outlet to be tested.

Step 3. Press and hold the red (S-2) button.

Step 4. Watch Wiring Error Lamps (1, 2 & 3).

OR



IND is OFF or flashing.

↓

Impedance is *greater* than the ohmic value shown on the instrument label.

↓

Correct the problem and retest.

IND is ON.

↓

Impedance is *less* than the ohmic value shown on the instrument label.

TEST #2

POSSIBLE SOLUTIONS:
- Remove some of the load from the circuit.
- Unplug something.
- Move an appliance to another circuit.
- Call the electric utility or an electrician.

Note: Cold Temperature Limitations

Cold temperature lengthens the time it takes the IND lamp to light (for only the voltage test). To warm the lamp quickly, plug instrument in and press and hold the (S-2) button until the IND lamp remains "ON" without the (S-2) button being held.

Step 1. Before you plug in the instrument, be sure the black button (S-1) and red button (S-2) are OUT and that you have passed test #1 before proceeding (Fig. 12).

Step 2. Plug the instrument into the outlet you are testing.

Step 3. Watch the IND lamp.

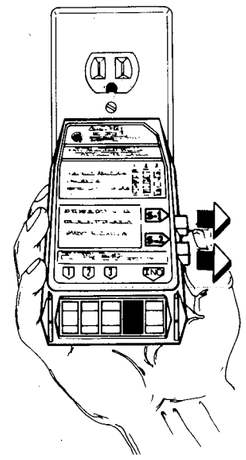
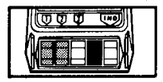
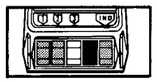


Figure 12



OR



IND lamp is OFF (Voltage is below 105V.)

↓

105V. is the minimum voltage for 120V. circuits.

↓

Correct the voltage and test again.

IND lamp is ON (Voltage is at or above 105V.)

↓

Go to Test #3.

TEST #3

Test #3. NEUTRAL TO GROUND SHORT TEST PROCEDURE.

NEUTRAL TO GROUND SHORT IS A SERIOUS SAFETY HAZARD THAT WILL ALSO FREQUENTLY CAUSE POOR PERFORMANCE IN OR DAMAGE TO COMPUTERS AND OTHER ELECTRONIC EQUIPMENT.

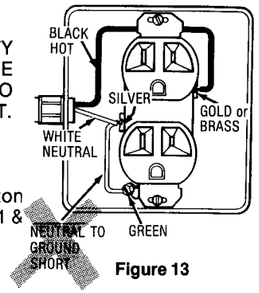


Figure 13

Reference N.E.C. Article 250-23a

Step 1. Be sure the black button (S-1) and the red button (S-2) are OUT and that you have passed tests #1 & 2 before proceeding.

Step 2. Plug the instrument into the outlet.

Step 3. Press the black (S-1) (IN).

Step 4. Press and hold the red (S-2) (Fig. 14).

Step 5. Watch the IND lamp.

IND is ON

↓

Neutral to Ground Shorted within 20′ of outlet being tested.

↓

Repair and test again before going to the next test.

IND is OFF or flashing

↓

No Neutral to Ground Short within 20 feet of the outlet being tested.

↓

Go to Test #4 (except if testing hardwired equipment—go to Test #5).

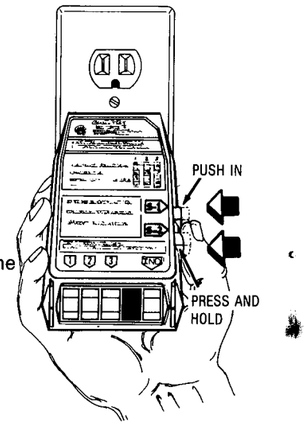


Figure 14

TEST #5B

TEST #5B NEUTRAL WIRE IMPEDANCE TESTING PROCEDURE, OUTLET OR 4-WIRE SYSTEM.

HIGH NEUTRAL IMPEDANCE WILL CAUSE COMMON AND NORMAL MODEL ELECTRICAL NOISE RESULTING IN POOR EQUIPMENT PERFORMANCE, PARTICULARLY OF COMPUTERS AND OTHER ELECTRONIC EQUIPMENT OR CONTROLS; POSSIBLE FIRE AND OTHER FAULTY CIRCUIT HAZARDS.

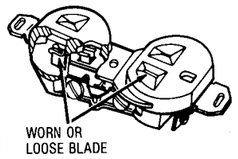


Figure 37

For this test you will need the Model 7564 Neutral Impedance Probe (and a NEMA adaptor, if necessary — See Special Wiring Conditions Section on page 5).

Causes of high neutral impedance include:

POSSIBLE CAUSES:

- Loose or worn neutral blade (large slot) on the outlet (Fig. 37).
- Loose neutral (silver) screw on the outlet (Fig. 38).
- Loose neutral connection at the branch or main panel or at a junction box (Fig. 39).
- Neutral wire sized too small (Fig. 38).
- Neutral wire too long.
- Missing or broken wire strands at neutral wire connection points.
- Improper use of aluminum wire.

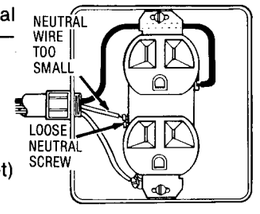


Figure 38

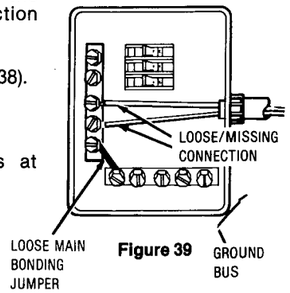


Figure 39

TEST #5A-5

Step 3. Connect the white clip lead to the neutral or "common" terminal and the black clip to the unmarked or "hot" terminal of the system. Check wiring lamps for "correct wiring" (Fig. 36).

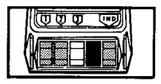
CAUTION! If the wiring lamps indicate an "Open Ground," reconnect the green clip to any exposed bare metal surface on the equipment. If you cannot achieve "Correct Wiring" after having moved the clip to several bare metal surfaces, the ground path of the equipment under test is *TOTALLY OPEN!*

THIS IS A HAZARDOUS CONDITION! UNPLUG AND REPAIR EQUIPMENT BEING TESTED.

Step 4. Press and hold the Red (S-2) button.

Step 5. Watch Wiring Errors Lamps (1, 2 & 3).

OR



IND is OFF or flashing.

↓

Impedance is *greater* than the ohmic value shown on the instrument label.

↓

Correct the problem and retest.

IND is ON.

↓

Impedance is *less* than the ohmic value shown on the instrument label.

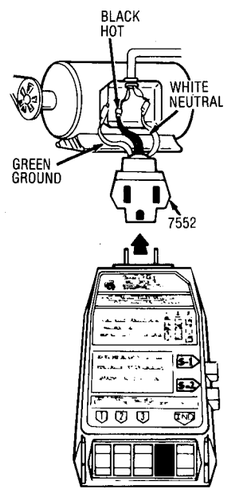


Figure 36

TEST #3

EXCEPTION: IF YOU ARE TESTING WITHIN 20′ OF THE MAIN ELECTRICAL SERVICE ENTRANCE OR AT A NEWLY CREATED ELECTRICAL SOURCE (EXAMPLES: ISOLATION TRANSFORMERS, POWER CONDITIONERS, GENERATORS, ETC.) THE INSTRUMENT WILL INDICATE THE REQUIRED NEUTRAL TO GROUND BOND IN THAT EQUIPMENT. *THIS IS NOT A PROBLEM.*

THE EXISTENCE OF A N/G SHORT AT ANY OTHER POINT IN THE ELECTRICAL SYSTEM IS A VIOLATION OF NATIONAL ELECTRICAL CODE AND SAFE WIRING PRACTICES.

Note: When a neutral wire and a ground wire are connected at an electrical source, the connection is called a bond (required condition).

When a neutral wire and a ground wire are connected at any other point in an electrical system, the connection is called a short (fault condition).

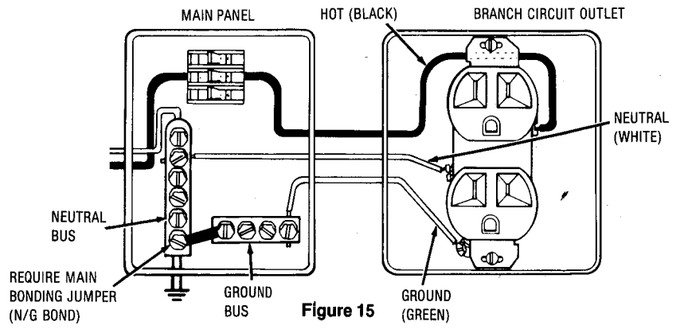


Figure 15

TEST #3

To locate a Neutral to Ground Short:

(a) at an outlet within 20′ of the main service entrance,
or
(b) at any other outlet,

Use a grounded (3-wire) extension cord (18 gauge) 15 feet long (Fig. 16).

Step 1. Plug the cord into the outlet.

Step 2. Plug the instrument into the cord.

Step 3. Perform Test #3 again (repeat steps 1-4 on page 12).

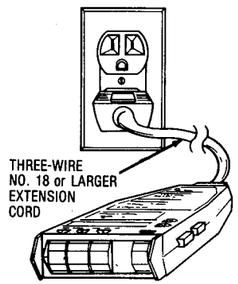


Figure 16

Note: If a neutral to ground short appears, the neutral to ground short is in the outlet. If no neutral to ground short appears, the neutral to ground short is between the outlet and the power panel.

(c) in electronic equipment that is plugged into the branch circuit under test.

Note: Electronic equipment often uses filters to suppress electrical noise. Such devices may contain circuits that create N/G shorts. To check this possibility, unplug the electronic filter or equipment from the branch circuit under test and retest the circuit.

TEST #3A

Test #3A. ISOLATED (DEDICATED GROUND SHORT) TEST PROCEDURE

AN ISOLATED GROUND SHORT OR "GROUND LOOP" WILL CAUSE ELECTRONIC EQUIPMENT PERFORMANCE PROBLEMS. AN ISOLATED GROUND IS USED

TEST #5A-5

TEST #5A-5. GROUNDING PATH IMPEDANCE TESTING PROCEDURE FOR ELECTRICAL OR ELECTRONIC HARDWIRED EQUIPMENT.

Use this test on hardwired equipment, terminal strips, panel boards, junction boxes or other power system grounds not accessible through an outlet, in order to assure safety and adequate performance of the equipment.

You will need Model 7552 Hardwired Equipment Probe to perform this test. Follow the preliminary steps shown below:

Step 1. Plug the instrument into the Model 7552 Probe.

Step 2. Connect the green clip lead of the test probe to the ground terminal of the system or to the grounded case of the junction box or panel board (Fig. 35).

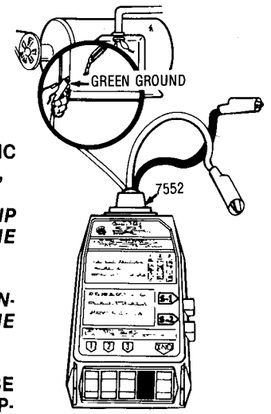


Figure 35

WARNING! TO AVOID THE POSSIBILITY OF ELECTRIC SHOCK WHEN USING THE 7552 PROBE,

1. **ALWAYS *CONNECT THE GREEN CLIP LEAD FIRST* AND *DISCONNECT THE GREEN CLIP LEAD LAST.***

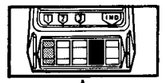
2. ***KEEP YOUR FINGERS ON THE INSULATED RUBBER COVERS OF THE CLIPS.***

   DO NOT TOUCH THE METAL PROBE TIPS OR METAL TERMINALS OF EQUIPMENT UNDER TEST.

TEST #5A-4

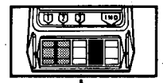
b. Use the 7565 Probe and perform steps #3 through #5 above on the shield of each cable, connecting the probe to the shield of the data cable, *NOT* the equipment frame or screws (Fig. 34).

c. Watch wiring Errors lamps (1, 2 & 3).



If the instrument indicates "OPEN GROUND," then the shield is not a parallel grounding path from the point of the test.

OR



If the instrument indicates "CORRECT WIRING," then the shield is a parallel grounding path from the point of the test.

This procedure may be repeated from various equipment locations or workstations.

TEST #3A

PRIMARILY FOR ELECTRONIC EQUIPMENT BECAUSE IT REDUCES THE INCIDENCE OF "NOISE" ON THE GROUNDING PATH.

Reference N.E.C. Article 250-74 Exception 4

Note: Use this test to determine the existence and quality of an isolated (dedicated) grounding path to an IG (Isolated Ground) outlet where such systems have been specified (Fig. 17).

All parts of the isolated ground system shown below *must* be present and properly connected.

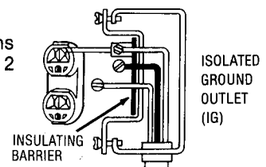
- The outlet must be orange or have a "delta" (Δ) on the front.
- The outlet must be grounded by an insulated green wire.
- The outlet must have an insulator between the grounding terminal and the mounting bracket.

Step 1. Look at the outlet. The outlet must be orange or have a "delta" (Δ) on the front. *If not,* the system is not isolated. DO NOT PROCEED — Replace with a correct outlet and repeat Tests 1, 2 and 3, before doing any more testing.

Step 2. Use Model 7562 Test Probe for this test.

Step 3. Be sure the black (S-1) and the red (S-2) buttons are OUT and that you have passed tests 1 and 2 before proceeding.

Step 4. Plug the instrument into the 7562 Probe.



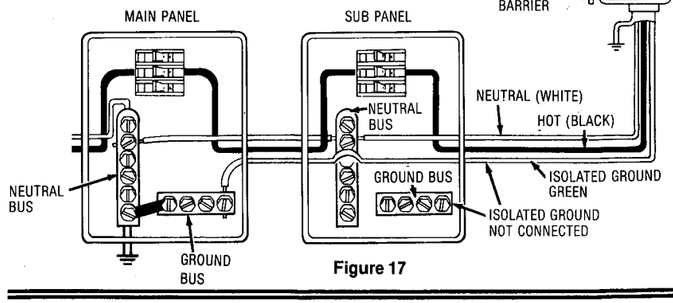


Figure 17

TEST #3A

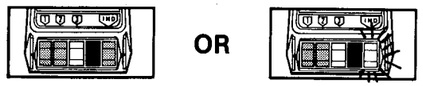
Step 5. Holding only the clip insulator, press the green clip lead **FIRMLY** against the metal mounting screw or the outlet cover plate or clip to the edge of the metal conduit box.

Step 6. Plug the 7562 Probe into the outlet (Fig. 18).

Step 7. Press the black (S-1) (IN).

Step 8. Press and hold the red (S-2).

Step 9. Watch the IND lamp.



OR

IND is ON

↓

Green wire is shorted to the conduit ground within 20′ of the outlet. System is *not* isolated.

↓

Repair and retest.

IND is OFF or flashes

↓

Green wire ground is isolated from the conduit ground.

↓

Go to Test #4.

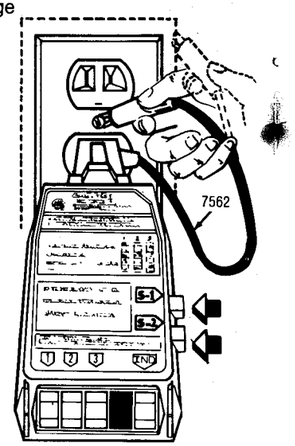


Figure 18

TEST #4

Test #4. NEUTRAL AND GROUND WIRE REVERSAL TEST PROCEDURE

NEUTRAL/GROUND REVERSAL IS A SERIOUS SAFETY HAZARD. IT ALSO FREQUENTLY CAUSES POOR PERFORMANCE OR DAMAGE TO COMPUTERS AND OTHER ELECTRONIC EQUIPMENT WITH SOLID STATE DEVICES.

Reference N.E.C. Article 250-23A

TEST #5A-4

ADDITIONAL PROCEDURE

PROCEDURE FOR FINDING GROUNDED CABLE SHIELDS (Parallel Grounding Paths)

Your instrument can also be used to test for the existence of parallel grounding paths that may be created by the grounded shields on data communication cables.

a. Disconnect all data cables from (E-1) (Fig. 34).

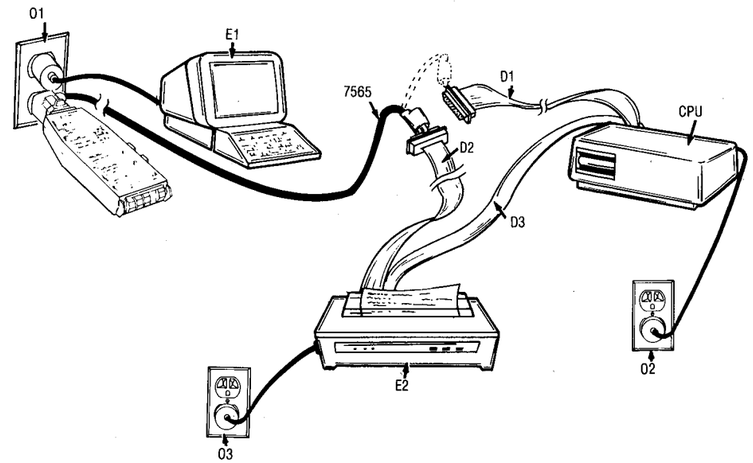
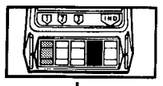
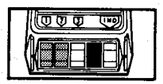


Figure 34

TEST #5A-4



OR



Step 6. If the instrument indicates "OPEN GROUND," (E-1) is isolated and NO parallel grounding paths exist.

Step 7. Reconnect equipment (E-1) power cord and retest (E-1) to determine impedance of frame and equipment grounding paths through power cord and the outlet (0-1) (Fig. 33).

Step 6. If the instrument indicates "CORRECT WIRING," then one or more parallel grounding paths exist.

Step 7. If one or more parallel grounding paths exist, see the additional procedure outlined on page 29.

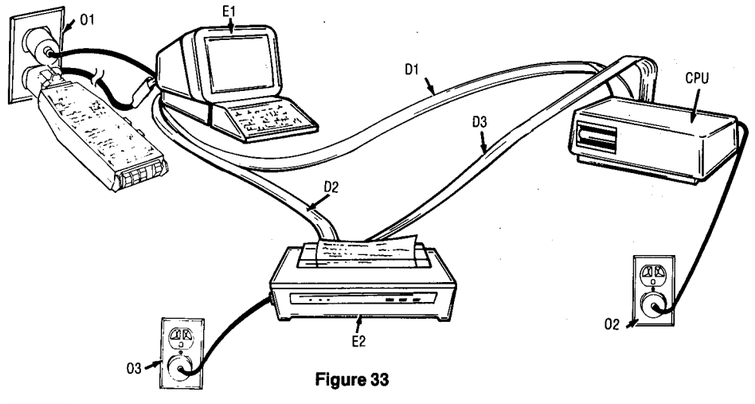


Figure 33

TEST #4

Below is a list of the four types of grounded power systems. This test applies only to system types 3 and 4, as shown in Table 1 below.

Types of Grounded Power Systems (Fig. 19)

Type 1. 2 wires (H,N) in metallic conduit or BX with standard outlet.

Type 2. 3 wires (H,N,G) in metallic conduit or BX with standard outlet.

Type 3. 3 wires (H,N,G) in metallic conduit or BX with designated isolated ground (IG) outlet.

Type 4. 3 wires (H,N,G) in Romex or plastic conduit and outlet boxes with standard or isolated ground outlet.

Table 1. When to use Neutral and Ground Reversal Test

System Type	N/G Reversal Test Req'd.	If N/G Reversed, the instrument will show:
1	NO	Cannot Exist
2	NO	N/G Shorted (Test #3)
3	YES	N/G Reversed
4	YES	N/G Reversed

Note: This test is applicable ONLY as described in the table above.

Use Model 7561 Test Probe in this test.

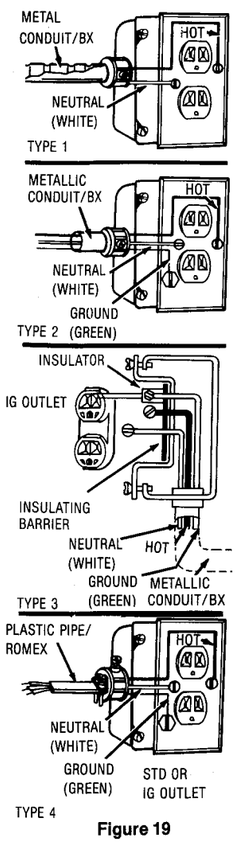


Figure 19

TEST #4

CAUTION! ***Before You Perform This Test, Both Outlets Must:***

- ***Show "Correct Wiring" (Test #1)***
- ***Show at Least 105 V. (Test #2)***
- ***Show No Neutral to Ground Short at Either Outlet (Test #3)***
- ***Be on the Same Branch Circuit.***

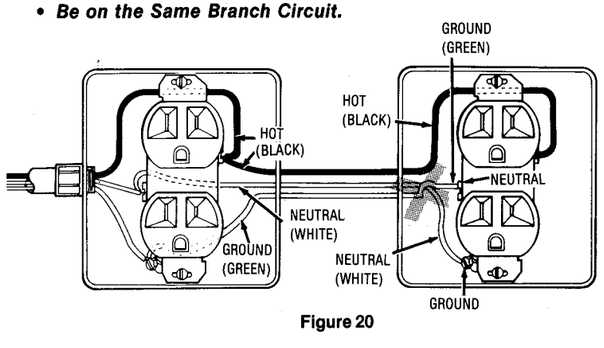


Figure 20

Step 1. Be sure the black (S-1) and red (S-2) buttons are OUT and that you have passed tests 1, 2 and 3 before proceeding.

Step 2. Insert the instrument into the adapter end of the 7561 probe.

Step 3. Insert the instrument into the first outlet.

Step 4. Press the black (S-1) button IN (Fig. 21).

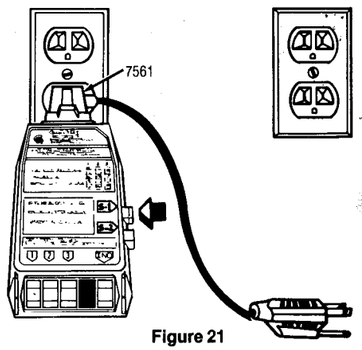


Figure 21

TEST #5A-4

TEST #5A-4. GROUNDING PATH IMPEDANCE TEST PROCEDURE FOR PARALLEL GROUNDING PATHS

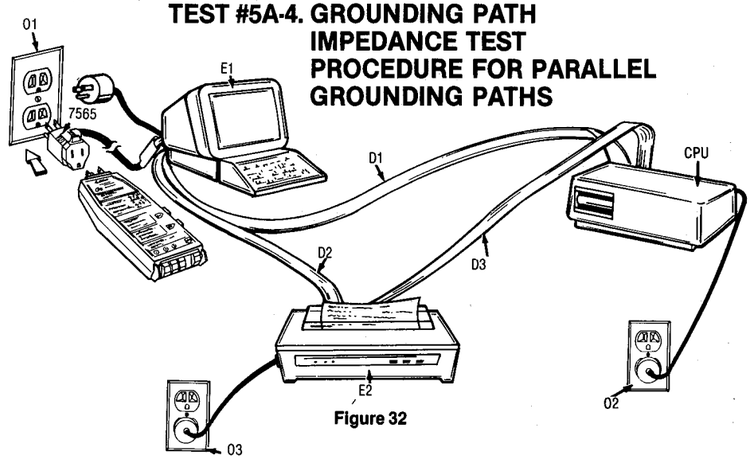


Figure 32

CAUTION! Turn the power switch *on the equipment to be tested (E-1)* to the "OFF" position.

Step 1. Disconnect equipment (E-1) from outlet. (See Fig. 32.)

Step 2. Make sure that outlet (0-1) passes Tests 1, 2 & 3.

Step 3. Plug instrument into 7565 Probe and attach green clip lead to the metal frame or metal screw heads of equipment (E-1).

Step 4. Plug instrument and probe into outlet (0-1).

Step 5. Watch Wiring Errors lamps (1, 2 & 3).

TEST #5A-3

To test the grounding path impedance on an equipment frame or on a GFCI protected outlet, without tripping the GFCI, follow these preliminary steps:

Step 1. Plug the instrument into Model 7565 Remote Ground Test Probe.

Step 2. Plug the 7565 Probe into a NON-GFCI PROTECTED previously tested outlet.

Step 3. Insert the clip lead of the 7565 Probe into the ground pin slot of the protected outlet, or touch the metal face plate or screw (Fig. 31).

Step 4. Perform test #5 below.

Test #5. Basic Impedance Test

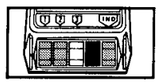
Step 1. Be sure the black (S-1) and red (S-2) buttons are OUT and that you have passed tests 1, 2, 3 & 4 before proceeding.

Step 2. Plug the instrument into the outlet to be tested.

Step 3. Press and hold the red (S-2) button (Fig. 31).

Step 4. Watch Wiring Errors Lamp (1, 2 & 3).

OR



IND is OFF or flashing.

↓

Impedance is *greater* than the ohmic value shown on the instrument label.

↓

Correct the problem and retest.

IND is ON.

↓

Impedance is *less* than the ohmic value shown on the instrument label.

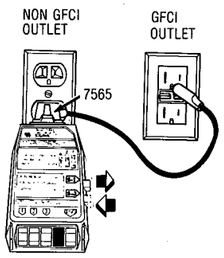


Figure 31

TEST #4

Step 5. Watch the IND lamp.

OR

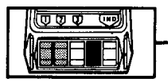
IND is OFF.

↓

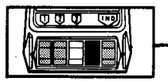
Step 6. Plug probe end of 7561 into second outlet on the branch circuit.

↓

Step 7. Watch IND lamp.



IND is OFF
N/G Reversed between the two outlets. Correct and retest.



IND is ON.
No N/G Reversal.
Go to Test #5.

IND is ON.

↓

Step 6. Plug probe end of 7561 into second outlet on the branch circuit.

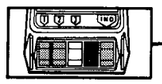
↓

Step 7. Press and hold the red (S-2) button (Fig. 22).

↓

Step 8. Watch the IND lamp.

IND is OFF or flashing.
N/G reversal exists.
Correct and retest.



IND is ON.
No N/G Reversal.
Go to Test #5.

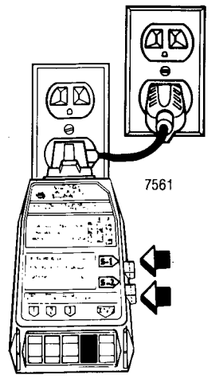


Figure 22

TEST #5

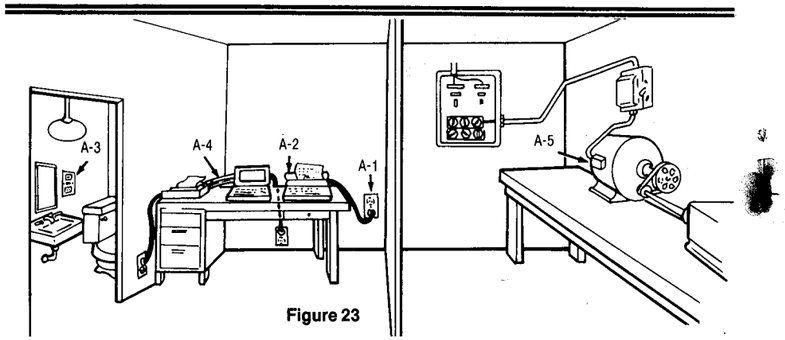


Figure 23

Test #5. IMPEDANCE TESTING PROCEDURES.

AN IMPEDANCE GREATER THAN THE OHMIC VALUE SHOWN ON THE INSTRUMENT MAY BE A SERIOUS SAFETY AND FIRE HAZARD. IT COULD PREVENT THE FUSE OR CIRCUIT BREAKER FROM IMMEDIATELY CUTTING OFF POWER WHEN A FAULT (SHORT OR HAZARDOUS WIRING PROBLEM) OCCURS.

Checking for a low impedance in the grounding path and neutral conductor is a critical part of testing your wiring system for safety and to help assure good performance of electronic equipment.

THE LOWER THE IMPEDANCE, THE BETTER!

Test #5 is the basic impedance test, for use in testing two impedance conditions:
A. Grounding path impedance
B. Neutral wire impedance

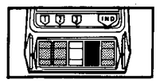
The following procedures cover six types of electrical situations where impedance tests should be performed, five to test grounding path impedance and one to test neutral wire impedance.

Several of these electrical situations require preliminary steps to connect probes to the instrument or to equipment but ALL use Test #5...the Basic Impedance Test.

TEST #5A-2

Step 4. Watch Wiring Error Lamps (1, 2 & 3).

OR



IND is OFF or flashing.
↓
Impedance is *greater* than the ohmic value shown on the instrument label.
↓
Correct the problem and retest.

IND is ON.
↓
Impedance is *less* than the ohmic value shown on the instrument label.

TEST #5A-3

TEST #5A-3. GROUNDING PATH IMPEDANCE TEST PROCEDURE FOR GFCI PROTECTED OUTLETS

This same procedure can be used to test the quality (impedance) of the grounding path in a GFCI (ground fault circuit interrupter) protected outlet. See procedure described below.

NOTE: In instances where the instrument is plugged directly into a GFCI protected outlet, the test current injected when the RED (S-2) button is pushed will cause the GFCI to trip immediately. This result means that the GFCI is working as it should (Fig. 30).

If the GFCI does not trip, indicated by any lamps on the instrument being "ON," unplug the instrument. The GFCI is not working properly, or the outlet is not GFCI protected. An electrician may be required.

Be sure to reset the GFCI after testing, so that the circuit has power again.

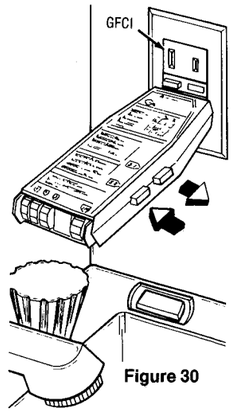


Figure 30

TEST #5A-2

protection device (fuse or circuit breaker) is located. This is the path that fault current will follow when a fault occurs. The lower the ohmic value of this path, the safer the equipment.

CAUTION! Turn the power switch *on the equipment to be tested* to the "OFF" position.

You will need Model 7565 Remote Ground Test Probe to perform this test.

To test the grounding path on equipment cases and frames, follow these preliminary steps:

Step 1. Plug the instrument into Model 7565 Remote Ground Test Probe.

Step 2. Attach the clip lead of the 7565 Probe to *bare metal* on the equipment frame or case (Fig. 29).

WARNING! ALWAYS CONNECT THE GREEN CLIP LEAD *BEFORE* YOU PLUG THE TEST PROBE INTO THE OUTLET AND DISCONNECT THE GREEN LEAD *AFTER* YOU UNPLUG THE TEST PROBE.

Step 3. Plug the 7565 Probe into a previously tested outlet.

Step 4. Perform Test #5 below.

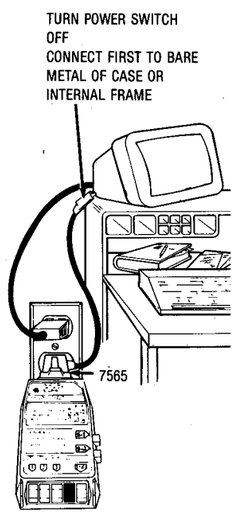


Figure 29

Test #5. Basic Impedance Test

Step 1. Be sure the black (S-1) and red (S-2) buttons are OUT and that tests 1, 2, 3 & 4 have been passed before proceeding.

Step 2. Plug the instrument into the outlet to be tested.

Step 3. Press and hold the red (S-2) button.

TEST #5

TEST #5A. GROUNDING PATH IMPEDANCE (Fig. 23)

A-1. Outlets, *not* GFCI (Ground Fault Circuit Interrupter) protected. (See page 23.)

A-2. Equipment Cases and frames. (See page 23.)

A-3. G.F.C.I. (Ground Fault Circuit Interrupter protected. (See page 25.)

A-4. Parallel Grounding Paths (cables). (See page 27.)

A-5. Hardwired Electrical or electronic equipment. (See page 31.)

Test #5B. NEUTRAL WIRE (SYSTEM GROUND) IMPEDANCE — OUTLET OR FOUR-WIRE SYSTEM.(See page 33.)

You may use one or more of these tests, depending on your wiring conditions. Most likely you will always perform tests A-1 and B. Tests A-2 through A-5 are more specialized.

CAUTION! Before performing this test, your equipment *must* have passed all previous test procedures (Tests #1, 2, 3 and 4 as applicable).

Test #5A. GROUND PATH IMPEDANCE TESTING PROCEDURES

TEST #5A

A GROUNDING PATH IMPEDANCE GREATER THAN THE OHMIC VALUE SHOWN ON THE INSTRUMENT LABEL MAY BE A SERIOUS SAFETY AND FIRE HAZARD. IT COULD PREVENT THE FUSE OR CIRCUIT BREAKER FROM IMMEDIATELY CUTTING OFF THE POWER WHEN A FAULT (SHORT OR HAZARDOUS WIRING PROBLEM) OCCURS.

TEST #5A

Reference N.E.C. Article 250-51

A good quality (low impedance) grounding path will also help assure good performance of electronic equipment by reducing the incidence and severity of normal and common mode electrical noise, static discharge and transient voltages.

POSSIBLE CAUSES:

- Loose or worn blade in the grounding slot of the outlet (Fig. 24).
- Loose connection at the ground (green) screw of the outlet (Fig. 25).
- Loose or missing connectors or screws at conduit joints (Fig. 26).
- Loose ground connections at a secondary or main panel or a junction box (Fig. 27).
- Loose main bonding jumping at main panel (Fig. 27).
- Ground wire sized too small (Fig. 25).
- Grounding wire too long.
- Grounding wire not run with supply circuit conductors.
- Missing or broken wire strands on grounding wire connections.
- Use of wire nuts to connect grounding wires.

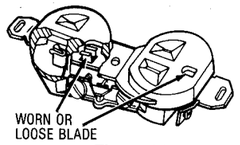


Figure 24

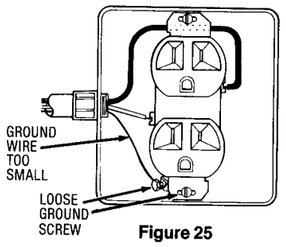


Figure 25

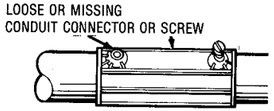


Figure 26

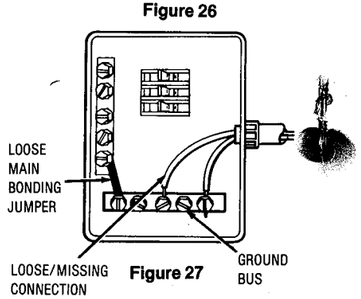


Figure 27

TEST #5A-1

TEST #5A-1. GROUNDING PATH IMPEDANCE TESTING PROCEDURE FOR OUTLET (NOT GFCI PROTECTED)

Test #5. Basic Impedance Test

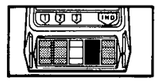
Step 1. Be sure the black (S-1) and red (S-2) buttons are OUT and that tests 1, 2, 3 & 4 have been passed before proceeding (Fig. 28).

Step 2. Plug the instrument into the outlet to be tested.

Step 3. Press and hold the red (S-2) button.

Step 4. Watch Wiring Error Lamps (1, 2 & 3).

OR



IND is OFF or flashing

↓

Impedance is *greater* than the ohmic value shown on the instrument label.

↓

Correct the problem and retest.

IND is ON

↓

Impedance is *less* than the ohmic value shown on the instrument label.

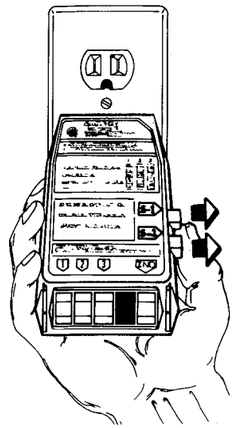


Figure 28

TEST #5A-2

TEST #5A-2. GROUNDING PATH IMPEDANCE TEST PROCEDURE FOR EQUIPMENT CASES/FRAMES

Your instrument will test the quality (impedance) of the grounding path from an equipment case/frame, through the equipment's power cord, into the outlet and all the way back to the main service panel where the overcurrent