BC Biomedical
A UNIT OF BC GROUP INTERNATIONAL, INC.

ELECTROSURGICAL UNIT ANALYZER

ESU-2050 SERIES

USER MANUAL

BC BIOMEDICAL
ESU-2050 SERIES
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WARNING - USERS

The ESU-2050 Series Analyzers are for use by skilled technical personnel only.

WARNING - USE

The ESU-2050 Series Analyzers are intended for testing only and they should never be used in diagnostics, treatment or any other capacity where they would come in contact with a patient.

WARNING - MODIFICATIONS

The ESU-2050 Series Analyzers are 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 Analyzer. A serious hazard may occur if the patient is connected when testing with the Analyzer. Do not connect any leads from the patient directly to the Analyzer or DUT.

WARNING - POWER ADAPTOR

Unplug the Power Adaptor before cleaning the surface of the Analyzer.

WARNING - LIQUIDS

Do not submerge or spill liquids on the Analyzer. Do not operate the Analyzer if internal components not intended for use with fluids may have been exposed to fluid, as the internal leakage may have caused corrosion and be a potential hazard.

CAUTION - SERVICE

The ESU-2050 Series Analyzers are intended to be serviced only by authorized service personnel. Troubleshooting and service procedures should only be performed by qualified technical personnel.

CAUTION - ENVIRONMENT

The ESU-2050 Series Analyzers are intended to function between 15 and 30 °C. Exposure to temperatures outside this range can adversely affect the performance of the Analyzer.

CAUTION - CLEANING

Do not immerse. The Analyzer should be cleaned by wiping gently with a damp, lint-free cloth. A mild detergent can be used if desired.

CAUTION - INSPECTION

The ESU-2050 Series Analyzers should be inspected before each use for wear and should be serviced if any parts are in question.

NOTICE – CE

The ESU-2050 Series Analyzers bear the CE 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 or Amps	**Amperes**
C	**Celsius**
CF	**Crest Factor**
°	**degree**
DFA	**Digital Fast Acquisition**
DUT	**Device Under Test**
Hz	**hertz**
k	**kilo- (10^3)**
kg	**kilogram(s)**
kHz	**kilohertz**
lbs	**pounds**
L1, L2, L3	**Location 1, 2, 3**
M	**Mega- (10^6)**
MHz	**Megahertz**
µ	**micro- (10^{-6})**
m	**milli- (10^{-3})**
mA	**milliampere(s)**
mm	**millimeter(s)**
ms	**millisecond(s)**
mV	**millivolt(s)**
Ω	**ohm(s)**
PC	**Personal Computer**
p or pk	**peak**
p-p or pk-pk	**peak-to-peak**
RF	**Radio Frequency**
RMS	**Root Mean Square**
US	**United States**
V	**volt(s)**
VDC	**Direct Current Voltage**
W	**watt(s)**

NOTICE – PERFORMING TESTS

REFER TO DUT MANUFACTURER'S SERVICE MANUAL FOR TEST PROCEDURES AND MEASUREMENT LIMITS.

NOTICE – DISCLAIMER

USER ASSUMES FULL RESPONISIBILITY FOR UNAUTHORIZED EQUIPMENT MODIFICATIONS OR APPLICATION OF EQUIPMENT OUTSIDE OF THE PUBLISHED INTENDED USE AND SPECIFICATIONS. SUCH MODIFICATIONS OR APPLICATIONS MAY RESULT IN EQUIPMENT DAMAGE OR PERSONAL INJURY.

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NOTICE – CONTACT INFORMATION

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BC BIOMEDICAL
ESU-2050 SERIES
ELECTROSURGICAL UNIT ANALYZER

The ESU-2050 Series Electrosurgical Unit Analyzers is a family of high-accuracy True RMS RF Voltmeters designed to be used in the routine performance verification of Electrosurgical Generators. They offer a higher degree of accuracy than previously attainable with conventional Electrosurgical Unit Analyzer designs. The ESU-2050 Series has been designed to be used in conjunction with an external RF Current Transformer (Pearson Electronics Model 411 and 4100 recommended) and external precision load resistors (Vishay Dale NH-250 Precision 1% tolerance resistors recommended) to measure various parameters relating to the routine service of Electrosurgical Generators. They are microprocessor based and utilize a combination of unique hardware and software to provide accurate and reliable test results, even from "noisy" ESU Generator waveforms such as "Spray". The Patent Pending DFA® Technology utilized in the ESU-2050 Series allows the system to aggressively digitize the complex RF waveforms produced by Electrosurgical Generators, analyze each individual digital data point, and provide highly accurate measurement results.

The following are highlights of some of the main features:

- TRUE RMS READINGS USING DFA® TECHNOLOGY
- INDUSTRY STANDARD CURRENT SENSING TECHNOLOGY
- MV, MV PEAK, MA, CREST FACTOR AND POWER (WATTAGE) RANGES
- LARGE GRAPHICS DISPLAY WITH CURSOR SELECTION OF OPTIONS AND SETUP OF PARAMETERS
- 1% OF READING MEASUREMENT ACCURACY
- DIGITAL DATA OUTPUT VIA USB AND RS232
- PC BASED INTERFACE AND DATA CAPTURE PROGRAM
- DIGITAL CALIBRATION – NO POTS TO TURN
- SELECTABLE DISPLAY OPTIONS
- DISPLAY CONTRAST IS SOFTWARE ADJUSTABLE
- TACTILE KEYS WITH AUDIO FEEDBACK
- GRAPHICAL ON-SCREEN REPRESENTATION OF MEASURED RF SIGNAL
- STANDARD (1000 MV) AND LOW RANGE (100 MV) WITH AUTOSCALING CAPABILITY
- CAN BE USED WITH 0.1:1 OR 1:1 VOLTAGE:CURRENT CURRENT TRANSFORMERS

- INTERNALLY PROTECTED INPUT CIRCUITRY GUARDS AGAINST INPUT OVERLOAD DAMAGE
- INTERNAL DATA STORAGE FOR 3 FULL DATA SETS

ESU-2050P HAS ALL THE BASIC MODEL FEATURES PLUS:

- PULSED RF WAVEFORM MEASUREMENT MODE FOR LOW DUTY CYCLE PULSED OUTPUTS OFFERED BY SOME ELECTROSURGICAL MANUFACTURERS

STANDARD ACCESSORIES:

BC20 – 00126	ACCESSORY KIT (TEST LEADS)
BC20 – 41352	COMMUNICATIONS CABLE (USB)
BC20 – 41341	COMMUNICATIONS CABLE (RS232)
BC20 – 00232	CT CABLE (BNC)
BC20 – 30108	SOFT SIDED CARRYING CASE
BC20 – 21104	UNIVERSAL POWER SUPPLY
BC20 – 205XX	STANDARD POWER ADAPTER (International Options, see Page 23 for details)

OPTIONAL ACCESSORIES:

BC20 – 41353	CD, ESU2050 INTERFACE SOFTWARE
BC20 – 00231	PEARSON ELECTRONICS MODEL 411 0.1:1 RATIO CURRENT TRANSFORMER
BC20 – 00230	PEARSON ELECTRONICS MODEL 4100 1:1 RATIO CURRENT TRANSFORMER

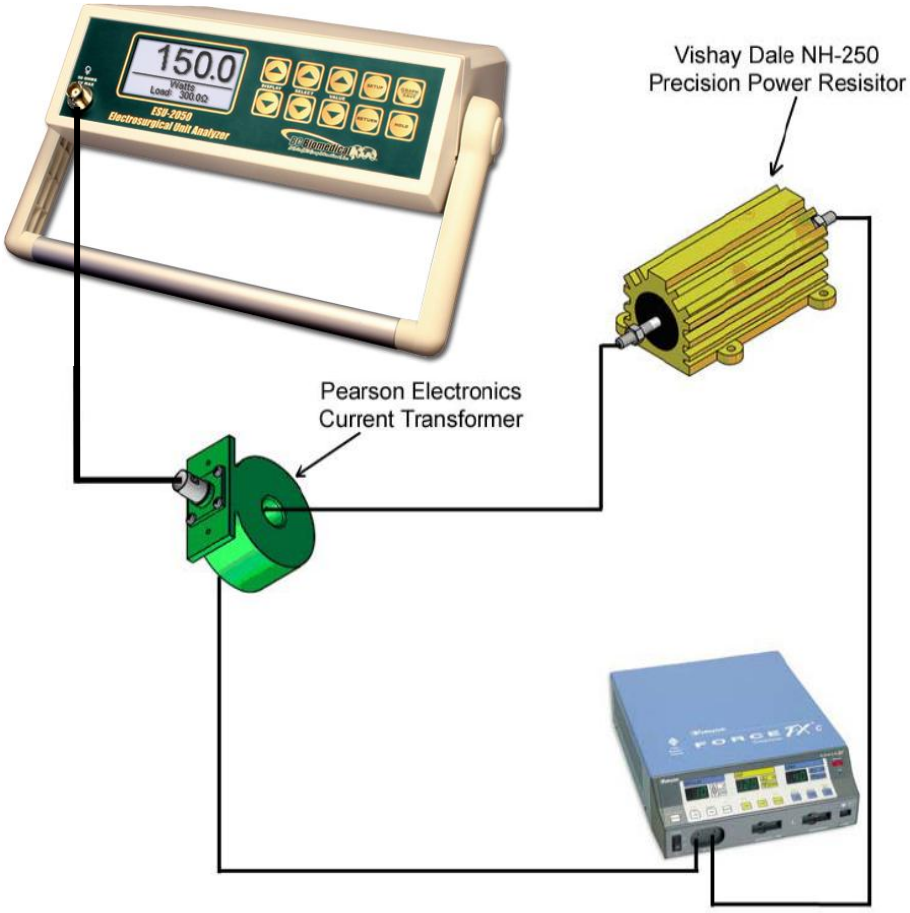
VISHAY-DALE 1% TOLERANCE LOAD RESISTORS:

BC20 – 00200	5 Ω, 250-WATT, NH-250 SERIES RESISTOR
BC20 – 00201	10 Ω, 250-WATT, NH-250 SERIES RESISTOR
BC20 – 00202	20 Ω, 250-WATT, NH-250 SERIES RESISTOR
BC20 – 00203	30 Ω, 250-WATT, NH-250 SERIES RESISTOR
BC20 – 00204	50 Ω, 250-WATT, NH-250 SERIES RESISTOR
BC20 – 00205	100 Ω, 250-WATT, NH-250 SERIES RESISTOR
BC20 – 00206	200 Ω, 250-WATT, NH-250 SERIES RESISTOR
BC20 – 00207	300 Ω, 250-WATT, NH-250 SERIES RESISTOR
BC20 – 00208	500 Ω, 250-WATT, NH-250 SERIES RESISTOR
BC20 – 00209	1000 Ω, 250-WATT, NH-250 SERIES RESISTOR
BC20 – 00210	2000 Ω, 250-WATT, NH-250 SERIES RESISTOR
BC20 – 00211	3000 Ω, 250-WATT, NH-250 SERIES RESISTOR
BC20 – 00212	4000 Ω, 250-WATT, NH-250 SERIES RESISTOR
BC20 – 00213	5000 Ω, 250-WATT, NH-250 SERIES RESISTOR
BC20 – 00214	1 Ω, 50-WATT, NH-50 SERIES RESISTOR
BC20 – 00215	125 Ω, 250-WATT, NH-250 SERIES RESISTOR
BC20 – 00216	150 Ω, 250-WATT, NH-250 SERIES RESISTOR
BC20 – 00217	400 Ω, 250-WATT, NH-250 SERIES RESISTOR

BC20 – 00218	800 Ω, 250-WATT, NH-250 SERIES RESISTOR
BC20 – 00219	1500 Ω, 250-WATT, NH-250 SERIES RESISTOR
BC20 – 00220	10 Ω, 50-WATT, NH-50 SERIES RESISTOR
BC20 – 00240	LOAD RESISTOR BANANA JACK ADAPTER SET (2)

TYPICAL TEST SETUP

Unlike all conventional ESU Analyzers with lesser degrees of accuracy, the ESU-2050 Series utilizes an external Current Transformer and external precision load resistors (values to be determined by the manufacturer's suggested test load for the generator you are testing or servicing) for typical Electrosurgical Generator testing. Many of the world's leading Electrosurgical generator manufacturers utilize this exact same technique when they test, service and calibrate their generators.



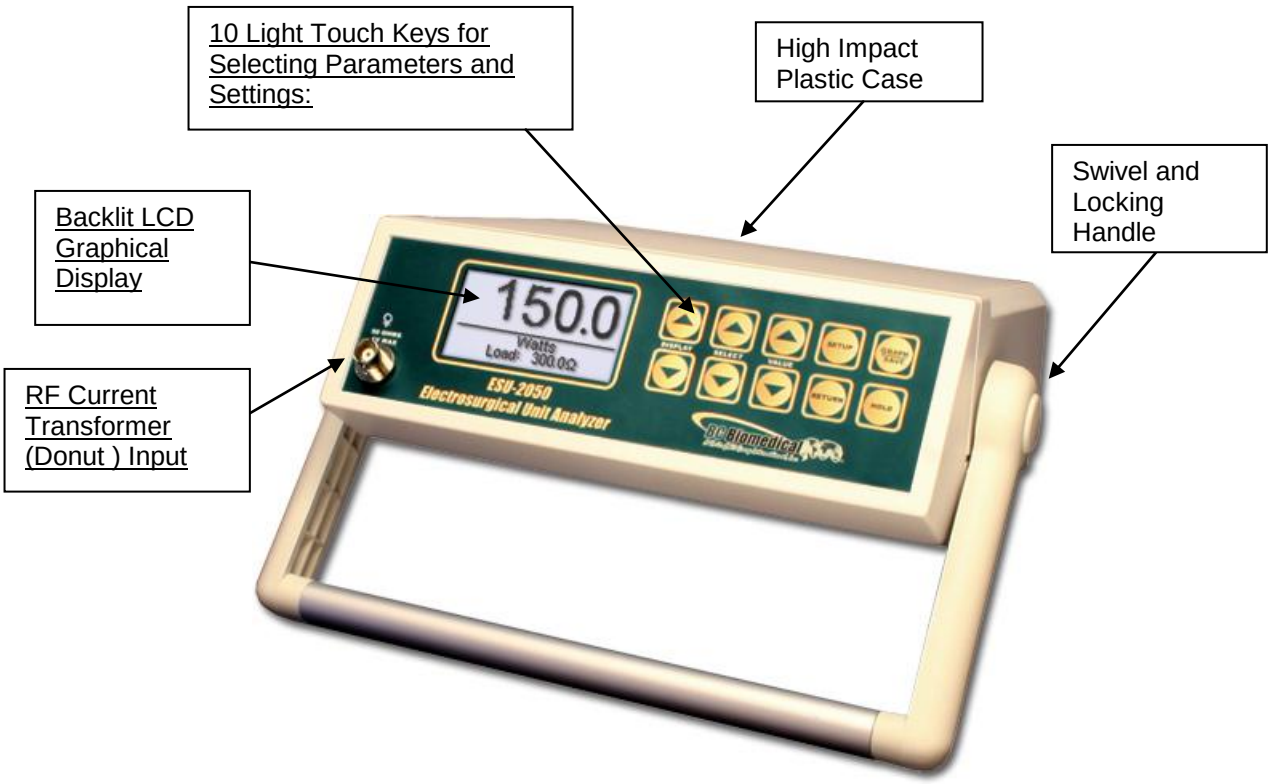
This methodology has several distinct advantages over conventional ESU Analyzers:

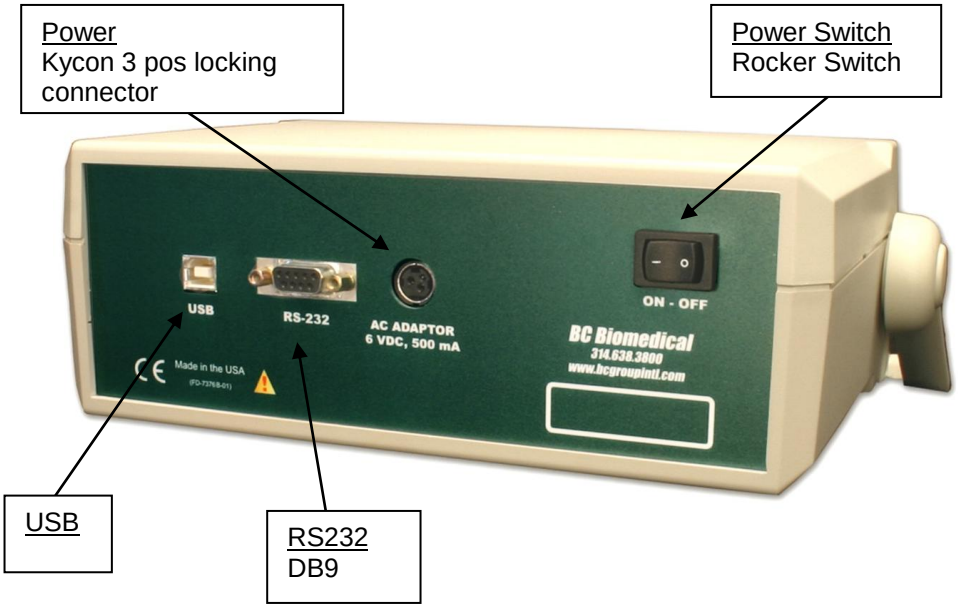
- Improved accuracy and resolution capabilities
- 100% manufacturer recommended test load compatibility
- Smaller and lighter weight instrumentation

The current transformer senses the RF current flowing through the external test load and produces a proportional voltage as an input to the ESU-2050. This input is either a direct 1 : 1 input (for current transformers with a ratio of 1 : 1 volts : amps) or a 0.1 : 1 input (for current transformers with a ratio of 0.1 : 1 volts : amps). Combining the standard and low ranges of the ESU-2050 with the use of either a 0.1:1 or 1:1 ratio current transformer, the user has full control over the ability to get high accuracy and high resolution readings from all types of Electrosurgical Generators.

OVERVIEW

This section looks at the layout of the ESU-2050 and gives descriptions of the elements that are present.





MAIN SCREENS – There are 7 main screens, 5 Display Screens which have 1, 2, 3, 4 and 5 display zones respectively, a Measurement List Screen which shows available measurements and the Quick Config Screen which displays the current hardware configuration. In the Display Screens, each Display Zone can be customized to show the desired parameter from the following options:

Parameter	Abbreviation	Description
mV RMS	mV	This is the mV measured directly from the RF donut.
mA RMS	mA	This is the converted mA measurement based on the RF donut mV to mA attenuation ratio.
Power in Watts	Watts	This is the computed power based on load setting and mA measured.
mV Peak	mV Pk	This is the maximum mV measured in the buffer. NOTE: This is shown as absolute value.
mV Peak - to - Peak	mV P-P	This is the difference between maximum mV measured and min mV measured.
mV Peak / Peak - to - Peak	Pk/P-P	This is the ratio of Peak versus Peak to Peak millivolts.
mV Positive Peak Only	mV Pk+	This is the maximum positive mV measured in the buffer. For asymmetric waveforms this can determine if the output polarity is reversed.
Crest Factor	CF	This is the ratio of peak to rms of the measured waveform.
Time Pulse - On	Ton	**ESU-2050P Only** This is the duration that the pulsed waveform is on. (See Diagram 1)
Time - Pulse Off	Toff	**ESU-2050P Only** This is the duration that the pulsed waveform is off. (See Diagram 1)
Time - Total Cycle	Tcyc	**ESU-2050P Only** This is the total cycle time of the pulsed waveform (i.e. Ton + Toff). (See Diagram 1)
% Duty Cycle	%Duty	**ESU-2050P Only** This is the ratio of the pulse on time (Ton) versus cycle time (Tcyc). (See Diagram 1)
mV Pulse	mV cyc	**ESU-2050P Only** This represents the RMS mV over one pulsed cycle. (See Diagram 1)
mA Pulse	mA cyc	**ESU-2050P Only** This represents the RMS mA over one pulsed cycle. (See Diagram 1)
Watts Pulse	Wcyc	**ESU-2050P Only** This represents the RMS Watts over one pulsed cycle. (See Diagram 1)

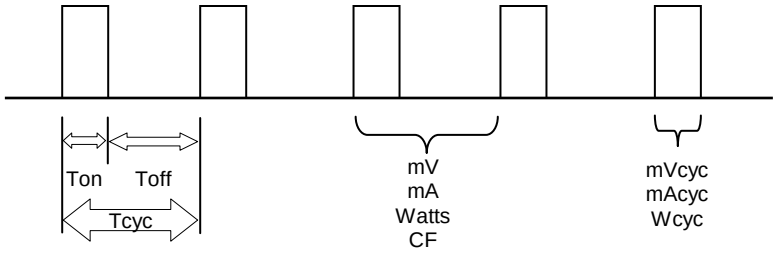


Diagram 1 (ESU-2050P Only)

The available screens can be toggled through using 

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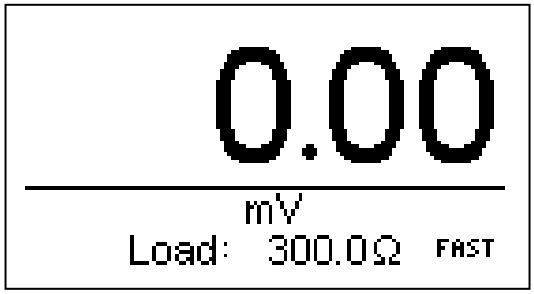
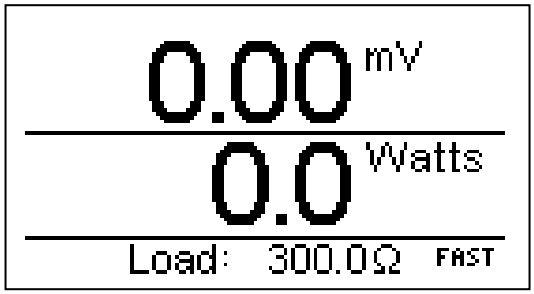
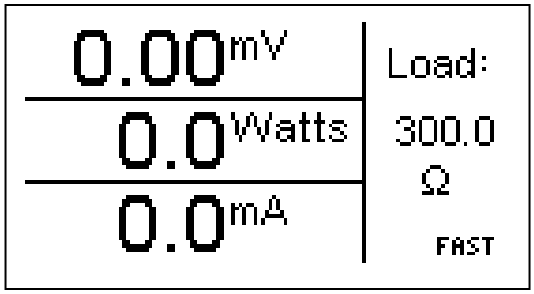
Display Screens



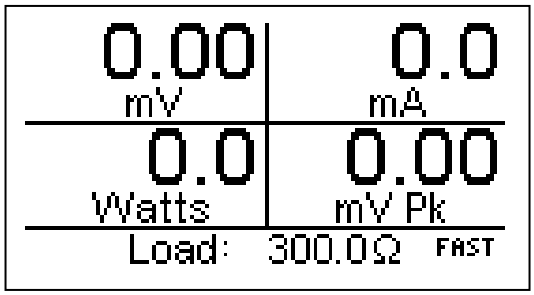
One Display Zone Screen with mV parameter selected



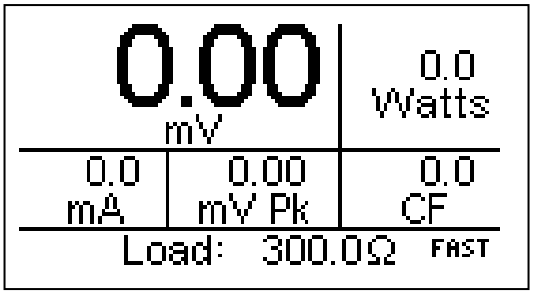
Two Display Zone Screen with mV and Watts parameters selected



Three Display Zone Screen with mV, Watts and mA parameters selected

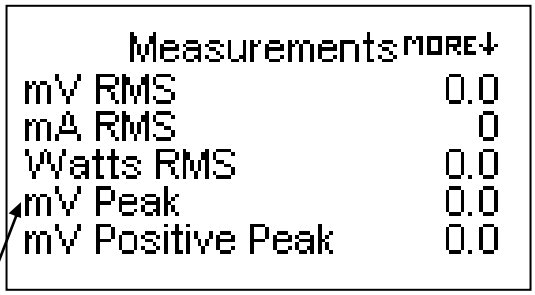


Four Display Zone Screen with mV, Watts, mA and mV Peak parameters selected



Five Display Zone Screen with mV, Watts, mA and mV Peak and CF parameters selected

Measurement List Screen:

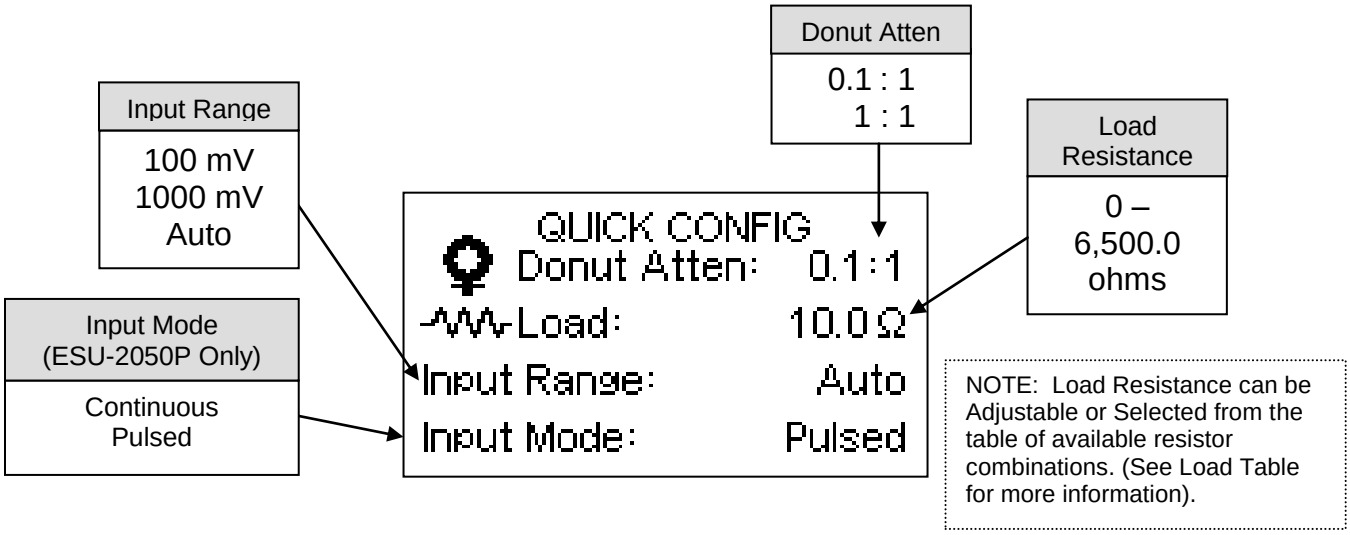


Measured Parameters

Parameter	Abbreviation
mV RMS	mV
mA RMS	mA
Watts RMS	Watts
mV Peak	mV Pk
mV Peak - to - Peak	mV P-P
mV Peak / Peak - to - Peak	Pk/P-P
mV Positive Peak	mV Pk+
Crest Factor	CF
Time Pulse – On *	Ton
Time - Pulse Off *	Toff
Time - Total Cycle *	Tcyc
% Duty Cycle *	%Duty
mV Pulse *	mV cyc
mA Pulse *	mA cyc
Watts Pulse *	Wcyc

* ESU-2050P Only

Quick Config Screen:



The Quick Config Screen allows the user to see the current configuration and provide a quick method of changing the RF Current Transformer (Donut) Attenuation, Load Resistance , Input Range or Input mode parameters.

Use 

to highlight the parameter to change and then 

to sequence through the available options.

NOTE: On power up, the Quick Config Screen will display for a few seconds to indicate the current configuration and then the default Display Screen will be displayed. The Quick Config Screen can be accessed using 

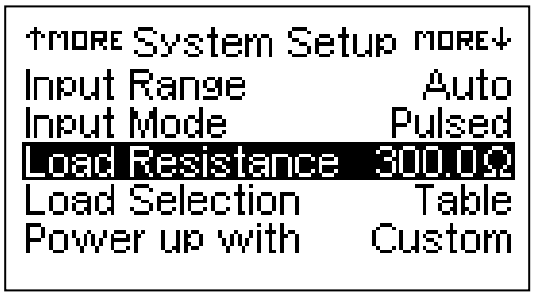
.

DISPLAY PARAMETERS – There are five options of parameters that can be selected for each Display Zone on the Main Screens. This allows users to custom configure the displays to best suit their needs.

Use SELECT to highlight the Display Zone to change and then VALUE to sequence through the available parameters.

NOTE: To save a custom configuration, see Power Up Settings section.

SYSTEM CONFIGURATION SCREEN – The SYSTEM SETUP MODE allows the user to adjust the configuration of the unit. The Setup Screen can be entered using the SETUP key. The parameters can be changed by using SELECT to highlight the line and VALUE to toggle the available options. The Setup Screen can be exited using the RETURN key.



Typical Setup Screen

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**
Donut Atten	Selects the RF Current Transformer Attenuation in Volts : Amp for the RF Donut being used. Default = 0.1 : 1	0.1 : 1 1 : 1 Volts : Amps
Input Zero	Zeros the input circuitry based on donut being used. Each donut can have a slightly different zero offset. This function will eliminate the offset from the readings. Press the SETUP key while this parameter is selected to perform the auto –zero function.	Press Setup
Input Range	Determines the input range. Default = Auto	100 mV 1000 mV Auto
Input Mode (ESU-2050P Only)	Determines whether the unit continuously monitors the Input Signal or looks for a Pulsed Input Signal. Default = Continuous	Continuous Pulsed
Load Resistance	Used for Power (Watts) calculation only. Can be adjustable or set by a table of fixed resistors. (See Load Selection and Load Table for more information.) Default = 500	0-6,500.0 ohms
Load Selection	Determines whether the Load Resistance Parameter is adjustable by tenths of ohms or selected from the Load Table. The Load Table is created from the Load Resistance Values set in the Factory Setup and the Load Sets. (See Load Sets, Load Table and Factory Setup for more information.) Default = Table	Adjustable or Table
Power up with	Determines the power up mode of the ESU-2050. The default mode shows a single mV 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. Default = Defaults	Defaults Custom Set Current as Custom
Num A/D Samples	Sets the number of A/D converter readings used in each mV RMS computation. A higher setting requires more computation and is slower, but results in a more stable reading. Default = 32,768	1024 2048 4096 8192 16384 32768
Display Averaging	Sets which display averaging parameter is to be used. Three independent averaging modes can be configured for optimum system performance.	Fast Medium Slow

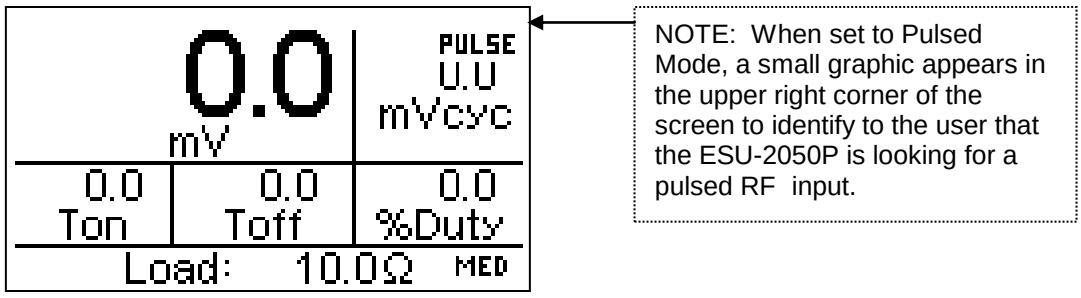
System Setup Configuration		
Parameter	**Description**	**Range**
Slow Averaging	Sets the number of mV RMS readings that are averaged when the Display Averaging parameter is set to Slow. A higher number will cause the display to update slower, but will give a more stable reading Default = 150	1-200 Readings
Medium Averaging	Sets the number of mV RMS readings that are averaged when the Display Averaging parameter is set to Medium. A higher number will cause the display to update slower, but will give a more stable reading Default = 15	1-200 Readings
Fast Averaging	Sets the number of mV RMS readings that are averaged when the Display Averaging parameter is set to Fast. A higher number will cause the display to update slower, but will give a more stable reading Default = 4	1-200 Readings
Averaging Window	Sets the range of input readings that will be averaged. If a new mV reading deviates from the average by less than this amount, it will be averaged with the rest of the readings in the display averaging buffer. Otherwise, the input is considered a step change and the display averaging buffer is flushed.	0.0 to 100.0 mV
Load Set 1	Assigns a resistance value for Set 1 from a combination of the available loads as determined by the Load Resistance Values set in the Factory Setup. (See Custom Load Sets for more information.) Default = None Selected	0-6,500.0 ohms
Load Set 2	Assigns a resistance value for Set 2 from a combination of the available loads as determined by the Load Resistance Values set in the Factory Setup. (See Custom Load Sets for more information.) Default = None Selected	0-6,500.0 ohms
Load Set 3	Assigns a resistance value for Set 3 from a combination of the available loads as determined by the Load Resistance Values set in the Factory Setup. (See Custom Load Sets for more information.) Default = None Selected	0-6,500.0 ohms
Load Set 4	Assigns a resistance value for Set 4 from a combination of the available loads as determined by the Load Resistance Values set in the Factory Setup. (See Custom Load Sets for more information.) Default = None Selected	0-6,500.0 ohms

System Setup Configuration		
Parameter	**Description**	**Range**
Load Set 5	Assigns a resistance value for Set 5 from a combination of the available loads as determined by the Load Resistance Values set in the Factory Setup. (See Custom Load Sets for more information.) Default = None Selected	0-6,500.0 ohms
Load Set 6	Assigns a resistance value for Set 6 from a combination of the available loads as determined by the Load Resistance Values set in the Factory Setup. (See Custom Load Sets for more information.) Default = None Selected	0-6,500.0 ohms
Load Set 7	Assigns a resistance value for Set 7 from a combination of the available loads as determined by the Load Resistance Values set in the Factory Setup. (See Custom Load Sets for more information.) Default = None Selected	0-6,500.0 ohms
Load Set 8	Assigns a resistance value for Set 8 from a combination of the available loads as determined by the Load Resistance Values set in the Factory Setup. (See Custom Load Sets for more information.) Default = None Selected	0-6,500.0 ohms
Load Set 9	Assigns a resistance value for Set 9 from a combination of the available loads as determined by the Load Resistance Values set in the Factory Setup. (See Custom Load Sets for more information.) Default = None Selected	0-6,500.0 ohms
Load Set 10	Assigns a resistance value for Set 10 from a combination of the available loads as determined by the Load Resistance Values set in the Factory Setup. (See Custom Load Sets for more information.) Default = None Selected	0-6,500.0 ohms
LCD Contrast	Sets the contrast of the display screen. Deault – 10	0-20
Access Code	In some cases it may be desirable to restrict access to the System Setup. This sets the number that must be matched in order to gain access to the System Setup. If set to 0, the Access Code feature is disabled. Default – 0	0 to 9999
Software	Displays current software program.	(Read Only)

INPUT ZERO– The Input Zero offset can be slightly different between RF donuts. This parameter accesses an auto-zeroing function that eliminates this offset. Independent settings are saved for the 0.1:1 RF donut and 1:1 RF donut. The user can switch between the two donut types without having to re-zero the input. The input needs to be zeroed only when a new donut is introduced.

INPUT RANGE – The input range can be scaled to accommodate the signal that is being measured. The input can be set to fixed ranges of 100mV Peak, 1000mV peak or Auto-Ranging. For Auto-Ranging mode, the low range will be used for readings from 0.00 to 30.00 mV RMS. The high range will be used for 20.0 to 700.0 mV RMS.

INPUT MODE (ESU-2050P Only) – There are two input modes to allow for measurement of continuous signals or pulsed signals. In Continuous Mode, the input is updated every 100 mS. This mode should be used for all Electrosurgical Generator waveform outputs in general use generators. A number of Electrosurgical generator manufacturers offer generators with pulsed outputs, where there is a long duty cycle (typically ½-second or more) and the actual RF output of the generator is active for a brief period of time within the duty cycle (typically 1/10th second or less). In Pulsed Mode, the input to the ESU-2050P is only processed when a signal over 20 mV in amplitude is detected. The ESU-2050P analyzes the pulsed input waveform and can provide the RMS readings for either the overall input or the pulse only (see Diagram 1, Page 7).



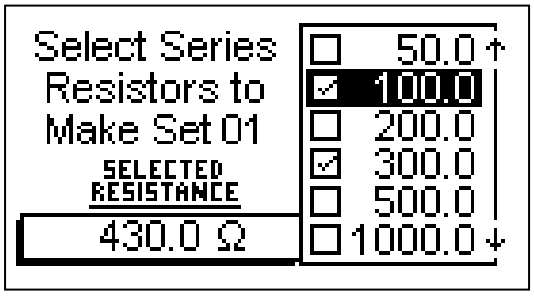
NOTE: When set to Pulsed Mode, a small graphic appears in the upper right corner of the screen to identify to the user that the ESU-2050P is looking for a pulsed RF input.

CUSTOM LOAD SETS – With twelve available loads, there is a possibility of 4096 combinations of resistors to use as a combined load. To simplify the selection of commonly used load configurations, 10 custom resistor sets are available. Each resistor set can consist of any combination of the available calibrated loads. The number of loads and load calibration is performed in the Factory Setup Screen.

A custom load set can be configured in the Setup Screen by either using SELECT to highlight the line and VALUE to toggle the available custom set resistance, or by using the SETUP key to access the Custom Resistor Set Menu.

This menu shows the current values of the loads as set in the Factory Setup Screen. The value of a Load Set can be changed by using SELECT to highlight the load line and VALUE to include or remove the resistor from the custom set. The total series resistance of the selected resistors is shown to aid in customizing the custom resistor set.

NOTE: If individual selected load values are changed in the Factory Setup Screen, the resistance value of the sets will change accordingly.



The Setup Screen can be exited using the RETURN key.

LOAD TABLE – Up to twelve Load Resistance Values (each with a range from 0.0 to 6,500.0 ohms) may be set in the FACTORY SETUP Configuration. These values are used in combination with the Custom Load Sets to determine the Load Configuration Table. These options are available if the Load Selection parameter is set to “Table”. The settings will be the individual calibrated loads followed by the Load Sets. Since these values can be set to the actual values of the real resistors, this allows for maximum accuracy in the wattage calculations. By default, the following values are loaded into this table when the ESU-2050 instruments ships from the factory:

Load #1: 10 Ω

Load #2: 20 Ω

Load #3: 30 Ω

Load #4: 50 Ω

Load #5: 100 Ω

Load #6: 200 Ω

Load #7: 300 Ω

Load #8: 500 Ω

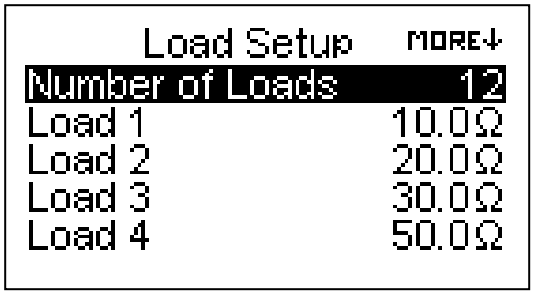
Load #9: 1000 Ω

Load #10: 2000 Ω

Load #11: 3000 Ω

Load #12: 4000Ω

LOAD CALIBRATION SCREEN – The LOAD SETUP MODE allows the user to adjust the calibration of the loads. The Load Setup Screen can be entered using the SETUP key while in the SYSTEM SETUP MODE. The parameters can be changed by using SELECT to highlight the line and VALUE to toggle the available options. The Load Setup Screen can be exited using the RETURN key.



Typical Load Setup Screen

The following is a breakdown of the parameters available in the LOAD SETUP MODE and their available options:

Load Setup Configuration		
Parameter	**Description**	**Range**
Number Of Loads	Sets the number of load resistors present in the system. This determines the maximum combination of resistors available when the Load Selection is set to Table.	1-12
Load 1	Calibrates the Load 1 Resistance Value. This should be set to the actual resistance of the smallest resistor in the system.	0.0-6500.0 ohms
Load 2	Calibrates the Load 2 Resistance Value. This should be set to the actual resistance of the next higher resistor in the system.	0.0-6500.0 ohms
Load 3	Calibrates the Load 3 Resistance Value. This should be set to the actual resistance of the next higher resistor in the system.	0.0-6500.0 ohms
Load 4	Calibrates the Load 4 Resistance Value. This should be set to the actual resistance of the next higher resistor in the system.	0.0-6500.0 ohms
Load 5	Calibrates the Load 5 Resistance Value. This should be set to the actual resistance of the next higher resistor in the system.	0.0-6500.0 ohms
Load 6	Calibrates the Load 6 Resistance Value. This should be set to the actual resistance of the next higher resistor in the system.	0.0-6500.0 ohms
Load 7	Calibrates the Load 7 Resistance Value. This should be set to the actual resistance of the next higher resistor in the system.	0.0-6500.0 ohms
Load 8	Calibrates the Load 8 Resistance Value. This should be set to the actual resistance of the next higher resistor in the system.	0.0-6500.0 ohms
Load 9	Calibrates the Load 9 Resistance Value. This should be set to the actual resistance of the next higher resistor in the system.	0.0-6500.0 ohms
Load 10	Calibrates the Load 10 Resistance Value. This should be set to the actual resistance of the next higher resistor in the system.	0.0-6500.0 ohms
Load 11	Calibrates the Load 11 Resistance Value. This should be set to the actual resistance of the next higher resistor in the system.	0.0-6500.0 ohms
Load 12	Calibrates the Load 12 Resistance Value. This should be set to the actual resistance of the next higher resistor in the system.	0.0-6500.0 ohms

LINE POWER – A Kycon 3 position locking receptacle is provided for the 6 VDC Universal Power Supply input.

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

SERIAL COMMUNICATION – There is a serial port on the rear panel. The RS-232 Port is used for Firmware upgrades and to interface with a PC.

USB COMMUNICATION – There is a USB port on the rear panel. The USB Port is used to interface with a PC.

POWER SWITCH - The main power switch for the Analyzer is located on the left side on the rear panel.

KEYS

Ten tactile-touch keys are provided for system operation:

– In the Main Screen, these keys will scroll through the available display screens.

In the GRAPH MODE, these keys will scroll through the horizontal zoom level for the graph.

– In the Main Screen, these keys will toggle through the available Display Zones.

In the SETUP MODE, these keys will scroll through the available parameters.

In the GRAPH MODE, these keys will select the waveform to be displayed.

– In the Main Screen, these keys will scroll through the available parameters.

In the SETUP MODE, these keys will scroll through the available settings for the parameters.

In the GRAPH MODE, these keys will Scroll through the selected data set.

– This key is used to toggle between the entering the SETUP MODE and the LOAD SETUP MODE, where the calibration can be viewed and adjusted.

– In the SETUP MODE, this key is used to exit and return to the previously viewed Main Screen. This will also save any changes to the internal EEPROM memory so they will be retained even with the power turned off.

In the GRAPH MODE, this key is used to exit and return to the previously viewed Main Screen.

In the SAVE MODE, this key is used to exit without saving.

– In the Main Screen, this key is used to enter the GRAPH MODE.

In the GRAPH MODE, this key is used to enter the SAVE MODE.

In the SAVE MODE, this key is used to save the data set.

– This key is used to toggle the HOLD MODE on and off. The HOLD MODE will lock the latest reading into the display and the current waveform in the register.

In HOLD MODE, a small “HOLD” message will be displayed in the upper right corner of the screen.

POWER UP SETTINGS

The ESU-2050 Series 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 MODE. Use 

to select the “Power up with” parameter.

Use 

to change the parameters to Default, Custom or Set Current as Custom.

The Setup screen can be exited using the 

key.

Default

If this option is selected, the unit will Power Up to the One Display Zone screen, showing the mV reading. The default parameters shown in the other Main Screens will be the same as shown in the Main Screens Section.

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. Each Main 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 of the five display screens to show the desired parameters in each Display Zone, selects this option and presses RETURN. The current configuration is then 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.

GRAPH MODE

The GRAPH MODE allows the user to view the measured waveform in the display. The horizontal axis can be zoomed in to display higher frequency waveform components. The vertical axis is auto-scaling and cannot be adjusted. Any of the stored waveforms can be graphed. Additionally, if the unit is placed in the HOLD MODE, the user can adjust which portion of the waveform is being displayed.

NOTE: Due to the limited number of pixels in the display, this should not be used as a calibrated reference, rather as a quick check of the waveform being measured.

Use 

to enter the GRAPH MODE.

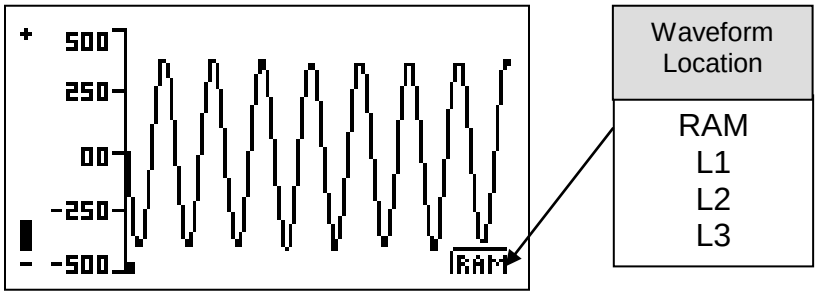
Use 

to exit the GRAPH MODE.

Selecting a Waveform

Use 

to select the waveform to be graphed, Ram or Location 1-3.

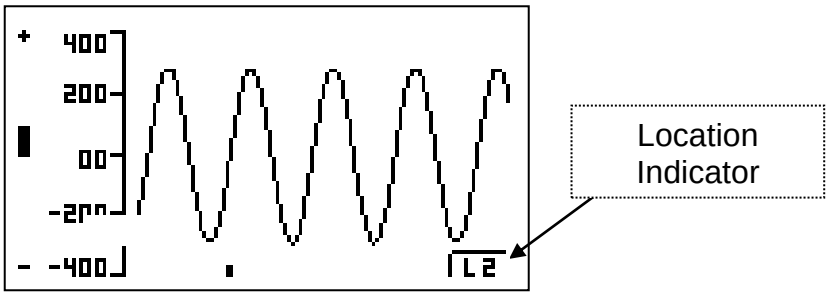


Location Indicator

Use 

to select a specific portion of the waveform buffer to be graphed.

The Location Indicator is a small square that moves along the bottom of the Graph Screen to indicate where the current viewing window portion of the waveform is from within the overall data set.

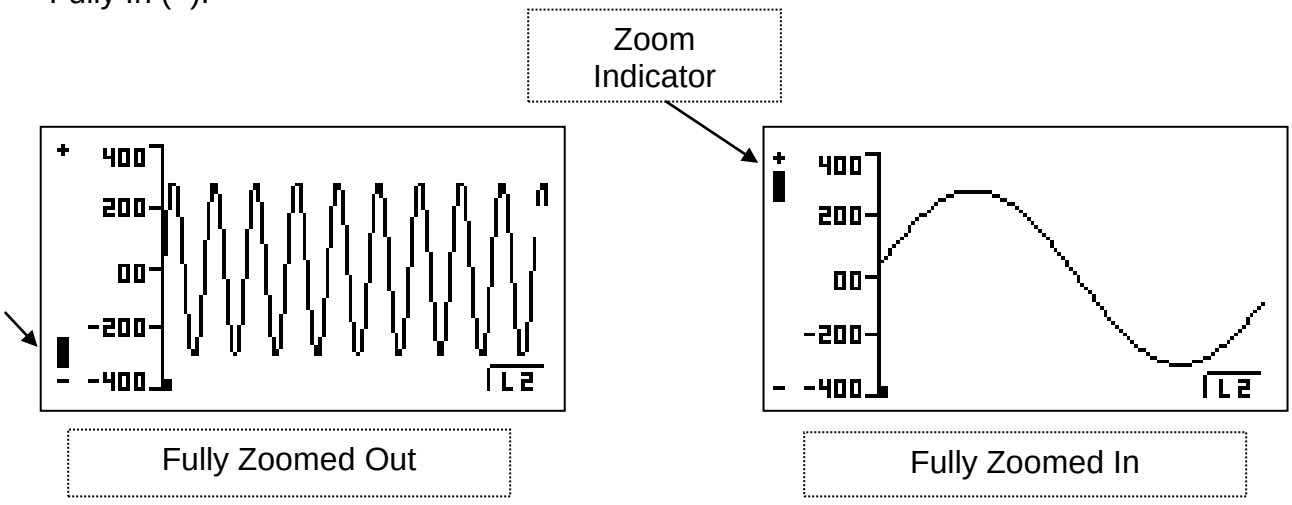


Zooming

Use 

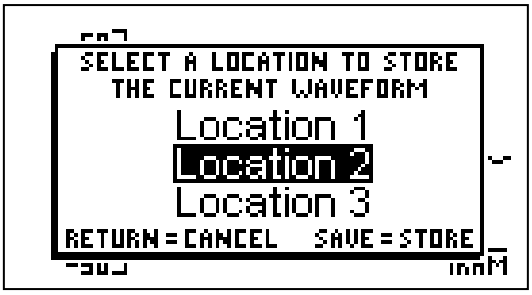
to zoom the graph in and out.

The Zoom Indicator is a bar that moves along the left side of the Graph Screen to indicate the Zoom level shown in the current viewing window. It adjusts from Fully Out (-) to Fully In (+).



Saving

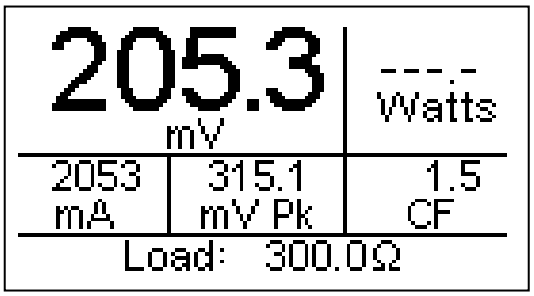
To save the displayed waveform, use GRAPH SAVE to enter the SAVE MODE.



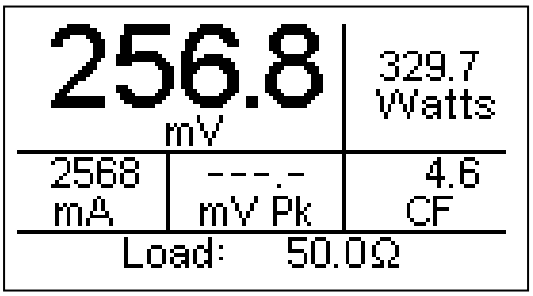
Use VALUE to select the desired storage location, then GRAPH SAVE to save the waveform, or RETURN can be pressed to cancel the save function. Once the save is complete, the newly saved waveform will be displayed.

ERROR MESSAGES

Several error messages are provided to indicate invalid operating conditions. Any values that are over range will be displayed as dashes.

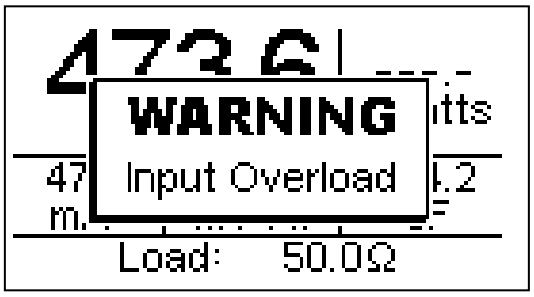


Watts Calculation out of range



Peak Voltage Input Out of range

When the input voltage rises above the range that is measurable by the system, the "WARNING Input Overload" message will be shown.



Input Voltage Overload

NOTE: Although the input is protected from damage at these voltages, the user should immediately remove any input voltage when this message is shown.

DFA® TECHNOLOGY

DFA® Digital Fast Acquisition Technology is a revolutionary new method of measuring ESU generator output power. A high-speed analog to digital converter is used to digitize the high frequency, high power output of the ESU generator. An RF Current Transformer is used to convert the current signal to a voltage signal, which is read by the analog to digital converter. By digitizing the signal a more accurate, frequency independent measurement can be made.

COMMUNICATION PROTOCOL

The communication protocol provides a means to completely configure and use the ESU-2050 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-2050 are accessible as well. This provides for hands free or automated operation of the ESU-2050.

Communication Ports

The ESU-2050 has two communication ports. Both ports use the same command format. The Serial port is configured as 115,200 Baud Rate, 8 Data Bits, 1 Stop Bit, and No Parity. The USB port appears to a PC as a serial port and is configured for 748,800 Baud Rate, 8 Data Bits, 1 Stop Bit, and No Parity.

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.

This path is represented in the following tables by placing the highest node in the left-most position. Further nodes are indented one position to the right, below the parent node.

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 load resistance to 100.5 ohms would be "CONFigure:LOAD:VALue 100.5<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 –2050 are not case sensitive. Upper and lower cases are only used when documenting the commands.

Parameter Form

The PARAMETER FORM column indicates the number and order of parameters in a command and their legal values. Parameter formats are listed in angle brackets (<>) while string parameters are simply listed.

Square brackets ([]) are used to enclose one or more parameters that are optional.

The vertical bar (|) can be read as "or" and is used to separate alternative parameter options.

The query form of a command is generated by appending a question mark (?) to the last keyword. However, not all commands have a query form, and some commands exist only in the query form. The COMMENTS column is used to indicate this.

Comments

The COMMENTS column indicates any notes.

CONFigure Subsystem

This group allows the user to setup the display and operational settings for the unit.

KEYWORD	PARAMETER FORM	COMMENTS
CONFigure		
:DISPlay :SxZy	S<display_screen_number> Z<zone_number> nn	

display_screen_number = 1-7
1 = One Parameter
2 = Two Parameters
3 = Three Parameters
4 = Four Parameters
5 = Five Parameters
6 = Measurement List Display (Non-editable)
7 = Quick Configuration Screen (Non-editable)

nn = Parameter for selected Zone	
0 = mV RMS	7 = Creast Factor
1 = mA RMS	8 = Time-Pulse On
2 = Watts RMS	9 = Time-Pulse Off
3 = mV Peak	10 = Time-Total Cycle
4 = mV Pk-Pk	11 = % Duty Cycle
5 = mV Pk / mV Pk-Pk	12 = mV Pulse Cycle
6 = mV Pk+	13 = mA Pulse Cycle
	14 = Watts Pulse Cycle

:SCReen	< numeric_value >	Range 1-7
		1-5 = # display zones
		6=Measurement List Display
		7=Quick Config Screen

:AVERaging	FAST | SLOW | MEDium	
:HOLD	ON | OFF	
:LOAD		
:MODE	TABle | ADJustable	
:VALue	< numeric_value >	Table Mode: 1-12 for individual resistors, 13-22 for resistor sets 1-10 Adjustable Mode: 0-6500.0
:SETn	< numeric_value >	n = Resistor set to configure (1-10) < numeric_value > = 16 bit binary value of resistors to include in set 'n' where bit 0 = Load 1, Bit 1 = load 2… Bit 11 = Load 12 each bit selects whether the load is included in the set. Bit = 1 includes the load Bit = 0 excludes the load.
:NUMber	< numeric_value >	set of valid numeric values
:Ln	< numeric_value >	n = Load to configure < numeric_value > = Actual value of load 'n'; 0-6500.0 ohms
INPut:		
Atten:	0.1 | 1	
RANGe:	100 | 1000 | AUTo	
NUMsamples:	1024 | 2048 | 4096 | 8192 | 16384 | 54768	
MODE:	CONTinous | PULs	

SYSTem Subsystem

This group allows the user to setup the startup mode for the unit, as well as directly control the unit, as if pressing the keys on the front panel.

KEYWORD	PARAMETER FORM	COMMENTS
SYSTem:		
POWer	DEFaults | CUStom | SETCurrent	
CONtrast	< numeric_value >	Numbers 1-20
KEY	DUP | DDN | SUP | SDN | VUP | VDN | SETup | RETurn | GSAVe | HOLD	
VER?		Read only

READ Subsystem

This group allows the user to get measurements from the unit.

KEYWORD	PARAMETER FORM	COMMENTS
READ:		
	MVrms | MArms | Warms | MVPeak | MVPP | MVP-PP | MVPK+ | CF | TON | TOFF | TCYC | DCYC | MVCyc | MACyc | WCyc	Read only
	DATA	Read only
	LOCn	Read only, 'n' = stored waveform location to read (1-3)

STATus Sub-system

This subsystem provides status on the operating mode of the unit including messages that would normally be seen on the display.

KEYWORD	PARAMETER FORM	COMMENTS
STATus?		Read Only

Bit	Value	Definition
0	1	Hold Mode
1	2	Graph Mode
2	4	Calibration Mode
3	8	
4	16	
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	
15	32768	

ESU-2050 Communication Command Summary

Keywords	Nodes	Subnodes	Values
CONFigure	DISPlay	SxZy nn	x is the Screen # (1-5) and y is the Zone # (1-5). nn=0 to 13: 0=mV RMS 1=mA RMS 2=Watts RMS 3=mV Peak 4=mV Pk-Pk 5=mV Pk / mV Pk-Pk 6=mV Pk+ 7=Crest Factor 8=Time-Pulse On 9=Time-Pulse Off 10=Time-Total Cycle 11=% Duty Cycle 12=mV Pulse Cycle 13=mA Pulse Cycle 14=Watts Pulse Cycle

		SCReen	Range: 1-7
			1-5 = # display zones
			6=Measurement List Display
			7=Quick Config Screen

		AVERaging	FAST, SLOW, MEDium
	HOLD	ON,OFF	
	LOAD	MODE	TABle, ADJustable
		VALue	Table Mode: 1-12 for individual Resistors, 13-22 for resistor sets 1-10 Adjustable Mode: 0-6500.0 Ohms
		SETn xxxx	n = Resistor set to configure, 1-10 XXXX = 16 bit Binary value of resistors to include in set 'n' Where Bit 0 = Load 1, Bit 1 =Load 2… Bit 11 = Load 12 Each bit selects whether the load is included in the set. Bit = 1 includes the load, Bit = 0 excludes the load. Example: a value of 9 would select loads 4 and 1 and exclude everything else
		NUMber	1-12 (determines the number of loads present in system)
		Ln xxxx	n = Load to configure xxxx = Actual value of load 'n', 0-6500.0 ohms.
	INPut	ATTen	0.1, 1 (donut attenuation)
		RANGe	100, 1000, AUTo
		NUMsamples	1024, 2048, 4096, 8192, 16384, 32768
		MODE	CONTinuous, PULsed
SYSTem	POWerup	DEFaults, CUStom, SETCurrent	
	CONtrast	0-20	
	KEY	DUP, DDN, SUP, SDN, VUP, VDN, SETup, RETurn, GSAVe, HOLD	
	VERsion?	[read only]	

ESU-2050 Communication Command Summary

Keywords	Nodes	Subnodes	Values
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]	
	MVP-PP?	Returns: mV Peak/Peak to Peak [read only]	
	MVPK+?	Returns: mV Positive Peak [read only]	
	CF?	Returns: Crest Factor [read only]	
	TON?	Returns: Time - Pulse On [read only]	
	TOFF?	Returns: Time - Pulse Off [read only]	
	TCYC?	Returns: Time - Total Cycle [read only]	
	DCYC?	Returns: % Duty Cycle [read only]	
	MVCyc?	Returns: mV Pulse Cycle [read only]	
	MACyc?	Returns: mA Pulse Cycle [read only]	
	WCyc?	Returns: Watts Pulse Cycle [read only]	
	DATA?	Returns: Entire Data Buffer [read only] Length = NUMSamples * 2 Data Format is mV in signed double byte format, Decimal place is assumed based on Input Range (Low Range = 2DP, High Range = 1DP)	
	LOCn?	Returns: Saved Data Buffer at Location 'n' , n= 1-3 [read only] Length = NUMSamples * 2 Data Format is mV in signed double byte format, Decimal place is assumed based on Input Range (Low Range = 2DP, High Range = 1DP)	

STATus?	Bit	Value	Definition
	0	1	Hold Mode
	1	2	Graph Mode
	2	4	Calibration Mode
	3	8	
	4	16	
	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	
	15	32768	

MANUAL REVISIONS

Revision #	Program #	Revisions Made
Rev 01	DT7376A	Origination
Rev 02	DT7376A	Specifications Updates
Rev 03	DT7376B	Factory Setup, Graph/Save Functions, PC Interface and Format Updated
Rev 04	DT7376C	Input Range, Input Mode, Load Sets, Load Table and Specifications Updated
Rev 05	DT7376CD	New Measurements Added and Specs Updated, Load Setup Screen and Measurement List Screen
Rev 06	DT7376CE	Implements 2050P model, Communication Package
Rev 07	DT7376CE	100mV Accuracy Specification Updated, Miscellaneous edits
Rev 08	DT7376CE	Address Updated
Rev 09	DT7376CE	Miscellaneous Edits
Rev 10	DT7376CE	Specifications Updated, Format Updated, Photos 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	IMPEDANCE	50 Ω		
	CONNECTION	BNC (50 Ω)		
	MAXIMUM VOLTAGE	3.3 V pk-pk Internally Protected		
	FREQUENCY	10 kHz – 10 MHz		
INPUT COMPATIBILITY	CURRENT TRANSFORMER	Pearson Electronics (Typical)		
	ATTENUATION RATIOS	0.1:1 (Pearson Model 411) 1:1 (Pearson Model 4100) User Selectable		
VOLTAGE (RMS)	100 mV RANGE	0.20 – 70.00 mV RMS 0.01 mV Resolution		
	1000 mV RANGE	2.0 – 700.0 mV RMS 0.1 mV Resolution		
VOLTAGE (pk, pk-pk)	100 mV RANGE	0.20 – 100.0 mV 0.01 mV Resolution		
	1000 mV RANGE	2.0 – 1000.0 mV 0.1 mV Resolution		
ACCURACY, 100 mV RANGE		f ≤ 1.0 MHz	1.0 MHz < f ≤ 2.5 MHz	f > 2.5 MHz
	Input ≤ 10.0 mV	± 1% Reading Or ± 0.25 mV	± 1% Reading Or ± 0.25 mV	± 1% Reading Or ± 1.0 mV
	10.0 mV < Input ≤ 35.0 mV	± 1% Reading Or ± 0.25 mV	± (1% Reading + 0.5% Range)	± (6% Reading + 0.5% Range)
	Input > 35.0 mV	± 1% Reading Or ± 0.25 mV	± (1% Reading + 0.5% Range)	± (6% Reading + 5% Range)
ACCURACY, 1000 mV RANGE		*f* ≤ 2.5 MHz		*f* > 2.5 MHz
	Input ≤ 50 mV	± 1% Reading Or ± 1 mV		± 1% Reading Or ± 1 mV
	50 mV < Input ≤ 400.0 mV	± 1% Reading		± 4% Reading
	Input > 400.0 mV	± (1% Reading + 0.25% Range)		± (4% Reading + 0.25% Range)

CALCULATED RANGES		
CURRENT (with 0.1:1 CT)	100 mV RANGE	2.0 - 700.0 mA RMS 0.1 mA Resolution
	1000 mV RANGE	20 - 7000 mA RMS 1 mA Resolution
CURRENT (with 1:1 CT)	100 mV RANGE	0.20 - 70.0 mA RMS 0.01 mA Resolution
	1000 mV RANGE	0.2 - 700.0 mA RMS 0.1 mA Resolution
VOLTAGE (mV pk, mV pk-pk)	100 mV RANGE	0.0 - 1.0 mV 0.1 mV Resolution
	1000 mV RANGE	0.0 - 1.0 mV 0.1 mV Resolution
POWER	0 - 999.9 W 0.1 W Resolution	
CREST FACTOR	1.4 – 500 0.1 Resoluton	

PULSE MODE TIMING MEASUREMENT (ESU-2050P ONLY)	
RESOLUTION	0.1 ms
ACCURACY	± 0.2 ms

PHYSICAL, ENVIRONMENTAL, AND ELECTRICAL		
DISPLAY	128 X 64 Pixels Graphical LCD, White LED Backlight	
MEMORY	SETUP	EEPROM, All Parameters
	DATA STORAGE	3 Sets of 32768 Data Points
	RETENTION	10 Years w/o Power
OPERATING RANGE	15 - 30 ° C 20 - 80% RH, Non-Condensing	
STORAGE RANGE	-40 - 60 ° C	
SIZE	3.4” x 9.1” x 8.0” 86.4 x 231.4 x 203.2 mm	
CONSTRUCTION	ENCLOSURE	ABS Plastic
	FACE	Lexan, Back Printed
WEIGHT	≤ 3 lbs. (1.36 kg)	
CONNECTIONS	RS-232 COMM.	DB-9 (Female) Receptacle
	USB	USB ‘B’ Receptacle, USB 2.0 Compliant
	POWER	Kycon 3-position Locking Receptacle
POWER	6 VDC, minimum 500 mA	

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