FLUKE®

Biomedical

ESA601

Electrical Safety Analyzer

Operators Manual

November 2004

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Warranty

Warranty and Product Support

Fluke Biomedical warrants this instrument against defects in materials and workmanship for one full year from the date of original purchase. During the warranty period, we will repair or, at our option, replace at no charge a product that proves to be defective, provided you return the product, shipping prepaid, to Fluke Biomedical. This warranty does not apply if the product has been damaged by accident or misuse or as the result of service or modification by other than Fluke Biomedical. IN NO EVENT SHALL FLUKE BIOMEDICAL BE LIABLE FOR CONSEQUENTIAL DAMAGES.

Only serialized products and their accessory items (those products and items bearing a distinct serial number tag) are covered under this one–year warranty. PHYSICAL DAMAGE CAUSED BY MISUSE OR PHYSICAL ABUSE IS NOT COVERED UNDER THE WARRANTY. Items such as cables and nonserialized modules are not covered under this warranty.

Recalibration of instruments is not covered under the warranty.

This warranty gives you specific legal rights, and you may also have other rights which vary from state to state, province to province, or country to country. This warranty is limited to repairing the instrument to Fluke Biomedical's specifications.

Warranty Disclaimer

Should you elect to have your instrument serviced and/or calibrated by someone other than Fluke Biomedical, please be advised that the original warranty covering your product becomes void when the tamper-resistant Quality Seal is removed or broken without proper factory authorization. We strongly recommend, therefore, that you send your instrument to Fluke Biomedical for factory service and calibration, especially during the original warranty period.

In all cases, breaking the tamper-resistant Quality Seal should be avoided at all cost, as this seal is the key to your original instrument warranty. In the event that the seal must be broken to gain internal access to the instrument, you must first contact Fluke Biomedical's Technical Assistance Department at 775-883-3400. You will be required to provide the serial number for your instrument as well as a valid reason for breaking the Quality Seal. You should break this seal only after you have received factory authorization. Do not break the Quality Seal before you have contacted us. Following these steps will help ensure that you will retain the original warranty on your instrument without interruption.

Notices

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Unpacking and Inspection

Follow standard receiving practices upon receipt of the instrument. Check the shipping carton for damage. If damage is found, stop unpacking the instrument. Notify the carrier and ask for an agent to be present while the instrument is unpacked. There are no special unpacking instructions, but be careful not to damage the instrument when unpacking it. Inspect the instrument for physical damage such as bent or broken parts, dents, or scratches.

Claims

Our routine method of shipment is via common carrier, FOB origin. Upon delivery, if physical damage is found, retain all packing materials in their original condition and contact the carrier immediately to file a claim. If the instrument is delivered in good physical condition but does not operate within specifications, or if there are any other problems not caused by shipping damage, please contact Fluke Biomedical or your local sales representative.

Standard Terms and Conditions

Refunds and Credits

Please note that only serialized products and their accessory items (i.e., products and items bearing a distinct serial number tag) are eligible for partial refund and/or credit. Nonserialized parts and accessory items (e.g., cables, carrying cases, auxiliary modules, etc.) are not eligible for return or refund. Only products returned within 90 days from the date of original purchase are eligible for refund/credit. In order to receive a partial refund/credit of a product purchase price on a serialized product, the product must not have been damaged by the customer or by the carrier chosen by the customer to return the goods, and the product must be returned complete (meaning with all manuals, cables, accessories, etc.) and in "as new" and resalable condition. Products not returned within 90 days of purchase, or products which are not in "as new" and resalable condition, are not eligible for credit return and will be returned to the customer. The Return Procedure (see below) must be followed to assure prompt refund/credit.

Restocking Charges

Products returned within 30 days of original purchase are subject to a minimum restocking fee of 15 %. Products returned in excess of 30 days after purchase, but prior to 90 days, are subject to a minimum restocking fee of 20 %. Additional charges for damage and/or missing parts and accessories will be applied to all returns.

Return Procedure

All items being returned (including all warranty-claim shipments) must be sent freight-prepaid to our factory location. When you return an instrument to Fluke Biomedical, we recommend using United Parcel Service, Federal Express, or Air Parcel Post. We also recommend that you insure your shipment for its actual replacement cost. Fluke Biomedical will not be responsible for lost shipments or instruments that are received in damaged condition due to improper packaging or handling.

Use the original carton and packaging material for shipment. If they are not available, we recommend the following guide for repackaging:

- Use a double–walled carton of sufficient strength for the weight being shipped.
- Use heavy paper or cardboard to protect all instrument surfaces. Use nonabrasive material around all projecting parts.
- Use at least four inches of tightly packed, industry-approved, shock-absorbent material around the instrument.

Returns for partial refund/credit:

Every product returned for refund/credit must be accompanied by a Return Material Authorization (RMA) number, obtained from our Customer Service Department:

Customer Service
Fluke Biomedical
800-648-7952 (USA) or 775-883-3400.

Returns for service/repair/calibration:

In order to expedite service, please schedule a repair or calibration by calling 888-99FLUKE (888-993-5853) to obtain an RMA # prior to sending the equipment. For international customers, please email service.international@fluke.com to obtain this RMA #.

Ship the instrument, freight-prepaid and fully insured, to the following address:

Fluke Customer Service Center
1420 – 75th Street SW
Everett, WA 98203

Certification

This instrument was thoroughly tested and inspected. It was found to meet Fluke Biomedical's manufacturing specifications when it was shipped from the factory. Calibration measurements are traceable to the National Institute of Standards and Technology (NIST). Devices for which there are no NIST calibration standards are measured against in-house performance standards using accepted test procedures.

WARNING

Unauthorized user modifications or application beyond the published specifications may result in electrical shock hazards or improper operation. Fluke Biomedical will not be responsible for any injuries sustained due to unauthorized equipment modifications.

Restrictions and Liabilities

Information in this document is subject to change and does not represent a commitment by Fluke Biomedical. Changes made to the information in this document will be incorporated in new editions of the publication. No responsibility is assumed by Fluke Biomedical for the use or reliability of software or equipment that is not supplied by Fluke Biomedical, or by its affiliated dealers.

Manufacturing Location

The ESA601 Electrical Safety Analyzer is manufactured in Everett, WA, U.S.A.

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Standards and Safety

Applicable Testing Standards

Fluke Biomedical's ESA601™ Electrical Safety Analyzer (hereafter called the ESA601) has been tested and certified to US and Canadian standards by CSA. The unit conforms to IEC/EN 61010-1 2nd Edition and IEC/EN 61326 and bears the CE mark.

USA Class A

⚠WARNING ⚠

Warning: Changes or modifications to this unit not expressly approved by the manufacturer could void the user's authority to operate the equipment.

This equipment has been tested and found to comply with the limits for a Class A digital device.

These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. Like all similar equipment, this equipment generates, uses, and can radiate radio frequency energy, and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause interference, in which case the user will be required to correct the interference at his/her own expense.

Canadian Department of Communications Class A

This digital apparatus does not exceed Class A limits for radio emissions from digital apparatus set out in the Radio Interference Regulations of the Canadian Department of Communications.

Le present appareil numerique n'met pas du bruits radioelectriques depassant les limites applicables aux appareils numerique de la Class A prescrites dans le Reglement sur le brouillage radioelectrique edicte par le ministere des Communications du Canada.

CE Based on the testing standards below, this device bears the CE mark.

EC Directive 89/336/EEC Electromagnetic Compatibility

Emissions - Class A

The system has been type tested and found to meet the requirements of EN 61326:1997/A1: 1998/A2: 2001 for Radiated Emissions and Line Conducted Emissions.

Immunity

The system has been type tested and found to meet the requirements of EN 61326:1997/A1: 1998/A2: 2001 for Immunity. Verification of compliance was conducted to the limits and methods of the following:

EN 61000-3-2	Harmonics Current Emission
EN 61000-3-3	Voltage Fluctuations and Flicker
EN 61000-4-2	Electrostatic Discharge
EN 61000-4-3	RF Electromagnetic Fields
EN 61000-4-4	Fast Transient/Burst
EN 61000-4-5	Surge Immunity
EN 61000-4-6	RF Common Mode Disturbances
EN 61000-4-11	Voltage Dips, Short Interruptions and AC Variations

EC Directive 73/23/EEC Low Voltage

User Safety

The system has been type tested and found to meet the requirements of EC Directive 73/23/EEC for Low Voltage. Verification of compliance was conducted to the limits and methods of the following:

EN 61010-1 (2001) 2nd Edition

"Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use, Part 1: General requirements" (including amendments 1 and 2).

Safety Considerations

Use of this instrument is restricted to qualified personnel who recognize shock hazards and are familiar with safety precautions used when operating electrical equipment. Read the manual carefully before operating the **ESA601**. The following warning and informational symbols may be found on the **ESA601**:

Symbol	Description
	**Protective-Earth Resistance**
	**Caution** **(Refer to accompanying documentation.)**
	**Caution** **Risk of electric shock**
	ON **(Connects power for operation.)**
	**OFF** **(Disconnects power.)**

⚠⚠Warning. Read before using the Analyzer

To avoid possible electrical shock or personal injury, follow these guidelines:

⇒ **Do not use the ESA601 in any manner not specified in this manual.**

⇒ **Before connecting or disconnecting a DUT to the ESA601, the FUNCTION-SELECTION KNOB should be set to the OFF position.**

⇒ **Exercise extreme caution when a shock hazard is present at the instrument's measurement terminals during the following tests:**

- **Mains-Insulation-Resistance test**
- **Applied-Parts-Insulation-Resistance test**
- **Mains-on-Applied-Parts-Leakage-Current test**
- **Equivalent-Device-Leakage-Current test**
- **Equivalent-Patient-Leakage-Current test**

⇒ **Always turn OFF power to the ESA601 and unplug the power cord before cleaning the outer surface.**

⇒ **Portable devices located in isolated power systems should be tested on an earth-referenced power system. Either remove the DUT to an area with an earth-referenced power system, or use an extension cord to bring earth-referenced power to the DUT.**

⇒ **Inspect the product, if the instrument appears damaged or appears to operate in a manner not specified in the manual, DO NOT CONTINUE USE. Return the product for service.**

⇒ **Avoid spilling liquids on the analyzer; fluid seepage into internal components creates corrosion and a potential shock hazard. Do not operate the instrument if internal components are exposed to fluid.**

⇒ **Do not open this product. There are no user replaceable parts.**

Caution

The ESA601 should be calibrated annually. Only qualified technical personnel should perform troubleshooting and service procedures on the ESA601.

Do not expose the system to temperature extremes. Ambient operating temperatures should remain between 10 to 40 °C. System performance may be adversely affected if temperatures fluctuate above or below this range.

Clean only with a damp, lint-free cloth, using a mild detergent, and wipe down gently.

Before each use, inspect the test-lead ends for possible wear, cracks or breaks.

Take leakage-current measurements only after earth resistance is measured and found to be compliant with the applied safety limit.

If the DUT fails the Protective-Earth-Resistance test, the operator must discontinue testing and label the DUT defective.*

If any single test fails, the test must be discontinued immediately and the DUT labeled defective.*

*** In order for the ESA601 controller software to comply with these statements, “stop autosequences on failures” would need to be checked on the general tab, under the system configure menu.**

Chapter 1
General Information

Introduction to the ESA601

The Fluke Biomedical ESA601™ Electrical Safety Analyzer (hereafter called the ESA601) is a full-featured, low-cost, compact analyzer, designed to verify the electrical safety of medical devices. The ESA601 satisfies international (IEC 601-1,VDE) and domestic (ANSI/AAMI ES1) electrical-safety standards. The integrated ANSI/AAMI ES1 and IEC 601-1 patient loads are easily selectable, utilizing a slide switch.

The ESA601 quickly and easily measures many important parameters for electrical-safety testing:

- Mains voltage
- Earth resistance (one-amp test current) with lead nulling
- 500 V AP and Mains insulation
- Earth leakage
- Enclosure leakage
- Patient and patient-auxiliary leakage
- Mains on applied parts
- Equivalent-device and equivalent-patient leakage
- Differential leakage
- Dual-lead leakage
- Dual-lead voltage

Test results can be printed, and the ESA601 can be automated via the RS-232 port. The ESA601 utilizes a switching power supply with a voltage range of minimum 90 V to maximum 264 V. The ESA601 carries the CE, cULus, and C-Tick marks.

Whenever possible, all product-enclosure nomenclature utilizes internationally recognized symbols, terms, and icons.

A listing of specifications for the ESA601 is available in this manual as Appendix A.

ESA601 Package Contents

Each packing carton comes with one ESA601 Electrical Safety Analyzer configured to the country in which it will be used, and a selection of standard accessories. Additional optional accessories may also be packed with the analyzer based on the orginal order.

ESA601 Electrical Safety Analyzer

The ESA601 is available in eight factory-set versions that are unique combinations of DUT outlet types (test receptacle), detachable line cord, and overlay language. Table 1-1 lists the available versions of the ESA601 and the configuration of each.

Table 1-1. ESA601 Electrical Safety Analyzer Versions

Version	DUT Outlet (Test Recepticle)	Detachable Power Cord	Language Overlay	Model Number
Australian	Australia/New Zealand AS/NZ 3112-1993	Australian	English 1	ESA601-AUS
ROW (International)	Schuko CEE7	European	English 1	ESA601-SHK
French	Schuko CEE7	European	French	ESA601-FRA
German	Schuko CEE7	European	German	ESA601-DEU
Italian	Schuko CEE7	European	Italian	ESA601-ITAL
United Kingdom	United Kingdom BS 1363A	British	English 1	ESA601-UK
United States	United States NEMA 5-15R	120 V / 15 A	English 1 IEC Terms	ESA601-USA/IEC
United States	United States NEMA 5-15R	120 V / 15A	English 2 AAMI Terms	ESA601-USA

Note

English 1 utilizes IEC nomenclature; English 2 utilizes AAMI (NFPA99) nomenclature.

Standard Accessories

The following accessories are provided with the ESA601:

- RED test lead with probe (P/N 2391738)
- BLACK test lead with probe (P/N 2391723)
- ESA601 Operator's Manual and ESA601 controller software on a single CD (P/N 2388919)
- Serial cable (Null Modem) (P/N 2238626)
- Five (5) alligator/banana plug adapters (P/N 2391714)
- Soft-sided carrying case (P/N 2248650)
- ESA601 Getting Started (P/N 2243822)
- Calibration certification
- Country-specific power cord
- Registration card

Optional Accessories

The following accessories are optional:

- Alligator clamp (P/N 2004175)
- Banana/ECG adapters (P/N 2391669)
- DPU414 serial printer, 40 columns (AC adapter included) (P/N 2248899), with choice of 120-V AC adapter (P/N 2235375) or 220-V AC adapter (P/N 2235382)
- Serial printer cable for DPU414 printer, DB9-F to DB9-M (P/N 2238659)
- North American 220-V adapter kit (P/N 2185787)
- U.S. 220 V power cord (P/N 2238671)
- ESA601 Service Manual (P/N 2243831)

Unpacking the ESA601

Unpack the ESA601 and accessories from the shipping carton. Inspect the unit carefully for damage, such as cracks, dents or bent parts. If any physical damage is apparent, please call Fluke Biomedical for assistance between 8:00 AM and 5:00 PM, Pacific Standard Time, Monday through Friday, except holidays: (800)-648-7952 (in the U.S.) or (775) 883-3400. Also, notify the carrier if the damage appears to be the result of a shipping mishap.

Storage and Maintenance

As with most electronic equipment, the ESA601 should be operated in a dry area within normal temperature limits (10 °C to 40 °C). The maximum relative humidity at temperatures up to 31 °C is 80%, decreasing linearly to 50% relative humidity at 40°C.

There are no special storage requirements. However, when storing the unit, maintain the storage temperature between –25 °C and 50 °C.

The ESA601 should be recalibrated once a year by a qualified technician. Although the power output from the ESA601 is not potentially dangerous, internal circuits carry potentially lethal voltages and currents.

⚠ Warning

For safety reasons, only an experienced technician should perform maintenance requiring internal access.

ESA Characteristics

The following two sections will help familiarize you with the ESA601 Safety Analyzer's controls and features.

Top and Side Panels

Table 1-2 lists and describes the controls on the top and side panels that are called out in Figure 1. Some controls will have two names. The first name is the IEC nomenclature and the second, the AAMI nomenclature.

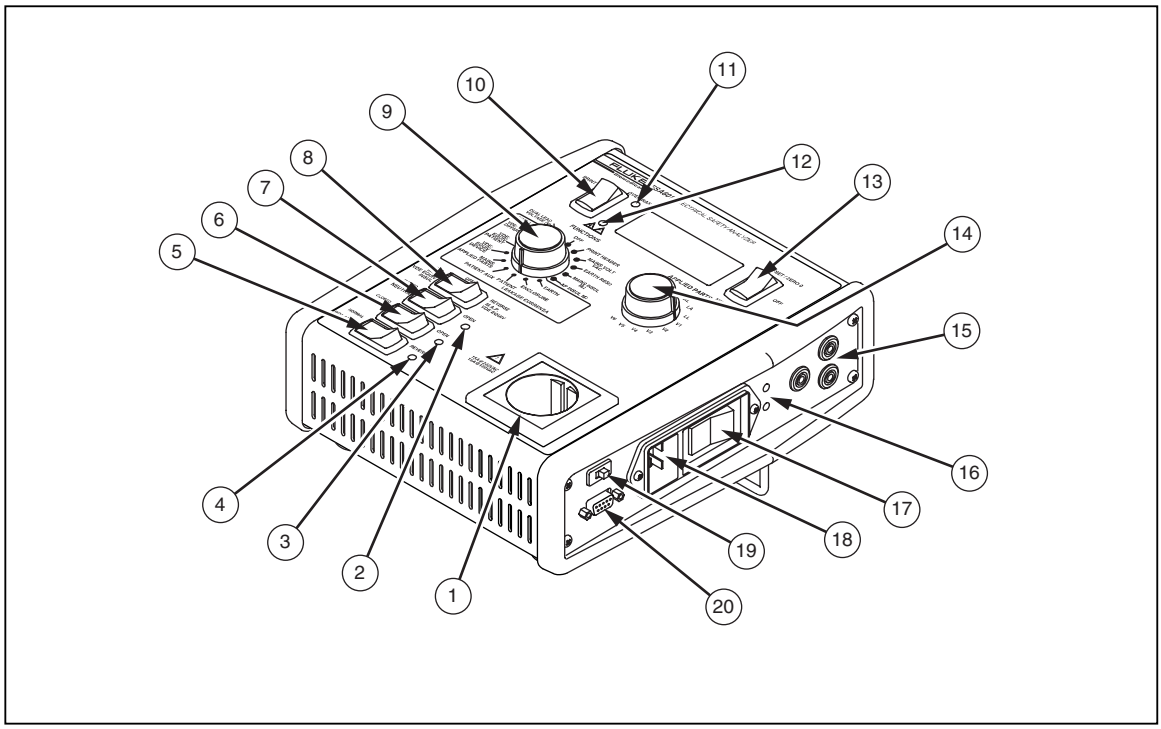

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Figure 1-1. Top and Side Panel Views of the ESA601

Table 1-2. Top and Side Panel Features

No.	Name	Description
1	TEST RECEPTACLE	An equipment outlet, specific to the version of the instrument, that provides a DUT connection: AS 3112-1993 (Australia); BS 1363A (English – United Kingdom); NEMA 5-15R (English – United States); Schuko CEE7 (French, German, Italian and ROW [international]).
2	OPEN-NEUTRAL INDICATOR	A LED next to the NEUTRAL SWITCH, which illuminates with an amber light (OPEN) if Equipment L2 is OPEN.
3	OPEN-EARTH INDICATOR OR OPEN GROUND INDICATOR	A LED next to the EARTH (or GROUND) SWITCH, which illuminates with an amber light (OPEN) if Equipment Earth is OPEN.
4	REVERSE-STATUS INDICATOR (DUT POLARITY)	A LED next to the POLARITY SWITCH, which illuminates with an amber light (REVERSE) if the Equipment-Outlet polarity is reversed.
5	POLARITY SWITCH	A rocker switch (toggle) with two positions (NORMAL, REVERSE), which reverses the polarity of the Equipment Outlet voltage.
6	EARTH SWITCH OR GROUND	A rocker switch (toggle) with two positions (CLOSED, OPEN), which opens the connection between Mains Earth and Equipment Earth (GROUND).
7	NEUTRAL SWITCH	A rocker switch (toggle) with two positions (CLOSED, OPEN), which opens the L2 line on the Mains side of the Mains POLARITY SWITCH.
8	M.A.P./ VDE EQUIV INSUL SWITCH OR ISO VDE EQUIV INSUL SWITCH	A rocker switch with three positions (NORMAL, OFF, REVERSE). The NORMAL and REVERSE positions are momentary, while the natural resting position is OFF. When the MAINS APPLIED PARTS (or LEAD ISOLATION) leakage-current test function is selected, this switch permits NORMAL and REVERSE polarity of the isolated Mains voltage. When either the VDE: EQUIV PATIENT or VDE:EQUIV DEVICE function is selected, this switch permits NORMAL and REVERSE polarity of the isolated Mains voltage. When either the MAINS INSUL or AP INSUL (or LEADS INSUL) function is selected, this switch enables the insulation-test voltage if (and only if) the switch is held down in the NORMAL position.
9	FUNCTION-SELECTION KNOB	A rotary switch with unlimited rotation, which enables the selection of any of sixteen functions.
10	PRINT SWITCH	A rocker switch with a momentary activation in the upward position, which sends the current measurement value to an ASCII text printer through the tester's RS-232 serial port. Applies only to Local Mode.

Figure 1-2. Top and Side Panel Features (cont.)

No.	Name	Description
11	OVER-RANGE-STATUS INDICATOR	A LED to the upper right of the PRINT SWITCH, which illuminates with a solid red light (OVER RANGE) if the input exceeds measurement range.
12	HIGH-VOLTS-STATUS INDICATOR 	A LED to the lower right of the PRINT SWITCH, with the pictures indicated below it, which illuminates with a flashing RED light (HIGH VOLTS) if M.A.P. voltage or 500 V DC is present on either the applied parts or L1/L2.
13	OHMS-FUNCTION SWITCH	A rocker switch that is functional only while the FUNCTION-SELECTION KNOB is positioned at the EARTH RES Ω (or GROUND WIRE RES Ω) function. This switch utilizes three positions (OFFSET / ZERO 0, OFF, MEASURE Ω). The mutually exclusive OFFSET / ZERO 0 and MEASURE Ω positions are momentary, while the natural resting position is OFF. A one-amp supply is turned ON when the switch is depressed to either the OFFSET / ZERO 0 or MEASURE Ω position, and is turned OFF when the switch is released. Meter readings are saved on the display for printing (if desired) upon release of the switch. A null offset is generated when OFFSET / ZERO 0 is depressed and the meter reads < 0.150 ohms; OL displays if a null offset was not generated. The null value is stored until another null is done.
14	APPLIED-PARTS-SELECTION KNOB OR ECG-LEADS-SELECTION KNOB	A rotary switch with eleven usable positions, which enables the selection of any individual – or all ten – applied parts (or ECG Leads) connectors.
15	SIGNAL CONNECTIONS	Three safety-style banana jacks, which provide signal connections: RED – signal input connection for Dual-Lead-Voltage, Dual-Lead-Leakage, Protective-Earth-Resistance (or Ground-Wire-Resistance) tests, and Leakage Currents; GREEN – direct connection to Equipment Outlet Earth; and BLACK – signal input connection for Dual-Lead-Voltage and Dual-Lead-Leakage tests.
16	POWER-STATUS INDICATORS	Two LEDs next to the POWER SWITCH. The lower LED illuminates with a green light (POWER) when the tester is switched on, while the upper LED illuminates with a RED light (POWER FAULT) if the inlet polarity is reversed or there is a fatal error at start-up.
17	POWER SWITCH	A rocker switch (toggle) with two positions (ON, OFF), which controls operating power to the tester.
18	POWER (MAINS) INLET	Accepts a standard IEC 60320-1 / C19 Mains inlet rated at 16 A and 250 V for Class-1 equipment in cold conditions.

Figure 1-2. Top and Side Panel Features (cont.)

No.	Name	Description
19	LOAD-SELECTION SWITCH	A slide switch, which permits the selection of either the ANSI / AAMI ES1 or the IEC 60601-1 patient load
20	RS-232 Port	A serial interface, which, in Remote Mode, enables remote operation of the ESA601, and provides a download port for processor firmware. In Local Mode, this port can be used to output test results to a serial ASCII printer when the PRINT SWITCH is pressed.

Back Panel

The back panel of the ESA601 features a full set of universal ECG jacks for connecting applied parts. Figure 1-2 shows the IEC nomenclature and Figure 1-3, the AAMI nomenclature. AHA and IEC color-coded dots label the jacks as an aid to connecting the corresponding U.S. and international ECG leads. Table 1-3 indentifies the use of each ECG jack.

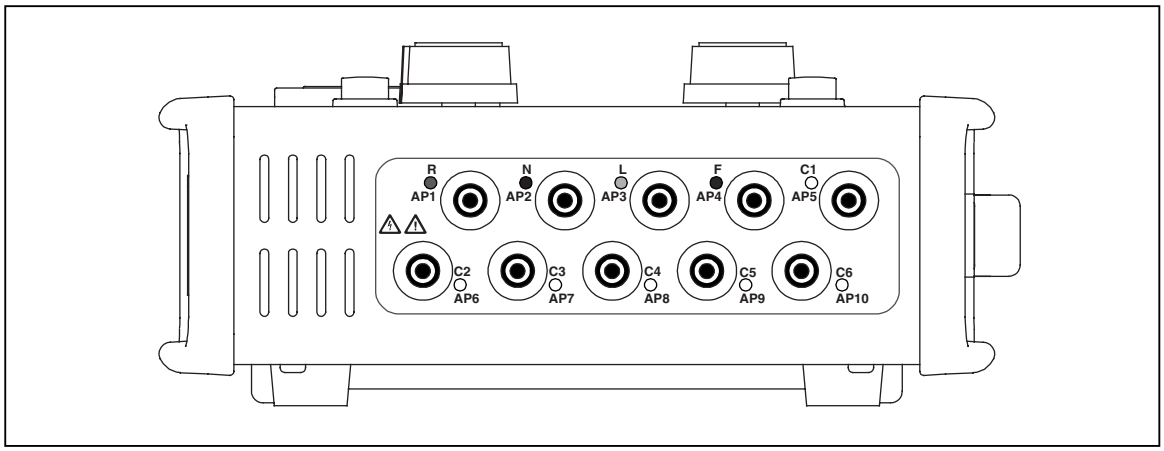

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Figure 1-2. Back Panel View of the ESA601 (IEC)

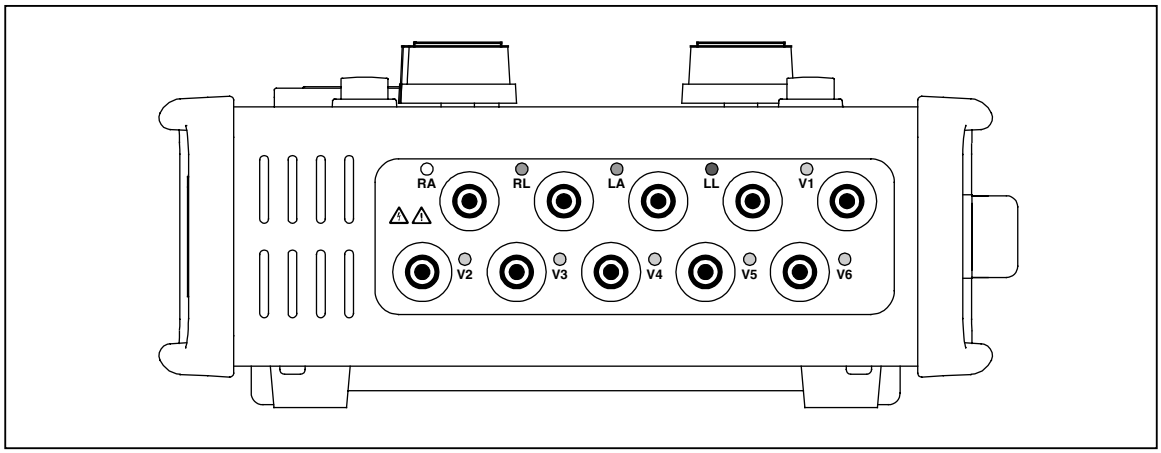

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Figure 1-3. Back Panel View of ESA601 (AAMI)

Table 1-3. Back Panel Connectors

Label	Meaning
RA or R, AP1	Right arm, applied part 1
RL or N, AP2	Right leg, applied part 2
LA or L, AP3	Left arm, applied part 3
LL or F, AP4	Left leg, applied part 4
V_1, V_2, V_3, V_4, V_5, and V_6	V Leads (U.S. and Canada), also referred to as pericardial, precordial, or unipolar chest leads
C_1, C_2, C_3, C_4, C_5, and C_6	Chest leads (international)
AP5, AP6, AP7, AP8, AP9 and AP10	Applied parts 5 through 10

Date of Manufacture

The date of manufacture of the ESA601 unit appears on a label on the bottom of the instrument, for example, MAY-04.

Chapter 2
Setting Up the ESA601

Title **Page**

Powering Up the ESA601

For the location of the FUNCTION-SELECTION KNOB, the POWER-STATUS INDICATORS, and the POWER SWITCH, refered to Figure 1-1 in Chapter 1 of this manual. Specifically locate items 10, 17, and 18, and the accompanying descriptions of switches and indicators on the unit's right-side and top panels.

With the controls identified, perform the following steps to power up the ESA601.

1. Turn the FUNCTION-SELECTION KNOB to the OFF position.
2. Power up the system by toggling the POWER SWITCH to the ON position. After three seconds the unit powers up, and a green light appears in the POWER LED to indicate the tester is switched on.
3. When the unit is powered up, the ESA601 will check for proper polarity and range of the AC-input voltage. During this check, the display indicates firmware X.XX (e.g. 1.00). If all goes well during power up, the display will show the word OFF.
4. If the FUNCTION-SELECTION KNOB is not set to OFF when the unit is powered up, the unit immediately moves (with audible clicking) to the mode indicated by the current FUNCTION-SELECTION KNOB setting, and the display indicates a reading related to that selected function (usually a meter reading).
5. If a fault is found at startup, a RED light appears in the POWER FAULT LED, and the ESA601 display indicates an error code. (For explanations of startup-error codes, see the section called "Error Codes" in Chapter 7 of this manual.

Note

Once you have the ESA601 up and running, please fill out the Registration Card and mail it to Fluke Biomedical.

Support

After power-up and connection, if the new ESA601 system fails to start or to operate successfully, please contact Fluke Biomedical immediately. The Technical Assistance Center is open between 8:00 AM and 5:00 PM, Pacific Standard Time, Monday through Friday, except holidays.

Contact Fluke Biomedical in the following ways:

(800) 648-7952 (in the U.S.) or (775) 883-3400
Fluke Biomedical
5200 Convair Drive
Carson City, NV 89706-0403
techservices@flukebiomedical.com
sales@flukebiomedical.com

When contacting the Technical Assistance Center, please provide the following information:

1. ESA601 version and serial number.
2. Specific steps necessary to reproduce the problem.
3. A phone number where you can be contacted during the day.

Chapter 3
Using the Printer

Selecting Language Options

Five language options support the eight available factory-set versions of the ESA601 that are unique combinations of types of DUT outlet (test receptacle), detachable line cord, and overlay language:

- English with IEC nomenclature (“E”)
- English with AAMI nomenclature (“E-US,” default)
- French (“F”)
- Italian (“I”)
- German (“D”)

When the unit is initially received, the factory-set, default-language option should match the instrument’s overlay language. However, if this is not the case, or if for any reason the current default language is not the one desired, perform the following steps to change the default:

1. Hold down the OHMS-FUNCTION SWITCH in the MEASURE Ω position while powering up the ESA601.
2. When the display indicates SEL, release the switch.
3. To cycle through optional language selections, repeatedly press and release the OHMS-FUNCTION SWITCH in the MEASURE Ω position.
4. When the code for the desired language option (i.e., E, F, I, or D) displays, wait for two seconds; the language selection indicated on the display is saved automatically.
5. The new default language remains in effect until steps #1 through #4 are repeated.

Note

Choosing a language option affects only the report printouts and the responses to the remote port. It does not affect the display.

Selecting the Printer Output

The printer used should support RTS/CTS or XON/XOFF protocols. Printer operation requires a straight-through serial printer cable.

For a sample ESA601-test printout, refer to Appendix B in this manual.

Note

For procedures on how to change the current default language for printouts, see the section in this chapter called “Selecting Language Options.”

Printing Electrical Safety Test Results

If you want your printout to have a header, press the PRINT SWITCH with the FUNCTION-SELECTION KNOB set to the PRINT HEADER position.

To print most electrical safety test results of a function test (usually a meter reading), press the PRINT SWITCH in the upward position with the FUNCTION-SELECTION KNOB set to the desired function position. The ESA601 provides the meter reading, as well as the current status of related front-panel switches.

For procedures on how to perform a Protective-Earth-Resistance test and print the test results, see “Performing Electrical-Safety Tests” in Chapter 5 of this manual.

Note

If the PRINT SWITCH is pressed with the FUNCTION-SELECTION KNOB set to the OFF position, no printout results.

Chapter 4
Testing Devices

Connecting the Device Under Test

While referring to Figure 4-1, follow the steps below to connect the ESA601 to a device under test (DUT).

Whenever connecting or disconnecting a DUT to the ESA601, the FUNCTION-SELECTION KNOB should be set to the OFF position.

1. Connect the DUT's applied parts to the universal ECG jacks on the back panel of the ESA601. (For an illustration of the back panel view of the ESA601, see Figure 2 and 3 in this manual in the section in Chapter 1 called "Unit Characteristics.") AHA and IEC color-coded dots label these jacks as an aid to connecting the corresponding U.S. and international ECG leads.
2. Connect the power cord from the DUT to the version-specific test receptacle on the ESA601.

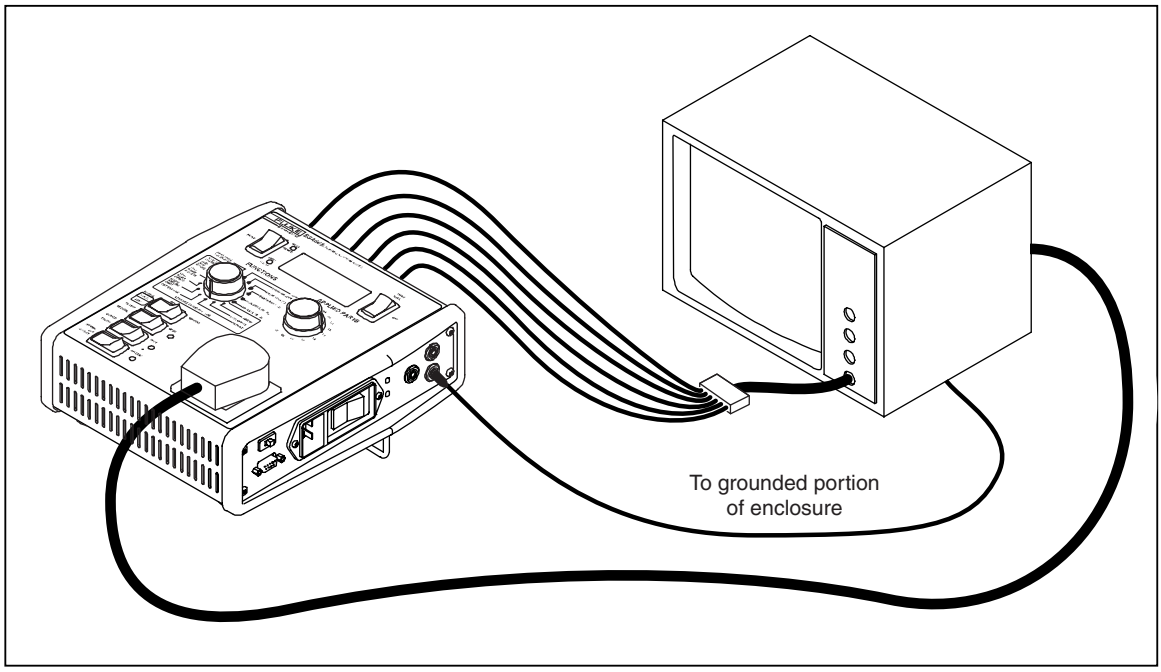

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Figure 4-1. ESA601 Connected to a Device Under Test

Selecting the Test Load

A slide switch on the ESA601 permits the selection of either the ANSI/AAMI ES1 or the IEC 60601-1 measurement load (American or European standards, respectively). The test-load type should be selected before beginning testing.

For the location of the LOAD-SELECTION SWITCH, refer to "Unit Characteristics" in Chapter 1 of this manual. Specifically, see item 20 in Figure 1-1 and the accompanying descriptions of switches and indicators on the unit's right-side panel.

Testing Device Types

For step-by-step instructions on making electrical safety tests with the ESA601, refer to "Performing Electrical-Safety Tests" in chapter 5 of this manual.

Permanently Wired Devices

Permanently wired devices can be tested only in an ON or OFF state. (This contrasts with portable units, which can plug directly into the front-panel receptacle of the ESA601, and for which receptacle conditions can be varied using front-panel switching on the ESA601.)

If a power outlet is available that has a common ground with the DUT, or if an adapter cord is available with a short ground wire, tests can be performed for enclosure leakage, earth resistance, patient leakage, and isolation. If neither a power outlet with a common ground, nor an adapter cord, is available, tests can be performed for enclosure leakage, patient leakage (using dual-lead leakage), and isolation.

Portable Devices Located in Isolated Power Systems

Portable devices located in isolated power systems should be tested on an earth-referenced power system. Either remove the DUT to an area with an earth-referenced power system, or use an extension cord to bring earth-referenced power to the DUT.

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Three-Phase Portable Devices

1. Plug the DUT into an adapter that has an interrupted ground but still provides power.
2. Plug the ESA601 into a conventional outlet. The outlet should have the same ground potential.
3. Test the device for enclosure leakage and patient leakage.

Chapter 5
Local Control

Mode Control

The operation of the ESA601 can be controlled through two separate modes: Local and Remote. The power-up default mode of the ESA601 is Local Mode where functions are selected by manually positioning the FUNCTION-SELECTION KNOB. (For the location of the FUNCTION-SELECTION KNOB, refer to "Unit Characteristics" in Chapter 1 of this manual. Specifically see item 10 in Figure 1-1.) In Remote Mode, the ESA601 can be controlled through its RS-232 port with commands from a PC.

To change modes from Local to Remote, use a terminal-emulation program (set to 9600 baud, 8 bit, no parity, 1 start, 1 stop) to send the remote command REMOTE (with no parameters) to the RS-232 serial port. The system responds with the message "REMOTE MODE," followed by the messages "WAIT" and "OK."

Note

When the mode is changed from Local to Remote, the system initially sets the "active" function to OFF. This action turns OFF all power to the Equipment Outlet and to applied parts, but leaves power to the ESA601ON.

To change modes from Remote to Local, send the remote command LOCAL (with no parameters)to the RS-232 serial port. The system responds with the message "LOCAL MODE."

The remainder of this chapter describes the operation of the ESA601 using the local mode. Remote mode operation is explained in Chapter 6 of this manual.

Function Selection

Table 5-1 describes the ESA601 electrical-safety tests that are selected by positioning the FUNCTION-SELECTION KNOB, a sixteen-position rotary switch. (For the location of the FUNCTION-SELECTION KNOB, refer to "Unit Characteristics" in Chapter 1 of this manual. Specifically see item 10 in Figure 1-1.) Some switch positions will have two names listed. The first name refers to the overlay with IEC nomenclature, and the second name refers to the overlay with AAMI nomenclature.

Table 5-1. Function Selection Switch Positions

Function Switch Position	Function Description
OFF	No function selected. Turns off all power to the equipment outlet and to applied parts, but does NOT turn off power to the ESA601.
PRINT HEADER	When this function is selected and the PRINT SWITCH is depressed in the upward position, a fixed test header in ASCII code is transmitted to an external printer through the RS-232 interface. Turns off all power to the equipment outlet and to applied parts. (For more details, refer to "Selecting the Printer Output." in Chapter 3.)
MAINS VOLT (VAC) or MAINS / LINE (VAC) Mains Voltage	Measures the RMS voltage between Mains L1 and Mains L2. No AC power is applied to the equipment outlet during this test. DUT power is off.

Table 5-1, Function Selector Switch Positions (cont.)

EARTH RES (Ω) or GROUND WIRE RES (Ω) Protective-Earth Resistance	Measures the resistance between the RED input connection and Equipment Outlet Earth (equivalent to the GREEN signal connection). DUT power is off. NOTE: A NULL (OFFSET / ZERO 0) capability is available to subtract the lead resistance from actual measurements. (For the location of the OHMS-FUNCTION SWITCH, refer to Figure 1-1 in Chapter 1, Item #14.)
MAINS INSUL (MΩ) Mains-Insulation Resistance	Uses a 500 V DC source to measure the insulation resistance between [Equipment Outlet L1 shorted to Equipment Outlet L2] and Equipment Outlet Earth. DUT power is off. NOTE 1: Voltage is available only when the momentary M.A.P./VDE EQUIV/INSUL (ISO/VDE EQUIV/INSUL) switch is pressed in the normal position. NOTE: For this test, the connection to Mains Earth is open and Mains power is disconnected.
AP INSUL (MΩ) or LEADS INSUL (MΩ) Applied-Parts-Insulation Resistance	Uses a 500 V DC source to measure the insulation resistance between all applied-parts connectors in common and Equipment Outlet Earth. DUT power is off. NOTE 1: Voltage is available only when the momentary M.A.P./VDE EQUIV/INSUL (ISO/VDE EQUIV/INSUL) switch is pressed in the normal position. NOTE: For this test, the connection between Equipment Outlet Earth and Mains Earth is open.
EARTH or GROUND WIRE Earth-Leakage Current	Measures the RMS current flowing in the measurement device connected between Equipment Outlet Earth and Mains Earth. DUT power is on. NOTE 1: The connection between Equipment Outlet Earth and Mains Earth is internally opened for this test and is restored to a closed condition upon exiting the test. The OPEN EARTH switch is not active. NOTE 2: All applied-parts connectors are grounded for this test when you select the ALL position with the Applied-Parts-Selection Knob. If the ALL position is not selected, all applied-parts connectors are open. (It is not possible to ground applied-parts connectors individually.)

Table 5-1, Function Selector Switch Positions (cont.)

ENCLOSURE or CHASSIS Enclosure-Leakage Current	Measures the RMS current flowing in the tester's measurement device connected between the RED signal connection and Mains Earth. DUT power is on. NOTE 1: All applied-parts connectors are grounded for this test when you select the ALL position with the Applied-Parts-Selection Knob. If the ALL position is not selected, all applied-parts connectors are open. (It is not possible to ground applied-parts connectors individually.) NOTE 2: To measure the leakage between two separate parts of the enclosure, connect two test leads to two ECG connectors, and perform the Patient-Auxiliary-Leakage-Current test.
PATIENT or LEAD TO GROUND Patient-Leakage Current	Measures the RMS current flowing in the tester's measurement device connected between each individual applied-parts connector, or all applied-parts connectors in common, and Mains Earth. DUT power is on.
PATIENT AUX or LEAD TO LEADS Patient-Auxiliary-Leakage Current	Places the tester's measurement-device circuit in series between each individual applied-parts connector and all other applied-parts connectors in common. DUT power is on.
MAINS APPLIED PARTS or LEAD ISOLATION Mains-on-Applied-Parts-Leakage Current	Places the tester's measurement-device circuit in series with the current-limited M.A.P. voltage and each individual applied-parts connector, or all applied-parts connectors in common, and Mains Earth. DUT power is ON. NOTE 1: Voltage is available only when the momentary M.A.P./VDE EQUIV/INSUL (ISO/VDE/EQUIV INSUL) switch is pressed. Both NORMAL M.A.P. voltage (in phase with Mains voltage) and REVERSE M.A.P. voltage (180 degrees out-of-phase with Mains voltage) are available. NOTE 2: The internal leakage generated by the coupling between the M.A.P. voltage, the tester circuitry and enclosure can be eliminated by subtracting an offset equivalent to this internal leakage from the measured reading. (The null current value is determined when the unit is calibrated periodically.)

Table 5-1, Function Selector Switch Positions (cont.)

VDE: EQUIV DEVICE VDE: Equivalent-Device-Leakage Current	Places the tester's measurement-device circuit in series with a current-limited M.A.P. voltage that is connected between [Equipment Outlet L1 shorted to Equipment Outlet L2 and disconnected from Mains power] and [Equipment Outlet Earth, Mains Earth, the RED signal connection, and all applied-parts connectors in common]. DUT power is off. NOTE 1: Voltage is available only when the momentary M.A.P./VDE EQUIV/INSUL (ISO/ VDE/EQUIV INSUL) switch is pressed. Both normal m.a.p. voltage (in phase with Mains voltage) and reverse m.a.p. voltage (180 degrees out-of-phase with Mains voltage) are available.
VDE: EQUIV PATIENT VDE: Equivalent-Patient-Leakage Current	Places the tester's measurement-device circuit in series with a current-limited M.A.P. voltage that is connected between [Equipment Outlet L1, Equipment Outlet L2, Outlet Earth, Mains Earth, and the RED signal connection] and [all applied-parts connectors in common]. DUT power is off. NOTE 1: Voltage is available only when the momentary M.A.P./VDE EQUIV/INSUL (ISO / VDE/EQUIV INSUL) switch is pressed. Both normal M.A.P. voltage (in phase with Mains voltage) and reverse M.A.P. voltage (180 degrees out-of-phase with Mains voltage) are available.
VDE: DIFF CURRENT VDE: Differential-Leakage Current	Measures the magnitude of the differential current flowing in the Equipment Outlet L1 and L2 circuits. The reading is taken after selecting this function. DUT power is on.
DUAL LEAD LEAKAGE Dual-Lead-Leakage Current	Places the tester's measurement-device circuit in series with the RED signal connection and the BLACK signal connection. DUT power is on.
DUAL LEAD VOLTAGE (V) Dual-Lead Voltage	Measures the RMS voltage between the RED signal connection and the BLACK signal connection. DUT power is on.

Table 5-2. Active Switch Settings for Selected Tests

SELECTED TEST	ACTIVE SWITCH SETTINGS for the TEST SELECTED						
	FUNCTION SELECTOR KNOB	APPLIED-PARTS SELECTOR KNOB	M.A.P./VDE EQUIV/ INSUL SWITCH (momentary)	NEUTRAL SWITCH	EARTH SWITCH	POLARITY SWITCH	OHMS FUNCTION SWITCH (momentary)
Mains Voltage	*Measures the RMS voltage between Mains L1 and Mains L2.*						
	MAINS VOLT (V)	INACTIVE	INACTIVE	INACTIVE	INACTIVE	INACTIVE	INACTIVE
Earth Resistance	*Measures the two-lead resistance between the RED input connection and Equipment Outlet Earth (equivalent to the GREEN signal connection).*						
	EARTH RES (Ω)	INACTIVE	INACTIVE	INACTIVE	INACTIVE	INACTIVE	ACTIVE
Mains-Insulation Resistance	*Uses a 500 V DC source to measure the insulation resistance between [Equipment Outlet L1 shorted to Equipment Outlet L2 and disconnected from Mains power] and Equipment Outlet Earth.*						
	MAINS INSUL (MΩ)	INACTIVE	ACTIVE	INACTIVE	INACTIVE	INACTIVE	INACTIVE
Applied-Parts-Insulation Resistance	*Uses a 500 V DC source to measure the insulation resistance between all applied-part connectors in common and Equipment Outlet Earth.*						
	AP INSUL (MΩ)	INACTIVE	ACTIVE	INACTIVE	INACTIVE	INACTIVE	INACTIVE
Earth Leakage	*Measures the RMS current flowing in the measurement device connected between Equipment Outlet Earth and Mains Earth.*						
	EARTH	INACTIVE	INACTIVE	ACTIVE	INACTIVE	ACTIVE	INACTIVE
Enclosure Leakage	*Measures the RMS current flowing in the tester's measurement device connected between the RED signal connection and Mains Earth.*						
	ENCLO-SURE	INACTIVE	INACTIVE	ACTIVE	ACTIVE	ACTIVE	INACTIVE
Patient-Lead Leakage	*Measures the RMS current flowing in the tester's measurement device connected between each individual applied-part connector, or all applied-part connectors in common, and Mains Earth*						
	PATIENT	ACTIVE	INACTIVE	ACTIVE	ACTIVE	ACTIVE	INACTIVE
Patient-Auxiliary-Current Leakage	*Places the tester's measurement-device circuit in series between each individual applied-part connector and all other applied-part connectors in common.*						
	PATIENT AUX	ACTIVE	INACTIVE	ACTIVE	ACTIVE	ACTIVE	INACTIVE
M.A.P. Leakage	*Places the tester's measurement-device circuit in series with the current-limited M.A.P. voltage and each individual applied-part connector, or all applied-part connectors in common, and Mains Earth.*						
	MAINS APPLIED PARTS	ACTIVE	ACTIVE	INACTIVE	INACTIVE	ACTIVE	INACTIVE

Table 5-2, Active Switch Settings for Selected Tests (cont.)

SELECTED TEST	ACTIVE SWITCH SETTINGS for the TEST SELECTED						
	FUNCTION SELECTOR KNOB	APPLIED-PARTS SELECTOR KNOB	M.A.P./VDE EQUIV/ INSUL SWITCH (momentary)	NEUTRAL SWITCH	EARTH SWITCH	POLARITY SWITCH	OHMS FUNCTION SWITCH (momentary)
Equivalent-Device Leakage	*Places the tester's measurement-device circuit in series with a current-limited M.A.P. voltage that is connected between [Equipment Outlet L1 shorted to Equipment Outlet L2 and disconnected from Mains power] and [Equipment Outlet Earth, Mains Earth, the RED signal connection, and all applied-part connectors in common].*						
	VDE: EQUIV DEVICE	INACTIVE	ACTIVE	INACTIVE	INACTIVE	INACTIVE	INACTIVE
Equivalent-Patient Leakage	*Places the tester's measurement-device circuit in series with a current-limited M.A.P. voltage that is connected between [Equipment Outlet L1, Equipment Outlet L2, Outlet Earth, Mains Earth, and the RED signal connection] and [all applied-part connectors in common].*						
	VDE: EQUIV PATIENT	INACTIVE	ACTIVE	INACTIVE	INACTIVE	INACTIVE	INACTIVE
Differential-Current Leakage	*Measures the magnitudes of the differential current flowing in the Equipment Outlets L1 and L 2 circuits.*						
	VDE: DIFF CURRENT	INACTIVE	INACTIVE	INACTIVE	INACTIVE	ACTIVE	INACTIVE
Dual-Lead Leakage	*Places the tester's measurement-device circuit in series with the RED signal connection and the BLACK signal connection.*						
	DUAL LEAD LEAKAGE	INACTIVE	INACTIVE	ACTIVE	INACTIVE	ACTIVE	INACTIVE
Dual-Lead Voltage	*Measures the RMS voltage between the RED signal connection and the BLACK signal connection.*						
	DUAL-LEAD VOLTAGE (V)	INACTIVE	INACTIVE	ACTIVE	ACTIVE	ACTIVE	INACTIVE

Performing Electrical-Safety Tests

The following section contains test-principle diagrams (with notes on switches and functions) and step-by-step instructions for performing the electrical-safety tests that are available by positioning the ESA601 FUNCTION-SELECTION KNOB.

Note

The following descriptions refer to holding down the PRINT SWITCH to print results. This is applicable only if a compatible printer is connected to the ESA601 for this use.

Mains-Voltage Test

1. Position the FUNCTION-SELECTION KNOB to OFF.
2. Power ON the ESA601. The unit goes through boot-up initialization for three seconds. (The ESA601 displays error codes if the Mains are wired improperly or are out of range.)
3. Position the FUNCTION-SELECTION KNOB to MAINS VOLT VAC (MAINS/LINE VAC).
4. After the meter settles, read the display, and/or press the PRINT SWITCH to print the reading.

Note

Power to the ESA601 front panel outlet is off during the Mains-Voltage test.

Protective-Earth-Resistance Test

The Protective-Earth-Resistance test measures the impedance between the outlet PE terminal of the ESA601and exposed conductive parts of the DUT that are connected to the DUT's Protective Earth. Figure 5-1 shows the electrical connections between the ESA601 and the DUT. The table below the diagram indicates the position of switches in the diagram during the test. Test current is applied for as long as the switch is held, which should be until a stable reading is taken (approximately three seconds). DUT power is off.

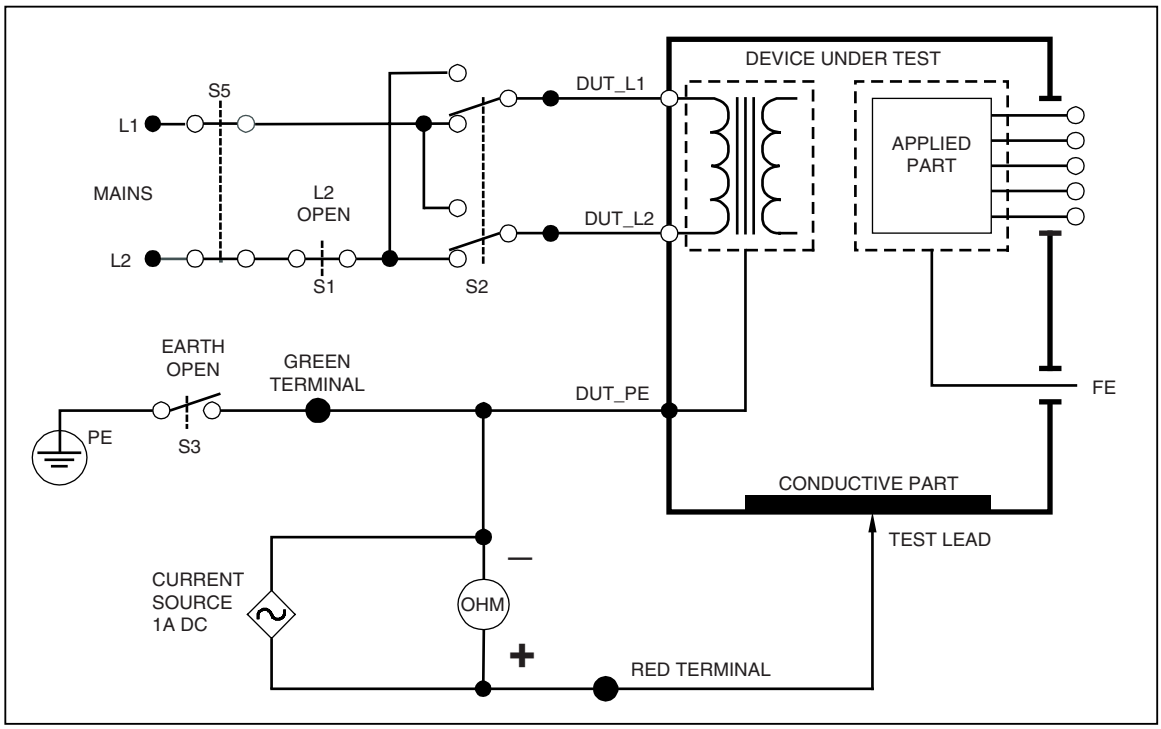

Figure 5-1. Protective-Earth-Resistance Test Configuration

SWITCH		ACTION
DIAGRAM REFERENCE	ESA601 NAME	
S1	NEUTRAL	N/A
S2	POLARITY	N/A
S3	EARTH	OPEN
S5	(N/A)	

When the EARTH RES Ω (GROUND WIRE RES Ω) function is selected initially, and the OHMS-FUNCTION SWITCH is set to the default (OFF) position, the ESA601 display indicates PE (Protective Earth), and the null offset value is equal to the last null offset value.

Action

1. Position the FUNCTION-SELECTION KNOB to EARTH RES Ω (GROUND WIRE RES Ω).
2. Connect the DUT power cord to the test receptacle on the ESA601
3. Connect the banana plug end of the red test lead into the RED signal jack and the probe end into to the GREEN signal jack that is labeled PE TEST POINT.*
4. Depress and hold down the OHMS-FUNCTION SWITCH in the OFFSET/ZERO 0 position.
5. After the meter settles, release the switch. If the operation is successful, a null offset is saved, and the ESA601 display indicates a string of zeroes. (If the meter will not zero, the ESA601 display indicates OL when the switch is released, meaning that the lead resistance is too high.)
6. Disconnect the lead's probe end from the PE-TEST POINT, and connect to the DUT enclosure at desired points. Connect the DUT power cord to the test receptacle on the ESA601.
7. Depress and hold down the OHMS-FUNCTION SWITCH in the MEASURE Ω position until a stable reading is obtained (approximately three seconds).
8. Release the switch to hold and display the reading.
9. Press the PRINT SWITCH to print the reading.
10. Repeat steps 6 through 9 as many times as necessary, using the RED test lead to connect to all exposed conductive parts of the DUT.

Note

When the EARTH RES Ω (GROUND WIRE RES Ω) function is exited, the NULL value (OFFSET/ZERO) is held. To ensure accuracy of readings, it is recommended that the nulling of the test lead resistance be performed periodically, whenever a test lead is disconnected and reconnected, when results are questionable, or when a new test lead is applied.

Mains-Insulation-Resistance Test

The Mains-Insulation-Resistance test measures the insulation resistance (at 500 V DC) between L1 and L2 and the DUT'S Protective Earth. Figure 5-2 shows the electrical connections between the ESA601 and the DUT. The table below the diagram indicates the position of switches in the diagram during the test. Voltage is available only when momentary M.A.P./VDE/INSUL (ISO/VDE EQUIV/INSUL) switch is pressed in the normal position. DUT power is off.

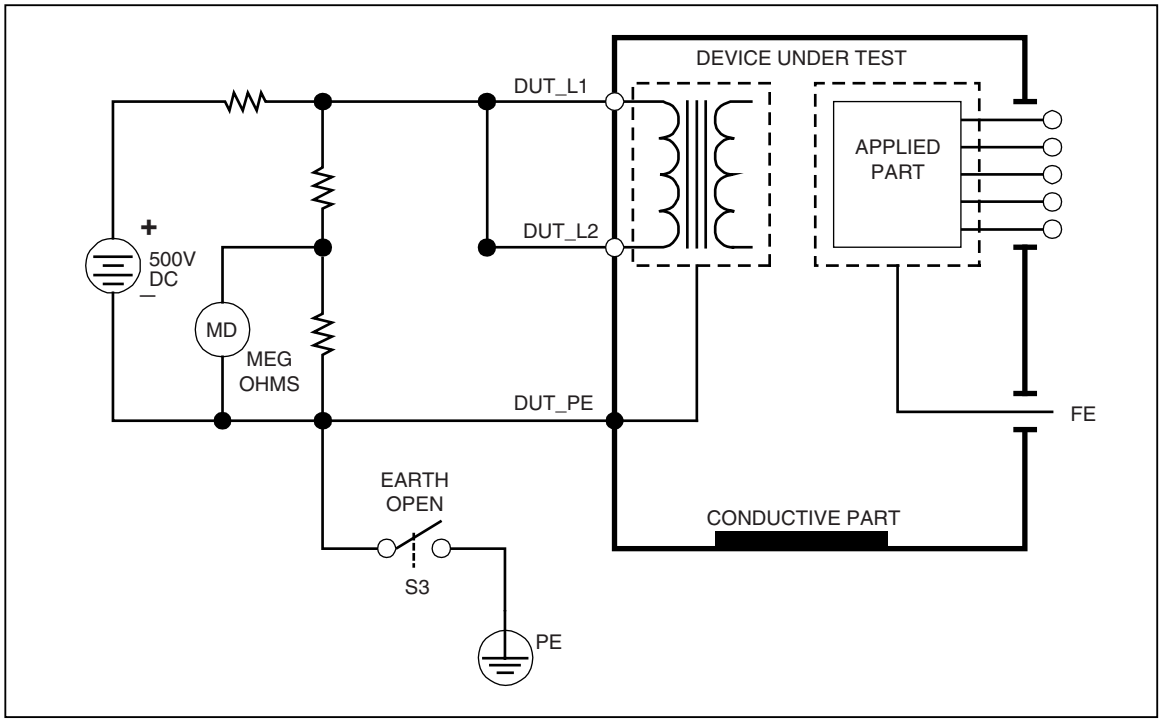

Figure 5-2. Mains-Insulation-Resistance Test Configuration

SWITCH		ACTION
DIAGRAM REFERENCE	ESA601 NAME	
S3	EARTH	OPEN

Action

1. Position the FUNCTION-SELECTION KNOB to MAINS INSUL MΩ.
2. Connect the DUT power cord to the test receptacle on the ESA601.
3. Depress and hold down the M.A.P./VDE EQUIV/INSUL SWITCH (ISO/VDE EQUIV/INSUL) in the NORMAL position.
4. After the meter settles, release the switch to hold and display a reading.
5. Press the PRINT SWITCH to print the reading.

Applied-Parts-Insulation-Resistance Test

The Applied-Parts-Insulation-Resistance test measures the insulation resistance (at 500 V DC) between all applied-parts connections and the DUT'S Protective Earth. Figure 5-3 shows the electrical connections between the ESA601 and the DUT. The table below the diagram indicates the position of switches in the diagram during the test. Voltage is available only when momentary M.A.P./VDE/INSUL (ISO/VDE EQUIV/INSUL) switch is pressed in the normal position. DUT power is off.

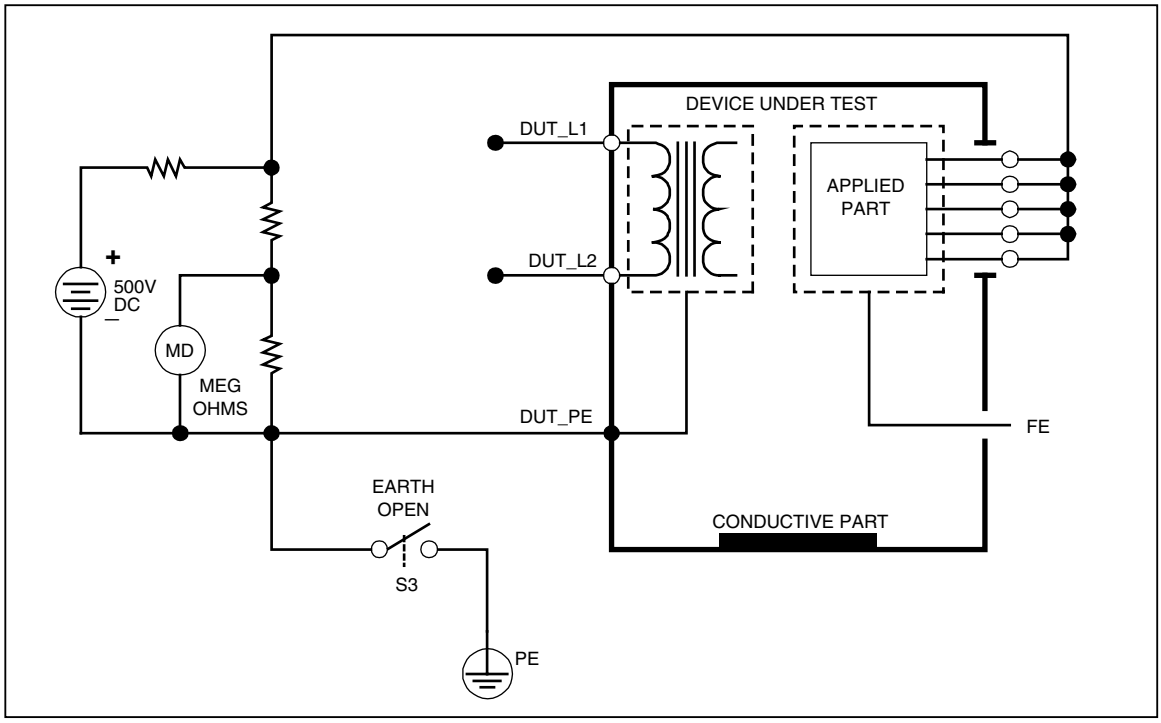

Figure 5-3. Applied-Parts-Insulation-Resistance Test Configuration

SWITCH		ACTION
DIAGRAM REFERENCE	ESA601 NAME	
S3	EARTH	OPEN

Note

The Applied-Parts-Insulation-Resistance test is applicable only to DUTs with applied parts.

Action

1. Position the FUNCTION-SELECTION KNOB to AP INSUL MΩ (LEAD INSUL MΩ).
2. Connect the DUT applied parts to the applied-parts jacks on the ESA601. Connect the DUT power cord to the test receptacle on the ESA601.
3. Select ALL on the APPLIED PARTS selector knob.
4. Depress and hold down the M.A.P./VDE EQUIV/INSUL SWITCH (ISO/VDE EQUIV/INSUL) in the NORMAL position.
5. After the meter settles, release the switch to hold and display a reading.
6. Press the PRINT SWITCH to print the reading.

Earth-Leakage-Current Test

The Earth-Leakage-Current Test measures the current flowing in the DUT's Protective Earth. Figure 5-4 shows the electrical connections between the ESA601 and the DUT. The table below the diagram indicates the position of switches in the diagram during the test. DUT power is on.

The test is performed with NORMAL and REVERSE Mains supply polarity using the POLARITY SWITCH, and single-fault condition OPEN L2 using the NEUTRAL SWITCH. For type-BF and type-CF equipment, measure with APPLIED-PARTS-SELECTION KNOB both OPEN (by selecting anything other than ALL) and CLOSED (by selecting ALL).

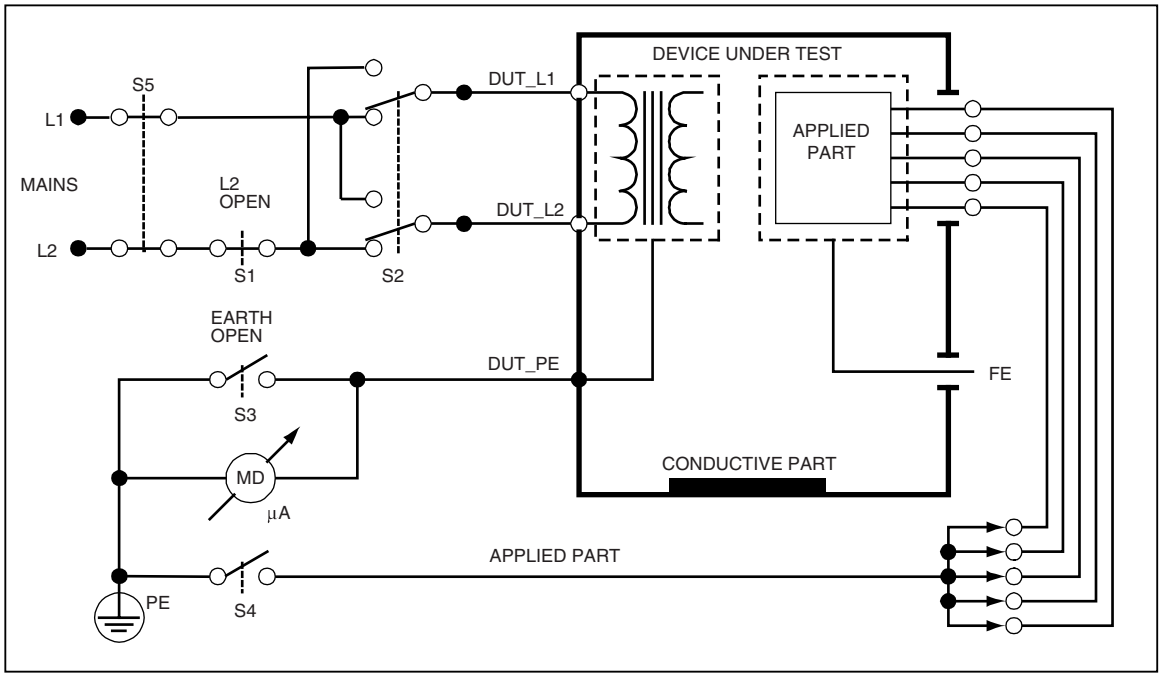

Figure 5-4. Earth-Leakage-Current Test Configuration

SWITCH		ACTION
DIAGRAM REFERENCE	ESA601 NAME	
S1	NEUTRAL	VARIABLE
S2	POLARITY	VARIABLE
S3	EARTH	OPEN
S4	APPLIED-PARTS-SELECTION KNOB	VARIABLE*
S5	(N/A)	

Action

1. Position the FUNCTION-SELECTION KNOB to EARTH (GROUND WIRE).
2. Position the APPLIED-PARTS-SELECTION KNOB to RA or AP1 (if applicable).

Note

For type-BF and type-CF equipment, perform the measurement with the APPLIED PARTS *selection knob both open (by selecting any selection except* ALL*, in the above case RA or AP1) and closed (by selecting* ALL*).*

3. Set the NEUTRAL SWITCH to CLOSED.
4. Set the POLARITY SWITCH to NORMAL.
5. Connect the DUT power cord to the test receptacle on the ESA601.
6. After the meter settles, read the display, and/or press the PRINT SWITCH to print the reading.
7. Set the NEUTRAL SWITCH to OPEN.
8. After the meter settles, read the display, and/or press the PRINT SWITCH to print the reading.
9. Return the NEUTRAL SWITCH to CLOSED.
10. Set the POLARITY SWITCH to REVERSE and wait for the REVERSE POLARITY indicator to illuminate.
11. After the meter settles, read the display, and/or press the PRINT SWITCH to print the reading.
12. Repeat steps 7 and 8.

Enclosure-Leakage-Current Test

The Enclosure-Leakage-Current test measures the current flowing from the RED terminal to MAINS PE. Figure 5-5 shows the electrical connections between the ESA601 and the DUT. The table below the diagram indicates the position of switches in the diagram during the test. DUT power is on.

The test is performed with NORMAL and REVERSE Mains supply polarity using the POLARITY SWITCH, and single-fault conditions using the NEUTRAL SWITCH, and the EARTH SWITCH. For type-BF and type-CF equipment, measure with applied APPLIED-PARTS-SELECTION KNOB both OPEN (by selecting anything other than ALL) and CLOSED (by selecting ALL).

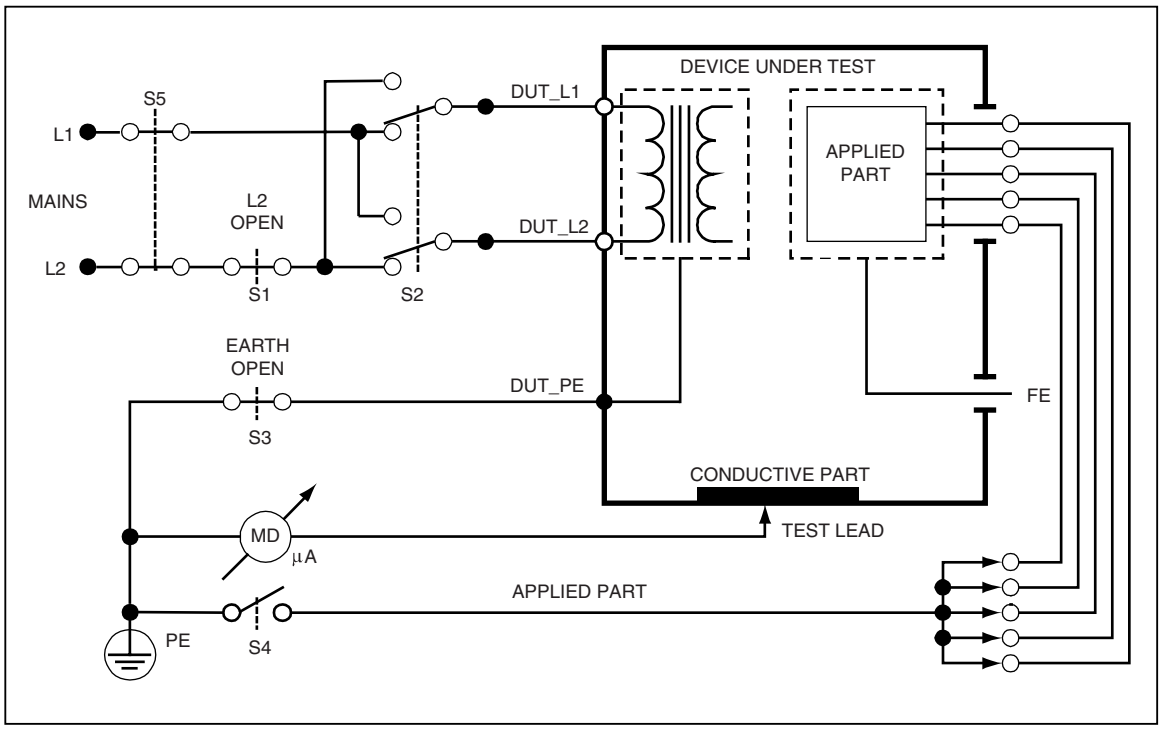

Figure 5-5. Enclosure-Leakage-Current Test Configuration

SWITCH		ACTION
DIAGRAM REFERENCE	ESA601 NAME	
S3	EARTH	OPEN

Action

1. Position the FUNCTION-SELECTION KNOB to ENCLOSURE (CHASSIS).
2. Set the APPLIED-PARTS-SELECTION KNOB to RA or AP1 (if applicable).

Note

For type-BF and type-CF equipment, perform the measurement with the APPLIED PARTS selection knob both open (by selecting any selection except ALL, in the above case RA or AP1) and closed (by selecting ALL).

3. Set the POLARITY SWITCH to NORMAL.
4. Set the NEUTRAL SWITCH to CLOSED.
5. Set the EARTH SWITCH to CLOSED.
6. Connect the banana plug end of the RED test lead into the RED signal jack and the probe end of the RED test lead to the DUT enclosure. Connect the DUT power cord to the test receptacle on the ESA601.
7. After the meter settles, read the display, and/or press the PRINT SWITCH to print the reading.
8. Set the EARTH SWITCH to OPEN.
9. Read the display, and/or press the PRINT SWITCH to print the reading.
10. Return the EARTH SWITCH to CLOSED.
11. Set the NEUTRAL SWITCH to OPEN.
12. Read the display, and/or press the PRINT SWITCH to print the reading.
13. Set the POLARITY SWITCH to REVERSE, and wait for the REVERSE POLARITY indicator to illuminate.
14. Read the display, and/or press the PRINT SWITCH to print the reading.
15. Repeat steps 8 through 12 while the POLARITY SWITCH is in the REVERSE position.

Patient-Leakage-Current Test

The Patient-Leakage-Current test measures the current flowing between a selected applied part, or ALL applied parts, and the Mains PE. Figure 5-6 shows the electrical connections between the ESA601 and the DUT. The table below the diagram indicates the position of switches in the diagram during the test. DUT power is on.

The test is performed with NORMAL and REVERSE Mains supply polarity using the POLARITY SWITCH and single-fault conditions using the EARTH SWITCH and the NEUTRAL SWITCH.

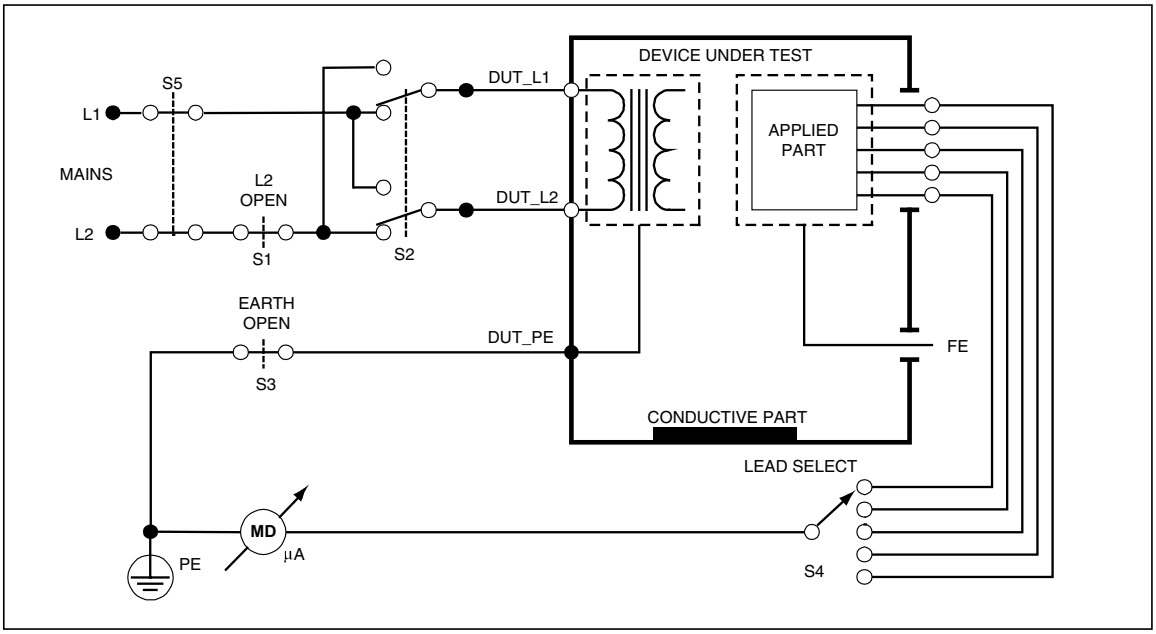

Figure 5-6. Patient-Leakage-Current Test Configuration

SWITCH		ACTION
DIAGRAM REFERENCE	ESA601 NAME	
S1	NEUTRAL	VARIABLE
S2	POLARITY	VARIABLE
S3	EARTH	VARIABLE
S4	APPLIED-PARTS-SELECTION KNOB	VARIABLE
S5	(N/A)	

Note

The Patient-Leakage-Current test is applicable only to DUTs with applied parts.

Action

1. Position the FUNCTION-SELECTION KNOB to PATIENT (LEAD TO GROUND).
2. Position the APPLIED-PARTS-SELECTION KNOB to ALL.
3. Set the NEUTRAL SWITCH to CLOSED.
4. Set the EARTH SWITCH to CLOSED.
5. Set the POLARITY SWITCH to NORMAL, and wait for the analyzer to switch to normal.
6. Connect the banana plug end of the RED test lead into the RED signal jack, and the probe end of the RED test lead to the DUT enclosure; connect the DUT applied parts to the applied-parts jacks on the ESA601; connect the DUT power cord to the test receptacle on the ESA601.
7. After the meter settles, read the display, and/or press the PRINT SWITCH to print the reading.
8. Set the NEUTRAL SWITCH to OPEN.
9. After the meter settles, read the display, and/or press the PRINT SWITCH to print the reading.
10. Set the NEUTRAL SWITCH to CLOSED.
11. Set the EARTH SWITCH to OPEN.
12. After the meter settles, read the display, and/or press the PRINT SWITCH to print the reading.
13. Set the EARTH SWITCH to CLOSED.
14. Set the POLARITY SWITCH to REVERSE, and wait for the REVERSE POLARITY indicator to illuminate.
15. Repeat steps 8 through 13.
16. Cycle the APPLIED-PARTS-SELECTION KNOB from RA (AP1) through V6 (AP10) (or the number of leads that are connected), repeating steps 8 through 15 for each applied-parts selection.

Patient-Auxiliary-Leakage-Current Test

The Patient-Auxiliary-Leakage-Current test measures the current between a selected applied part and all others. Figure 5-7 shows the electrical connections between the ESA601 and the DUT. The table below the diagram indicates the position of switches in the diagram during the test. DUT power is on.

The test is performed with NORMAL and REVERSE Mains supply polarity using the POLARITY SWITCH and single-fault conditions using the NEUTRAL SWITCH and the EARTH SWITCH.

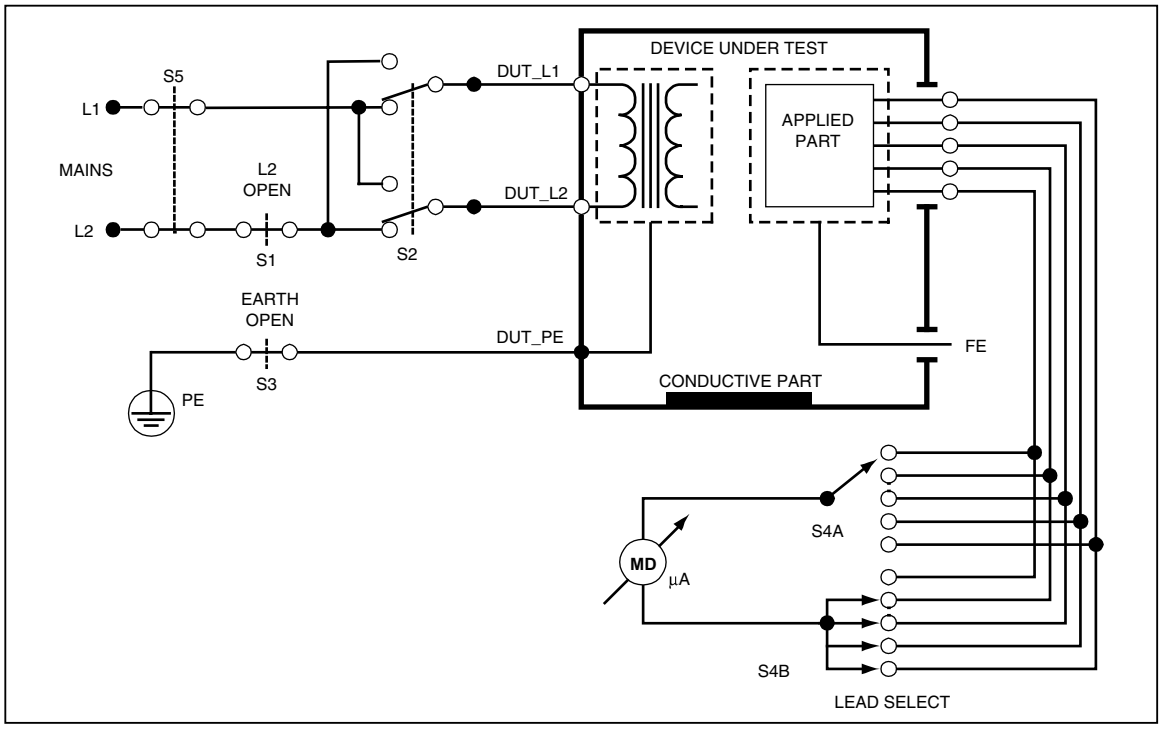

Figure 5-7. Patient-Auxiliary-Leakage-Current Test Configuration

SWITCH		ACTION
DIAGRAM REFERENCE	ESA601 NAME	
S1	NEUTRAL	VARIABLE
S2	POLARITY	VARIABLE
S3	EARTH	VARIABLE
S4	APPLIED-PARTS-SELECTION KNOB	VARIABLE
S5	(N/A)	

Note

The Patient-Auxiliary-Leakage-Current test is applicable only to DUTs with applied parts.

Action

1. Position the FUNCTION-SELECTION KNOB to PATIENT AUX (LEAD TO LEADS).
2. Position the APPLIED-PARTS-SELECTION KNOB to RA.
3. Set the NEUTRAL SWITCH to CLOSED.
4. Set the EARTH SWITCH to CLOSED.
5. Set the POLARITY SWITCH to NORMAL, and wait for the analyzer to switch to normal.
6. Connect the banana plug end of the RED test lead into the RED signal jack, and the probe end of the RED test lead to the DUT enclosure; connect the DUT applied parts to the applied-parts jacks on the ESA601; connect the DUT power cord to the test receptacle on the ESA601.
7. After the meter settles, read the display, and/or press the PRINT SWITCH to print the reading.
8. Set the NEUTRAL SWITCH to OPEN.
9. After the meter settles, read the display, and/or press the PRINT SWITCH to print the reading.
10. Set the NEUTRAL SWITCH to CLOSED.
11. Set the EARTH SWITCH to OPEN.
12. After the meter settles, read the display, and/or press the PRINT SWITCH to print the reading.
13. Set the EARTH SWITCH to CLOSED.
14. Set the POLARITY SWITCH to REVERSE, and wait for the REVERSE POLARITY indicator to illuminate.
15. Repeat steps 8 through 13.
16. Cycle the APPLIED-PARTS-SELECTION KNOB from RL (AP2) through V6 (AP10) (or the number of leads that are connected), repeating steps 7 through 15 for each applied-parts selection.

Mains-On-Applied-Parts-Leakage-Current Test

The Mains-On-Applied-Parts-Leakage-Current test measures the current that flows in response to an isolated AC voltage applied between a selected applied part, or ALL applied parts, and Earth (and any conductive part connected to the RED terminal). Figure 5-7 shows the electrical connections between the ESA601 and the DUT. The table below the diagram indicates the position of switches in the diagram during the test. DUT power is on.

The test is performed with NORMAL and REVERSE Mains supply polarity using the POLARITY SWITCH, and NORMAL and REVERSE isolated voltage supply polarity using the M.A.P./VDE EQUIV/INSUL (ISO/VDE EQUIV/INSUL) SWITCH. The magnitude of the voltage is at least 110 % of the Mains voltage.

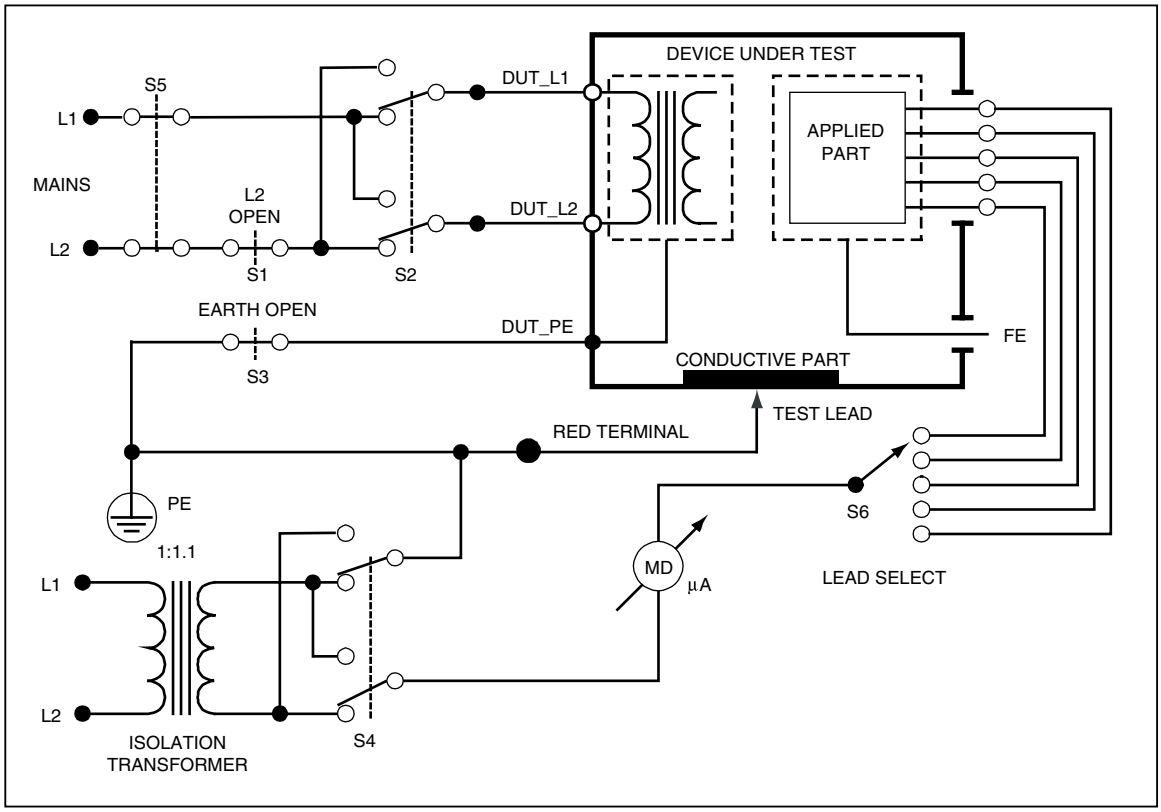

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Figure 5-8. Mains-On-Applied-Parts-Leakage-Current Test Configuration

SWITCH		ACTION
DIAGRAM REFERENCE	ESA601 NAME	
S1	NEUTRAL	CLOSED
S2	POLARITY	VARIABLE
S3	EARTH	CLOSED
S4	M.A.P./500 V	VARIABLE
S5	(N/A)	
S6	APPLIED-PARTS-SELECTION KNOB	VARIABLE

Note

The Mains-on-Applied-Parts-Leakage-Current test is applicable only to DUTs with applied parts.

Action

1. Position the FUNCTION-SELECTION KNOB to MAINS APPLIED PARTS (LEAD ISOLATION).
2. Position the APPLIED-PARTS-SELECTION KNOB to ALL.
3. Set the POLARITY SWITCH to NORMAL, and wait for the analyzer to switch to normal.
4. Connect the banana plug end of the RED test lead into the RED signal jack, and the probe end of the RED test lead to the DUT enclosure; connect the DUT applied parts to the applied-parts jacks on the ESA601; connect the DUT power cord to the test receptacle on the ESA601.
5. Depress and hold down the M.A.P./VDE EQUIV/INSUL (ISO/VDE EQUIV/INSUL) SWITCH in the NORMAL position.
6. After the meter settles, release the switch to hold and display the reading and/or press the PRINT SWITCH to print the reading.
7. Depress and hold down the M.A.P./VDE EQUIV/INSUL (ISO/VDE EQUIV/INSUL) SWITCH in the REVERSE position.
8. After the meter settles, read the display, and/or press the PRINT SWITCH to print the reading.
9. Set the POLARITY SWITCH to REVERSE, and wait for the REVERSE POLARITY indicator to illuminate.
10. Repeat steps 5 through 8.
11. Set the POLARITY SWITCH to NORMAL, and wait for the analyzer to switch to normal.
12. Cycle the APPLIED-PARTS-SELECTION KNOB from RA (AP1) through V6 (AP10) (or the number of leads that are connected), repeating steps 5 through 11 for each applied-parts selection.
13. Disconnect all applied parts from the analyzer.
14. Using the probe end of the RED test lead, touch any exposed conductive part of the DUT and wait for the meter to settle.
15. While keeping the probe end of the RED test lead connected to the DUT, read the display, and/or press the PRINT SWITCH to print the reading.
16. Repeat steps 14 through 15 for each exposed conductive part tested.

VDE: Equivalent-Device-Leakage-Current Test

The VDE:Equivalent-Device-Leakage-Current test measures the current that flows between the shorted Mains terminals (L1 and L2) of the DUT to the PE, applied parts, and exposed conductive parts of the DUT (connected to the RED signal connection) in response to an isolated AC voltage source with a magnitude of at least 110 % of Mains voltage. Figure 5-8 shows the electrical connections between the ESA601 and the DUT. The table below the diagram indicates the position of switches in the diagram during the test. DUT power is off.

This test is performed with both NORMAL and REVERSE isolated voltage supply polarity using the M.A.P./VDE EQUIV/INSUL (ISO /VDE EQUIV/INSUL) SWITCH.

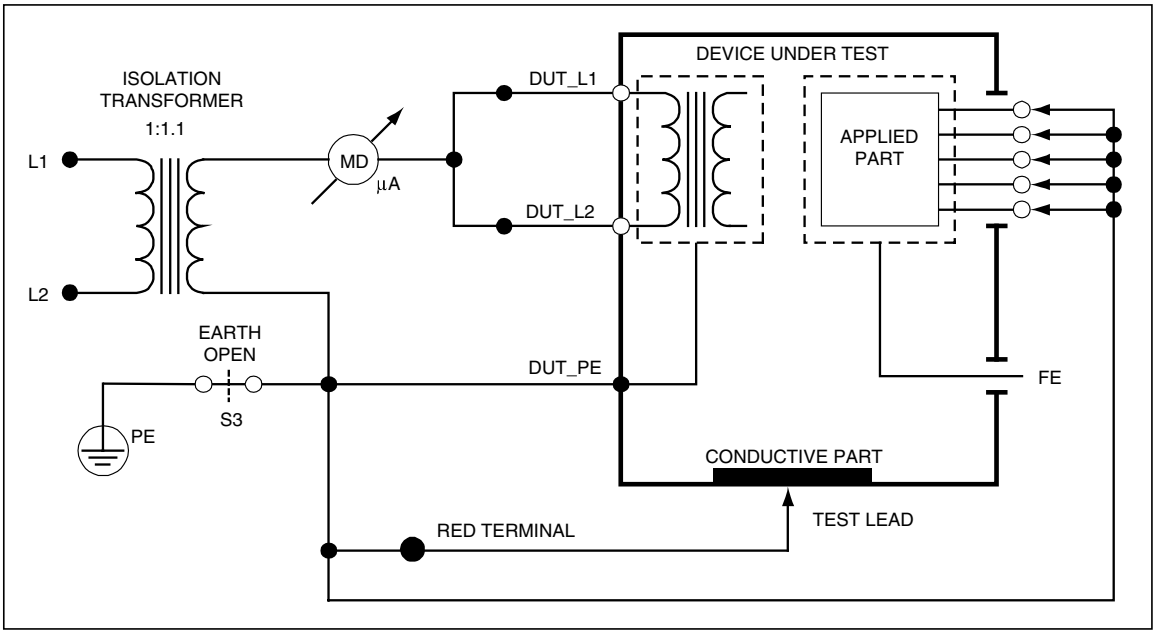

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Figure 5-9. VDE: Equivalent-Device-Leakage-Current Test Configuration

SWITCH		ACTION
DIAGRAM REFERENCE	ESA601 NAME	
S3	EARTH	CLOSED

Action

1. Connect the banana plug end of the RED test lead into the RED signal jack, and the probe end of the RED test lead to the DUT enclosure; connect the DUT applied parts to the applied-parts jacks on the ESA601; connect the DUT power cord to the test receptacle on the ESA601.
2. Position the APPLIED PARTS (or ECG LEADS) selector knob to ALL.
3. Position the FUNCTION-SELECTION KNOB to VDE: EQUIV DEVICE.
4. Depress and hold down the M.A.P./VDE EQUIV/INSUL (ISO/VDE EQUIV/INSUL) SWITCH in the NORMAL position.
5. After the meter settles, release the switch to hold and display the reading and/or press the PRINT SWITCH to print the reading.
6. Depress and hold down the M.A.P./VDE EQUIV SWITCH in the REVERSE position.
7. After the meter settles, release the switch to hold and display the reading and/or press the PRINT SWITCH to print the reading.

VDE: Equivalent-Patient-Leakage-Current Test

The VDE:Equivalent-Patient-Leakage-Current test measures the current that flows between the applied-parts terminals of the DUT to the PE, Mains terminals (L1 and L2), and exposed conductive parts of the DUT (connected to RED signal connection) in response to an isolated AC voltage source with a magnitude of at least 110 % of Mains voltage. Figure 5-10 shows the electrical connections between the ESA601 and the DUT. DUT power is off. The table below the diagram indicates the position of switches in the diagram during the test.

This test is performed with both NORMAL and REVERSE isolated voltage supply polarity using the M.A.P./VDE EQUIV/INSUL (ISO/VDE EQUIV/INSUL) SWITCH.

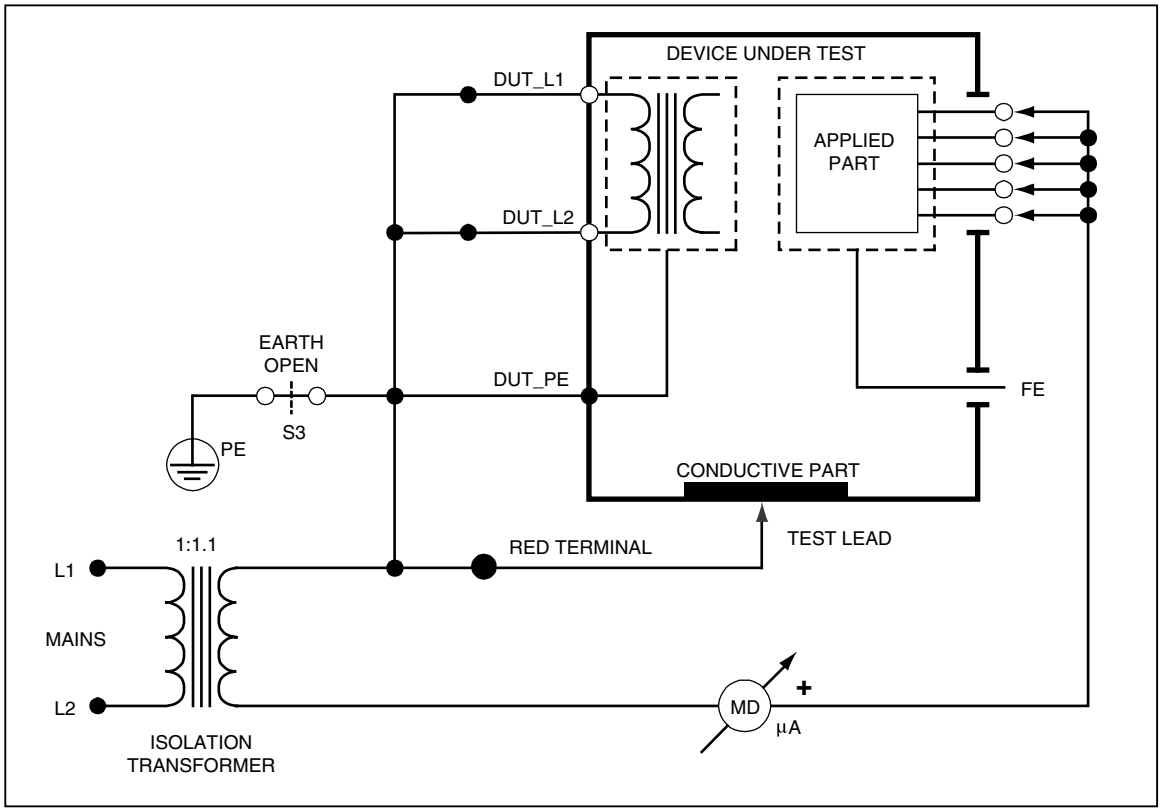

Figure 5-10. VDE: Equivlent-Patient-Leakage-Current Test Configuration

SWITCH		ACTION
DIAGRAM REFERENCE	ESA601 NAME	
S3	EARTH	CLOSED

Action

1. Connect the banana plug end of the RED test lead into the RED signal jack, and the probe end of the RED test lead to the DUT enclosure; connect the DUT applied parts to the applied-parts jacks on the ESA601; connect the DUT power cord to the test receptacle on the ESA601.
2. Position the APPLIED PARTS (or ECG LEADS) selector knob to ALL.
3. Position the FUNCTION-SELECTION KNOB to VDE: EQUIV PATIENT.
4. Depress and hold down the M.A.P./VDE EQUIV/INSUL (ISO/VDE EQUIV/INSUL) SWITCH in the NORMAL position.
5. After the meter settles, release the switch to hold and display the reading and/or press the PRINT SWITCH to print the reading.
6. Depress and hold down the M.A.P./VDE EQUIV SWITCH in the REVERSE position.
7. After the meter settles, release the switch to hold and display the reading and/or press the PRINT SWITCH to print the reading.
8. Disconnect all applied parts from the analyzer.

VDE: Differential-Leakage-Current Test

The VDE: Differential-Leakage-Current test measures the magnitudes of the differential current flowing in the Equipment Outlet L1 and L2 circuits. Figure 5-11 shows the electrical connections between the ESA601 and the DUT. The reading is taken after selecting this function. DUT power is ON.

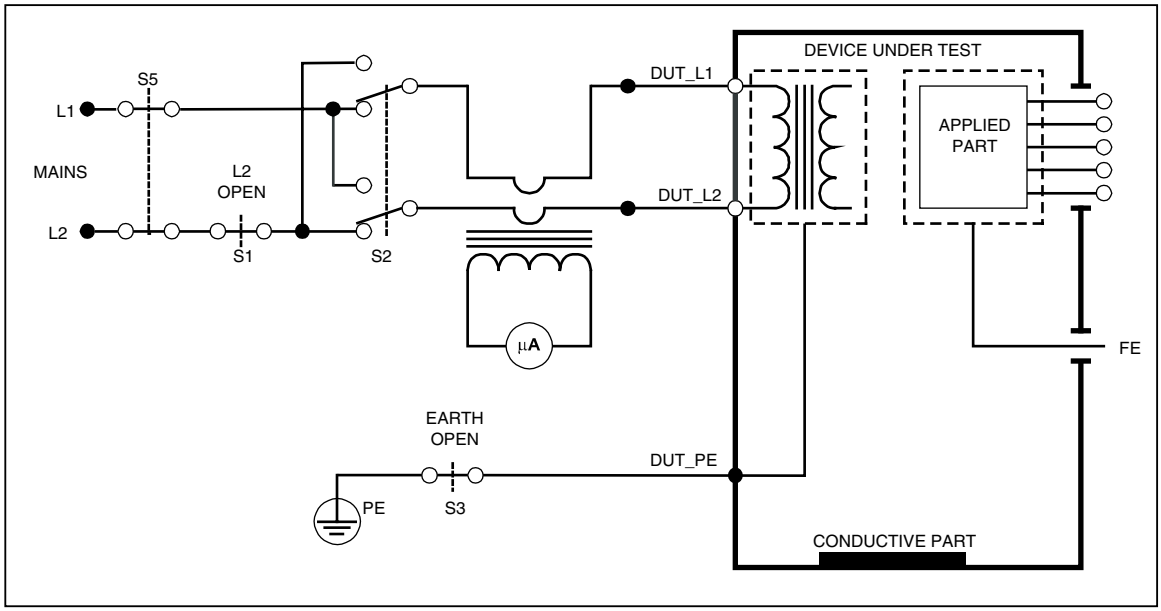

Figure 5-11. VDE: Differential-Leakage-Current Test Configuration

Action

1. Position the FUNCTION-SELECTION KNOB to VDE: DIFF CURRENT.
2. Connect the DUT power cord to the test receptacle on the ESA601.
3. After the meter settles, read the display, and/or press the PRINT SWITCH to print the reading.

Dual-Lead-Leakage-Current Test

The Dual-Lead-Leakage-Current test measures the current flowing from the RED signal connection to the BLACK signal connection. Figure 5-12 shows the electrical connections between the ESA601 and the DUT. DUT power is on. The table below the diagram indicates the position of switches in the diagram during the test.

The test can be performed with NORMAL and REVERSE Mains supply polarity using the POLARITY SWITCH, single-fault condition OPEN L2 using the NEUTRAL SWITCH.

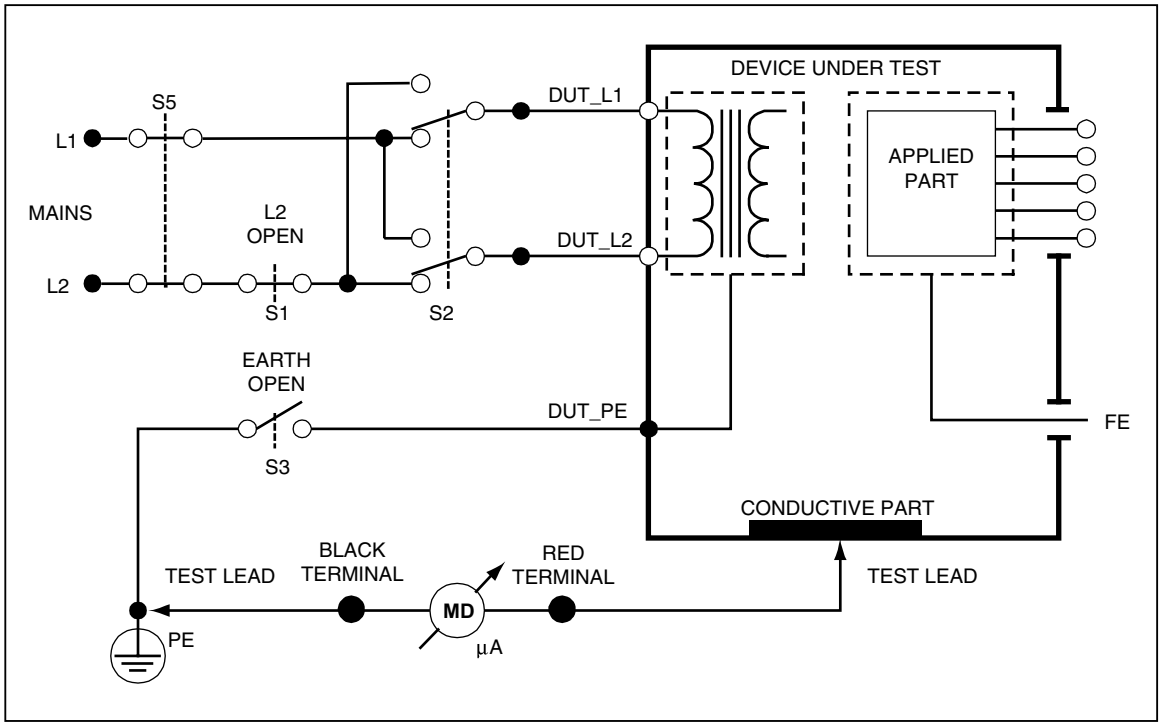

Figure 5-12. Dual-Lead-Leakage-Current Test Configuration

SWITCH		ACTION
DIAGRAM REFERENCE	ESA601 NAME	
S1	NEUTRAL	VARIABLE
S2	POLARITY	VARIABLE
S3	EARTH	OPEN
S5	(N/A)	

Action

1. Connect the RED and BLACK test leads to the RED and BLACK test jacks on the ESA601.
2. Position the FUNCTION-SELECTION KNOB TO DUAL LEAD LEAKAGE.
3. Connect the RED test lead to the DUT enclosure; connect the DUT power cord to the test receptacle on the ESA601.
4. Connect the BLACK test lead to the protective earth or any other test point.
5. After the meter settles, read the display (current flowing between the RED and BLACK test leads), and/or press the PRINT SWITCH to print the reading.
6. Repeat steps 4 and 5 for any other exposed conductive part of the DUT.

Note

The followings steps can be performed if desired.

7. Set the NEUTRAL SWITCH to OPEN.
8. After the meter settles, read the display, and/or press the PRINT SWITCH to print the reading.
9. Set the NEUTRAL SWITCH to CLOSED.
10. Set the POLARITY SWITCH to REVERSE, and wait for the REVERSE POLARITY indicator to illuminate.
11. Repeat steps 7 through 9.

Dual-Lead-Voltage Test

The Dual-Lead-Voltage test measures voltage between RED signal connection and the BLACK signal connection. This test can be used to measure the voltage present on accessible parts relative to Mains PE. Figure 5-13 shows the electrical connections between the ESA601 and the DUT. The test is repeated with NORMAL and REVERSE Mains polarity and single-faults of no Earth and no L2. DUT power is on.

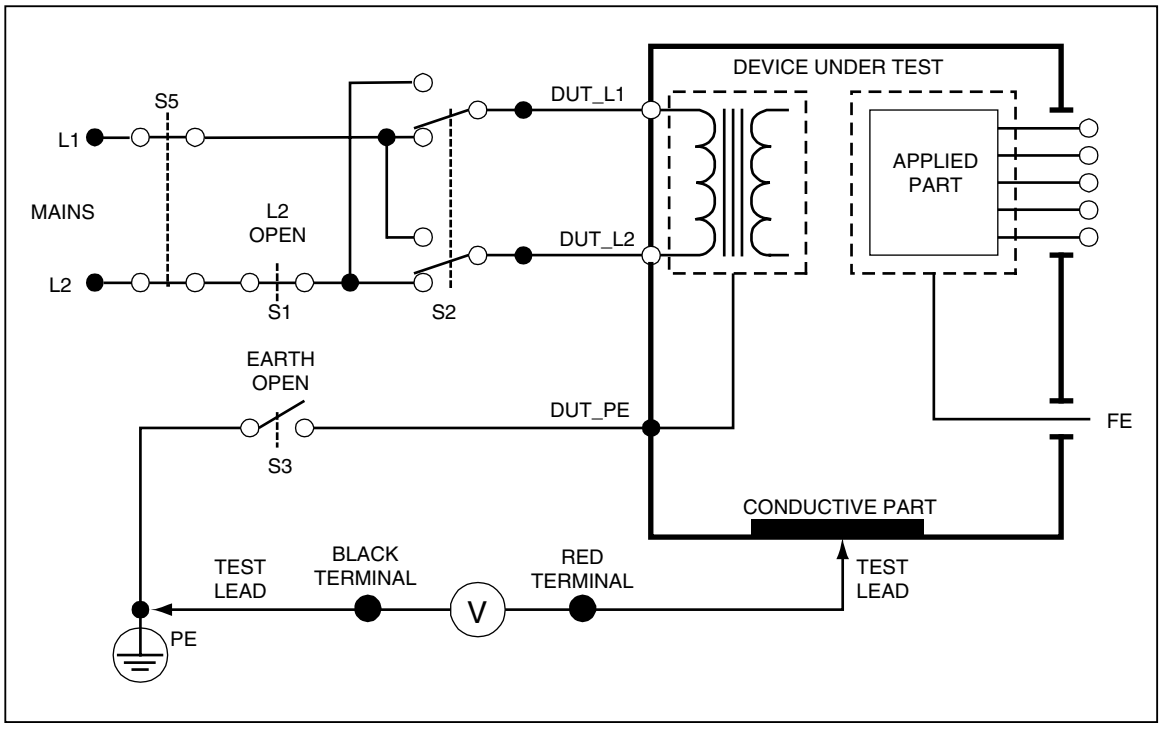

Figure 5-13. Dual-Lead-Voltage Test Configuration

SWITCH		ACTION
DIAGRAM REFERENCE	ESA601 NAME	
S1	NEUTRAL	VARIABLE
S2	POLARITY	VARIABLE
S3	EARTH	VARIABLE
S5	(N/A)	

Action

1. Connect the RED and BLACK test leads to the RED and BLACK test jacks on the ESA601.
2. Position the FUNCTION-SELECTION KNOB to DUAL LEAD VOLTAGE.
3. Connect the RED test lead to the DUT enclosure; connect the DUT power cord to the test receptacle on the ESA601.
4. Connect the BLACK test lead to the protective earth or any other test point.
5. After the meter settles, read the display (voltage between the RED and BLACK test leads), and/or press the PRINT SWITCH to print the reading.
6. Repeat steps 4 and 5 for any other exposed conductive part of the DUT.

Note

The followings steps can be performed if desired.

7. Set the NEUTRAL SWITCH to OPEN.
8. After the meter settles, read the display, and/or press the PRINT SWITCH to print the reading.
9. Set the NEUTRAL SWITCH to CLOSED.
10. Set the EARTH SWITCH to OPEN.
11. After the meter settles, read the display, and/or press the PRINT SWITCH to print the reading.
12. Set the EARTH SWITCH to CLOSED.
13. Set the POLARITY SWITCH to REVERSE, and wait for the REVERSE POLARITY indicator to illuminate.
14. Repeat steps 7 through 12.

Chapter 6
Remote Control

Title **Page**

Using Remote Control

The ESA601 can be controlled by sending remote commands to the RS-232 serial port.

Setup Requirements

Set up the terminal emulator to 9600 baud, 8 bit, no parity, 1 start, 1 stop.

The serial-port connector is a 9-pin female D-SUB, configured as Data Communications Equipment (DCE) and intended to connect straight through to Data Terminal Equipment (DTE).

The supplied cable (P/N 2238626), is a cable with modem elimination (or null modem) that can be used to connect to a PC serial port. If a “straight” serial cable is used, a modem eliminator adapter is required.

To run a COM port or a PC, a terminal emulation program is required, with XON/XOFF and RTS/CTS capabilities.

Note

For computer-setup specifications, refer to Appendix A in this manual.

ESA601 Controller Software Introduction

The Controller 601 software is a standard accessory to the ESA601 Electrical Safety Analyzer. The Controller 601 software provides you with the ability to automate the various country standard electrical-safety compliancy measurement tests performed on the ESA601. The software includes “standards-based” tests (Autosequences), test result collection, storage, review, printing to any Windows compatible printer, and export to Microsoft Excel format (.XLS). At minimum, Autosequences are provided for the following electrical-safety standards: IEC 601-1,VDE, HEI, DB9801S1, AAMI / NFPA-99. With all provided Autosequences you have the ability to deselect or change the standard limits.

To utilize the Controller 601 computer automation, install the software and connect your computer to the ESA601 via the supplied null modem serial communication cable. The Controller 601 software is included on the same CD-ROM as the ESA601 Operator’s Manual. Instructions for the application’s setup and use can be found in the Controller 601 online help. This software is a Windows® XP-based application (also compatible with Windows 2000).

Sending Commands from the Host Computer

1. Press ENTER on the PC keyboard to check communications. The analyzer should return “?”.
2. Using the terminal-emulation program, type the command “REMOTE”. The analyzer responds with "REMOTE MODE" and switches to the OFF function, that is, turns OFF all Equipment-Outlet power.
3. Type the command for the selected function. For example, typing the command below switches the ESA601 to the Protective-Earth-Resistance test:

```
FUNC=EARTH_RES
```

(For a complete list of remote-entry commands, refer to “Remote Control Commands.” in this chapter.)

Remote Control Commands

The following guidelines apply to entering the remote-control commands in the table below:

- The ESA601 executes a command upon a carriage return and/or a line feed.
- Alphabetic characters in commands are NOT case sensitive
- When entering commands using the keyboard, the **BACKSPACE** key operates normally (that is, deletes the previously recorded character)
- When entering commands manually, the escape key discards the entire command. Likewise, a programmed “ESC” (0x1b) discards the entire command.
- Whe a command is completed, a message is returned (usually “OK”).
- If a meter reading is over range, the analyzer responds with the message “OL”.

Table 6-1. Remote Control Commands

COMMAND	PARAMETERS	ACTION
IDENT	(no parameters)	Returns model number and program version number.
VER	(no parameters)	Returns program version number.
LOCAL	(no parameters)	Enters Local Mode. (Responds with "LOCAL MODE.")
REMOTE	(no parameters)	Enters Remote Mode. (Responds with "REMOTE MODE.")
SERN	(no parameters)	Returns six-digit serial number.
FUNCT=	OFF	Turns OFF all Equipment-Outlet power.
FUNCT=	MAINS	Sets Function = AC Input.
FUNCT=	EARTH_RES	Switches to the Protective-Earth-Resistance test.
FUNCT=	MAINS_INS	Switches to the Mains-Insulation-Resistance test.
FUNCT=	AP_INS	Switches to the Applied-Parts-Insulation-Resistance test.
FUNCT=	EARTH_LEAK	Switches to the Earth-Leakage-Current test.
FUNCT=	ENCL_LEAK	Switches to the Enclosure-Leakage-Current test.
FUNCT=	PAT_LEAK	Switches to the Patient-Leakage-Current test.
FUNCT=	PAT_ AUX	Switches to the Patient-Auxiliary-Leakage-Current test.
FUNCT=	MAP	Switches to the Mains-on-Applied-Parts-Leakage-Current test.
FUNCT=	VDE_DEV_LEAK	Switches to the VDE: Equivalent-Device-Leakage-Current test.
FUNCT=	VDE_PAT_LEAK	Switches to the VDE: Equivalent-Patient-Leakage-Current test.
FUNCT=	DIF_CUR	Switches to the VDE: Differential-Current test.

Table 6-1. Remote Control Commands (cont.)

COMMAND	PARAMETERS	ACTION
FUNCT=	DUAL_LEAK	Switches to the Dual-Lead-Leakage-Current test.
FUNCT=	DUAL_VOLTS	AC - BLACK jack to RED jack
PART=	RA LA RL LL V1 V2 V3 V4 V5 V6 ALL	Switches to a selected, or all, applied part(s).
MAP=	NORM OFF REV	Switches to M.A.P. polarity.
NEUT=	OPEN CLOSED	Switches to AC Neutral to Equipment Outlet.
EARTH=	OPEN CLOSED	Switches to Physical Earth (PE).
EO_POL=	NORM REV	Switches to Equipment Outlet Polarity.
OHMS=	NULL OFF RES	Switches to OHMS function.
LOAD=	AAMI IEC	Switches to LOAD-SELECTION function.
LANGUAGE	(no parameters)	Will return the selected language. Possible responses are; "US ENGLISH", "ENGLISH", "FRENCH", "ITALIAN", "GERMAN".
READ_METER	(no parameters)	Reads meter. (Sends data to serial port.) If reading is over range, returns "OL."
REPORT_HDR	(no parameters)	Reads report (WITH HEADER) for current function. (Sends report to serial port.)
REPORT	(no parameters)	Reads report for current function. (Sends report to serial port.)
500V=	ON, OFF	Turns ON/OFF 500 volts for insulation tests.
CAL=	PASSWORD	Enters calibration mode. (Requires password.)
$		Goes to Bootloader.

Chapter 7
Operator Messages and Service

Title **Page**

Error Codes

The ESA601 performs self-diagnostic tests during power-up and startup. If a problem is detected during these times, an error code will be displayed.

Power-up Error Codes

A power-up error is indicated if the ESA601 has the power LED on, fault LED on, blank display and continuously outputs one of the following codes to the Serial Transmit line. If any of the power-up error codes occur, contact your local Fluke service center to arrange repair of the ESA601.

Table 7-1. Power Up Error Codes

Error Code	Meaning
0x01	INSTRUCTION-TEST ERROR
0x05	RAM-TEST ERROR
0x09	FLASH-CHECKSUM TEST ERROR

Start Up Diagnostic Error Codes

If a fault is found at startup, a red light may appear in the POWER FAULT LED, and the ESA601 displays one of the following error codes:

Table 7-2. Sart Up Diagnostice Errors

Code	Description	User Action
Err0	EEPROM checksum error. - The unit probably needs calibration	To continue, hold down the OHMS-FUNCTION SWITCH in the OFFSET/ZERO 0 position
Err1	Input AC is out of range. (Turns ON the POWER FAULT LED). -The meter may be out of calibration.	To continue, hold down the OHMS-FUNCTION SWITCH in the OFFSET/ZERO 0 position.
Err2	Physical Earth to Neutral voltage is incorrect. (Turns ON the POWER FAULT LED.) This may mean that: - AC Hot and Neutral are reversed. - There is a bad connection to Earth Ground. - The meter may need calibration.	To continue, hold down the OHMS-FUNCTION SWITCH in the OFFSET/ZERO 0 position.
Err3	Error during SPI Bus Initialization. -This is a fatal error.	Contact Fluke Service Department.
Err4	Error in reading back SPI Bus data from the power control board. -This is a fatal error.	Contact Fluke Service Department.
Err5	Continuous input overload.	To reset this error, remove inputs to the ESA601. Then, power OFF and back ON.

Service

The ESA601 should be calibrated once a year by a qualified technician. It is recommended that the instrument be sent to Fluke for factory calibration and service.

Service (Repairs and Calibration):

Fluke Customer Service Center
1420 – 75th Street SW
Everett, Washington, 98203

Repair and Calibration: 1-888-99FLUKE (1-888-993-5853)

For international customers, please email serviceinternational@fluke.com to obtain an RMA#.

However, if you choose to calibrate the ESA601, it is important to be aware that the warranty on the unit becomes void if the tamper-resistant Quality Seal is broken without proper factory authorization. (Refer to the "Warranty Disclaimer" in this manual on Page ii.)

Note

When returning the unit for calibration, repair, or service, be sure to follow the "Return Procedure" (i.e., to call or email for an RMA number prior to sending unit) in "Standard Terms and Conditions" in the section in this manual called "Notices."

To order the ESA601 Service Manual, use part number 2243831.

Appendices

Appendix A
Specifications

General Specifications

POWER:	**Operating Voltage Range:** Minimum 90 V AC, Maximum 264 V AC. **Line Cords and AC Mains Inlet:** 16 A or greater, 250 V for Class-1 equipment in cold conditions. **Equipment Outlet:** 15 A, 250 V for Class-1 equipment in cold conditions for Australian, European, and United States versions. Reduced to 13 A for the United Kingdom version.
PROTECTION CIRCUITRY:	Signal I/O connections (excluding the RS-232 port and earth connections) withstand a continuous input of 264 V AC, 47-63 Hz, or ± 264 V DC without causing permanent damage.
SIZE:	9.8 L x 3 D x 8.25 W (inches)
WEIGHT:	<= 5 pounds
TEMPERATURE:	**Storage:** -25 to 50 °C. **Operation:** 10 to 40 °C.
MAXIMUM HUMIDITY:	80 % relative humidity up to 31 °C, decreasing linearly to 50 % relative humidity at 40 °C.

Performance Specifications

LEAKAGE-CURRENT MEASUREMENT:

Ranging: Auto

Configuration: RMS current flowing through the IEC 60601-1 test load or ANSI / AAMI ES1 test load (selectable).

Measurement Range: 0 - 8000 μA True RMS

Display Units: μA

Display Resolution: 1 μA

Accuracy: ±1% of reading (±2 μA) @ DC and 25 Hz to 1000 Hz †
±2.5% of reading (±2 μA) 1kHz tp 200 kHz *†
Frequency response DC to 1 MHz (-3dB)†

†Accuracy (Mains-On-Applied-Part Leakage Current): ± 2 % of reading, ± 6 μA

Crest Factor: <3

Input Impedance: Per Figure 15 of IEC 601-1 1995

* Fullscale input

VOLTAGE MEASUREMENT:

Ranging: Auto

Range (Mains Voltage): 90 to 264 V True RMS

Range (Accessible Voltage): 0 to 264 V True RMS

Display Units: V

Display Resolution: 1 V

Accuracy: ± 2 % of reading, ± 2 V

Crest Factor: <3

Frequency Response: DC to 1000Hz (-3dB point)

DC Input Impedance: 1 MΩ

EARTH-RESISTANCE MEASUREMENT:

Ranging: Auto

Display Units: Ω

Range: 0 to 1.999 Ω

Display Resolution: 0.001 Ω

Accuracy: ± 2 % of reading, ± 5 mΩ

Current Source Amplitude: 1 A DC (± 10 %)

INSULATION MEASURMENT:

Ranging: Auto

Display Units: MΩ

Range: 0.5 MΩ to 100 MΩ

Display Resolution: 0.1 MΩ

Accuracy: 0.5 MΩ to 20 MΩ, ± 2 % of reading, ± 200 kΩ;
above 20 MΩ, ± 5 % of reading,, ± 200 kΩ

Voltage Source Amplitude: 500 V DC (± 10 %)

VDE DIFFERENTIAL CURRENT:

Ranging: Auto

Display Units: μA

Range: 10 μA to 10000 μA

Display Resolution: 10 μA

Accuracy: ± 2 % of full scale

MAINS ON APPLIED PARTS:

Voltage: >= 110 % of input Mains voltage (at no load)

Phase: In-phase or 180 ° out-of-phase with Mains voltage

Input/Output Connection Specifications

MAINS INLET:	Standard IEC 60320-1 / C20 Mains inlet rated at 16 A and 250 V for Class-1 equipment in cold conditions
EQUIPMENT OUTLET (TEST RECEPTACLE):	Specific to version of instrument: AS 3112-1993 (Australia) BS 1363A (English – United Kingdom) NEMA 5-15R (English – United States) Schuko CEE7 (English) Schuko CEE7 (French, German, Italian and ROW [International])
SIGNAL CONNECTIONS:	Three safety-style banana jacks: RED – signal input / output connection GREEN – direct connection to Equipment Outlet Earth BLACK – signal input / output connection for Dual-Lead-Voltage and Dual-Lead-Leakage tests
APPLIED-PART CONNECTIONS:	Ten banana jacks that enable the connection of applied-parts (in some cases ECG) leads to the meter circuit: RA (or R and AP1), RL (or N and AP2), LA (or L and AP3), LL (or F and AP4), and V1-V6 (or C1-C6 and AP5 - AP10)
RS-232 SERIAL PORT:	A serial interface to be used with ESA601 Controller software, or in Remote Mode, enables remote operation of the ESA601, and provides a download port for processor firmware. In Local Mode, this port can be used to output test results to a serial ASCII printer when the PRINT SWITCH is pressed.

Computer-Setup Specifications

SERIAL CABLE	Null modem is required (P/N 75029)
PORT:	Bidirectional (Data Communications Equipment) RS-232
BAUD RATE:	9600
PARITY:	None
START BITS	1
STOP BITS:	1
DATA BITS:	8

Appendix B
Sample ESA601 Test Printouts

Introduction

Printouts created by the ESA601 will vary in text depending on the version used. Besides the language, the terms may also vary. The two sample printouts in this appendix are from the two English language versions of the ESA601. Appendix C lists the words used in all the versions of the ESA601.

Sample Printout, English 1 Version (ESA601-US/IEC, -UK, -SHK, & -AUS)

FLUKE BIOMEDICAL

DATE:_____

LOCATION:_____

DEVICE TYPE:_____

MANUFACTURER:_____

SERIAL# :_____

TECHNICIAN:_____

ESA601:

Comments:

MAINS VOLTAGE [V	122.4
PROT. EARTH RESISTANCE [OHM]	1.035
INSUL RESISTANCE [MOHM]	
L1,L2-CASE	095.6
INSUL RESISTANCE [MOHM]	
AP-CASE	099.5
EARTH LEAKAGE CUR. [uA]	
NORM POL, NO EARTH:	0001
NORM POL, NO L2, NO EARTH:	0001
REV POL, NO EARTH:	0001
NORM POL, NO EARTH:	
All-Earth	0001
NORM POL, NO EARTH:	0001
ENCL. LEAKAGE CUR. [uA]	
NORM POL:	0000
NORM POL, NO L2:	0000
NORM POL, NO EARTH:	0000
NORM POL, NO L2, NO EARTH:	0000
REV POL:	0000
REV POL, NO L2:	0000
REV POL, NO L2, NO EARTH:	0000
NORM POL:	
All-Earth	0000
PATIENT LEAKAGE CUR [uA]	
NORM POL:	
AP1-Earth	4686
NORM POL:	
All-Earth	4677
AP1-Earth	4682
AP2-Earth	4686
AP3-Earth	4686
AP4-Earth	4687
AP5-Earth	4688
AP6-Earth	4692
AP7-Earth	4692
AP8-Earth	4690
AP9-Earth	4691
AP10-Earth	4693
REV POL:	
All-Earth	4654
AP1-Earth	4684
AP2-Earth	4741
AP3-Earth	4738
AP4-Earth	4742
AP5-Earth	4741
AP6-Earth	4745

AP7-Earth	4742
AP8-Earth	4740
AP9-Earth	4738
AP10-Earth	4741
REV POL, NO L2:	
AP1=Earth	4710
REV POL, NO L2, NO EARTH:	
AP1-Earth	4728
NORM POL, NO L2, NO EARTH:	
AP1-Earth	4677
NORM POL, NO L2:	
AP1-Earth	4651
NORM POL:	
AP1-Earth	4670

PATIENT AUX CURRENT [uA]

NORM POL:	
AP1-All	0001
AP2-All	0001
AP3-All	0001
AP4-All	0001
AP5-All	0001
AP6-All	0001
AP7-All	0001
AP8-All	0001
AP9-All	0001
AP10-All	0001
INVALID TEST	
REV POL:	
AP1-All	0001
NORM POL, NO EARTH:	
AP1-All	0001
REV POL, NO EARTH:	
AP1-All	0001
REV POL, NO L2, NO EARTH:	
AP1-All	0001
REV POL, NO L2:	
AP1-All	0001
NORM POL, NO L2:	
AP1-All	0001
NORM POL:	
AP1-All	0001

MAINS ON APP. PART [uA]

NORMAL ISOLATION POL, NORM POL:	
All-Earth	0000
NORMAL ISOLATION POL, NORM POL:	
AP1-Earth	0001
NORMAL ISOLATION POL, NORM POL:	
AP2-Earth	0001

NORMAL ISOLATION POL, NORM POL:	
AP3-Earth	0001
NORMAL ISOLATION POL, NORM POL:	
AP4-Earth	0001
NORMAL ISOLATION POL, NORM POL:	
AP5-Earth	0001
NORMAL ISOLATION POL, NORM POL:	
AP6-Earth	0001
NORMAL ISOLATION POL, NORM POL:	
AP7-Earth	0001
NORMAL ISOLATION POL, NORM POL:	
AP8-Earth	0001
NORMAL ISOLATION POL, NORM POL:	
AP9-Earth	0001
NORMAL ISOLATION POL, NORM POL:	
AP10-Earth	0001
REVERSE ISOLATION POL, NORM POL:	
AP1-Earth	0001
REVERSE ISOLATION POL, NORM POL:	
All-Earth	0000
REVERSE ISOLATION POL, REV POL:	
AP1-Earth	0001
NORMAL ISOLATION POL, REV POL:	
AP1-Earth	0001
EQUIV. DEVICE LEAK [uA]	
NORMAL ISOLATION POL, NO L2:	0002
REVERSE ISOLATION POL, NO L2:	0004
EQUIV. PATIENT LEAK [uA]	
NORMAL ISOLATION POL, NO L2:	0002
REVERSE ISOLATION POL, NO L2:	0002
VDE DIFFERENTIAL CUR [uA]	0016
DUAL LEAD LEAKAGE [uA]	
NORM POL, NO EARTH:	0217
NORM POL, NO L2, NO EARTH:	0217
REV POL, NO EARTH:	0217
REV POL, NO L2, NO EARTH:	0217
DUAL LEAD VOLTAGE [V]	
NORM POL:	009.6
NORM POL, NO L2:	009.6
NORM POL, NO EARTH:	009.5
NORM POL, NO L2, NO EARTH:	009.6
REV POL:	009.5
REV POL, NO L2:	009.5
REV POL, NO EARTH:	009.5
REV POL, NO L2, NO EARTH:	009.5

Sample Printout, US-English 2 Version (ESA601-USA)

FLUKE BIOMEDICAL

DATE:_____

LOCATION:_____

DEVICE TYPE:_____

MANUFACTURER:_____

SERIAL# :_____

TECHNICIAN:_____

ESA601:

Comments:

MAINS VOLTAGE [V]	122.4
GROUND WIRE RESISTANCE [OHM]	1.035
INSUL RESISTANCE [MOHM]	
L1,L2-CASE	095.6
INSUL RESISTANCE [MOHM]	
LEADS-CASE	099.5
GROUND WIRE LEAKAGE CUR. [uA]	
NORM POL, NO GROUND:	0001
NORM POL, NO L2, NO GROUND:	0001
REV POL, NO GROUND:	0001
NORM POL, NO GROUND:	
All-GROUND	0001
NORM POL, NO GROUND:	0001
CHASSIS LEAKAGE CUR. [uA]	
NORM POL:	0000
NORM POL, NO L2:	0000
NORM POL, NO GROUND:	0000
NORM POL, NO L2, NO GROUND:	0000
REV POL:	0000
REV POL, NO L2:	0000
REV POL, NO L2, NO GROUND:	0000
NORM POL:	
ALL-GROUND	0000

LEAD TO GROUND LEAKAGE CUR [uA]	
NORM POL:	
RA-GROUND	4686
NORM POL:	
All-GROUND	4677
RA-GROUND	4682
RL-GROUND	4686
LA-GROUND	4686
LL-GROUND	4687
V1-GROUND	4688
V2-GROUND	4692
V3-GROUND	4692
V4-GROUND	4690
V5-GROUND	4691
V6-GROUND	4693
REV POL:	
All-GROUND	4654
RA-GROUND	4684
RL-GROUND	4741
LA-GROUND	4738
LL-GROUND	4742
V1-GROUND	4741
V2-GROUND	4745
V3-GROUND	4742
V4-GROUND	4740
V5-GROUND	4738
V6-GROUND	4741
REV POL, NO L2:	
RA-GROUND	4710
REV POL, NO L2, NO GROUND:	
RA-GROUND	4728
NORM POL, NO L2, NO GROUND:	
RA-GROUND	4677
NORM POL, NO L2:	
RA-GROUND	4651
NORM POL:	
RA-GROUND	4670

LEAD TO LEADS CURRENT [uA]	
NORM POL:	
RA-All	0001
RL-All	0001
LA-All	0001
LL-All	0001
V1-All	0001
V2-All	0001
V3-All	0001
V4-All	0001
V5-All	0001
V6-All	0001
INVALID TEST	

REV POL:
RA-All 0001
NORM POL, NO GROUND:
RA-All 0001
REV POL, NO GROUND:
RA-All 0001
REV POL, NO L2, NO GROUND:
RA-All 0001
REV POL, NO L2:
RA-All 0001
NORM POL, NO L2:
RA-All 0001
NORM POL:
RA-All 0001

LEAD ISOLATION [uA]
NORMAL ISOLATION POL, NORM POL:
All-GROUND 0000
NORMAL ISOLATION POL, NORM POL:
RA-GROUND 0001
NORMAL ISOLATION POL, NORM POL:
RL-GROUND 0001
NORMAL ISOLATION POL, NORM POL:
LA-GROUND 0001
NORMAL ISOLATION POL, NORM POL:
LL-GROUND 0001
NORMAL ISOLATION POL, NORM POL:
V1-GROUND 0001
NORMAL ISOLATION POL, NORM POL:
V2-GROUND 0001
NORMAL ISOLATION POL, NORM POL:
V3-GROUND 0001
NORMAL ISOLATION POL, NORM POL:
V4-GROUND 0001
NORMAL ISOLATION POL, NORM POL:
V5-GROUND 0001
NORMAL ISOLATION POL, NORM POL:
V6-GROUND 0001
REVERSE ISOLATION POL, NORM POL:
V3-GROUND 0001
REVERSE ISOLATION POL, NORM POL:
All-GROUND 0000
REVERSE ISOLATION POL, REV POL:
RA-GROUND 0001
NORMAL ISOLATION POL, REV POL:
RA-GROUND 0001

EQUIV. DEVICE LEAK [uA]
NORMAL ISOLATION POL, NO L2: 0002
REVERSE ISOLATION POL, NO L2: 0004

EQUIV. PATIENT LEAK [uA]

NORMAL ISOLATION POL, NO L2:	0002
REVERSE ISOLATION POL, NO L2:	0002
VDE DIFFERENTIAL CUR [uA]	0016
DUAL LEAD LEAKAGE [uA]	
NORM POL, NO GROUND:	0217
NORM POL, NO L2, NO GROUND:	0217
REV POL, NO GROUND:	0217
REV POL, NO L2, NO GROUND:	0217
DUAL LEAD VOLTAGE [V]	
NORM POL:	009.6
NORM POL, NO L2:	009.6
NORM POL, NO GROUND:	009.5
NORM POL, NO L2, NO GROUND:	009.6
REV POL:	009.5
REV POL, NO L2:	009.5
REV POL, NO GROUND:	009.5
REV POL, NO L2, NO GROUND:	009.5

Appendix C
Equivalent Report Terms

Introduction

Table lists the words used in the five different languages of the ESA601.

Table C-1. Language Equivalents for Terms on Report Printouts

ENGLISH IEC TERM	ENGLISH AAMI TERM	FRENCH TERM	ITALIAN TERM	GERMAN TERM
Language selected "E"	Language selected "E-US"	Language selected "F"	Language selected "I"	Language selected "D"
FLUKE BIOMEDICAL	FLUKE BIOMEDICAL	FLUKE BIOMEDICAL	FLUKE BIOMEDICAL	FLUKE BIOMEDICAL
DATE	DATE	DATE	DATA	DATUM
LOCATION	LOCATION	SERVICE	REPARTO	STANDORT
DEVICE TYPE	DEVICE TYPE	TYPE D'APP.	COSTRUTTORE	GERAETETYP
MANUFACTURER	MANUFACTURER	FABRICANT	MODELLO	HERSTELLER
SERIAL#	SERIAL#	NO.SERIE	N.S.	SERIEN#
TECHNICIAN	TECHNICIAN	TECHNICIEN	TECNICO	TECHNIKER
ESA601	ESA601	ESA601	ESA601	ESA601
Comments	Comments	Commentaire	Commento	Kommentar
MAINS VOLTAGE [V]	MAINS VOLTAGE [V]	TENSION SECTEUR [V]	TENSIONE ALIMETAZIONE [V]	NETZSPANNUNG [V]
DUAL-LEAD VOLTAGE [V]	DUAL-LEAD VOLTAGE [V]	TENSION EXTERNE [V]	TENSIONE DUE FILI [V]	SPANNUNG [V]
DUAL LEAD LEAKAGE [uA]	DUAL LEAD LEAKAGE [uA]	COURANT EXTERNE [uA]	DISPERSIONE A DUE FILI [uA]	STROM [uA]
INSUL RESISTANCE [MOHM]	INSUL RESISTANCE [MOHM]	RES. D'ISOLEMENT [MOHM]	RES. ISOLAMENTO [MOHM]	ISOL.-WIDERSTAND [MOHM]
L1,L2-CASE	L1,L2-CASE	PH, N -ENVELOPPE.	L1,L2-INV.	NETZ-GEHAEUSE
AP-CASE	LEADS-CASE	PARTIES APPL.	PA. INV	ANW. TEILE

Figure C-1. Language Equivalents for Terms on Report Printouts (cont.)

ENGLISH IEC TERM	ENGLISH AAMI TERM	FRENCH TERM	ITALIAN TERM	GERMAN TERM
PROT. EARTH RESISTANCE [OHM]	GROUND WIRE RESISTANCE [OHM]	RES. DE TERRE DE PROT [OHM]	RES COND. PROTEZIONE [OHM]	SCHUTZLEITERWID ERSTAND [OHM]
EARTH LEAKAGE CUR. [uA]	GROUND WIRE LEAKAGE CUR. [uA]	COUR. FUITE TERRE [uA]	CDD. VERSO TERRA [uA]	ERDABLEITSTROM [uA]
ENCL. LEAKAGE CUR. [uA]	CHASSIS. LEAKAGE CUR. [uA]	COUR. FUITE ENVEL [uA]	CDD. INVOLUCRO [uA]	GEHAEUSEABLEITS TROM [uA]
EQUIV. DEVICE LEAK [uA]	EQUIV. DEVICE LEAK [uA]	COUR FUITE APP. EQUIV [uA]	DISP.APP EQUIV. [uA]	ERSATZGER.- ABL.STROM [uA]
EQUIV. PATIENT LEAK [uA]	EQUIV. PATIENT LEAK [uA]	COUR FUITE PAT. EQUIV [uA]	DISP. PAZ EQUIV. [uA]	ERSATZPAT.- ABL.STROM [uA]
MAINS ON APP. PART [uA]	LEADS ISOLATION [uA]	TENSION SECTEUR S. PA [uA]	RETE SU PARTI APPL. [uA]	NETZ AM ANWENDERTEIL [uA]
REVERSE ISOLATION POL	REVERSE ISOLATION POL	POL. INV ISO. .	POL. INV. ISO.	TESTSP. NORM. POL
NORMAL ISOLATION POL	NORMAL ISOLATION POL	POL. NOR ISO.	POL. DIR. ISO.	TESTSP UMGEPOLT
PATIENT LEAKAGE CUR. [uA]	LEAD TO GROUND LEAKAGE CUR [uA]	COUR. FUITE PATIENT [uA]	CDD NEL PAZIENTE [uA]	PATIENTENABLEITS TROM [uA]
PATIENT AUX CURRENT [uA]	LEAD TO LEADS CURRENT [uA]	COURANT AUX PATIENT [uA]	CORR. AUSIL. PAZIENTE [uA]	PATIENTENHILFSST ROM [uA]
VDE DIFFERENTIAL CUR [uA]	VDE DIFFERENTIAL CUR [uA]	COURANT DIFFER. [uA]	CORR. DIFFERENZIALE VDE. [uA]	DIFFERENZSTROM [uA]
NORM POL	NORM POL	POL. NORMALE	POL NORM	NORM POL
REV POL	REV POL	POL. INVERSEE	POL. INV	UMPOLUNG
NO EARTH	NO GROUND	TERRE DEBRA	NO TERRA	SCHULTZ. UNTERBR
NO L2	NO L2	NEUTRE DEBRA	NO L2	NULLEITER UNTERBR
AP1-Earth	RA GROUND	AP1-Terre	PA1-Terra	ANW TEIL 1
AP2-Earth	RL GROUND	AP2-Terre	PA2-Terra	ANW TEIL 2
AP3-Earth	LA GROUND	AP3-Terre	PA3-Terra	ANW TEIL 3
AP4-Earth	LL GROUND	AP4-Terre	PA4-Terra	ANW TEIL 4
AP5-Earth	V1 GROUND	AP5-Terre	PA5-Terra	ANW TEIL 5
AP6-Earth	V2 GROUND	AP6-Terre	PA6-Terra	ANW TEIL 6
AP7-Earth	V3 GROUND	AP7-Terre	PA7-Terra	ANW TEIL 7
AP8-Earth	V4 GROUND	AP8-Terre	PA8-Terra	ANW TEIL 8
AP9-Earth	V5 GROUND	AP9-Terre	PA9-Terra	ANW TEIL 9
AP10-Earth	V6 GROUND	AP10-Terre	PA10-Terra	ANW TEIL 10
All-Earth	All GROUND	Toutes-Terre	Tutte-Terra	Alle
AP1-All	RA-All	AP1-Tous	PA1-Tutte	ANW TEIL 1/Alle
AP2-All	RL-All	AP2-Tous	PA2-Tutte	ANW TEIL 2/Alle
AP3-All	LA-All	AP3-Tous	PA3-Tutte	ANW TEIL 3/Alle
AP4-All	LL-All	AP4-Tous	PA4-Tutte	ANW TEIL 4/Alle
AP5-All	V1-All	AP5-Tous	PA5-Tutte	ANW TEIL 5/Alle
AP6-All	V2-All	AP6-Tous	PA6-Tutte	ANW TEIL 6/Alle
AP7-All	V3-All	AP7-Tous	PA7-Tutte	ANW TEIL 7/Alle

Figure C-1. Language Equivalentsfor Terms on Report Printouts (cont.)

ENGLISH IEC TERM	ENGLISH AAMI TERM	FRENCH TERM	ITALIAN TERM	GERMAN TERM
AP8-All	V4-All	AP8-Tous	PA8-Tutte	ANW TEIL 8/Alle
AP9-All	V5-All	AP9-Tous	PA9-Tutte	ANW TEIL 9/Alle
AP10-All	V6-All	AP10-Tous	PA10-Tutte	ANW TEIL 10/Alle
INVALID TEST	INVALID TEST	ESSAI INADMISSIBLE	PROVA NON VALIDA	UNZULAESSIGER TEST

Appendix D
Abbreviations

Abbreviations

A	ampere
AAMI	American Association of Medical Instrumentation
AP	applied parts
CTS	clear to send
dB	decibel
DCE	data communication equipment
DTE	data terminal equipment
DUT	device under test
Hz	hertz
IEC	International Electrotechnical Commission
kHz	kilohertz
LA	left arm
LED	light-emitting diode
LL	left leg
MΩ	megohm
M.A.P. / MAP	Mains on applied parts
MHz	megahertz
MΩ	megohm
PCBA	printed circuit board assembly
PE	Protective Earth

pF	picofarad
P/N	part number
RA	right arm
RL	right leg
RTS	ready to send
SPI	serial peripheral interface
V	volt
Ω	ohm
µA	microampere
°C	degrees Celsius (centigrade)