# BC BIOMEDICAL
# ESU-2300
## TABLE OF CONTENTS

WARNINGS, CAUTIONS, NOTICES ................................................................. ii  
DESCRIPTION ......................................................................................... 1  
LAYOUT ................................................................................................. 3  
OPERATION ......................................................................................... 6  
SCREENS ............................................................................................... 9  
POWER UP SETTINGS ........................................................................... 16  
TESTING................................................................................................ 18  
ERROR MESSAGES .............................................................................. 34  
COMMUNICATION PROTOCOL ................................................................. 37  
COMMUNICATION COMMAND SUMMARY ............................................. 38  
MANUAL REVISIONS............................................................................ 39  
LIMITED WARRANTY ........................................................................... 39  
SPECIFICATIONS .................................................................................. 40  
NOTES ................................................................................................. 42
WARNING - USERS
The ESU-2300 is for use by skilled technical personnel only.

WARNING - USE
The ESU-2300 is intended for testing only and should never be used in diagnostics, treatment or any other capacity where it could come in contact with a patient.

WARNING - MODIFICATIONS
The ESU-2300 is intended for use within the published specifications. Any application beyond these specifications or any unauthorized user modifications may result in hazards or improper operation.

WARNING - CONNECTIONS
All connections to patients must be removed before connecting the DUT to the ESU-2300. A serious hazard may occur if the patient is connected when testing with the ESU-2300. Do not connect any leads from the patient directly to the ESU-2300 or DUT.

WARNING - TEST LEADS
There are retractable ends on the test leads for use with the DUT to avoid possible electric shock, skin burns or personal injury. Do not touch any metal on the banana plugs or probes.

WARNING - POWER SUPPLY
Unplug the Power Supply before cleaning the surface of the Analyzer.
CAUTION - LIQUIDS
Do not submerge or spill liquids on the ESU-2300.

CAUTION - SERVICE
The ESU-2300 is intended to be serviced only by authorized service personnel. Troubleshooting and service procedures should only be performed by qualified technical personnel.

CAUTION - CLEANING
Do not immerse. The ESU-2300 should be cleaned by wiping gently with a damp, lint-free cloth.

CAUTION - VENTILATION
The ESU-2300 includes ventilation slots to prevent overheating during operation. These slots and internal fan should not be blocked.

CAUTION - ENVIRONMENT
Exposure to environmental conditions outside the specifications can adversely affect the performance of the ESU-2300. Allow ESU-2300 to acclimate to specified conditions for at least 30 minutes before attempting to operate it.

CAUTION - INSPECTION
The ESU-2300 should be inspected before each use for wear and should be serviced if any parts are in question.
NOTICE – CE

The ESU-2300 Analyzers bear the CE mark
Based on the following testing standards:

ELECTROMAGNETIC COMPATIBILITY DIRECTIVE

“Electrical equipment for measurement, control and laboratory use – EMC requirements”

This equipment has been type tested by an independent, accredited testing laboratory and compliance was demonstrated to the above standard to the extent applicable.

EMISSIONS
Radiated and Line Conducted Emissions
EN 61000-3-2 Harmonic Current Emissions
EN 61000-3-3 Voltage Fluctuation and Flicker

IMMUNITY – CLASS C
EN 61000-4-2 Electrostatic Discharge
EN 61000-4-3 Radiated Electric Field Immunity
EN 61000-4-4 Electrical Fast Transients / Bursts
EN 61000-4-5 Surge Voltage
EN 61000-4-6 Conducted Disturbance
EN 61000-4-11 Voltage Dips and Short Interrupts

LOW VOLTAGE DIRECTIVE
EC – Directive 73/23/EC

EN 61010-1:2001
“Safety requirements for electrical equipment for measurement, control, and laboratory use – General requirements”

This equipment has been type tested and compliance was demonstrated to the above standard to the extent applicable.
NOTICE – SYMBOLS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>!</td>
<td>Caution (Consult Manual for Further Information)</td>
</tr>
<tr>
<td>⚡</td>
<td>RF Current Transformer</td>
</tr>
</tbody>
</table>


NOTICE – ABBREVIATIONS

- A: Ampere(s)
- A/D: Analog to Digital
- C: Celsius
- CF: Crest Factor
- °: degree(s)
- DUT: Device Under Test
- DFA: Digital Fast Acquisition
- ESU: Electrosurgical Unit
- Ext: External
- Int: Internal
- kg: kilogram(s)
- kHz: kilohertz
- MHz: Megahertz
- µA: microampere(s)
- mA: milliampere(s)
- mm: millimeter(s)
- ms: millisecond(s)
- mV: millivolt(s)
- #: Number
- Ω: Ohm(s)
- Pk: Peak
- Pk-Pk: Peak to Peak
- PC: Personal Computer
- Lbs: pounds
- RF: Radio Frequency
- RH: Relative Humidity
- RMS: Root Mean Square
- sec: second(s)
- USA: United States of America
- VDC: Volts Direct Current
- W: Watt(s)
NOTICE – DISCLAIMER

BC GROUP INTERNATIONAL, INC. WILL NOT BE RESPONSIBLE FOR ANY INJURIES SUSTAINED DUE TO UNAUTHORIZED EQUIPMENT MODIFICATIONS OR APPLICATION OF EQUIPMENT OUTSIDE OF THE PUBLISHED INTENDED USE AND SPECIFICATIONS.

NOTICE – DISCLAIMER

BC GROUP INTERNATIONAL, INC. RESERVES THE RIGHT TO MAKE CHANGES TO ITS PRODUCTS OR SPECIFICATIONS AT ANY TIME, WITHOUT NOTICE, IN ORDER TO IMPROVE THE DESIGN OR PERFORMANCE AND TO SUPPLY THE BEST POSSIBLE PRODUCT. THE INFORMATION IN THIS MANUAL HAS BEEN CAREFULLY CHECKED AND IS BELIEVED TO BE ACCURATE. HOWEVER, NO RESPONSIBILITY IS ASSUMED FOR INACCURACIES.

NOTICE – CONTACT INFORMATION

BC BIOMEDICAL
BC GROUP INTERNATIONAL, INC.
3081 ELM POINT INDUSTRIAL DRIVE
ST. CHARLES, MO 63301
USA

1-800-242-8428
1-314-638-3800

www.bcgroupintl.com
sales@bcgroupintl.com
The Model ESU-2300 is a highly accurate Electrosurgical Analyzer containing an internal precision load bank. We have designed the ESU-2300 to comply with electrosurgical manufacturer industry-standard current sensing technology. A highly accurate RF Current Transformer is used to convert the high frequency RF signal from the ESU generator to a voltage signal. This technique results in a much more accurate and frequency-independent measurement. Our DFA™ (Digital Fast Acquisition) technology then digitizes the Current Transformer output signal using a high-speed analog to digital converter. This technology allows the ESU-2300 to directly measure complex electrosurgical waveforms, and provides highly accurate and stable results not requiring interpretation. The ESU-2300 is intended to be routinely used to measure the various parameters relating to the testing and performance validation of electrosurgical generators.

The following are highlights of some of the main features:

- TRUE RMS READINGS USING PATENT PENDING DFA™ TECHNOLOGY
- INDUSTRY STANDARD CURRENT SENSING TECHNOLOGY
- mA, mV, mV PEAK, CREST FACTOR AND POWER (WATTAGE) RANGES
- INTERNAL PRECISION LOAD RESISTOR NETWORK: 50 Ω TO 750 Ω OHMS IN 50 Ω INCREMENTS
- EXTERNAL LOAD RESISTOR CAPABILITY – ALLOWS THE USE OF EXTERNAL RESISTORS EITHER AS AN INDEPENDENT LOAD OR IN CONJUNCTION WITH THE INTERNAL LOAD.
- INTERNAL LOAD RESISTOR NETWORK IS COOLED WITH TEMPERATURE AND POWER CONTROLLED COOLING FAN
- USES AN INTERNAL 0.1:1 RATIO PRECISION RF CURRENT TRANSFORMER
- INDEPENDENT CQM (REM/ARM) RESISTOR NETWORK: 1 Ω TO 500 Ω IN 1 Ω INCREMENTS
- RF LEAKAGE MEASUREMENTS THROUGH 200 Ω AUXILIARY TEST LOAD
- INTERNAL RECHARGEABLE BATTERY ALLOWS OPERATION INDEPENDENT OF LINE POWER
- LARGE GRAPHICS DISPLAY WITH CURSOR SELECTION OF OPTIONS AND SETUP OF PARAMETERS
- DIGITAL CALIBRATION – NO POTS TO TURN
- SELECTABLE DISPLAY OPTIONS
- TACTILE KEYS WITH AUDIO FEEDBACK
STANDARD ACCESSORIES:

- BC20 – 00125  ACCESSORY KIT (TEST LEADS)
- BC20 – 21105  UNIVERSAL POWER SUPPLY
- BC20 – 41352  COMMUNICATIONS CABLE (USB)
- BC20 – 41341  COMMUNICATIONS CABLE (RS232)
- BC20 – 205XX  STANDARD POWER ADAPTER
  (International Options, see Page 8 for details)

OPTIONAL ACCESSORIES:

- BC20 – 00232  BNC TO BNC CABLE

VISHAY-DALE NH-250 PRECISION 1% TOLERANCE NON-INDUCTIVE LOAD RESISTORS:

- BC20-00200  5 Ω, 250 WATT RESISTOR
- BC20-00201  10 Ω, 250-WATT RESISTOR
- BC20-00202  20 Ω, 250-WATT RESISTOR
- BC20-00203  30 Ω, 250-WATT RESISTOR
- BC20-00204  50 Ω, 250-WATT RESISTOR
- BC20-00205  100 Ω, 250-WATT RESISTOR
- BC20-00206  200 Ω, 250-WATT RESISTOR
- BC20-00207  300 Ω, 250-WATT RESISTOR
- BC20-00208  500 Ω, 250-WATT RESISTOR
- BC20-00209  1000 Ω, 250-WATT RESISTOR
- BC20-00210  2000 Ω, 250-WATT RESISTOR
- BC20-00211  3000 Ω, 250-WATT RESISTOR
- BC20-00212  4000 Ω, 250-WATT RESISTOR
- BC20-00213  5000 Ω, 250-WATT RESISTOR
- BC20-00240  POWER RESISTOR BANANA JACK ADAPTER (2 PER SET)
This section looks at the layout of the ESU-2300 and gives descriptions of the elements that are present.

- **Large LCD Graphical Display with High Intensity Backlight**
- **Ventilation Slots (Both Sides) for efficient load resistor cooling**
- **Back Light Key for turning on and off the backlight**
- **Carrying Handle**
- **5 Light Touch Keys for Dynamic functions:** These keys are labeled in the bottom portion of the screen and change function based on operating mode.
Active Input
Banana Jack
input for RF
signal from DUT

Oscilloscope
Output
BNC connector

Loop Input
Banana Jack for
use when an
external load
resistor is
attached

Dispersive Inputs
Banana Jacks for
connection to generator
patient return path

Earth/Ground
Reference Jacks
Banana Jacks for
use during RF
leakage tests

CQM Test Inputs
Banana Jacks for
use during CQM
(REM/ARM) and
RECQM Tests

Aux Test Load Jacks
Banana Jacks for
use during RF
leakage tests

Power On/Off
Rocker Switch

RS-232
Comm Port

USB
Comm Port

LED Indicators
Line Power
Battery Charging

External Power Input
Kycon 3 position
locking receptacle

Line Power
Battery Charging

Battery Charging
Accessory Kit, BC20-00125:

- **Active Leads**: RECQM Lead (Pin), CQM Lead (No Pin)
- **Dispersive Lead**
- **Jumper Leads**
- **Earth/Gound Lead**
- **Banana Jack Alligator Clips**
- **Ground Lug**
GENERAL OPERATION

The ESU-2300 is controlled by 5 light touch keys for navigation, plus 1 light touch key for LCD display backlight control. The navigation keys allow the user to move around within the displayed parameters, select the desired options, choose a specific category and control the setup for the unit. When a key is depressed there is an audio click when it is accepted, or a “Razz” tone if the key is invalid.

A large LCD graphics display with high intensity white backlight provides the user with information about the current status of the device configuration options, test results and more. The display identifies the function of each key on a dynamic basis. As the operation mode changes, the key functions change to suit the operating mode.

BACKLIGHT KEY

The Graphic LCD display may be viewed with or without the backlight. Depressing any key will activate the backlight. However, since the backlight will drain the internal rechargeable battery at an accelerated rate if left on, it will automatically be shut off after a user programmable delay when running the ESU-2300 on battery power.

The key is provided to toggle the backlight on or off at any time.

NOTE: The backlight parameter in the System Setup screen may be set to Off, 1-20 sec or Always On.
FUNCTION KEYS

There are five keys that are used to provide general operational control. The functions of the keys vary depending on the current screen. The section of the screen just above the key indicates its current meaning.

NOTE: Only functions that are available to the user will be visible at any given time.

SERIAL COMMUNICATIONS

There are two serial ports on the side panel. One is a standard USB port and the other is a DB-9 RS-232 port. Both ports can be used to connect to a PC to get measurements and remotely configure the ESU-2300. The RS-232 port is also used to update the ESU-2300 firmware. For more details on remote operation see the Communication Protocol section on page 53.

OSCILLOSCOPE OUTPUT

A BNC connector is provided to connect an oscilloscope to the unit. This output is an uncalibrated attenuated version of the ESU Generator output waveform.

POWER SWITCH

The main power switch for the Analyzer is located on the side panel.
**LINE POWER**

A Kycon 3 position locking connector is provided for the 9 VDC external universal power supply for using the ESU-2300 with line power. When connected to line power, this connection also provides a connection for Earth/Ground.

The Universal Power Supply takes a Standard Power Adapter Cable with Small Standard Product Plug and Required International Connector (See Options Below).

**POWER UP SETTINGS**

The unit may be setup to turn on using either the factory default settings or a custom set of parameters as previously saved by the user (See Power Up Settings section for details).
When the ESU-2300 is first powered up, the DISPLAY SCREEN will be shown. This screen contains one, two or five parameter DISPLAY ZONES, the LOAD SETTING and the available FUNCTION KEYS. Each Display Zone can be customized to show the desired RF measurement parameters of RMS Current (mA), RMS Voltage (mV), RMS Power (Watts), Peak Voltage (mV pk), Peak to Peak Voltage (mV Pk-Pk) or Crest Factor (CF). The Load Mode Setting can be set to show the desired Internal, External and Internal/External loads. The Load Selection can be set to change the internal, external, or internal plus external load resistances.

**DISPLAY ZONES:**

- Sample Display Screen with one Display Zone
- Sample Display Screen with two Display Zones
- Sample Display Screen with five Display Zones
The Display Zones can be toggled through using [DISPLAY]. The parameters can be changed using the [CHANGE] key to enter the Display Parameters Configuration Screen.

**LOAD SETTING**

The Load Setting portion of the Display Screen shows the load selection and value that will be used for ESU output tests. There are three load set up choices for testing with the ESU-2300: Internal, External and Internal/External.

![Load Settings](image)

The Load Setting and value can be toggled through using the [CHANGE] key to enter the Display Parameters Configuration Screen.

In Internal mode, the user applies the Active Lead to the Active Jack and the Dispersive Lead to the Dispersive Jack. The RF current is routed through the selected internal loads and the internal Current Transformer to measure the current and power.

In External mode, the user applies the Active Lead to the Active Jack and then connects another lead from the Loop Jack to the external load(s). The Dispersive Lead then goes to the other side of the external load(s). It is important to make sure that the external load resistance parameter in the ESU-2300 is set to the real value of the external load(s).
In Internal/External mode, the user applies the Active Lead to the Active Jack and then connects another lead from the Dispersive Jack to the external load(s). The Dispersive Lead then goes to the other side of the external load(s). It is important to make sure that the external load resistance parameter in the ESU-2300 is set to the real value of the external load(s).

**FUNCTION KEYS**

<table>
<thead>
<tr>
<th>DISPLAY</th>
<th>CHANGE</th>
<th>HOLD</th>
<th>RECQM</th>
<th>SETUP</th>
</tr>
</thead>
</table>

**DISPLAY** – This key will toggle between one parameter, two parameter or five parameter Display Zones.

**CHANGE** – This key will enter the Display Parameters Configuration Screen where parameters can be selected and changed.

**HOLD** – This key will freeze the current reading in the Display Zone.

**RECQM** – This key will enter the RECQM Test Screen.

**SETUP** – This key will enter the System Setup Screen.
The parameters on the DISPLAY SCREEN can be changed by using the **CHANGE** key to enter the DISPLAY PARAMETERS CONFIGURATION SCREEN. This screen adds a highlight line to the DISPLAY SCREEN and changes the FUNCTION KEYS.

Use the **SELECT** keys to highlight the parameter to change. The last FUNCTION KEY will be **EXIT**. Use this key to return to the DISPLAY SCREEN.

Use the **VALUE** keys to sequence through the available values of the highlighted parameter. The last FUNCTION KEY will be **ENTER**. Use this key to save the current value.

**NOTE:** Using the **SELECT** keys to highlight the next parameter will also save the current value.

**NOTE:** To save a custom configuration, see Power Up Settings section.
The RECQM TEST SCREEN can be entered using the RECQM key from the DISPLAY SCREEN.

Use the keys to change the value of the resistance setting. This setting ranges from 1 Ω to 500 Ω in 1 Ω increments. The last FUNCTION KEY will be . Use this key to return to the DISPLAY SCREEN.
The SETUP Mode allows the user to adjust the configuration of the unit. The SETUP SCREEN can be entered using the SETUP key.

Use the keys to highlight the parameter to change. The last FUNCTION KEY will be EXIT. Use this key to return to the DISPLAY SCREEN.

Use the keys to sequence through the available values of the highlighted parameter. The last FUNCTION KEY will be ENTER. Use this key to save the current value.

NOTE: Using the keys to highlight the next parameter will also save the current value.

NOTE: To save a custom configuration, see Power Up Settings section.
The following is a breakdown of the parameters available in the configuration of the unit and their available options:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Backlight</td>
<td>Controls whether the backlight is on or off or how long to wait for user input before automatically turning off the backlight in battery powered mode.</td>
<td>Off, 0-20 sec, Always on (Factory Default = 10)</td>
</tr>
<tr>
<td>Battery Life</td>
<td>Displays remaining battery life (charge) in percent</td>
<td>0-100% (Read Only)</td>
</tr>
<tr>
<td>Power Source</td>
<td>Displays whether the unit is on battery power or line powered</td>
<td>Battery or Line (Read Only)</td>
</tr>
<tr>
<td>Power up with</td>
<td>Determines the power up mode of the ESU-2300. The default mode shows a single mA parameter display. Set this parameter to custom to display the saved startup mode. Set this parameter to Save current as custom to save the settings for the next time power is cycled.</td>
<td>Defaults Custom Set Current as Custom</td>
</tr>
<tr>
<td>Num A/D Samples</td>
<td>Sets the number of A/D converter readings used in each mA RMS computation. A higher setting requires more computation and is slower, but results in a more stable reading.</td>
<td>1024, 2048, 4096, 8192, 16384, 32768 (Factory Default = 32768)</td>
</tr>
<tr>
<td>Display Averaging</td>
<td>Sets the number of mA RMS readings that are averaged. A higher number will cause the display to update slower, but will give a more stable reading.</td>
<td>1-30 Readings (Factory Default = 11)</td>
</tr>
<tr>
<td>Software</td>
<td>Displays current software program.</td>
<td>(Read Only)</td>
</tr>
</tbody>
</table>
POWER UP SETTINGS

The ESU-2300 allows the user to customize the settings that the unit will have on Power Up. The “Power up with” parameter in the System Setup Menu allows for the selection of either Default or Custom selections.

Use [SETUP] to enter the SETUP SCREEN. Use the ▲ SELECT ▼ keys to highlight the “Power up with” parameter.

Use the ▲ VALUE ▼ keys to change the parameters to Default, Custom or Set Current as Custom. The last FUNCTION KEY will be [ENTER]. Use this key to save the current value.

NOTE: Using the ▲ SELECT ▼ keys to highlight the next parameter will also save the current value.

The last FUNCTION KEY will then be [EXIT]. Use this key to return to the DISPLAY SCREEN.
**Default**

If this option is selected, the unit will power up to the dual display zone screen, which will:

- Show the mA and Watts readings
- Put the ESU-2300 into Internal Load mode
- Use 300 ohms as the default internal load

**Custom**

If this option is selected, the unit will Power Up using the unique sets of parameters that were last customized and saved by the user. The DISPLAY SCREEN will use the parameters in the Display Zones that were last configured and saved by the user.

**Set Current as Custom**

This choice is provided to create the set of custom startup screen parameters. The user simply configures each screen to show the desired parameters and then enters the Set Current as Custom choice in the SETUP SCREEN. The current configuration is saved as the Custom Power Up values and will be used when the “Power up with” parameter is set to Custom. This configuration will remain the Custom configuration until it is written over using the Set Current as Custom option in the “Power up with” parameter.
The purpose of this test is to verify the output accuracy of the Electrosurgical Generator Device Under Test (DUT) at a given RF power setting, based on the selected internal precision test load (50 to 750 Ω in 50 Ω increments) from the ESU-2300 resistor network. The ESU-2300 should always be set to match the electrosurgical generator manufacturer’s specified test load for the mode and output waveform selected.

Connections

Monopolar outputs:

1. Yellow Active Lead from Active Jack on ESU-2300 to DUT Output.

2. Blue Dispersive Lead from Dispersive Jack on ESU-23-00 to DUT Dispersive.
Bipolar outputs:

1. Yellow Active Lead from Active Jack on ESU-2300 to DUT Bipolar Output Electrode #1.

2. Second Yellow Active Lead from Dispersive Jack on ESU-2300 to DUT Bipolar Output Electrode #2.

ESU-2300 Screen

DISPLAY SCREEN with LOAD SETTING set to Internal and Load Value set to the desired number.

Results

Watts reading on DISPLAY SCREEN will display the measured power through the currently selected load resistance. The DUT specs should be verified based on this information.
The purpose of this test is to verify the output accuracy of the Electrosurgical Generator Device Under Test (DUT) at a given RF power setting, based upon an attached external load resistor. The external load resistor attached to the ESU-2300 should always be set to match the electrosurgical generator manufacturer’s specified test load for the mode and output waveform selected.

**Connections**

**Monopolar:**

1. Yellow Active Lead from Active Jack on ESU-2300 to DUT Output.
2. Blue Dispersive Lead from Loop Jack on ESU-2300 to External Load.
3. External Load to DUT Dispersive.
**Bipolar:**

1. Yellow Active Lead from Active Jack on ESU-2300 to DUT Bipolar Output Electrode #1.

2. Second Active Lead from Loop Jack on ESU-2300 to External Load.

3. External Load to DUT Bipolar Output Electrode #2.

**ESU-2300 Screen**

DISPLAY SCREEN with LOAD SETTING set to External and Load Value set to the desired number.

**Results**

Watts reading on DISPLAY SCREEN will display the measured power through the external load resistance(s). The DUT specs should be verified based on this information.
The purpose of this test is to verify the output accuracy of the Electrosurgical Generator Device Under Test (DUT) at a given RF power setting, based on the selected internal precision test load (50 to 750 Ω in 50 Ω increments) from the ESU-2300 resistor network, in addition to series-connected external load resistor (0 to 5200 Ω in 1 Ω increments). The resulting test load (the ESU-2300 internal load + the external load) should always be set to match the electrosurgical generator manufacturer's specified test load for the mode and output waveform selected.

**Connections**

**Monopolar:**

1. Yellow Active Lead from Active Jack on ESU-2300 DUT Output.

2. Blue Dispersive Lead from Dispersive Jack on ESU-2300 to External Load.

3. External Load to DUT Dispersive Lead
**Bipolar:**

1. Yellow Active Lead from Active Jack on ESU-2300 to DUT Bipolar Output Electrode #1.

2. Second Yellow Active Lead from Dispersive Jack on ESU-2300 to External Load.

3. External Load to DUT Bipolar Output Electrode #2.

**ESU-2300 Screen**

DISPLAY SCREEN with LOAD SETTING set to Internal/External and Load Values set to the desired number.

**Results**

Watts reading on DISPLAY SCREEN will display the measured power through the summed load consisting of the internal load resistance and the external load resistance(s). The DUT specs should be verified based on this information.
The Return Electrode Contact Quality Monitor Test Mode allows the user to test the CQM/RECQM (REM/ARM) safety feature available on most electrosurgical generators. This feature exists mainly to prevent high frequency burns caused when the dispersive electrode contact with the patient degrades to a high impedance connection, resulting in increased current density at the electrode site. To prevent this, electrosurgical generators typically employ a dual-sided pad, with independent electrical connections from each side of the pad to the generator. The generator utilizes special electronic circuitry that circulates a small current flow at a specific frequency through this circular electrical path to monitor the contact impedance between the pad and the patient.

There are two basic types of this safety feature:

1. A basic continuity type test, where the ESU is looking for a very low resistance (usually < 20 ohms) between the two dispersive pads

2. A more advanced RECQM test where the generator usually tests for a resistance between the two dispersive pads to be greater than 5 ohms and less than 135 ohms, as well as testing whether the measured resistance has changed by a certain percentage over the initial measured resistance.

The usual way to test these two safety features of the electrosurgical generators is to use a separate decade box and go through the ranges, checking when the generator alarms out. However, the ESU-2300 includes a digitally adjustable resistor, separate from the internal test load resistor network, giving the user the ability to do all testing with one device.
In this feature, the resistance across the two white CQM Jacks can be varied from 0 Ω to 500 Ω in 1 Ω increments.

**WARNING – CQM TEST**
Do not connect the Electrosurgical Generator Active Electrode while conducting this test. 
Do not enable the Electrosurgical Output at any time.

**Connections**

**For CQM (continuity type):**

1. CQM Lead (without pin) from CQM Jacks on side of ESU-2300 to DUT Dispersive.

**For RECQM (resistance type):**

1. RECQM Lead (with pin) from CQM Jacks on side of ESU-2300 to DUT Dispersive

---

ESU (DUT) Patient Return/ Dispersive Electrode

---
**ESU-2300 Screen**

RECQM SCREEN with OHMS SETTING set to the desired value.

**Results**

The DUT should be checked for appropriate alarms in both safety modes (CQM and RECQM).

---

**NOTICE – MANUFACTURER’S SPECS**

The user must consult the manufacturer’s manual for each DUT to determine the correct test procedures and alarm specifications to follow.
This leakage test, specified by the IEC as Active (or Dispersive) Electrode to Ground, is for testing the RF leakage to Earth/ Ground of an Isolated Output type CF electrosurgical generator from a single active or dispersive lead. The test complies with IEC 601.2.2, section 19.101b, figure 104 and section 19.102, adopted by ANSI/AAMI HF18-2001. The purpose of this test is to verify that open circuit RF leakage of the Device Under Test (DUT) meets or exceeds the IEC specification.

**NOTE:** DO NOT TEST AN EARTH REFERENCED TYPE BF ELECTROSURGICAL GENERATOR WITH THIS TEST, THE RESULTING MEASUREMENT WILL BE ERRONEOUS.

**WARNING – ONE LEAD AT A TIME**
Only test one lead of the ESU Generator at a time
Connections

1. Either Active Lead from Active Jack on ESU-2300 to DUT Active Output.

   or

   Dispersive Lead from Active Jack on ESU-2300 to DUT Dispersive

2. Jumper Lead from Dispersive Jack on ESU-2300 to Earth/Ground on ESU-2300.

   

   ![ESU (DUT) Active Electrode]

   

   **NOTE:** When the ESU-2300 is operating on battery power it is necessary to supply an Earth/Ground reference to the unit prior to performing any RF Leakage Tests. Simply connect the Ground Lead from the Earth/Ground Jack on the right side panel of the ESU-2300 to the DUT equipotential chassis ground using the green Safety Alligator Clip. An alternative connection can be made using the Receptacle Earth/Ground, as long as the receptacle is on the same circuit used to power the DUT. Install the Ground Lug adaptor into Receptacle Earth/Ground. Connect the Ground Lead from the Earth/Ground Jack on the ESU-2300 to the Ground Lug. There is a retractable and non-retractable end on the Ground Lead. The retractable end must be used on the Ground Lug side.
ESU-2300 Screen

DISPLAY SCREEN with LOAD SETTING set to Internal and Load Value set to 200 ohm.

Results

Activate the Electrosurgical Generator Output and read the RF leakage measurement as the mA leakage readings on the DISPLAY SCREEN. These readings should be verified against the appropriate electrosurgical generator standards.

NOTE: Remember to disable the Electrosurgical Generator Output when testing is completed.
This leakage test, specified by the IEC as Earth Reference Leakage Type BF (Load Between Electrodes), is for testing the leakage to Earth/Ground of a Ground Referenced Output type BF electrosurgical generator from the active output. This test complies with IEC 601.2.2, section 19.101a, test 1, figure 102, and section 19.102, adopted by ANSI/AAMI HF18-2001. The purpose of this test is to verify that the RF leakage of the Device Under Test (DUT) meets or exceeds the IEC specification.

**Connections**

1. Active Lead from Aux Jack on ESU-2300 to DUT Active Output.
2. Jumper Lead from Earth/Ground on ESU-2300 to Active Jack on ESU-2300.
4. Dispersive Lead from Dispersive Jack on ESU-2300 to DUT Dispersive.
**ESU-2300 Screen**

DISPLAY SCREEN with LOAD SETTING set to Internal and Load Value set to 200 ohm.

**Results**

Activate the Electrosurgical Generator Output and read the RF leakage measurement as the mA leakage readings on the DISPLAY SCREEN. These readings should be verified against the appropriate electrosurgical generator standards.

**NOTE:** Remember to disable the Electrosurgical Generator Output when testing is completed.

**NOTE:** When the ESU-2300 is operating on battery power it is necessary to supply an Earth/Ground reference to the unit prior to performing any RF Leakage Tests. Refer to page 29 for connection details.
This leakage test, specified by the IEC as Earth Reference Leakage Type BF (Load from Active Electrode to Earth) is for testing the leakage to Earth/Ground of a Ground Referenced Output type BF electrosurgical generator from the active output. This test complies with IEC 601.2.2, section 19.101a, test 2, figure 102, and section 19.102, adopted by ANSI/AAMI HF18-2001. The purpose of this test is to verify that the RF leakage of the Device Under Test (DUT) meets or exceeds the IEC specification.

**Connections**

1. Active Lead from Aux Jack on ESU-2300 to DUT Active Output.
2. Jumper Lead from Earth/Ground on ESU-2300 to Aux Jack on ESU-2300.
3. Jumper Lead from Earth/Ground on ESU-2300 to Dispersive Jack on ESU-2300.
4. Dispersive Lead from Active Jack on ESU-2300 to DUT Dispersive.
**ESU-2300 Screen**

DISPLAY SCREEN with LOAD SETTING set to Internal and Load Value set to 200 ohm.

**Results**

Activate the Electrosurgical Generator Output and read the RF leakage measurement as the mA leakage readings on the DISPLAY SCREEN. These readings should be verified against the appropriate electrosurgical generator standards.

**NOTE:** Remember to disable the Electrosurgical Generator Output when testing is completed.

**NOTE:** When the ESU-2300 is operating on battery power it is necessary to supply an Earth/Ground reference to the unit prior to performing any RF Leakage Tests. Refer to page 29 for connection details.
Several error messages are provided to indicate invalid operating conditions.

**Input Overload**

When the input signal rises above the range that is measurable by the system, the “WARNING INPUT OVERLOAD” message will be shown. Although the input is protected from damage at these levels, the user should immediately remove any input signal when this message is shown.

**High Load Temperature**

When the measured load bank temperature goes over the Warning Temperature the “WARNING HIGH LOAD TEMPERATURE” message will be shown. The user should disable the electrosurgical generator output immediately and let the ESU-2300 cool down for a period of time.
**Fan Blocked**

If there is a mechanical problem with the internal fan, such as a locked bearing or some physical item blocking the path of the fan blades, the “WARNING FAN BLOCKED” message will be shown. The user should check the unit for any obvious protrusions. The user should not use the unit for any electrosurgical generator testing and should return the ESU-2300 to the factory for immediate servicing.

**WARNING – FAN BLOCKED WARNING**

Do not activate the electrosurgical generator to the internal loads of the ESU-2300, as there will be no way for the internal loads to cool down.

**Disable Electrosurgery Generator Output Before Changing Load**

If the user tries to change load resistances while the ESU-2300 detects RF power applied, the “CAUTION DISABLE ESU OUTPUT BEFORE CHANGING LOAD” message will be displayed.
Low Battery Lockout

This message will be shown when the battery voltage is too low for proper operation. When this message is displayed, the keys are locked out. Line power should be applied as soon as possible to recharge the system battery.
The communication protocol provides a means to completely configure and use the ESU-2300 from a PC. All of the functions available through the front panel can be performed through the communication ports. All of the measurements made by the ESU-2300 are accessible as well. This provides for hands free or automated operation of the ESU-2300.

**Command Syntax**

The command description is broken into 3 columns; the KEYWORD, the PARAMETER FORM and COMMENTS.

**Keyword**

The KEYWORD column provides the name of the command. The actual name of the command consists of one or more keywords since SCPI commands are based on a hierarchical structure, also known as a tree system.

In such a system, associated commands are grouped together under a common node in the hierarchy, analogous to the way leaves at a same level are connected at a common branch. This and similar branches are connected to fewer and thicker branches, until they meet at the root of the tree. The closer to the root, the higher a node is considered in the hierarchy. To activate a particular command, the full path to it must be specified.

The highest level node of a command is called the Keyword, followed by the Node, Subnode, and then the value.

Not all commands require the complexity of the full command path. For example, the Status? command doesn’t have a Node or Subnode.

Some commands allow for reading and writing data and some commands are Read Only. To indicate a read function, a question mark (?) is placed at the end of the command path. For example, a write command to change the internal load resistance to 100 ohms would be “CONFigure:LOAD:INTernal 100<cr>”, where <cr> indicates a carriage-return. For example, a mArms read command would be “READ:MArms?<cr>”, which would return a value of “xxx.x<cr><lf>” where <cr> is a carriage-return and <lf> is a linefeed.

Lowercase letters indicate the long-form of the command (for example, CONFigure:INPut:RANGe?) and can be omitted for simplification. Uppercase letters indicate the abbreviated, or short-form, of the commands and must be included (for example, CONF:INP:RANG?).

All commands sent to the unit are terminated with a Carriage Return.

**NOTE:** Commands can be entered in either upper or lowercase or a mixture of the two, uppercase and lowercase. Commands sent to the ESU-2300 are not case sensitive.
# ESU-2300 Communication Command Summary

## Keywords

**CONFigure**

**DISPlay**

- **SxZy nn**
  - x is the Screen # (1-3) and y is the Zone # (1-5).
  - nn=0 to 5:
    - 0 = mA RMS
    - 1 = Watts RMS
    - 2 = mV RMS
    - 3 = mV Peak
    - 4 = Crest Factor
    - 5 = mV Pk-Pk

**SCReen**

- Range: 1-4
  - 1-3 = # display zones
  - 4=RECQM Display

**HOLD**

ON, OFF

**LOAD**

**MODE**

- INTernal, EXternal, INT/EXTernal

**INTernal**

- Internal load resistance, 50-750 ohms in 50 ohm steps

**EXTernal**

- External load resistance, 0 to 5200 ohms

**RECqm**

- 0-500 ohms

**INPut**

- **AVERaging**
  - 1-30 readings

**NUMsamples**

- 1024, 2048, 4096, 8192, 16384, 32768

**SYSTem**

**POWerup**

- DEFaults, CUSTom, SETCurrent

**BACKlight**

- 0-21 (special cases: 0 = always off, 21=always on)

**KEY**

- BKLT, KEY1-KEY5

**VERsion?**

- [read only]

## READ

**MVrms?**

- Returns: mV RMS [read only]

**MArms?**

- Returns: mA RMS [read only]

**WArms?**

- Returns: Watts RMS [read only]

**MVPeak?**

- Returns: mV Peak [read only]

**MVPP?**

- Returns: mV Peak to Peak [read only]

**CF?**

- Returns: CF [read only]

**FANspeed?**

- Returns: Fanspeed [read only]

**TEMPerature?**

- Returns: Current Load Bank Temperature [read only]

## STATus?

<table>
<thead>
<tr>
<th>Bit</th>
<th>Value</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>Hold Mode</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>Calibration Mode</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>Low Battery</td>
</tr>
<tr>
<td>3</td>
<td>8</td>
<td>Fan Blocked Rotor</td>
</tr>
<tr>
<td>4</td>
<td>16</td>
<td>Load Bank Overtemp</td>
</tr>
<tr>
<td>5</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>64</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>128</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>256</td>
<td>Error Present</td>
</tr>
<tr>
<td>9</td>
<td>512</td>
<td>mV Out of Range</td>
</tr>
<tr>
<td>10</td>
<td>1024</td>
<td>mA Out of Range</td>
</tr>
<tr>
<td>11</td>
<td>2048</td>
<td>Watts Out of Range</td>
</tr>
<tr>
<td>12</td>
<td>4096</td>
<td>mV Peak Out of Range</td>
</tr>
<tr>
<td>13</td>
<td>8192</td>
<td>Crest Factor Out of Range</td>
</tr>
<tr>
<td>14</td>
<td>16384</td>
<td>mV Peak to Peak Out of Range</td>
</tr>
<tr>
<td>15</td>
<td>32768</td>
<td></td>
</tr>
</tbody>
</table>
MANUAL REVISIONS

<table>
<thead>
<tr>
<th>Revision #</th>
<th>Program #</th>
<th>Revisions Made</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rev 01</td>
<td>DT7377A</td>
<td>Origination</td>
</tr>
<tr>
<td>Rev 02</td>
<td>DT7377D</td>
<td>Added 5 zone display screen, added 3 parameters</td>
</tr>
<tr>
<td>Rev 03</td>
<td>DT7377E</td>
<td>Added Communications, Revised External Load</td>
</tr>
<tr>
<td>Rev 04</td>
<td>DT7377CE</td>
<td>Miscellaneous Edits</td>
</tr>
<tr>
<td>Rev 05</td>
<td>DT7377CF</td>
<td>Modify Battery Measurement</td>
</tr>
<tr>
<td>Rev 06</td>
<td>DT7377CF</td>
<td>Format Updated, Specifications Updated</td>
</tr>
</tbody>
</table>

LIMITED WARRANTY

WARRANTY: BC GROUP INTERNATIONAL, INC. WARRANTS ITS NEW PRODUCTS TO BE FREE FROM DEFECTS IN MATERIALS AND WORKMANSHIP UNDER THE SERVICE FOR WHICH THEY ARE INTENDED. THIS WARRANTY IS EFFECTIVE FOR TWELVE MONTHS FROM THE DATE OF SHIPMENT.

EXCLUSIONS: THIS WARRANTY IS IN LIEU OF ANY OTHER WARRANTY EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

BC GROUP INTERNATIONAL, INC. IS NOT LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES.

NO PERSON OTHER THAN AN OFFICER IS AUTHORIZED TO GIVE ANY OTHER WARRANTY OR ASSUME ANY LIABILITY.

REMEDIES: THE PURCHASER'S SOLE AND EXCLUSIVE REMEDY SHALL BE: (1) THE REPAIR OR REPLACEMENT OF DEFECTIVE PARTS OR PRODUCTS, WITHOUT CHARGE, (2) AT THE OPTION OF BC GROUP INTERNATIONAL, INC., THE REFUND OF THE PURCHASE PRICE.
## SPECIFICATIONS

### RF MEASUREMENT

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>INPUT FREQUENCY</strong></td>
<td>10 kHz to 10 MHz</td>
</tr>
<tr>
<td><strong>CURRENT</strong></td>
<td></td>
</tr>
<tr>
<td>RANGE</td>
<td>20 to 2500 mA RMS</td>
</tr>
<tr>
<td>RESOLUTION</td>
<td>1 mA RMS</td>
</tr>
<tr>
<td>ACCURACY</td>
<td>± 2.5% of Reading or ± 15 mA, whichever is greater</td>
</tr>
<tr>
<td><strong>POWER</strong></td>
<td></td>
</tr>
<tr>
<td>RANGE</td>
<td>400.0 W</td>
</tr>
<tr>
<td>RESOLUTION</td>
<td>0.1 W</td>
</tr>
<tr>
<td>ACCURACY</td>
<td>± 4% of Reading or ± 3 W, whichever is greater</td>
</tr>
<tr>
<td><strong>CALCULATED RANGES (CT)</strong></td>
<td></td>
</tr>
<tr>
<td>VOLTAGE RANGE</td>
<td>2.0 to 700.0 mV</td>
</tr>
<tr>
<td>RESOLUTION</td>
<td>0.1 mV</td>
</tr>
<tr>
<td>VOLTAGE PEAK RANGE</td>
<td>1000.0 mV</td>
</tr>
<tr>
<td>RESOLUTION</td>
<td>0.1 mV</td>
</tr>
<tr>
<td>VOLTAGE PK-TO-PK RANGE</td>
<td>0.0 to 1.0 mV</td>
</tr>
<tr>
<td>RESOLUTION</td>
<td>0.1 mV</td>
</tr>
<tr>
<td>CREST FACTOR RANGE</td>
<td>1.4 to 500</td>
</tr>
<tr>
<td>RESOLUTION</td>
<td>0.1</td>
</tr>
<tr>
<td><strong>OSCILLOSCOPE OUTPUT</strong></td>
<td></td>
</tr>
<tr>
<td>OUTPUT</td>
<td>Isolated, Uncalibrated</td>
</tr>
<tr>
<td>CONNECTION</td>
<td>BNC (50 Ω)</td>
</tr>
<tr>
<td><strong>SELECTIONS</strong></td>
<td>INTERNAL, EXTERNAL, INTERNAL + EXTERNAL</td>
</tr>
<tr>
<td><strong>VARIABLE LOAD</strong></td>
<td></td>
</tr>
<tr>
<td>INTERNAL RANGE</td>
<td>50 to 750 Ω</td>
</tr>
<tr>
<td>RESOLUTION</td>
<td>50 Ω</td>
</tr>
<tr>
<td>TYPE</td>
<td>Non-Inductive</td>
</tr>
<tr>
<td>ACCURACY</td>
<td>± 1% ± 0.5 Ω</td>
</tr>
<tr>
<td>POWER RATING</td>
<td>225 W</td>
</tr>
<tr>
<td>DUTY CYCLE</td>
<td>10 seconds on, 30 seconds off</td>
</tr>
<tr>
<td>EXTERNAL RANGE</td>
<td>0 to 5200 Ω</td>
</tr>
<tr>
<td>RESOLUTION</td>
<td>1 Ω</td>
</tr>
<tr>
<td><strong>AUXILLARY (LEAKAGE) LOAD</strong></td>
<td></td>
</tr>
<tr>
<td>VALUE</td>
<td>200 Ω</td>
</tr>
<tr>
<td>TYPE</td>
<td>Non-Inductive</td>
</tr>
<tr>
<td>ACCURACY</td>
<td>± 1%</td>
</tr>
<tr>
<td>POWER RATING</td>
<td>225 W</td>
</tr>
<tr>
<td><strong>CONNECTIONS</strong></td>
<td>4 mm SAFETY BANANA</td>
</tr>
<tr>
<td><strong>RETURN ELECTRODE MONITOR TEST LOAD</strong></td>
<td></td>
</tr>
<tr>
<td>--------------------------------------</td>
<td>---</td>
</tr>
<tr>
<td>RANGE</td>
<td>0 to 500 Ω</td>
</tr>
<tr>
<td>RESOLUTION</td>
<td>1 Ω</td>
</tr>
<tr>
<td>ACCURACY</td>
<td>± 2% FS or ± 2 Ω, whichever is greater</td>
</tr>
<tr>
<td>CONNECTIONS</td>
<td>4 mm SAFETY BANANA</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>PHYSICAL &amp; ENVIRONMENTAL</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>DISPLAY</td>
<td>240x64 Pixel Graphical LCD, White LED Backlight</td>
</tr>
<tr>
<td>MEMORY</td>
<td>SETUP: EEPROM, All Parameters</td>
</tr>
<tr>
<td></td>
<td>RETENTION: 10 Years w/o Power</td>
</tr>
<tr>
<td>FAN</td>
<td>120 mm Internal Fan</td>
</tr>
<tr>
<td>CONSTRUCTION</td>
<td>ENCLOSURE: Kydex Plastic</td>
</tr>
<tr>
<td></td>
<td>FACE: Lexan, Back Printed</td>
</tr>
<tr>
<td>SIZE</td>
<td>6.30 x 13.50 x 13.40 inches</td>
</tr>
<tr>
<td></td>
<td>160.0 x 342.9 x 340.4 mm</td>
</tr>
<tr>
<td>WEIGHT</td>
<td>≤ 17.5 Lbs (7.95 kg)</td>
</tr>
<tr>
<td>OPERATING RANGE</td>
<td>15 to 30 °C (59 to 86 °F)</td>
</tr>
<tr>
<td></td>
<td>20 to 80% RH, Non-Condensing</td>
</tr>
<tr>
<td>STORAGE RANGE</td>
<td>-20 to 60 °C (-4 to 140 °F)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>ELECTRICAL</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>BATTERY</td>
<td>6V, 7.2 Amp-Hour Sealed Lead Acid</td>
</tr>
<tr>
<td>BATTERY CHARGER</td>
<td>Internal 2-state Independent charger with float mode</td>
</tr>
<tr>
<td>POWER SUPPLY ADAPTER</td>
<td>9 VDC, 5 A</td>
</tr>
<tr>
<td></td>
<td>BC20-21105 (Universal)</td>
</tr>
<tr>
<td></td>
<td>See Ordering Section for Country-specific Power cord</td>
</tr>
<tr>
<td>POWER CONSUMPTION</td>
<td>ON: &lt; 3 A</td>
</tr>
<tr>
<td></td>
<td>OFF: &lt; 250 μA</td>
</tr>
<tr>
<td>USB COMMUNICATIONS</td>
<td>CONNECTIONS: USB-B</td>
</tr>
<tr>
<td></td>
<td>BAUD: 115200</td>
</tr>
<tr>
<td></td>
<td>DATA BITS: 8</td>
</tr>
<tr>
<td></td>
<td>START BITS: 1</td>
</tr>
<tr>
<td></td>
<td>STOP BITS: 1</td>
</tr>
<tr>
<td></td>
<td>PARITY: None</td>
</tr>
<tr>
<td></td>
<td>HANDSHAKING: None</td>
</tr>
<tr>
<td></td>
<td>CONNECTIONS: DB-9 Female</td>
</tr>
</tbody>
</table>