



ELECTROSURGICAL UNIT ANALYZER



ESU-2300

USER MANUAL

**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 - 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 - VENTILATION

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

CAUTION - CLEANING

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

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  mark
Based on the following testing standards:

ELECTROMAGNETIC COMPATIBILITY DIRECTIVE
**EMC – Directive 89/336/EEC and 2004/108/EC as amended by
92/31/EEC, 93/68/EEC and Directive 91/263/EEC [TTE/SES]**

EN 61326-1:1997 + A1:1998 + A2:2001 + A3:2003
**“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

Symbol

Description



Caution
(Consult Manual for Further Information)



RF Current Transformer



Per European Council Directive
2002/95/EC, do not dispose of this
product as unsorted municipal waste.

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.bcgrouptl.com
sales@bcgrouptl.com

<p style="text-align: center;">BC BIOMEDICAL ESU-2300 ELECTROSURGICAL UNIT ANALYZER</p>
--

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)

LAYOUT

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

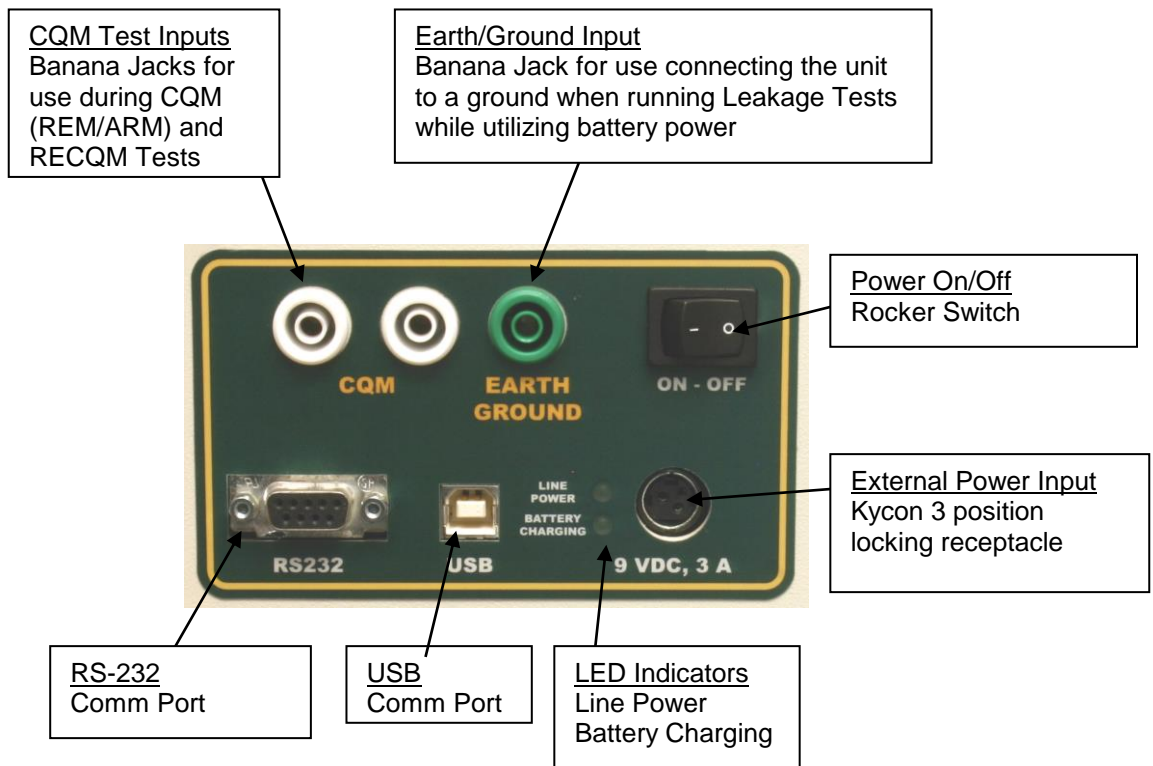
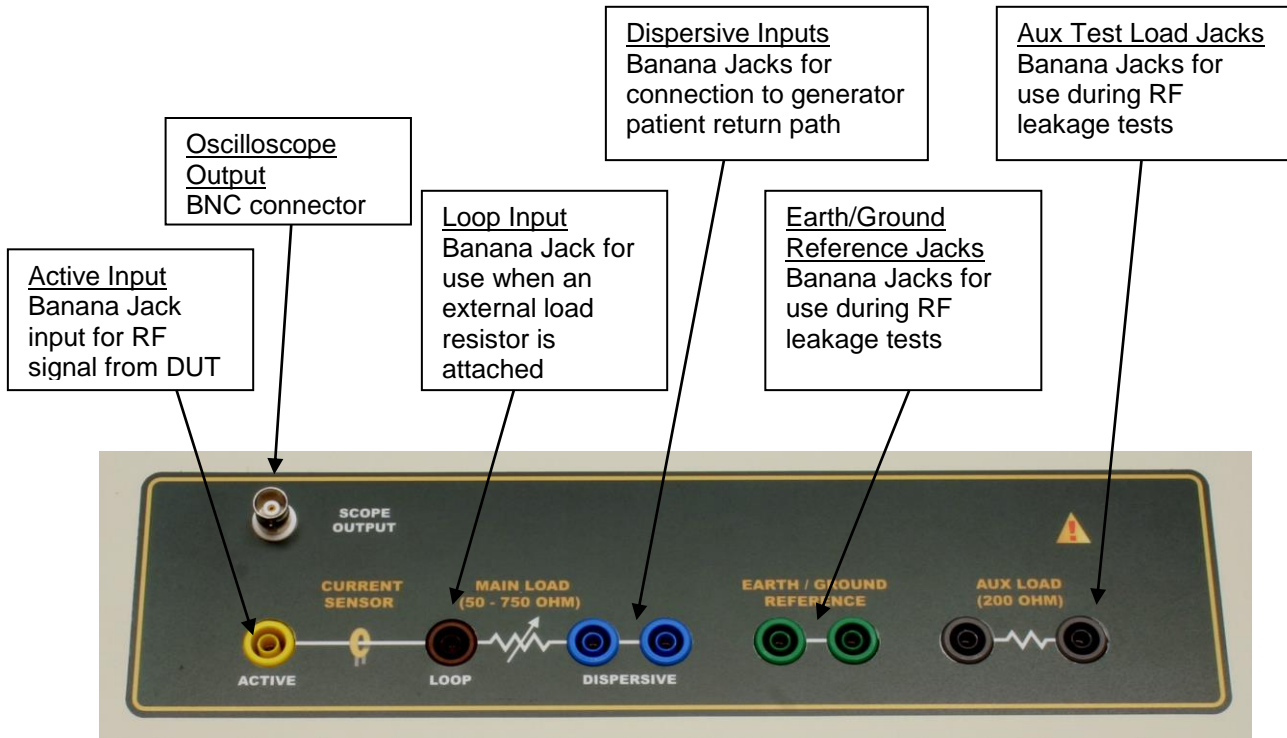


Ventilation Slots (Both Sides) for efficient load resistor cooling

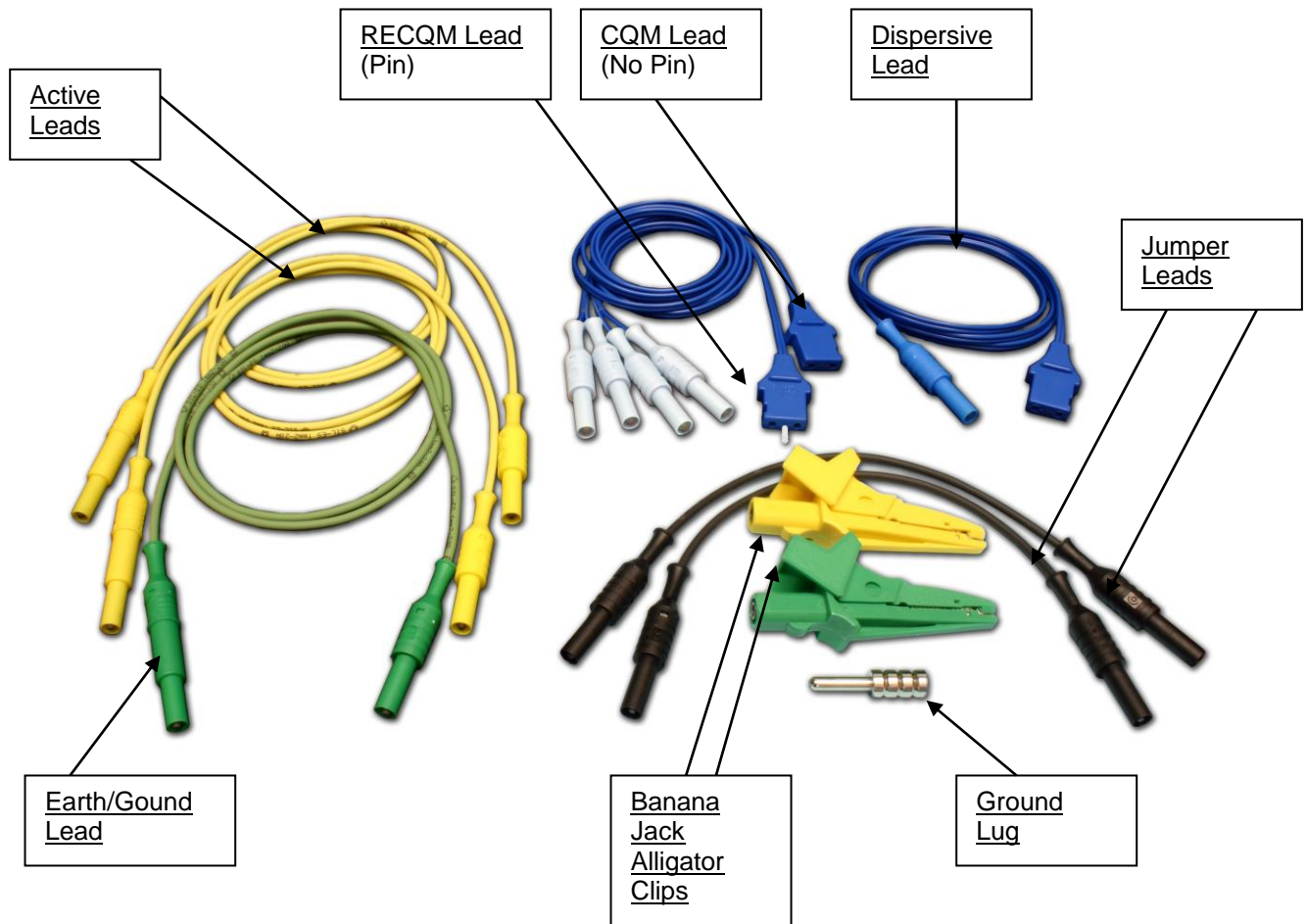
Back Light Key for turning on and off the backlight

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.



Accessory Kit, BC20-00125:



OPERATION


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.

63		0.5		Load	
mA		Watts		Int	50
				Ext	100
				Sum	150
				Int/Ext	
DISPLAY	CHANGE	HOLD	RECOM	SETUP	



Sample Function Key Labeling

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.

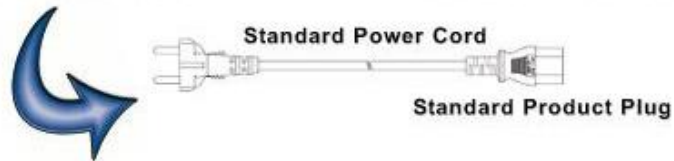
The Universal Power Supply takes a Standard Power Adapter Cable with Small Standard Product Plug and Required International Connector (See Options Below).

Typical Power Cord Options Available for the ESU-2300



Pick Your Country's
Connector from Above

to Connect to the
Universal Power Supply



POWER UP SETTINGS

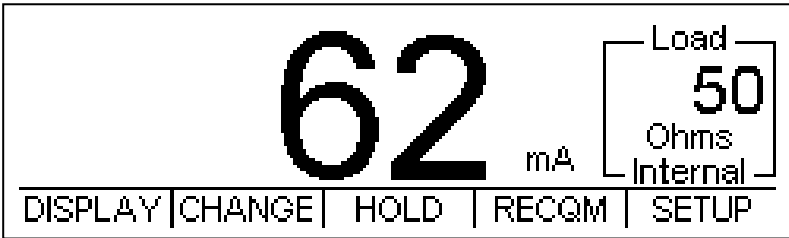
The unit may be setup to turn on using either the factory default settings or a custom set of parameters as previously saved by the user (See Power Up Settings section for details).

SCREENS

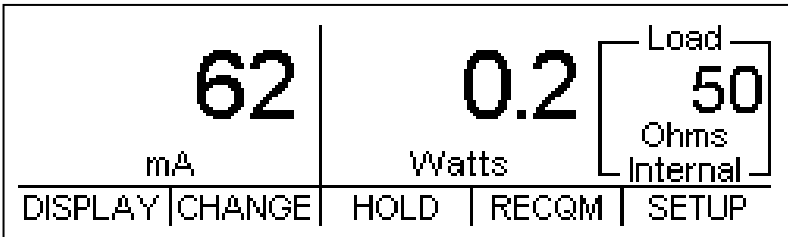
DISPLAY SCREEN

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.

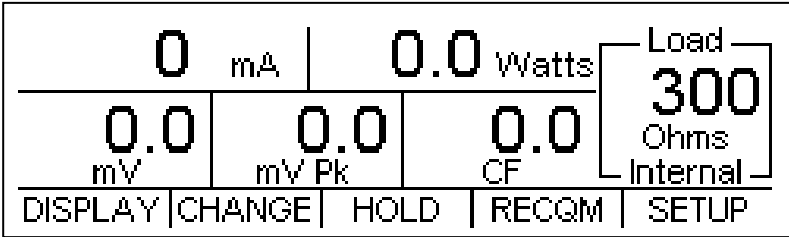
DISPLAY ZONES:



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	
	50
Ohms	
Internal	

Load	
	100
Ohms	
External	

Load	
Int	50
Ext	100
Sum	150
Int/Ext	

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



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.

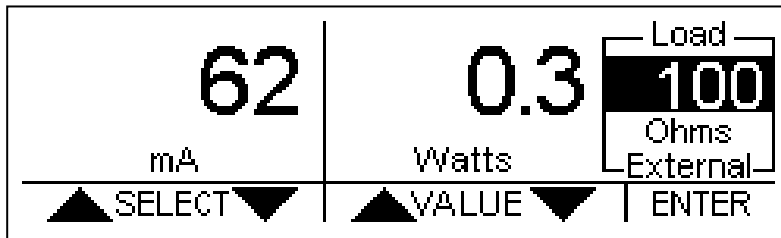
HOLD – This key will freeze the current reading in the Display Zone.

RECQM – This key will enter the RECQM Test Screen.

SETUP – This key will enter the System Setup Screen.

DISPLAY PARAMETERS CONFIGURATION 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.



Sample Display Parameters Configuration Screen with the load value highlighted

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.

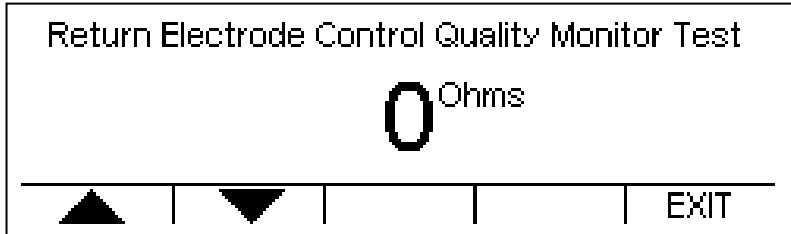
Use the **VALUE** keys to sequence through the available values of the highlighted parameter. The last FUNCTION KEY will be **ENTER**. Use this key to save the current value.

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.

CQM/RECQM (REM/ARM) TEST SCREEN

The RECQM TEST SCREEN can be entered using the **RECQM** key from the DISPLAY SCREEN.

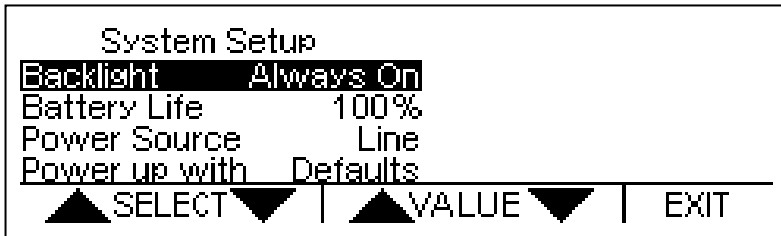


Sample RECQM Test Screen

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 **EXIT**. Use this key to return to the DISPLAY SCREEN.

SYSTEM SETUP SCREEN

The SETUP Mode allows the user to adjust the configuration of the unit. The SETUP SCREEN can be entered using the **SETUP** key.



Sample System Setup
Screen

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.



SYSTEM SETUP



The following is a breakdown of the parameters available in the configuration of the unit and their available options:


System Setup Configuration		
Parameter	Description	Range
Backlight	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.	Off, 0-20 sec, Always on (Factory Default = 10)
Battery Life	Displays remaining battery life (charge) in percent	0-100% (Read Only)
Power Source	Displays whether the unit is on battery power or line powered	Battery or Line (Read Only)
Power up with	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.	Defaults Custom Set Current as Custom
Num A/D Samples	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.	1024 2048 4096 8192 16384 32768 (Factory Default = 32768)
Display Averaging	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.	1-30 Readings (Factory Default = 11)
Software	Displays current software program.	(Read Only)


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  to enter the SETUP SCREEN. Use the  keys to highlight the “Power up with” parameter.

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

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

The last FUNCTION KEY will then be  . 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.

TESTING

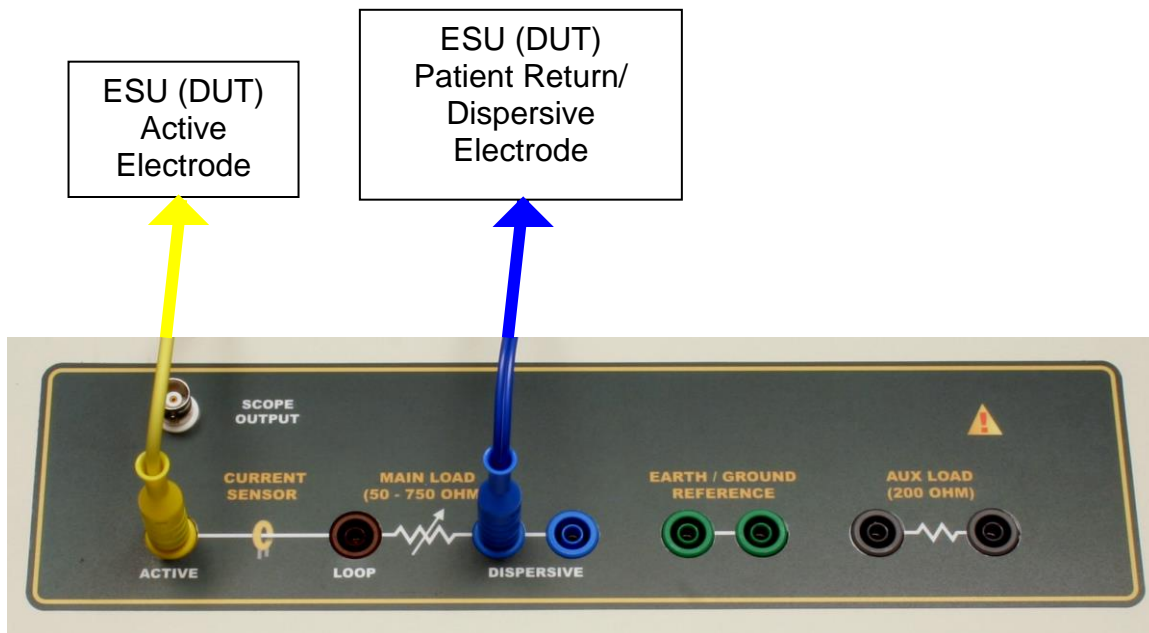
GENERATOR OUTPUT TESTS USING INTERNAL LOADS

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

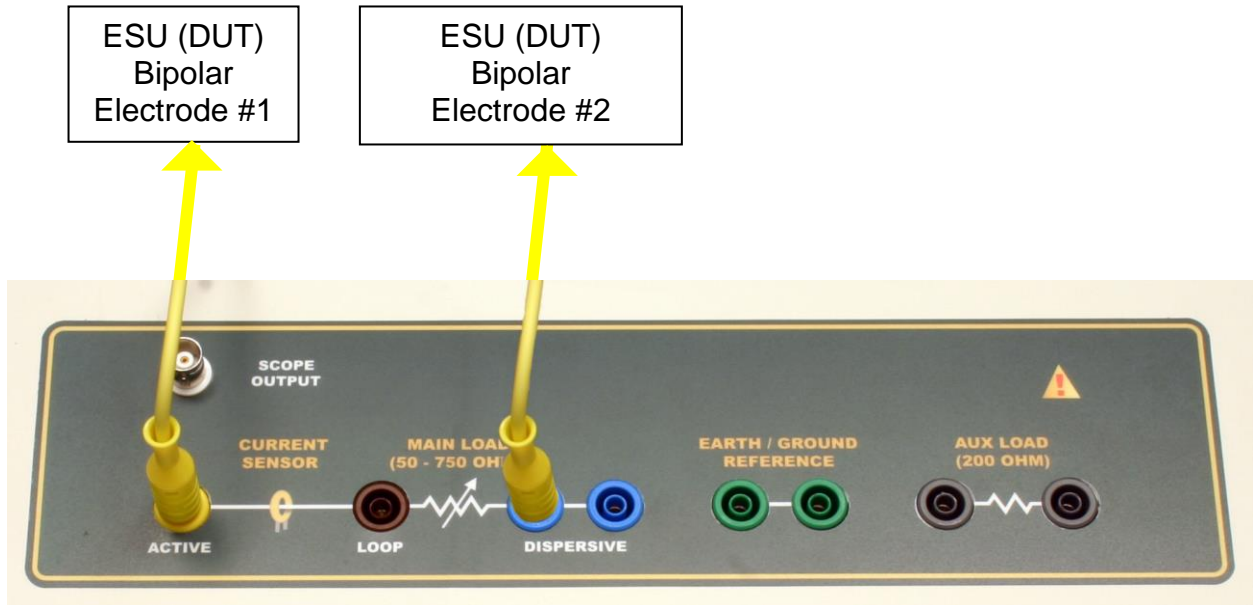
Monopolar outputs:

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.

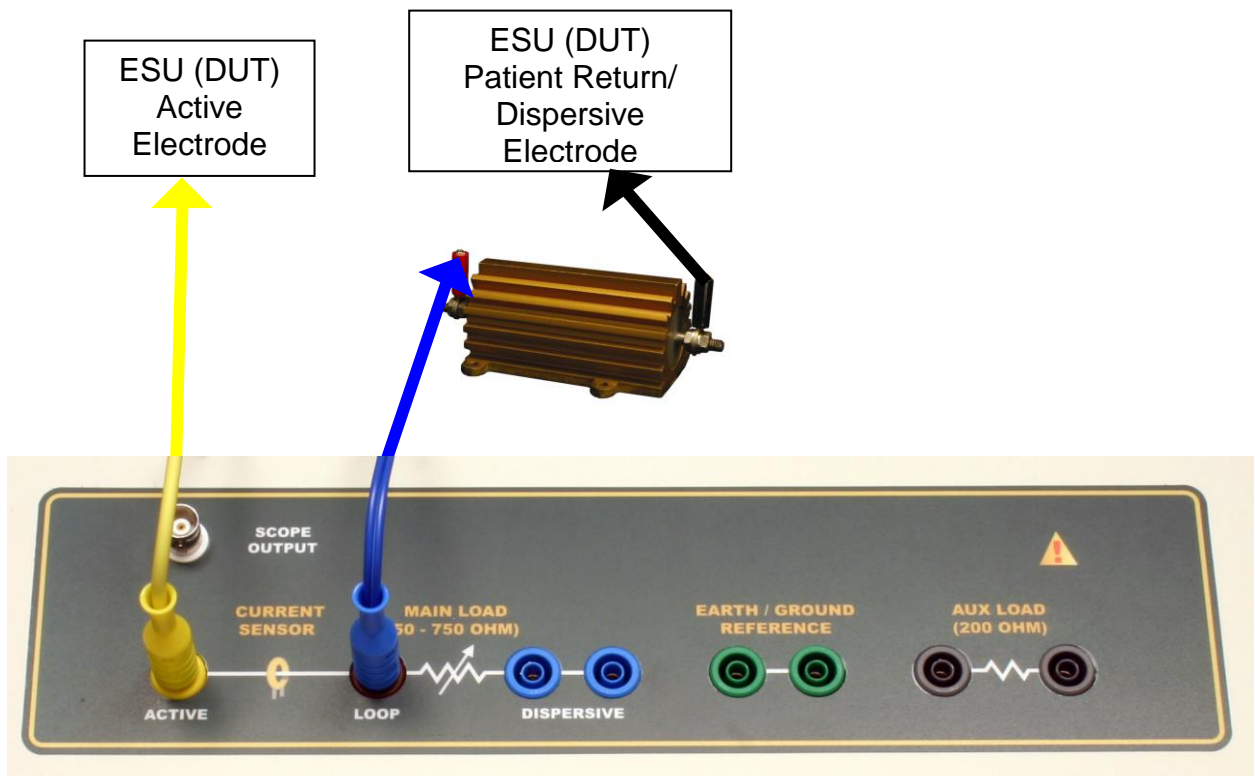
GENERATOR OUTPUT TESTS WITH EXTERNAL LOADS

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

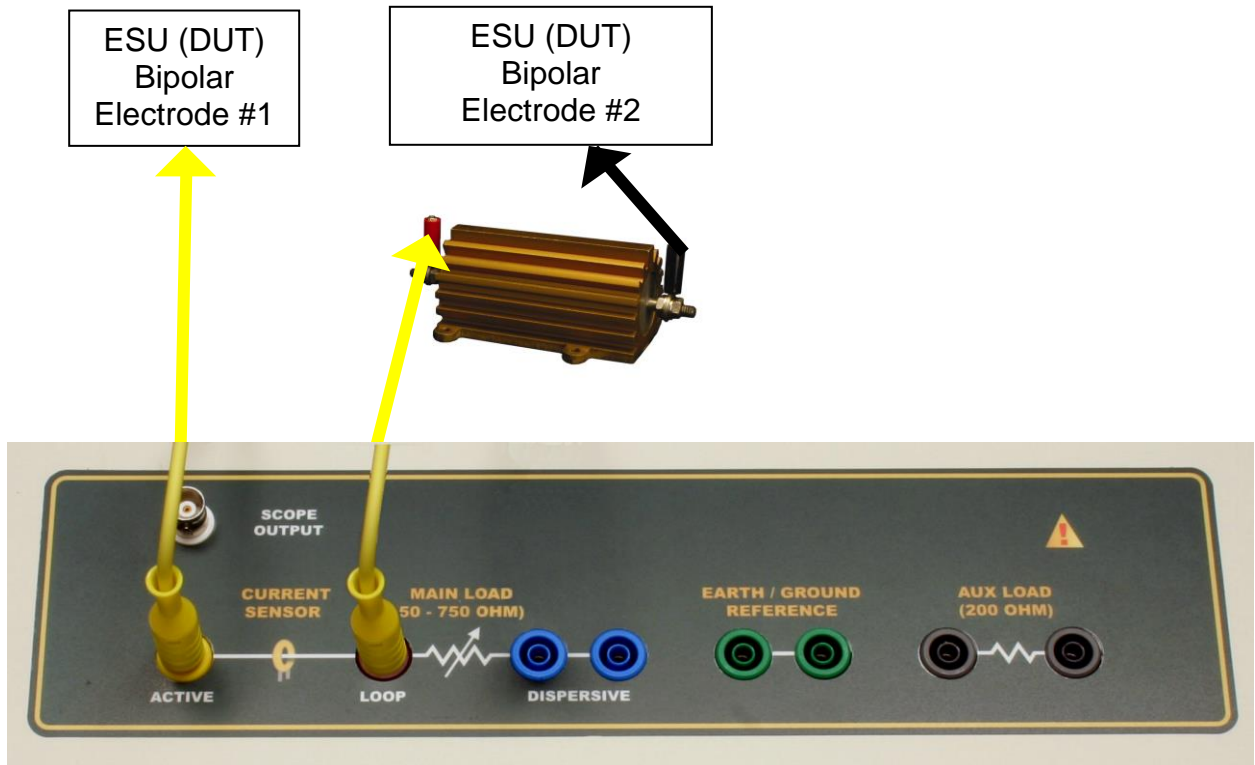
Monopolar:

1. Yellow Active Lead from Active Jack on ESU-2300 to DUT Output.
3. Blue Dispersive Lead from Loop Jack on ESU-2300 to External Load.
4. 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.

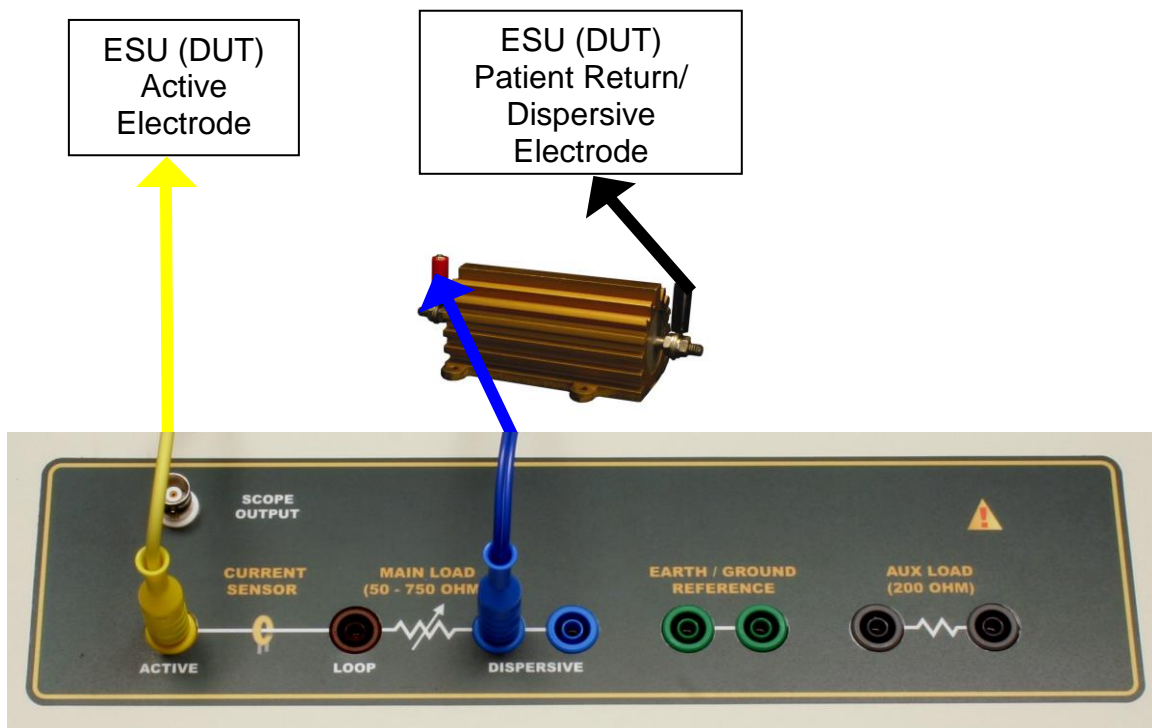
GENERATOR OUTPUT TESTS WITH INTERNAL / EXTERNAL TEST LOADS

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

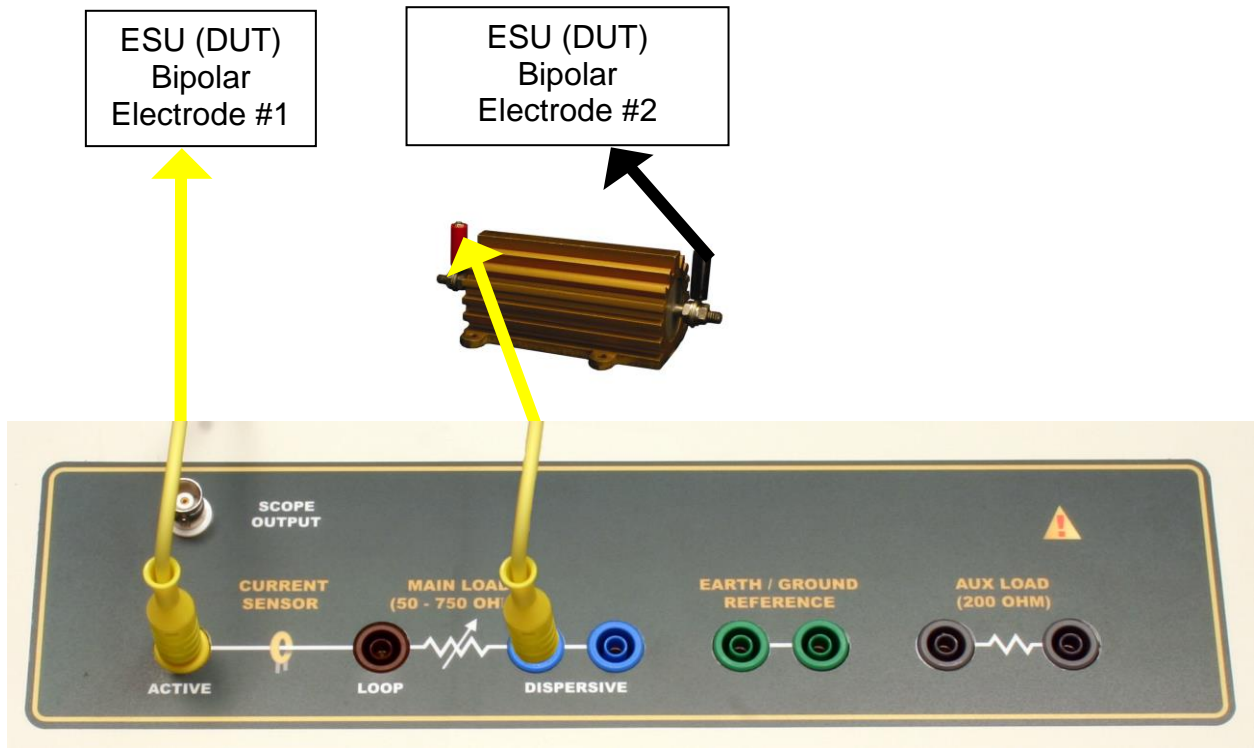
Monopolar:

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.

CQM (REM/ARM) TEST

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.

RF LEAKAGE TEST #1

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.

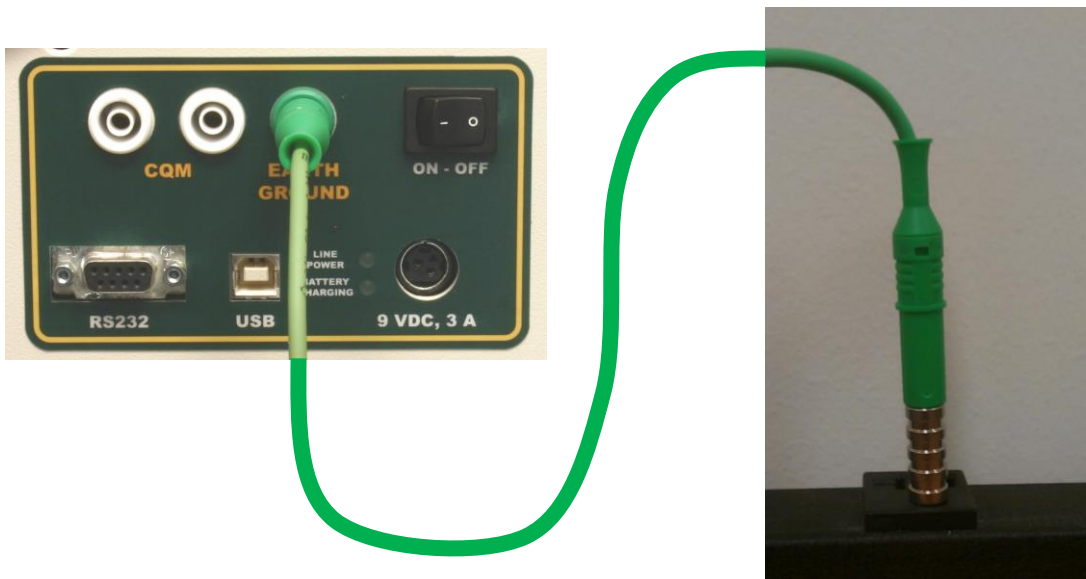
WARNING – ONE LEAD AT A TIME
Only test one lead of the ESU Generator at a time

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.



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.

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.

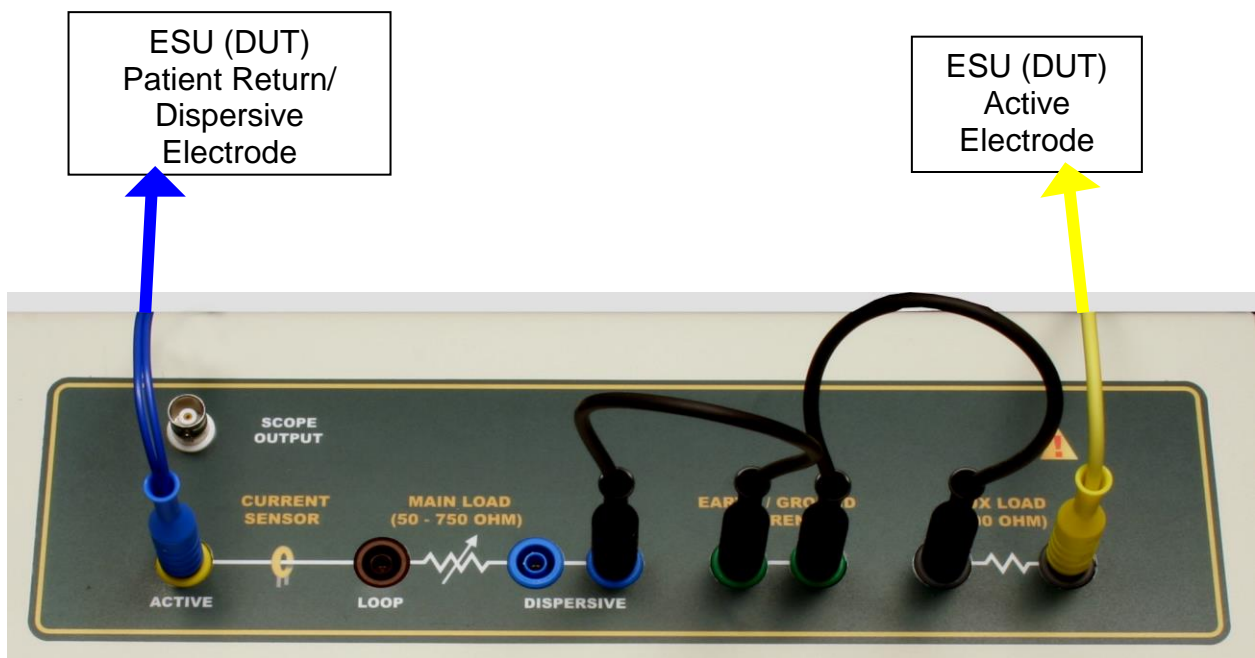
NOTE: When the ESU-2300 is operating on battery power it is necessary to supply an Earth/Ground reference to the unit prior to performing any RF Leakage Tests. Refer to page 29 for connection details.

RF LEAKAGE TEST #3

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.

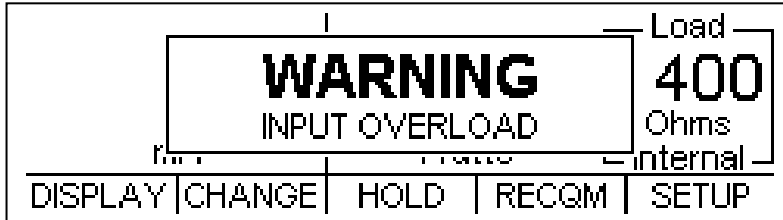
NOTE: Remember to disable the Electrosurgical Generator Output when testing is completed.

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.

ERROR MESSAGES

Several error messages are provided to indicate invalid operating conditions.

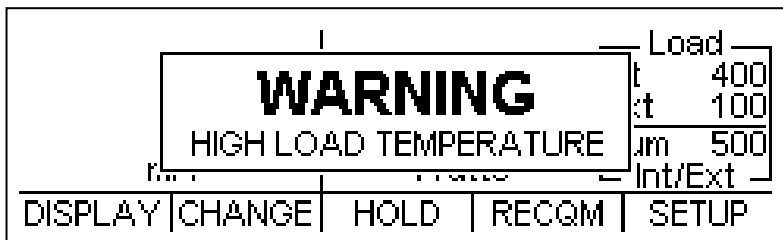
Input Overload



Sample Input Overload Screen

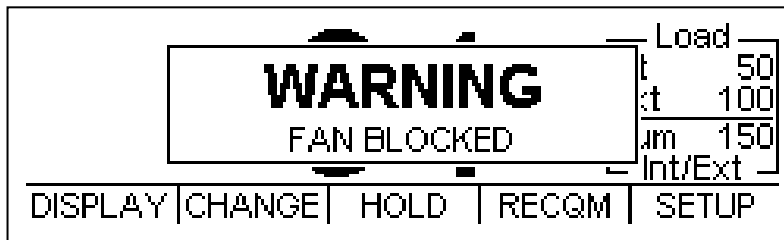
When the input signal rises above the range that is measurable by the system, the “WARNING INPUT OVERLOAD” message will be shown. Although the input is protected from damage at these levels, the user should immediately remove any input signal when this message is shown.

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

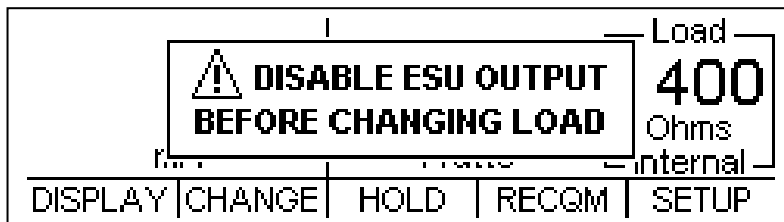


Sample Fan Blocked Screen

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.

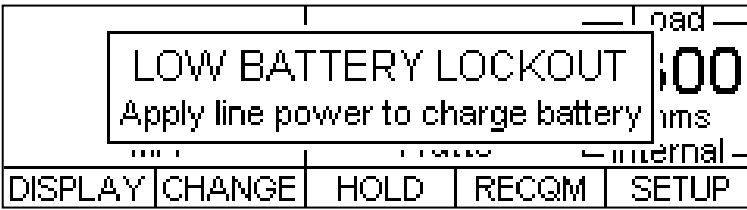
Disable Electrosurgery Generator Output Before Changing Load



Sample Disable Output Screen

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.

COMMUNICATION PROTOCOL

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

MANUAL REVISIONS

<u>Revision #</u>	<u>Program #</u>	<u>Revisions Made</u>
Rev 01	DT7377A	Origination
Rev 02	DT7377D	Added 5 zone display screen, added 3 parameters
Rev 03	DT7377E	Added Communications, Revised External Load
Rev 04	DT7377CE	Miscellaneous Edits
Rev 05	DT7377CF	Modify Battery Measurement
Rev 06	DT7377CF	Format Updated, Specifications Updated
Rev 07	DT7377CF	Specifications Updated

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

RETURN ELECTRODE MONITOR TEST LOAD		
RANGE	0 to 500 Ω	
RESOLUTION	1 Ω	
ACCURACY	$\pm 2\%$ Reading or $\pm 2 \Omega$, whichever is greater	
CONNECTIONS	4 mm SAFETY BANANA	
PHYSICAL & ENVIRONMENTAL		
DISPLAY	240x64 Pixel Graphical LCD, White LED Backlight	
MEMORY	SETUP	EEPROM, All Parameters
	RETENTION	10 Years w/o Power
FAN	120 mm Internal Fan	
CONSTRUCTION	ENCLOSURE	Kydex Plastic
	FACE	Lexan, Back Printed
SIZE	6.30 x 13.50 x 13.40 inches 160.0 x 342.9 x 340.4 mm	
WEIGHT	≤ 17.5 Lbs (7.95 kg)	
OPERATING RANGE	15 to 30 $^{\circ}\text{C}$ (59 to 86 $^{\circ}\text{F}$) 20 to 80% RH, Non-Condensing	
STORAGE RANGE	-20 to 60 $^{\circ}\text{C}$ (-4 to 140 $^{\circ}\text{F}$)	
ELECTRICAL		
BATTERY	6V, 7.2 Amp-Hour Sealed Lead Acid	
BATTERY CHARGER	Internal 2-state Independent charger with float mode	
POWER SUPPLY ADAPTER	9 VDC, 5 A BC20-21105 (Universal) See Ordering Section for Country-specific Power cord	
POWER CONSUMPTION	ON	< 3 A
	OFF	< 250 μA
USB COMMUNICATIONS	CONNECTIONS	USB-B
RS-232 COMMUNICATIONS	BAUD	115200
	DATA BITS	8
	START BITS	1
	STOP BITS	1
	PARITY	None
	HANDSHAKING	None
	CONNECTIONS	DB-9 Female

NOTES



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

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

**www.bcgrouptl.com
sales@bcgrouptl.com**

**ESU-2300 User Manual
02/15 – Rev 07**

**Copyright © 2015
Made in the USA**