

FLUKE®

Biomedical

RF303

Electrosurgical Analyzer

Operators Manual

PN 2202027

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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.

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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.

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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.

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For application support or answers to technical questions, either email techservices@flukebiomedical.com or call 1-800-648-7952 or 1-425-446-6945.

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

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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.

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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 Order Entry Group at 1-800-648-7952 or 1-425-446-6945.

Repair and calibration:

To find the nearest service center, go to www.flukebiomedical.com/service, or

In the U.S.A.:

Cleveland Calibration Lab

Tel: 1-800-850-4606

Email: globalcal@flukebiomedical.com

Everett Calibration Lab

Tel: 1-888-99-FLUKE (1-888-993-5853)

Email: service.status@fluke.com

In Europe, Middle East, and Africa:

Eindhoven Calibration Lab

Tel: +31-402-675300

Email: ServiceDesk@fluke.com

In Asia:

Everett Calibration Lab

Tel: +425-446-6945

Email: service.international@fluke.com

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 RF303 Electrosurgical Analyzer is manufactured in Everett, Washington by Fluke Biomedical, 6920 Seaway Blvd., Everett, WA, U.S.A.

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Chapter 1

Introduction and Specifications

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Introduction

The RF303 Electrosurgical Analyzer, hereafter referred to as the “Analyzer”, tests electrosurgical units (ESU) for generator output and high frequency (HF) leakage. It is compatible with both isolated and earth/ground-referenced types of electrosurgical units. You can test both the high-level monopolar and the low-level bipolar ESU outputs using this versatile Analyzer.

The Analyzer uses a precision high-voltage capacitive attenuator to sample the applied ESU signal. You can use this attenuated HF voltage and the selected test load resistance value to derive the true-rms values of both current and wattage.

The Analyzer internal test load simulates the range of resistance encountered during surgical procedures. Additionally, a second, 200 ohm (Ω) auxiliary test load resistance is built-in to analyze earth/ground-referenced ESUs as specified in the International Standard IEC 601-2-2.

The exclusive use of non-conductive, high-impact plastic case material minimizes extraneous high frequency leakages within the Analyzer.

General Safety Information

This Analyzer complies with safety and technical requirements described in the following directives:

- UL 3101-1
- CAN/CSA C22.2 No. 1010.1 (1992)
- EC 73/23/EEC EN 61010-1
- ANSI / AAMI HF-18-1986
- IEC 601-2-2
- IEC 1289-1
- IEC 1289-2











A **Warning** identifies hazardous conditions and actions that could cause bodily harm or death.

A **Caution** identifies conditions and actions that could damage the Analyzer, the equipment under test, or cause permanent loss of data.

Symbols

Table 1-1 describes the symbols used in this document.

Table 1-1. Symbols

Symbol	Description	Symbol	Description
	Risk of danger. Important information. See manual.		Hazardous voltage. Risk of electrical shock.
	Conforms to relevant Canadian and U.S. standards		Conforms to European Union directives
	Underwriters Laboratories listed product		AC (Alternating Current)
	Indicates that a terminal is connected to the chassis when such a connection is not apparent.		DC (Direct Current)
	Earth ground		Do not dispose of this product as unsorted municipal waste. Contact Fluke or a qualified recycler for disposal.

Warnings and Cautions

When testing electrosurgical units, observe the following to ensure operator safety and maintain integrity of the high frequency (HF) measurement.

Warning

To avoid possible electric shock, burning of the skin, or personal injury, follow these guidelines:

- **Use only test leads supplied with the Analyzer to test the ESU. These test leads utilize a shrouded 4mm plug to limit exposure to the high-voltage and high frequency ESU signal. The retractable ends of these leads are for use on ESU only.**

- **Do not plug in or remove a test lead from either the ESU or the Analyzer while the ESU generator is activated (or keyed). This high frequency ESU signal can be several thousand volts in amplitude when the output is open-circuited.**
- **Whenever practical during testing, activate the ESU generator output using the foot switch supplied with the ESU.**
- **No probes or accessories supplied with the analyzer are intended for handheld use. Set up using the safety test leads and stand clear when activating the ESU with the footswitch.**
- **Place the Analyzer on an insulated, non-conductive work surface to limit possible HF current paths to earth ground.**
- **Routinely inspect test leads for wear and tear. Repair or replace the test leads to maintain operator safety and Analyzer performance.**

Note

To ensure accuracy of measurement, follow these guidelines:

- *Whenever practical during testing, place test leads carrying the ESU signals in parallel, approximately 0.5 meters apart, to limit capacitive coupling.*
- *Avoid crossing or tangling test lead cables during use and do not drape them across conductive, grounded surfaces. Due to their length, erroneously high HF readings may result.*

Electromagnetic Interference and Susceptibility

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 could cause interference, in which case the user will be required to correct the interference and bear any

costs. The limits established by the following organizations are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment.

The Analyzer has been tested by independent testing laboratories and found to meet the following requirements:

EC Directive 89/336/EEC EN 50081-1 Emissions

Radiated Emissions and Line Conducted Emissions. Verification was to the limits and methods of EN 55011. The device is classified as EN 55011, Group A.

EC Directive 89/336/EEC EN 50082-1 Immunity

Electrostatic Discharge Susceptibility, Radiated Susceptibility, and Electrical Fast Transient/Burst Susceptibility. Verification of compliance was conducted to the limits and methods of EN 50082-1:1992, IEC 1000-4-2; EN 61000-4-3; IEC 1000-4-4; EN 61000-4-5; EN 61000-4-6; EN 61000-4-11.

USA Federal Communications Commission

This equipment has been found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules.

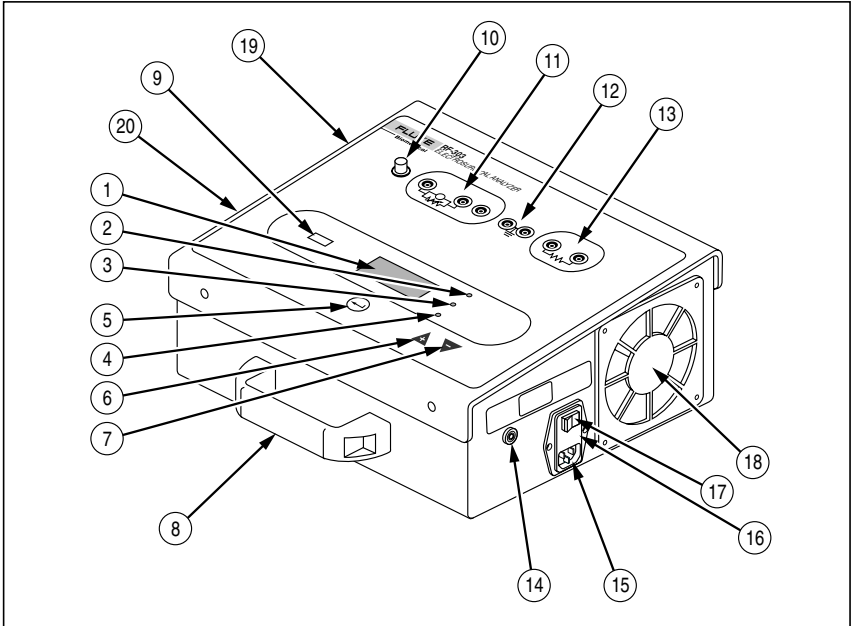
Canadian Department of Communications

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 présent appareil numérique n'émet pas de bruits radioélectriques dépassant les limites applicables aux appareils numériques de la Class A prescrites dans le Règlement sur le brouillage radioélectrique édicté par le ministère des Communications du Canada.

Control and Interface Panels

Figure 1-1 and Table 1-2 describe the controls and interfaces of the Analyzer.



exz14.eps

Figure 1-1. Analyzer Control and Interface Panels

Table 1-2. Controls and Connections

Item	Name / Description
1	Display Backlit, numeric, 4-digit LCD
2	Power Indicator (WATTS) Lamp Displays reading in watts.
3	Current Indicator (mA) Lamp Displays readings in milliamperes (mA).

Table 1-2 Controls and Connections (cont.)

Item	Name / Description
4	Test Load (OHMS) Lamp Displays resistance in ohms.
5	Mode Selection (MODE SELECT ENT) Pushbutton Toggles the display between Power (in watts) and Current (in mA).
6	Increase Test Load (OHMS SELECT +) Pushbutton
7	Decrease Test Load (OHMS SELECT -) Pushbutton
8	Carrying Handle
9	Battery Status Lamp
10	Scope Output BNC connector
11	Measuring Resistance/HF Meter All measurements made through these inputs.
12	Earth Connections Provides earth reference for HF Leakage tests.
13	HF Load Resistance Auxiliary test load for earth/ground-referenced Type BF Tests 2 and 3.
14	Battery Ground / Signal Earth Ground
15	Power Cord Inlet
16	Fuse Cover Both power mains fuses are located behind this panel.
17	Power On/Off Switch
18	Ventilation Air Outlet
19	Ventilation Air Inlet
20	RS232 Port

Instrument Specifications

Modes of Operation

- Line Powered (Battery Charge and Maintenance Charge)
- Battery Operation
- Offline (Battery Charge and Maintenance Charge)

Displayed Parameters

- Power (Watts)
- HF Current (milliamperes)
- Test Load (ohms)

Test Performed

- Generator Output
- HF Leakage Performs HF leakage tests to IEC 601 2-2, 1289-2, ANSI/AAMI standards: Type BF Test 1 – Earth referenced monopolar output Type CF/Bipolar – Isolated monopolar or bipolar output

Measurement

- Technique Precision high-voltage capacitive attenuator samples applied ESU signal. This directly measured HF voltage and the selected test load resistance value utilized to derive the true-rms values of both current and wattage readings.
- HF Power (watts)
 - Resolution 1 to 400 W / Resolution: 0.1 W
 - Maximum power input 400 W rms
 - Accuracy $\pm 5\%$ of reading or ± 3 watts, whichever is greater
- HF Current
 - Range 30 to 2500 mA rms, Resolution: 1 mA
 - Accuracy $\pm 2.5\%$ of reading or ± 15 mA, whichever is greater.

Bandwidth/System Response

- Bandwidth of rms converter circuit (1 % accuracy)
 - Flat response 10 kHz to 10 MHz
 - 3 dB points 1 kHz to 20 MHz
- System Response (measurement circuitry and selected test load):
 - 3 dB points 1 kHz to 10 MHz @ 300 Ω

Test Load Section

Main Test Load

Selections	15
Selection range	50 to 750 Ω
Step size	50 Ω
Duty Cycle	50 % @ 400 W (maximum 30 seconds ON during any one-minute period)
Resonance impedance variation	\pm 0.5 dB maximum (<10 MHz)
Accuracy (DC to 500 kHz)	\pm 4 % of selected value measured at calibration to: \pm 1 % (across the entire operating temperature range)

Auxiliary Leakage Test Load Fixed:

200 Ω Accuracy..... \pm 4 %

Power rating225 W

Input Capacitance (nominal)

Active to dispersive30 pF

Active or Dispersive to Earth ground.....40 pF

Battery

Type: Sealed lead-acid

Voltage12 volts nominal

Capacity2.2 A H

Field serviceableNo

Typical time between recharges.....2-hour minimum

Battery cycles200

RechargingInstrument has internal, automatic charger that is activated when unit is plugged into wall with power cord. No external charger required.

Auxiliary Contact Quality Monitor

Testing FeatureThe main test load section is used to perform a simple Auxiliary Contact Quality Monitor Testing Feature (CQM) operational check.

Display

TypeLCD, 7-segment

Display sizeFour full digits

Overall display size2.0" x 0.75"

Front-Panel Controls / Pushbuttons

Measurement Select (1)

Load Select:

Increment test load (+) one step

Decrement test load (-) one step

Designations:

Generator output-active (1)

Generator output-dispersive (2)

Auxiliary HF leakage load (2)

Connector type 4-mm (0.160") diameter safety sockets

Input voltage limit 10,000 V peak

Input current limit 3 amperes rms

Installation category II

Side Input connection

Designation Signal reference

Oscilloscope Output

Transformer coupled output

Scale Factor uncalibrated

Connector type BNC

Calibration Period

Calibration recommended every 12 months.

General Specifications

Temperature Range

Operating: 15 to 35 °C

Storage 0 to 50 °C

Humidity Range

90 % non-condensing

Altitude

To 2,000 meters

Ventilation

Internal fan with variable speed control

Over temperature detector

Magnetic tachometer sensor to detect blocked fan motor

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Power Requirements

Universal input switching supply (12 V dc output)

Operating Voltages:

Specified.....115 V ac/230 V ac

Maximum range.....83 to 264 V ac

Operating frequencies:

Specified.....50 Hz/60 Hz

Maximum range.....47 to 63 Hz

Maximum input requirement.....60 VA

Fusing

External (user-replaceable)

Quantity.....2

250 V, 3.15 A, Type F, L1 and L2

Case construction

High-impact plastic, UL94-V0

Weight

5.6 kg (14.15 lb)

Dimensions

15.24 cm H x 34.24 cm W x 30.48 cm D (6.00 in. H x 13.48 in. W x 12.00 in. D)

Intended Use

Indoor

Installation category II

Pollution degree 2

Portable equipment

Sound levels less than 65 db A

Accessories

Table 1-3 lists the accessories provided with the Analyzer and their corresponding Fluke part numbers. Table 1-4 lists optional accessories and their part numbers.

Table 1-3. Accessories Provided with the Analyzer

Accessory	Fluke Part #
Analyzer Operators Manual	2202027
Analyzer Accessory Kit Includes: (quantity)	2202009
Fuse: type F, 3.15 A, 250 V (2)	2183792
Suregrip large alligator clip set (2/set)	1610159
Test lead set with retractable sheaths (2/set)	1903307
ESU – Dispersive safety lead (1)	2772171
ESU – CQM safety lead (1)	2772180
ESU – Jumper safety lead (2)	2772209
Ground pin adapter (1)	2242165

Table 1-4. Optional Accessories for the Analyzer

Accessory	Fluke Part #
Watertight protective carrying case	2248587
Serial cable	2204472

Chapter 2

Installation, Setup, and Maintenance

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Installation and Setup

The Analyzer has a universal power supply and automatically operates with applied main voltages having a maximum range of 83-264 V ac. You do not need to adjust voltage via jumpers or programming tabs to operate the Analyzer.

Set up the Analyzer for operation by attaching the supplied power cord to the power cord inlet located on the right panel of the Analyzer case. If necessary, please refer to “Instrument Familiarity” to help you identify the power cord inlet.

Power-Up Sequence

After plugging the Analyzer into a correctly rated earth-ground outlet, locate the power switch on the right panel. Move the switch to the ON position (marked with the **—** symbol). Next, you should observe the following power-up sequence:

1. The three front LED indicator lamps illuminate, and you see this information momentarily appear in the display:



2. Next the installed version of the Analyzer’s firmware briefly appears in the display. Here’s an example:

exz01.eps



exz02.eps

Note

The letter E, followed by a number indicates an error condition; the Analyzer has encountered a problem during its internal self-test. See “Power-Up Error Condition Codes”, below.

3. The instrument will briefly display several random numbers that are associated with the rms output offset during initialization.
4. The display then reverts to a Power Save Mode, where the display is blanked out, and the backlight is dim. The battery and mode LEDs remain ON. The Analyzer advances to its default test load condition of 300 ohms, ready to measure ESU power in watts.

Power-Up Error Condition Codes

Table 2-1 shows all error condition code numbers that can appear in the display at power-up and the condition indicated by the code.

Table 2-1. Power-Up Error Condition Codes

Code Number	Error Condition Indicated
E 03	EPROM checksum wrong
E 04	RAM bad
E 05	EEPROM checksum wrong
E 06	ac-to-dc power converter bad
E 07	RMS converter bad
E 08	Peak detectors bad
E 09	Temperature sensors bad

Operating the Analyzer Using Battery Power

You can operate the Analyzer using either ac power or dc power. When you power on the Analyzer with the supplied ac power cord installed and connected to an appropriate ac power source, the Analyzer operates on ac power. When you power on the Analyzer with the ac power cord disconnected, the Analyzer automatically operates on battery (dc) power.

Note

The battery is a sealed lead-acid type. Do not attempt to replace the battery. Return the Analyzer to a service center for replacement of the battery.

The Analyzer contains an internal ac/dc converter. During ac power operation, this converter assists in charging the battery, if it is not already fully charged. If the battery is fully charged, it is held in a maintenance float mode.

If you remove the ac power cord while the Analyzer is powered on, the Analyzer automatically resets in a battery-powered mode. The Analyzer can operate on a fully-charged battery for approximately two hours. Battery age, previous battery cycles, and Analyzer operating conditions all affect the actual length of time that the Analyzer operates on battery power.

When the battery nears the end of its discharge cycle, the unit automatically turns off to protect the battery from damage. This action is preceded by a warning interval of about 5 minutes, indicated by a flashing red light of the battery status indicator.

When the ac power cord is connected between the Analyzer and an ac power source, and the Analyzer is not powered on, the battery charger is active. However, instrument controls and measurement circuits do not receive power. See Table 2-2, below for a summary of battery operating status under various conditions.

Table 2-2. Battery Operating Status

Analyzer Connected to ac Power Source?	On/Off Switch Setting	Power Source to Analyzer Instrument Controls and Measurement Circuits	Battery Status
No	On	Battery	Discharging
No	Off	No power	Open circuit, minimal leakage
Yes	Off	No power	Charging
Yes	On	AC	Charging

Battery Status Light

The battery status indicator light is labeled **BATTERY STATUS**. Table 2-3 shows status light displays and their corresponding conditions.

Table 2-3. Battery Status Light

Light	Battery Condition
Flashing green	Battery is being qualified (checked) with medium charge or receiving full charge. Voltage is OK.
Steady green	Maintenance charge voltage OK or battery operation with voltage OK.
Flashing red and green	Automatic shut-down is pending, battery is nearly exhausted.
Flashing red	Automatic shut-down is imminent.
Steady red	When plugged in; indicates that the battery is not charging and needs replacement by the Fluke Biomedical Service Center.

Note

The Analyzer should be charged overnight, when the battery is fully drained.

LED Backlight Display Operation

The Analyzer's display lights when you select a load or when a test measurement is received by the instrument.

Ventilation

The Analyzer requires proper ventilation so that it does not overheat during operation. Always ensure that the two ventilation ports, located on each side of the Analyzer, are not blocked during use. Maintain at least four inches (10.2 centimeters) of clear space around each of these ports.

An internal fan located immediately behind the grille on the left side port supplies forced-air ventilation. Sensors measure the temperature of the load resistors, and the fan accelerates as the load temperature increases. Fan rotation is monitored also. If the load temperature is excessive or if the fan is not functioning, an error condition is indicated on the display, and the audio transducer emits a beeping sound. The error display codes are:

E 01: Temperature too high.

E 02: Fan not operating.

⚠ Caution

Permanent damage to the Analyzer can occur if you continue to apply a high-level ESU signal after the alert has been activated.

Connecting Test Leads between the ESU and the Analyzer

A complete set of test leads is supplied with the Analyzer. Use these test leads to connect the ESU generator output to the Analyzer and to configure the Analyzer to conduct a specific ESU test. Safe connection to the Analyzer is facilitated by shrouded safety plugs.

⚠ ⚠ Warning

To avoid possible electric shock, burning of the skin, or personal injury, follow these guidelines: Retractable end of test leads are for use on ESU only. No probes or accessories supplied with the Analyzer are intended for handheld use. Set up using the safety test leads and stand clear when activating the ESU with the footswitch.

The following is a description of the supplied test leads.

Test Lead Set with Retractable Shrouds

Part # 1903307

Color: One red and one black

Quantity: Two/set

One end of each test lead has a fixed shroud 4mm banana plug to connect with the Analyzer. The other end has a retractable shroud 4mm banana plug compatible with the active electrode/bipolar jacks on most ESU panels. A red safety alligator clip is included for direct connection to an actual active electrode element if preferred.

A removable black clamp facilitates firm attachment to a ground reference point. This lead is important for making leakage measurements in the battery mode of operation.

ESU- Dispersive Safety Lead

Part # 2772171

Color: Clear with blue connectors

Quantity: One

One end of the test lead has a single fixed-shroud 4mm banana plug to connect with the Analyzer. The other end has a CQM style two-pin connector that plugs directly into the neutral (or dispersive) electrode jack on most ESU panels.

Note

The mechanical pin is removed from the CQM connector to disable CQM during ESU generator output tests.

ESU Jumper Safety Lead

Part # 2772209

Color: Black

Quantity: Two

Both ends of these two short jumpers have fixed shroud 4mm banana plugs and are used to configure the Analyzer for the IEC Type BF Tests 1 and 2, which utilize the auxiliary HF load resistance (200 Ω). Both jumpers are required to conduct these tests.

ESU CQM Safety Lead

Part # 2772180

Color: Clear with blue and yellow connectors

Quantity: One

One end of the test lead has two fixed shroud 4mm banana plugs to connect across the Analyzer test load. The other end has a CQM style 2PIN connector that plugs directly into the neutral (or dispersive) electrode jack on most ESU panels.

Note

The mechanical pin is intact to enable the CQM function during CQM testing. Do not use this lead for output testing.

Maintenance

Follow the recommendations below to keep the Analyzer in good working condition.

Cleaning

Moisten a clean cloth with a mild solution of detergent and water only and wipe the Analyzer clean.

⚠ Caution

To avoid damaging the Analyzer, use only dilute, mild detergent for cleaning.

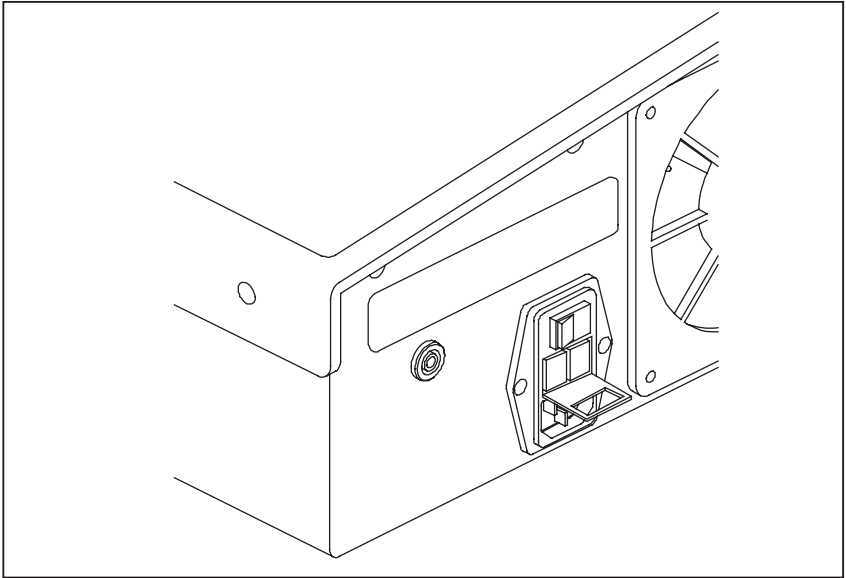
Calibration

Calibrate the Analyzer every 12 months.

Replacing Fuses

The Analyzer contains two operator-replaceable fuses, rated as Type F, 3.15 A, and 250 V. These fuses are in the two main supply lines.

You can replace one or both of these fuses by opening the fuse cover located on the right panel. Refer to Figure 2-1 for a diagram of the fuse cover assembly. If necessary, see “Instrument Familiarity”, to identify the fuse cover.



exz16.eps

Figure 2-1. Fuse Cover

⚠ ⚠ Warning

To avoid severe electrical shock, disconnect the power source before replacing fuses.

1. Make sure that the power switch is in the OFF position (**O**) and disconnect the power cord. The Analyzer is now safely powered down.
2. Pry the left side of the fuse cover up from the power inlet assembly, using a small flat-blade screwdriver. The fuse cover latches on the right side and remains attached to the Analyzer.
3. Remove a fuse carrier with your fingers, lifting it from the power inlet housing.

Note

To avoid damage to the Analyzer, do not use any sharp instrument to lift a fuse carrier.

4. Replace the fuse in the carrier with one of the same amperage and voltage ratings.

5. Reinstall the fuse carrier into the power inlet module, ensuring that the arrows on the ends of the fuse carriers point up.
6. Close the fuse cover until it snaps into place.
7. Reconnect the power cord, and power-up the Analyzer, if desired.

If you have replaced these fuses and the Analyzer still does not work properly, contact the Fluke Biomedical Technical Assistance Center at 800-648-7952.

Chapter 3

Operation

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The Signal Averaging Mode (SAM)

Upon power-up, the Analyzer defaults to the instantaneous algorithm for power output measurement, which shows fluctuating ESU output if it exists. You can select the desired SAM by depressing the **MODE SELECT** and **-OHM SELECT** keys simultaneously. Each time you initiate this key sequence, the Analyzer increments to the next mode. Starting at the default mode (“F 0”), the next mode entered is the one-second signal-averaging mode (“F 1” appears on the display). Initiating the key sequence again selects the two-second signal averaging mode (“F 2” appears on the display). Initiating the key sequence again brings the unit back to the default instantaneous mode (“F 0” appears on the display), and so on.

Testing the ESU

The sections that follow describe the specific ESU tests you can perform using the Analyzer. Test procedures prompt you to manually connect test leads in the required configuration.

⚠ ⚠ Warning

To avoid possible electric shock, burning of the skin, or personal injury, follow these guidelines: Retractable end of test leads are for use on ESU only. No probes or accessories supplied with the analyzer are intended for handheld use. Set up using the safety test leads and stand clear when activating the ESU with the footswitch.

The Analyzer does not internally configure the test leads. You can view functional-block diagrams for each test at the end of each test procedure section in this chapter. Additional information about test leads is given in “Installation.”

Note

The Analyzer can test a wide range of electrosurgical units for basic operation and performance. It is compatible with both isolated and earth-ground referenced outputs, and with both monopolar and bipolar outputs. If you have any questions about testing an ESU, you can review “Specifications” and the technical service manual for the ESU you want to test. In addition, you can contact our technical assistance center at 800-648-7952.

Key to Panel Diagrams

The Analyzer uses lights to indicate whether the value displayed in the window represents watts, mA, or ohms. The diagrams in this section resemble the Analyzer panel. The key is as follows:

- Analyzer panel light is off
- Analyzer panel light is on

Generator Output Test

The Analyzer provides an effective method of attaching a resistive load to the ESU under test and displays the output directly in either watts or HF current of the applied ESU signal. See Figure 3-1 for a diagram of the generator output test.

Test Procedures

This test involves:

- connecting the ESU you want to test to the Analyzer
- selecting a test load resistance
- measuring the ESU’s power output
- measuring the ESU’s current output
- ending the test

To connect the ESU to the Analyzer for a monopolar output test:

1. Connect the ESU Active electrode to the yellow jack (marked) active, using one of the test leads from the set, Part # 1903307.

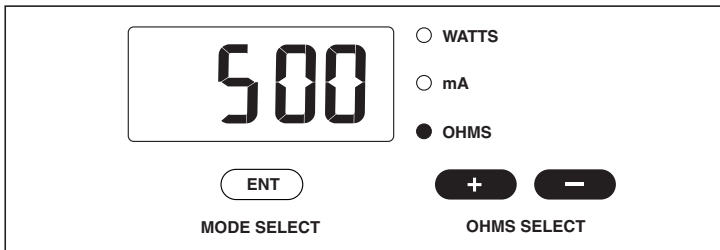
2. Connect the ESU Neutral/Dispersive electrode to the left blue jack dispersive, using the test lead, Part # 2772171.
3. Continue to load selection.

To connect the ESU to the Analyzer for a bipolar output test:

1. Connect the ESU Bipolar-1 electrode to the yellow jack (marked) active, using one of the test leads from the set, Part # 1903307.
2. Connect the ESU Bipolar-2 electrode to the left blue jack dispersive, using the other test lead from the set, Part # 1903307.
3. Continue to load selection.

To select the desired test load resistance:

1. Press the **OHMS SELECT** increase (+) or decrease (-) buttons until the test load value you want appears in the display. After approximately one second, the display returns to a blank screen. Below is an example of a test load value as it appears in the display.



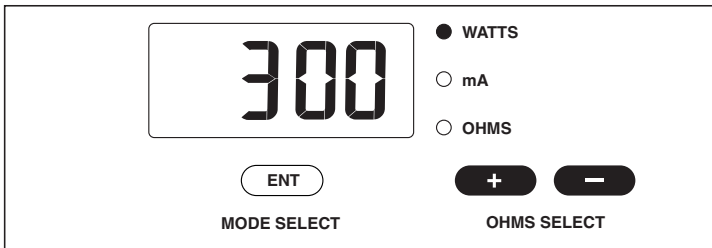
exz03.eps

Note

The default (or initial power-up) test load selection is 300 ohms.

To measure the ESU's power output:

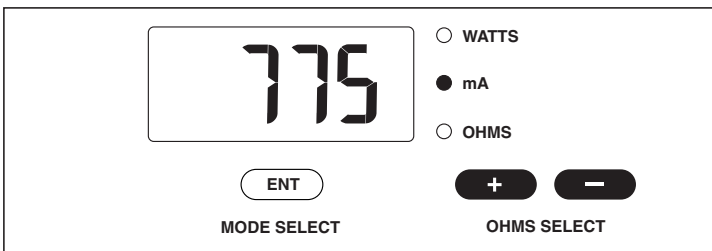
1. Activate the ESU.
2. If the **WATTS** indicator lamp on the panel is lit, go to Step 3. If it is not lit, press the **MODE SELECT (ENT)** button to select **WATTS** and go to Step 3.
3. View the power measurement on the display. Here is an example:



exz04.eps

To measure the ESU's current output:

1. While the ESU is still activated, press the **MODE SELECT (ENT)** button until the milliamperes (**mA**) indicator lamp lights.
2. View the ESU's current output (in mA). Below is an example.



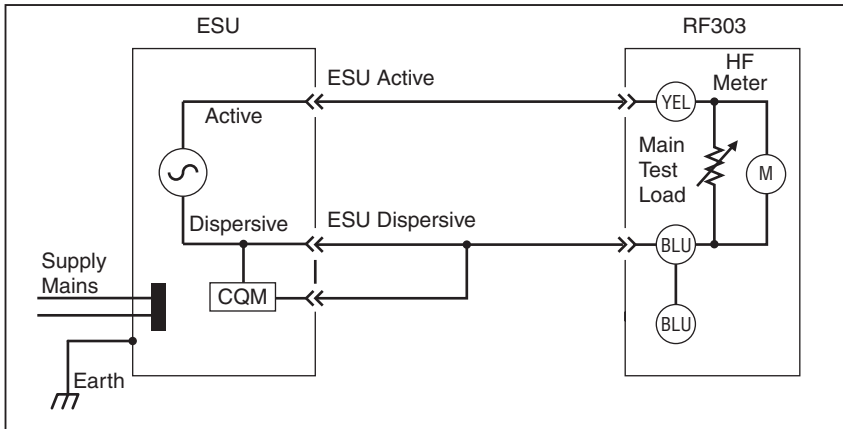
exz05.eps

To end the generator output test:

Deactivate the ESU.

⚠ Caution

To avoid damage to the Analyzer and the ESU under test, do not exceed the Analyzer's duty cycle, which is 30 seconds ON during any continuous one-minute period.



exz06.eps

Figure 3-1. Generator Output Test

Basic Contact Quality Monitor (CQM) Test

This test of the contact quality monitor uses the Analyzer’s test load to simulate a patient’s skin resistance in contact with the dual element neutral/dispersive electrode pad.

Note

Perform this test on electrosurgical units without energizing the generator output. Do not connect the ESU active electrode to the Analyzer during this test.

The CQM (REM) test is intended for the neutral/dispersive electrode of monopolar ESUs equipped with a contact quality monitor. The neutral/dispersive electrode is actually two separate pads attached to the patient’s skin. The CQM (REM) circuit issues an alarm only if the patient loses contact with one or both of the two pads. See Figure 3-2 for a diagram at the end of this section.

Test Procedures

The procedures involved with this test include:

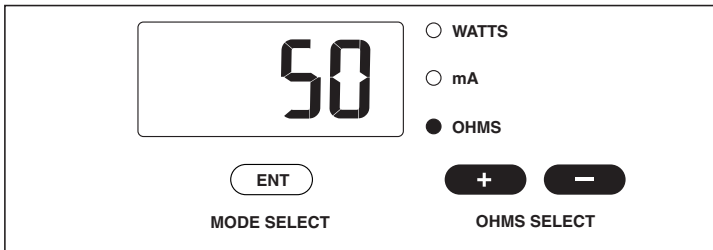
- connecting the ESU neutral/dispersive electrode to the Analyzer
- selecting a 50-ohm test load resistance
- increasing load resistance on the Analyzer to observe the ESU's visual or audio alarm

To connect the ESU's neutral/dispersive electrode to the Analyzer:

1. Connect one of the two color-coded banana plugs (test lead Part # 2772180) to the Analyzer's yellow jack active.
2. Connect the other banana plug to the Analyzer's left blue jack dispersive.
3. Connect the 2PIN CQM (REM) connector on the other end of the test lead to the neutral/dispersive electrode of the ESU.

To select a 50-ohm test load resistance setting:

1. Press the **OHMS SELECT** increase (+) or decrease (-) buttons as needed until the test load value 50 appears in the display. After approximately one (1) second, the display returns to a blank screen. Below is an example of a test load value as it appears in the display.



exz12.eps

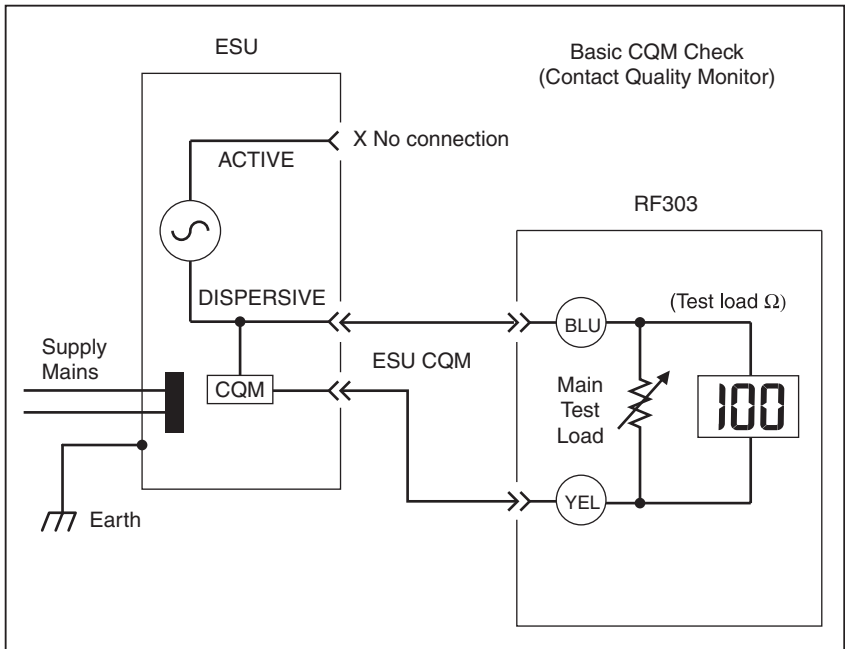
To observe the ESU's visual or audible alarm:

1. With the 50-ohm test load attached to the ESU CQM (REM) input, it should sense this level of resistance in the "pass zone." Depending upon the ESU device manufacturer, this pass zone can extend from 135 to 250 ohms. Test load settings over the pass zone activate the CQM alarm.

Note

Refer to the technical support/service manual of the ESU you are testing for the recommended check-out procedure for the ESU CQM feature.

2. Increase the test load from 50 ohms until the CQM alarm sounds. The value at that point is the CQM alarm resistance.



exz13.eps

Figure 3-2. Basic CQM Check

HF Leakage Current Test 1

The HF leakage current test number one is an IEC isolated output/bipolar, CF-type leakage current test. It shows you the amount of open-circuit high frequency current leakage from a single isolated electrode to earth/ground through a 200-ohm resistive test load. See Figure 3-3 for a diagram of this test at the end of this section.

Note

This high frequency leakage current test is intended only for isolated output electrosurgical units. If you test the active electrode of an earth-referenced Type BF ESU in the manner described in this section, you will be measuring the full output of the generator, not a high frequency leakage current. While conducting this test inappropriately will not damage the Analyzer, the resulting high frequency leakage current measurement will not be valid for an earth/ground referenced ESU.

Test Procedures

The procedures involved with this test include:

- connecting the ESU electrode you want to test to the Analyzer
- selecting a 200-ohm test load resistance
- measuring the ESU's HF leakage current
- ending the test

To connect the ESU electrode to the Analyzer:

1. If you are testing the ESU's active or single bipolar electrode, connect the electrode to the yellow jack active, using one of the test leads from the set, Part # 1903307, or

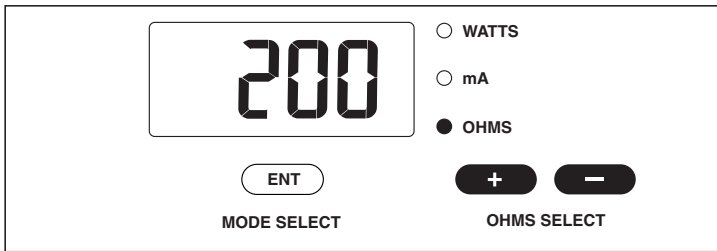
If you are testing the ESU's neutral/dispersive electrode, connect that electrode to the yellow jack active, using the test lead Part # 2772171.

2. Connect the jumper between the right blue jack dispersive and the left green jack ground earth reference, using test lead Part # 2772209.

3. If operating under battery power, attach a test lead from the set (Part # 1903307) from the battery ground on the side panel to the ground earth reference.

To select a 200-ohm test load resistance setting:

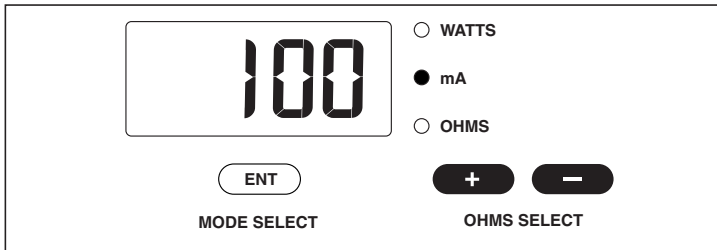
1. Press the **OHMS SELECT** increase (+) or decrease (-) buttons as needed until the test load value 200 appears in the display. After approximately one second, the display returns to a blank screen. Below is an example of a test load value as it appears in the display.



exz07.eps

To measure the ESU's signal HF leakage:

1. If the **mA** indicator lamp on the panel is lit, go to Step 2. If it is not lit, press the **MODE SELECT (ENT)** button to select **mA** and go to Step 2.
2. Activate the ESU and view the signal HF leakage measurement in milliamperes on the display. Here is an example.



exz18.eps

To end HF leakage test number one:

Deactivate the ESU to end the HF leakage test.

⚠ Caution

To avoid damage to the Analyzer and the ESU under test, do not exceed the Analyzer's duty cycle, which is 30 seconds ON during any continuous one-minute period.

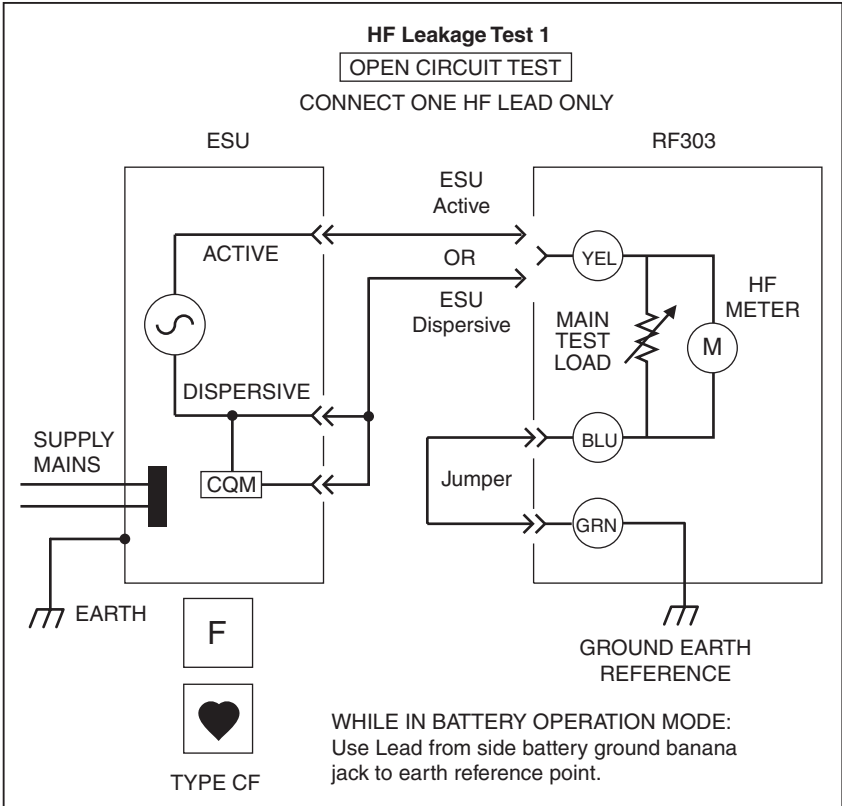


Figure 3-3. HF Leakage Test Number One

HF Leakage Current Test 2

The HF leakage test number two is an IEC earth-referenced, BF-type leakage current test. You perform the test by connecting a 200-ohm resistive test load from the ESU's active electrode to earth/ground on the Analyzer. High frequency leakage current is then measured through a second 200-ohm resistive load. You can view the resulting measurement on the Analyzer's display. See Figure 3-4 for a diagram of this test at the end of this section.

Test Procedures

The procedures involved with this test include:

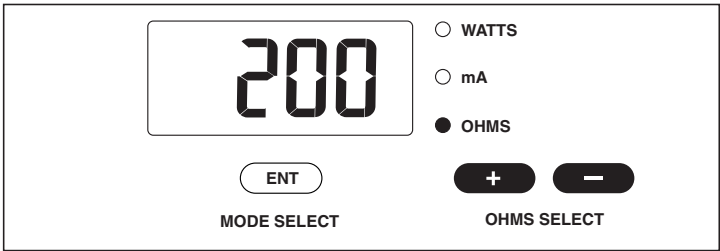
- connecting the ESU you want to test to the Analyzer
- selecting a 200-ohm test load resistance
- measuring the ESU's HF leakage current
- ending the test

To connect the ESU to the Analyzer:

1. Connect the ESU Active electrode to the right gray jack aux HF leakage, using one of the test leads from the set, Part # 1903307.
2. Connect the ESU Neutral/Dispersive electrode to the left blue jack dispersive, using test lead Part # 2772171.
3. Connect a jumper between the yellow jack active and the left green jack ground earth reference, using test lead Part # 2772209.
4. Connect a jumper between the right blue jack dispersive and the left gray jack aux HF leakage, using test lead Part # 2772209.
5. If operating under battery power, attach a test lead from the set (Part # 1903307) from the battery ground on the side panel to the ground earth reference.

To select a 200-ohm test load resistance setting:

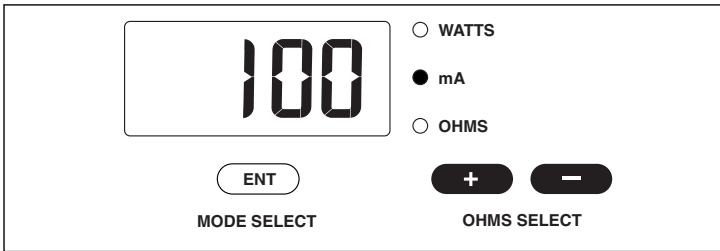
1. Press the **OHMS SELECT** increase (+) or decrease (-) buttons repeatedly until the test load value 200 appears in the display. After approximately one second, the display returns to a blank screen. Below is an example of a test load value as it appears in the display.



exz07.eps

To measure the ESU's signal HF leakage:

1. If the **mA** indicator lamp on the panel is lit, go to Step 2. If it is not lit, press the **MODE SELECT (ENT)** button to select **mA** and go to Step 2.
2. Activate the ESU and view the signal HF leakage measurement in milliamperes on the display. Here is an example.



exz18.eps

To end HF leakage test number two:

Deactivate the ESU to end the HF leakage test.

⚠ Caution

To avoid damage to the Analyzer and the ESU under test, do not exceed the Analyzer's duty cycle, which is 30 seconds ON during any continuous one-minute period.

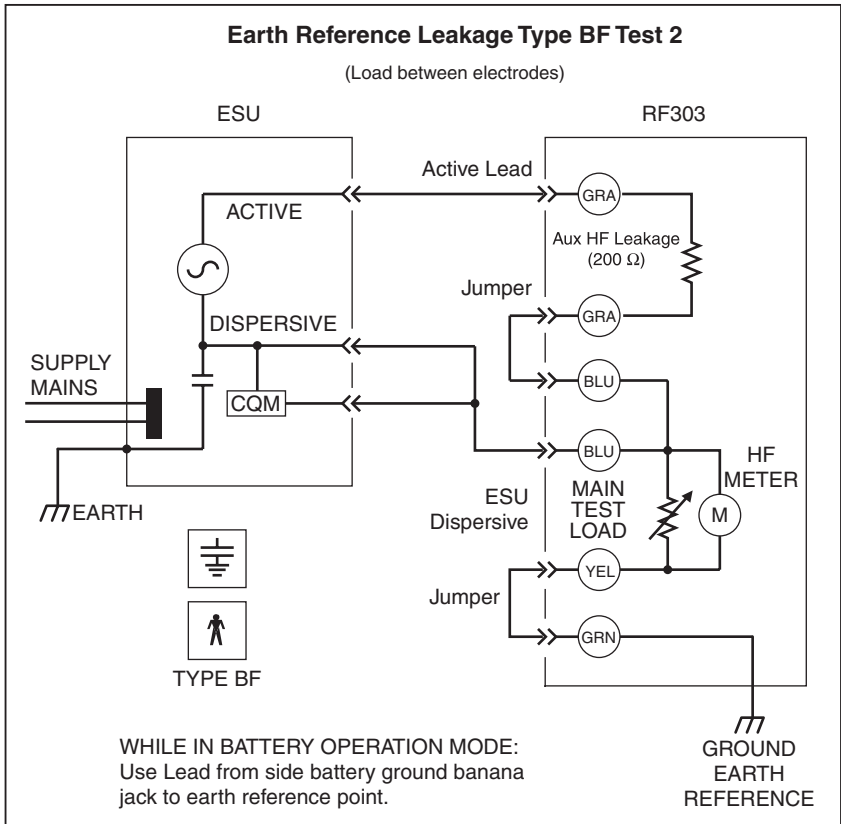


Figure 3-4. HF Leakage Test Number Two

HF Leakage Current Test 3

The HF leakage test number three is an IEC earth-referenced, BF-type leakage current test. You perform the test by connecting a 200-ohm resistive test load from the ESU's active electrode to earth/ground on the Analyzer. Then you connect a second 200-ohm resistive load from the ESU's neutral/dispersive electrode to earth/ground on the Analyzer. The Analyzer then displays the high frequency current leakage from the ESU you're testing. See Figure 3-5 for a diagram of this test at the end of this section.

Test Procedures

The procedures involved with this test include:

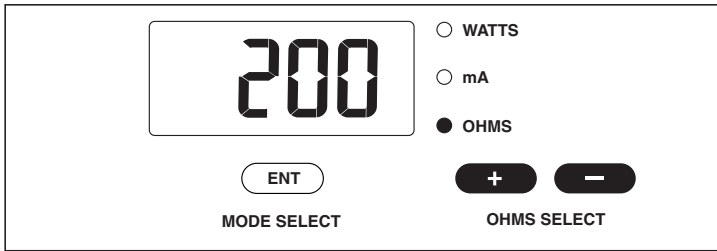
- connecting the ESU you want to test to the Analyzer
- selecting a 200-ohm test load resistance
- measuring the ESU's HF leakage current
- ending the test

To connect the ESU to the Analyzer:

1. Connect the ESU Active electrode to the right gray jack aux HF leakage, using one of the test leads from the set, Part # 1903307.
2. Connect the ESU Neutral/Dispersive electrode to yellow jack active, using test lead Part # 2772171.
3. Connect a jumper between the right blue jack dispersive and the left green jack ground earth reference, using test lead Part # 2772209.
4. Connect a jumper between the right green jack ground earth reference and the left gray jack aux HF leakage, using test lead Part # 2772209.
5. If operating under battery power, attach a test lead from the set (Part # 1903307) from the battery ground on the side panel to the ground earth reference.

To select a 200-ohm test load resistance setting:

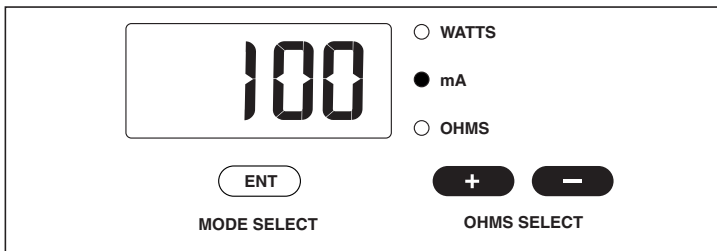
1. Press the **OHMS SELECT** increase (+) or decrease (-) buttons as needed until the test load value 200 appears in the display. After approximately one second, the display returns to a blank screen. Below is an example of a test load value as it appears in the display.



exz07.eps

To measure the ESU's signal HF leakage:

1. If the **mA** indicator lamp on the panel is lit, go to Step 2. If it is not lit, press the **MODE SELECT (ENT)** button to select **mA** and go to Step 2.
2. Activate the ESU and view the signal HF leakage measurement on the display. The measurement will be in milliamperes. Here is an example.



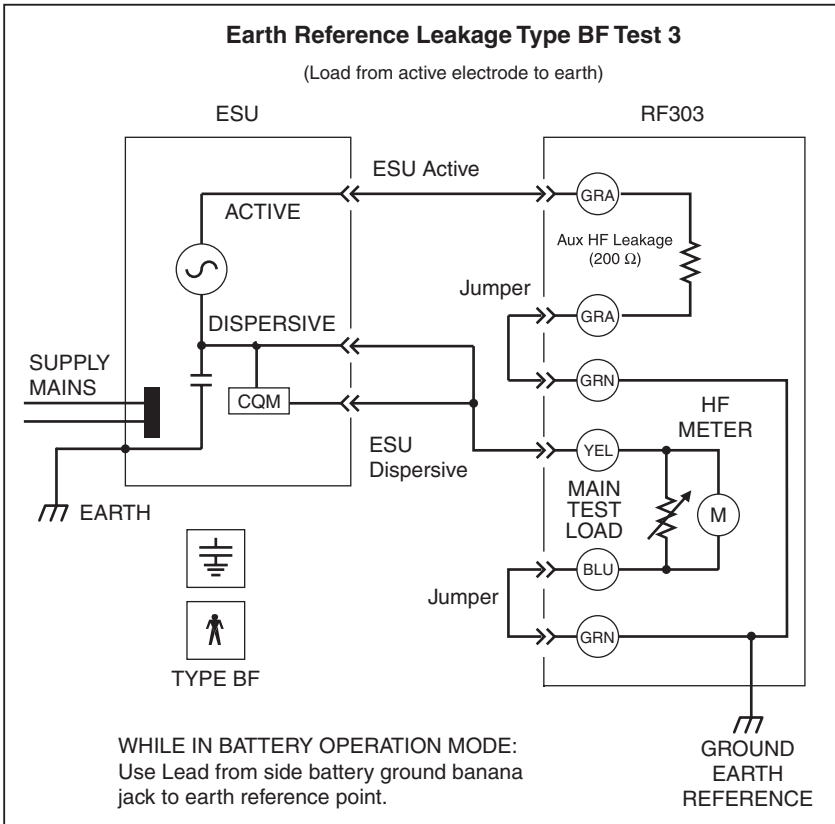
exz18.eps

To end HF leakage test number three:

Deactivate the ESU to end the HF leakage test.

⚠ Caution

To avoid damage to the Analyzer and the ESU under test, do not exceed the Analyzer's duty cycle, which is 30 seconds ON during any continuous one-minute period.

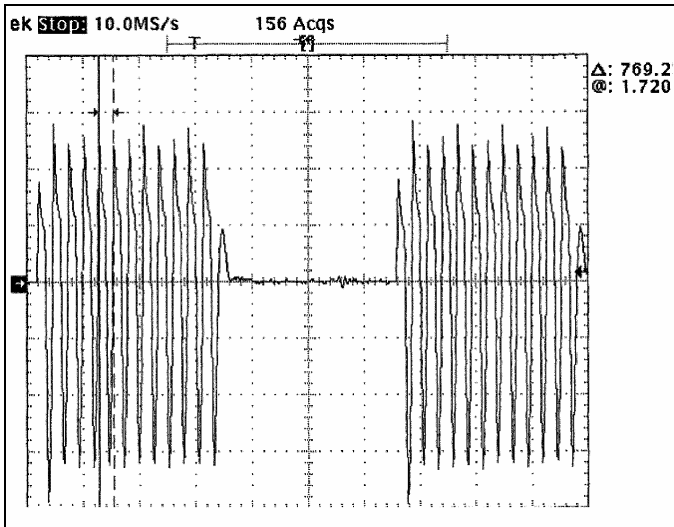


exz10.eps

Figure 3-5. HF Leakage Test Number Three

Connecting an Oscilloscope to the Analyzer

You can connect an oscilloscope to the Analyzer. Connect a standard coaxial cable to the scope out BNC connector located on the top left of the panel. Adjust your oscilloscope to view the applied waveform. Refer to Figure 3-6 to see a typical burst waveform.



exz17.bmp

Figure 3-6. Burst Waveform on Oscilloscope Display

Remote Operation via the RS-232 Function

You can operate the Analyzer locally or remotely. Local mode is the default; you manually control the Analyzer by pressing the buttons on the panel. Set the desired test load and indicate whether to measure in watts or milliamperes. All test load and measurement values appear on the display.

Two remote modes are also available: Simplex Mode (unidirectional communication) and Duplex Mode (bi-directional communication).

Setting Up and Operating the Analyzer in Simplex Mode

In Simplex Mode, you control operation of the Analyzer from the panel. By pressing the **MODE SELECT (ENT)** key, you can transmit a fixed data string to a host device that includes the ESU readings (in watts), HF current (in milliamps), and test load value (in ohms). The Analyzer sends data to a host device at a fixed baud rate. The Analyzer cannot receive commands from a remote terminal or computer in Simplex Mode.

To set up and operate in Simplex Mode, follow these steps:

1. Connect the Analyzer to the computer with a serial interface cable, Part # 2238659.
2. Set the computer to receive data at a baud rate of 2400 with 8 data bits, no parity, and 1 stop bit.
3. With the Analyzer power turned off, press and hold both the + and - **OHMS SELECT** keys located on the panel.
4. Power-up the Analyzer, and then release both keys when the double beep is heard.
5. Set up the Analyzer to conduct the desired ESU measurement.
6. Press and release the **MODE SELECT** key to transmit the data while a measurement is displayed.
7. Data transfers in the format:
Watts =XXXX, I=YYYY, Load =ZZZ.
8. To exit Simplex Mode, power down the Analyzer.

Setting Up and Operating the Analyzer in Duplex Mode

In Duplex Mode, you control operation of the Analyzer from a remote terminal or computer by issuing specific remote commands that control all features of the Analyzer. You can view test data received as a result of sending a remote command on the host controller's display. In Duplex Mode, all panel keys are "locked out" to allow all functions to be under full direction of the host controller.

To set up and operate in Duplex Mode, follow these steps:

1. Connect the Analyzer to the computer with a serial interface cable, Part # 2238659.

2. Set the computer to communicate with a baud rate of 2400 with 8 data bits, no parity, and 1 stop bit.

Note

Serial port flow control uses neither XON/XOFF signals nor hardware flow control (RTS/CTS).

3. Power-up the Analyzer without pressing any keys.
4. To set the Analyzer in Remote Mode, send the GOTOREMOTE command. After the command is received by the Analyzer, four horizontal bars appear on the display. Since the controlling computer always receives a return value, a response, the asterisk will be displayed on the monitor.
5. Control the Analyzer with the desired commands.
6. To exit Remote Mode and return to Local Mode, send the GOTOLocal command.

Observe the following while operating in Duplex Mode:

- Commands must be terminated by a carriage return/ line feed (CR) (LF).
- Setup commands always end with the colon character and a parameter: (plus the parameter) For example, the setup command SETLOAD requires the colon followed by the load value (in ohms): SETLOAD: 50
- Multiple commands (or parameters) are separated by commas. All possible command (parameter) choices are shown. Unless otherwise stated, the default parameters are listed first.
- As mentioned earlier, every command returns a value as a response. The return value may be a string of alphanumeric characters. Commands that do not require any special return value will show the star character * simply to indicate that the command has been executed.
- After the Analyzer receives a command, it will ignore all other commands until after it has responded to the first command.
- If you do not enter a command and just press the Enter key (carriage return) on the computer keyboard, the Analyzer will return the ? (question mark) character.

- All responses are uppercase, followed by CR and LF.
- Measurement readings from the Analyzer are returned identically as they would appear on the Analyzer's display; that is, as numbers, with or without a decimal point, and followed by any appropriate unit of measurement.
- Errors always return a response beginning with: ?ERR=XX (plus the description). Table 3-1 lists each of the error responses.

Table 3-1. Error Responses

Error Response	Explanation
?ERR=01,BAD OR MISSING PARAMETERS	The received command requires parameters, and there were none, or they were not recognized.
?ERR=02,ILLEGAL NUMBER OF PARAMETERS	The command did not include the correct number of parameters.
?ERR=03,PARAMETER OUT OF RANGE OR SYNTAX ERROR	One or more of the parameters were out of the correct range, or there was an error in the syntax of the command.
?ERR=04,COMMAND NOT AVAILABLE FROM THIS MODE	The Model Analyzer is not in the special sub mode within the remote that is required for the command.
?ERR=05, DEACTIVATE ESU BEFORE ADJUSTING	There is an ESU signal present at the meter inputs that is not allowed for the command to be executed.
?ERR=06,ACCESS DENIED	The command is a calibration command and the calibration jumper is not connected

Table 3-2 describes various commands available in Duplex Mode.

Table 3-2. Available Duplex Mode Commands

Command	Description	Parameters Required	Return Value (Response)
GOTOREMOTE	Places the Analyzer in the duplex remote mode.	None	*
GOTOLOCAL	Returns the Analyzer to normal (local mode) operation / exits duplex remote mode.	None	*
IDENT	Identifies the Analyzer model and firmware version number.	None	Model Analyzer name and the version of the firmware. Example: MODEL Analyzer VERSION X.XX Where X.XX is the version number.
VER	Identifies the firmware version number.	None	Firmware version number. Example: VERSION X.XX Where: X.XX is the version number.
SETMODE:{parm}	Changes the format of the Analyzer response to the RDMETER command. Separate the command from the desired mode (parameter) using a colon. Refer to RDMETER below. Example: SETMODE:OUTPUT	OUTPUT (for measuring generator output). RFLKG (for measuring HF leakage). RARF (for conducting CQM test).	*

Table 3-2. Available Duplex Mode Commands (cont.)

Command	Description	Parameters Required	Return Value (Response)
RDMODE	Prompts the Analyzer to transmit the currently selected mode.	None	NONE OUTPUT RFLKG RARF
EXITMODE	Prompts the Analyzer to exit the currently selected mode. Note: You must exit the current mode before entering another.	None	*
SETLOAD:{parm}	Sets the measurement test load resistance from 50-750 ohms in 50 ohm increments. Not available in RFLKG mode.	Values of 50-750 in increments of 50	*
RDLOAD	Resistance value of the selected test load appears in the display.	None	RRRR (ohms) Where RRRR is the load value in ohms. Formatted to four digits with leading spaces as required.
RDPOWER	Prompts an Analyzer power measurement in watts. Not available in RFLKG and RARF modes.	None	PPP.P (w)

Table 3-2. Available Duplex Mode Commands (cont.)

Command	Description	Parameters Required	Return Value (Response)
RDCURRENT	Prompts an Analyzer current measurement in milliamperes. Not available in RARF mode.	None	AAAA (mA) Where AAAA is current in milliamperes.
RDMETER	Prompts the Analyzer to measure the applied signal of the ESU.	None	
	Prompts the Analyzer to return all measurements of the applied signal of the ESU. {MODE=NONE}	None	I=AAAA(mA), CF=XX.X, KVPP=XXX, PWR=PPP.P(w) Where AAAA is the Current reading in milliamps, XX.X is the Crest Factor, XXX is the peak-to-peak voltage in kVolts and PPP.P is the power in watts.

Table 3-2. Available Duplex Mode Commands (cont.)

Command	Description	Parameters Required	Return Value (Response)
	<p>Prompts the Analyzer to return all measurements of the applied signal of the ESU.</p> <p>{MODE=OUTPUT}</p>	<p>None</p>	<p>I=AAAA(mA), CF=XX.X, KVPP=XXX, PWR=PPP.P(w)</p> <p>Where AAAA is the Current reading in milliamps, XX.X is the Crest Factor, XXX is the peak-to-peak voltage in kVolts and PPP.P is the power in watts</p>
	<p>Prompts the Analyzer to measure the applied signal current of the ESU.</p> <p>{MODE=RFLKG}</p>	<p>None</p>	<p>I=AAAA(mA)</p> <p>Where AAAA is the Current reading in milliamps.</p>
	<p>Prompts the Analyzer to return the current test load.</p> <p>{MODE=RARF}</p>	<p>None</p>	<p>REM RESISTANCE=RRR</p> <p>Where RRR is the load value in ohms.</p>

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Appendix A

Load Issues

Load Issues

The load resistors typically used in ESU analyzers are not ideal; they have some reactive components that are frequency dependent. The RF303 Analyzer derives applied power by measuring the voltage across the set load and calculating the power (V^2/R). Most other ESU analyzers on the market derive the applied power by measuring the current flowing through a set load and calculating the power ($I^2 \cdot R$).

At fundamental frequencies below 500 kHz and regardless of the load setting, the two methods of measurement are comparable. Above 500 kHz, and at the extremes of the loads, the readings displayed by the two methods differ on opposite sides of the expected value.

As an example, when testing the Conmed Excalibur Electrosurgical Unit in the monopolar output with the Analyzer load set to 50 ohms, the set value on the Conmed correlates with the displayed value on the Analyzer. When in the bipolar mode, the Analyzer displays higher than expected values – up to 35% higher. The same test performed on some current measuring analyzers produces lower than expected values. This discrepancy is caused by the difference in fundamental frequencies between the monopolar and bipolar modes. The Conmed operates at 500 kHz in monopolar mode and 1 MHz in bipolar mode. When comparing readings measured with a V^2/R device to those measured with an $I^2 \cdot R$ device, the total measurement difference is usually larger than 35%, because of different methods of deriving power.

This difference does not mean that the Analyzer is malfunctioning or is in error. Rather, it reflects the different results that the two measurement techniques produce when the load deviates from the nominal value used in the power calculations.

Note

Most ESU manufacturers use the current measuring technique to calibrate production units.

Appendix B

Interpretation of Fluctuating Readings

Interpretation of Fluctuating Readings

The RF303 Analyzer incorporates an accurate digital measurement system that operates in three modes. The first measurement mode (default mode) utilizes a relatively short sampling time and does not filter or average ESU output. The two selectable measurement modes utilize longer sampling times that average ESU output. When using the default measurement mode, you may observe some ESU output readings that fluctuate plus or minus 10% or more, depending on the unit under test. This is normal operation and is not indicative of a problem with the Analyzer.

When fluctuating readings are observed, take note and determine if this is normal behavior for the ESU under test, or if this behavior is a sign of a problem.

- Older ESUs may have unstable output due to old technology or design. This is typical and is acceptable, based on the manufacturer's limits.
- Many newer-generation ESUs utilize instantaneous feedback loops, which constantly adjust the output and can cause an oscillating effect. This result is also satisfactory and is considered normal for these devices.
- In some cases, fluctuating ESU power output is evidence of a problem. Fluctuating output on some ESUs may indicate the weakening of output from power transistors or other ESU ailments and is not acceptable.

If an ESU normally has fluctuating output, then operating the Analyzer in one of the Signal Averaging Modes (SAM) may be desirable. SAM significantly reduces fluctuating readings on the display of the Analyzer making it easy to read an average value.

Appendix C

Abbreviations

Abbreviations

The following list includes abbreviations used in this document.

A	ampere
ANSI	American National Standards Institute
AAMI	Association for the Advancement of Medical Instrumentation
BLU	blue (color)
BPM	beats per minute
dB	decibel
°C	degrees Celsius (centigrade)
CQM	Contact Quality Monitor
DMM	digital multimeter
EEPROM	electrically erasable PROM
ECG	electrocardiograph or electrocardiogram
ESU	Electrosurgery Unit
EUT	equipment under test
°F	degrees Fahrenheit
GRA	gray (color)
GRN	green (color)
Hz	hertz

in	inch
K	kilo (10^3)
kg	kilogram
kHz	kilohertz
k Ω	kilohm
lb	pound
LED	light-emitting diode
LCD	liquid crystal display
M	meg(a) (10^6)
MHz	megahertz
M Ω	megohm
m	meter
m	milli (10^{-3})
mA	milliampere
mm	millimeter
mV	millivolt
p-p	peak-to-peak
REM	Return Electrode Monitor
s	second
YEL	yellow (color)
μ	micro (10^{-6})
μ A	microampere
μ V	microvolt
Ω	ohm