

**October
2014**

User & Installation Guide

G4500 / G3500 BlackBox Portable Power Quality Analyzer



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Introduction - System Overview

Tailored for PQ Analysis at any location, the Portable BLACKBOX has been especially designed to address the needs of **Site Engineers, Electrical Consultants & Utilities:**

- **No Missed Events**
- **Quick & Simple Setup**
- **Remote Connectivity**
- **Plug & Play**

Empowered by the patented **PQZIP compression** technology, the G4500/G3500 can store up to a thousand times more than other typical file formats. The **PQZIP allows the Portable BLACKBOX** to continuously record & store all electrical waveforms, all the time, for extended periods, with no gaps in the data. Capture everything, Trends, Volts/Amps/Hz, Events, Harmonics, THD, Flicker, Power & Energy to get down to the root cause of all your Power Quality issues. The Portable BLACKBOX fully complies with IEC 61000-4-30 Class A standards for: aggregations, time clock uncertainty, flagging & transient influence quantities.

The advanced **PQSCADA & Investigator Enterprise Analysis** software enables the operator to detect, view, control, analyze & isolate the minutest PQ anomaly for the diagnosis & effective maintenance of equipment. It simplifies troubleshooting & time-synchronized data recorded by any number of BLACKBOX devices, can be compared within a particular site &/or across many sites.

The embedded **Website** serves as the main user-interface with the unit, providing enhanced management, unit configuration & real-time monitoring of all parameters.

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Warranty

Each Elspec product is under warranty to be free from defects in material and workmanship under normal use and service. The warranty period is for one year and commences on the date of shipment. Parts, product repairs, and services are under warranty for 90 days. This warranty extends only to the original buyer or end-user customer and it does not apply to fuses, disposable batteries, or to any product which, in Elspec's opinion, has been misused, altered, neglected, contaminated, or damaged by accident or abnormal conditions in the operation or handling of the product. Elspec guarantees that the software will operate substantially in accordance with its functional specifications for 90 days and that it has been properly recorded on non-defective media. Elspec does not guarantee that the software will be error free and operate without interruption.

Elspec authorized re-sellers shall extend this warranty on new and unused products to end-user customers only, but do not have authority to extend a greater or different warranty on behalf of Elspec. Warranty support is available only if the product is purchased through an Elspec authorized sales outlet or Buyer has paid the applicable international price. Elspec reserves the right to invoice the Buyer for any importation costs for the repair/replacement of parts when the product purchased in one country is submitted for repair in another country.

Elspec's warranty obligation is limited, at Elspec's option, to refund of the purchase price, free of charge repair, or replacement of a defective product which is returned to Elspec within the warranty period. For warranty service, contact Elspec directly to obtain a return-authorization. On receipt of the authorization, return the product to Elspec with a description of the problem, including prepaid postage and insurance (FOB destination). Elspec assumes no risk for damage in transit. Following warranty repair, the product will be returned to the Buyer, transportation prepaid (FOB destination). If Elspec determines that the failure was caused by neglect, misuse, contamination, alteration, accident, or abnormal condition of operation or handling, including overvoltage failures caused by use outside the product's specified rating, or normal wear and tear of mechanical components, Elspec will provide an estimate of repair costs and obtain authorization before commencing work. Following repair, the product will be returned to the Buyer, transportation prepaid, and the Buyer will be billed for the repair and return postage transportation charges (FOB Shipping Point).

This warranty is the Buyer's sole and exclusive remedy and is in lieu of all other warranties, express or implied, including but not limited to any implied warranty of merchantability or fitness for a particular purpose. Elspec shall not be liable for any special, indirect, incidental, or consequential damages or losses, including loss of data arising from any cause or theory. Since some countries or states do not allow limitation of the term of an implied warranty, or exclusion or limitation of incidental or consequential damages, the limitations and exclusions of this warranty may not apply to every buyer. If any provision of this Warranty is held invalid or unenforceable by a court or other decision-maker of competent jurisdiction, such holding will not affect the validity or enforceability of any other provision.

NOTICE REGARDING PROPRIETARY RIGHTS

This publication contains information proprietary to Elspec. By accepting & using this manual, you agree that the information contained herein will be used solely for the purpose of operating equipment developed & manufactured by Elspec.

SEE ALSO:

- [System Overview](#)
- [Acronyms](#)
- [Product Selection Guide](#)

Acronyms

The following acronyms are being used within this document:

ACRONYM	DEFINITION
PQ	Power Quality
V	Voltage
I	Current
AC	Alternating Current
DC	Direct Current
F	Frequency
V_N	Voltage Neutral
I_N	Current Neutral
A	Ampere
CT	Current Transformer
PF	Power Factor
PT100	Platinum Resistance Thermometers
PU	Per Unit
PT	Potential Transformer (transformation ratio in both magnitude and phase)
CT	Current Transformer
HV	High Voltage
MV	Medium Voltage
LV	Low Voltage
THD	Total Harmonic Distortion
ADC	Analog to Digital Converter
SSL	Secure Sockets Layer
GPS	Global Positioning System

ACRONYM	DEFINITION
UTC	Coordinated Universal Time
LAN	Local Area Network
WAN	Wide Area Network
ADSL	Asymmetric Digital Subscriber Line
CF	Compact Flash
OLP	OLE for Process Control (set of connectivity standards for industrial automation)
OPC	Open Connectivity (formerly OLE for Process Control)
TCP	Transport Control Protocol
FTP	File Transfer Protocol
DHCP	Dynamic Host Configuration Protocol
DNP3	Distributed Network Protocol
PPP	Point to Point Protocol
PAP	Password Authentication Protocol
CHAP	Challenge Handshake Authentication Protocol
UART	Universal Asynchronous Receiver Transmitter
ISP	Internet Service Provider
INIT	Initialization (INIT String used in Modem)
AT	A command string should start with "AT" or "at", except for the commands "A/" and "+++". At or aT are invalid
PST	Value measured over x period that characterizes the likelihood that the voltage fluctuations would result in perceptible light flicker
THD	Total Harmonic Distortion
TDD	Total Demand Distortion
Ampl	Amplitude
FIFO	First In First Out

ACRONYM	DEFINITION
FFT	Fast Fourier Transform
csv	Comma Separated Values

ACRONYM	DEFINITION
ELSPEC G4500/G3500 BLACKBOX DEVICE & ACCESSORIES	
BB	BLACKBOX
G4500 / G3500	BLACKBOX Portable Power Quality Analyzers
G4150	Mobile Analysis Lab
PQA	Power Quality Analyzer
R/O	Perform Read Only Functions Within the BLACKBOX Interface
R/W	Perform Read & Write Functions Within the BLACKBOX Interface
RTC	BLACKBOX Internal Real Time Clock
DSP	Digital Signal Processing Module (Located Internally)
PQZIP	Power Quality Data Compression & Archive File Format
PQSCADA	Power Quality Supervisory Control and Data Acquisition
S/N	Serial Number
HW	Hardware
SW	Software
FW	Firmware - BLACKBOX Software

See also:

- [System Overview](#)
- [Warranty](#)
- [Product Selection Guide](#)

Product Selection Guide

The product selection guide will assist you in choosing the optimal Portable PQ Analyzer that will suit your needs & requirements. The BLACKBOX device series includes 2 products, namely the G4500 & G3500. They are mainly differentiated by their measurement capabilities, storage capacity, PQ analysis & communication ports.

CAPABILITIES	PRODUCT SERIES	
	G4500	G3500
REAL-TIME MEASUREMENTS		
Voltage Sampling Rate, Maximum Samples/Cycle	1024	512
Voltage/Current - Per Phase, Average, Unbalanced	√	√
Power: Real, Reactive, Apparent, Power Factor, Frequency	√	√
Energy: Bidirectional, Total, Import, Export, Net	√	√
Demand: Block	√	√
Voltage Harmonics (Individual, Even, Odd, Total) Up to-	511 TH	255 TH
Type of Analog to Digital Converter	16/20 ¹ Bit	16/20 ¹ Bit
Measurement During Overloading (From Nominal)	x10	x10
DATA & WAVEFORMS LOGS		
Cycle-By-Cycle PQZIP Recording	√	√
Event Logs	√	√
Continuous Waveform Recording	√	√
Min/Max Logs For Any Parameter	√	√

CAPABILITIES	PRODUCT SERIES	
	G4500	G3500
TIME STAMPS, RESOLUTION (MICROSECONDS)		
With Ethernet Synchronization	50	50
With GPS Synchronization	1	1
STORAGE CAPACITY		
Internal Memory	32 GB 32TB ²	256 MB 256 GB ²
POWER QUALITY ANALYSIS		
Transient Detection, Microseconds (50Hz/60Hz)	19.5/16.3μs	39/32.5μs
Sag/Swell Monitoring	√	√
Unbalance Components: Zero, Negative, Positive	√	√
Flicker (IEC 61000-4-15)	√	√
Fast Flickering	√	√
Compliance Testing To EN50160	√	√
EN50160 Timestamps	√	√
Configurable for IEEE519-1992, IEEE159 (SEMI)	√	√
Time Stamps Of Above	√	√
Inter-Harmonics	√	√
POWER SUPPLY		
Power Over Ethernet (PoE- In) ³	According to 802.3af	
Operating Range	100-260VAC: 50/60Hz 100-300VDC	
Auxiliary AC Supply	48VDC	
Battery Backup	2 Hours	
E-MAIL NOTIFICATIONS		
SMTP Client	√	√

CAPABILITIES		PRODUCT SERIES	
		G4500	G3500
COMMUNICATION			
CONTROL			
Web Server	Comprehensive web server for local & remote real-time monitoring & control		
FTP Server	Standard protocol for main storage memory		
Channels	1 x Change Over		
Max Voltage	277 VAC		
Max Current	5A / 250VAC 10A / 110VAC 5A / 30VDC		
Max Reaction time	10ms		
Max Drop-out time	4ms		
Output Resistance	50MΩ		
¹ Effective Bits ² Equivalent Memory Needed Without Pqzip Compression ³ G4500 Unit Only DISCLAIMER: OUTLINED CAPABILITIES SUBJECT TO CHANGE WITHOUT PRIOR NOTICE			
PORTS			
Ethernet Ports	2 LAN & 1 WAN (Integrated Router, NAT & Firewall)	1 LAN	
RS-232, RS-485 Ports	1	1	
Wi-Fi Communications (802.11g)	1 (With Integrated Antenna)	—	
LAN 1			
Communication Protocols	TELNET, OPC, SMTP Client		
Power Over Ethernet (PoE- In) ³	According to 802.3af		
LAN 2			
Communication Protocols	Modbus TCP, Modbus RTU, OPC, DNP3 & SMTP Client		

MULTI IO	
DIGITAL INPUTS	
Channels	4
Sampling	800 Hz @ 50Hz (16 spc) 960 Hz @ 60Hz (16 spc)
Range	0 - 220 VDC
Pulse Type	0->1->0, 1->0->1, KYZ
Functionality	Triggers based on events / Energy pulse counting
Isolation Connector	125V
RELAY OUTPUT	
Power Over Ethernet (PoE- Out)	1 (Available as Output - 48V / 13 Watt)

See also:

- [System Overview](#)
- [Warranty](#)
- [Acronyms](#)



WARNINGS

REVIEW THE ENTIRE MANUAL BEFORE USING THE INSTRUMENT AND ITS ACCESSORIES

OBSERVE ALL WARNINGS AND CAUTIONS

DO NOT OPERATE THE INSTRUMENT AROUND EXPLOSIVE GAS OR VAPOR

AVOID WORKING ALONE

BEFORE USE, INSPECT THE INSTRUMENT, LEADS AND ACCESSORIES FOR MECHANICAL DAMAGE, AND REPLACE WHEN DAMAGED

PAY SPECIAL ATTENTION TO THE INSULATION SURROUNDING THE CONNECTORS AND PLUGS

REMOVE ALL ACCESSORIES THAT ARE NOT IN USE

MAKE SURE THE INSTRUMENT IS PROPERLY GROUNDED TO A PROTECTIVE EARTH GROUND

DO NOT APPLY INPUT VOLTAGES ABOVE THE RATING OF THE INSTRUMENT AS SHOWN ON THE NAME PLATE

DO NOT INSERT METAL OBJECTS INTO CONNECTORS AND OPENINGS

NEVER OPEN THE INSTRUMENT'S ENCLOSURE DURING OPERATION; DANGEROUS VOLTAGES ARE PRESENT

USE THE INSTRUMENT ONLY AS SPECIFIED IN THIS MANUAL, OR THE PROTECTION PROVIDED BY THE INSTRUMENT MAY BE IMPAIRED

DO NOT EXPOSE THE INSTRUMENT TO EXTREME MOISTURE AND OR RAIN

TO AVOID SHOCK OR FIRE

VERIFY THAT THE UNIT IS DISCONNECTED FROM THE MAIN POWER SUPPLY

INSPECT ALL ELECTRICAL AND MECHANICAL CONNECTIONS VISUALLY FOR MECHANICAL DAMAGE AND INTEGRITY OF COMPONENTS AND ACCESSORIES

INSPECT CURRENT TRANSFORMER WIRING FOR PROPER DIRECTION THROUGH THE CYLINDRICAL APERTURE OF THE CURRENT SAMPLING MODULE

TEST ALL CONTROL WIRING TO ENSURE SECURE SEATING IN TERMINALS

BEFORE USE, INSPECT THE INSTRUMENT, LEADS AND ACCESSORIES FOR MECHANICAL DAMAGE, AND REPLACE WHEN DAMAGED

DO NOT OPERATE THE INSTRUMENT OR ITS ACCESSORIES IF IT BECAME WET FOR ANY REASON

See also:

- [What You'll Need](#)
- [Unpacking Components & Accessories](#)
- [G4500 BLACKBOX Unit](#)
- [G3500 BLACKBOX Unit](#)




What You'll Need

Familiarize yourself with the [G4500](#) & [G3500](#) BLACKBOX Unit, [Components & Accessories](#). In addition, ensure that you follow the outlined [Safety Precautions](#). You will need the following tools & additional items for the initial installation:

- Wire Strippers
- Phillips Screwdriver
- Flat Head Screwdriver
- Portable BLACKBOX Unit, Components & Accessories
- This User Guide

See also:

- [Safety Precautions](#)
- [Unpacking Components & Accessories](#)
- [G4500 BLACKBOX Unit](#)
- [G3500 BLACKBOX Unit](#)







QUANTITY	ILLUSTRATION	DESCRIPTION & PART NUMBER
DEVICE, COMPONENTS & ACCESSORIES		
1		<p>Portable BLACKBOX Device</p> <ul style="list-style-type: none"> ▪ G4500 BLACKBOX: SPG-4500-0090 ▪ G3500 BLACKBOX: SPG-3500-0090 <div style="background-color: black; color: white; padding: 5px;">SEE ALSO</div> <ul style="list-style-type: none"> ▪ Product Selection Guide
1		<p>G4150 Mobile Analysis Lab</p> <ul style="list-style-type: none"> ▪ SNT-4420-0000¹
1		<p>Elspec BLACKBOX Installation & Demonstration Disc [SMX-0408-0103] Containing:</p> <ul style="list-style-type: none"> ▪ INVESTIGATOR Software V4 SOF-4001-0000 ▪ PQSCADA Software V4 SOF-4000-0000 ▪ Generic Configuration Utility V1 SOF-4003-0000 ▪ Elspec Search Utility V1 SOF-4004-0000 ▪ Software Support Utilities ▪ G4500/G3500 Quick Reference Guide V1 SMR-3011-0110 ▪ G4500 User Guide V1 SMX-0603-0100 ▪ PQSCADA User Manual V4 SMX-0619-0100 ▪ INVESTIGATOR User Manual SMM-5011-0809 ▪ G4500/G3500 Brochure V1 SMX-0218-0100 ▪ Tutorials V3 SMX-1608-0100

Unpacking Components & Accessories

The Portable BLACKBOX is shipped from Elspec's factory in a sealed case to protect it from damage during transportation. The small parts are shipped in a sealed bag with the unit.

TO UNPACK THE UNIT & ITS ACCESSORIES

Remove the unit & all of the following components from the casing:



QUANTITY	ILLUSTRATION	DESCRIPTION & PART NUMBER
1		Carrying Trolley Case (For Mobility) <ul style="list-style-type: none"> MEB-2999-0000
1		5 AC VOLTAGE TEST LEADS & CLIPS: <ul style="list-style-type: none"> Black Voltage Cord with Crocodile Clip + Fuse (3M) EAH-4303-5100 Red Voltage Cord with Crocodile Clip + Fuse (3M) EAH-4303-5200 Blue Voltage Cord with Crocodile Clip + Fuse(3M) EAH-4303-5300 Yellow Voltage Cord with Crocodile Clip + Fuse(3M) EAH-4303-5400 Green Voltage Cord with Crocodile Clip(3M) EAH-4303-9500
1		2 DC VOLTAGE TEST LEADS & CLIPS²: <ul style="list-style-type: none"> Black Voltage Cord with Crocodile Clip + Fuse (3M) EAH-4303-5100 Red Voltage Cord with Crocodile Clip + Fuse (3M) EAH-4303-5200
1		<u>Custom Clamp 3-Flexible Current Probes (Adjustable 30/300/3000A)</u> <ul style="list-style-type: none"> SOA-3003-0270
1		<u>Custom Clamp 1-Flexible Current Probe (Adjustable 30/300/3000A)</u> <ul style="list-style-type: none"> SOA-3000-0270
1		Power Cable for Cont. 10A/125V, Straight, 1.8M, Black: <ul style="list-style-type: none"> Europe: EPC-2012-2190 North America: EPC-7012-2190





QUANTITY	ILLUSTRATION	DESCRIPTION & PART NUMBER
1		48VDC Terminal Block Connector (RoHS Compliant): <ul style="list-style-type: none"> ENT-1002-0190
1		Temperature Sensor Terminal Block Connector PT100 Type (RoHS Compliant) <ul style="list-style-type: none"> ENT-1002-0191
1		RS485/422 Communication Terminal Block Connector (RoHS Compliant) <ul style="list-style-type: none"> ENT-1004-0190
1		Multi IO Terminal Block Connector (RoHS Compliant) <ul style="list-style-type: none"> ENT-2008-0190
1		Relay Terminal Block Connector (RoHS Compliant) <ul style="list-style-type: none"> ENT-1003-0190
1		LAN Communication Cord Length: 2M <ul style="list-style-type: none"> TOE-0010-0013
1		Relay Terminal Block Connector (RoHS Compliant) <ul style="list-style-type: none"> ENT-1002-0190







¹ The mobile analysis lab may be excluded from your Order, if so preferred. The default keyboard for the lab is English. Please ensure that your order has indicated your choice of preference

² G4500 unit only

Orders for optional accessories will be delivered as well in a sealed casing. Unpack these parts from their sealed bags:

OPTIONAL ACCESSORIES		
QUANTITY	ILLUSTRATION	DESCRIPTION & PART NUMBER
As Ordered		GPS (Global Position System) (For Mobile Time Synchronization) <ul style="list-style-type: none"> SOA-0232-0400
As Ordered		Multi-Frequency 3.5G Wireless Modem (For Fast Mobile Communication Access) <ul style="list-style-type: none"> SCM-0001-0000
As Ordered		Protective Weatherproof Pelican Case (IP64) <ul style="list-style-type: none"> SPG-4501-0090
As Ordered		DWL-P50 Standard POE to Remote Devices (8 - 12 Volts Adapter) <ul style="list-style-type: none"> EBO-5050-0000
As Ordered		<u>Custom Clamp 3-Flexible Current Probes</u> <ul style="list-style-type: none"> SOA-3003-0270
Current Range 30A / 300A / 3000A AC RMS		
Operating Temperature -20°C to + 65°C		
Probe Cable Length 610mm (24")		
		Probe Cable Diameter 194mm (7.5")

QUANTITY	ILLUSTRATION	DESCRIPTION & PART NUMBER
As Ordered		<u>Custom Clamp 3-Flexible Current Probes</u> <ul style="list-style-type: none"> SOA-3000-0270
		Current Range 30A / 300A / 3000A AC RMS
		Operating Temperature -20°C to + 65°C
		Probe Cable Length 610mm (24")
		Probe Cable Diameter 194mm (7.5")
As Ordered		<u>DC Current Custom Clamp</u> <ul style="list-style-type: none"> SOA-0270-1400
		Current Measurement 1,500A DC / 1,000A AC
		Output Signal 1m V/A, 10m V/A
		Operating Temperature - 20 °C to + 60 °C
		Cable Length 1.4M
As Ordered		<u>1-6 A Mini Clamp</u> <ul style="list-style-type: none"> SOA-0010-0500
		Measurement Range Up to 6A AC (1A Nominal)
		Output Signal 100 mV/A
		Operating Temperature - 20 °C to + 60 °C
		Cable Length 1.2M
As Ordered		<u>100 A Mini Clamp</u> <ul style="list-style-type: none"> SOA-0180-5000
		Measurement Range Up to 100A _{PK} AC
		"Hole" Dimensions 10mm Max
		Operating Temperature - 20 °C to + 60 °C
		Cable Length 1.2M

QUANTITY	ILLUSTRATION	DESCRIPTION & PART NUMBER
As Ordered		<u>300 A Flexible Current Clamp</u> <ul style="list-style-type: none"> SOA-9091-3000
		Measurement Range 9A ÷ 1050A
		Output Signal AC: 46mV/1KA
		Operating Temperature -20°C to + 60°C
		Cable Length 2m
As Ordered		<u>3000 A Flexible Current Clamp</u> <ul style="list-style-type: none"> SOA-9045-3001
		Measurement Range 10Hz ÷ 20kHz
		Output Signal AC: 46mV/1KA
		Operating Temperature -20°C to + 60°C
		Cable Length 2m
As Ordered		Adaptor - Elspec Clamps to BNC (160cm) <ul style="list-style-type: none"> SOA-0270-0000
As Ordered		Adaptor - Elspec Clamps to Fixed Banana (60cm) <ul style="list-style-type: none"> SOA-0270-0001
As Ordered		Adaptor - Elspec Clamps to Separated Banana (160cm) <ul style="list-style-type: none"> SOA-0270-0002
As Ordered		Extension Cable for Elspec Clamps (600cm) <ul style="list-style-type: none"> SOA-4500-0000

See also:

- [Safety Precautions](#)
- [What You'll Need](#)
- [G4500 BLACKBOX Unit](#)
- [G3500 BLACKBOX Unit](#)

The G4500 BLACKBOX Portable PQ Analyzer

The innovative design of the G4500 BLACKBOX has been uniquely adapted for PQ Analysis at any location. It continuously records all waveform data at a sampling rate for Voltage 1,024 samples per cycle & Current 256 samples per cycle. With an onboard memory of 32GB you can capture everything for more than a year depending on the selected resolution & the individual network condition. It is important to remember that with the built-in PQZIP compression this onboard memory is equivalent to 32TB, enabling you to get to the root cause of all your PQ Anomalies. It features an ultra capacitors' ride-through for up to 25 seconds, an AC/DC power supply, DC/DC converter, can be powered by Power of the Ethernet (PoE In) or by an onboard battery for up to 2 Hours.

The front panel of the unit mainly facilitates the communication interfaces, the auxiliary power supply & I/O module. It also facilitates one of the important features of the device, namely the remote Wifi antenna & activity indicator.

The rear panel houses another important feature of the G4500, namely the sensor sockets for all the probes. You may use any custom / Elspec probes supplied with the device. Simply plug it in & all the probes will be automatically recognized. The rear panel also houses the On/Off Switch of the Main Power & Inlet Socket.

The illustrations & tables below will serve as a navigational map of all the unit's controls & indicators.

Physical layout of the controls & indicators of the G4500's Front Panel:



Physical layout of the controls & indicators of the G4500's Rear Panel:



INDICATOR / CONTROL	DETAILED USAGE REFERENCE
FRONT PANEL	
Wi-Fi Activity & Antenna	Wireless Single PC Connection
Auxiliary Power Supply	Unit Powering
Digital Inputs	IO Ports
Serial Ports	Establish 1st Time Connection
USB Network Communication Port	Establish 1st Time Connection
Battery Indicator	Battery Replacements
Power Indicator	Unit Powering
Main Power Supply On/Off Switch	Unit Powering
LAN Ports	Establish 1st Time Connection
WAN Port	Establish 1st Time Connection
External Temperature Port	IO Ports
Reset Button	Instrument Settings
Relay Port	IO Ports

REAR PANEL

Voltage Clamp Inputs	Connect Voltage Probes
Current Clamp Inputs	Connect Current Clamps
DC Current Input	Connect Current Clamp
DC Voltage Inputs	Connect Voltage Probes
Main Power On/Off Switch	Unit Powering
Main Power Inlet Socket	Unit Powering

See also:

- [Safety Precautions](#)
- [What You'll Need](#)
- [Unpacking Components & Accessories](#)
- [G3500 BLACKBOX Unit](#)

The G3500 BLACKBOX Portable PQ Analyzer

The innovative design of the G3500 BLACKBOX has been uniquely adapted for PQ Analysis at any location. It continuously records all waveform data at a sampling rate for Voltage 512 samples per cycle & Current 512 samples per cycle. With an onboard memory of 256MB you can capture everything for more than a year depending on the selected resolution & the individual network condition. It is important to remember that with the built-in PQZIP compression this onboard memory is equivalent to 256GBG, enabling you to get to the root cause of all your PQ Anomalies. It features an ultra capacitors' ride-through for up to 25 seconds, an AC/DC power supply, DC/DC converter, can be powered by Power of the Ethernet (PoE In) or by an onboard battery for up to 2 Hours.

The front panel of the unit mainly facilitates the communication interfaces, the auxiliary power supply & I/O module.

The rear panel houses another important feature of the G3500, namely the sensor sockets for all the probes. You may use any custom / Elspec probes supplied with the device. Simply plug it in & all the probes will be automatically recognized. The rear panel also houses the On/Off Switch of the Main Power & Inlet Socket.

The illustrations & tables below will serve as a navigational map of all the unit's controls & indicators.

Physical layout of the controls & indicators of the G3500's Front Panel:



Physical layout of the controls & indicators of the G3500's Rear Panel:



INDICATOR / CONTROL	DETAILED USAGE REFERENCE
FRONT PANEL	
Auxiliary Power Supply	Unit Powering
Digital Input	IO Ports
Serial Ports	Establish 1ST Time Connection
Battery Supply	Battery Replacements
Power Indicator	Unit Powering
LAN Ethernet Port	Establish 1ST Time Connection
Reset Button	Instrument Settings
Relay Port	IO Ports
REAR PANEL	
Voltage Clamp Inputs	Connect Voltage Probes
Current Clamp Inputs	Connect Current Clamps
Main Power On/Off Switch	Unit Powering
Main Power Inlet Socket	Unit Powering

See also:

- [Safety Precautions](#)
- [What You'll Need](#)
- [Unpacking Components & Accessories](#)
- [G4500 BLACKBOX Unit](#)

Installation

This section contains the installation & setup procedure for the Portable BLACKBOX that is quick & simple to follow. After you have installed your BLACKBOX device, you can:

- Monitor the Quality of your Electrical Power,
- Monitor PQ Parameters according to EN50160, IEC61000-4-30 & Customized Standards
- Store a 1000 Times More than other typical file formats with PQZIP

QUICK & SIMPLE INSTALLATION



The simple Step-x-Step procedure includes:

- [Unit Powering](#)
- [Establish 1st Time Connection](#)
- [Plug in & Play the Voltage & Current Probes](#)
- [Unit Access](#)
- [Quick Unit Configuration](#)
- [Verify Measurement Readings](#)
- [Enable PQZIP Recording](#)

⚠ WARNING

Before you start ensure that the panel is de-energized & that you take the necessary Safety Precautions!

Unit Powering

You may either power up either G4500 / G3500 Portable BLACKBOX by using the main AC Power Supply / the Auxiliary Power Supply / Battery Power Supply:

connect by using the AC POWER SUPPLY:

⚠ WARNING

85-260V AC \pm 10%, 50/60Hz

OR

120-370V DC

35-55V DC Watt Maximum

- 2A/250V Fuse Holder
- Use only suitable fuse replacement!
- Make sure the Instrument is properly grounded through the power cord to protective earth ground

- On the Rear Panel connect the female end of the [Power Cable](#) to the [Main Power Supply](#) inlet socket of the unit:



- Connect the male plug end of the Power Cable to the electrical supply outlet

- [On the Front Panel turn on the Main Power Supply](#) Switch to the ON position:



- [On the Rear Panel turn on the Main Power Switch](#) to the ON position:



- [Verify that the unit is running on AC Power](#) by using the status indicator lights:

Flashing Blue Main Power Applied, Battery Charging

Solid Blue Main Power Applied, Battery Fully Charged



connect by using the Auxiliary Power Supply:

WARNING

48V DC
(35- 55V)

35 Watt Maximum

- No replaceable fuse protection!
- Do not allow significant overvoltage!
- The 48VDC power supply should be isolated from the mains by double or reinforced insulation

- [On the Front Panel](#) connect the female end of the [Auxiliary Cable](#) to the [Auxiliary Port](#) of the unit to the corresponding +/- connection:



- [On the Front Panel](#) turn on the [Main Power Supply](#) Switch to the ON position:



- [Verify that the unit is running on Auxiliary Power](#) by using the status indicator lights:

Flashing Blue

Main Auxiliary Power Applied,
Battery Charging

Solid Blue

Main Auxiliary Power Applied,
Battery Fully Charged



Power the unit by using the Battery Supply:

The BLACKBOX Portable contains an internal, uninterrupted power supply module providing a short period of self-powered measurements sessions &/or power supply interruptions ride-through. The Internal UPS system contains a lithium battery for a up to 2 hours of fully- functioning operation & a super capacitors module allowing an additional 25 seconds of short interruptions ride-through even in the case of the main battery being fully discharged. The battery & super capacitors modules require no maintenance and are designed for a long service life. However, if the battery shows a significant decrease in performance, it should be replaced with a factory original. Consult with your local Elspec agency for replacement battery ordering information & see Battery Replacement, in order to change your Battery.

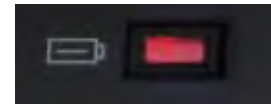
Procedure for using the Battery Supply:

- [On the Front Panel turn on the Main Power Supply Switch to the ON position:](#)



- [Verify that the unit is running on Battery Power](#) by using the status indicator lights:

Red **Powered by the Internal Battery**



- Go to the next step - [Unit Wiring](#)

see also:

- [About Quick Installation](#)
- [About Portable Wiring](#)
- [Plug and Play Voltage & Current Probes](#)
- [Grounding](#)
- [Establish 1st Time Connection](#)
- [Unit Access](#)
- [About Quick Configuration](#)
- [Verify Measurement Readings](#)
- [Enable PQZIP Recording](#)

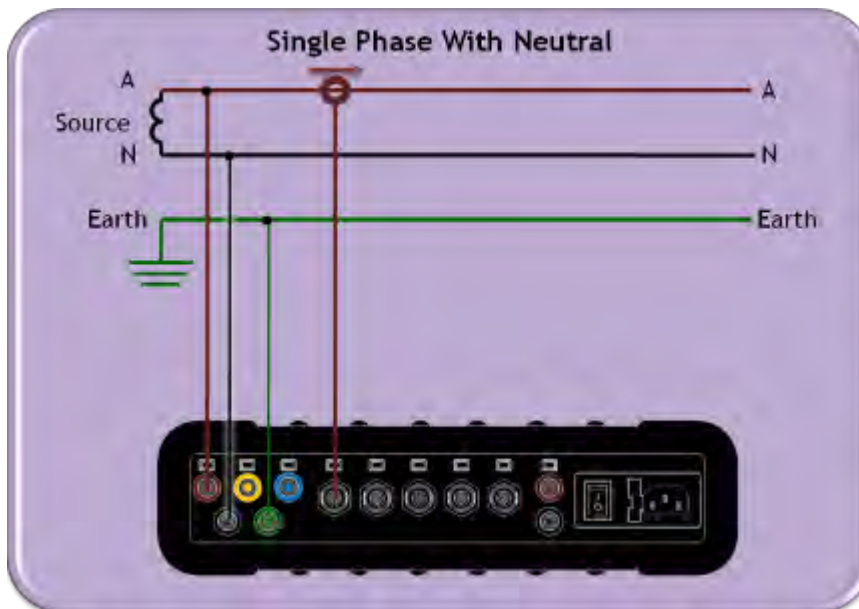
G4500 & G3500 Unit Wiring

An essential part of the Wiring Procedure is the Power Configuration, which is configured in the Web Interface. Prior to proceeding with [Plugging in & Playing your Voltage & Current Probes](#), familiarize yourself with the types of Power Topology the BLACKBOX Portable supports & [Grounding](#) of the unit.

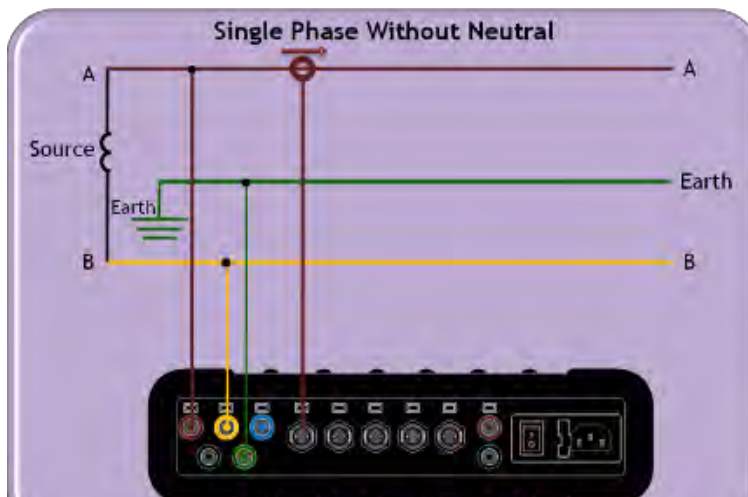
BLACKBOX PORTABLE POWER TOPOLOGY SUPPORTS

The BLACKBOX is designed to serve in virtually any power topology configuration. The diagrams below outline the types of topologies with their applicable Configuration in Elspec's Web Interface. It includes the Portable BLACKBOX configurations followed by the actual power configuration in brackets:

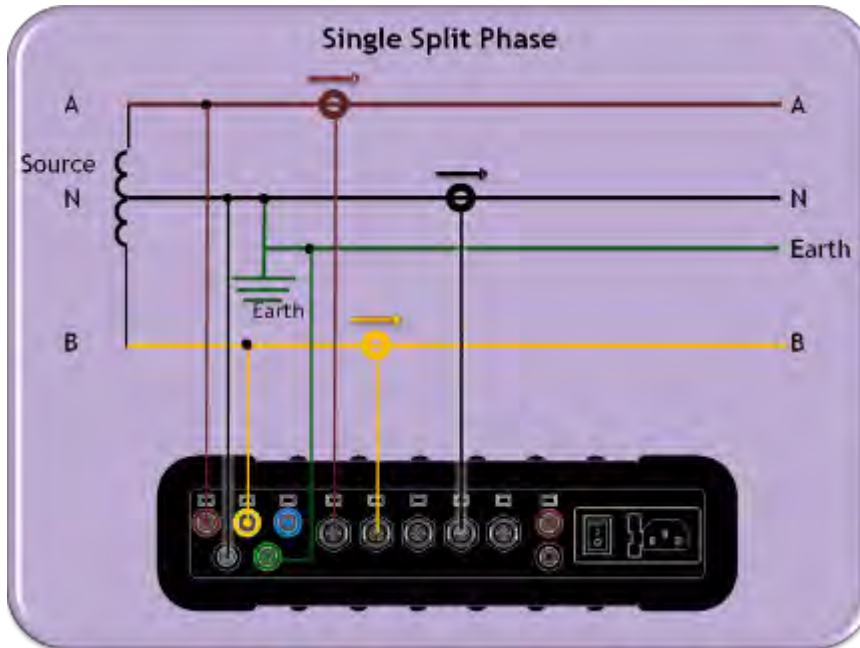
Single LN [SINGLE PHASE WITH NEUTRAL]:



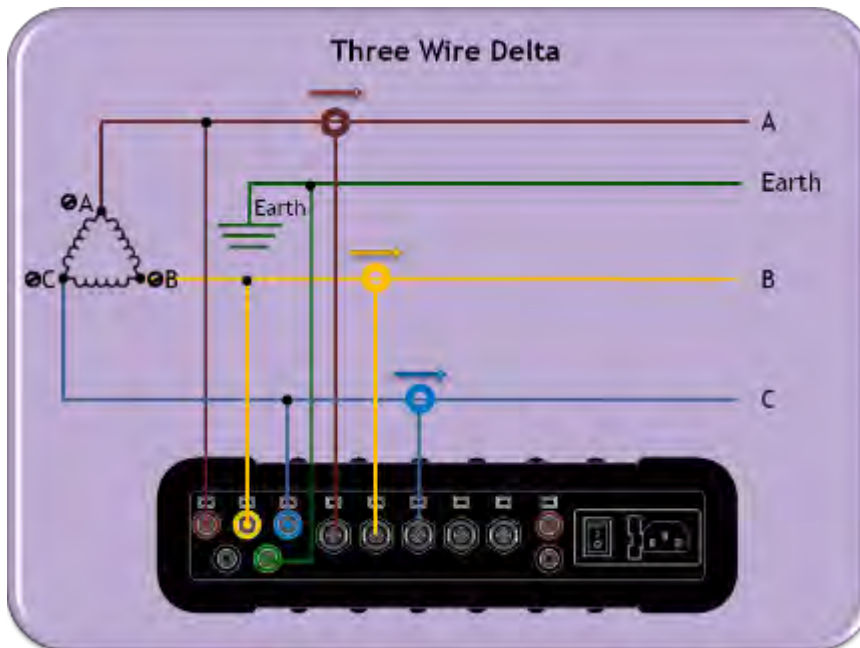
Single LL [SINGLE PHASE WITHOUT NEUTRAL]:



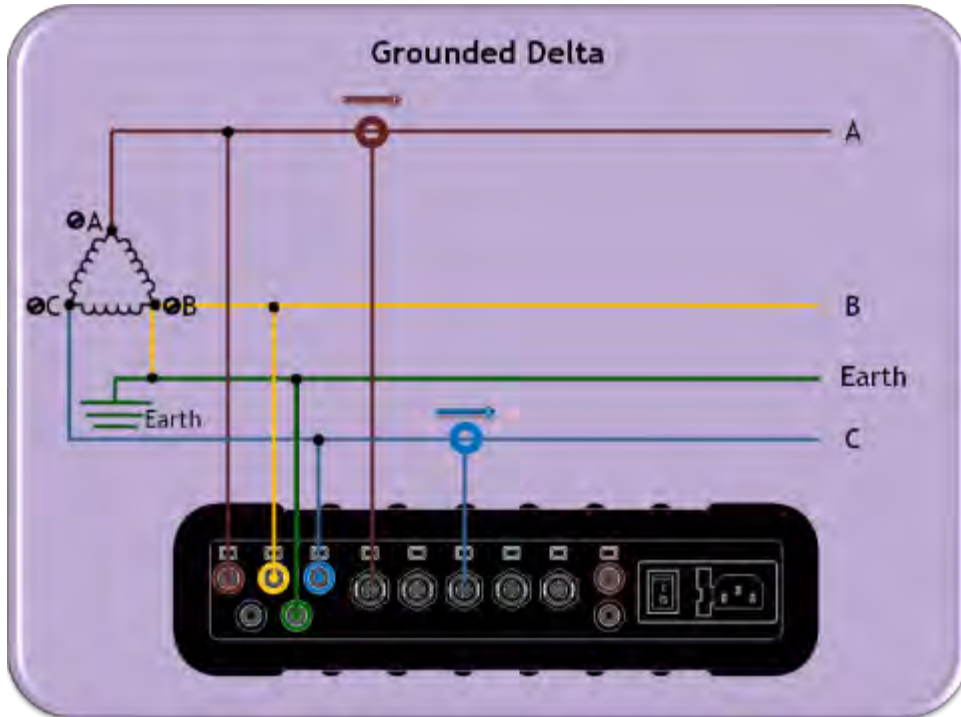
2Phase TR [SINGLE SPLIT PHASE]:



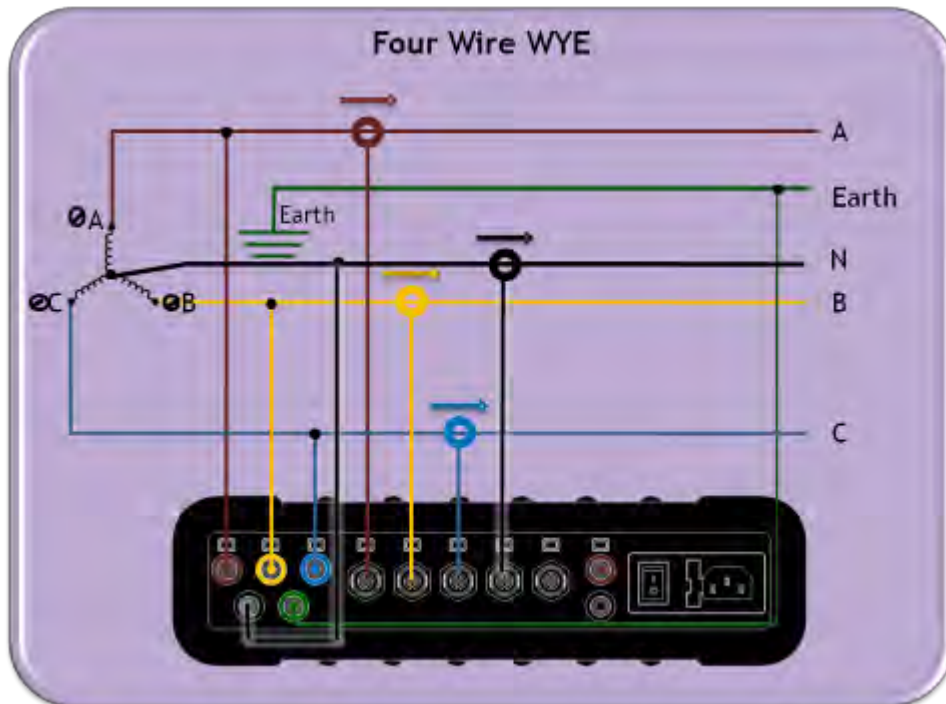
delta 3 wires [THREE WIRE DELTA]:



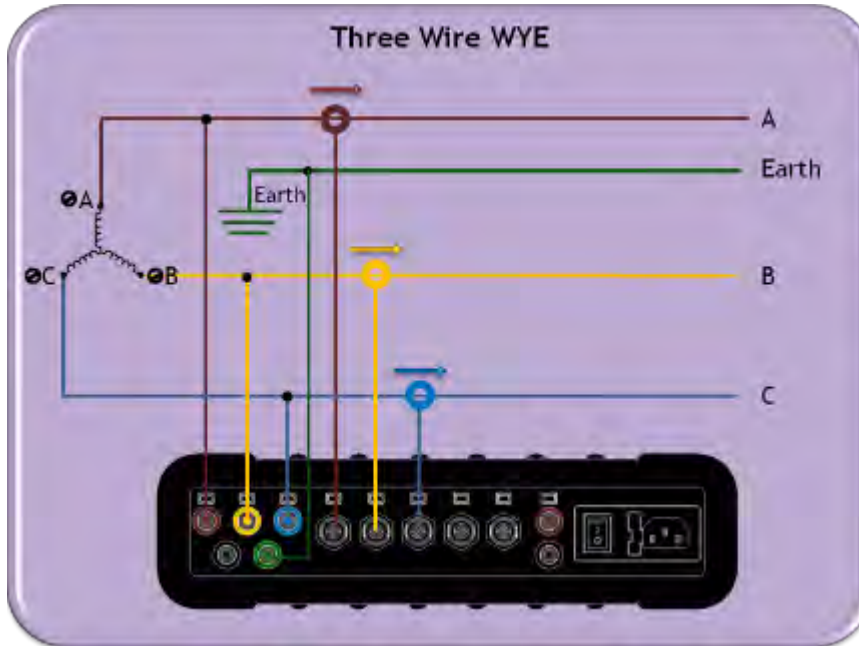
delta 3 wires [Grounded Delta]:



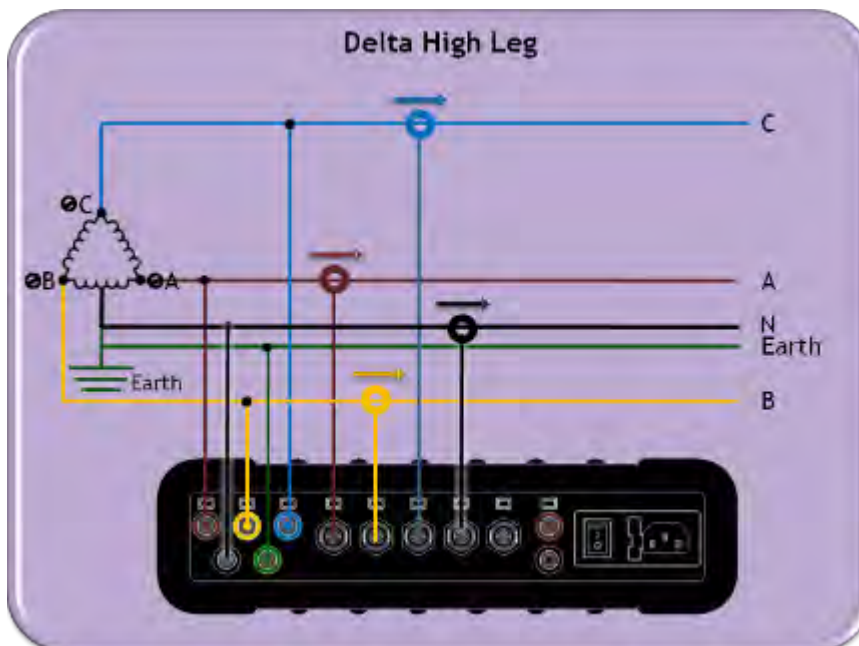
wye 4 wires [four wire wye]:



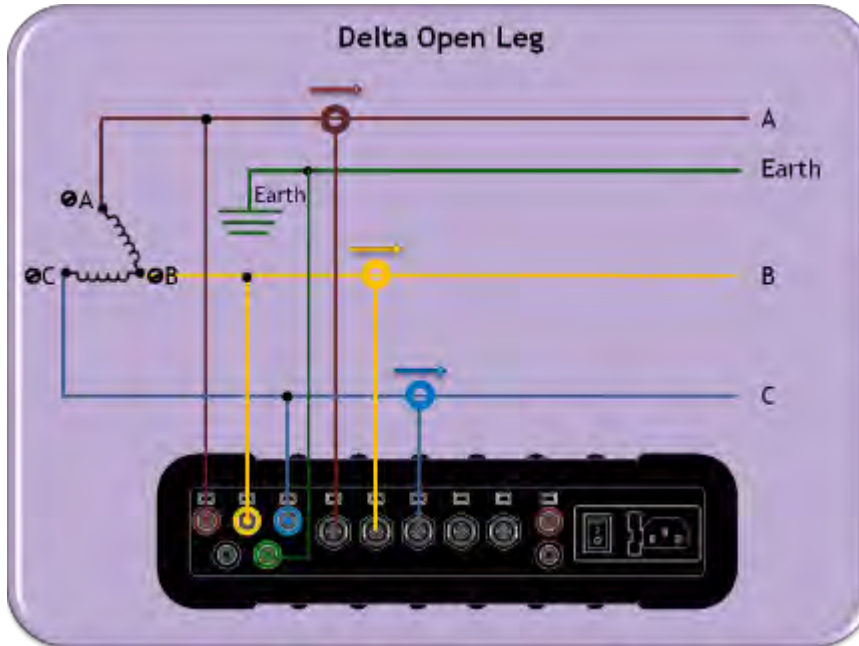
wye 4 wires [three wire wye]:



Delta 3 wires [delta high leg]:



Delta 3 wires [delta Open Leg]:



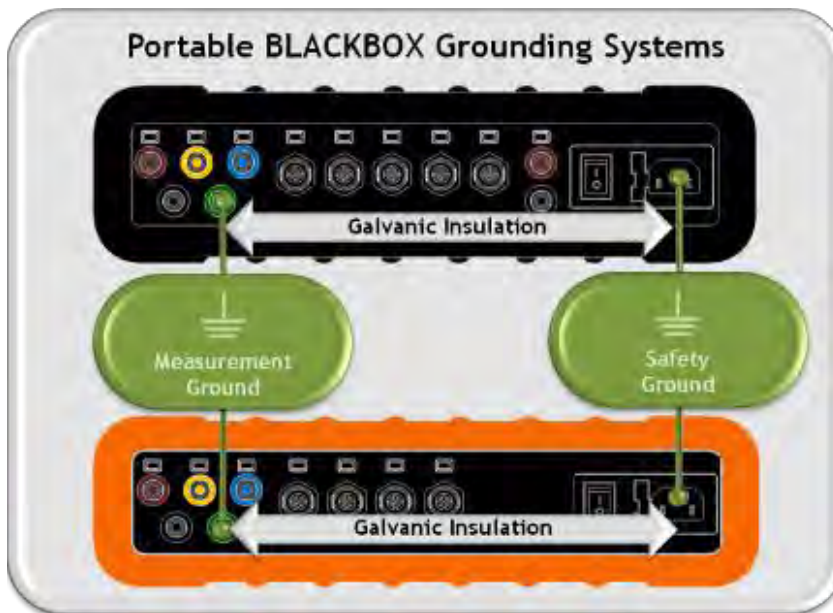
see also:

- [About Quick Installation](#)
- [Unit Powering](#)
- [Plug and Play Voltage & Current Probes](#)
- [Grounding](#)
- [Establish 1st Time Connection](#)
- [Unit Access](#)
- [About Quick Configuration](#)
- [Verify Measurement Readings](#)
- [Enable PQZIP Recording](#)

Grounding

The Portable BLACKBOX contains two independent ground systems, one for measurements & one for safety. Internally the ground systems are isolated in order to avoid ground loops. Externally they may be safely connected to the same or different ground systems.

- **Point 1 - Measurement Ground:** The reference point for measured electrical system,
- **Point 2 - Safety Ground:** The reference for the line cord ground. Enclosure for connectors related metal parts:



NOTE NOTE NOTE

- Maximum permitted voltage between Measurement & Safety Grounds is 2kV DC or 1.5kV AC.
- The Ground input is the reference for all channels therefore it is essential to connect it properly.

- Proceed to the next step - [Plug and Play Voltage & Current Probes](#)

see also:

- [About Quick Installation](#)
- [Unit Powering](#)
- [About Portable Wiring](#)
- [Plug and Play Voltage & Current Probes](#)
- [Establish 1st Time Connection](#)
- [Unit Access](#)
- [About Quick Configuration](#)
- [Verify Measurement Readings](#)

Plug & Play - Voltage & Current Probes

The Portable BLACKBOX houses [5 x AC Voltage](#), [4 x AC Current](#) & [1 x AC/DC Current](#) Sockets. In addition the G4500 houses [2 x VDC Sockets](#). It is a simple matter of plugging in the Voltage & Current Probes into the device & it will be automatically recognized.

The BLACKBOX is designed to serve in virtually any power topology configuration, see Circuit Topologies in order to interface your device with your circuit topology.

NOTE NOTE NOTE

- **Current Clamps:** The Portable BLACKBOX is certified to measure currents only when using Certified 61010-2-032 Third Edition Current Clamps.
- **Voltage Clamps:** The Portable BLACKBOX is certified to measure voltage only when using Certified to 61010-031 Third Edition Voltage Clamps.

plug in the ac voltage probes:

- Plug in the [Voltage Probes](#) into the applicable sockets located on the [Rear Panel](#). Plug the phase & ground cables in as:
 - L1 to L1 (Red to Red)
 - L2 to L2 (Yellow to Yellow)
 - L3 to L3 (Blue to Blue)
 - Ground to Ground (Green to Green)
 - Earth to Earth (Black to Black)



- Attached [Crocodile Ends of the Probes](#) to the Measured Power Source:



- The LED light will illuminate confirming a solid connection & the Voltage Levels are above 10% of the nominal value:



SPECIFICATION	G4500	G3500
Maximum Voltage Input	1KV	1KV
Nominal Voltage Range	110 to 690V	110 to 690V
Maximum Peak Measurement Voltage	8KV	8KV
Input Impedance	3MΩ	3MΩ
Bandwidth	25kHz	12.5kHz
Nominal Frequency	42.5Hz to 69Hz	42.5Hz to 69Hz

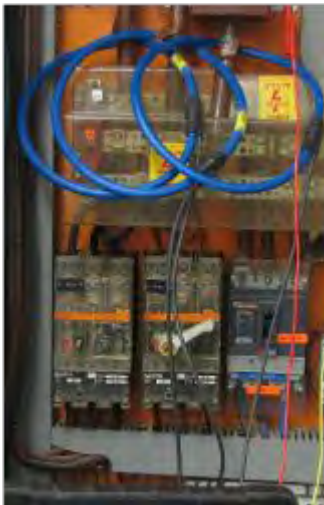
plug in the current probes:

You may use any clamp (either Elspec / Custom clamps). The clamps convert current to low voltage.

- Plug in the [Current Probes](#) into the applicable sockets located on the [Rear Panel](#) (Pay attention to the phase connections, as the channels are calibrated according to the clamps - I1 for I1; I2 for I2; I3 for I3; I4 for I4 & IDC for the DC Clamp):



- Connect the measurement end to the measured power source:



- The LED light will illuminate confirming a solid connection:



SPECIFICATION	G4500	G3500
Number of Inputs	4 (3 Phases & Neutral) + DC/Ground	4 (3 Phases & Neutral)
Maximum Peak Measurement	I1 to I4: 10 V _{pk} I5: 3 V _{pk} From Clamp	I1 to I4: 10 V _{pk} From Clamp
Type	Clamp On Current Transformer With mV Output	Clamp On Current Transformer With mV Output
Range	I1 to I4: 0 to 10 V _{pk} I5: 0 to 3 V _{pk} From Clamp	I1 to I4: 0 to 10 V _{pk} From Clamp
Burden	0.05VA (Typical) @ 5 IRMS	0.05VA (Typical) @ 5 IRMS
Bandwidth	25kHz (Typical) @ 5 IRMS	12.5kHz

plug in the G4500'S VDC probes:

The G4500 facilitates Auxiliary DC(+) & DC(-) voltage & current inputs & provides an independent input to the main AC/DC channel DC voltage readings. The measurement range ranges from -1000VDC to +1000VDC at a rate of once every second. This is mainly suitable for a voltage converter DC link side reading while the main voltage channels are on the grid side.

- Plug in the [DC Probes](#) into the applicable sockets located on the [Rear Panel](#) - Red(+) & Black(-):



- Connect the measurement end to the measured power source
- No configuration is necessary for the automatically recognized DC V/I Probes, you may however choose to **Enable / Disable** the recording at your own choosing. See [Capture DC](#).

SPECIFICATION	
Maximum Voltage Input	1KV
Galvanic Insulation from Main AC / DC Channels	3KV
Recording Resolution	200 μ s

- Go to the next step - [Establishing a 1st Time Connection](#)

see also:

- [About Quick Installation](#)
- [Unit Powering](#)
- [About Portable Wiring](#)
- [Grounding](#)
- [Establish 1st Time Connection](#)
- [Unit Access](#)
- [About Quick Configuration](#)
- [Verify Measurement Readings](#)
- [Enable PQZIP Recording](#)

Establish 1st Time Connection

A quick & simple connection can be established to your Network or G4150 or your local PC by using the Portable BLACKBOX's fast Ethernet ports (10/100 MB) / Wireless Link.

G4500 Portable BLACKBOX:

- **Wi-Fi:** Convenient Wireless Connection
- **WAN:** Broadband router (ADSL/ Cable / Cellular) for Internet accessibility - [See Communication](#)
- **LAN1:** G4150/ DHCP/ PC / Laptop Connection - [See Communication](#)
- **LAN2/LCD:** Direct connection to LAN Network of Computers - [See Communication](#)
- **Serial Interface Ports:** [See Communication](#)

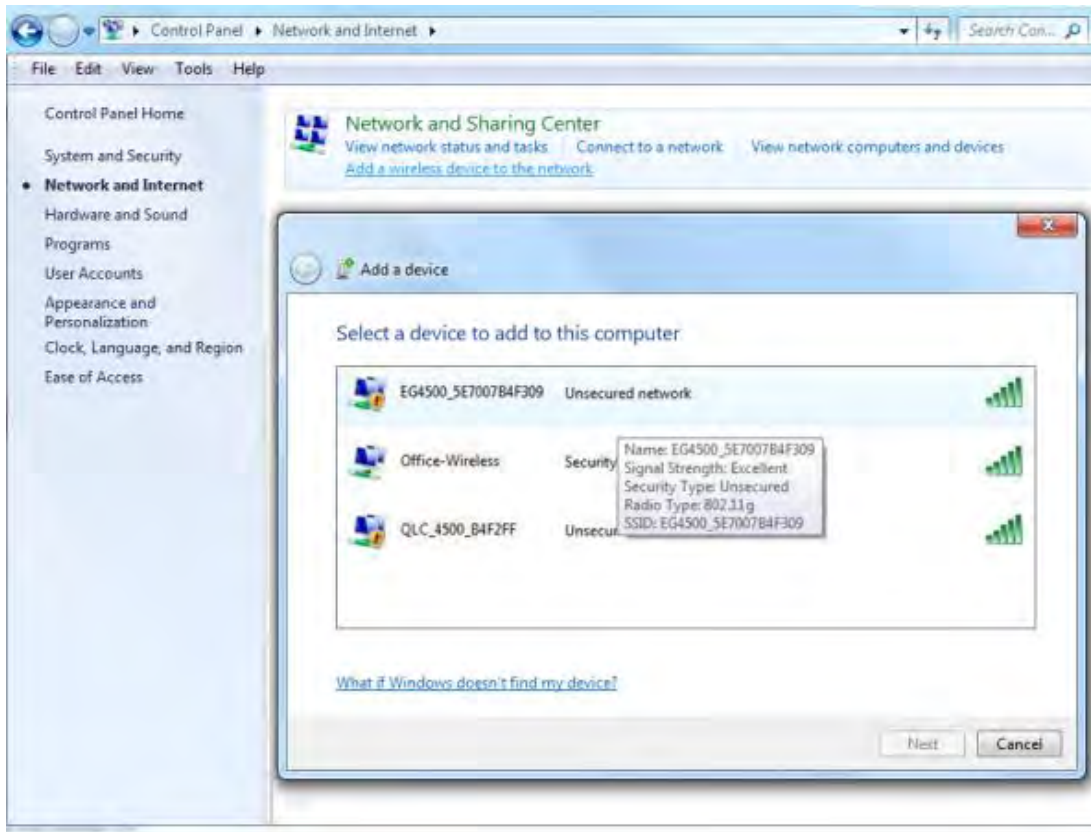
G3500 Portable BLACKBOX:

- **LAN/LCD:** Main connection port (G4150/ DHCP / PC/ Laptop/ LAN Network of Computers)
- **Serial Interface Ports:** [See Communication](#)

G4500 WI-FI CONNECTION

Equipped with a built-in IEEE 802.11 g/b router configured as an industry standard access point, the G4500 provides convenient & instant connectivity to your G4150, including to a PC/Laptop that is Wi-Fi enabled.

- [After you have switched on](#) your G4500 Portable PQ Analyzer, search for the device by its unique [S/N](#):



- The S/N is located on the G4500's name plate:



- The Wi-Fi Activity Indicator will confirm connection (Flashing / Solid Blue):

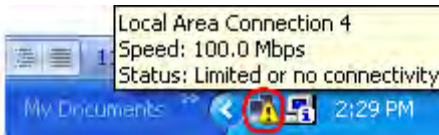


G3500 LAN/LCD CONNECTION

- [After you have switched on](#) your G3500 Portable PQ Analyzer, connect the [LAN Communication Cord](#) to the port marked LAN/LCD on the units' [Front Panel](#):



- The green link-LED of the LAN1 connector begins to flash as Windows begins communicating with the unit
- Wait for about 2 minutes as the Windows operating system reverts to the default "No Server" IP configuration
- When this is completed, the "Local Area Connection Status" icon in the "Quick Start" tray will change to "Limited or no connectivity":

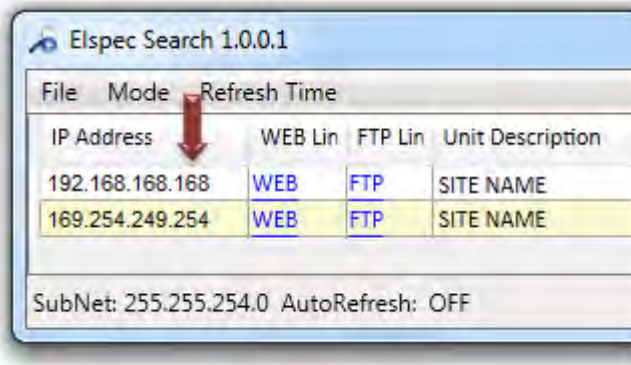


see also:

- [About Quick Installation](#)
- [Unit Powering](#)
- [About Portable Wiring](#)
- [Grounding](#)
- [Plug and Play Voltage & Current Probes](#)
- [Unit Access](#)
- [About Quick Configuration](#)
- [Verify Measurement Readings](#)
- [Enable PQZIP Recording](#)

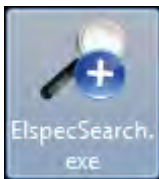
G4500 / G3500 Unit Access

Once you have [Connected the Device for the 1st Time](#), you may access your Portable BLACKBOX Unit by simply clicking the WEB Hyperlink button in your Elspec's Search Utility. Alternatively you can simply access the device directly via the Internet Explorer by inserting the Device's IP address directly (address is also indicated in Elspec's Search Utility).

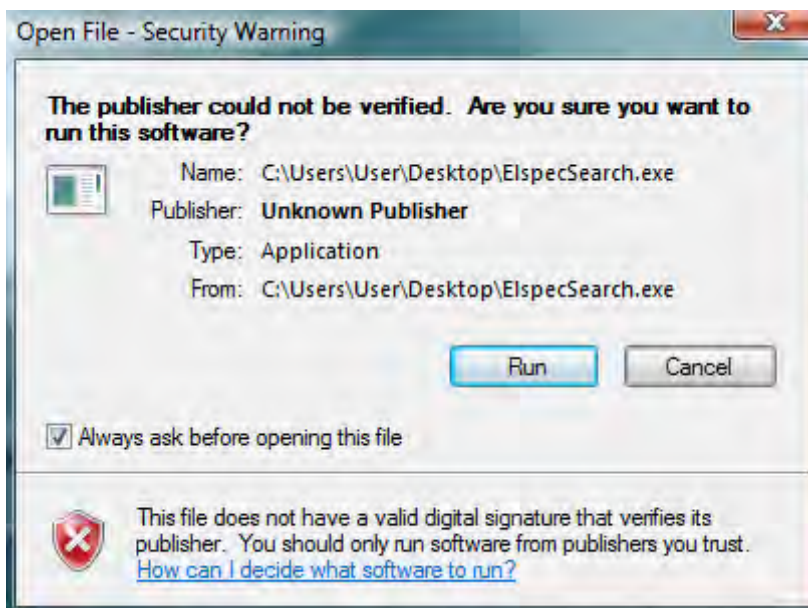


Access Elspec's search utility:

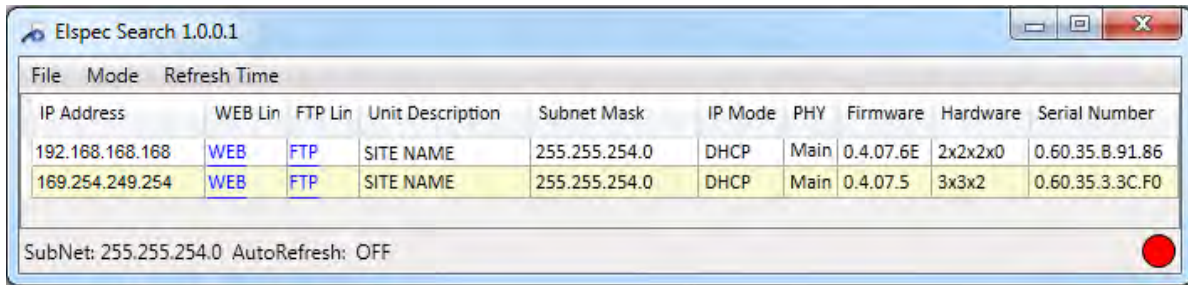
- After you have Copied the Utility on your Desktop, access it by clicking on the Elspec's Search Icon:



- Initially, the program may trigger a verification warning similar to the one below. You may proceed by clicking Run:



- A scan procedure is initiated; the Elspec Search utility appears as a grid displaying all BLACKBOX devices found on the intranet network:



IP Address	WEB Lin	FTP Lin	Unit Description	Subnet Mask	IP Mode	PHY	Firmware	Hardware	Serial Number
192.168.168.168	WEB	FTP	SITE NAME	255.255.254.0	DHCP	Main	0.4.07.6E	2x2x2x0	0.60.35.8.91.86
169.254.249.254	WEB	FTP	SITE NAME	255.255.254.0	DHCP	Main	0.4.07.5	3x3x2	0.60.35.3.3C.F0

SubNet: 255.255.254.0 AutoRefresh: OFF

Access instrument via the web hyperlink (Recommended):

- Select the **Web** link for your device, Elspec's Web Interface will now open:



- In order to view the different languages in the Web Interface, you will need to upload the language feature from [Elspec's Website](#) when installing your new Firmware. Once uploaded, simply select the applicable interface language from the drop-down list:



- The supported languages are:
 - English (Default)
 - Chinese
 - Czech
 - German
 - French
 - Russian
 - Spanish

(For other languages - please contact your local Elspec distributor)

- The Password field defines user level/privileges. The user levels are **Viewer / Administrator** (See Security Settings). The default password including privileges for each level are:
 - Viewer is **123** (Read only, can choose interface language only, no operations related changes are allowed)
 - Administrator is **12345** (Administration, setup & full control)

NOTE NOTE NOTE

- The Website is optimized to work with Internet Explorer 7, 8 or 9 in “Compatibility View”. Ensure that the Internet Explorer is running in **Compatibility View**:

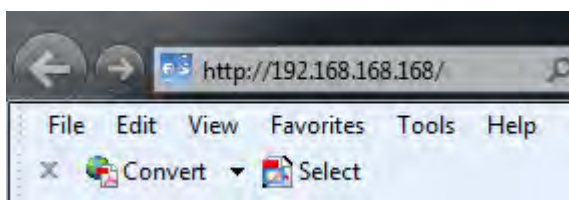


Other web browser applications can limit some functionality and/or show an incorrect layout.

- For local networking the browser should be configured as working without a proxy server. Refer to Disable Proxy Server in Internet Explorer.
- Should you be running Skype simultaneously with Elspec’s Search, you will not be able to access the device via the Web Link. Close Skype & access Elspec’s Search again to follow the Web Link.
- The passwords above are factory default values. You are advised to modify Admin password if extended security measures are required (See Security Settings).

direct instrument access via internet explorer:

Access the device by typing the BLACKBOX's IP address in the address field in Internet Explorer:



- Choose the language & enter the password as outlined above

see also:

- [About Quick Installation](#)
- [Unit Powering](#)
- [About Portable Wiring](#)
- [Plug and Play Voltage & Current Probes](#)
- [Grounding](#)
- [Establish 1st Time Connection](#)
- [About Quick Configuration](#)
- [Verify Measurement Readings](#)
- [Enable PQZIP Recording](#)

About Quick Unit Configuration

This section focuses only on the major configurations needed for initial installation of your Portable BLACKBOX device. Configurations are done via [Elspec's Web Interface](#). For a more detailed & comprehensive procedure see Instrument Settings. This procedure includes a quick & simple configuration procedure for your:

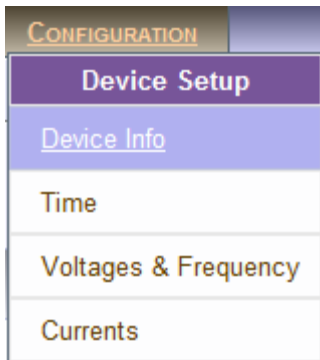
- [Portable BLACKBOX Unit](#)
- [Voltage & Frequency](#)
- [Currents](#)

see also:

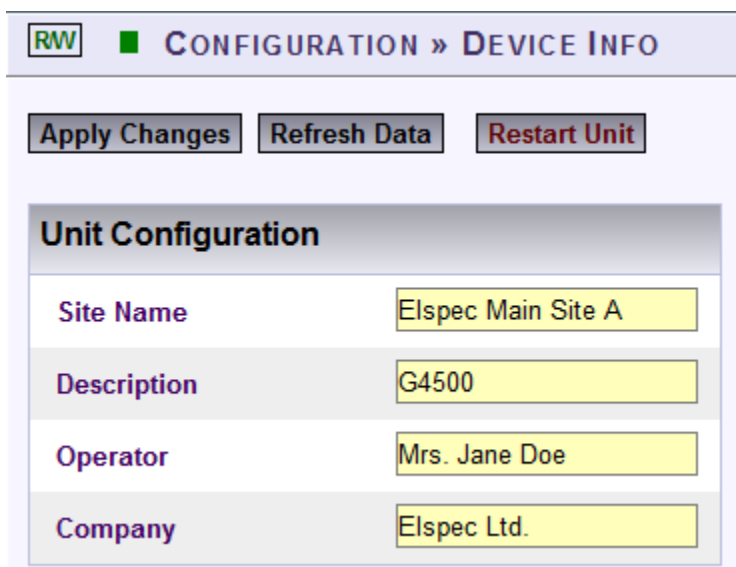
- [About Quick Installation](#)
- [Unit Powering](#)
- [About Portable Wiring](#)
- [Plug and Play Voltage & Current Probes](#)
- [Grounding](#)
- [Establish 1st Time Connection](#)
- [Unit Access](#)
- [Verify Measurement Readings](#)
- [Enable PQZIP Recording](#)

Quick Unit Configuration

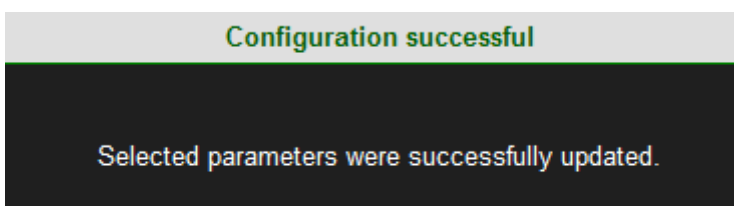
- After you have [Plugged in your Device](#), you will need to configure the unit itself. [Access](#) your Portable Device via [Elspec's Web Interface](#) ➔ log on as the **Administrator** ➔ under **Configuration** ➔ **Device Setup** select the **Device Info** Tab:



- In the **G4 Unit Configuration** Section complete:
 - Site Name:** Enables the user to define a description of the site where the device is installed. This site description also appears in the Elspec's Search utility under Unit Description when searching for devices
 - Description:** An additional text field for you to use optionally as you see fit
 - Operator:** A text field typically for inputting operator/technician name
 - Company:** A text field typically for inputting company name



- To apply your changes select [Apply Changes](#). A success message will confirm your changes:

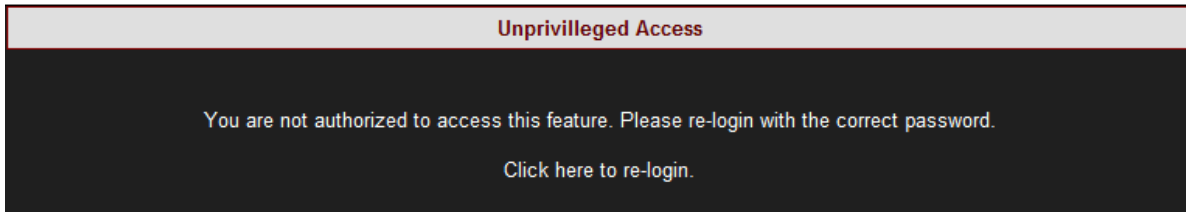


[Refresh Data](#)

- Go to the next step [Configuring Voltage & Frequency](#)

NOTE NOTE NOTE

If you are not logged on as the Administrator, you will not be able to change any of these settings & you will receive the following error message in your attempt to do so:



Once you have signed on at the Administrator ensure that you select [Apply Changes](#) to actually affect your changes.

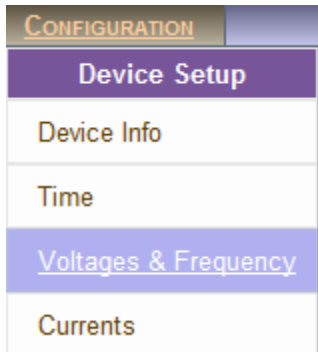
see also:

- [About Quick Configuration](#)
- [Voltage & Frequency](#)
- [Currents](#)

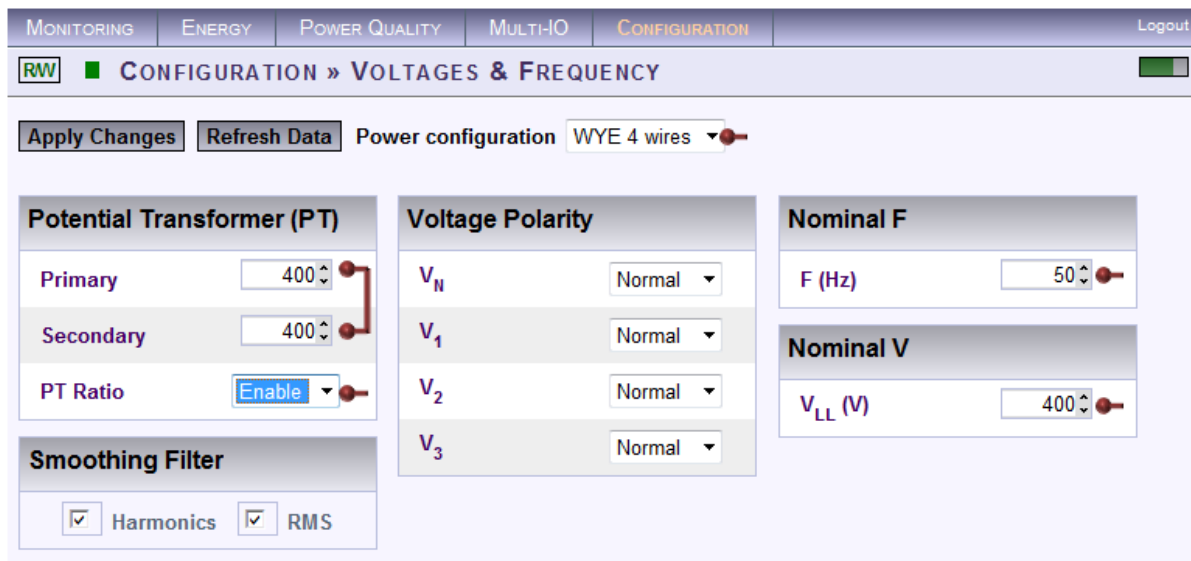
Voltage & Frequency Configurations

As mentioned previously, after you have [Plugged in the Voltage Probes](#) it will be automatically recognized. Therefore, only minor configuration adjustments will need to be made in the **Voltage & Frequency Configuration Window**.

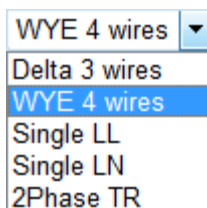
- [Access your Portable BLACKBOX Unit](#) via Elspec's Web Interface → log on as the Administrator → under Configuration → Device Setup select the **Voltage & Frequency Tab**:



- In the **Voltage & Frequency Window**:



- Select the applicable **Network Type Settings** according to your Network Type from the drop-down selection:



- If you wish to measure the Potential Transformer (MV/HV Networks - Voltage Measurements by PT's) select **Enable**:

PT Ratio	Disable ▾
	Disable
	Enable

- For MV/HV Networks (Voltage Measurements by PT's) set the correct **Primary & Secondary Ratio** (with /) - according to the **PT Manufacturer's Specifications** & not just the **Ratio**:

Potential Transformer (PT)	
Primary	400 ▾
Secondary	400 ▾

- Define the **Nominal Values** for Frequency (F) and Voltages (V) (with ▲/▼):

Nominal F	
F (Hz)	50 ▾

Nominal V	
V_{LL} (V)	400 ▾

- The ratio for LV Networks (<1kV) is based on the same concept & specifications:

<p>Set the Primary & Secondary Ratio (with /) -(according to the PT Manufacturer's Specifications & not just the Ratio):</p> <table border="1"> <thead> <tr> <th colspan="2">Potential Transformer (PT)</th> </tr> </thead> <tbody> <tr> <td>Primary</td> <td>5 ▾</td> </tr> <tr> <td>Secondary</td> <td>1 ▾</td> </tr> </tbody> </table>	Potential Transformer (PT)		Primary	5 ▾	Secondary	1 ▾	<p>Define the Nominal Values for Frequency (F) and Voltages (V) (with /):</p> <table border="1"> <thead> <tr> <th colspan="2">Nominal F</th> </tr> </thead> <tbody> <tr> <td>F (Hz)</td> <td>50 ▾</td> </tr> </tbody> </table> <table border="1"> <thead> <tr> <th colspan="2">Nominal V</th> </tr> </thead> <tbody> <tr> <td>V_{LL} (V)</td> <td>230 ▾</td> </tr> </tbody> </table>	Nominal F		F (Hz)	50 ▾	Nominal V		V_{LL} (V)	230 ▾
Potential Transformer (PT)															
Primary	5 ▾														
Secondary	1 ▾														
Nominal F															
F (Hz)	50 ▾														
Nominal V															
V_{LL} (V)	230 ▾														

- To apply your changes select **Apply Changes** ➔ **Refresh Data** to review your changes
- Go to the next step [Current Configuration](#)

NOTE NOTE NOTE

If you are not logged on as the Administrator, you will not be able to change any of these settings & you will receive the following error message in your attempt to do so:

Unprivileged Access
You are not authorized to access this feature. Please re-login with the correct password.
Click here to re-login.

Once you have signed on at the Administrator ensure that you select **Apply Changes** to actually affect your changes.

Leakage Voltage

A designated PQZIP channel for calculated leakage voltage

Note:

- i. The default nominal value of V5 equals 2.3V i.e., 1% of 230V.
- ii. Changing the Nominal value of V5 can only be made through editing the unit's configuration file.

see also:

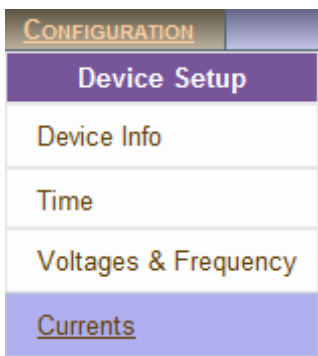
- [About Quick Configuration](#)
- [Unit Configuration](#)
- [Currents](#)

Currents

As mentioned previously, after you have [Plugged in your Current Probes](#) it will be automatically recognized. Therefore, only minor configuration adjustments will need to be made in the **Current Configuration Window**. Elspec supplies a complete range of Clamps with the Portable BLACKBOX that are divided into two categories: Custom Clamps & all other Clamps - See [Optional Accessories](#).

The Custom clamps are capable of measuring currents up to 3000 Amps at very high frequencies of 10 kHz. The probes provide a linear voltage output replicating input current waveform ranges of either 30, 300, or 3000 Amperes. The Ampere setting is controlled & set by the user via a Rotary-Switch. Due to the nature of this setting, the Hardware range needs to be configured accordingly in the unit's Web Interface. As such, the configurations differ for the two different groups of Clamps -

- [Access your Portable BLACKBOX Unit](#) via Elspec's Web Interface ➡ log on as the Administrator ➡ under Configuration ➡ Device Setup select the Currents Tab:



- As mentioned all the connected clamps will be automatically recognized. Adjust the **Currents Probe Info** in the applicable sections:
 - **Primary & Secondary Transformation Ratios** for all the Current channels;
 - **Nominal Ampere Values** for all the Current Channels (Nominal is set for the current measurements that will define PQZIP threshold / tolerance value & it is also used for event settings);
 - Either **Reverse the Polarity** / maintain it at **Normal** from the drop-down selection (Polarity toggling is used to correct incorrect wiring);
 - Clamp's **Current / Voltage Ratio** as per the **Clamp's Rotary Current Setting** - use the table below as your guide:

CLAMP ROTARY CURRENT SETTING	I/V Ratio
30A	100 mVA
300A	10 mVA
3000A	1 mVA

- The Hardware Range as per the Clamp's Rotary Current Setting - use the table below as your guide:

CLAMP ROTARY CURRENT SETTING	HARDWARE RANGE
30A	70.710678A
300A	707.10678A
3000A	7071.0678A

The screenshot displays the 'CONFIGURATION » CURRENTS' screen in the ESPEC G4500 BLACKBOX software. It features several sections for configuring current probes:

- Current Probes Info:** A table with columns for Channel, CT Ratio (A) (Primary, Secondary, Nominal), Polarity, Clamp Info, and Behavior simulation. Channels I₁ through I₅ are configured with CT ratios of 3000, 300, 30, and 50 respectively, all with 'Normal' polarity and 'Custom clamp' info.
- Custom/DC probes Info:** A table with columns for Clamp Info, I/V Ratio (Current, Voltage), and Hardware Range. It lists hardware ranges for Custom clamp I₁ (70.710678 A), I₂ (707.106787 A), I₃ (7071.067871 A), and I₅ (2144.047363 A).
- Non-measured Currents:** Includes a 'Calculated Phase' dropdown set to 'All Present' and a 'Use I₅ for' dropdown with options for 'Physical input current' and 'Calculated leakage current'.

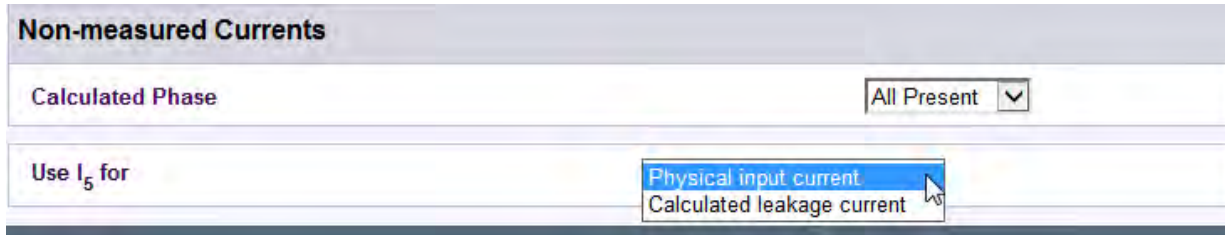
Leakage Current

A designated channel is used for leakage current in one of the following manners

- i. Calculated channel
- ii. Physical channel measured via IDC channel of a portable unit

Note: I₅ nominal value should be configured to suit the expected leakage current value which is usually a fraction of the nominal phase current.

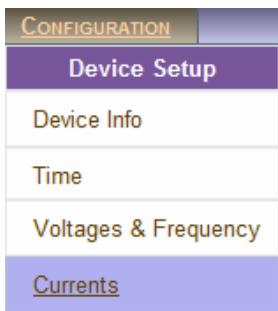
I₅ should be configured according to the mode of work i.e., physical leakage measurement or calculated leakage as illustrated below.



- To apply your changes select **Apply Changes** ➔ **Refresh Data** to review your changes;
For more on the Custom Clamp’s Specifications, See [Optional Accessories](#).

Currents Configuration - Other Elspec Clamps:

- [Access your Portable BLACKBOX Unit](#) via Elspec's Web Interface ➔ log on as the Administrator ➔ under Configuration ➔ Device Setup select the Currents Tab:



- As mentioned all the connected clamps will be automatically recognized. Adjust the **Currents Probe Info** in the applicable sections:
 - Primary & Secondary Transformation Ratios** for all the Current channels (As per Clamp's individual Specifications);
 - Nominal Ampere Values** for all the Current Channels (Nominal is set for the current measurements that will define PQZIP threshold / tolerance value & it is also used for event settings);
 - Either **Reverse** the **Polarity** / maintain it at **Normal** from the drop-down selection (Polarity toggling is used to correct incorrect wiring)
 - The **Behavior Simulation** may be reversed 300/3000A Flexible Clamp. Ensure that you adjust the CT Ratio accordingly;
 - The **Hardware Range** is only applicable for the DC & Custom Clamps. This is adjust according to the Clamp's individual Specifications - See [Optional Accessories](#):

Current Probes Info

Channel	CT Ratio (A)		Nominal (A)	Polarity	Clamp Info	Behavior simulation
	Primary	Secondary				
I ₁	100	100	100	Normal	Mini 100A:1A/1mV	No Simulation
I ₂	3000	3000	3000	Normal	Flex clamp-3000A	No Simulation
I ₃	3000	3000	3000	Normal	Flex clamp-300A	Flex clamp-3000A
I _N	---	---	---	Normal	No Probe Detected	No Simulation
I ₅	1	1	1	Normal	Mini 1-5A:1A/1V	No Simulation

Custom/DC probes Info

Clamp Info	I/V Ratio		Hardware Range
	Current	Voltage	

Non-measured Currents

Calculated Phase: All Present

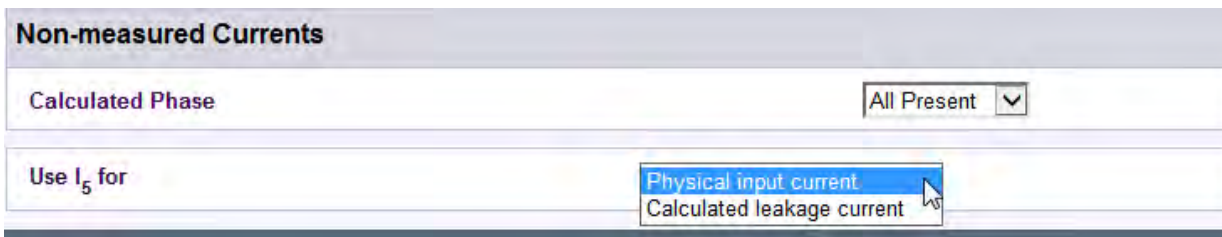
Use I₅ for: Physical input current

Leakage Current

A designated channel is used for leakage current in one of the following manners

- i. Calculated channel
 - ii. Physical channel measured via IDC channel of a portable unit
- Note:** I5 nominal value should be configured to suit the expected leakage current value which is usually a fraction of the nominal phase current.

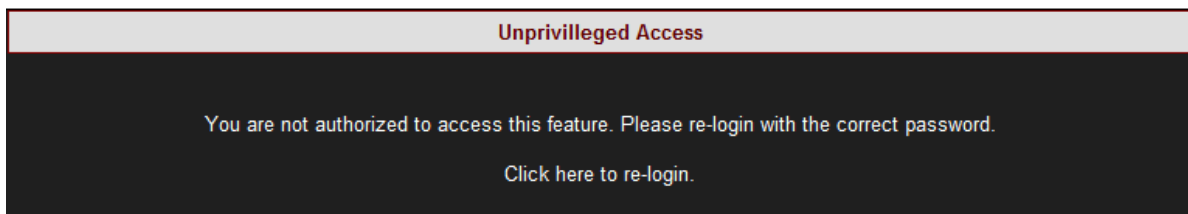
I5 should be configured according to the mode of work i.e., physical leakage measurement or calculated leakage as illustrated below.



- To apply your changes select **Apply Changes** → **Refresh Data** to review your changes;

NOTE NOTE NOTE

If you are not logged on as the Administrator, you will not be able to change any of these settings & you will receive the following error message in your attempt to do so:



Once you have signed on at the Administrator ensure that you select **Apply Changes** to actually affect your changes.

see also:

- [About Quick Configuration](#)
- [Unit Configuration](#)
- [Voltage & Frequency](#)

About Verifying Measurement Readings

The final step after you have [Configured your Device](#), is to verify the voltage & current measurements of your Portable BLACKBOX. This verification step covers only a partial section of the BLACKBOX's Full PQ Monitoring Capabilities. It includes:

- [Accessing & Reviewing the Measurement Summary](#)
- [Accessing & Reviewing Voltage & Current Measurements](#)
- [Accessing & Reviewing the Power](#)

see also:

- [Quick Installation](#)
- [Unit Powering](#)
- [Establish 1st Time Connection](#)
- [Plug & Play - Voltage & Current Probes](#)
- [Unit Access](#)
- [Quick Unit Configuration](#)
- [Enable PQZIP Recording](#)

Access the Measurement Summary

The Measurement Summary summarizes all your measurement readings. The most important parameters you will need to focus on in this window are **Phase Order (for 3 phase systems) & DSP Synchronization**:

- **Phase Order:** Confirms the order of the voltage phases starts from V_1 & are moving in a clockwise direction
- **DSP Synchronization:** Confirms that the unit is synchronized with the network
- For a full description on all the definitions & subsequent parameter calculations see PQ Monitoring

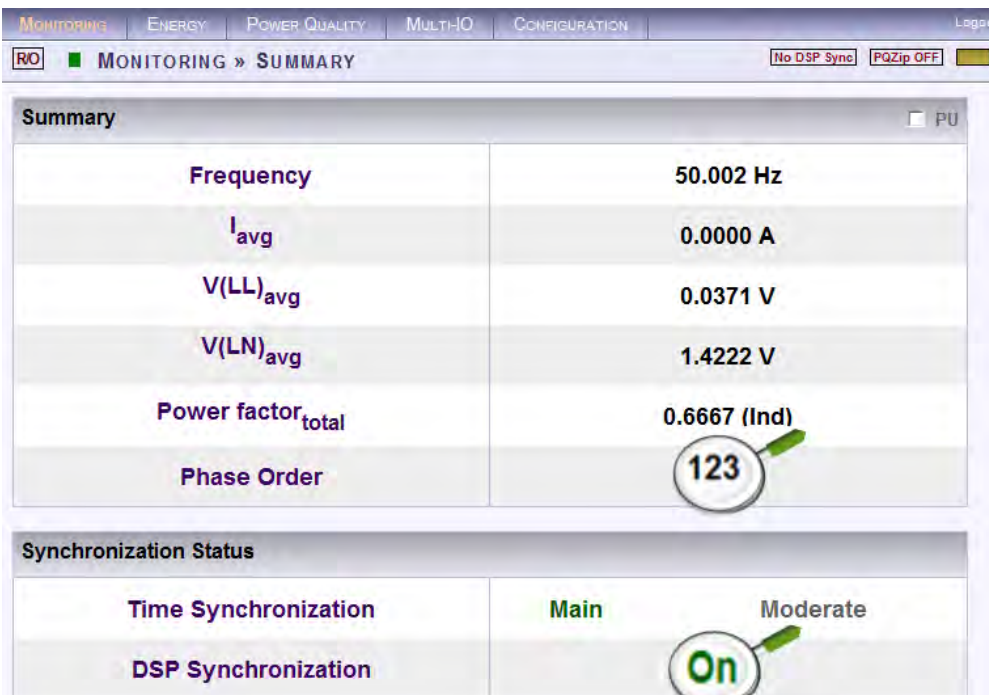
ACCESS THE SUMMARY WINDOW

- [Access your Portable BLACKBOX Unit](#) via the Web Interface → Open Monitoring

→ Summary:

MONITORING	ENERGY	POWER QUALITY
Summary	V & I harmonics	
Voltage & Current	P & Q harmonics	
Average	Spectrum	
Power	Harmonics Table	
Temperature	V/I Min/Max Harmonics	
Phasors	P/Q Min/Max Harmonics	
Waveforms		
Voltage Flickering		
Pinst Waveform		
Min/Max Flickering		

- The Summary Window will now open:



Summary PU

Frequency	50.002 Hz
I_{avg}	0.0000 A
$V(LL)_{avg}$	0.0371 V
$V(LN)_{avg}$	1.4222 V
Power factor _{total}	0.6667 (Ind)
Phase Order	123

Synchronization Status

Time Synchronization	Main	Moderate
DSP Synchronization	On	

see also:

- [About Measurement Readings](#)
- [Verify Voltage & Current](#)
- [Verify Power](#)

Verify Voltage & Current Readings

This page displays specific values as per the parameters configured for [Voltage & Current](#) for your G4500/G3500 Unit. For a full description on all the definitions & subsequent parameter calculations see Voltage & Current.

- [Access your Portable BLACKBOX Unit](#) via the Web Interface ➔ **Open Monitoring**
 ➔ **Voltage & Current:**

MONITORING	ENERGY	POWER QUALITY
Summary		V & I harmonics
<u>Voltage & Current</u>		P & Q harmonics
Average		Spectrum
Power		Harmonics Table
Temperature		V/I Min/Max Harmonics
Phasors		P/Q Min/Max Harmonics
Waveforms		
Voltage Flickering		
Pinst Waveform		
Min/Max Flickering		

- Verify that the **RMS** values are as expected for both **Voltage & Current** are as per your Configurations:

MONITORING » VOLTAGE & CURRENT						
V/I PU						
	RMS	Min Value	Max Value	THD	Crest Factor	K Factor
V ₁	1.4231 V	1.3982 V	230.67 V	6.8858 %	1.9276	---
V ₂	1.4215 V	1.3983 V	229.43 V	6.9813 %	1.5061	---
V ₃	1.4277 V	1.4037 V	230.67 V	6.8337 %	1.9216	---
V _N	0.2064 V	0.1398 V	0.2833 V	----	----	---
V ₁₂	0.0451 V	0.0382 V	1.2344 V	----	----	---
V ₂₃	0.0449 V	0.0379 V	1.2347 V	----	----	---
V ₃₁	0.0224 V	0.0117 V	0.0249 V	----	----	---
I ₁	0.0000 A	0.0000 A	49.982 A	----	----	----
I ₂	0.0000 A	0.0000 A	1.6611 kA	----	----	----
I ₃	0.0000 A	0.0000 A	46.349 kA	----	----	----
I _N	0.0789 A	0.0000 A	21.106 A	6.0762 %	35.674	1.2583

- Should the values be incorrect, recheck the PT/CT Ratios as well as the power source, [Voltage & Current Probe Connections](#).
- Go to the next step - [Verifying your Power](#) in order to verify that the **Active Power** readings are based on your [Current Configurations](#)

see also:

- [About Measurement Readings](#)
- [Access Measurement Summary](#)
- [Verify Power](#)

Verify Power Readings

Although Power Configurations is comprehensively dealt with in the Power Section, this section is necessary to verify that all the **Active Power** readings reflect **Positive Values**. Corrections can be made by toggling the polarity in the [Current Configurations](#).

For a full description on all the configurations, definitions & subsequent parameter calculations see Power.

- Access your **Portable BLACKBOX Unit** via the Web Interface → Open **Monitoring** → **Power**:

MONITORING	ENERGY	POWER QUALITY
Summary		V & I harmonics
Voltage & Current		P & Q harmonics
Average		Spectrum
Power		Harmonics Table
Temperature		V/I Min/Max Harmonics
Phasors		P/Q Min/Max Harmonics
Waveforms		
Voltage Flickering		
Pinst Waveform		
Min/Max Flickering		

- Verify that the **Active Power** readings reflect **Positive Values**:

MONITORING » POWER			CONFIGURATION » CURRENTS																																				
Power Summary <table border="1"> <thead> <tr> <th></th> <th>Active Power</th> <th>Reactive Power</th> </tr> </thead> <tbody> <tr> <td>Phase1</td> <td>51.375 kW</td> <td>-32.354 kVAr</td> </tr> <tr> <td>Phase2</td> <td>26.294 kW</td> <td>13.854 kVAr</td> </tr> <tr> <td>Phase3</td> <td>-0.0589 kW</td> <td>0.0025 kVAr</td> </tr> <tr> <td>Neutral</td> <td>0.0000 kW</td> <td>0.0000 kVAr</td> </tr> <tr> <td>Total</td> <td>77.610 kW</td> <td>-18.497 kVAr</td> </tr> </tbody> </table>				Active Power	Reactive Power	Phase1	51.375 kW	-32.354 kVAr	Phase2	26.294 kW	13.854 kVAr	Phase3	-0.0589 kW	0.0025 kVAr	Neutral	0.0000 kW	0.0000 kVAr	Total	77.610 kW	-18.497 kVAr	Apply Changes Refresh Data																		
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			Current Probes Info <table border="1"> <thead> <tr> <th rowspan="2">Channel</th> <th colspan="2">CT Ratio (A)</th> <th rowspan="2">Nominal (A)</th> <th rowspan="2">Polarity</th> </tr> <tr> <th>Primary</th> <th>Secondary</th> </tr> </thead> <tbody> <tr> <td>I₁</td> <td>---</td> <td>---</td> <td>---</td> <td>Normal</td> </tr> <tr> <td>I₂</td> <td>---</td> <td>---</td> <td>---</td> <td>Normal</td> </tr> <tr> <td>I₃</td> <td>100</td> <td>100</td> <td>100</td> <td>Reverse</td> </tr> <tr> <td>I_N</td> <td>300</td> <td>300</td> <td>300</td> <td>Normal</td> </tr> <tr> <td>I₅</td> <td>1</td> <td>1</td> <td>0.5</td> <td>Normal</td> </tr> </tbody> </table>					Channel	CT Ratio (A)		Nominal (A)	Polarity	Primary	Secondary	I ₁	---	---	---	Normal	I ₂	---	---	---	Normal	I ₃	100	100	100	Reverse	I _N	300	300	300	Normal	I ₅	1	1	0.5	Normal
Channel	CT Ratio (A)		Nominal (A)	Polarity																																			
	Primary	Secondary																																					
I ₁	---	---	---	Normal																																			
I ₂	---	---	---	Normal																																			
I ₃	100	100	100	Reverse																																			
I _N	300	300	300	Normal																																			
I ₅	1	1	0.5	Normal																																			

- Should any of the **Phase Integers** display a negative value (as per the highlighted section above) you will need to **Reverse** the **Polarity** for the **Phase** in the [Current Configurations](#). Alternatively you may also physically reverse the current clamp at the power source, by changing the direction. Generators commonly display a negative Active Power value.

see also:

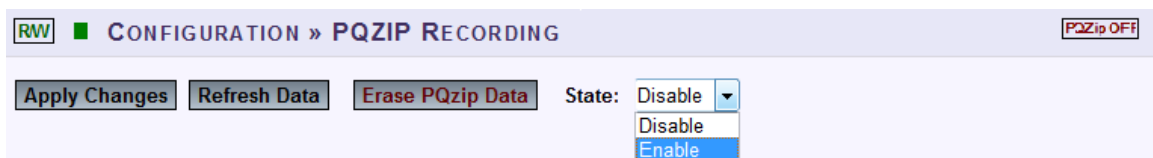
- [About Measurement Readings](#)
- [Access Measurement Summary](#)
- [Verify Voltage & Current](#)

Enabling PQZIP Recording

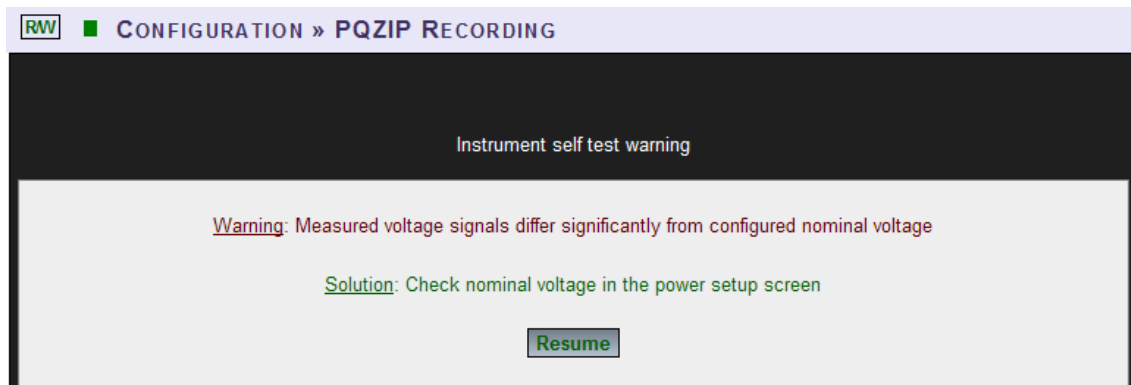
In order to record actual data for further analysis by PQSCADA & Investigator, you must first enable the PQZIP Recording.

HOW TO ENABLE PQZIP RECORDING

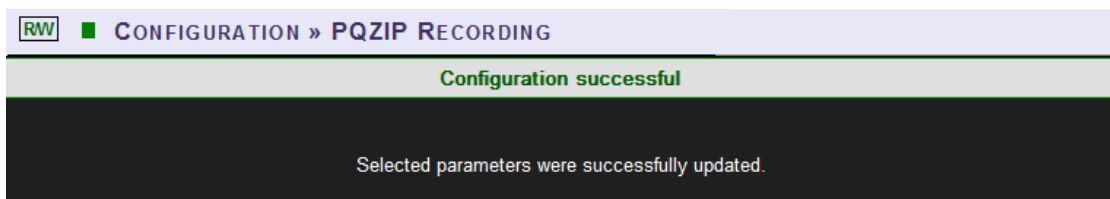
- [Access your Portable BLACKBOX Unit](#) via the Web Interface ➔ Open Configuration ➔ PQZIP Recording
- In the State drop-down selection select Enable:



- To apply your changes select **Apply Changes**
- The following warning may appear if some parameter readings are inconsistent with the configuration. In this case make sure all parameters are correct before enabling the PQZIP:



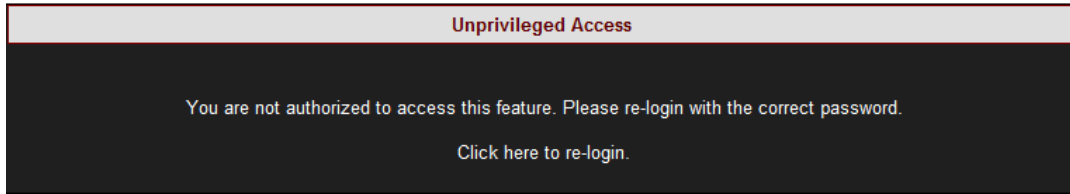
- Confirm by selecting **Resume** & the following success message will appear:



- To view your changes (refresh your current view) select **Refresh Data**

NOTE NOTE NOTE

- If you are not logged on as the Administrator, you will not be able to change any of these settings & you will receive the following error message in your attempt to do so:



- Once you have signed on at the Administrator ensure that you select **Apply Changes** to actually affect your changes.
- Once you have enabled the PQZIP recording, the PQZIP OFF Icon will no longer appear on the right-hand side on this & any other screen:



see also:

- [About Quick Installation](#)
- [Unit Powering](#)
- [About Portable Wiring](#)
- [Plug and Play Voltage & Current Probes](#)
- [Grounding](#)
- [Establish 1st Time Connection](#)
- [Unit Access](#)
- [About Quick Configuration](#)
- [Verify Measurement Readings](#)

About Monitoring Real Time Data

The Monitoring section displays real time readings and graphs of the grid's parameters. The graph display requires an ActiveX plug-in from Gigasoft that is downloadable either from [Elspec's Website's Support Section](#) or alternatively can be installed directly from your BLACKBOX CD. The ActiveX plug-in allows different view options needed for your PQ Monitoring. In the PQ Monitoring Section you will be able to monitor the following PQ measurements of your Portable BLACKBOX:

- Total measurements in the Summary Window
- [Voltage & Current Measurements](#)
- [Average Measurements](#)
- [Power Measurements](#)
- [Internal & External Temperature Readings](#)
- [Voltage & Current Phase Diagrams](#)
- [Voltage & Current Waveforms](#)
- [Short & Long Term Voltage Flickering](#)
- [Flickering Waveforms](#)
- [Minimum & Maximum Flickering Values](#)
- [Voltage & Current Harmonics Spectrum](#)
- [Active & Reactive Harmonic Powers](#)
- [Voltage & Current Sub & Inter-Harmonics](#)
- [Voltage & Current Harmonics in Values, %'s & Angles](#)
- [Minimum, Maximum Values & Angles of Voltage & Current Harmonics](#)
- [Minimum & Maximum Values of Active & Reactive Power Harmonics](#)

Access the PQ monitoring summary:

- Access your **Portable BLACKBOX Unit** via the Web Interface → Open **Monitoring** → **Summary**:

MONITORING	ENERGY	POWER QUALITY
Summary	V & I harmonics	
Voltage & Current	P & Q harmonics	
Average	Spectrum	
Power	Harmonics Table	
Temperature	V/I Min/Max Harmonics	
Phasors	P/Q Min/Max Harmonics	
Waveforms		
Voltage Flickering		
Pinst Waveform		
Min/Max Flickering		

- The **Summary & Synchronization Status Window** will now open:

MONITORING » SUMMARY		
Summary PU		
Frequency	50.002 Hz	
I_{avg}	0.0114 A	
V(LL)_{avg}	0.0421 V	
V(LN)_{avg}	1.2997 V	
Power factor_{total}	0.0736 (Ind)	
Phase Order	123	
Synchronization Status		
Time Synchronization	Main	Good
DSP Synchronization	On	

TABLE - PQ calculation method:

The table outlines the sections' Parameters including definitions:

Parameter	Definition
SUMMARY WINDOW	
Frequency	The number of cycles per second
I_{AVG}	The current in a single phase system or the current averaged over all three phases in a three phase system
$V(LL)_{AVG}$	Line to line voltage averaged over all three phases in a three phase system
$V(LN)_{AVG}$	Line to neutral voltage averaged over the three phases
Power Factor _{TOTAL}	Total True Power Factor over three phases, averaged by default over 1 minute
Phase Order	The order of the voltage phases starting from V_1 moving in a clockwise direction
SYNCHRONIZATION STATUS	
Time Synchronization	Indicates the connection quality to the time source. This connection supplies the instrument with world time (UTC) from a time source. The Time Sync quality is essential to PQZIP coherent file generation
DSP Synchronization	The unit is synchronized with the signals of the device

Voltage & Current Measurements

This page displays specific values for Voltage & Current Measurements. The viewed parameters depend on how your Portable BLACKBOX Unit has been Configured.

- [Access your Portable BLACKBOX Unit](#) via the Web Interface ➔ select **Monitoring** ➔ **Voltage & Current:**

MONITORING	ENERGY	POWER QUALITY
Summary		V & I harmonics
Voltage & Current		P & Q harmonics
Average		Spectrum
Power		Harmonics Table
Temperature		V/I Min/Max Harmonics
Phasors		P/Q Min/Max Harmonics
Waveforms		
Voltage Flickering		
Pinst Waveform		
Min/Max Flickering		

- The Voltage & Current PQ Monitoring Window will now open

Voltage & Current section (rms, min/max value, thd, crest factor, k factor):

V/I ☐ PU						
	RMS	Min Value	Max Value	THD	Crest Factor	K Factor
V ₁	1.4231 V	1.3982 V	230.67 V	6.8858 %	1.9276	---
V ₂	1.4215 V	1.3983 V	229.43 V	6.9813 %	1.5061	---
V ₃	1.4277 V	1.4037 V	230.67 V	6.8337 %	1.9216	---
V _N	0.2064 V	0.1398 V	0.2833 V	----	----	---
V ₁₂	0.0451 V	0.0382 V	1.2344 V	----	----	---
V ₂₃	0.0449 V	0.0379 V	1.2347 V	----	----	---
V ₃₁	0.0224 V	0.0117 V	0.0249 V	----	----	---
I ₁	0.0000 A	0.0000 A	49.982 A	----	----	----
I ₂	0.0000 A	0.0000 A	1.6611 kA	----	----	----
I ₃	0.0000 A	0.0000 A	46.349 kA	----	----	----
I _N	0.0789 A	0.0000 A	21.106 A	6.0762 %	35.674	1.2583
I ₅	0.0794 A	0.0000 A	75.190 A	5.8634 %	35.563	1.0700

table - Voltage & Current section (rms, min/max value, thd, crest factor, k factor) calculation method:

Parameter	Definition
PU	By selecting PU (Per Unit) will present the values as part of nominal (for example: 230V → 100.0%)
VRMS	$V_{RMS_x} = \sqrt{\sum_{n=1} ((V \cos \varphi)^2 + (V \sin \varphi)^2)}$ <p>n = Number of Samples</p> <p>x = Specific Channel</p> <p>10/12 Continuous Non-Overlapping Cycles Accordance with IEC61000-4-30</p> <p style="text-align: right;">In</p>
ARMS	$I_{RMS_x} = \sqrt{\sum_{n=1} ((I \cos \varphi)^2 + (I \sin \varphi)^2)}$ <p>n = Number of Samples</p> <p>x = Specific Channel</p> <p>10/12 Continuous Non-Overlapping Cycles Accordance with IEC61000-4-30</p> <p style="text-align: right;">In</p>
Min Value	Minimum RMS value since the initial power up or the most recent selection of: Reset All Min/Max
Max Value	Maximum RMS value since the initial power up or the most recent selection of: Reset All Min/Max
THD	$\sqrt{\frac{\sum_{n=2}^{50} C_n^2}{C_1^2}}$ <p>C = Harmonic RMS Value</p> <p>n = Harmonic Order</p>

Parameter	Definition
V Crest Factor	$\frac{V_{PEAK}}{V_{RMS}}$ <p>Measures Ratio Between the VPEAK and VRMS</p>
A Crest Factor	$\frac{I_{peak}}{I_{RMS}}$ <p>Measures Ratio Between the IPEAK and IRMS</p>
K Factor	$\frac{\sum_{n=1}^{25} (i_n * n)^2}{\sum_{n=1}^{25} i_n^2}$ <p>Where n is the Harmonic #, and i_n is the RMS value of the n^{TH} Harmonic</p>

Voltage & Current section (tdd, thd eVEN, thd ODD, OVER-DEVIATION, UNDER DEVIATION):

VII					
	TDD	THD Even	THD Odd	Over-deviation	Under-deviation
V ₁	---	1.7418 %	6.6401 %	230.94 V	1.4234 V
V ₂	---	1.4148 %	6.9192 %	230.94 V	1.4231 V
V ₃	---	1.6601 %	6.5897 %	230.94 V	1.4287 V
V _N	---	----	----	230.94 V	0.2043 V
V ₁₂	---	----	----	400.00 V	0.0447 V
V ₂₃	---	----	----	400.00 V	0.0447 V
V ₃₁	---	----	----	400.00 V	0.0225 V
I ₁	----	----	----	---	---
I ₂	----	----	----	---	---
I ₃	----	----	----	---	---
I _N	4.1911 %	4.0172 %	5.0738 %	---	---
I ₅	6.0551 %	3.9180 %	4.2431 %	---	---

table voltage & Current section (tdd, thd eVEN, thd ODD, OVER-DEVIATION, UNDER DEVIATION) calculation method:

Parameter	Definition
TDD	<p>Total Demand Distortion - TDD - is the current distortion (harmonics above the 1st) as a percent of maximum demand load. TDD is defined using the following relationship:</p> $I_{TDD} = \sqrt{\sum_{h=2}^{\infty} \left[\frac{I_h^2}{I_L^2} \right]} * 100\%$
THD Even	$\sqrt{\frac{\sum_1^{25} C_{2n}^2}{C_1^2}}$ <p>C = Harmonic RMS Value n = Harmonic Order</p>
THD Odd	$\sqrt{\frac{\sum_1^{25} C_{2n+1}^2}{C_1^2}}$ <p>C = Harmonic RMS Value n = Harmonic Order</p>
Over-Deviation	The Over-Deviation indicates how much higher the RMS Voltage is than the Reference Voltage
Under-Deviation	The Under-Deviation indicates how much lower the RMS Voltage is than the Reference Voltage

unbalance section (avg, min, max):

Unbalance			
	Avg.	Min.	Max.
U ₋ Unbalance	123.90 %	0.5155 %	4227.8 %
U ₊ Positive Sequence	0.0020 V	0.0000 V	0.6441 V
U ₋ Negative Sequence	0.0025 V	0.0000 V	0.6333 V
U ₀ Sequence	2.0041 V	0.1559 V	327.24 V
u ₀ Zero sequence ratio	98272 %	8984.5 %	***
i ₋ Unbalance	----	----	----
i ₊ Positive Sequence	----	----	----
i ₋ Negative Sequence	----	----	----
i ₀ Zero sequence	----	----	----

table - unbalance section (Avg, Min, Max) parameters calculation method:

The table outlines the sections' Parameters including Calculation:

Parameter	Definition
Unbalance	The Supply Voltage Unbalance is Evaluated Using the Method of Symmetrical Components in Accordance with IEC61000-4-30
Unbalance Avg.	The Average Supply Voltage Unbalance is Evaluated Using the Method of Symmetrical Components in Accordance with IEC61000-4-30
Unbalance Min.	The Minimum Supply Voltage Unbalance is Evaluated Using the Method of Symmetrical Components in Accordance with IEC61000-4-30
Unbalance Max.	The Maximum Supply Voltage Unbalance is Evaluated Using the Method of Symmetrical Components in Accordance with IEC61000-4-30
Zero Sequence Unbalance	$U_0 = \left \frac{u_0}{u_1} \right * 100$
Negative Sequence Unbalance	$U_2 = \left \frac{u_2}{u_1} \right * 100$
Positive Sequence	<p>Defined as the symmetrical vector system derived by application of the Fortescue's transformation matrix, and that rotates in the same direction as the power frequency voltage (or current):</p> $\underline{U}_1 = \frac{1}{3} (\underline{U}_a + a \cdot \underline{U}_b + a^2 \cdot \underline{U}_c)$ <p>where $a = 1\angle 120^\circ = -\frac{1}{2} + j\frac{\sqrt{3}}{2}$ and $\underline{U}_a, \underline{U}_b, \underline{U}_c$ and are line to neutral voltages (fundamental component)</p> <p>In Accordance With IEC61000-3-13, ed. 1.0 (2008-02) Ref: 3.26.3</p>
Negative Sequence	<p>Defined as the symmetrical vector system derived by application of the Fortescue's transformation matrix, and that rotates in the opposite direction to the power frequency voltage (or current):</p> $\underline{U}_1 = \frac{1}{3} (\underline{U}_a + a^2 \cdot \underline{U}_b + a \cdot \underline{U}_c)$ <p>where $a = 1\angle 120^\circ = -\frac{1}{2} + j\frac{\sqrt{3}}{2}$ and $\underline{U}_a, \underline{U}_b, \underline{U}_c$ and are line to neutral voltages (fundamental component)</p> <p>In Accordance With IEC61000-3-13, ed. 1.0 (2008-02) Ref: 3.26.4</p>
Zero Sequence	<p>Defined as the in-phase symmetrical vector system derived by application of the Fortescue's transformation matrix:</p> $\underline{U}_0 = \frac{1}{3} (\underline{U}_a + \underline{U}_b + \underline{U}_c)$ <p>where $\underline{U}_a, \underline{U}_b, \underline{U}_c$ and are line to neutral voltages (fundamental component)</p> <p>In Accordance With IEC61000-3-13, ed. 1.0 (2008-02) Ref: 3.26.5</p>

DC VOLTAGE & CURRENT SECTION (rms, Min, Max):

DC V/I			
	RMS	Min Value	Max Value
V_{DC}	0.5273 V	-0.5273 V	0.5273 V
I_{DC}	2.7393 A	-611.00 A	1.5670 kA

table - DC VOLTAGE & CURRENT SECTION (rms, Min, Max) parameters calculation method:

The table outlines the sections' Parameters including Calculation:

Parameter	Definition
DC Voltage & Current RMS	RMS-DC is the Root Mean Square of the DC component of the signal
DC Voltage & Current Min.	Minimum RMS value since the initial power up or the most recent selection of: Reset All Min/Max
DC Voltage & Current Max.	Maximum RMS value since the initial power up or the most recent selection of: Reset All Min/Max

see also:

- [About PQ Monitoring](#)
- [Averaging](#)
- [Power](#)
- [Temperature](#)
- [Phasors](#)
- [Waveforms](#)
- [Voltage Flickering](#)
- [Pinst Waveforms](#)
- [Min/Max Flickering](#)
- [Voltage & Current Harmonics](#)
- [PQ Harmonics](#)
- [Spectrum](#)
- [Harmonics Table](#)
- [V/I Min/Max Harmonics](#)
- [P/Q Min/Max Harmonics](#)

Average

In accordance to the IEC-61000-4-30 measurement standards, the Portable BLACKBOX displays the following Average Measurements: Aggregation of 150/180 cycles (3seconds); 10 minutes & 2 hours based at a Frequency of 10 minutes.

open the average window:

- [Access your Portable BLACKBOX Unit](#) via the Web Interface ➔ select **Monitoring**
➔ **Average:**

MONITORING	ENERGY	POWER QUALITY
Summary		V & I harmonics
Voltage & Current		P & Q harmonics
<u>Average</u>		Spectrum
Power		Harmonics Table
Temperature		V/I Min/Max Harmonics
Phasors		P/Q Min/Max Harmonics
Waveforms		
Voltage Flickering		
Pinst Waveform		
Min/Max Flickering		

- The Average Window will now open:

MONITORING » AVERAGE			
Frequency			
Frequency _{Over 10 sec}		50.002 Hz	
Averages			
	150/180 Cycles	10 Min.	2 Hours
Timestamp	25/12/2011 15:56:25	25/12/2011 15:50:00	DD/MM/YYYY HH:MM:SEC
Flag	Flagged: V1,V2,V3	Flagged: V1,V2,V3	Not flagged
V ₁	1.4311 V	1.4215 V	0.0000 V
V ₂	1.4310 V	1.4209 V	0.0000 V
V ₃	1.4366 V	1.4266 V	0.0000 V
V _N	0.2114 V	0.2054 V	0.0000 V
V ₁₂	0.0468 V	0.0473 V	0.0000 V
V ₂₃	0.0469 V	0.0476 V	0.0000 V
V ₃₁	0.0224 V	0.0217 V	0.0000 V
Under-deviation			
	150/180 Cycles	10 Min.	2 Hours
V ₁	99.380 %	99.384 %	0.0000 %
V ₂	99.381 %	99.385 %	0.0000 %
V ₃	99.378 %	99.382 %	0.0000 %
V _N	0.2114 %	99.911 %	0.0000 %
V ₁₂	99.987 %	99.988 %	0.0000 %
V ₂₃	99.987 %	99.988 %	0.0000 %
V ₃₁	99.994 %	99.995 %	0.0000 %
Over-deviation			
	150/180 Cycles	10 Min.	2 Hours
V ₁	0.0000 %	0.0000 %	0.0000 %
V ₂	0.0000 %	0.0000 %	0.0000 %
V ₃	0.0000 %	0.0000 %	0.0000 %
V _N	0.0000 %	0.0000 %	0.0000 %
V ₁₂	0.0000 %	0.0000 %	0.0000 %
V ₂₃	0.0000 %	0.0000 %	0.0000 %
V ₃₁	0.0000 %	0.0000 %	0.0000 %
Over-deviation			
	150/180 Cycles	10 Min.	2 Hours
V ₁	0.0000 %	0.0000 %	0.0000 %
V ₂	0.0000 %	0.0000 %	0.0000 %
V ₃	0.0000 %	0.0000 %	0.0000 %
V _N	0.0000 %	0.0000 %	0.0000 %
V ₁₂	0.0000 %	0.0000 %	0.0000 %
V ₂₃	0.0000 %	0.0000 %	0.0000 %
V ₃₁	0.0000 %	0.0000 %	0.0000 %
Unbalance			
	150/180 Cycles	10 Min.	2 Hours
u ₋ Unbalance	84.576 %	107.64 %	0.0000 %
U ₊ Positive Sequence	0.0030 V	0.0028 V	0.0000 V
U ₋ Negative Sequence	0.0022 V	0.0022 V	0.0000 V
U ₀ Sequence	1.8455 V	1.8429 V	0.0000 V
u ₀ Zero sequence ratio	67545 %	78179 %	0.0000 %
i ₋ Unbalance	100.000 %	100.01 %	0.0000 %
I ₊ Positive Sequence	0.0006 A	0.0013 A	0.0000 A
I ₋ Negative Sequence	0.0006 A	0.0013 A	0.0000 A
I ₀ Zero sequence	0.0006 A	0.0013 A	0.0000 A
i ₀ Zero sequence ratio	100.000 %	100.03 %	0.0000 %

table - average calculation method:

The table outlines the sections' Parameters including Definition:

Parameter	Definition
Frequency	Frequency - 10 seconds averaging
Average 150/180 Cycles	Average Measurements at an aggregation of 150/180 cycles (~3seconds)
Average 10 Min.	Average Measurements at an aggregation of 10 minutes
Average 2 Hours	Average Measurements at an aggregation of 2 hours
Under Deviation 150/180 Cycles	Displays how much lower the Average RMS Voltage is than the Reference Voltage at an aggregation of 150/180 cycles (~3seconds)
Under Deviation 10 Min.	Displays how much lower the Average RMS Voltage is than the Reference Voltage at an aggregation of 10 minutes
Under Deviation 2 Hours	Displays how much lower the Average RMS Voltage is than the Reference Voltage at an aggregation of 2 hours
Over Deviation 150/180 Cycles	Displays how much higher the Average RMS Voltage is than the Reference Voltage at an aggregation of 150/180 cycles (~3seconds)
Over Deviation 10 Min.	Displays how much higher the Average RMS Voltage is than the Reference Voltage at an aggregation of 10 minutes
Over Deviation 2 Hours	Displays how much higher the Average RMS Voltage is than the Reference Voltage at an aggregation of 2 hours
Unbalance 150/180 Cycles	<p>The Supply Voltage Unbalance is Evaluated Using the Method of Symmetrical Components in Accordance with IEC61000-4-30:</p> $Unbalance = \left[\frac{I_n}{I_p} \right] * 100$ <p>This entry displays the Average Maximum/Minimum Unbalanced Values at an aggregation of 150/180 cycles (~3seconds)</p>
Unbalance 10 Min.	This entry displays the Average Maximum/Minimum Unbalanced Values at an aggregation of 10 minutes
Unbalance 2 Hours	This entry displays the Average Maximum/Minimum Unbalanced Values at an aggregation of 2 hours

see also:

- [About PQ Monitoring](#)
- [Voltage & Current](#)
- [Power](#)
- [Temperature](#)
- [Phasors](#)
- [Waveforms](#)
- [Voltage Flickering](#)
- [Pinst Waveforms](#)
- [Min/Max Flickering](#)
- [V&I Harmonics](#)
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- [Spectrum](#)
- [Harmonics Table](#)
- [V/I Min/Max Harmonics](#)
- [P/Q Min/Max Harmonics](#)

Power

This page displays different electrical power parameters relevant to the Specific G4500/G3500 BLACKBOX Unit Configuration.

open the Power summary window:

- [Access your Portable BLACKBOX Unit](#) via the Web Interface → select **Monitoring**
→ **Power**:

MONITORING	ENERGY	POWER QUALITY
Summary		V & I harmonics
Voltage & Current		P & Q harmonics
Average		Spectrum
Power		Harmonics Table
Temperature		V/I Min/Max Harmonics
Phasors		P/Q Min/Max Harmonics
Waveforms		
Voltage Flickering		
Pinst Waveform		
Min/Max Flickering		

- The Power Summary Window will now open:

Power Summary					
	Active Power	Reactive Power	Apparent Power	True PF	Displacement PF
Phase1	14.478 kW	2.4813 kVAr	14.689 kVA	0.9856 (Ind)	0.9942 (Ind)
Phase2	14.823 kW	2.3731 kVAr	15.012 kVA	0.9874 (Ind)	0.9999 (Ind)
Phase3	10.906 kW	-2.1986 kVAr	11.126 kVA	0.9803 (Cap)	0.9931 (Cap)
Neutral	0.0000 kW	0.0000 kVAr	0.0000 kVA	0.0489 (Ind)	---
Total	40.207 kW	2.6558 kVAr	40.827 kVA	0.9848 (Ind)	0.9942 (Ind)

Should any of the **Phase Integers** display a negative value, you will need to **Reverse** the **Polarity** for the **Phase** in the [Current Configurations](#). Alternatively you may also physically reverse the current clamp at the power source, by changing the direction. Generators commonly display a negative Active Power value.

table - power calculation method:

The table outlines the sections' Parameters including Definition:

Parameter	Definition
<p>Active Power</p>	<p>The amount of Active Power consumed as usable energy. Sometimes referred to as Real Power. The portion of power flow that, averaged over a complete cycle of the AC waveform, results in the net transfer of energy in one direction expressed as kWh.</p> <p>Elspec calculates the Active Power accurately by taking all Harmonics up to the 40th into account using the following formula:</p> $P = \frac{1}{2} \sum_i V_{i,j} \cdot I_{i,j} \cdot \cos \theta_{i,j} \text{ [Watt]}$ <p>i = Harmonic j = Phase</p>
<p>Reactive Power</p>	<p>The amount of Reactive Power consumed as unusable energy. Energy that flows back and forth with no actual power flow. Reactive Power flow transfers no net energy to the load and is sometimes referred to as Wattless power. Elspec calculates reactive power using the following formula:</p> $Q = -P_q = - V I \sin\theta = -\vec{V} \times \vec{I} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ V_x & V_y & 0 \\ I_x & I_y & 0 \end{vmatrix} = \hat{k}(-V_x I_y + I_x V_y) \text{ [VAR]}$ <p>Elspec calculates the sign of Q using the following formula:</p> <p>Sign of Q = sign of: $\left(\sum_i (-V_{xi} \cdot I_{yi} + V_{yi} \cdot I_{xi}) \right)$</p>
<p>Apparent Power</p>	<p>The amount of Apparent Power; a vector addition of the Active and Reactive Power. The combination of active and reactive energy (kVAh)</p> <p>Elspec uses formula:</p> $S = V_{RMS} * I_{RMS} \text{ [VA]}$

PARAMETER	DEFINITION																									
True Power Factor (PF)	<p>The ratio between Real Power & Apparent Power (a value between 0 and 1). The most accurate measure of efficiency is the True Power Factor. It is defined as the sum of the P/S ratio over all the Harmonics:</p> $PF_{sign} = P_{sign} * Q_{sign}$ <p>if $PF_{sign} > 0$ than IND; $PF_{sign} < 0$ than CAP</p> <table border="1"> <thead> <tr> <th>QUADRAT</th> <th colspan="3"></th> <th>PF UNIT</th> </tr> </thead> <tbody> <tr> <td>I</td> <td>+</td> <td>+</td> <td>+</td> <td>IND</td> </tr> <tr> <td>II</td> <td>-</td> <td>+</td> <td>-</td> <td>CAP</td> </tr> <tr> <td>III</td> <td>-</td> <td>-</td> <td>+</td> <td>IND</td> </tr> <tr> <td>IV</td> <td>+</td> <td>-</td> <td>-</td> <td>CAP</td> </tr> </tbody> </table>	QUADRAT				PF UNIT	I	+	+	+	IND	II	-	+	-	CAP	III	-	-	+	IND	IV	+	-	-	CAP
QUADRAT				PF UNIT																						
I	+	+	+	IND																						
II	-	+	-	CAP																						
III	-	-	+	IND																						
IV	+	-	-	CAP																						
Displacement Power Factor (PF)	<p>Same as True PF, But Only With Fundamental Components:</p> $true\ PF = \left \frac{P_{h1}}{S_{h1}} \right , \text{ if } Q > 0 \text{ than CAP; if } Q < 0 \text{ than IND}$																									

SEE ALSO

- [About PQ Monitoring](#)
- [Voltage & Current](#)
- [Averaging](#)
- [Temperature](#)
- [Phasors](#)
- [Waveforms](#)
- [Voltage Flickering](#)
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- [P/Q Min/Max Harmonics](#)

Temperature

Ambient temperature is an important parameter for both the immediate external environment and within your Portable BLACKBOX Unit. Temperature extremes do affect measuring accuracy. Therefore, monitoring the internal temperature of the instrument is important when monitoring all measured electrical parameters to ensure that the values can be assumed to be of maximum accuracy. A rise in power supply temperature could be a sign of incorrect probe connections or some other malfunction.

open the temperature window:

- [Access your Portable BLACKBOX Unit](#) via the Web Interface → select **Monitoring** → **Temperature:**

MONITORING	ENERGY	POWER QUALITY
Summary	V & I harmonics	
Voltage & Current	P & Q harmonics	
Average	Spectrum	
Power	Harmonics Table	
<u>Temperature</u>	V/I Min/Max Harmonics	
Phasors	P/Q Min/Max Harmonics	
Waveforms		
Voltage Flickering		
Pinst Waveform		
Min/Max Flickering		

- The **Temperature Window** will now open:

RO ■ MONITORING » TEMPERATURE			
Reset All Min/Max			
Internal Temperature			
Internal _{avg}	Internal _{min}	Internal _{max}	
45.95 °C	43.99 °C	47.98 °C	
External Temperature			
External _{avg}	External _{min}	External _{max}	
No PT100	No PT100	No PT100	
PSU Temperature			
PSU _{avg}	PSU _{min}	PSU _{max}	
52.19 °C	48.50 °C	57.16 °C	

table - temperature Options:

The table outlines the sections' Parameters including Definition:

Parameter	Definition
Internal Temperature	The average, minimum, and maximum internal temperature of the DSP Module
External Temperature	Utilizing a PT100 Thermometer , average, minimum, and maximum outside temperatures are monitored. The temperatures measured every network cycle and averaged over 10 cycles. The data is stored in the PQZIP files every 10 minutes.
PSU Temperature	The average minimum and maximum temperature of the General Power Supply of your Portable BLACKBOX Unit
Reset All Min/Max	Reset all Min/Max measurements of your G4K Unit

SEE ALSO

- [About PQ Monitoring](#)
- [Voltage & Current](#)
- [Averaging](#)
- [Power](#)
- [Phasors](#)
- [Waveforms](#)
- [Voltage Flickering](#)
- [Pinst Waveforms](#)
- [Min/Max Flickering](#)
- [V&I Harmonics](#)
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- [V/I Min/Max Harmonics](#)
- [P/Q Min/Max Harmonics](#)

Phasors

A Phasor is a vector representation of the Voltages & Currents in the system. The Phasor Window of the BLACKBOX Web Interface represents both Wye and Delta Voltage Configurations in a Phasor format. Therefore, the Phasors are a vector representation of the First Harmonic.

NOTE NOTE NOTE

- In order to display the Phasor graph, ensure that you install the ActiveX plug-in from Gigasoft (downloadable either from [Elspec's Website's Support Section](#) or alternatively can be installed directly from your [BLACKBOX CD](#)). You will receive the following error message if the program is not installed:

**Charting plugin initialization failed!
Browser security prevents automatic
installation of ActiveX control**

- **For Internet Explorer 8/9 Users:** Once you have installed Gigasoft, ensure that the Internet Explorer is running in **Compatibility View**:



open the phasors window:

- [Access your Portable BLACKBOX Unit](#) via the Web Interface ➔ select **Monitoring**
➔ **Phasors:**

MONITORING	ENERGY	POWER QUALITY
Summary		V & I harmonics
Voltage & Current		P & Q harmonics
Average		Spectrum
Power		Harmonics Table
Temperature		V/I Min/Max Harmonics
Phasors		P/Q Min/Max Harmonics
Waveforms		
Voltage Flickering		
Pinst Waveform		
Min/Max Flickering		

- The Phasor Window will now open:

RO ■ MONITORING » PHASORS

[Voltage]
 [Current]
 [Diff Voltage]
 [Normalize]

	Ampl	Angle
■ V ₁	230.7 V	0 °
■ V ₂	229.4 V	0 °
■ V _s	230.6 V	0 °
■ V _N	0.017 V	85.4 °
■ V ₁₂	1.233221 V	-0.51 °
■ V ₂₃	1.230224 V	179.97 °
■ V ₃₁	0.000393 V	147.05 °
■ I ₁	0.000 A	39.17 °
■ I ₂	29.40 A	2.93 °
■ I ₃	0.001 A	76.22 °
■ I _N	28.29 A	0.93 °

table - phasors options:

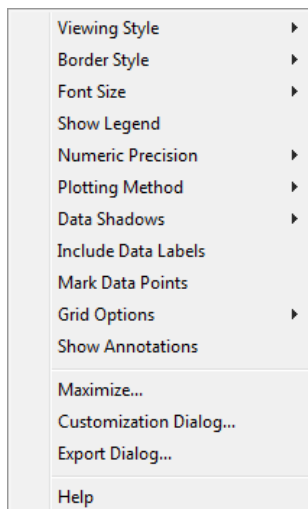
The table outlines the sections' Parameter options (for your selection) including their Definition:

Parameter	Definition
-----------	------------

Voltage	Displays Voltage Phase to Neutral Phasor (only present with WYE 4 Wire configuration)
Current	Displays Phase Current
Diff Voltage	Displays the Phase to Neutral Voltages Phasor
Diff Current	Displays the Phase to Phase Current (only present with Delta 3 Wire configuration)
Normalize	Displays the all vector as part of the largest vector
Ampl	The Amplitude of each Phasor
Angle	V1 /V12 is at 0°, all other vectors are in relation to V1 /V12

chart options:

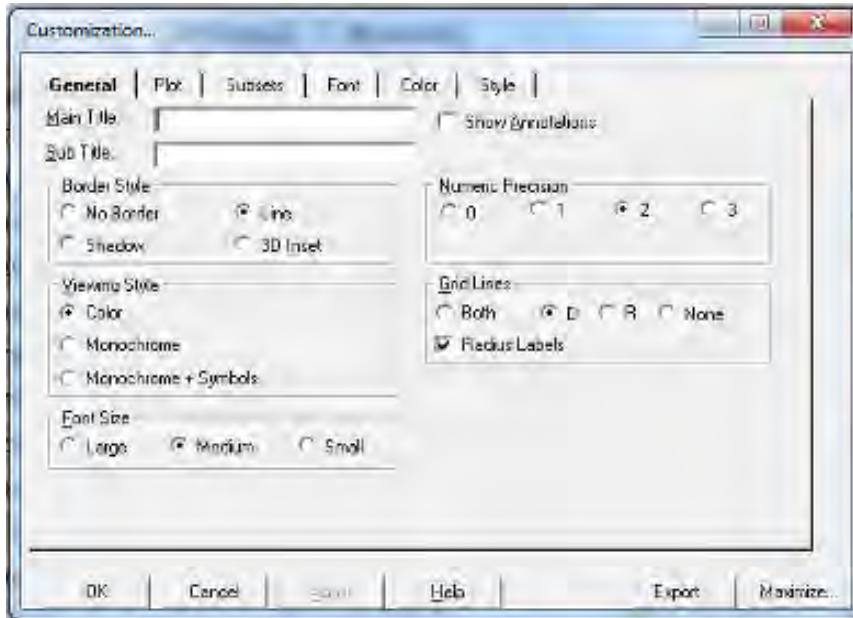
- Right-click on the chart to access various options & capabilities for the chart:



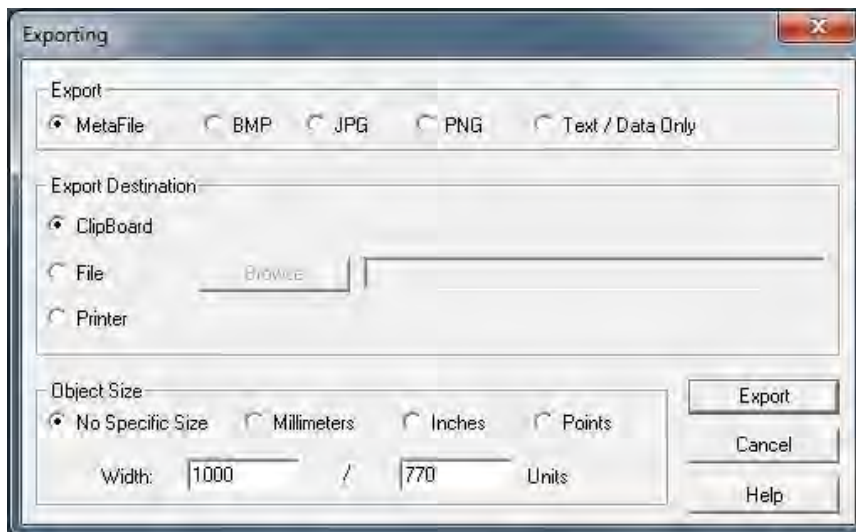
You may use the following chart options & capabilities:

- **Viewing Style:** Different styling options Color / Monochrome (B&W) with/without Symbols / Bitmap etc. By selecting the option you can view on screen the different styles available to you
- **Border Style:** No Border, Thin Line, Shadow / Inset
- **Font Size:** Large / Medium / Small
- **Show Legend:** Display / Not display Legend
- **Plotting Method:** From Line / Point / Point & Line
- **Data Shadows:** Off / Shadow / 3D
- **Include Data Labels:** Include / Exclude Numeric Data Labels
- **Mark Data Points:** Mark/Unmark Data Points

- **Grid Options:** Extend Radius Tick Marks, Both Degrees & Radius, Degrees, Radius, Hid Grid Lines, Thin Grid Lines, Thick Grid Lines, Dotted Grid Lines, Dashed Grid Lines & One Pixel Grid Lines
- **Maximize:** Min / Max the Phasor Graph Only
- **Customization Dialog:** Various General Graph Customization Options (all options):



- **Export Dialog - Various Export Options:**



SEE ALSO

- [About PQ Monitoring](#)
- [Voltage & Current](#)
- [Averaging](#)
- [Power](#)
- [Temperature](#)
- [Waveforms](#)
- [Voltage Flickering](#)
- [Pinst Waveforms](#)
- [Min/Max Flickering](#)
 - [V&I Harmonics](#)
- [P&Q Harmonics](#)
- [Spectrum](#)
- [Harmonics Table](#)
- [V/I Min/Max Harmonics](#)
- [P/Q Min/Max Harmonics](#)

Waveforms

The Waveform page displays the actual Voltage & Current waveforms monitored by your Portable BLACKBOX Unit.

NOTE NOTE NOTE

- In order to display the Phasor graph, ensure that you install the ActiveX plug-in from Gigasoft (downloadable either from [Elspec's Website's Support Section](#) or alternatively can be installed directly from your [BLACKBOX CD](#)). You will receive the following error message if the program is not installed:

**Charting plugin initialization failed!
Browser security prevents automatic
installation of ActiveX control**

- **For Internet Explorer 8/9 Users:** Once you have installed Gigasoft, ensure that the Internet Explorer is running in **Compatibility View**:



OPEN the waveforms window:

- [Access your Portable BLACKBOX Unit](#) via the Web Interface → select **Monitoring**
→ **Waveforms**:

MONITORING	ENERGY	POWER QUALITY
Summary	V & I harmonics	
Voltage & Current	P & Q harmonics	
Average	Spectrum	
Power	Harmonics Table	
Temperature	V/I Min/Max Harmonics	
Phasors	P/Q Min/Max Harmonics	
Waveforms		
Voltage Flickering		
Pinst Waveform		
Min/Max Flickering		

- The Waveforms Window will now open:

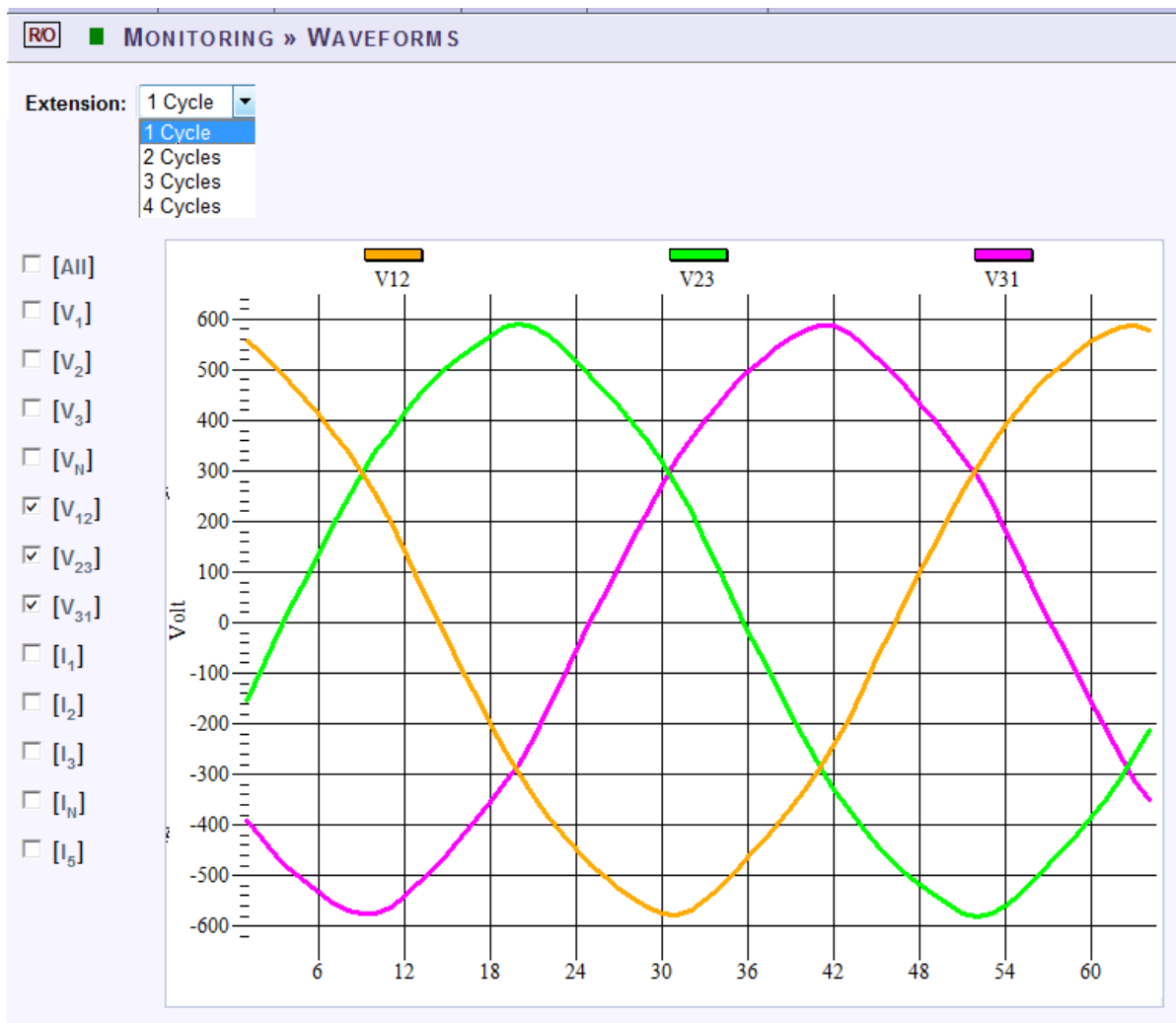


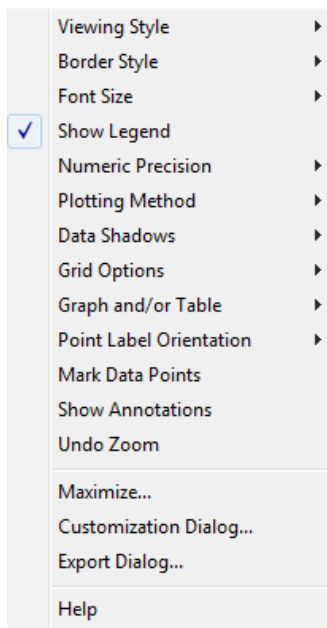
table - waveform options:

The table outlines the sections' Parameter options (for your selection) including their Definition:

Parameter	Definition
Cycle	Cycle Selection (1-4 Cycles)
All	Checking the "All graphs" box will automatically select all the boxes below
Voltage & Current	Depending on your power configuration, you can view all combinations of phase to phase and phase to line voltage and current combinations by making selections in the appropriate check boxes

chart options:

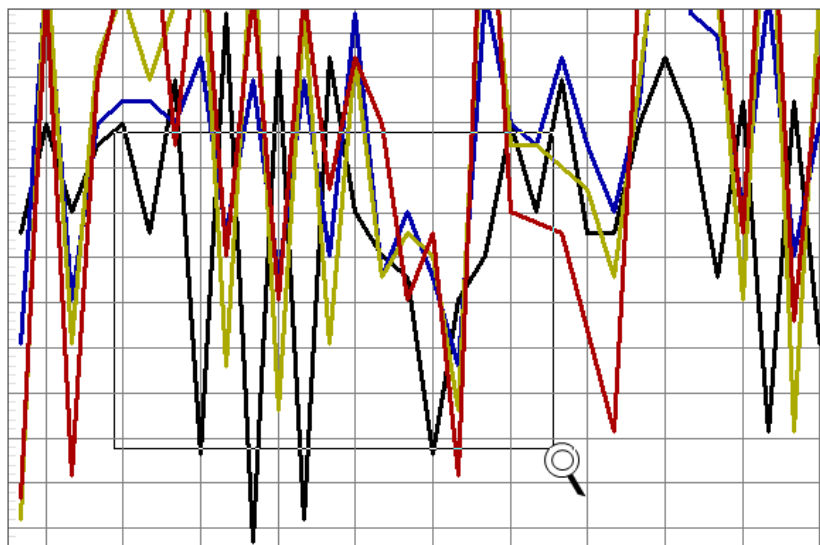
- By right-clicking on the chart you have various chart options & capabilities available to you:



- **Viewing Style:** Different styling options Color / Monochrome (B&W) with/without Symbols / Bitmap etc. By selecting the option you can view on screen the different styles available to you
- **Border Style:** No Border, Thin Line, Shadow / Inset
- **Font Size:** Large / Medium / Small
- **Display / Not display Legend**
- **Numeric Precision:** No up to 3 Decimals
- **Plotting Method:** From Line / Bar / Point / Area / Spline / Combinations
- **Data Shadows:** Off / Shadow / 3D
- **Grid Options:** Various grid options ranging from dots / lines / different axis etc.
- **Graph & Table:** Display either the graph / table / both:

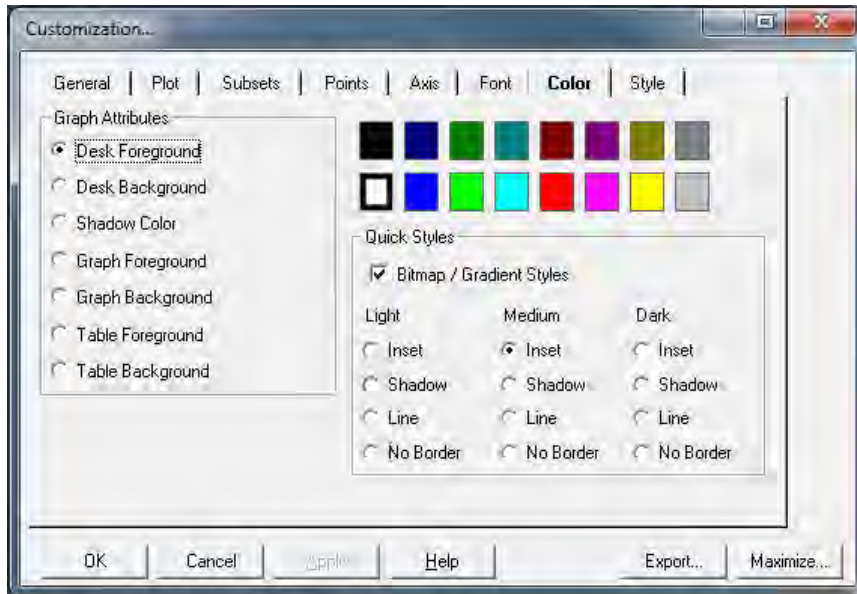
V1	-0.610	0.316	0.487	-0.659	-0.220	0.512	-0.413	-1.240	-0.145	0.245
V2	-0.514	0.270	0.245	-0.586	-0.219	0.391	-0.075	-0.516	0.097	0.195
V3	-0.927	0.439	0.463	-0.903	-0.367	0.756	-0.243	-0.876	0.465	0.318
VN	0.122	-0.049	-0.391	-0.293	-0.513	-0.318	-0.293	-0.220	0.024	0.073
V12	0.244	0.049	0.098	-0.047	-0.338	0.001	-0.000	-0.266	-0.243	0.340
V23	0.317	0.365	-0.293	-0.050	0.509	-0.123	-0.146	0.388	0.219	-0.365
V31	-0.561	-0.415	0.195	0.097	-0.172	0.122	0.146	-0.123	0.024	0.025
I1	3.906	0.244	-1.465	0.488	-0.244	0.488	1.221	0.977	-0.977	0.488
I2	3.418		-1.709	0.244	-0.488	0.977	0.732	0.732	-1.465	0.244
I3	3.174	0.488	-1.221	0.488		0.488	0.244	0.488	-1.221	-1.221
IN	0.732	-0.244	-1.953	-1.465	-2.197	-0.488		-0.977	-1.465	-0.488

- **Point Label Orientation:** Auto / Vertical / Horizontal / Slanted
- **Mark Data Points:** Displays data points on graph
- **Show Annotations:** Displays annotations data descriptions
- **Zoom / Undo Zoom - Zoom in /out on your graph:**
 - From the main Waveform window, select an area to zoom in. Left-click and drag the mouse to define the area:

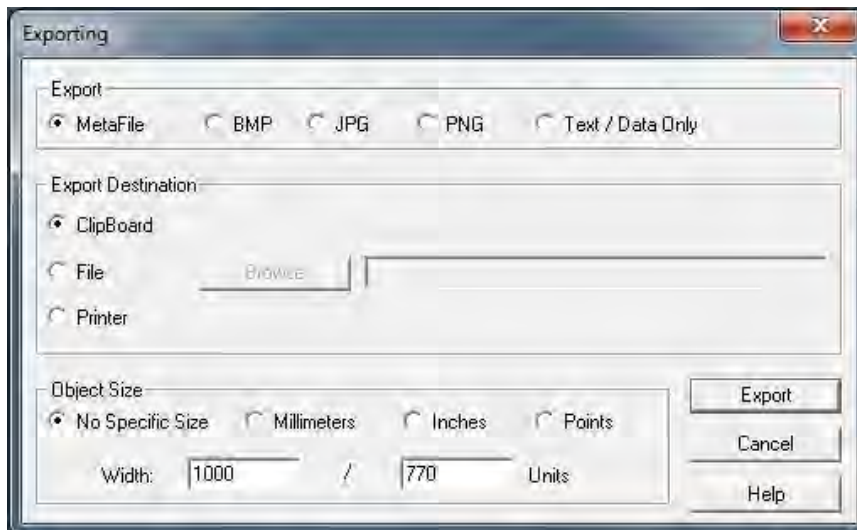


- The enlarged area will now appear in the window
- Zoom out by right/click ➡ & select **Zoom out**
- **Maximize:** Maximize / Minimize graph

- **Customization Dialog - Various General Graph Customization Options** (all options apart from zooming above):



- **Export Dialog - Various Export Options:**



SEE ALSO

- [About PQ Monitoring](#)
- [Voltage & Current](#)
- [Averaging](#)
- [Power](#)
- [Temperature](#)
- [Phasors](#)
- [Voltage Flickering](#)
- [Pinst Waveforms](#)
- [Min/Max Flickering](#)
- [V&I Harmonics](#)
- [P&Q Harmonics](#)
- [Spectrum](#)
- [Harmonics Table](#)
- [V/I Min/Max Harmonics](#)
- [P/Q Min/Max Harmonics](#)

Voltage Flickering

Displays the short & long term Voltage Flickering to a very close approximation of the EN50160 values.

OPEN THE VOLTAGE FLICKERING WINDOW:

- Access your **Portable BLACKBOX Unit** via the Web Interface → select **Monitoring** → **Voltage Flickering**:

MONITORING	ENERGY	POWER QUALITY
Summary	V & I harmonics	
Voltage & Current	P & Q harmonics	
Average	Spectrum	
Power	Harmonics Table	
Temperature	V/I Min/Max Harmonics	
Phasors	P/Q Min/Max Harmonics	
Waveforms		
Voltage Flickering		
Pinst Waveform		
Min/Max Flickering		

- The **Voltage Flickering Window** will now open:

MONITORING » VOLTAGE FLICKERING								
Reset Flickering								
Voltage Flickering								
	PST INST	PSST 10 Sec.	PST 10 Min.	SPLT 1 Hour	PLT 2 Hour	LPLT 10 Hour	LPLT 1 Day	LPLT 7 Day
V ₁	10.261	9.9621	96.653	10.472	N/A	N/A	N/A	N/A
V ₂	3.0913	2.8673	95.901	3.2235	N/A	N/A	N/A	N/A
V ₃	9.8416	9.7259	95.952	10.159	N/A	N/A	N/A	N/A
V ₁₂	1172.1	1561.5	152.00	182.70	N/A	N/A	N/A	N/A
V ₂₃	1253.7	1611.5	150.77	182.70	N/A	N/A	N/A	N/A
V ₃₁	1155.0	1069.4	182.70	182.70	N/A	N/A	N/A	N/A
		10 Min.			2 Hours			
Timestamp	25/12/2011 16:40:00			DD/MM/YYYY HH:MM:SEC				
Flag	Flagged: V1,V2,V3			Not flagged				

TABLE - VOLTAGE FLICKERING CALCULATIONS & WINDOW OPTIONS:

The table outlines the sections' Parameter options (for your selection) including their Definition:

Parameter	Definition
PST INST	Instantaneous flicker evaluation. Output of Block 5 of the Flickermeter in Accordance with IEC61000-4-15 Edition 2
PSST 10 Sec.	<p>An Elspec measurement designed to get quicker results regarding Flicker evaluation. This measurement reaches a very close approximation of the EN50160 values, but in a fraction of the time.</p> <p>The PSST is calculated the same as PST but averaged over 10 seconds. This Elspec defined value is valuable in that it enables faster assessment of the flicker. Elspec PSST converges to a real value within 3 min from a drastic flicker change, or immediately for periodic steady state flicker</p>
PST	$P_{ST} = \sqrt{0.0314P_{0.1} + 0.0525P_{1s} + 0.0657P_{3s} + 0.28P_{10s} + 0.08P_{50s}}$ <p>Where the Percentiles $P_{0.1}$, P_1, P_3, P_{10} & P_{50} are the Flicker Levels Exceeded for 0.1, 1, 3, 10 & 50% of the Time During The Observation Period. The Suffix "s" in the Formula Indicates that the Smoothed Value Should be Used. The Smoothed Values are Obtained Using the Following Formulas:</p> $P(1s) = (P(.7) + P(1) + P(1.5))/3$ $P(3s) = (P(2.2) + P(3) + P(4))/3$ $P(10s) = (P(6) + P(8) + P(10) + P(13) + P(17))/5$ $P(50s) = (P(30) + P(50) + P(80))/3$
PST 10 Min	<p>Short term flicker evaluation.</p> <p>P_{ST} is a value measured over 10 minutes that characterizes the likelihood that the voltage fluctuations would result in perceptible light flicker. A value of 1.0 is designed to represent that 50% of people would perceive flicker in a 60 watt incandescent bulb.</p>
PLT	$P_{LT} = \sqrt[3]{\frac{\sum_{i=1}^N P_{ST_i}^3}{N}}$ <p>Where P_{ST_i} ($i = 1, 2, 3, \dots$) are the Consecutive Readings of the P_{ST}</p>
SPLT 1 Hour	<p>An Elspec measurement designed to get quicker results regarding Flicker evaluation. This measurement reaches a very close approximation of the EN50160 values, but in a fraction of the time.</p> <p>The SPLT is calculated the same as PLT but averaged over 1 hour. This Elspec defined value is valuable in that it enables faster assessment of the flicker</p>

Parameter	Definition
PLT 2 Hour	The Long-Term PLT is Derived From the Short-Term Values Over 12 Short-Term Values of 10 Minutes Each Over a Period of 2 hours
LPLT 10 Hour	An Elspec measurement designed to give better results regarding Flicker evaluation by using a longer averaging time. The LP_{LT} is calculated the same as P_{LT} but averaged over 10 hours to allow a quicker "long term" average
LPLT 7 Day	An Elspec measurement designed to give better results regarding Flicker evaluation by using a longer averaging time. The LP_{LT} is calculated the same as P_{LT} but averaged over 7 days, as per EN50160 parts 4-15
Reset Flickering	Reset all Flickering measurements of your G4K Unit

SEE ALSO:

- [About PQ Monitoring](#)
- [Voltage & Current](#)
- [Averaging](#)
- [Power](#)
- [Temperature](#)
- [Phasors](#)
- [Waveforms](#)
- [Pinst Waveforms](#)
- [Min/Max Flickering](#)
- [V&I Harmonics](#)
- [P&Q Harmonics](#)
- [Spectrum](#)
- [Harmonics Table](#)
- [V/I Min/Max Harmonics](#)
- [P/Q Min/Max Harmonics](#)

Pinst Waveform

Pinst is instantaneous flicker sensation that the G4500/G3500 Portable BLACKBOX calculates for every selected channel.

OPEN PINST WAVEFORM WINDOW:

- [Access your Portable BLACKBOX Unit](#) via the Web Interface → select **Monitoring** → **Pinst Waveforms**:

MONITORING	ENERGY	POWER QUALITY
Summary		V & I harmonics
Voltage & Current		P & Q harmonics
Average		Spectrum
Power		Harmonics Table
Temperature		V/I Min/Max Harmonics
Phasors		P/Q Min/Max Harmonics
Waveforms		
Voltage Flickering		
Pinst Waveform		
Min/Max Flickering		

- The Pinst Waveforms Window will now open:

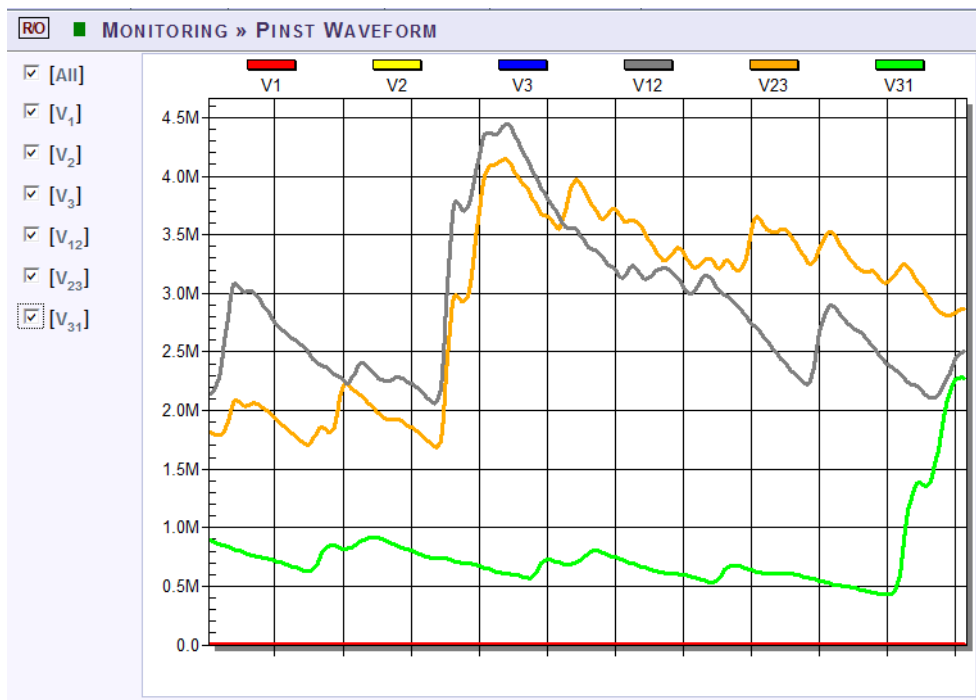


TABLE - PINST WAVEFORM WINDOW OPTIONS:

The table outlines the sections' Parameter options (for your selection) including their Definition:

Parameter	Definition
All	Checking the "All graphs" box will automatically select all the boxes below
Voltage Channels	Select the applicable channel for Flickering Waveform display.

SEE ALSO:

- [About PQ Monitoring](#)
- [Voltage & Current](#)
- [Averaging](#)
- [Power](#)
- [Temperature](#)
- [Phasors](#)
- [Waveforms](#)
- [Voltage Flickering](#)
- [Min/Max Flickering](#)
- [V&I Harmonics](#)
- [P&Q Harmonics](#)
- [Spectrum](#)
- [Harmonics Table](#)
- [V/I Min/Max Harmonics](#)
- [P/Q Min/Max Harmonics](#)

Minimum / Maximum Flickering

Displays the minimum & maximum short & long term Voltage Flickering vales to a very close approximation of the EN50160 values.

OPEN MIN/MAX FLICKERING WINDOW:

- [Access your Portable BLACKBOX Unit](#) via the Web Interface ➔ select **Monitoring**
➔ **Min/Max Flickering:**

MONITORING	ENERGY	POWER QUALITY
Summary	V & I harmonics	
Voltage & Current	P & Q harmonics	
Average	Spectrum	
Power	Harmonics Table	
Temperature	V/I Min/Max Harmonics	
Phasors	P/Q Min/Max Harmonics	
Waveforms		
Voltage Flickering		
Pinst Waveform		
Min/Max Flickering		

- The Min/Max Flickering Window will now open:

RO ■ MONITORING » MIN/MAX FLICKERING

Reset All Min/Max

Min/Max Flickering		PSST 2 Sec.	PSST 10 Sec.	PST 10 Min.	SPLT 1 Hour	PLT 2 Hour	LPLT 10 Hour	LPLT 1 Day	LPLT 7 Day
V ₁	Min.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Max.	***	***	96.653	10.472	N/A	N/A	N/A	N/A
V ₂	Min.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Max.	***	***	95.901	3.2235	N/A	N/A	N/A	N/A
V ₃	Min.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Max.	***	***	95.952	10.159	N/A	N/A	N/A	N/A
V ₁₂	Min.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Max.	32223	15293	182.70	182.70	N/A	N/A	N/A	N/A
V ₂₃	Min.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Max.	31954	15188	182.70	182.70	N/A	N/A	N/A	N/A
V ₃₁	Min.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Max.	2537.0	1680.0	182.70	182.70	N/A	N/A	N/A	N/A

TABLE - MIN/MAX FLICKERING CALCULATION METHOD:

The table outlines the sections' Parameter options (for your selection) including their Definition:

Parameter	Definition
PST INST	Instantaneous flicker evaluation. Output of Block 5 of the Flickermeter in Accordance with IEC61000-4-15 Edition 2
PSST 10 Sec.	<p>An Elspec measurement designed to get quicker results regarding Flicker evaluation. This measurement reaches a very close approximation of the EN50160 values, but in a fraction of the time.</p> <p>The PSST is calculated the same as PST but averaged over 10 seconds. This Elspec defined value is valuable in that it enables faster assessment of the flicker. Elspec PSST converges to a real value within 3 min from a drastic flicker change, or immediately for periodic steady state flicker</p>
PST	$P_{ST} = \sqrt{0.0314P_{0.1} + 0.0525P_{1s} + 0.0657P_{3s} + 0.28P_{10s} + 0.08P_{50s}}$ <p>Where the Percentiles $P_{0.1}$, P_1, P_3, P_{10} & P_{50} are the Flicker Levels Exceeded for 0.1, 1, 3, 10 & 50% of the Time During The Observation Period. The Suffix “s” in the Formula Indicates that the Smoothed Value Should be Used. The Smoothed Values are Obtained Using the Following Formulas:</p> <p>$P(1s) = (P(.7) + P(1) + P(1.5))/3$</p> <p>$P(3s) = (P(2.2) + P(3) + P(4))/3$</p> <p>$P(10s) = (P(6) + P(8) + P(10) + P(13) + P(17))/5$</p> <p>$P(50s) = (P(30) + P(50) + P(80))/3$</p>
PST 10 Min	<p>Short term flicker evaluation.</p> <p>P_{ST} is a value measured over 10 minutes that characterizes the likelihood that the voltage fluctuations would result in perceptible light flicker. A value of 1.0 is designed to represent that 50% of people would perceive flicker in a 60 watt incandescent bulb.</p>
PLT	$P_{LT} = \sqrt[3]{\frac{\sum_{i=1}^N P_{STi}^3}{N}}$ <p>Where P_{STi} ($i = 1, 2, 3, \dots$) are the Consecutive Readings of the P_{ST}</p> <p>Where P_{sti} ($i = 1, 2, 3, \dots$) are Consecutive Readings of the Short-Term Severity P_{ST}</p>

Parameter	Definition
SPLT 1 Hour	<p>An Elspec measurement designed to get quicker results regarding Flicker evaluation. This measurement reaches a very close approximation of the EN50160 values, but in a fraction of the time.</p> <p>The SPLT is calculated the same as PLT but averaged over 1 hour. This Elspec defined value is valuable in that it enables faster assessment of the flicker</p>
PLT 2 Hour	<p>The Long-Term PLT is Derived From the Short-Term Values Over 12 Short-Term Values of 10 Minutes Each Over a Period of 2 hours</p>
LPLT 10 Hour	<p>An Elspec measurement designed to give better results regarding Flicker evaluation by using a longer averaging time. The LP_{LT} is calculated the same as P_{LT} but averaged over 10 hours to allow a quicker "long term" average</p>
LPLT 7 Day	<p>An Elspec measurement designed to give better results regarding Flicker evaluation by using a longer averaging time.</p> <p>The LP_{LT} is calculated the same as P_{LT} but averaged over 7 days, as per EN50160 parts 4-15</p>
Reset Flickering	Reset all Flickering measurements of your G4K Unit

SEE ALSO:

- [About PQ Monitoring](#)
- [Voltage & Current](#)
- [Averaging](#)
- [Power](#)
- [Temperature](#)
- [Phasors](#)
- [Waveforms](#)
- [Voltage Flickering](#)
- [Pinst Waveforms](#)
- [V&I Harmonics](#)
- [P&Q Harmonics](#)
- [Spectrum](#)
- [Harmonics Table](#)
- [V/I Min/Max Harmonics](#)
- [P/Q Min/Max Harmonics](#)

Voltage & Current Harmonics

This window opens the Spectrum of Voltage & Current Harmonics measured by your Portable BLACKBOX Unit. The graph in the web interface displays up to 50 Harmonics. In order to view the full Harmonic spectrum, kindly access PQSCADA.

OPEN V&I HARMONICS WINDOW:

- [Access your Portable BLACKBOX Unit](#) via the Web Interface → select **Monitoring** → **V&I Harmonics**:

MONITORING	ENERGY	POWER QUALITY
Summary		V & I harmonics
Voltage & Current		P & Q harmonics
Average		Spectrum
Power		Harmonics Table
Temperature		V/I Min/Max Harmonics
Phasors		P/Q Min/Max Harmonics
Waveforms		
Voltage Flickering		
Pinst Waveform		
Min/Max Flickering		

- The V&I Harmonics Window will now open:

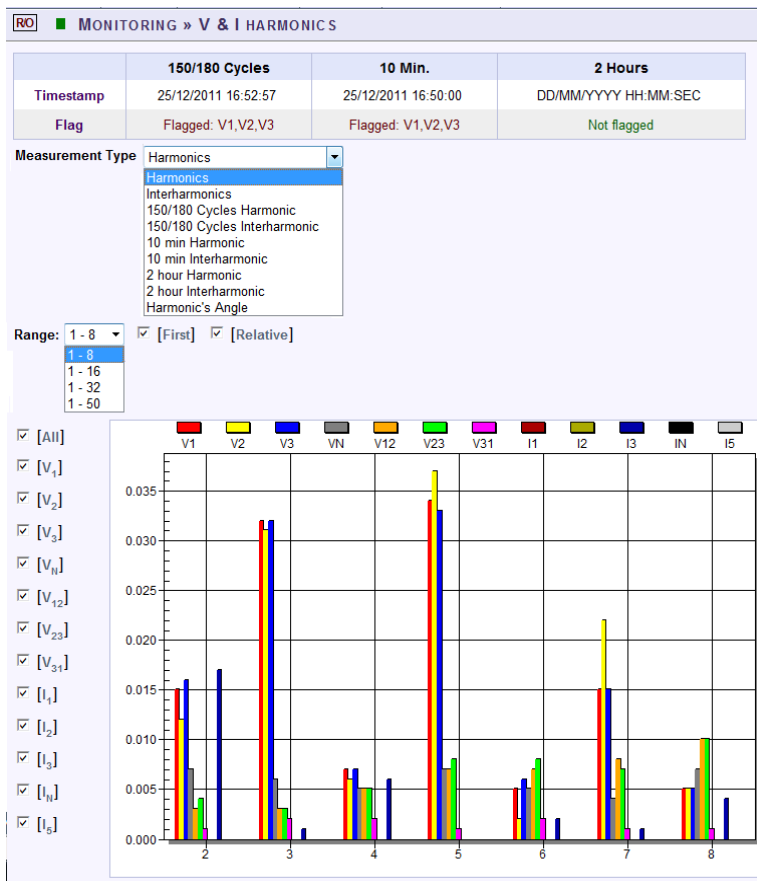


TABLE - V&I HARMONICS CALCULATION METHOD & WINDOW OPTIONS:

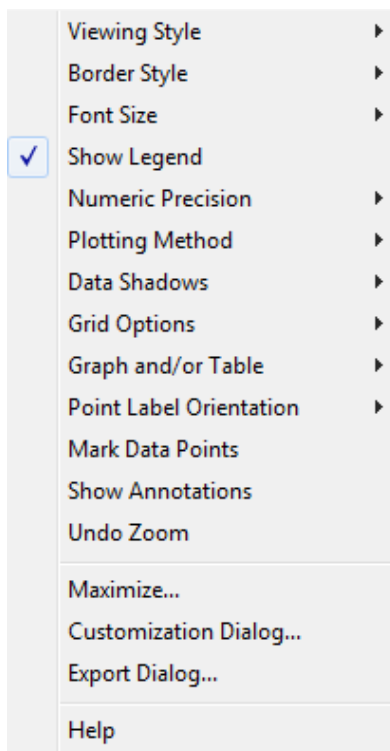
The table outlines the sections' Parameter options (for your selection) including their Definition:

Parameter	Definition
Timestamp	Indicates the timestamps of the last averaging intervals
Flag	Indicates whether or not the last interval is valid according to the set standard
MEASUREMENT TYPE	
Harmonics	Real time (10/12 cycles) calculation of sub group harmonics, in accordance with IEC61000-4-7: $G_{sg,n}^2 = \sum_{i=1}^1 C_{k+i}^2$
Interharmonics	Real time (10/12 cycles) calculation of inter sub group harmonics, in accordance with IEC61000-4-7
150/180 Cycles Harmonic	150/180 Cycle averaging of the sub group harmonics
150/180 Cycles Interharmonic	150/180 Cycle averaging of the inter sub group harmonics
10 Min Harmonic	10 Minutes averaging of the sub group harmonics
10 Min Interharmonic	10 Minutes averaging of the inter sub group harmonics
2 Hour Harmonic	2 Hours averaging of the 10 minutes averaging of the sub group harmonics
2 Hour Interharmonic	2 Hours averaging of the 10 minutes averaging of the inter sub group harmonics
Harmonic's Angle	The angle of each harmonic based on the real time value
RANGE	
1-8	Select the number of harmonics to be displayed 1-8
1-16	Select the number of harmonics to be displayed 1-16
1-32	Select the number of harmonics to be displayed 1-32

1-50	Select the number of harmonics to be displayed 1-50
OPTIONS	
First	Check/Uncheck the checkbox in order to display/not display the first harmonic
Relative	Check/Uncheck the checkbox in order to display/not display the harmonics relative to the first harmonic (Whereas the first harmonic is 100, and the other harmonic values as part of the harmonic 100)
All	Checking the "All" will display all the channels
Voltage & Current	Select the applicable Voltage / Current channel to be displayed

CHART OPTIONS:

- By right-clicking on the chart you have various chart options & capabilities available to you:



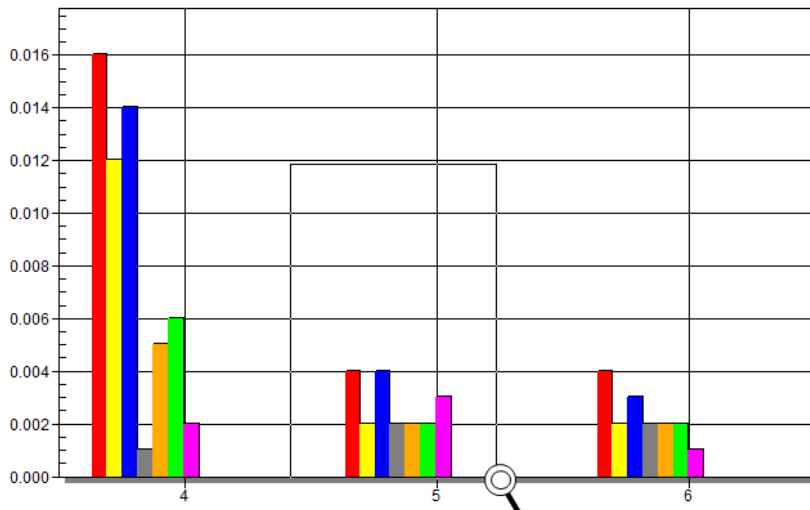
- Viewing Style:** Different styling options Color / Monochrome (B&W) with/without Symbols / Bitmap etc. By selecting the option you can view on screen the different styles available to you
- Border Style:** No Border, Thin Line, Shadow / Inset
- Font Size:** Large / Medium / Small
- Display / Not display Legend**
- Numeric Precision:** No up to 3 Decimals
- Plotting Method:** From Line / Bar / Point / Area / Spline / Combinations

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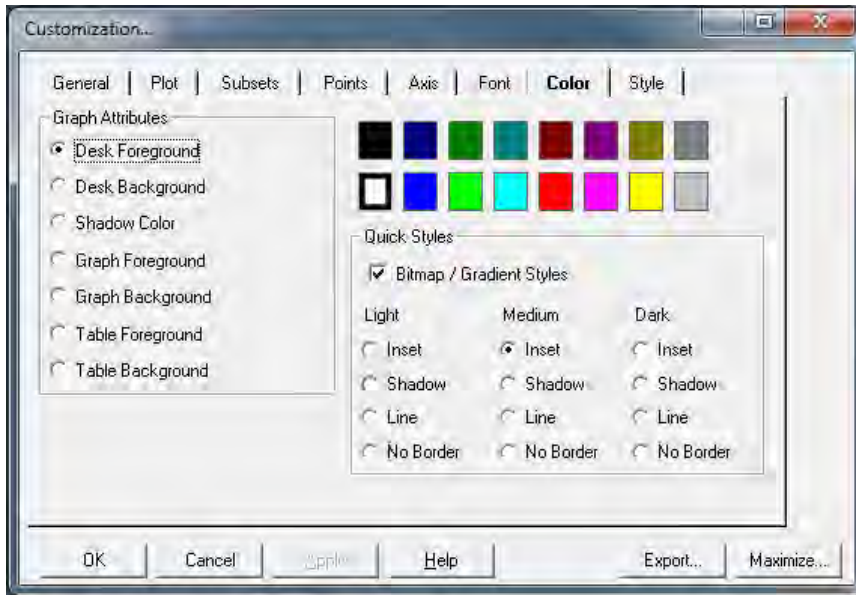
- **Grid Options:** Various grid options ranging from dots / lines / different axis etc.
- **Graph & Table:** Display either the graph / table / both:

	4	5	6
V1	0.016	0.003	0.005
V2	0.013	0.003	0.003
V3	0.017	0.003	0.005
VN	0.002	0.003	0.003
V12	0.005	0.003	0.003
V23	0.006	0.002	0.003
V31	0.003	0.003	0.002

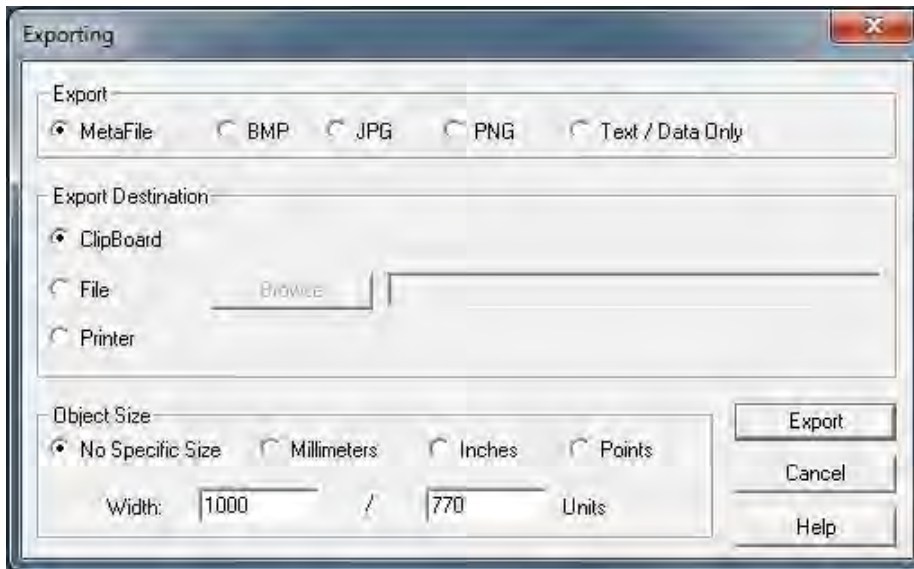
- **Point Label Orientation:** Auto / Vertical / Horizontal / Slanted
- **Mark Data Points:** Displays data points on graph
- **Show Annotations:** Displays annotations data descriptions
- **Zoom / Undo Zoom - Zoom in /out on your graph:**
 - From the main Waveform window, select an area to zoom in. Left-click and drag the mouse to define the area:



- The enlarged area will now appear in the window
 - Zoom out by right/click ➡ & select **Zoom out**
- **Maximize:** Maximize / Minimize graph
- **Customization Dialog - Various General Graph Customization Options** (all options apart from zooming above):



▪ **Export Dialog - Various Export Options:**



SEE ALSO

- [About PQ Monitoring](#)
- [Voltage & Current](#)
- [Averaging](#)
- [Power](#)
- [Temperature](#)
- [Phasors](#)
- [Waveforms](#)
- [Voltage Flickering](#)
- [Pinst Waveforms](#)
- [Min/Max Flickering](#)
- [P&Q Harmonics](#)
- [Spectrum](#)
- [Harmonics Table](#)
- [V/I Min/Max Harmonics](#)
- [P/Q Min/Max Harmonics](#)

PQ Harmonics

This window opens the Active & Reactive Harmonic Powers measured by your Portable BLACKBOX Unit.

OPEN THE P&Q HARMONICS WINDOW:

- [Access your Portable BLACKBOX Unit](#) via the Web Interface → select **Monitoring**
 → **P&Q Harmonics:**

MONITORING	ENERGY	POWER QUALITY
Summary		V & I harmonics
Voltage & Current		P & Q harmonics
Average		Spectrum
Power		Harmonics Table
Temperature		V/I Min/Max Harmonics
Phasors		P/Q Min/Max Harmonics
Waveforms		
Voltage Flickering		
Pinst Waveform		
Min/Max Flickering		

- The **P&Q Harmonics Window** will now open:

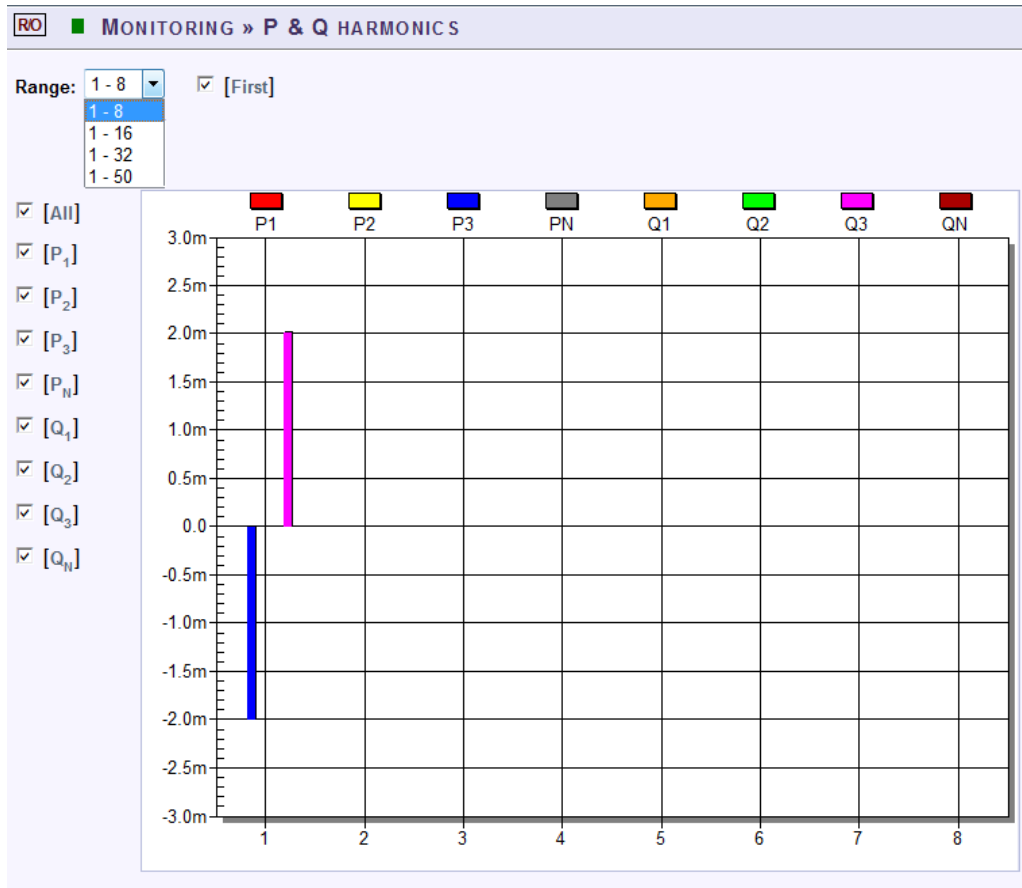


TABLE - P&Q HARMONICS RANGE & WINDOW OPTIONS:

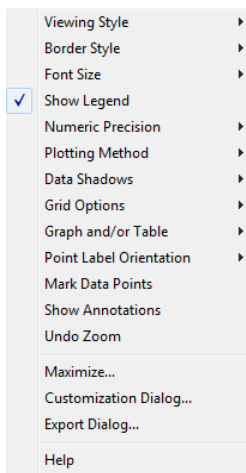
The table outlines the sections' Parameter options (for your selection) including their Definition:

Parameter	Definition
RANGE	
1-8	Select the number of harmonics to be displayed 1-8
1-16	Select the number of harmonics to be displayed 1-16
1-32	Select the number of harmonics to be displayed 1-32
1-50	Select the number of harmonics to be displayed 1-50
OPTIONS	
First	Select either Yes/No in order to display or not display the first harmonic
All	Checking the "All" will display all the channels
P1	Checking the "P1" box will display the Active Power (P) of the first line
P2	Checking the "P2" box will display the Active Power (P) of the second line

P3	Checking the "P3" box will display the Active Power (P) of the third line
Q1	Checking the "Q1" box will display the Reactive Power (Q) of the first line
Q2	Checking the "Q2" box will display the Reactive Power (Q) of the second line
Q3	Checking the "Q3" box will display the Reactive Power (Q) of the third line

CHART OPTIONS:

- By right-clicking on the chart you have various chart options & capabilities available to you:



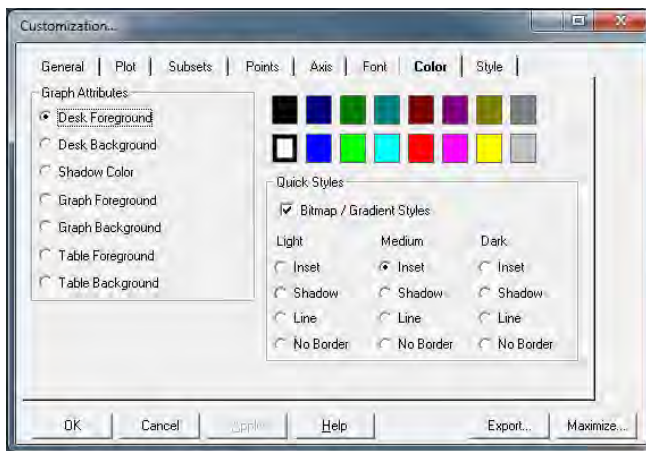
- Viewing Style:** Different styling options Color / Monochrome (B&W) with/without Symbols / Bitmap etc. By selecting the option you can view on screen the different styles available to you
- Border Style:** No Border, Thin Line, Shadow / Inset
- Font Size:** Large / Medium / Small
- Display / Not display Legend**
- Numeric Precision:** No up to 3 Decimals
- Plotting Method:** From Line / Bar / Point / Area / Spline / Combinations
- Data Shadows:** Off / Shadow / 3D
- Grid Options:** Various grid options ranging from dots / lines / different axis etc.
- Graph & Table:** Display either the graph / table / both:

Q1	-0.610	0.316	0.487	-0.659	-0.220	0.512	-0.413	-1.240	-0.145	0.245
Q2	-0.514	0.270	0.245	-0.586	-0.219	0.391	-0.075	-0.516	0.097	0.195
Q3	-0.927	0.439	0.463	-0.903	-0.367	0.756	-0.243	-0.876	0.465	0.318
Q.N.										

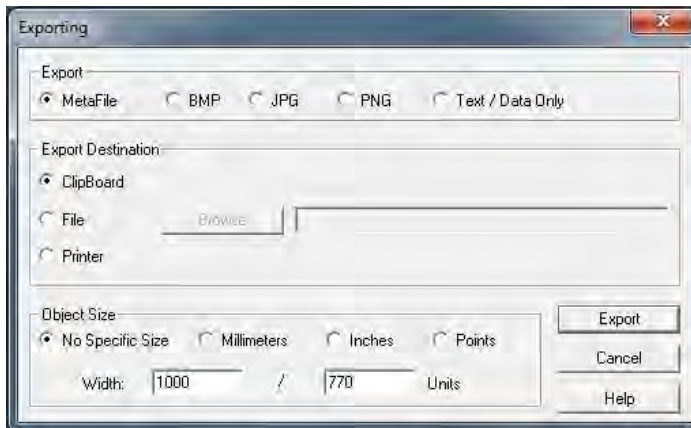
- Point Label Orientation:** Auto / Vertical / Horizontal / Slanted
- Mark Data Points:** Displays data points on graph
- Show Annotations:** Displays annotations data descriptions
- Zoom / Undo Zoom - Zoom in /out on your graph:**
 - From the main Waveform window, select an area to zoom in. Left-click and drag the mouse to define the area:



- The enlarged area will now appear in the window
- Zoom out by right/click ➔ & select **Zoom out**
- **Maximize:** Maximize / Minimize graph
- **Customization Dialog - Various General Graph Customization Options** (all options apart from zooming above):



- **Export Dialog - Various Export Options:**





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