

ELSPEC G4500

BLACKBOX

Portable

**Operational
Manual**



Issue 1.1

April 2009

©2009 Elspec Ltd, All rights reserved.

All product names are trademarks of their respective companies



Warranty Notice

Each Elspec product is warranted to be free from defects in material and workmanship under normal use and service. The warranty period is one year and begins on the date of shipment. Parts, product repairs, and services are warranted for 90 days. This warranty extends only to the original buyer or end-user customer and 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 of operation or handling. Elspec warrants 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 warrant that the software will be error free and operate without interruption.

Elspec authorized resellers 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 Buyer for importation costs of repair/replacement parts when the product is purchased in one country and 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.

To obtain warranty service, contact Elspec directly to obtain return authorization information, and then send the product to Elspec, with a description of the problem, postage and insurance prepaid (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.

Table of Contents

| | |
|---------------------------------------|-----------|
| INTRODUCTION | 1 |
| SAFETY INFORMATION | 3 |
| THE HARDWARE | 4 |
| Specifications | 4 |
| Physical Dimensions | 6 |
| Default Accessories | 7 |
| Optional Accessories | 9 |
| 3000 Amp Flexible Current Clamp | 9 |
| 300 Amp Flexible Current Clamp | 9 |
| Mini Clamp..... | 9 |
| Controls and Indicators | 10 |
| Front Panel..... | 10 |
| Rear Panel..... | 10 |
| Reference | 11 |
| Voltage Inputs..... | 13 |
| Fast AC/DC Channels | 13 |
| Indication | 14 |
| Auxiliary DC Voltage Channel | 14 |
| DC Voltage Specifications | 14 |
| Current Inputs | 15 |
| AC Current Channels..... | 15 |
| Auxiliary AC/DC Current Channel | 16 |
| Power Type Diagrams | 16 |
| Single Phase with Neutral | 16 |
| Single Phase without Neutral | 17 |
| Single Split Phase | 17 |
| Three Wire Delta..... | 18 |
| Four Wire WYE..... | 18 |

| | |
|---|-----------|
| Three Wire WYE..... | 19 |
| Delta High Leg..... | 19 |
| Delta Open Leg..... | 20 |
| Power Supply..... | 21 |
| Main Power..... | 21 |
| Auxiliary Power Supply | 22 |
| Status Indications | 22 |
| Battery Status Indicator | 22 |
| Operation ON/OFF Switch’s Indicator | 23 |
| Operational Status Indicator..... | 23 |
| Internal UPS | 23 |
| Grounding | 24 |
| Networking..... | 25 |
| Ethernet Ports View | 25 |
| Serial Communication..... | 28 |
| Temperature Sensor | 31 |
| Digital Inputs | 31 |
| Pin Description | 32 |
| Reset Button..... | 32 |
| WIRELESS ROUTER..... | 34 |
| Factory Default Setup | 35 |
| WEBSITE..... | 41 |
| Access | 41 |
| Login Page | 41 |
| Low Bandwidth..... | 42 |
| System Limitations..... | 43 |
| The Site Structure | 44 |
| Monitoring Section | 45 |

| | |
|---------------------------------------|------------|
| Graphic Data Representation | 52 |
| Energy Section | 53 |
| Consumption & Demand | 53 |
| Detailed Info | 55 |
| Measurement Status | 56 |
| TDD | 57 |
| Power Quality Section | 58 |
| The Compliance Info Page | 61 |
| The Compliance Chart Page | 62 |
| The User Defined Pages | 62 |
| Service Section | 63 |
| Unit Setup | 64 |
| Network Setup | 66 |
| Power Setup | 70 |
| Events Setup | 75 |
| Display Setup | 83 |
| Firmware Upgrade | 83 |
| Multi-IO Section | 89 |
| LCD Section | 90 |
| TIME SYNCHRONIZATION | 91 |
| INTEGRATED FTP SERVER | 96 |
| Login | 96 |
| System limitations | 99 |
| The File Structure | 99 |
| PQZip Files | 100 |
| INTEGRATED TELNET SERVER | 102 |
| Telnet Client Application | 102 |
| Establishing a Telnet Session | 104 |

Telnet Commands 104

PQZIP RECORDING 105

Principle of Operation 105

Operation 106

Configuration..... 107

 Enabling/disabling..... 108

 FIFO Concept..... 108

 Fixed Quality versus Fixed Ratio 109

 File Capacity 110

 Record Mode 110

 Record Type 111

 Erasing All PQZip Data..... 111

THE SOFTWARE 112

PQSCADA Suite 112

PQSCADA Server 113

PQSCADA Management Studio..... 113

 Administration Console 114

 Components..... 114

 The Node Status Fields..... 114

Elspec Investigator 121

 Getting Started..... 122

 Adding a Measurement SITE 122

 Operation..... 126

Elspec Search Utility 130

 Obtaining the Search Utility 130

 Operation..... 131

 Limitations 133

 Useful Features 133

HOW TO....? 135

- Replacing the Battery 135**
 - Before You Begin135
 - Removing the Battery136
 - Installing the New Battery138

- Disabling Proxy Server in Internet Explorer 139**

- Establishing a Security on Wireless Interface..... 142**
 - WPA Configuration Example.....143

- Restore Wireless Router to Factory Defaults 145**

- Simplified Power Curve Verification (PCV) Report 146**
 - Configuration147
 - The Outcome147

- Producing a Simple Time of Use (TOU) Energy Report..... 150**
 - Configuration150
 - The Outcome151

Introduction



The ELSPEC G4500 BLACKBOX *Portable* is the next generation in electrical Power Quality recorders and analyzers. Powered by revolutionary PQZip¹ compression technology, the G4500 BLACKBOX is capable of recording up to 1000 times more information than competitive instruments with equivalent memory sizes. Practically, the G4500 BLACKBOX is designed to store continuously, cycle by cycle, all parameters of data, including waveforms at maximum resolution for more than a year, internally, without the need of an external storage device or computer. The integrated PQSCADA software package provides an innovative and convenient way of performing even the most complicated power quality investigations. A State of the Art PQSCADA Investigator application helps to explore power quality events, zooming in and out on any parameter at High Definition resolution, from months to microseconds in mouse-click speed and simplicity.

The following are key features of the G4500 BLACKBOX *Portable*:

- **No field setup required:** Powered by a unique, continuous all-parameters recording with self-identifying current probes, the BLACKBOX Portable does not require any field setup or configuration for most of the usage scenarios (except PT/CT ratios)
- **8 GB of internal memory:** Capable of storing more than a year of continuous, all-inclusive data with 1024 samples per cycle resolution for AC voltages and 256 samples per cycle resolution for currents
- **Integrated WEB server:** and wireless Wi-Fi router and access point for the most convenient control and operation

¹ Refer to “PQZip” chapter on page 105 for more information

- **Mobile Analysis Lab** A Touch screen, LCD display for setup, control, and comprehensive power quality analysis which offers a full Tablet PC functionality
- **Up to 9 AC measurement channels** 4 AC/DC Voltages, 5² AC currents
- **Additional 2 DC measurement channels** Additional DC Voltage and DC current channels for simultaneous primary/secondary assessment of DC voltage converters
- **Internal and external (PT100) temperature recording** Internal and (optional) external temperature is recorded during the entire measurement session
- **Superior time synchronization** Ultimate time synchronization abilities for the most accurate multi-point assessment
- **Integrated rechargeable battery** For up to 2 hours of self-powered operation

² A 5th, DC current channel could be operated for “Earth” AC/DC current recording in 256 samples per cycle resolution.

Safety Information



To avoid electrical shock or fire:

- Review the entire manual before using the Instrument and its accessories and observe all warnings and cautions.
- Avoid working alone.
- Do not operate the Instrument around explosive gas or vapor.
- Use only insulated current and voltage probes.
- Before use, inspect the Instrument, voltage and current probes, leads and accessories for mechanical damage, and replace when damaged. Pay special attention to the insulation surrounding the connectors and plugs.
- Remove all probes, test leads, and accessories that are not in use.
- Make sure the Instrument is properly grounded through the power cord to 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 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.
- Do not operate the Instrument or its accessories when found wet for any reason.

The Hardware

Specifications

| General | |
|---|--|
| Power Requirements | 100-240V RMS $\pm 10\%$ 47-63Hz, 35W 120-270VDC 48VDC (35- 55V) |
| Operation Time during Interruptions (internal UPS operation) | >2 hours on fully charged battery 25 seconds minimum on empty battery |
| Internal memory capacity for data | 8 GB |
| Maximum recording period | Unlimited |
| Maximum Number of Events | Unlimited |
| Typical recording period | 12 ³ months of continuous, every cycle data |
| Real-time clock accuracy | Non synchronized: Not more than ± 1 s/day Synchronized ⁴ : up to ± 50 uS all times |
| Clock/Calendar | Leap years, 24-hour clock |
| Dimensions | 250 x 60 x 300 mm |
| Mass (Weight) | 3.7 kg |
| Power Quality Standard conformance | EN61000-4-30 Class A EN61000-4-15 EN50160 IEEE519 |
| Voltage and Current Inputs | |
| Input channels | Voltage: 4AC/DC + 1DC Current: 4AC + 1AC/DC |
| Voltage channels | Input resistance: 3 M Ω Input capacitance: < 20pF |
| Current channels | Self-identifying probes Types available: current probes, flexible Rogowski coil types |
| Measuring method | Simultaneous digital sampling of voltages and currents. Digital PLL synchronized sampling, internal frequency reference used during voltage drops. |
| Synchronization and sampling | |
| PLL-Synchronized source | The PLL synchronized automatically to the best out of L12 (between L1-L2 lines) and L3-G (between L3 to earth) measurement channels |
| PLL Lock Range | 42.5 to 69Hz |

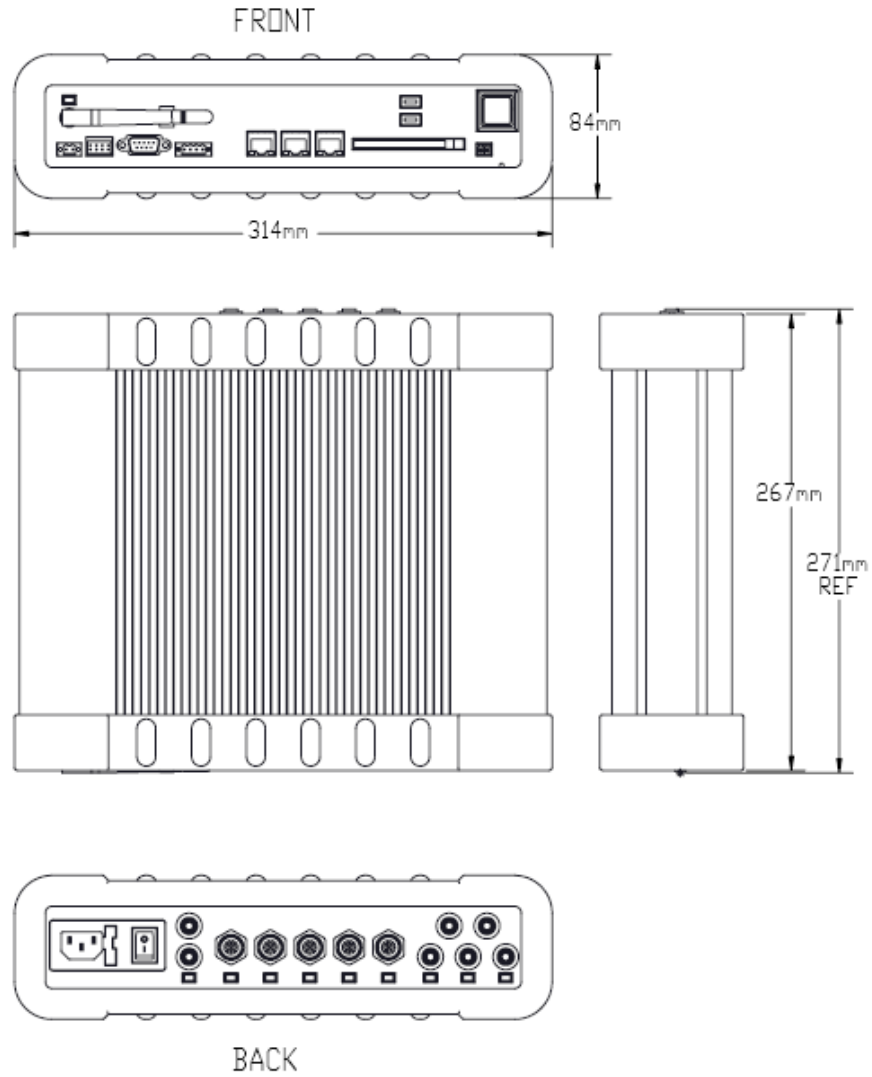
³ Based on 700MB per month PQZip settings

⁴ Required high accuracy GPS time source

| | |
|--|--|
| Sampling Frequency | Voltage: 1024 samples/cycle Current: 256 samples/cycle Auxiliary DC Voltage: 200mS |
| Measurement Ranges | |
| Voltage Measurement Range | AC Voltage: 1kV RMS, ± 8 kV Transients DC Voltage: ± 1 kV DC |
| Current Measured Range | Depends on current probe used |
| Internal temperature | -40C° : +125C° |
| External temperature (PT100) | -100C° : +99C° |
| Measurement Accuracy | |
| RMS Voltages | TBD |
| RMS Currents | TBD |
| Powers | TBD |
| Energy | TBD |
| Voltage Harmonics | TBD |
| Current Harmonics | TBD |
| Flickering | $\leq 5\%$ (by EN6100-4-15) |
| Internal temperature | $\leq 1\%$ |
| External temperature (PT100) | $\leq 1\%$ |
| Transient Voltage detection | |
| Measurement type | 1024 samples/cycle wave shape sampling, no peak detect |
| Full scale | 8000 V pk |
| Sample resolution | 19.5uSec (50Hz) 16uSec (60Hz). |
| Interfaces | |
| Color display | Touch screen "Mobile Analysis Lab" with complete tablet PC functionality |
| Optional B/W display | PoE self powered G4100 display |
| Integrated WEB server | Full control and real time monitoring |
| Integrated FTP server | A standard interface for a main storage memory |
| Integrated Telnet server | Command line control and troubleshooting |
| Communication | |
| Ethernet Ports | 3 x 10/100Mb Fast Ethernet Ports, Integrated router, NAT and Firewall |
| Power Over Ethernet (PoE) | Available as output, 13Watt |
| Wi-Fi interface | 802.11 b/g with integrated antenna |
| Serial Interface | 1 x RS-232, 1 x RS-485 |
| Digital I/O | 6 x 5-24VDC digital inputs |
| Extension slot | 1xPCMCIA |
| Supported Protocols | HTTP, FTP, TELNET, OPC DA, Modbus RTU, |
| Wireless Security | WEP, WPA(TKIP), WPA2(AES), WPA2(Mixed) |
| Environmental and safety Specifications | |
| Operating Environment | Indoors or in covered area outdoors, up to 2000 m latitude |
| Storage Temperature and Humidity | -20 °C to 60 °C, 80% rh max, non- condensing |
| Operating Temperature and Humidity | 0 °C to 50 °C, 80% rh max, non-condensing |

| | |
|-----------------------------|-----------------------------------|
| Enclosure Protection | IP30 (per EN 60529) |
| Standard Conformance | |
| EMC | EN61326 FCC part 15, subpart B |
| Safety | EN61010-1 (Ed.2, 2001) |

Physical Dimensions



Default Accessories


The following are the standard accessories that come shipped with the device:

| Qty | Part Number | Description | Illustration |
|-----|----------------------|---|---|
| 1 | SNT-1010-0000 | Mobile Analysis Lab with complete tablet PC functionality |  |
| 1 | MEB-2999-0000 | Trolley Carrying Case |  |
| 1 | SOF-4000-xxxx | PQSCADA– Power Quality Management Software Enterprise Edition installation CD |  |
| 4 | SOA-9045-3001 | Flexible AC current clamps 3000A (Diameter: 80 CM cable length: 2M) |  |
| 1 | EAH-4123-5100 | AC Voltage Cord with Crocodile Clip + Fuse (1.2M) |  |
| 1 | EAH-4123-5200 | Red AC Voltage Cord with Crocodile Clip + Fuse (1.2M) | |
| 1 | EAH-4123-5300 | Blue AC Voltage Cord with Crocodile Clip + Fuse(1.2M) | |
| 1 | EAH-4123-5400 | Yellow AC Voltage Cord with Crocodile Clip + Fuse(1.2M) | |
| 1 | EAH-4123-9500 | Green AC Voltage Cord with Crocodile Clip(1.2M) | |


| | | | |
|---|----------------------|---|---|
| 1 | EAH-4123-5100 | Black DC Voltage Cord with Crocodile Clip + Fuse (1.2M) |  |
| 1 | EAH-4123-5200 | Red DC Voltage Cord with Crocodile Clip + Fuse (1.2M) | |
| 1 | ENT-1002-0190 | 48VDC terminal block connector (RoHS Compliant) |  |
| 1 | ENT-1002-0191 | Temperature Sensor terminal block connector PT100 type (RoHS Compliant) |  |
| 1 | ENT-1004-0190 | RS485/422 Communication terminal block connector (RoHS Compliant) |  |
| 1 | ENT-2008-0190 | Multi IO terminal block connector (RoHS Compliant) |  |
| 1 | TOE-0010-0013 | LAN communication cord length: 2M |  |
| 1 | EPC-2012-2190 | Power Cable for Cont. Europe 10A/125V, straight, 1.8M, Black |  |
| | EPC-7012-2190 | Power Cable for North America 10A/125V, straight, 1.8M, Black | |

Optional Accessories


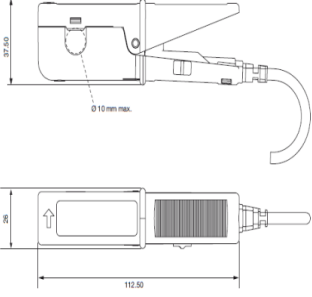
| 3000 Amp Flexible Current Clamp | |
|---|-----------------|
| Ordering information (part name) | SOA-9045-3001 |
| Loop length | 80cm |
| Measurement range | Up to 14000A AC |
| Linearity | < 0.3% |
| Operating temperature | -20°C to + 60°C |
| Cable length | 2M |



| 300 Amp Flexible Current Clamp | |
|---|------------------|
| Ordering information (part name) | SOA-9045-3000 |
| Loop length | 45cm |
| Measurement range | Up to 1400A AC |
| Linearity | < 0.3% |
| Operating temperature | - 20°C to + 60°C |
| Cable length | 2M |

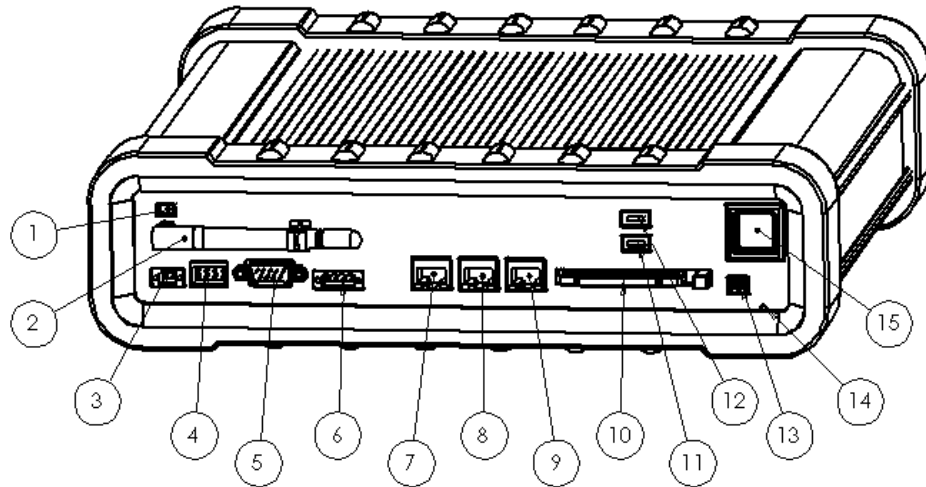


| Mini Clamp | |
|---|--|
| Ordering information (part name) | SOA-0130-0100 |
| A "hole" dimensions | 10mm Max |
| Measurement range | Up to 6A AC (10A range) Up to 60A AC (100A range) |
| Basic accuracy | ≤3% |
| Operating temperature | - 20°C to + 60°C |
| Cable length | 1.2M |

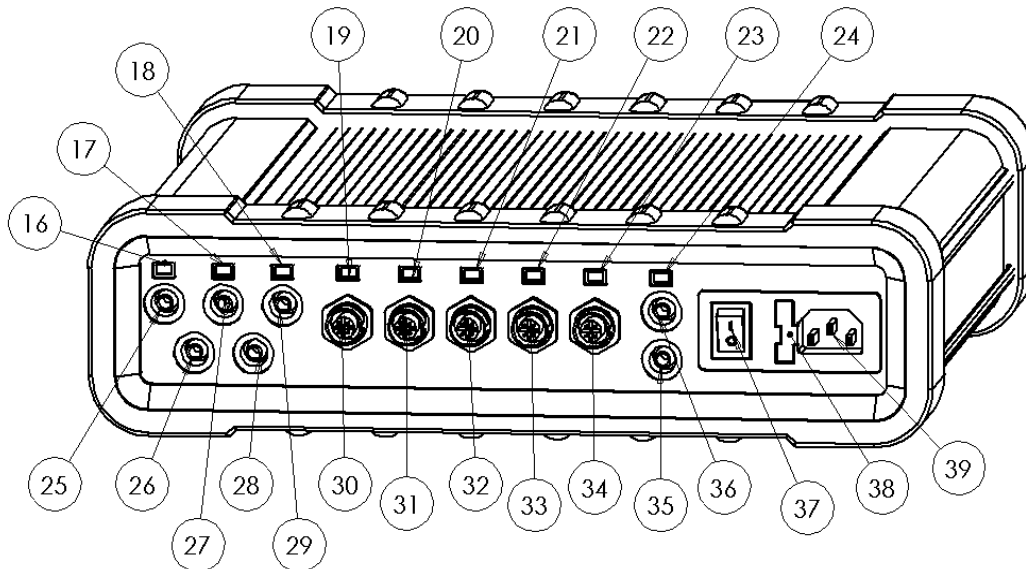



Controls and Indicators

Front Panel



Rear Panel



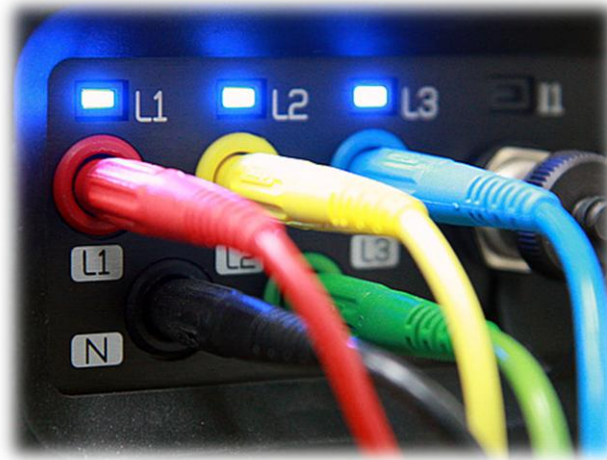
Reference

| # | Description | For details refer to: |
|----|--|--|
| 1 | Wi-Fi activity indicator | The Wi-Fi Access Point on page 26 |
| 2 | Wi-Fi antenna | The Wi-Fi Access Point on page 26 |
| 3 | Auxiliary power supply socket | Auxiliary Power Supply on page 22 |
| 4 | Digital Inputs socket | Digital Inputs on page 31 |
| 5 | RS232 communication socket | RS232 Interface on page 29 |
| 6 | RS485/422 communication socket | RS485/422 Interface” on page 29 |
| 7 | WAN – 10/100Mb RJ45 Ethernet socket | Ethernet Ports View on page 25 |
| 8 | LAN1 – 10/100Mb RJ45 Ethernet socket | Ethernet Ports View on page 25 |
| 9 | LAN2/LCD – 10/100Mb RJ45 Ethernet socket | Ethernet Ports View on page 25 |
| 10 | PCMCIA Extension slot | TBD |
| 11 | Battery status indicator | Battery Status Indicator” on page 22 |
| 12 | Operational status indicator | Operational Status Indicator on page 23 |
| 13 | External temperature sensor socket | Temperature Sensor on page 31 |
| 14 | Reset to “factory defaults” button | Reset Button on page 32 |
| 15 | Operation ON/OFF switch with indicator | Operation ON/OFF Switch’s Indicator on page 23 |
| 16 | L1 voltage “presence” indicator | Indication on page 14 |
| 17 | L2 voltage “presence” indicator | Indication on page 14 |
| 18 | L3 voltage “presence” indicator | Indication on page 14 |
| 19 | I1/L1 current probe detection indicator | AC Current Channels on page 15 |

| # | Description | For details refer to: |
|----|--|--|
| 20 | I2/L2 current probe detection indicator | AC Current Channels on page 15 |
| 21 | I3/L3 current probe detection indicator | AC Current Channels on page 15 |
| 22 | I4/Neutral current probe detection indicator | AC Current Channels on page 15 |
| 23 | Idc/Earth probe detection indicator | Auxiliary AC/DC Current Channel on page 16 |
| 24 | Vdc “presence” indicator | Auxiliary DC Voltage Channel on page 14 |
| 25 | L1 voltage sensor socket | Voltage Inputs on page 13 |
| 26 | Neutral voltage sensor socket | Fast AC/DC Channels on page 13 |
| 27 | L2 voltage sensor socket | Voltage Inputs on page 13 |
| 28 | Earth/Ground reference socket | Voltage Inputs on page 13 |
| 29 | L3 voltage sensor socket | Voltage Inputs on page 13 |
| 30 | I1/L1 current probe socket | AC Current Channels on page 15 |
| 31 | I2/L2 current probe socket | AC Current Channels on page 15 |
| 32 | I3/L3 current probe socket | AC Current Channels on page 15 |
| 33 | I4/Neutral current probe socket | AC Current Channels on page 15 |
| 34 | Idc/Earth current probe socket | Auxiliary AC/DC Current Channel on page 16 |
| 35 | Vdc (minus) probe socket | Auxiliary DC Voltage Channel on page 14 |
| 36 | Vdc (plus) probe socket | Auxiliary DC Voltage Channel on page 14 |
| 37 | Main Power supply ON/OFF Switch | Power Supply on page 21 |
| 38 | Fuse holder | Power Supply on page 21 |
| 39 | Main Power Supply inlet socket | Power Supply on page 21 |

Voltage Inputs

The BLACKBOX Portable provides 4 fast sampling AC/DC voltage inputs and an auxiliary DC voltage input.



Fast AC/DC Channels

The fast sampling AC/DC channels are designed for AC network monitoring but are suitable for DC voltage readings as well. The inputs are marked as L1, L2, L3, and N with corresponded colors Red for L1, Yellow – L2, Blue – L3 and Black for an N (Neutral).

All inputs are sensed/sampled simultaneously and continuously at 1024 samples per cycle resolution using the Earth terminal (Green colored) as a reference. The Phase (line to neutral) and Line (line to line) voltages are further calculated by a digital signal processor unit at the same 1024 samples per cycle resolution.

| | |
|--|---|
| Specifications | $\pm 8\text{kV}$ peak (to Earth terminal) |
| Maximum voltage | $\pm 8\text{kV}$ peak (to Earth terminal) |
| Maximum continuous voltage | 1kV (to Earth terminal) |
| Maximum voltage between channels | 10kV |
| Input impedance (to Earth terminal) | $>3\text{ M}\Omega$ |
| Input capacitance | $< 20\text{pF}$ |
| Reference | Earth terminal |
| Recording resolution | 1024 samples per cycle ⁵ , continues |

⁵ Defined by PLL frequency

| | |
|--|---|
| A/D resolution | 16Bit normal range + 16Bit extended range |
| PLL-Synchronized source | The PLL synchronizes automatically to the best out of L12 (between L1-L2 lines) and L3-G (between L3 to earth) measurement channels |
| PLL Lock Range | 42.5 to 69Hz |
| PLL frequency when out of range | 55Hz |
| PLL sensitivity | 5% of nominal |
| Indication LEDs | 10V AC |

Indication

The L1, L2 and L3 voltage input channels are equipped with presence- indication LEDs. On voltage levels of above 10% of the nominal value the LED light illuminates in blue.



Auxiliary DC Voltage Channel

The auxiliary DC voltage channel provides an additional and independent input to the main AC/DC channel DC voltage readings. This is mainly suitable for a voltage converter DC link side reading while the main voltage channels are on the grid side.

DC Voltage Specifications

| | | |
|---|----------------|--|
| Maximum voltage | ±1kV | |
| Maximum continues voltage | ±1kV | |
| Galvanic insulation from the main AC/DC voltage channels | 3kV | |
| Recording resolution | 200mS | |
| Indications (Vdc LED) | > ±20V (blue) | |

Current Inputs

The BLACKBOX Portable provides 4 AC and 1 AC/DC current measurement channels/inputs.

AC Current Channels



The AC current Channels are marked as **1-4** (see picture above).

The inputs are designed to operate only with Elspec G4500 BLACKBOX compatible current probes. When the probe is connected and identified, the corresponding LED illuminates in blue.

| | | |
|------------------------------|--|--|
| Maximum input voltage | 5VDC | |
| Recording resolution | 256 samples per cycle, continuous | |
| Suitable probe types | AC voltage output probes Rogowski flexible probes | |

Auxiliary AC/DC Current Channel

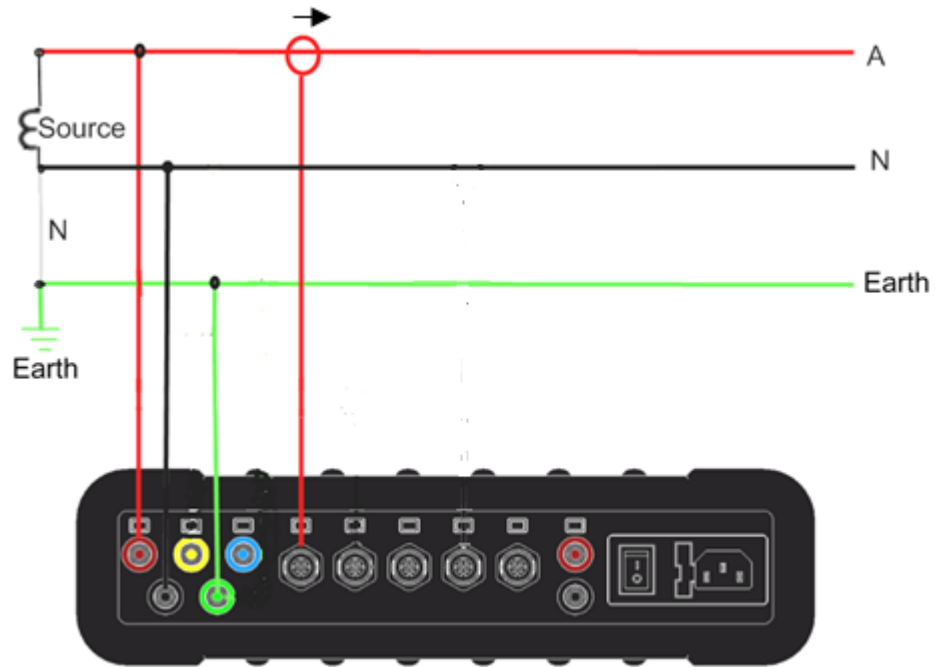
The Auxiliary AC/DC Current Channel is marked as **Idc**.

| | |
|-----------------------------|---|
| Maximum voltage | 5VDC |
| Recording resolution | 256 samples per cycle, continuous |
| Suitable probe types | AC/DC voltage output probes Rogowski flexible probes |

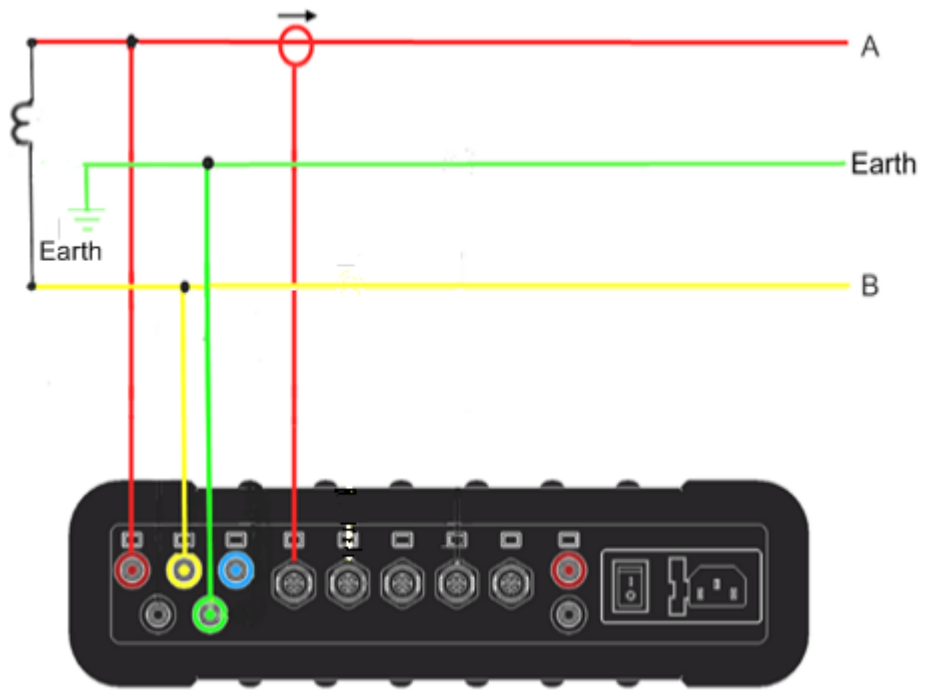
Power Type Diagrams

The G4500 BLACKBOX Portable is designed to serve in virtually any power topology configuration. Below are some of the most popular power types with suggested connection diagrams.

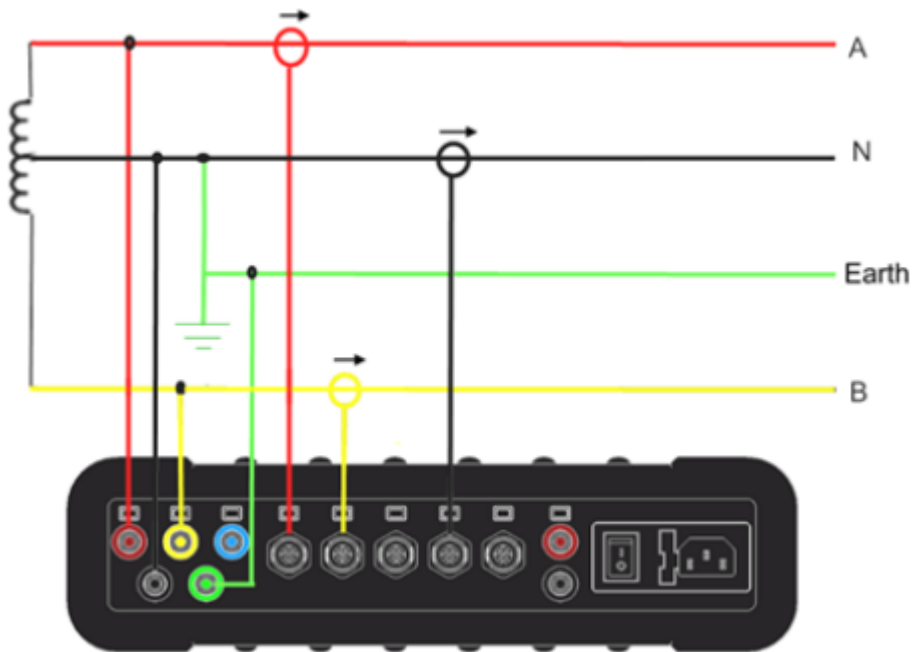
Single Phase with Neutral



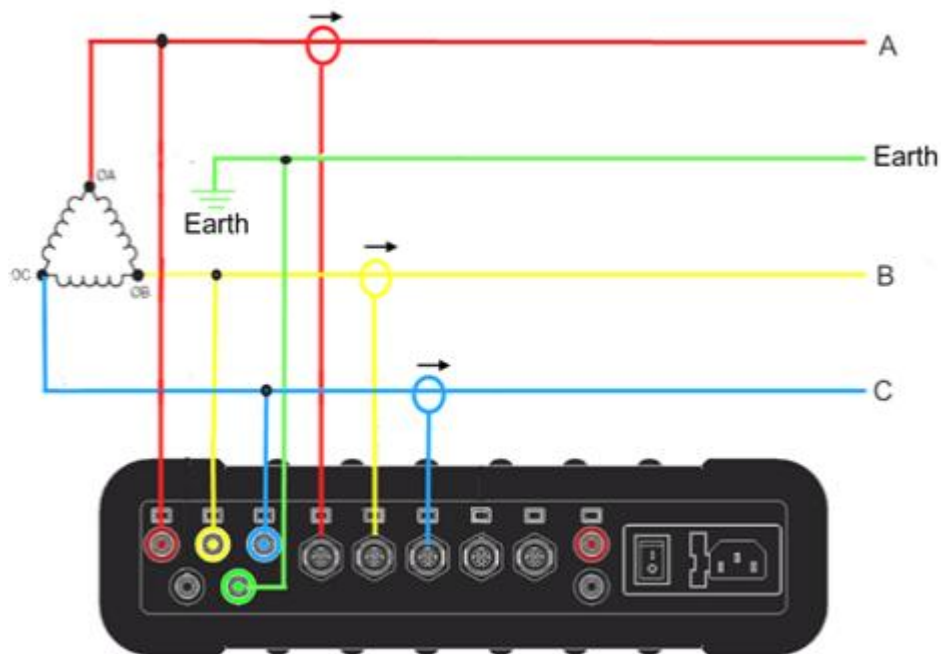
Single Phase without Neutral



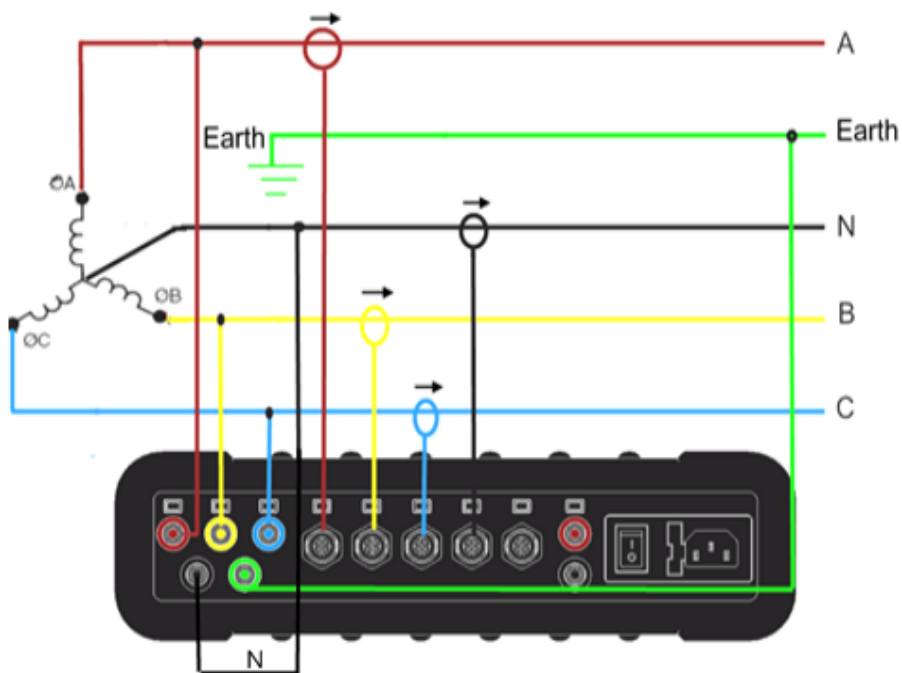
Single Split Phase



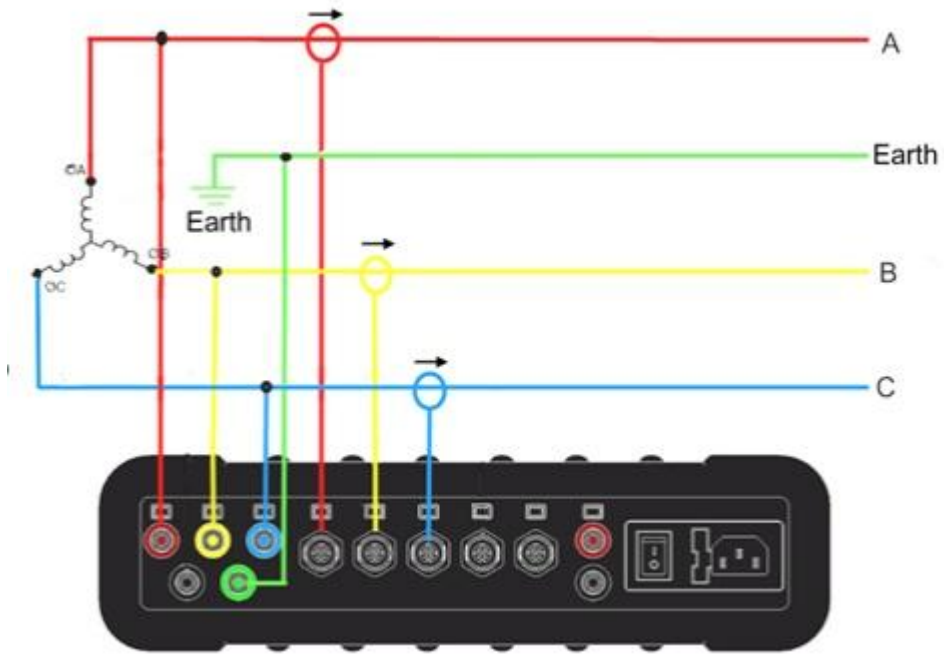
Three Wire Delta



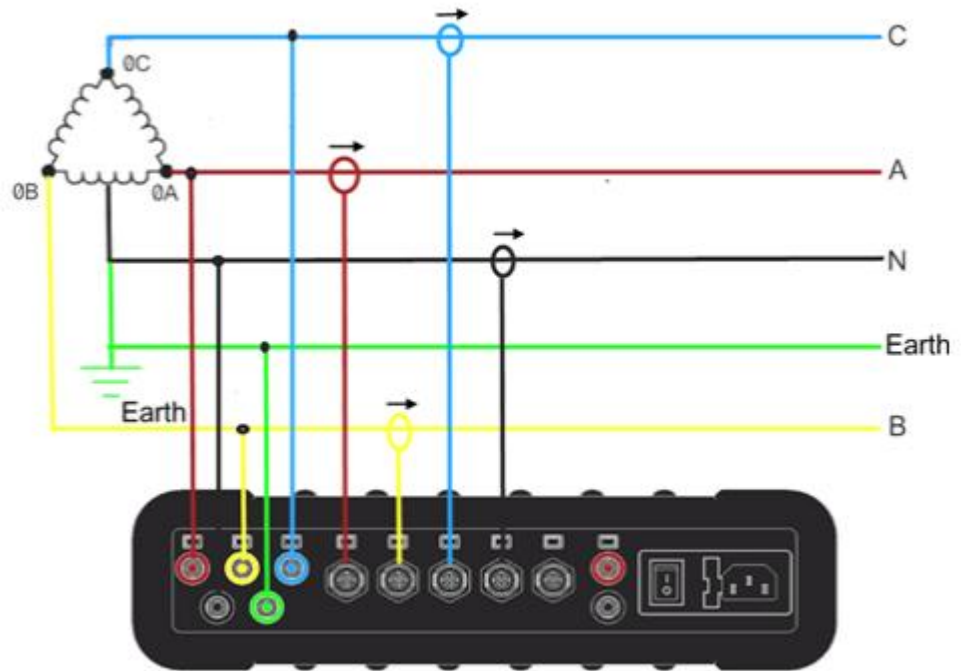
Four Wire WYE



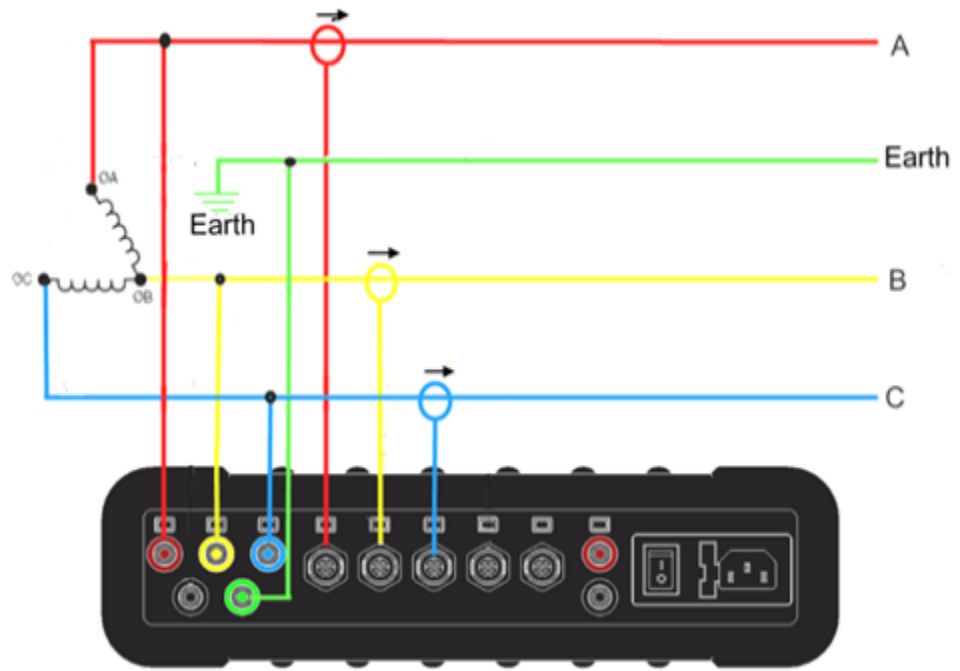
Three Wire WYE



Delta High Leg



Delta Open Leg

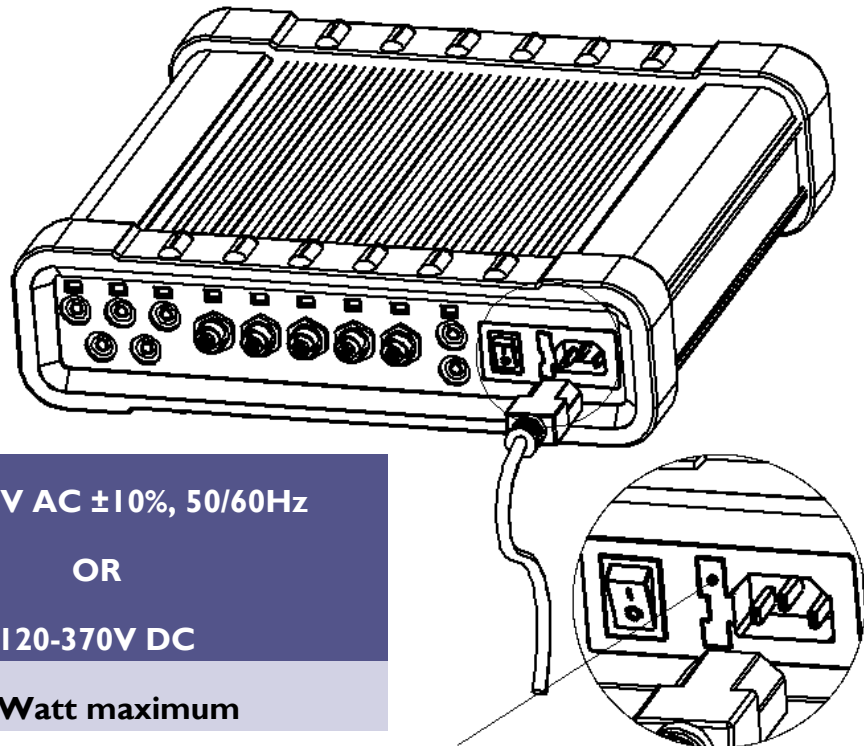


Power Supply

The BLACKBOX Portable can be powered by a main AC/DC or auxiliary DC power supply. The auxiliary power supply can be used with the main power supply at the same time, providing better redundancy.

Main Power

When the Main Power Supply ON/OFF switch (refer to [Rear Panel on page 10](#)) is switched ON, the internal battery starts charging regardless of an Operation ON/OFF switch position.



100-240V AC $\pm 10\%$, 50/60Hz

OR

120-370V DC

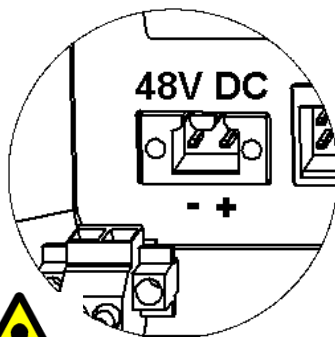
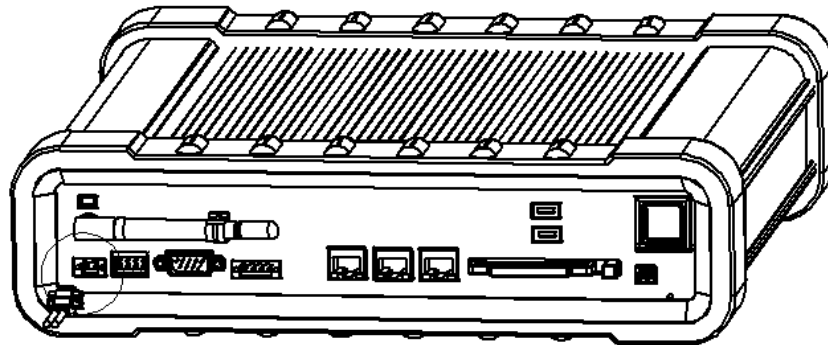
35 Watt maximum



2A/250V fuse holder

Allow only suitable fuse replacement!

Auxiliary Power Supply



48V DC
(35- 55V)

35 Watt maximum

No replaceable fuse protection!

Do not allow significant overvoltage!

Status Indications


Battery Status Indicator

(Refer to: [Front Panel on page 10](#))

| Status | State | |
|----------------------|---|--|
| Flashing blue | Main or auxiliary power applied, Battery charging | |
| Solid blue | Main or auxiliary power applied, Battery fully charged | |
| Red | No main or auxiliary power available, Powered by internal battery | |


Operation ON/OFF Switch's Indicator

(Refer to: [Front Panel on page 10](#))

| Status | State |  |
|---------------|--------------------------|---|
| Flashing blue | Booting or shutting down | |
| Solid blue | Normal operation | |

Operational Status Indicator

(Refer to: [Front Panel on page 10](#))

| Status | State |  |
|---------------|---|--|
| Solid blue | Normal operation, PQZip recording active | |
| Solid Red | PQZip OFF / Flash Error / DSP Error / Error in initialization | |
| Blinking Blue | Initialization state | |
| Blinking Red | Communication Problem / Logger Problem / Shutdown in process | |

Internal UPS

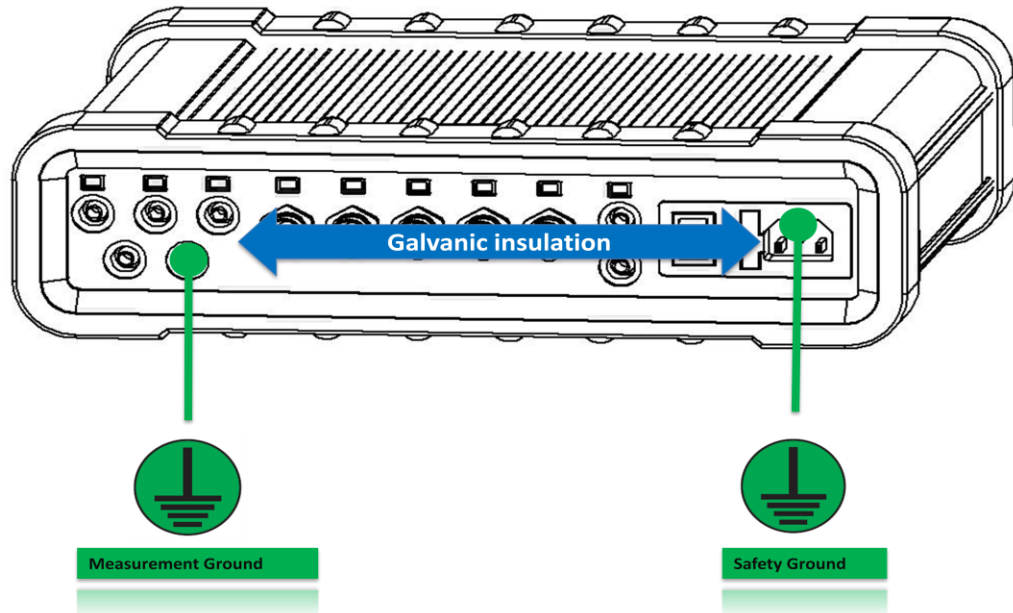
The BLACKBOX Portable contains an internal, uninterruptable power supply module providing a short period of self-powered measurements sessions and/or power supply interruptions ride-through.

The Internal UPS system contains a lithium battery for a up to 2 hours of fully-functioning operation and 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 and 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. Please refer to [Replacing the Battery on page 135](#).

Grounding

The BLACKBOX Portable contains two independent ground systems:



- **Measurement ground:** The reference ground for a measured electrical system
- **Safety ground:** The line cord ground, same potential to all enclosure and connectors-related metal parts

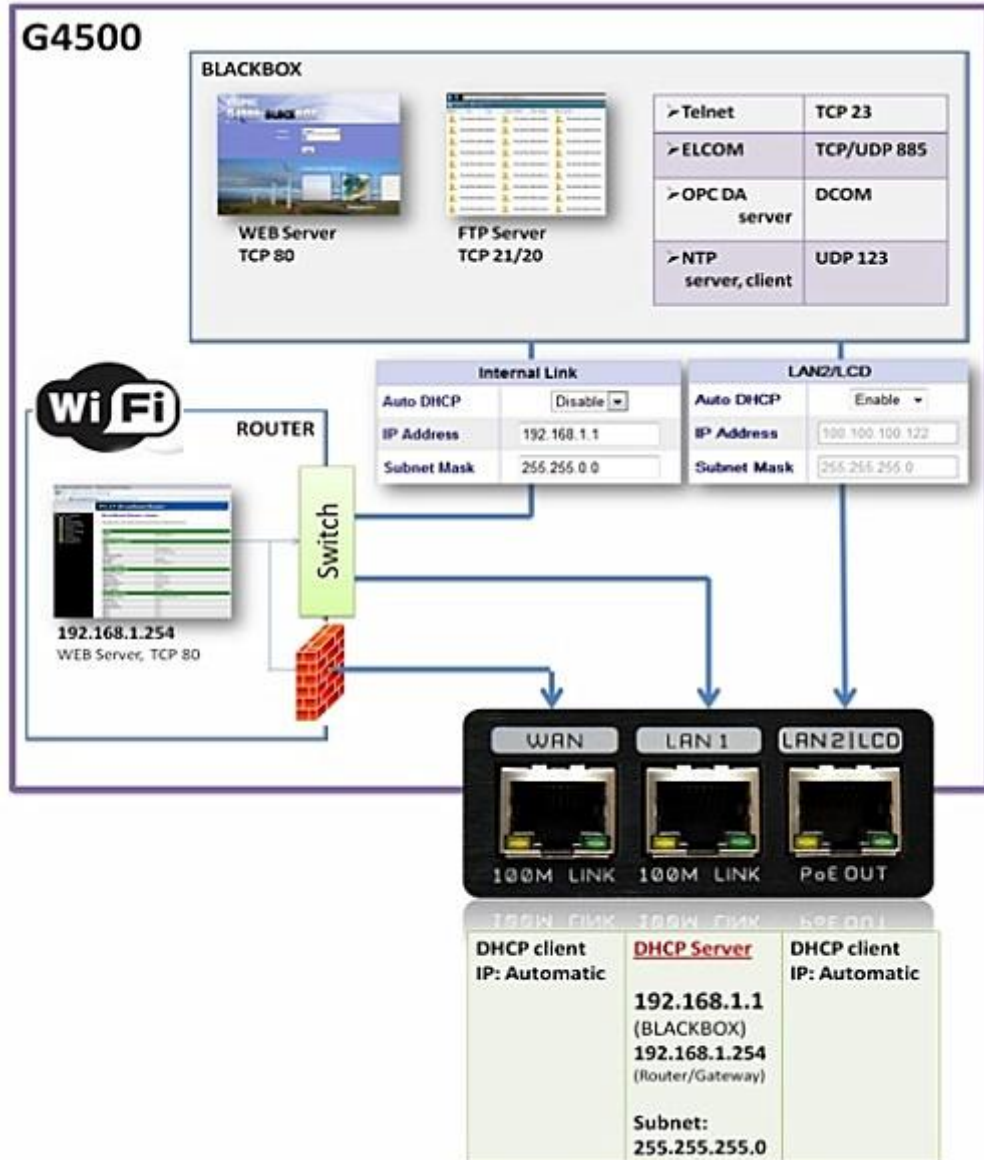
The ground systems are internally isolated to avoid ground loops when externally they could be safely connected to the same or different ground systems.



Maximum permitted voltage between Safety and Measurement grounds is 2kV DC or 1.5kV AC.

Networking

Ethernet Ports View

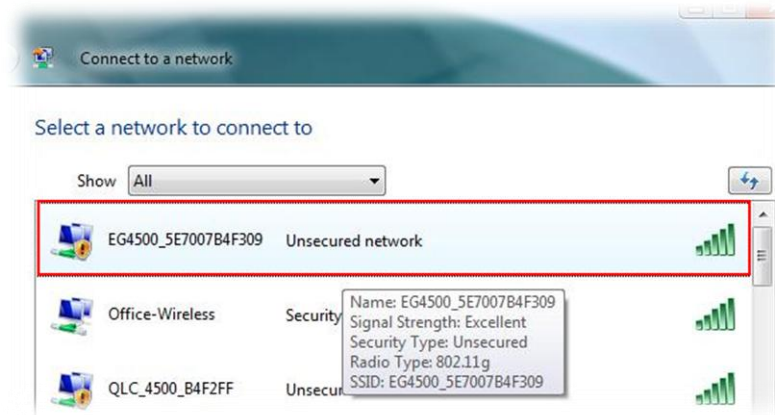


The above figure shows the factory default setting for the internal LAN and its default IP addresses for external use.

The **BLACKBOX Portable** has 3 fast Ethernet link 10/100Mb ports in addition to the wireless access point:

- **Wide Area Network (WAN):** Designed to connect the device's internal LAN with other types of networks. The most useful usage scenario would be connecting to the external Broadband router such as ADSL, Cable or Cellular for global, over Internet accessibility.
- **LAN1:** The main Ethernet port with DHCP server configured as active. This port is the main choice for a standalone PC or Laptop connection with the unit.
- **LAN2/LCD:** Direct connection port to the BLACKBOX device, bypassing the internal router. This port is mainly suitable for connecting the unit with a local LAN of computers.

The Wi-Fi Access Point



The BLACKBOX Portable contains an integrated IEEE 802.11g/b router pre-configured as an industry standard access point. This is to provide the most convenient and simplest connectivity with the Mobile Analysis Lab or any other laptop or desktop Wi-Fi-enabled PC.

The internal Wi-Fi Access Point is configured by the factory default as an unsecured network. The SSID name is configured as EG4500_*[device serial number]*.

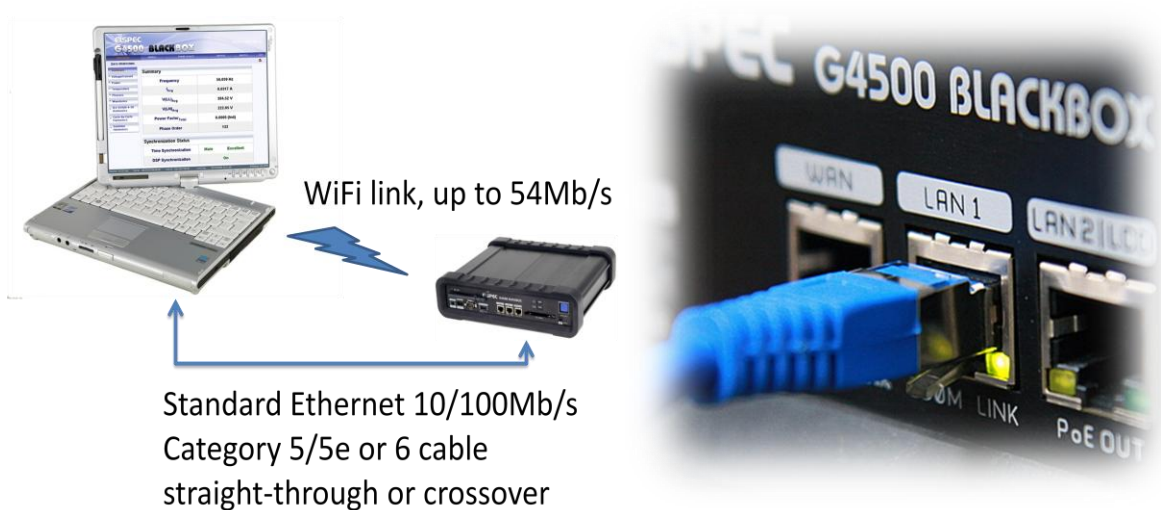
The *[device serial number]* is a unique string which allows for distinguishing among several available devices. The device serial number is located on the name plate as shown below.





The Wi-Fi link is active when a Wi-Fi activity indicator light is flashing or solid blue.

A Mobile Analysis Lab or a Single PC Connection



The most convenient way to connect a Mobile Analysis Lab or any other PC is by using a Wi-Fi or wired Ethernet link. It is best to make only one connection type at a time, and when a wired connection is used, disconnect or disable the wireless link.

Technically, any of the available Ethernet ports can be used for a single PC connection. However, the most recommended is a LAN1 option (as shown above) because of the integrated DHCP server available thru that port. When connected, a PC will automatically obtain an IP address configuration which allows a seamless connection to the BLACKBOX Portable's internal WEB/FTP servers as well as to a router management WEB server.

Office LAN Connection

When connected to an Office network, it most likely already employs a DHCP server. Do not connect a BLACKBOX Portable to the office network by LAN1 port, since an Office DHCP server operation could be interrupted which could lead to severe network malfunctions.

Use only WAN or LAN2 ports connecting to DHCP active LANs



Serial Communication

The BLACKBOX Portable is equipped with 2 isolated Serial Communication interfaces.



RS232 Interface

A standard DTE (Data Terminal Equipment) interface suitable for direct communication with COM compatible interface, such as a standard PC serial COM port

| Description | Symbol | Pin no. |
|------------------------------------|--------|---------|
| Data Carrier Detect | DCD | 1 |
| Receive Data (Serial data input) | RDx | 2 |
| Transmit Data (Serial data output) | TDx | 3 |
| Data Terminal Ready. | DTR | 4 |
| Signal ground | SG | 5 |
| Data ready state | DSR | 6 |
| Request to send | RTS | 7 |
| Clear to send | CTS | 8 |
| Ring Indicator | RI | 9 |

Specifications

| | |
|------------------------------|--|
| Maximum cable length | Up to 50 feet (15.2m) |
| Supported protocols | TTY mode (HyperTerminal, Telnet emulation) MODBUS RTU GPS |
| Duplex | Full |
| Insulation | 2kV |
| Suitable plug connector type | Industry standard D-Type 9 pins, Female |
| Default configuration | Baud rate: 19200, Data bits:8 , Parity: None, Stop Bits:1 |

RS485/422 Interface

A standard RS485 (full duplex) or RS422 (half duplex) interface

The connector pin description is shown below.



| 1 | 2 | 3 | 4 |
|-----|-----|-----|-----|
| TxD | TxD | RxD | RxD |
| + | - | + | - |


Specifications

| | |
|-------------------------------------|---|
| Maximum cable length | Up to 500 feet (152m) |
| Supported protocols | TTY mode (HyperTerminal, Telnet emulation) MODBUS RTU GPS |
| Duplex | Half/Full |
| Insulation | 2kV |
| Suitable plug connector type | ENT-1004-0190 (supplied as default accessory, <i>refer to page 7</i>) |
| Default configuration | Baud rate: 19200 Data bits: 8 Parity: none Stop bits: 1 |
| Supported data rates | <div style="border: 1px solid black; padding: 5px;"> <p>19200 ▾</p> <p>1200</p> <p>2400</p> <p>4800</p> <p>9600</p> <p>14400</p> <p style="background-color: #e0e0e0;">19200</p> <p>38400</p> <p>57600</p> <p>115200</p> </div> |
| Wiring requirements | 24AWG twisted pair |
| Termination | Shunt capacitance of 16pF per foot |

Temperature Sensor

The BLACKBOX Portable is equipped with an external connection terminal for a 2-wire PT-100 temperature sensor. The PT100 is an industry standard thermocouple. Pt100 is also called an RTD element (Resistance Temperature Detector).



| | | |
|--|---|--|
| <p>Suitable plug connector type</p> | <p>ENT-1002-0191 (supplied as default accessory, refer to page 7)</p> |  |
| <p>Insulation</p> | <p>No insulation</p> | |

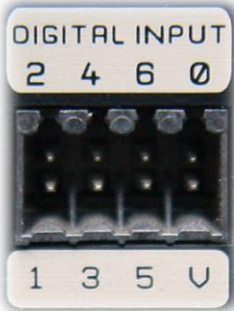
Digital Inputs

The BLACKBOX Portable has 6 Digital Inputs for continuous recording.

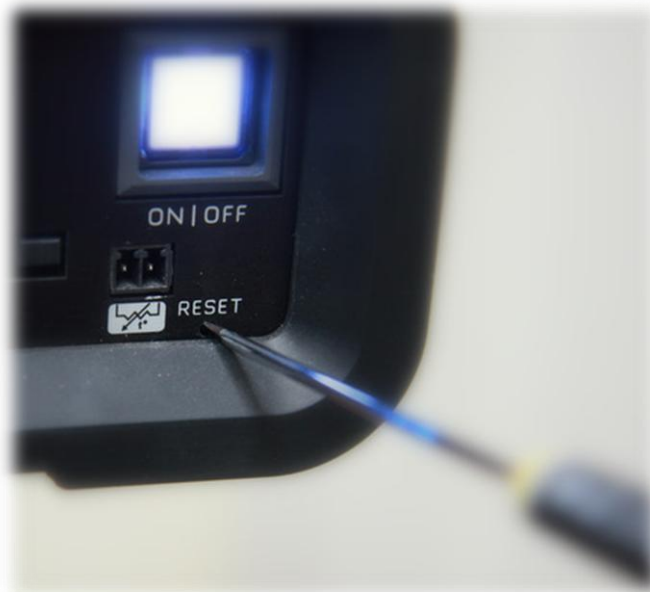
| | |
|-------------------------------|---|
| <p>Specifications</p> | |
| <p>Maximum voltage</p> | <p>50VDC</p> |
| <p>Insulation</p> | <p>1kV</p> |
| <p>Sampling rate</p> | <p>16 times per cycle (~1.25mSec at 50Hz, ~1mSec at 60Hz)</p> |
| <p>Contact type</p> | <p>Dry contact</p> |

Pin Description

| Pin no. | Description |
|---------|------------------|
| 1 | Digital Input #1 |
| 2 | Digital Input #2 |
| 3 | Digital Input #3 |
| 4 | Digital Input #4 |
| 5 | Digital Input #5 |
| 6 | Digital Input #6 |
| V | +5V |
| 0 | Common |



Reset Button



The Reset Button serves two main purposes:

- Check LED operation.
- Restore factory default settings.

To perform an action, the instrument should be powered ON and the Operational Status Indicator should be solid blue or red.

The button can be accessed by a sharp instrument such as a small screwdriver (*as shown*).

Press and hold the reset button:

After **5** seconds – All LEDs turn on. At that stage you can check if all the LEDs are okay.

After an additional **8** seconds-- The BLACKBOX Portable reboots and restarts with the factory default settings.

Wireless Router

1. To access the internal Wi-Fi router type **http://192.168.1.254** on a Microsoft Explorer address field.

A status WEB page appears:

The screenshot displays the 'Broadband Router Status' page. The left sidebar menu includes 'Status', 'Setup Wizard' (highlighted in red), 'Operation Mode', 'Wireless', 'TCP/IP Settings', 'Firewall', 'VPN Setting', and 'Management'. The main content area shows the following configuration details:

| System | |
|------------------|--------------------|
| Uptime | 5day: 0h: 23m: 26s |
| Firmware Version | v1.4.2 |

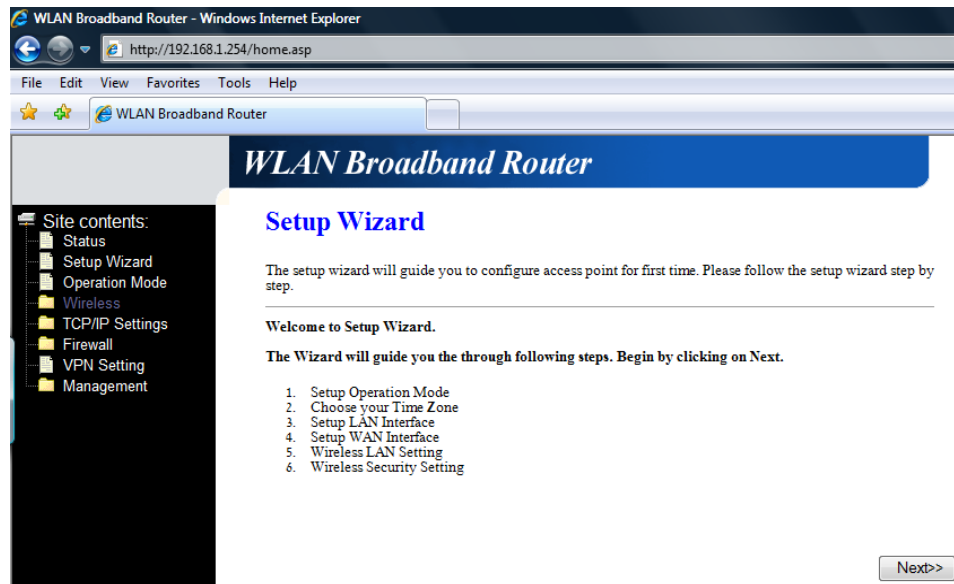
| Wireless Configuration | |
|------------------------|---------------------|
| Mode | AP |
| Band | 2.4 GHz (B+G) |
| SSID | EG4500_5E7007B4F309 |
| Channel Number | 11 |
| Encryption | Disabled |
| BSSID | 00:02:72:68:e1:5f |
| Associated Clients | 1 |

| TCP/IP Configuration | |
|----------------------|-------------------|
| Attain IP Protocol | Fixed IP |
| IP Address | 192.168.1.254 |
| Subnet Mask | 255.255.255.0 |
| Default Gateway | 192.168.1.254 |
| DHCP Server | Enabled |
| MAC Address | 00:02:72:68:e1:5f |

| WAN Configuration | |
|--------------------|--------------------------------|
| Attain IP Protocol | Getting IP from DHCP server... |
| IP Address | 0.0.0.0 |
| Subnet Mask | 0.0.0.0 |
| Default Gateway | 0.0.0.0 |
| DNS 1 | 0.0.0.0 |
| DNS 2 | 0.0.0.0 |
| DNS 3 | 0.0.0.0 |
| MAC Address | 00:02:72:68:e1:60 |

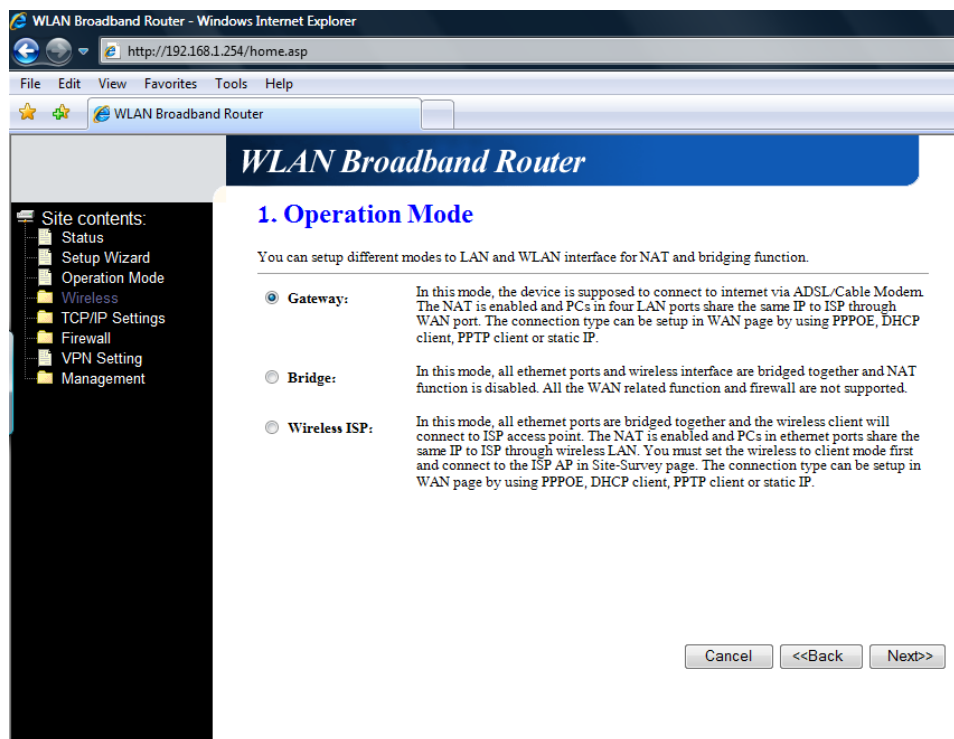
The most simplified way to verify settings or configure the router is using the **Setup Wizard** (*marked in red above*).

Factory Default Setup

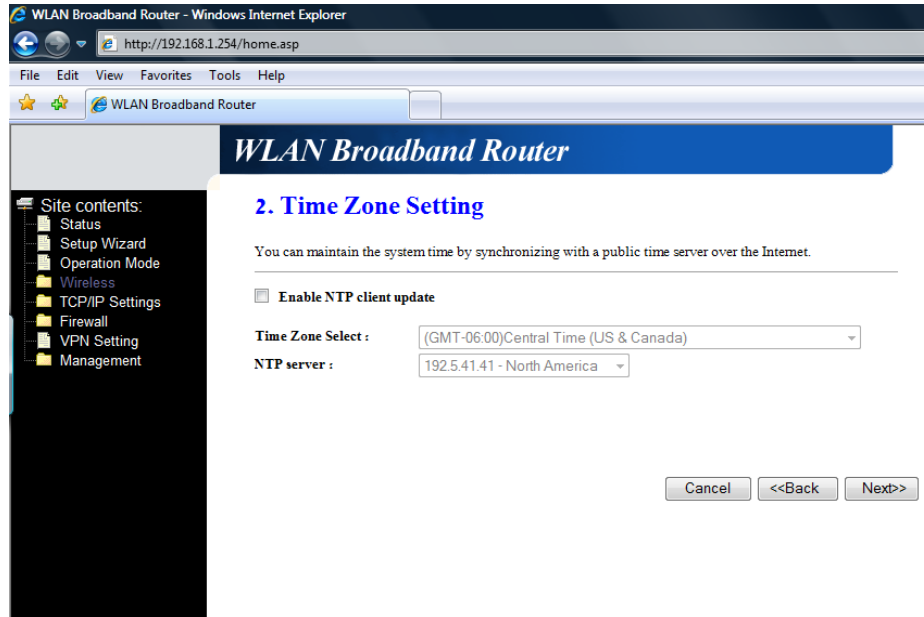


When initiated, the Setup Wizard begins with the above page.

2. To proceed with the setup procedure, press the *next* button.



3. Define the mode of operation. (The default operation mode is Gateway).

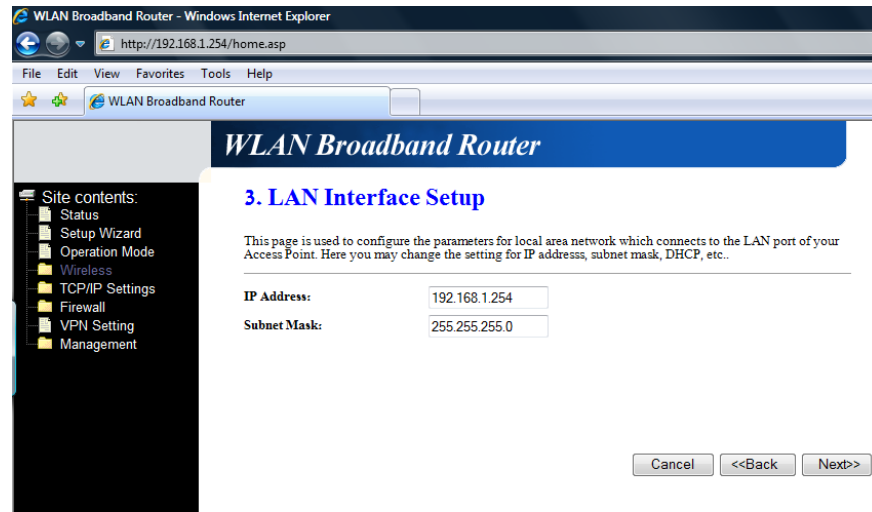


4. The second step is for the configuration of the automatic time synchronization option.

The default configuration for the router's time synchronization is **Disabled**.



The time synchronization refers to the router's internal time only. This setting has no influence on the G4500 time synchronization. Refer to G4500 website configuration for G4500 time synchronization options.



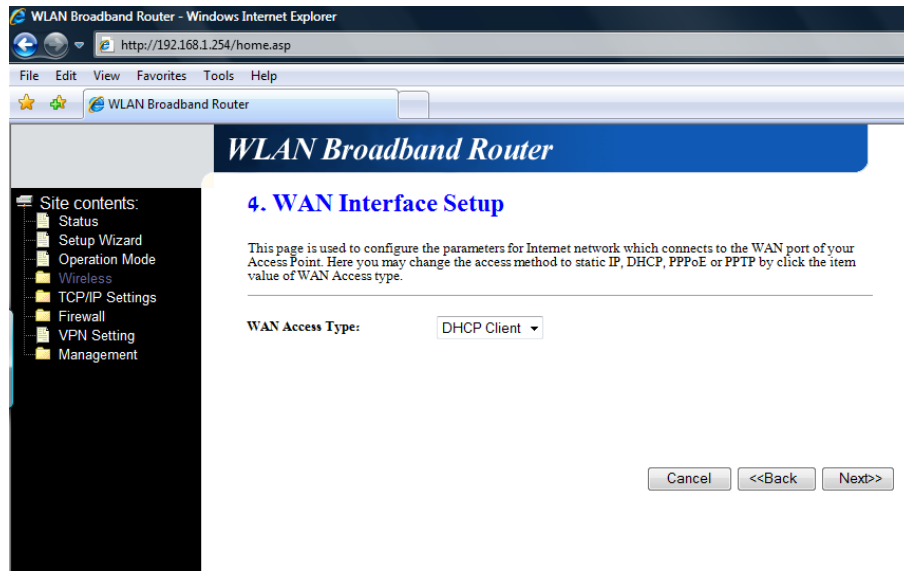
5. Specify the IP address and subnet mask for the router management interface, then click **Next**.

The default configuration is **192.168.1.254** with **255.255.255.0** subnet mask.

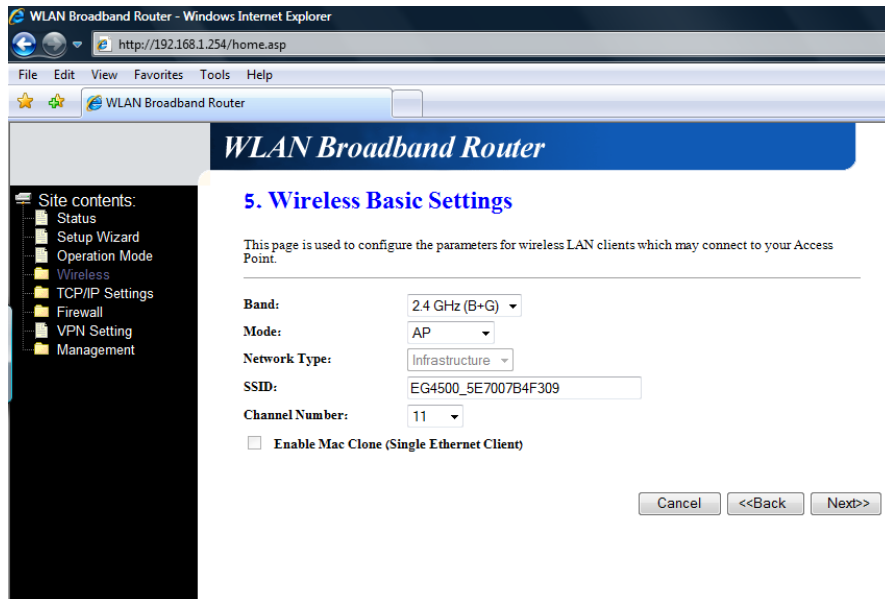


Change the G4500 LAN1 configuration accordingly when you modify the default IP address for the router.

Refer to G4500 website configuration for details.



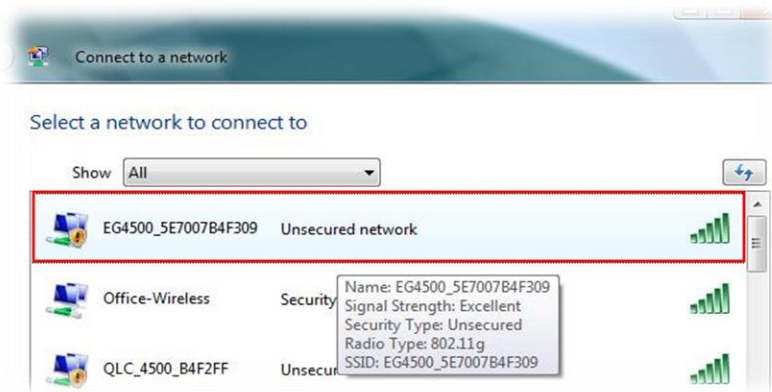
6. Set the WAN port operation type. The default setting is **DHCP Client**.



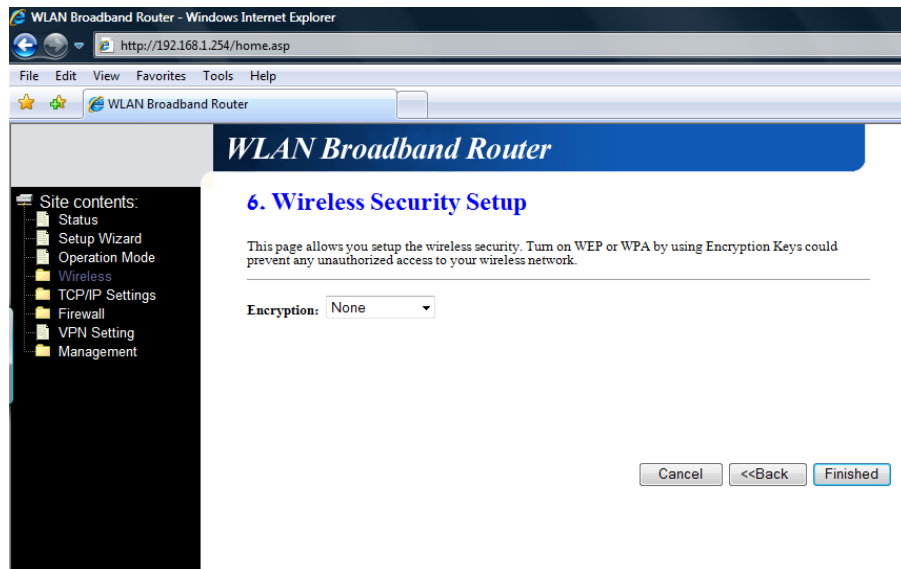
7. Configure the basic configuration of the Wireless interface.

The default settings are:

- Band: 2.4Ghz (B+G), enabling both 802.11b and 802.11g interfaces
- Mode: AP, (Access point)
- SSID: EG4500_[serial number]. Define what name string (SSID string) will appear on a list of wireless networks available.

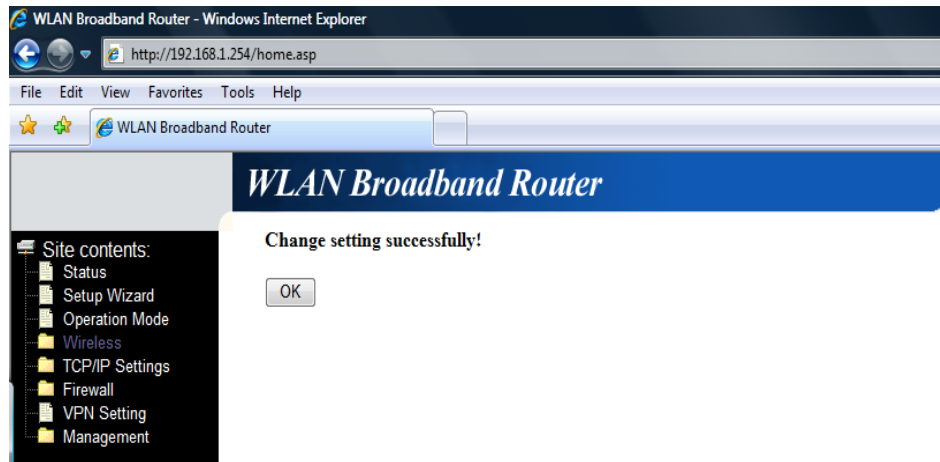


- Channel number: 11. The 2.4 GHz Wi-Fi signal range is divided into a number of smaller bands or "channels," similar to television channels. But unlike television channels, some Wi-Fi channel numbers overlap each other. Channel 1 uses the lowest frequency band and each subsequent channel increases the frequency slightly. Therefore, the further apart two channel numbers are, the less the degree of overlap and likelihood of interference. If encountering interference with a neighbor's WLAN, change to a distant channel.
- Enable Mac clone: **Disabled**



8. Select your security method for the wireless interface. The default setting is: None– unsecured.

When complete the final screen appears.

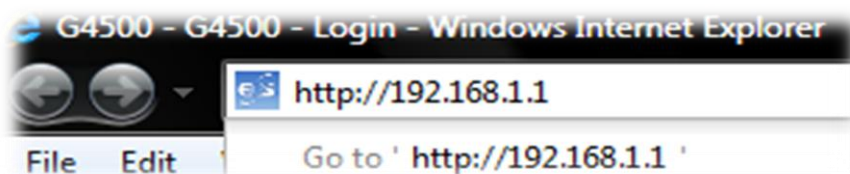


Website

The BLACKBOX Portable's internal Website is designed to serve as a main user interface with the instrument, providing enhanced management, configuration and real-time monitoring functionality.

Access

When a wired or wireless Ethernet connection is established, the internal Website can be accessed by simply typing the device IP address in the address field on a WEB browser application.



The Website is optimized to work with Microsoft® Explorer 7. 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

Disabling Proxy Server in Internet Explorer chapter for instructions.

When the device IP address is unknown, use the Elspec Search utility to discover it. ([Refer to page 102](#))

Login Page

The first page to appear is a Login Page.

Choose the interface language. The supported languages are:

- English (Default)
- Russian
- German
- Spanish

(For other languages – please contact your local Elspec distributor.)



The Password field defines user level/privileges. Two user levels are supported:

| User level | Password | Role |
|------------|----------|--|
| Viewer | 123 | Read only, can choose interface language only, no operations related changes are allowed |
| Admin | 12345 | Administration, setup and full control |

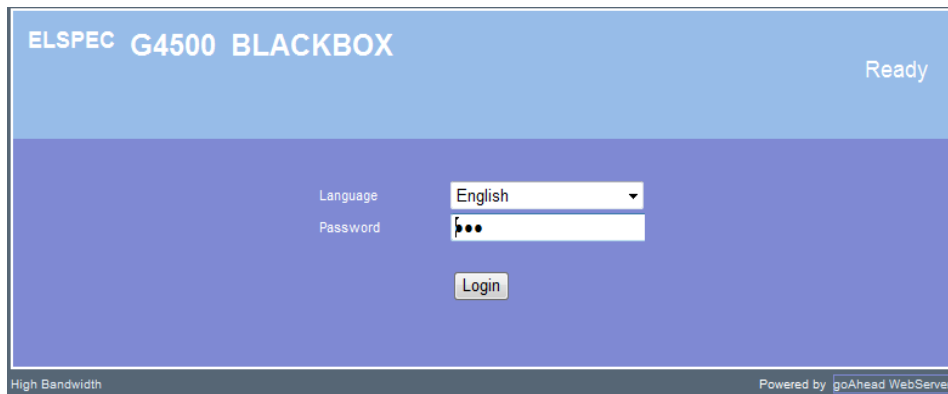
The passwords above are factory default values. You are advised to modify Admin password if extended security measures are required.

Low Bandwidth

If you have low bandwidth access, it is possible to reduce the site’s complexity by using fewer graphics, images and other data.



To activate a graphics-free interface, press the *Low Bandwidth* button as shown above.



A graphics-free interface appears. To deactivate the feature, press *High Bandwidth*.

System Limitations

The BLACKBOX Portable's integrated Web Server is designed to support a maximum of 3 concurrent user interface connections. However, the Admin level can be logged in only one at a time. In the event that a new Admin connection is established (a user has successfully logged in with Admin password), the previous Admin connection will be automatically logged off. Also, any Admin connection which is idle for more than 5 minutes will be automatically logged off.

The Site Structure

The BLACKBOX Portable embedded website is organized into 6 subsections:

- **Monitoring:** Real time monitoring of a variety of electrical parameters
- **Energy:** Integrated energy meter readings
- **Power Quality:** Power Quality standard compliance monitoring and setup
- **Service:** Main entry for setup and device status monitoring
- **Multi-IO:** Integrated digital inputs setup and monitoring
- **LCD:** A virtual, black and white LCD emulation

The screenshot displays the ELSPEC G4500 BLACKBOX website interface. The top navigation bar includes tabs for MONITORING, ENERGY, POWER QUALITY, SERVICE, MULTI-IO, and LCD. The 'MONITORING' tab is selected, and the 'DATA MONITORING' section is active. The interface shows a 'Summary' table with the following data:

| Summary | |
|-------------------------------|--------------|
| Frequency | 50.031 Hz |
| I_{Avg} | 22.890 A |
| $V(LL)_{Avg}$ | 390.83 V |
| $V(LN)_{Avg}$ | 225.65 V |
| Power Factor _{Total} | 0.0956 (Cap) |
| Phase Order | 123 |

Below the summary table is the 'Synchronization Status' section:

| Synchronization Status | |
|------------------------|----------------|
| Time Synchronization | Main Excellent |
| DSP Synchronization | On |

The footer of the interface shows: Version 0.3.50.12, Serial 5E-70-07-B4-F3-08, Unit time 29/01/2009 15:06:52, © Elspec Ltd 2008.

Monitoring Section

The Monitoring section contains the following pages:

Summary

| DATA MONITORING | | | | | | | | | | | | | | | | | |
|---|---|-----------|-----------|-----------|----------|---------------|----------|-------------------------------|--------------|-------------|-----|----------------------|------|------|---------------------|----|--|
| <ul style="list-style-type: none">SummaryVoltage/CurrentPowerTemperaturePhasorsWaveformsV/I HarmonicsSub/Inter HarmonicsP/Q HarmonicsHarmonics TableV/I Min/Max HarmonicsP/Q Min/Max HarmonicsVoltage FlickeringMin/Max Flickering | <div><h4>Summary</h4><table border="1"><tbody><tr><td>Frequency</td><td>49.978 Hz</td></tr><tr><td>I_{Avg}</td><td>226.39 A</td></tr><tr><td>$V(LL)_{Avg}$</td><td>393.62 V</td></tr><tr><td>Power Factor_{Total}</td><td>0.2268 (Cap)</td></tr><tr><td>Phase Order</td><td>123</td></tr></tbody></table><h4>Synchronization Status</h4><table border="1"><tbody><tr><td>Time Synchronization</td><td>Main</td><td>Good</td></tr><tr><td>DSP Synchronization</td><td colspan="2">On</td></tr></tbody></table></div> | Frequency | 49.978 Hz | I_{Avg} | 226.39 A | $V(LL)_{Avg}$ | 393.62 V | Power Factor _{Total} | 0.2268 (Cap) | Phase Order | 123 | Time Synchronization | Main | Good | DSP Synchronization | On | |
| Frequency | 49.978 Hz | | | | | | | | | | | | | | | | |
| I_{Avg} | 226.39 A | | | | | | | | | | | | | | | | |
| $V(LL)_{Avg}$ | 393.62 V | | | | | | | | | | | | | | | | |
| Power Factor _{Total} | 0.2268 (Cap) | | | | | | | | | | | | | | | | |
| Phase Order | 123 | | | | | | | | | | | | | | | | |
| Time Synchronization | Main | Good | | | | | | | | | | | | | | | |
| DSP Synchronization | On | | | | | | | | | | | | | | | | |

- Frequency
- Average Voltage and Currents
- Total Power Factor
- Phase Order
- Synchronization status

**Voltage/
Current**

DATA MONITORING

Summary
Voltage/Current
 Power
 Temperature
 Phasors
 Waveforms
 V/I Harmonics
 Sub/Inter Harmonics
 P/Q Harmonics
 Harmonics Table
 V/I Min/Max Harmonics
 P/Q Min/Max Harmonics
 Voltage Flickering
 Min/Max Flickering

Reset All Min/Max

V/I

| | RMS | Min Value | Max Value | THD |
|-----------------|----------|-----------|-----------|----------|
| V ₁₂ | 392.37 V | 386.59 V | 410.81 V | 1.3845 % |
| V ₂₃ | 393.99 V | 386.13 V | 410.88 V | 1.4626 % |
| V ₃₁ | 393.42 V | 385.63 V | 409.81 V | 1.4880 % |
| I ₁ | 274.14 A | 0.0000 A | 419.56 A | 8.3732 % |
| I ₂ | 187.66 A | 0.0000 A | 405.13 A | 9.4264 % |
| I ₃ | 219.20 A | 0.0000 A | 507.47 A | 7.7435 % |
| I ₁₂ | 68.682 A | 0.0000 A | 143.44 A | 18.090 % |
| I ₂₃ | 115.94 A | 0.0000 A | 275.97 A | 3.2842 % |
| I ₃₁ | 95.355 A | 0.0000 A | 165.59 A | 12.789 % |

Averages

| | 3 sec | 10 min |
|--------------------|--------------------|--------------------|
| Flag | Not Flagged | Not Flagged |
| V ₁₂ | 392.81 V | 393.22 V |
| V ₂₃ | 394.36 V | 394.53 V |
| V ₃₁ | 393.62 V | 393.76 V |
| V _{Unbal} | 0.2274 % | 0.1966 % |

Unbalance

| | Avg |
|--------------------------------|----------|
| V _{Unbalance} | 0.2204 % |
| V _{Positive Sequence} | 393.59 V |
| V _{Negative Sequence} | 0.8676 V |
| I _{Unbalance} | 31.273 % |
| I _{Positive Sequence} | 90.558 A |
| I _{Negative Sequence} | 28.320 A |

DC V/I

| | RMS | Min Value |
|-----------------|----------|-----------|
| V _{DC} | 1.0547 V | 0.0000 V |
| I _{DC} | 1.0000 A | 1.0000 A |

- RMS Voltages and Currents per phase
- Unbalance, Positive and Negative Sequences
- DC Voltage and Current channels readings

Power

| DATA MONITORING | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|-----------------------|--|--|--|--|--|--|-------------------|---------------------|-------------------|---------------------|---------------------|-----------------|---------|-----------|-------------|------------|--------------|--------------|---------|------------|--------------|------------|--------------|--------------|---------|-----------|--------------|------------|--------------|--------------|--------------|-------------------|---------------------|-------------------|---------------------|---------------------|
| Summary | <h3>Power Summary</h3> <table border="1"> <thead> <tr> <th></th> <th>Active Power</th> <th>Reactive Power</th> <th>Apparent Power</th> <th>True PF</th> <th>Displacement PF</th> </tr> </thead> <tbody> <tr> <td>Phase12</td> <td>4.1225 kW</td> <td>25.742 kVAr</td> <td>26.070 kVA</td> <td>0.1581 (Ind)</td> <td>0.1612 (Ind)</td> </tr> <tr> <td>Phase23</td> <td>-41.982 kW</td> <td>-11.533 kVAr</td> <td>43.538 kVA</td> <td>0.9642 (Cap)</td> <td>0.9648 (Cap)</td> </tr> <tr> <td>Phase31</td> <td>12.841 kW</td> <td>-33.336 kVAr</td> <td>35.726 kVA</td> <td>0.3594 (Cap)</td> <td>0.3633 (Cap)</td> </tr> <tr> <td>Total</td> <td>-25.020 kW</td> <td>-19.128 kVAr</td> <td>105.33 kVA</td> <td>0.2374 (Cap)</td> <td>0.2393 (Cap)</td> </tr> </tbody> </table> | | | | | | | Active Power | Reactive Power | Apparent Power | True PF | Displacement PF | Phase12 | 4.1225 kW | 25.742 kVAr | 26.070 kVA | 0.1581 (Ind) | 0.1612 (Ind) | Phase23 | -41.982 kW | -11.533 kVAr | 43.538 kVA | 0.9642 (Cap) | 0.9648 (Cap) | Phase31 | 12.841 kW | -33.336 kVAr | 35.726 kVA | 0.3594 (Cap) | 0.3633 (Cap) | Total | -25.020 kW | -19.128 kVAr | 105.33 kVA | 0.2374 (Cap) | 0.2393 (Cap) |
| | | | | | | | Active Power | Reactive Power | Apparent Power | True PF | Displacement PF | | | | | | | | | | | | | | | | | | | | | | | | | |
| Phase12 | | | | | | | 4.1225 kW | 25.742 kVAr | 26.070 kVA | 0.1581 (Ind) | 0.1612 (Ind) | | | | | | | | | | | | | | | | | | | | | | | | | |
| Phase23 | | | | | | | -41.982 kW | -11.533 kVAr | 43.538 kVA | 0.9642 (Cap) | 0.9648 (Cap) | | | | | | | | | | | | | | | | | | | | | | | | | |
| Phase31 | | | | | | | 12.841 kW | -33.336 kVAr | 35.726 kVA | 0.3594 (Cap) | 0.3633 (Cap) | | | | | | | | | | | | | | | | | | | | | | | | | |
| Total | | | | | | | -25.020 kW | -19.128 kVAr | 105.33 kVA | 0.2374 (Cap) | 0.2393 (Cap) | | | | | | | | | | | | | | | | | | | | | | | | | |
| Voltage/Current | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Power | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Temperature | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Phasors | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Waveforms | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| V/I Harmonics | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Sub/Inter Harmonics | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| P/Q Harmonics | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Harmonics Table | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| V/I Min/Max Harmonics | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| P/Q Min/Max Harmonics | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Voltage Flickering | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Min/Max Flickering | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

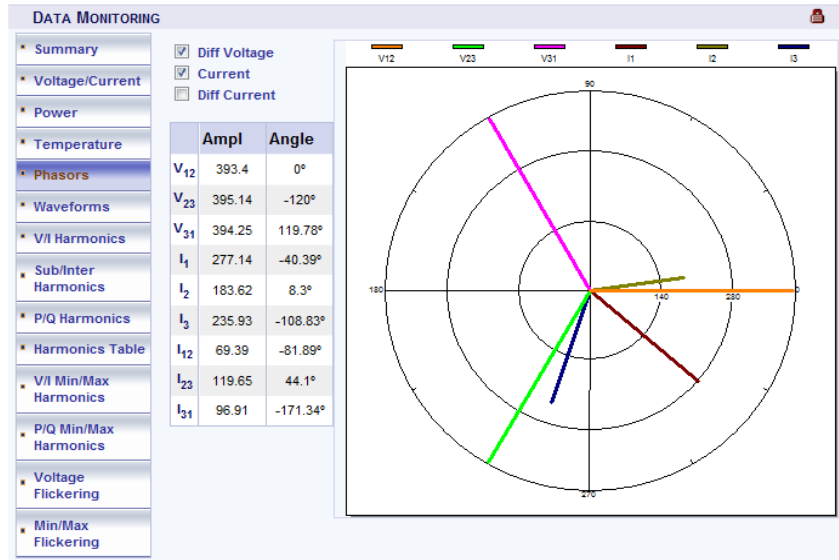
- Active Power
- Reactive Power
- Apparent Power
- True and Displacement Power Factor

Temperature

| DATA MONITORING | | | | | | | | | | | | | | | | | | | | | |
|-------------------------|--|--|--|-------------------------|-------------------------|-------------------------|----------|----------|----------|-------------------------|-------------------------|-------------------------|----------|----------|----------|--------------------|--------------------|--------------------|----------|----------|----------|
| Summary | <div style="text-align: right;">Rese</div> <h3>Internal Temperature</h3> <table border="1"> <thead> <tr> <th>Internal_{Avg}</th> <th>Internal_{Min}</th> <th>Internal_{Max}</th> </tr> </thead> <tbody> <tr> <td>39.28 °C</td> <td>35.30 °C</td> <td>39.52 °C</td> </tr> </tbody> </table> <h3>External Temperature</h3> <table border="1"> <thead> <tr> <th>External_{Avg}</th> <th>External_{Min}</th> <th>External_{Max}</th> </tr> </thead> <tbody> <tr> <td>No Pt100</td> <td>No Pt100</td> <td>No Pt100</td> </tr> </tbody> </table> <h3>PSU Temperature</h3> <table border="1"> <thead> <tr> <th>PSU_{Avg}</th> <th>PSU_{Min}</th> <th>PSU_{Max}</th> </tr> </thead> <tbody> <tr> <td>46.34 °C</td> <td>37.66 °C</td> <td>59.91 °C</td> </tr> </tbody> </table> | | | Internal _{Avg} | Internal _{Min} | Internal _{Max} | 39.28 °C | 35.30 °C | 39.52 °C | External _{Avg} | External _{Min} | External _{Max} | No Pt100 | No Pt100 | No Pt100 | PSU _{Avg} | PSU _{Min} | PSU _{Max} | 46.34 °C | 37.66 °C | 59.91 °C |
| Internal _{Avg} | | | | Internal _{Min} | Internal _{Max} | | | | | | | | | | | | | | | | |
| 39.28 °C | | | | 35.30 °C | 39.52 °C | | | | | | | | | | | | | | | | |
| External _{Avg} | | | | External _{Min} | External _{Max} | | | | | | | | | | | | | | | | |
| No Pt100 | | | | No Pt100 | No Pt100 | | | | | | | | | | | | | | | | |
| PSU _{Avg} | | | | PSU _{Min} | PSU _{Max} | | | | | | | | | | | | | | | | |
| 46.34 °C | | | | 37.66 °C | 59.91 °C | | | | | | | | | | | | | | | | |
| Voltage/Current | | | | | | | | | | | | | | | | | | | | | |
| Power | | | | | | | | | | | | | | | | | | | | | |
| Temperature | | | | | | | | | | | | | | | | | | | | | |
| Phasors | | | | | | | | | | | | | | | | | | | | | |
| Waveforms | | | | | | | | | | | | | | | | | | | | | |
| V/I Harmonics | | | | | | | | | | | | | | | | | | | | | |
| Sub/Inter Harmonics | | | | | | | | | | | | | | | | | | | | | |
| P/Q Harmonics | | | | | | | | | | | | | | | | | | | | | |
| Harmonics Table | | | | | | | | | | | | | | | | | | | | | |
| V/I Min/Max Harmonics | | | | | | | | | | | | | | | | | | | | | |
| P/Q Min/Max Harmonics | | | | | | | | | | | | | | | | | | | | | |
| Voltage Flickering | | | | | | | | | | | | | | | | | | | | | |
| Min/Max Flickering | | | | | | | | | | | | | | | | | | | | | |

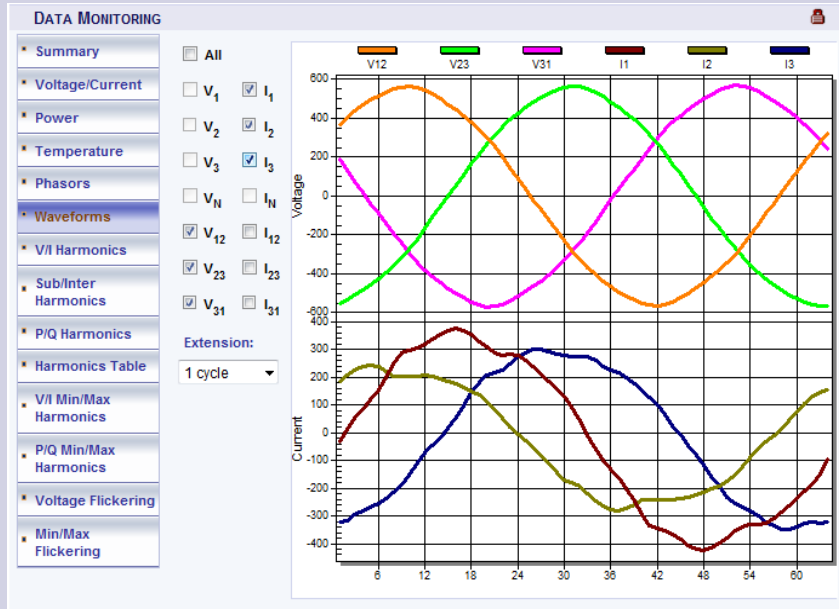
- Internal and External Temperature readings

Phasors



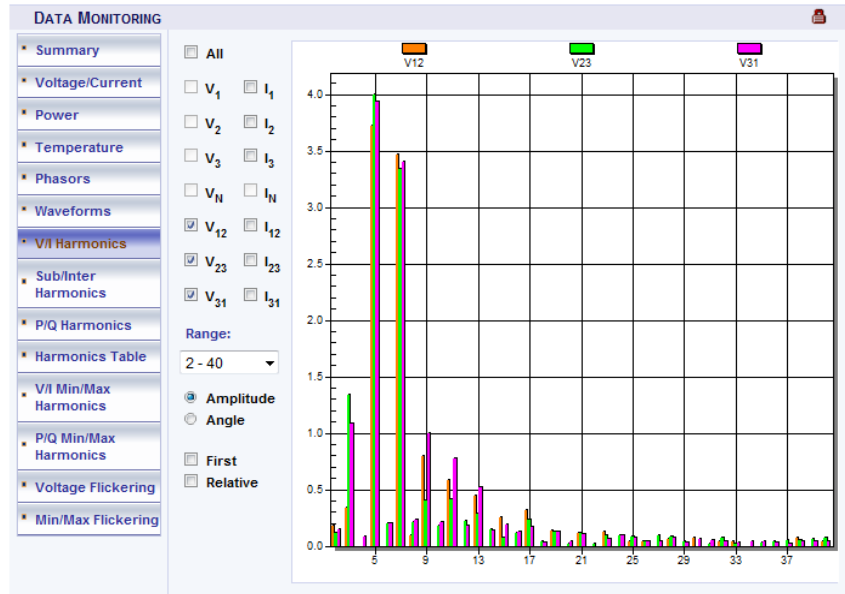
- Voltage and Current Phase diagram
- Refer to Graphic Data Representation paragraph below

Waveforms



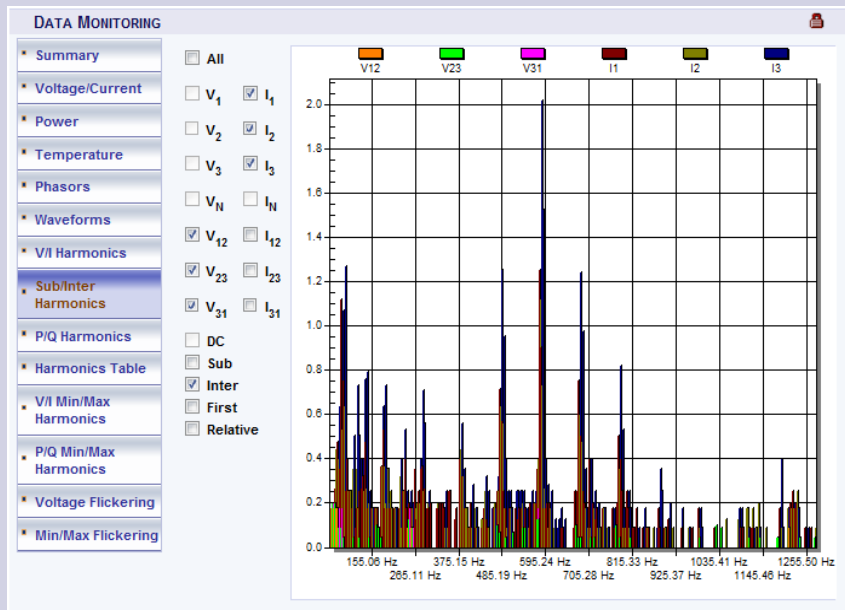
- Voltage and Current waveforms
- Refer to Graphic Data Representation paragraph below

V/I Harmonics



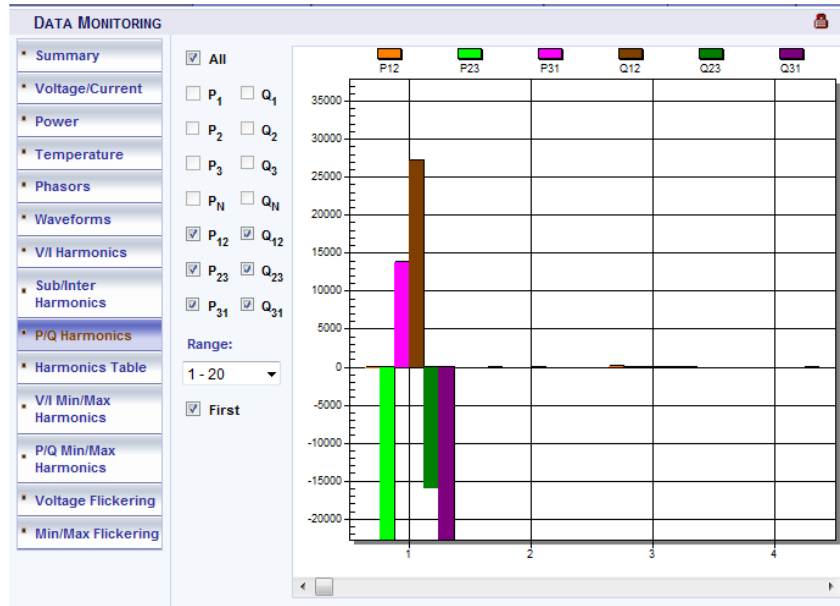
- Voltage and Current harmonics spectrum (up to 40)
- Refer to Graphic Data Representation paragraph below

Sub/Inter harmonics



- Voltage and Current sub and inter harmonics (in 5Hz bins)
- Refer to Graphic Data Representation paragraph below

P/Q Harmonics



- Active and Reactive Harmonic powers
- Refer to Graphic Data Representation paragraph below

Harmonics Table

The screenshot shows the 'ELSPEC G4500 BLACKBOX' interface with the 'Harmonics Table' selected. The table displays 'V & I Harmonics' data for H1 through H11. The columns are V₁₂, V₂₃, V₃₁, I₁, I₂, I₃, I₁₂, I₂₃, and I₃₁. The table is set to 'Amplitude' and 'Relative' mode.

| | V ₁₂ | V ₂₃ | V ₃₁ | I ₁ | I ₂ | I ₃ | I ₁₂ | I ₂₃ | I ₃₁ |
|-----------------|-----------------|-----------------|-----------------|----------------|----------------|----------------|-----------------|-----------------|-----------------|
| H ₁ | 393.26 V | 394.6 V | 393.66 V | 249.17 A | 181.26 A | 234.35 A | 64.255 A | 118.55 A | 88.9 A |
| H ₂ | 0.0968 V | 0.1369 V | 0.079 V | 1.1772 A | 1.1018 A | 3.2308 A | 0.6779 A | 1.3423 A | 1.04 A |
| H ₃ | 0.1046 V | 1.1556 V | 1.1053 V | 19.687 A | 14.309 A | 13.706 A | 11.306 A | 1.0949 A | 11.1 A |
| H ₄ | 0 V | 0.0442 V | 0.0395 V | 0.6777 A | 0.5448 A | 1.2537 A | 0.3705 A | 0.5653 A | 0.32 A |
| H ₅ | 3.895 V | 4.1002 V | 4.1431 V | 6.8816 A | 6.5013 A | 0.9073 A | 0.9234 A | 2.0977 A | 2.25 A |
| H ₆ | 0 V | 0.1896 V | 0.1768 V | 0.7964 A | 0.6398 A | 1.5706 A | 0.4342 A | 0.6555 A | 0.45 A |
| H ₇ | 3.9275 V | 3.5878 V | 3.7036 V | 4.6177 A | 3.0905 A | 3.1242 A | 2.4686 A | 2.0455 A | 0.73 A |
| H ₈ | 0.079 V | 0.2192 V | 0.2338 V | 0.6386 A | 0.542 A | 1.4731 A | 0.3286 A | 0.5742 A | 0.35 A |
| H ₉ | 0.7342 V | 0.3087 V | 0.8422 V | 7.8871 A | 5.7042 A | 5.9035 A | 4.1315 A | 0.3502 A | 4.31 A |
| H ₁₀ | 0 V | 0.1996 V | 0.1854 V | 0.9378 A | 0.8459 A | 1.994 A | 0.5652 A | 0.8523 A | 0.52 A |
| H ₁₁ | 0.6519 V | 0.5394 V | 0.8587 V | 2.283 A | 1.8648 A | 1.5242 A | 0.7613 A | 0.6149 A | 0.3 A |

- Voltage and Current harmonics in values, % and angles

V/I Min/Max Harmonics

ELPEC G4500 BLACKBOX Demo unit

MONITORING ENERGY POWER QUALITY SERVICE MULTI-IO LCD

DATA MONITORING

Summary Voltage/Current Power Temperature Phasors Waveforms V/I Harmonics Sub/Inter Harmonics P/Q Harmonics Harmonics Table V/I Min/Max Harmonics P/Q Min/Max Harmonics Voltage Flickering Min/Max Flickering

Reset All Min/Max Amplitude Angle

Harmonics Min & Max

| | | V ₁₂ | V ₂₃ | V ₃₁ | I ₁ | I ₂ | I ₃ | I ₁₂ | I ₂₃ |
|----------------|-----|-----------------|-----------------|-----------------|----------------|----------------|----------------|-----------------|-----------------|
| H ₁ | Min | 387.02 V | 387.95 V | 387.33 V | 0 A | 0 A | 0 A | 0 A | 0 A |
| | Max | 410.48 V | 410.5 V | 409.44 V | 399.63 A | 349.99 A | 407.74 A | 109.51 A | 213.89 A |
| H ₂ | Min | 0 V | 0 V | 0 V | 0 A | 0 A | 0 A | 0 A | 0 A |
| | Max | 5.2189 V | 5.0269 V | 5.4862 V | 74.293 A | 66.367 A | 84.308 A | 29.861 A | 46.537 A |
| H ₃ | Min | 0 V | 0.6993 V | 0.7395 V | 0 A | 0 A | 0 A | 0 A | 0 A |
| | Max | 2.8617 V | 3.4687 V | 3.2323 V | 55.024 A | 53.805 A | 67.43 A | 23.198 A | 34.32 A |
| H ₄ | Min | 0 V | 0 V | 0 V | 0 A | 0 A | 0 A | 0 A | 0 A |
| | Max | 5.3276 V | 5.6747 V | 5.2021 V | 77.761 A | 87.134 A | 62.224 A | 22.222 A | 46.812 A |
| H ₅ | Min | 0.831 V | 0.9409 V | 0.7384 V | 0 A | 0 A | 0 A | 0 A | 0 A |
| | Max | 5.2967 V | 5.0332 V | 4.8628 V | 36.184 A | 31.522 A | 38.001 A | 12.292 A | 21.734 A |
| | Min | 0 V | 0 V | 0 V | 0 A | 0 A | 0 A | 0 A | 0 A |

- Minimum and maximum values and angles of Voltage and Current harmonics

P/Q Min/Max Harmonics

DATA MONITORING

Summary Voltage/Current Power Temperature Phasors Waveforms V/I Harmonics Sub/Inter Harmonics P/Q Harmonics Harmonics Table V/I Min/Max Harmonics P/Q Min/Max Harmonics Voltage Flickering Min/Max Flickering

Reset All Min/Max

P & Q Min-Max Harmonics

| | | P ₁₂ | P ₂₃ | P ₃₁ | Q ₁₂ | Q ₂₃ | Q ₃₁ |
|----------------|-----|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| H ₁ | Min | -27.149 kW | -59.544 kW | -7.7101 kW | 0 kVar | -62.521 kVar | -41.569 kVar |
| | Max | 20.687 kW | 0 kW | 40.825 kW | 36.087 kVar | 12.917 kVar | 0 kVar |
| H ₂ | Min | -0.0004 kW | -0.0008 kW | -0.0163 kW | -0.0096 kVar | -0.0004 kVar | -0.0013 kVar |
| | Max | 0.0194 kW | 0.019 kW | 0.0004 kW | 0.0006 kVar | 0.0391 kVar | 0.0139 kVar |
| H ₃ | Min | -0.0081 kW | -0.0104 kW | -0.036 kW | -0.0138 kVar | -0.0019 kVar | -0.0177 kVar |
| | Max | 0.0087 kW | 0.0028 kW | 0.0046 kW | 0.0073 kVar | 0.032 kVar | 0.0055 kVar |
| H ₄ | Min | -0.0021 kW | -0.0007 kW | -0.0102 kW | -0.0084 kVar | -0.0004 kVar | -0.0081 kVar |
| | Max | 0.016 kW | 0.012 kW | 0.0033 kW | 0.0015 kVar | 0.0302 kVar | 0.0064 kVar |
| H ₅ | Min | -0.0044 kW | -0.0197 kW | -0.0179 kW | -0.0099 kVar | -0.0359 kVar | -0.0114 kVar |
| | Max | 0.0171 kW | 0.0149 kW | 0.0054 kW | 0.0102 kVar | 0.0054 kVar | 0.0138 kVar |
| H ₆ | Min | -0.0002 kW | -0.0003 kW | -0.0004 kW | -0.0005 kVar | -0.0003 kVar | -0.0004 kVar |
| | Max | 0 kW | 0 kW | 0 kW | 0 kVar | 0 kVar | 0 kVar |

- Minimum and maximum values of Active and Reactive power harmonics

Voltage Flickering

DATA MONITORING

Summary

Voltage/Current

Power

Temperature

Phasors

Waveforms

V/I Harmonics

Sub/Inter Harmonics

P/Q Harmonics

Harmonics Table

V/I Min/Max Harmonics

P/Q Min/Max Harmonics

Voltage Flickering

Min/Max Flickering

Voltage Flickering Reset 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 ₁₂ | | 0.1523 | 0.2042 | 0.2776 | 0.9242 | 0.2809 | 0.3379 | 2.2222 | 0.0000 |
| V ₂₃ | | 0.1870 | 0.1947 | 0.2669 | 1.2925 | 0.3384 | 0.3319 | 2.3227 | 0.0000 |
| V ₃₁ | | 0.1538 | 0.1934 | 0.2825 | 1.2885 | 0.3276 | 0.3387 | 2.4166 | 0.0000 |

- Short and long term voltage flickering

Min/Max Flickering

DATA MONITORING

Summary

Voltage/Current

Power

Temperature

Phasors

Waveforms

V/I Harmonics

Sub/Inter Harmonics

P/Q Harmonics

Harmonics Table

V/I Min/Max Harmonics

P/Q Min/Max Harmonics

Voltage Flickering

Min/Max Flickering

Min/Max Flickering Reset All Min/Max

| | | 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 ₁₂ | Min | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| | Max | 12.304 | 12.304 | 8.7238 | 8.7238 | 8.7238 | 2.3898 | 2.2222 | 0.0000 |
| V ₂₃ | Min | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| | Max | 12.564 | 12.564 | 9.0972 | 9.0972 | 9.0972 | 2.4980 | 2.3227 | 0.0000 |
| V ₃₁ | Min | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| | Max | 12.412 | 12.412 | 9.4539 | 9.4538 | 9.4538 | 2.5991 | 2.4166 | 0.0000 |

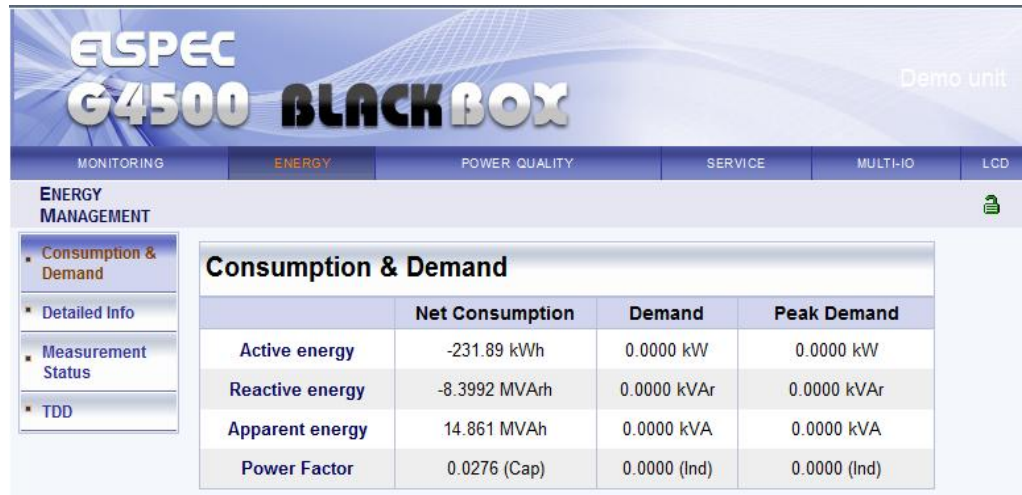
- Minimum and maximum flickering values

Graphic Data Representation

The BLACKBOX Portable website requires a third party ActiveX control (PE-Graph designed by Gigasoft) to present graphical data such as waveforms and harmonic spectral charts. The control can be downloaded from support section on <http://www.elspec-ltd.com> or directly from:

<http://www.elspec.biz/g4kplugins/GigaPE.exe>.

Energy Section



The screenshot shows the Elspec G4500 Blackbox Energy Management interface. The top navigation bar includes 'MONITORING', 'ENERGY' (selected), 'POWER QUALITY', 'SERVICE', 'MULTI-IO', and 'LCD'. The 'ENERGY MANAGEMENT' section is active, with a sidebar menu containing 'Consumption & Demand', 'Detailed Info', 'Measurement Status', and 'TDD'. The main display area shows a table titled 'Consumption & Demand' with the following data:

| | Net Consumption | Demand | Peak Demand |
|-----------------|-----------------|--------------|--------------|
| Active energy | -231.89 kWh | 0.0000 kW | 0.0000 kW |
| Reactive energy | -8.3992 MVAh | 0.0000 kVA | 0.0000 kVA |
| Apparent energy | 14.861 MVAh | 0.0000 kVA | 0.0000 kVA |
| Power Factor | 0.0276 (Cap) | 0.0000 (Ind) | 0.0000 (Ind) |

Energy is defined as power consumed over time. In electrical distribution systems, the unit of time is one hour for all energy measurements and the kWh is the basis for payment for buying and selling energy. This chapter focuses on the flow of energy or power both within a system (active, reactive) as well as the flow of power to and from the system to the grid (delivered or received). The following are commonly used terms in describing energy flow within a system:

- **Active or Real:** 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.
- **Reactive /Volt Amperes Reactive (kVAh):** 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.
- **Apparent:** The combination of active and reactive energy (kVAh).
- **Power Factor:** The ratio between real power and apparent power (a value between 0 and 1).

Consumption & Demand

Energy is produced and consumed within an electrical distribution system. Some sites produce energy for the grid (Received Energy), others consume energy from the grid (Delivered Energy), and still others both consume and produce energy for/from the grid. The Net Consumption is the difference between energy that is used and produced. Therefore, a negative value for Net Consumption indicates that the site is producing more than it is consuming, or a *received net consumption*.

| ENERGY MANAGEMENT | | | | |
|---------------------------------|-----------------|--------------|--------------|--|
| Consumption & Demand | | | | |
| | Net Consumption | Demand | Peak Demand | |
| Active energy | -1.7104 MWh | -23.703 kW | -28.952 kW | |
| Reactive energy | -221.49 kVAh | -10.260 kVA | 57.236 kVA | |
| Apparent energy | 4.4736 MVAh | 63.533 kVA | 215.40 kVA | |
| Power Factor | 0.9917 (Cap) | 0.0000 (Cap) | 0.4514 (Ind) | |

The Consumption & Demand page is a quick look at some of the key components of the Detailed Info page. Here you find a cross-sectional summary view of the amount and makeup (active or reactive) of the Net Energy (Received – Delivered) produced/consumed by a site.

A Demand is an arbitrary measurement of power per configurable unit time using different averaging methods. A demand is measured in units of power even though a time element does exist, while Peak Demand is the highest demand calculated since the last demand reset. Please refer to the Service → Power Setup

[Reset demand](#)

Detailed Info

For a detailed breakdown of energy flow components, the **Detailed Information** page presents all **Active, Reactive, and Power Factor** energy values individually for both produced and consumed (**Received or Delivered**) energy. Also shown below are the Net difference (**Net Energy**) as well as the sum total (**Total Energy**) computations. The **Total Energy** computation contains the combined figure for Active and Reacive Energy (**Apparent Energy**).

As previously stated, the summary page(**Consumption & Demand**) is extracted from the details page. (see below) Note that the red and blue boxed areas are consistent between the different page views. Please note that all values may(not) be absolutely identical due to the delay in page views.

Consumption & Demand

Detailed Info

Measurement Status

TDD

| Received Energy | | | | |
|-----------------|----------------|-------------------|------------|--------------|
| | Current Period | Total Consumption | Demand | Peak Demand |
| Active energy | 0.0000 kWh | 0.2519 kWh | 0.0000 kW | 8.7144 kW |
| Reactive energy | 0.0000 kVAh | 219.13 kVAh | 0.0000 kVA | 84.868 kVA |
| Power Factor | *** | 0.0011 (Ind) | *** | 0.1021 (Ind) |

| Delivered Energy | | | | |
|------------------|----------------|-------------------|--------------|--------------|
| | Current Period | Total Consumption | Demand | Peak Demand |
| Active energy | 3.7100 kWh | 1.7093 MWh | 22.865 kW | 37.667 kW |
| Reactive energy | 1.6727 kVAh | 440.09 kVAh | 10.342 kVA | 27.632 kVA |
| Power Factor | 0.9116 (Ind) | 0.9684 (Ind) | 0.9111 (Ind) | 0.8063 (Ind) |

| Net Energy (Received-Delivered) | | | | |
|---------------------------------|----------------|-------------------|--------------|--------------|
| | Current Period | Total Consumption | Demand | Peak Demand |
| Active energy | -3.7100 kWh | -1.7091 MWh | -22.865 kW | -28.952 kW |
| Reactive energy | -1.6727 kVAh | -220.96 kVAh | -10.342 kVA | 57.236 kVA |
| Power Factor | 0.9116 (Cap) | 0.9917 (Cap) | 0.0000 (Cap) | 0.4514 (Ind) |

| Total Energy (Received+Delivered) | | | | |
|-----------------------------------|----------------|-------------------|--------------|--------------|
| | Current Period | Total Consumption | Demand | Peak Demand |
| Active energy | 3.7055 kWh | 1.7096 MWh | 22.863 kW | 46.381 kW |
| Reactive energy | 1.6705 kVAh | 659.22 kVAh | 10.342 kVA | 112.50 kVA |
| Power Factor | 0.9116 (Ind) | 0.9330 (Ind) | 0.0000 (Ind) | 0.3812 (Ind) |
| Apparent energy | 10.429 kVAh | 4.4702 MVAh | 64.623 kVA | 215.40 kVA |

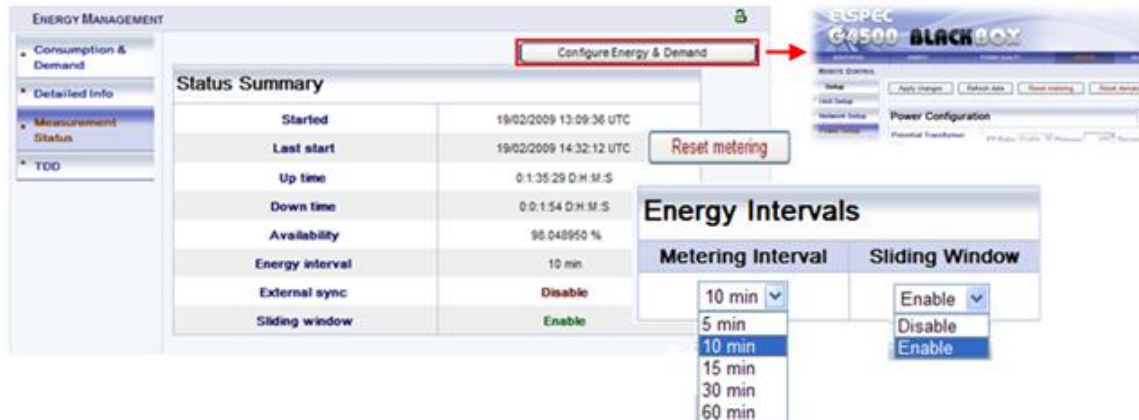
ENERGY MANAGEMENT

Consumption & Demand

| | Net Consumption | Demand | Peak Demand |
|-----------------|-----------------|--------------|--------------|
| Active energy | -1.7104 MWh | -23.703 kW | -28.952 kW |
| Reactive energy | -221.49 kVAh | -10.260 kVA | 57.236 kVA |
| Apparent energy | 4.4736 MVAh | 63.533 kVA | 215.40 kVA |
| Power Factor | 0.9917 (Cap) | 0.0000 (Cap) | 0.4514 (Ind) |

Measurement Status

The Measurement Status page provides additional statistical information and necessary energy context information. The parameters and counters on this page are actually set up in the **Service→Power Setup** section using the **Configure Energy & Demand** button below.



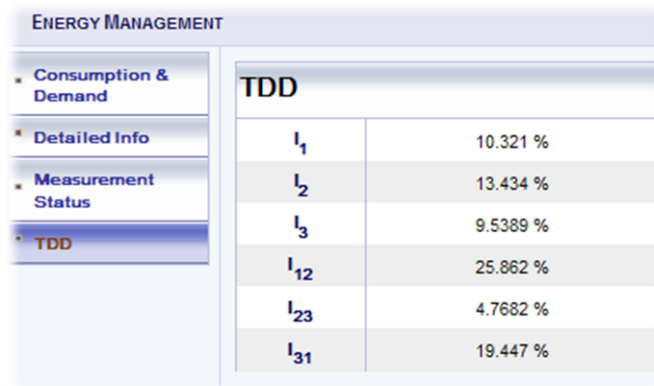
An explanation of all Status Summary terms follows:

- **Started:** This is the date and time stamp from the last energy reset
- **Last start:** This is the date and time stamp for the last metering reset. Total consumption is reset.
- **Up time:** The total cumulative time the mechanism has been operational during the current period (since last start).
- **Down time:** The total cumulative time the mechanism has not been operational during the current period.
- **Availability:** The percentage of time the system has been operational. This is important because if this time exceeds a certain threshold, the data may not be considered reliable
- **Energy (Metering) interval:** The energy interval is the size of the window used in computing demand (e.g. 10 minutes).
- **External Sync:** This function is currently fixed in disable mode.
- **Sliding window:** Information regarding the demand averaging system in use:
 - **Enabled:** The demand is calculated using a sliding window averaging system.
 - **Disabled:** The demand is calculated according to stationary time points.

TDD

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:

$$I_{TDD} = \sqrt{\sum_{h=2}^{\infty} \left[\frac{I_h^2}{I_L^2} \right]} * 100\%$$



The screenshot shows the 'ENERGY MANAGEMENT' software interface. On the left is a navigation menu with the following items: 'Consumption & Demand', 'Detailed Info', 'Measurement Status', and 'TDD'. The 'TDD' item is selected and highlighted. The main content area displays a table titled 'TDD' with two columns: the harmonic order and the percentage value.

| TDD | |
|----------|----------|
| I_1 | 10.321 % |
| I_2 | 13.434 % |
| I_3 | 9.5389 % |
| I_{12} | 25.862 % |
| I_{23} | 4.7682 % |
| I_{31} | 19.447 % |

Power Quality Section

The BLACKBOX Portable contains a power quality compliance engine that enables real-time evaluation of power quality according to standards such as EN50160.

Power quality compliance or in short PQ Compliance is a set of electrically measured parameters which are typically calculated based on some pre-defined intervals or event triggers and are evaluated over a large observation window. For most of the PQ parameters, the observation window is one week, which means the displayed online information refers to the previous week. However, using ELSPEC's PQSCADA and Investigator applications, all time intervals are able to be observed.

A PQ parameter is typically based on a power quality event. For example the DIP PQ parameter is based on counting DIP events over some observation period.

Different national standards vary in the way a specific PQ parameter is being measured or observed. The PQ Engine also supports a user-customizable mode in which all compliance parameters can be self-edited and modified by a user in order to meet new conditions, rules, measuring intervals and even different observation periods.

The Power Quality section in the WEB interface is used to control and view power quality measurement and compliance information computed by the PQ Engine.

The Compliance Summary Page This page enables you to select the specific compliance standard to be evaluated by the unit's internal compliance engine. This page further contains on-line information and compliance status.

The screenshot displays the ELSPEC G4500 BLACKBOX web interface. At the top, there is a navigation bar with tabs for MONITORING, ENERGY, POWER QUALITY (selected), SERVICE, MULTI-IO, and LCD. Below this, the 'POWER QUALITY' section is active, showing a 'Compliance Summary' page. The page includes a left-hand navigation menu with options like 'Compliance Summary', 'Compliance Info', 'Compliance Chart', and 'User Defined' pages. The main content area features two tables: 'Summary' and 'Status'. The 'Summary' table lists parameters such as Compliance Type (EN50160), Running Status (Stop), Embedded Report (None), Evaluation Status (N/A), Start Time (***), Window Time On (0:0:0 D:H:M:S), Window Time Off (0:0:0 D:H:M:S), and Measurement Flag (Not Flagged). The 'Status' table lists various parameters like Voltage Frequency, Supply Voltage Variations, Rapid Voltage Changes, Supply Voltage Dips, Short Interruptions, Long Interruptions, Temporary Overvoltage, Flicker Severity, Harmonic Voltage, and Supply Voltage Unbalance, all with a status of N/A.

The Compliance Type sets the compliance standard.

In order to change or to activate a new compliance type:

1. If the PQ Engine is already running, set the Running Status to *Stop*, then Click *Apply changes*.

Wait for the WEB page to refresh.

2. Select the desired compliance type, then change Running Status to *Running*.
3. Click *Apply changes*, then wait for the WEB page to refresh.

The new compliance type is now activated and running.

4. Verify that the Start Time field has changed.

Continuous compliance statistical information and events are stored in PQZIP files. In addition, the Embedded Report field further indicates a type of report that is auto-generated internally in the device's file system. Most compliance types are not generating any specific report, and therefore, the report type will be **None**. However, CREG type of compliance (used in Colombia) also auto-generates a specific format of report files as defined by the local regulator. The report files can be found in the [Integrated FTP Server on page 96](#).

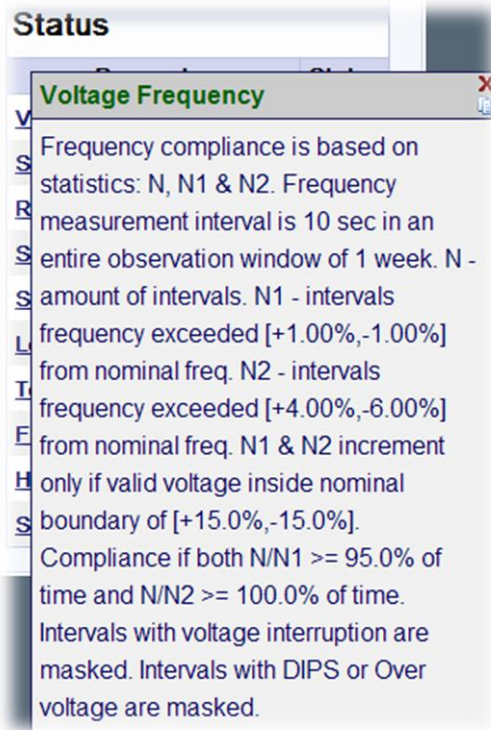
The Evaluation Status field provides an overall status of PASS or FAIL of the entire compliance. Anytime the evaluation period is not complete (typically it is required 1 week observation), the status will be N/A (Not Available).

The Start Time field shows the last time the compliance engine was restarted. The entire state and observation window history is stored on the internal non-volatile memory, so even after powering down, the Engine will continue its evaluation and maintain all indications. (Start time remains unchanged after device powered up.)

The Window Time On/Off fields specify how much aggregated time is already in the observation window. ON refers to the aggregated window time the device was powered on and OFF refers to the amount of window time the device power was off. The format presented is [Days: Hours: Minutes: Seconds]. Ideally the OFF time is all zeroes and the ON time is 7 days (which is the typical full observation period in most of the compliance types). Once the observation window reaches 7 days, it will start to slide in steps of 2 hours. Sliding means the information from the oldest 2 hours is being dropped, where a new up-to-date 2-hour interval is being stored.

The Measurement Flag field indicates whether the compliance evaluation is currently Masked (equals Flagged) or not. Flagged time means a power quality event such as DIP/SWELL or INTERRUPTION.

The **Status Table** shows a high level PASS or FAIL indication of each PQ parameter. Any PQ parameter that has an incomplete observation period will be presented as N/A (Not Available). Additional information of how a PQ parameter is being evaluated can be seen by simply clicking on the parameter's text. For example, clicking on the Voltage Frequency parameter within the EN50160 compliance mode will show an info page as shown on the figure below.



The Compliance Info Page

This page contains detailed compliance information.

| Detailed Compliance Info | | | | | | Status: Running <input type="button" value="v"/> |
|---|----------|-------------|------------------|-----------------------|----------|---|
| | Status | | Window Interval | Time OK | Time | Total Events |
| | Partial | Observation | | Time Fail | N/A | |
| Voltage Frequency | OK OK | Complete | 1 week 10 sec | 100.000 % 0.0000 % | 0.0000 % | 0 |
| Supply Voltage Variations | OK OK | Complete | 1 week 10 min | 100.000 % 0.0000 % | 0.0000 % | 0 |
| Rapid Voltage Changes | OK OK | Complete | 1 week 3 sec | 100.000 % 0.0000 % | 0.0000 % | 0 |
| Supply Voltage Dips | OK OK | Complete | 1 week 10 ms | 100.000 % 0.0000 % | 0.0000 % | 0 |
| Short Interruptions | OK OK | Complete | 1 week 10 ms | 100.000 % 0.0000 % | 0.0000 % | 0 |
| Long Interruptions | OK OK | Complete | 1 week 10 ms | 98.837 % 1.1626 % | 0.0000 % | 1 |
| Temporary Overvoltage | OK OK | Complete | 1 week 10 ms | 100.000 % 0.0000 % | 0.0000 % | 0 |
| Flicker Severity | OK OK | Complete | 1 week 10 min | 100.000 % 0.0000 % | 0.0000 % | 0 |
| Harmonic Voltage | OK OK | Complete | 1 week 10 min | 100.000 % 0.0000 % | 0.0000 % | 0 |
| Supply Voltage Unbalance | OK OK | Complete | 1 week 10 min | 100.000 % 0.0000 % | 0.0000 % | 0 |

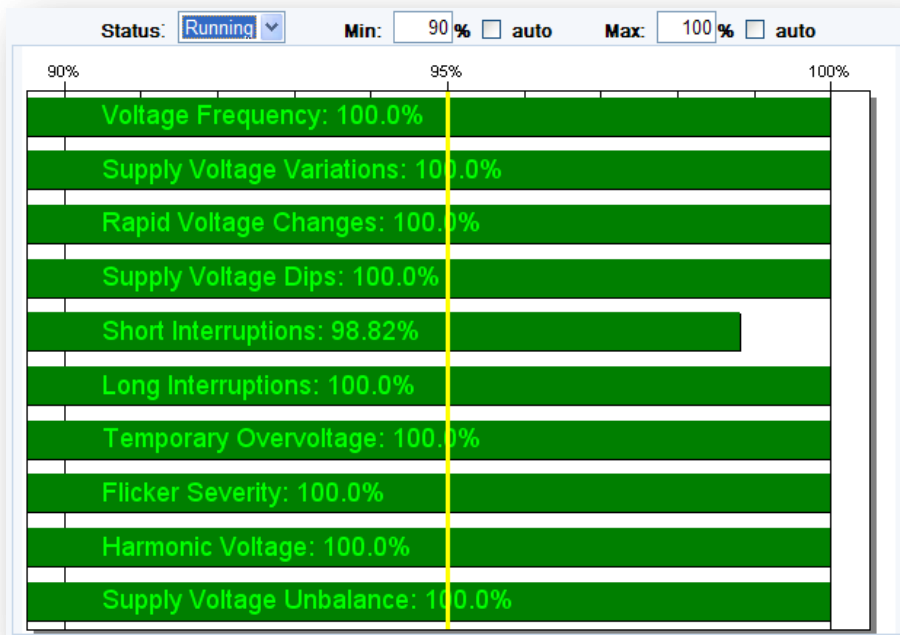
By clicking on the parameter's text, you get the following detailed information:

- **Status/Partial** contains two status indicators. The upper indicator refers to the entire observation window's PASS/FAIL result (same status as presented in the Summary page), while the lower indicator is a PASS/FAIL indicator of the most recent period. This recent indicator is served as real-time indicator and typically reflects only minutes to a few hours of history (this is dependent on the specific PQ parameter measurement intervals and method).
- **Observation** indicates whether the observation window of the PQ parameter is complete.

- **Window/Interval** provides the observation window time in the upper area and measurement interval time in the lower area. *Time OK/Time FAIL* provides the percentage of time the PQ parameter was OK (as green text on the upper area) and percentage of time the PQ parameter was outside the defined limits or failed (as red text in the lower area).
- **Time N/A** provides the percentage of time the unit was not measuring due to lack of power.
- **Total Events** provides the overall number of PQ events influenced by the PQ parameter in the observation window.

The Compliance Chart Page

This page displays graphical bars of compliance levels (equals to percentage of time OK). The minimum and maximum values in the chart are configurable.





The User Defined Pages

These pages allow you to fully customize the compliance parameters. In order to be able to configure, you first need to change the compliance type to User Defined (under Compliance Summary page).

Service Section

The Setup pages are used to configure the BLACKBOX Portable. Notice that in order to setup any of the pages and parameters in the BLACKBOX Portable interface, there is a need to login as Administrator.

To verify Administrator login, you should notice the unlocked sign  at the right side of the page. A locked sign  means Viewer level only and does not allow configuration.

(Refer to Login Page chapter on page 41)



Unit Setup

The Unit Setup page is used to configure the main properties of BLACKBOX Portable unit identification.

The screenshot shows the 'Unit Setup' page with a sidebar menu on the left containing: Setup, Unit Setup (selected), Network Setup, Power Setup, Events Setup, Display Setup, RS-485/422, Firmware Upgrade, PPP Setup, Diagnostics, System Log, Network Status, Power Status, PQZIP Status, GPS Module, E-mail Alerts, and Alarm Setup. At the top right are buttons for 'Apply changes', 'Refresh data', and 'Reset unit'.

G4 Unit Configuration

| | |
|--------------|--|
| Product: | Name: BLACKBOX Type: G4500 |
| Version: | Boot: 0.3.02 SW: 0.3.52.1.C5A4 HW: 2x2x1x0 DSP: 812.28 |
| Site: | <input type="text" value="Demo unit"/> |
| Description: | <input type="text" value="G4500 Unit"/> |
| Operator: | <input type="text" value="OPERATOR NAME"/> |
| Company: | <input type="text" value="COMPANY NAME"/> |

Password Setup

Viewer
 Admin

Password:

Confirm:

Time Setup

| RTC Counter | Time Zone | Unit Date & Time | |
|--------------------|---|----------------------|----------------------|
| 69:7:15:43 D:H:M:S | UTC +2 <input type="button" value="v"/> | <input type="text"/> | <input type="text"/> |

G4 Unit Configuration Section

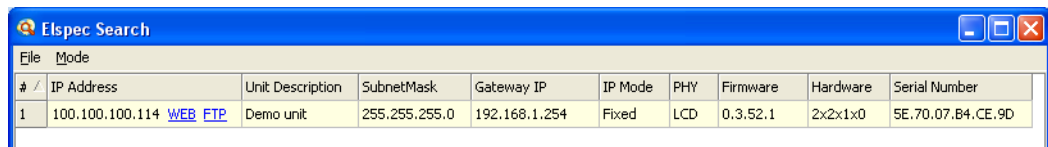
The Product field specifies the type of BLACKBOX model in use. This field is for future use.)

The Version field specifies internal HW and SW versions in which:

- Boot:** Specified Boot application version. The boot application is a small separated part of the firmware. The Boot is stored on a secured sector in the internal flash memory chip and is used for the very beginning of HW initialization and further execution of the BLACKBOX firmware. The Boot executes either Bank A or Bank B firmware. [\(Refer to Firmware Upgrade on page 83\)](#)
- SW:** BLACKBOX firmware version. Notice that BLACKBOX device contains two banks of firmware, while the version in this field refers to the currently executed firmware. [\(Refer to Firmware Upgrade on page 83\)](#)
- HW:** BLACKBOX hardware version.

- **DSP:** BLACKBOX DSP version. The BLACKBOX contains a dedicated DSP (Digital Signal Processing) module for high speed calculations. This field defines the firmware version of the code being executed on this DSP.
- **The Site field** enables the user to define a description of the site where the device is installed. This site's description also appears in the EL-SPEC Search utility under Unit Description when searching for devices.

For example:



| # / | IP Address | Unit Description | SubnetMask | Gateway IP | IP Mode | PHY | Firmware | Hardware | Serial Number |
|-----|---|------------------|---------------|---------------|---------|-----|----------|----------|-------------------|
| 1 | 100.100.100.114 WEB FTP | Demo unit | 255.255.255.0 | 192.168.1.254 | Fixed | LCD | 0.3.52.1 | 2x2x1x0 | 5E.70.07.B4.CE.9D |

- **The Description field** is an additional text field for optional use.
- **The Operator field** is an additional text field typically for inputting operator/technician name.
- **The Company field** is additional text field typically for inputting company name.

Password Setup section

This section enables the Administrator to change or reset the passwords of Viewer and Administrator levels. Notice that the default (Reset) passwords are:

- **123:** Viewer (can view but cannot configure)
- **12345:** Administrator (can view as well as configure the device)

Time Setup

The Time Setup section is used to set and control the displayed time.

- **The RTC Counter** refers to the counting of the internal battery backup real time clock. The RTC starts its counting from the manufacture date. RTC Counter format is: Days, Hours, Minutes, and Seconds.
- **Time Zone** specifies the date and time to be presented on the WEB (time and date are presented at the bottom of the page). The presented time is the local time derived from the GMT time and the configured Time Zone which shifts the GMT time backward or forward in accordance. (Greenwich Mean Time (GMT) means time at Greenwich, London . It is also referred to as UTC.)
- **Unit Date & Time** allows you to set the current time and date manually. Once you click on the configuration box, the date or time will instantly appear and you can set it. Click on the *Set Date & Time* button and the time is changed. However, if the unit's Time Synchronization module is synchronizing with an external source (like NTP or GPS), the time will

be overridden as soon as the time is updated. To prevent automatic updates, set the Time Sync module on Self synchronization refer to [Time Synchronization on page 91](#).

Network Setup

The BLACKBOX Portable provides 3 Fast Ethernet Links and a Wireless connection (Wi-Fi Access point and router).

The Network Setup page is used to configure all units' Network connection settings, except for the wireless access point which is an additional web interface. Refer to [Ethernet Ports View on page 25](#).

Setup

- Unit Setup
- Network Setup
- Power Setup
- Events Setup
- Display Setup
- RS-485/422
- Firmware Upgrade
- PPP Setup
- Diagnostics
- System Log
- Network Status
- Power Status
- PQZIP Status
- GPS Module
- E-mail Alerts
- Alarm Setup

LAN Setup

LAN2/LCD

| | |
|-------------|--|
| Auto DHCP | <input type="text" value="Enable"/> |
| IP Address | <input type="text" value="100.100.100.114"/> |
| Subnet Mask | <input type="text" value="255.255.255.0"/> |

Internal Link

| | |
|-------------|--|
| Auto DHCP | <input type="text" value="Disable"/> |
| IP Address | <input type="text" value="192.168.1.1"/> |
| Subnet Mask | <input type="text" value="255.255.0.0"/> |

| | |
|-------------|--|
| Gateway | <input type="text" value="192.168.1.254"/> |
| SMTP Server | <input type="text" value="0.0.0.0"/> |

Network Time

| | |
|----------------|--|
| Transport | <input type="text" value="Automatic"/> |
| Main SNTP | <input type="text" value="100.100.100.55"/> |
| Alternate SNTP | <input type="text" value="169.254.249.254"/> |
| Using SNTP | Main |
| Slew Mode | <input type="text" value="Automatic"/> |
| Slew Factor | <input type="text" value="49.867"/> % |
| Step Time | <input type="text" value="10"/> sec |

Ports Setup

| SMTP port | HTTP port | FTP daemon | FTP data |
|---------------------------------|---------------------------------|---------------------------------|---------------------------------|
| <input type="text" value="25"/> | <input type="text" value="80"/> | <input type="text" value="21"/> | <input type="text" value="20"/> |

Access Setup

FTP Login

Password:

Confirm:

LAN2/LCD Port Setup

This port is for direct connection to the BLACKBOX Portable device, bypassing its internal router (suitable for connecting the unit with local LAN of computers/servers).

- **The Auto DHCP field** is used to control the IP automatic setup method; if set to *enable*, the unit gets its IP configuration from a DHCP server on the LAN2 port side. If set to *disable*, the unit uses a fixed IP configuration on its LAN2 side as further defined.
- **The IP Address** is used for setting the BLACKBOX Portable's internet address on LAN2 side.
- **The Subnet Mask** is used for setting the BLACKBOX Portable's subnet mask on LAN2 side.

Internal Link Port Setup

This port is an internal link between the BLACKBOX Portable's internal main CPU and the internal router. [Ethernet Ports View on page 25.](#)

- **The Auto DHCP field** is used to control the IP automatic setup method; if set to *enable*, the unit gets its IP configuration from the internal BLACKBOX Wi-Fi router. If set to *disable*, the unit uses a fixed IP configuration on its Internal Link side as further defined.
- **The IP Address** is used for setting the BLACKBOX Portable's internet address on Internal Link side.
- **The Subnet Mask** is used for setting the BLACKBOX Portable's subnet mask on Internal Link side.

Address Range Validation

Valid addresses range resulting from LAN2 pair of IP address and subnet mask must be different than the address range resulting from the same pair of settings on the Internal Link; otherwise, a connection failure is expected.

| LAN Setup | |
|---------------|---------------|
| LAN2/LCD | |
| Auto DHCP | Disable |
| IP Address | 169.254.1.12 |
| Subnet Mask | 255.255.255.0 |
| Internal Link | |
| Auto DHCP | Disable |
| IP Address | 192.168.1.1 |
| Subnet Mask | 255.255.0.0 |
| Gateway | 192.168.1.254 |
| SMTP Server | 0.0.0.0 |

Correct

LAN2 = 169.254... is different than

Internal Link = 192.168....

Ok, Different ranges.

Gateway and SMTP

The Gateway is used for setting the BLACKBOX Portable's default Gateway IP address. This address is used when the BLACKBOX Portable needs to send data to IP addresses outside its LAN2 and Internal Link network range. Typically this is set to the internal router.

The SMTP Server is used for setting an IP Address for Email Server to be used for sending notification emails.

Ports Setup: This is a legacy option for remote access. Port Setup enables changing the standard configuration of internet port numbers for standard communication protocols (Emails, File Transfer, & Web browsing). This might be used in networks where standard port numbers are forbidden or reserved by firewalls or in case one wishes to reserve the standard port number for a legacy modem/router that does not support port forwarding. (Notice that most external modems/routers on the market today do support port forwarding). It is suggested to leave the port numbers in their default setup so that it will be straight forward for web browsers or FTP clients to access the device via LAN/Internet.

- **The SMTP Port** is used for setting port number of mail transfer.
- **The HTTP Port** is used for setting port number of Web browsing.

| LAN Setup | |
|---------------|---------------|
| LAN2/LCD | |
| Auto DHCP | Disable |
| IP Address | 192.168.1.12 |
| Subnet Mask | 255.255.255.0 |
| Internal Link | |
| Auto DHCP | Disable |
| IP Address | 192.168.1.1 |
| Subnet Mask | 255.255.0.0 |
| Gateway | 192.168.1.254 |
| SMTP Server | 0.0.0.0 |

Incorrect

LAN2 = 192.168... equals to

Internal Link = 192.168....

IP range conflict!!!

- **The FTP Daemon** is used for setting port number of File transfer (control channel).
- **The FTP Data** is used for setting port number of File transfer (data channel).



Notice that change of FTP ports also requires a change in PQSCADA configuration.

Access Setup

This controls the FTP login and FTP password (FTP is File Transfer) for security measures. If no security measures are required, it is suggested to leave the default settings for straightforward PQSCADA connection.



Notice that change of access setup also requires a change in PQSCADA configuration.

Network Time

This section controls Time Synchronization.

- **Transport** is used to set whether the Time Sync module selects the source automatically or is manually forced to NTP or GPS source.
- **Main SNTP** is used to configure the IP address of the Primary NTP server to be used.
- **Alternate SNTP** is used to configure the IP address of the secondary NTP server to be used, in case the primary is not available.

[\(Refer to on page 91 for more information.\)](#)

Power Setup

ELSPEC G4500 BLACKBOX Demo unit

MONITORING ENERGY POWER QUALITY SERVICE MULTI-IO LCD

REMOTE CONTROL

Setup Apply changes Refresh data Reset metering Reset demand

Power Configuration WYE 4 wires

Potential Transformer (PT) PT Ratio: Disable Primary: 400 Secondary: 400

Nominals F (Hz): 50 V (V): 400

Voltage Polarity V_N: Normal V₁: Normal V₂: Normal V₃: Normal

Current probes info

| Channel | CT Ratio (A) | | Nominal (A) | Polarity | Info |
|----------------|--------------|-----------|-------------|----------|--------------------------------|
| | Primary | Secondary | | | |
| I ₁ | --- | --- | 3000 | Normal | Chauvin Arnoux-3000A: 1KA/46mV |
| I ₂ | 1 | 1 | 1 | Normal | mini clamp: 1A/1V |
| I ₃ | --- | --- | --- | Normal | No probe detected |
| I _N | --- | --- | --- | Normal | No probe detected |

Energy Intervals Metering Interval: 15 min Sliding Window: Enable

Non-measured Currents Calculated Phase: All measured

Meter Readings Log Mode: Disable Duration: 1/Month Log restart: UTC: 12:00, every 1 of month Local: 14:00, every 1 of month

Version 0.3.52.1 Serial 5E-70-07-B4-CE-9D Unit time 18/02/2009 15:02:32 © Elspec Ltd 2008

The Power Setup page contains the following subsections:

- Power Configuration
- Current probes info
- Energy Intervals
- Non-measured Current
- Meter Readings Log

Power Configuration

This page defines the network type and nominal voltage and frequency values.

The network type settings are represented by five different configurations, although the actual number of supported networks could be extended to virtually any existing configuration.

The following table proposes the recommended configurations for several supported power types.

| Power Type | Power Configuration to use |
|------------------------------|----------------------------|
| Single Phase with Neutral | Single LN |
| Single Phase without Neutral | Single LL |
| Single split phase | 2Phase TR |
| Three Wire Delta | Delta 3 wires |
| Four Wire WYE | WYE 4 wires |
| Three Wire WYE | WYE 4 wires |
| Delta High Leg | Delta 3 wires |
| Delta Open Leg | Delta 3 wires |

(Refer to Power Type Diagrams on page 16 for connection diagrams.)

Potential Transformer (PT)

| | | | |
|----------------------------|--|--|--|
| Potential Transformer (PT) | PT Ratio <input type="text" value="Enable"/> | Primary <input type="text" value="400"/> | Secondary <input type="text" value="400"/> |
|----------------------------|--|--|--|

Potential Transformer configuration is required only for a MV/HV networks where the voltage is measured using PTs. When enabled, the Primary and Secondary transformer values should be configured.

Nominals

| | | |
|----------|--|--|
| Nominals | F (Hz) <input type="text" value="50"/> | V (V) <input type="text" value="400"/> |
|----------|--|--|

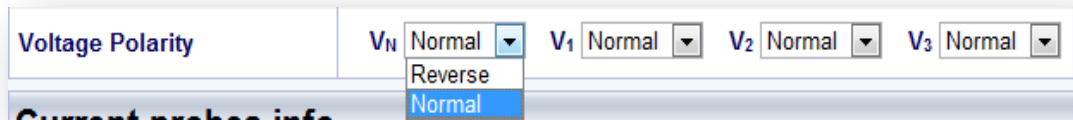
The Nominals section defines the nominal values for frequency (F) and Voltages (V). The Frequency nominal affects compliance ([refer to Power Quality Section on page 58](#)) and the EN61000-4-30 measurement window. When 50Hz nominal is set, the window is 10 cycles, and for 60Hz, it is 12 cycles.

The Voltage Nominal also affects the compliance engine ([refer to Power Quality Section on page 58](#)) and PQZip recording ([refer to PQZip on page 105](#)).



*For maximum logging resolution and efficiency it is recommended keeping **NOMINAL** values as close to the expected normal condition values and **NOT** to maximum values!*

Voltage Polarity



The Voltage Polarity settings allow for toggling the polarity without it being necessary to change the wiring when voltage probes are connected in wrong polarity due to a wiring mistake.

Current Probes Info

| Current probes info | | | | | |
|---------------------|--------------|-----------|-------------|----------|--------------------------------|
| Channel | CT Ratio (A) | | Nominal (A) | Polarity | Info |
| | Primary | Secondary | | | |
| I ₁ | --- | --- | 3000 | Normal | Chauvin Arnoux-3000A: 1KA/46mV |
| I ₂ | 1 | 1 | 1 | Normal | mini clamp: 1A/1V |
| I ₃ | --- | --- | --- | Normal | No probe detected |
| I _N | --- | --- | --- | Normal | No probe detected |

The Current Probes Info section provides the status and configuration for the current probe detection mechanism. When it is successfully detected, the probe type is displayed on the Info section. If no probe is connected/detected, the Info shows a *No probe detected* string.

Configuration options are directly dependent on the probe type, for example, the mini clamp 1A/1V (refer to page 9 for specifications) is normally used to measure a secondary current of a current transformer (CT). In that case, the CT should be defined as Primary/Secondary values. On flexible probe types, these settings are not available.

Nominal (A) value plays an important role for the PQZip recording functionality (refer to PQZip on page 105). In the event that the probe is identified, the value is automatically set to probe default.



*For maximum logging resolution and efficiency it is recommended keeping **NOMINAL** values as close to the expected normal condition values and **NOT** to maximum values!*

Energy Intervals

| Energy Intervals | | | | | | | |
|---|--|--------------|--|------|----------|--|--|
| Metering Interval | Sliding Window | | | | | | |
| <div style="border: 1px solid black; padding: 2px;"> 10 min ▼ 5 min 10 min 15 min 30 min 60 min </div> | <div style="border: 1px solid black; padding: 2px;"> Enable ▼ </div> | | | | | | |
| <table border="1"> <thead> <tr> <th colspan="2">Metering Log</th> </tr> <tr> <th>Time</th> <th>Duration</th> </tr> </thead> <tbody> <tr> <td> </td> <td> </td> </tr> </tbody> </table> | | Metering Log | | Time | Duration | | |
| Metering Log | | | | | | | |
| Time | Duration | | | | | | |
| | | | | | | | |

The Energy Intervals section defines the interval of energy consumption information to be aggregated and stored. The same interval is applicable for the Meter Reading Log (see below).

The aggregation for demand calculations can be further defined as a sliding window by enabling a Sliding Window parameter. The sliding window's step is defined as 1 second.

Non-measured Current

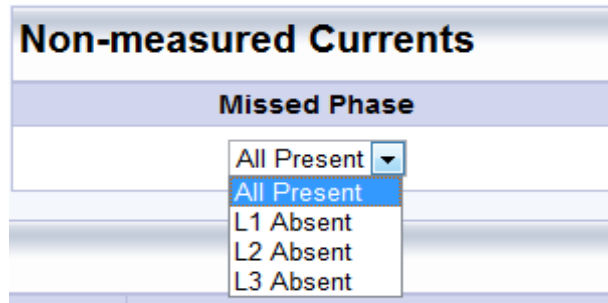
The Non-measured Current section helps to configure calculated current channels. The options are different for WYE and DELTA setups.

On WYE network type configurations:

| Non-measured Currents | |
|---|--|
| Calculated Phase | |
| <div style="border: 1px solid black; padding: 2px;"> All measured ▼ All measured In calculated </div> | |

The neutral current (In) could be optionally calculated from the sum of three-phase currents, or alternatively, measured by the I4-current channel.

On DELTA network configurations:



One of the three-phase current channels could optionally be calculated from the $I1+I2+I3=0$.

Meter Readings Log

| Meter Readings Log | | |
|--------------------|----------|--|
| Mode | Duration | Log restart |
| Disable | 1/Month | UTC: 12:00, every 1 of month Local: 14:00, every 1 of month |

The Meter Reading Log section provides some extended meter reporting capabilities:

- Energy report ([refer to page 150 for details](#))
- Power Curve Verification (PVC) report ([refer to page 146 for details](#))

Events Setup

The Events Setup page is used for configuring custom events. While in the compliance configuration pages you are limited to configure only power quality events, in this page you are free to define any type of events notifications. Events can be triggered based on any measured parameters and conditioned by complex logical or mathematical functions.

Events setup is not related to power quality events. The Events setup is based on a custom events engine that works in parallel to the power quality events engine.

The BLACKBOX Portable contains following event types:

| Type | Event Code range |
|-------------------------------------|------------------|
| System Events | 1-200 |
| User Custom Events Setup | 201-232 |
| Power Quality and Compliance Events | 233-300 |

| | |
|---------------------------------|--------|
| Reserved for other/future usage | 301... |
|---------------------------------|--------|

All events triggered in the BLACKBOX Portable are stored in the logger (flash memory) which is viewable through the System Log page.

In addition, all events are also stored in the PQZIP files and can be further analyzed in the ELSPEC PQSCADA/Investigator software.

Events can generate an email-notification (refer to E-mails Alerts page for more information).

Codes 201 – 232 are used for configuring up to 32 different, fully customized events.

A custom event is typically built from one or more logical/mathematical conditions. When the conditions are met, the event is triggered and the following information is generated and stored:

- Time Stamp of beginning
- Event Code number
- Duration of event
- Magnitude (A parameter value recorded during the event)
- Magnitude deviation (from the normal/configured value/treshold)
- Phases that were influenced
- Severity of the Event (value indicating how severe ithe event is)

Although the information implies a power related event, you are free to configure other type of events that are not related to specific power network parameters, such as digital input-based events or even temperature-based events and so on. (In such cases the Phases involved information should be left blank/ignored.)

Events can also be based on multiple conditions, for example an event which is triggered if both voltage is above some treshold and outside (PT-100) temprature exceeds a certain limit.

The Events Setup Page

This page contains buttons for applying changes/creating/deleting and performing various actions on selected events.

Events List

The Events List section shows the existing user events. There are few modes to use. A user may create events manually or select an already prepared set of events from the Preset list.

- **Preset 1, Preset 2...:** An already prepared events configurations (hard coded in the firmware). Preset 2 is very useful for DFR (Digital Fault Recording) applications.
- **User Defined:** Manual creation of events



Notice that changing between presets will erase the content of what is already defined.

When selecting User Defined, you can create multiple events. Once an event is created, it is added to the list.

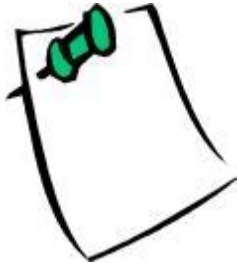
Example:

| Events List | | | | | Preset: User Defined |
|--------------------------|----|------|-------------|---------|----------------------|
| <input type="checkbox"/> | On | Code | Description | Counter | |
| <input type="checkbox"/> | ✓ | 201 | Event 201 | 0 | |
| <input type="checkbox"/> | ✓ | 202 | Event 202 | 1 | |

The check boxes at the left are used to select either all (if press on top) or a selective event entry. On the selected events, you may select a specific

action from the Action on Selected Events list and then press the *Apply action* button to perform the action.

The Counter shows the current count of events. The counter can be zeroed by using the Reset Counter action.



Review the System Log to view the events online.

Creating a new User Defined Event

In order to create a new event, click on the button. The following section appears:

| Custom Event Configuration | | More | Save | Cancel |
|----------------------------|--|--|------|--------|
| Description | <input type="text" value="Event 201"/> | Code: | 201 | |
| Condition | <input type="text" value="Add New"/> | <input type="button" value="Edit Condition"/> | | |
| Trigger | <input type="text" value="On both begin and end"/> | <input checked="" type="checkbox"/> Notify by e-mail | | |



Notice the underlined fields which can be clicked for hints that provide online information about the field and its usage.

- **The Description** is used to set a meaningful name for the event.
- **The Code** is the event code #. The code number is selected automatically from the available user events codes.
- **An event** is based on one or more conditions. There are two types of conditions Single and Multiple. No matter what type of condition is linked to the event, the link between an event and its dependent condition/s is by a condition ID string as selected in the Condition selection box. Use the *Edit Condition* button to create new or edit an existing condition.

- **An event** is basically a logic signal. Anytime a condition is not active, the event remains in a "0" state. When a condition is met, the event becomes "1" state (beginning of event). The event remains on "1" state until the condition is de-activated (end of event). The trigger configuration field defines what situations will generate an event record. Notification is either on the beginning state, end state or at both states.



Notice that if selecting the beginning of an event, the duration indication of the event will be recorded as zero.

User events are stored automatically in the system log and PQZIP. In addition, you may set the Notify by Email to create an email notification as soon as the event is triggered.

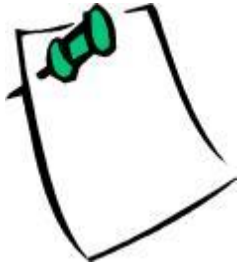
- The *Save* button is used to save the configuration.
- The *More* button displays more advanced settings that you can control.

Creating Event's Conditions

A screenshot of a software dialog box titled "Condition Configuration". It has three buttons at the top right: "More", "Save", and "Cancel". Below the title bar, there is a text field containing "Condition 1", followed by "(# 1)", and a "Type:" label with a dropdown menu currently set to "Single".

| | | | | | |
|--------------------------------|-------------|-------|-------|--------|--------|
| Condition Configuration | | | More | Save | Cancel |
| ID: | Condition 1 | (# 1) | Type: | Single | ▼ |

- **The Single type** of condition is defined as the result of some rule (mathematical operation on some system parameters), For instance, a percentage voltage drops below the threshold or a change of digital input and so on. The condition has 2 logic states, Activated(1) and De-activated(0). Transition to each state is fully user configurable.
- **A Multiple-type** of condition is a combination of 2 other subconditions. A Multiple-type condition must be linked to 2 subconditions, each of these 2 subconditions can be either Multiple or Single type. Therefore, the Multiple- type condition can be used to create a complex hierarchy of conditions.



Notice that until there are at least 2 conditions defined, it is impossible to create a Multiple condition.

- **The ID Condition** is identified by a text ID. Two conditions cannot be set to the same ID string.
- **The Type** selects the type of condition (either Single or Multiple).

Single Type Condition

| Condition Configuration | | More | Save | Cancel |
|-------------------------|----------------------------|-------------------|------------------------------|--------|
| ID: | Condition 1 | (# 1) | Type: | Single |
| <u>Based on:</u> | Per Phase [V/I], Frequency | <u>Parameter:</u> | I1 RMS | |
| <u>Activation</u> | | | | |
| <u>Compare to:</u> | Parameter | <u>Parameter:</u> | Nominal I | |
| <u>Deviation:</u> | 10 % | <u>Operation:</u> | $100 * ((X - V) / V) \geq D$ | |
| <u>DeActivation</u> | | | | |
| <u>Compare to:</u> | Parameter | <u>Parameter:</u> | Nominal I | |
| <u>Deviation:</u> | 10 % | <u>Operation:</u> | $100 * ((X - V) / V) < D$ | |

- **The Based on list box** is used to select a group of parameters for further user selection.
- **The Parameter list box** is used to select the specific parameter from a previously selected group. The selected parameter will be used as the "X" variable in the condition rules (operation).
- **The Activation area** is used to configure the rules that will be applied to cause real-time activation of the condition (change from 0 -> 1). For example, if you set the following: Voltage RMS 1 (X = V1), Compare to is set to the configured Nominal voltage (say, V = 230V), Deviation is set 10 (D = 10%) and Operation is set $100 * ((X - V) / V) \geq D$, the condition

will be activated when the RMS voltage of channel 1 goes 10% above or 10% below nominal voltage.

- **The Deactivation** area is used to configure the rules that will be applied to cause real-time de-activation of the condition (change from 1 -> 0). For example, if you set the following: Voltage RMS 1 ($X = V1$), Compare to is set to the configured Nominal voltage (say, $V = 230V$), Deviation is set 10 ($D = 10\%$) and Operation is set $100 * (|X - V| / V) < D$, the condition will be de-activated when the RMS voltage of channel 1 goes below 10% deviation from nominal.
- **The Compare** to list is used to select the type of reference value ("V") to compare to the X parameter value.
- **The Parameter** is for setting reference to system parameter such as nominal voltage value.
- **User Value** enables the user to edit his own reference value.
- **Interval average** enables user to compare X to its averaged value over a defined time interval.
- **Value Δ** enables dX/dt (time deviation) operation, which means X is compared to its previous sample value. For instance, if the selected X parameter is V1 RMS (from group 10[ms] Fast RMS than $V = X[-1]$ (meaning, previous 10ms RMS value).
- **Deviation** defines the Deviation ("D") value used in the operation formula. Notice that some operations do not contain deviation; in such cases the deviation configuration is not in use.
- **Operation** defines the rule or mathematical operation to apply for Activation or Deactivation of condition.

Multiple Type Condition

Condition Configuration More Save Cancel

ID: Condition 1 (# 1) Type: Multiple

Condition A: Add New Edit Subcondition

Condition B: Add New Edit Subcondition

Logic: A not B Magnitude Combination: Avg(A,B)

- **Condition A** is used to select ID of first sub-condition.
- **Condition B** is used to select ID of second sub-condition.

- **Logic** is used to define the combined logic state between the two sub-conditions A and B.
- **Magnitude Combination** instructs the events engine how to compute the Magnitude resulting from a combined condition. For instance, say condition A and condition B are both voltage parameters. In this case, selecting Avg. (Average) or Max (Maximum) is practical. However if condition A is voltage and condition B is current, then AVG or MAX is irrelevant, while A-only option is more practical (meaning only magnitude of voltage from condition A will be taken).

Display Setup

The Display Setup page enables customization for regional and generic display-related settings.

The screenshot shows the 'Display Format' configuration page. The left sidebar contains a menu with 'Display Setup' selected. The main content area has a table with the following settings:

| Display Format | |
|---------------------|---------|
| Phase Format | N123 |
| PF Unit Format | Cap/Ind |
| Temperature Format | Celsius |
| Lightweight Website | Disable |
| Table Data Accuracy | Regular |
| Default language | English |

Firmware Upgrade

The BLACKBOX's internal software (firmware) can be upgraded on demand using a Firmware Upgrade page located on Service section.

The screenshot shows the 'Firmware Upgrade' page. The left sidebar contains a menu with 'Firmware Upgrade' selected. The main content area has two sections:

FTP Firmware Upgrade

| | |
|-------------------|-----------------|
| FTP server | 212.143.246.204 |
| FTP username | ELSPEC |
| FTP password | elspecelspec |
| Firmware filename | G4k.bin |

Banks Active bank: A

| | |
|----------------|----------|
| Bank A version | 0.3.52.1 |
| Bank B version | 0.3.52.0 |

Local Image Firmware Upload

Browse...
Upload local firmware image

The firmware upgrade procedure requires Admin level privileges.
(Refer to Access on page 41.)

Firmware Banks

The BLACKBOX Portable implements a comprehensive firmware management mechanism designed to insure a failure-free field upgrading functionality. The mechanism insures that at any time there are two firmware images available, where only one is active, which means running, another is available to be upgraded.

The firmware images are stored in a dedicated non-volatile flash memory block referred to as Bank.

The Bank's status is displayed on the Banks section on Firmware Upgrade page.

| Banks | | Active bank: A ▼ |
|-----------------------|----------|-------------------------|
| Bank A version | 0.3.52.1 | |
| Bank B version | 0.3.52.0 | |

- **Active Bank** shows which firmware Bank is actually in use.
- **Bank A/B version** displays a Bank's firmware and condition. A numerical- only firmware name means valid firmware, which is ready to use. In some situations the firmware could be further marked with a prefix character to identify a firmware status. The table below describes status prefixes available:

| Prefix | Status |
|-----------------------|---|
| "*" (Asterisk) | The firmware was upgraded and reboot is pending to activate the image for the first time. The user is free to initiate reboot manually to complete the upgrading procedure. |
| "F" | The firmware image failed to complete the initialization process successfully. The firmware was declared as "Faulty", another bank is being used. |
| "+" | The firmware bank is being upgraded at the moment, wait for a completion. |
| "E" | The bank is empty. |

For example, if firmware 0.3.52.0 would be found faulty/damaged/corrupted it will appear as F0.3.52.0 on the Bank A/B version field. In such a case it is recommended to check if the firmware file is authentic and attempt to upgrade it again.

Firmware File

New, complimentary firmware upgrades that can offer new and improved functionalities are released often. Usually, new firmware can be expected to be released every couple of months. The new firmware files are available in the Service/Download section on the Elspec web site: <http://elspec-ltd.com/>.



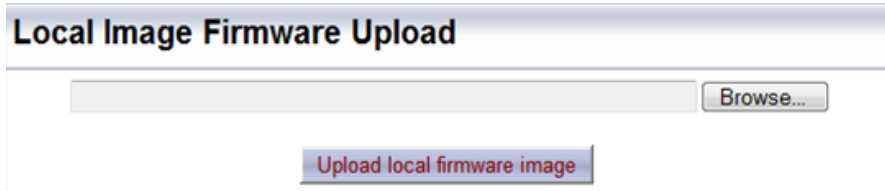
a) Select Power Quality Analyzers Section.



b) Download the latest firmware version from the Software section.

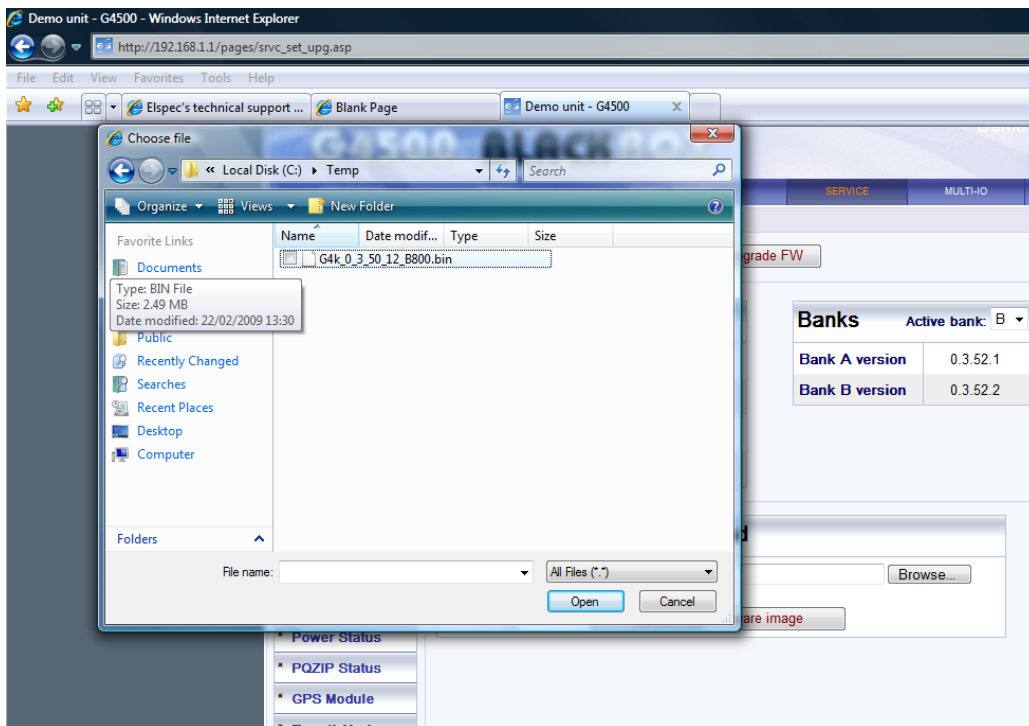
HTTP Upgrade

Probably, the simplest way of upgrading your instrument is by using the HTTP Upgrade functionality.



This can be initiated by using the Local Image Firmware Upload section.

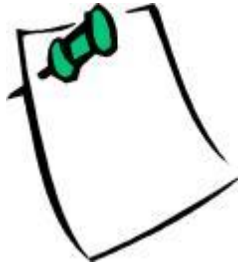
- a) Press the *Browse* button and select the image file you've downloaded on your local computer.



- b) Press *Open*.



- c) Press the *Upload local firmware image* button to initiate an actual upgrade process.



It is recommended using “simple” folders such as c:\Temp for local firmware upgrades.

Folders which require a special security, such as “My Documents” or “Desktop” may not operate correctly with HTTP upload.

FTP Upgrade

An alternative option of upgrading your instrument is by using an FTP (File Transfer Protocol) interface. The BLACKBOX Portable employs an FTP client module which is capable of downloading a firmware image file from an external FTP server automatically.

The screenshot shows the web interface for the ELSPEC G4500 BLACKBOX. The top navigation bar includes tabs for MONITORING, ENERGY, POWER QUALITY, SERVICE, MULTI-I/O, and LCD. The main content area is titled 'REMOTE CONTROL' and features a sidebar with various setup options. The 'Firmware Upgrade' option is selected, displaying the 'FTP Firmware Upgrade' configuration page. This page includes fields for FTP server (212.143.246.204), FTP username (ELSPEC), FTP password (elspecelspec), and Firmware filename (G4k.bin). There are also buttons for 'Apply changes', 'Refresh data', and 'Upgrade FW'. To the right, a 'Banks' section shows the active bank (A) and versions for Bank A and Bank B (both 0.3.52.2).

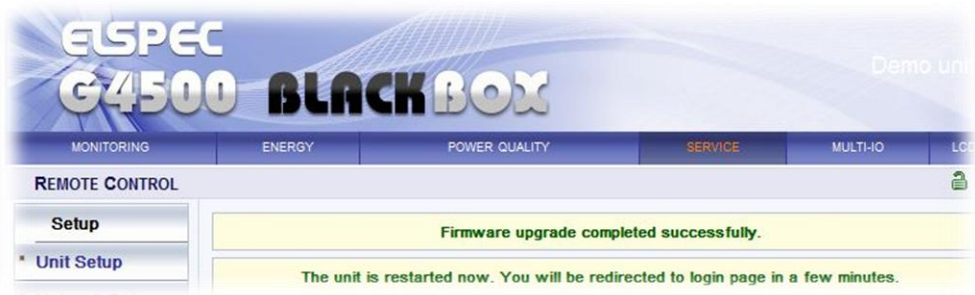
The FTP firmware upgrade functionality is configured in the FTP Firmware Upgrade section. The factory default configuration settings define an ELSPEC corporate FTP server which is loaded with a latest released firmware. Alternatively, any other FTP server could be used. We recommend Filezilla, a free FTP server (<http://filezilla-project.org/>) or similar.

| | |
|--------------------------|--|
| FTP server | The IP address of the external FTP server where the firmware file is located. The default settings is: 212.143.246.204 which is the ELSPEC's FTP server which is loaded with a latest released firmware |
| FTP username | The username to login to the FTP server. The default is ELSPEC , as for Elspec's FTP server |
| FTP password | The password to login to the FTP server. The default is elspecelspec , as for Elspec's FTP server |
| Firmware filename | The firmware filename. As default, the latest firmware located under Elspec's FTP server is G4k.bin |

- When ready, press *Upgrade FW* to initiate the upgrade process.

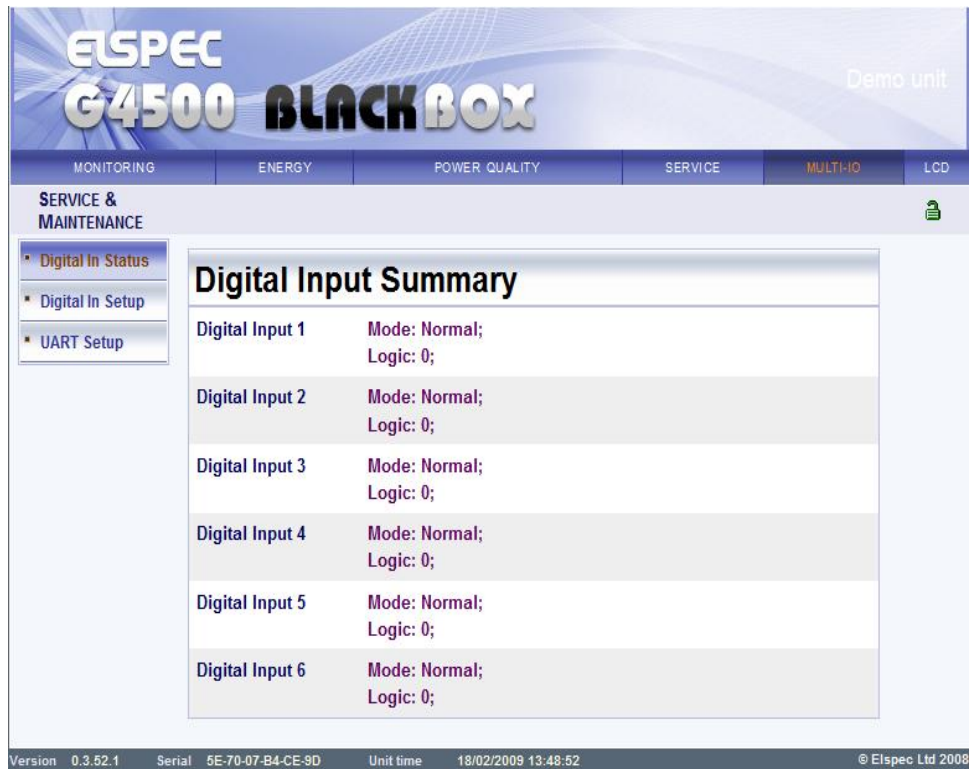


When, completed it appears as:



Multi-IO Section

The Multi-IO Section provides the status and configuration for the digital Inputs and RS232 serial interface.



LCD Section

The LCD Section main page emulates an optional B/W display interface.



Time Synchronization

The BLACKBOX Portable contains a Time Synchronization module. This module maintains and tracks time that is being used by the entire BLACKBOX system and specifically by the PQZIP engine for storing compressed waveforms in accurate time stamp.



The Time Sync module is a multi-time-source receiver and manager that utilizes a unique algorithm to select the optimal time source, to adjust time and to compensate on various delays, jitters and other communication-related distortions.

The main purpose of synchronizing a BLACKBOX device is to be able to analyze and compare among multiple devices via the ELSPEC PQSACADA/Investigator system, such as analyzing an event's source or propagation over multiple points across the power network.

The following time sources are supported:

- Primary NTP Network Server
- Alternative NTP Network Server
- GPS Receiver
- RTC (internal real-time clock)

Typically, the Time Sync module selects the time source automatically per availability and quality of the existing time sources. However, the Time Sync module can be configured to work manually and force a specific time source (*explained later in this section*).

- **The NTP Network Server** is an external server machine that provides NTP Clients (such as a BLACKBOX or a PC) a time over IP network using NTP standard protocol. Time Sync supports two NTP Servers. The first is acting as primary, and the second is an alternative in case the primary is not available. NTP server is identified by an Internet (IP) address. The BLACKBOX is basically acting as an NTP Client that initiates time requests towards NTP servers. However the BLACKBOX also acts as an NTP time server, and therefore, it can respond and provide time for other BLACKBOX units that are configured to its NTP server.
- Synchronizing more than 5 BLACKBOX units to the same BLACKBOX is not recommended, as it may overload its server. Instead, use a maximum of 5 BLACKBOX client units to request time from one BLACKBOX server, and then direct up to 5 others to one of the previous 5, etc. NTP Time synchronization method is recommended anywhere there is a relatively good internet or intranet communication.
- **A GPS Receiver** is a GPS unit that receives a satellite signal and therefore requires special installation with a sky view or transponder from a GPS receiver with a sky view. A GPS unit provides location and time in-

formation via a serial port (typically RS232/RS485 communication port to the BLACKBOX). The GPS option is for remote sites where internet/intranet communication is not an option or, alternatively, network communication is poor.

- The **RTC** is an internal peripheral in the BLACKBOX unit that serves as a default time source when no other external source available. The RTC is powered by a battery to maintain clock progress even when the BLACKBOX device power is off.
- **The Time Sync module** provides the BLACKBOX system with a global time format called GMT or UTC. Using a global time approach enables the BLACKBOX to synchronize measurements with other BLACKBOXs located somewhere else around the globe. While the time being recorded with PQZIP files is always GMT, the time shown on the WEB interface is the local time (refer to Unit Time at the bottom of the WEB page). The Local time is internally computed by the BLACKBOX from the UTC obtained from the Time SYNC module plus the Time Zone (which is the number of hours offset per specific country/area). The Time Zone is configurable (under *Service* tab, *Unit setup* page, *Time Setup* section).

The Time SYNC module also provides the source and the expected quality of time in Synchronization Status. ([Refer to Monitoring Section on page 45](#))

| Synchronization Status | | |
|-----------------------------|-------------|-------------|
| Time Synchronization | Main | Good |
| DSP Synchronization | On | |

In this example the Main refers to primary NTP Server, while the Good refers to a good quality of time synchronization (meaning that the learned/estimated time is very close to the true GMT obtained from the external time source).

Displayed Time Sources:

- **Main:** Primary NTP Server source is currently the active time source.
- **Alternate:** Alternative NTP Server is currently the active time source.
- **GPS:** GPS is currently the active time source.
- **Self:** RTC is currently the active time source.

Displayed Time Synchronization Quality/Accuracy:

- **Perfect:** Perfect time quality, expected less than 10 [microseconds] deviation from GMT
- **Good:** Good time quality, expected less than 100 [microseconds] deviation from GMT
- **Moderate:** Moderate time quality, expected less than 10[millisecond] deviation from GMT
- **Poor:** Poor time quality, expected less than 1[Second] deviation from GMT
- **No Time Synchronization:** No external time source available/expected more than 1 second deviation from GMT

Configuring the Time Sync Module

In order to configure the Time Synchronization module go to *Service* tab, *Network Setup* page, The *Network Time* section.

| Network Time | |
|----------------|--|
| Transport | Automatic <input type="button" value="v"/> |
| Main SNTP | 100.100.100.55 |
| Alternate SNTP | 169.254.249.254 |
| Using SNTP | Self |
| Slew Mode | Automatic <input type="button" value="v"/> |
| Slew Factor | 8.9207 % |
| Step Time | 10 sec |

- **Transport** is used to set whether the Time Sync module selects the source automatically or is manually forced to NTP or GPS source.
- **The Main SNTP** is used to configure the IP address of Primary NTP server to be used.
- **The Alternate SNTP** is used to configure the IP address of secondary NTP server to be used, in case primary is not available.

Using SNTP shows the current NTP server in use (Main, Alternate or Self if no external NTP is used)

- Slew Mode configures the type of time slewing (adjustment) approach to be used by the Time Sync module to compensate for time deviations and network communication jitters. The default and preferred mode is Automatic. When set to automatic, the slewing factor is according to time source communication quality and you may only view the auto selected slew factor and step time in the below fields.

You may further configure the slewing mode to manual and set the Slew Factor and Step Time fields.

- Slew Factor is a percentage value between 0 to 100%, defining how much to correct time in percentage towards the new GMT learned from time source. 100% means full correction, or a step towards the received time as is, and 0% means no change at all.
- Step Time is time in seconds and defines the threshold value. Above this value, the Time Sync module will simply step towards the new learned GMT time.
- Manual slew modes contain Master and Slave, -which are manual modes with the same user control. The only difference is that the defaults are

automatically written in the WEB interface (SLEW Factor and Step Time fields). While the Master values fit more to a situation of a BLACKBOX receiving unstable time and acting as an NTP server that further feeds other BLACKBOX with its learned time, Slave values fit a situation of a BLACKBOX only acting as an NTP client without further spreading time to other units.

Time Sync and PQZIP Time Stamping

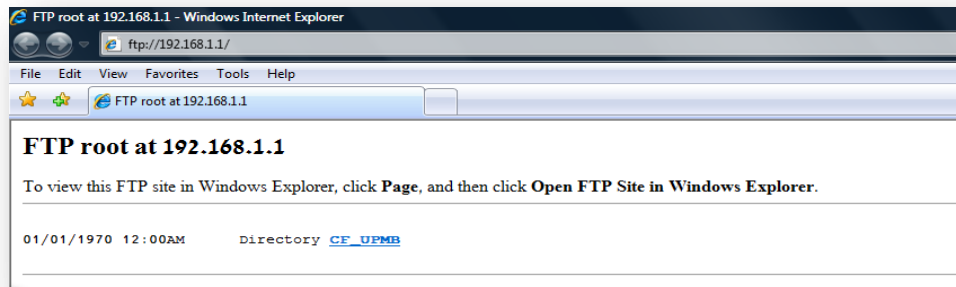
Since the main purpose of the BLACKBOX Portable is to continuously record and measure channels for analysis, it is essential to maintain a very accurate UTC time stamp. A PQZIP file is built from time records; typically a record represents several minutes. Each record contains a beginning and an end UTC time stamp. Once the Time Sync module detects that time is continuously drifting beyond a few tenths of milliseconds, the slewing is not enough to compensate for the drift. Instead, a time step/jump is made and the corresponding PQZIP record is closed with the old time stamp while a new record is opened with the new stepped time. Such cases may happen if the time source (NTP Server/GPS) is unstable or when the communication link with the NTP server is inconsistent.

Integrated FTP Server

FTP is a file transfer protocol for exchanging and manipulating files over a TCP computer network. The BLACKBOX Portable uses an integrated FTP server providing the most convenient computer network standard interface to the generated PQZip files and auto generated reports. The PQSCADA software system makes use of the FTP server interface by automatically downloading PQZip files.

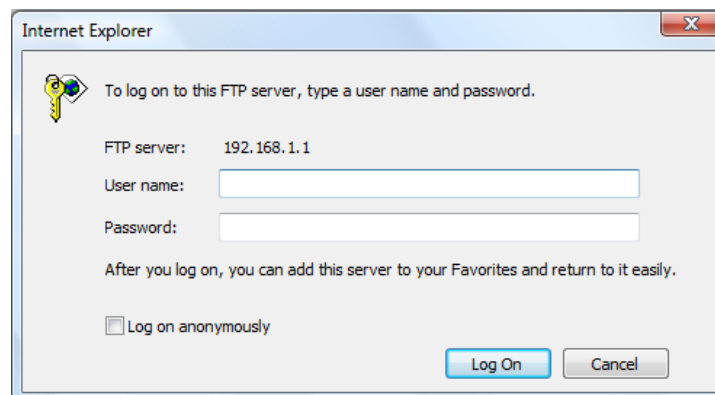
One of the easiest ways to launch an FTP session, which allows the user to access the BLACKBOX Portable's internal memory, is by using the Elspec Search utility ([refer to Launching WEB or FTP Session on page 133](#)).

Another way is by typing [ftp://\[device ip address\]/](#) in the Windows Internet Explorer or Windows Explorer address field.



Login

When initiated from Elspec Search utility, this page will probably appear as shown above. On manual operation it will most likely require a user name and password like:



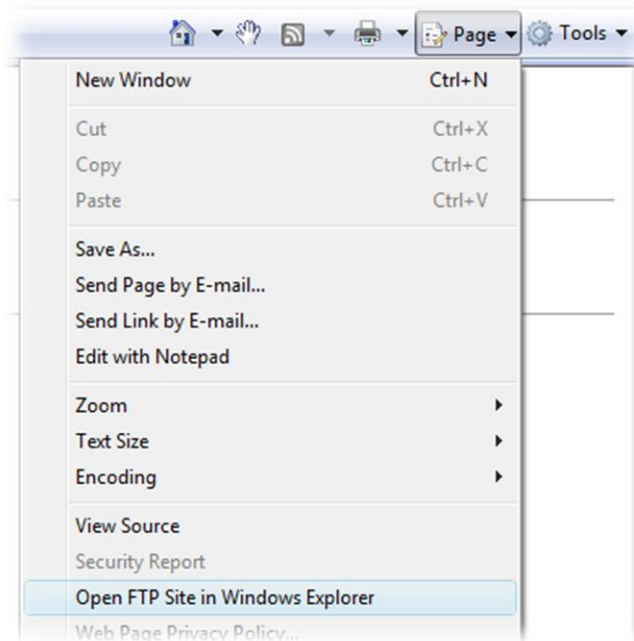
If so, type:

User name: **ELSPEC**

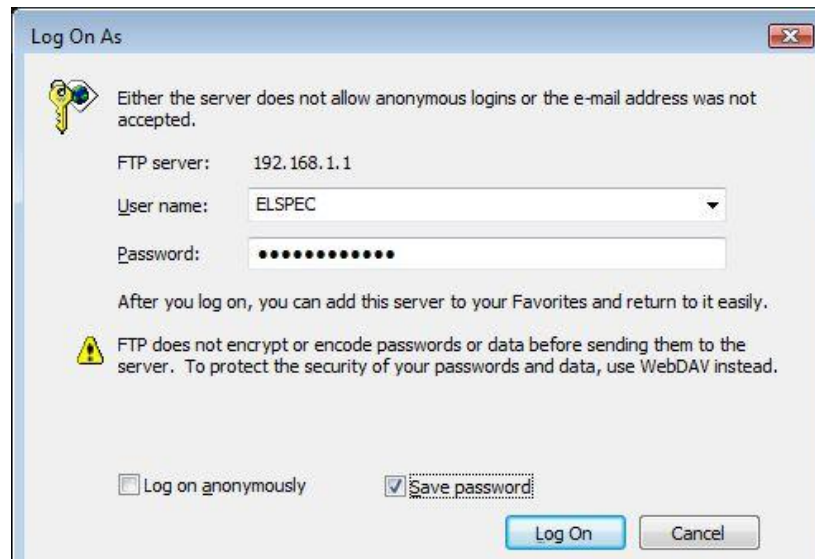
Password: **elspecelspec**

It is recommended to open the folder in Microsoft Explorer rather than Internet Explorer, since the latter may have some issues related to file operations.

To switch from Internet Explorer to the Windows Explorer, press the *Page* button and select *Open FTP Site in Windows Explorer*.



This will probably require typing a password again:

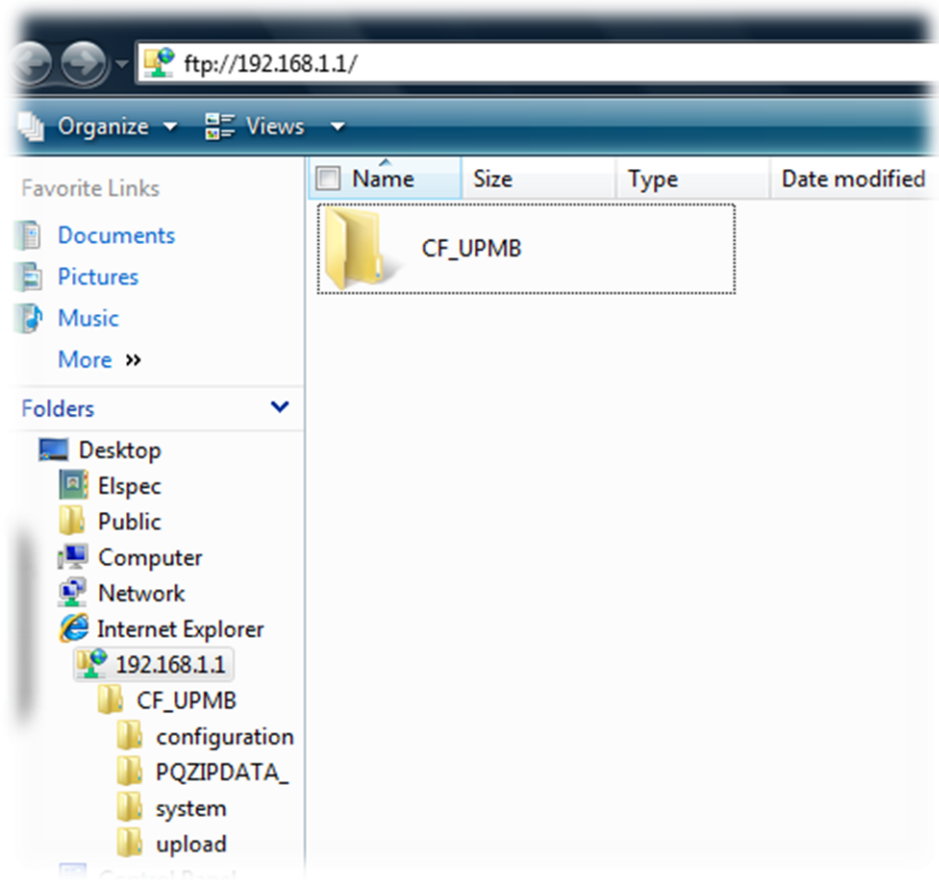


It is recommended marking the Save password checkbox if you prefer skipping that procedure the next time.

System limitations

The BLACKBOX Portable's integrated FTP server is limited by design to handle up to 4 concurrent FTP connections. Any connection while another 4 are still active will be denied. Connection which is idle for more than 2 minutes will be closed automatically.

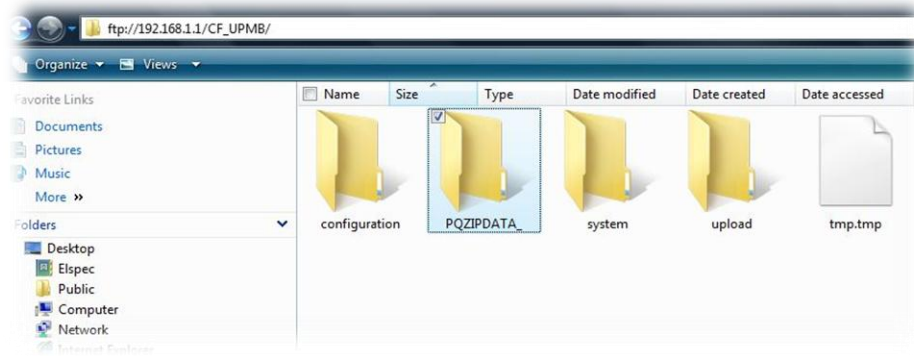
The File Structure



The root directory of the BLACKBOX Portable's FTP server appears as CF_UPMB which points to the main storage memory drive.

PQZip Files

The PQZip Files are located under PQZIPDATA_ folder

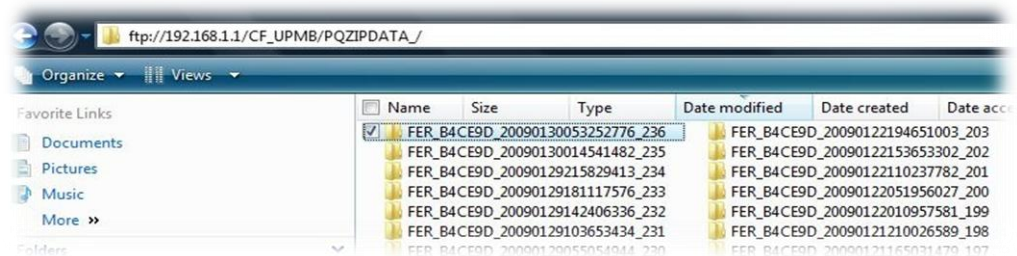


The PQZip files are organized under PQZip folders. The folder names are constructed as:

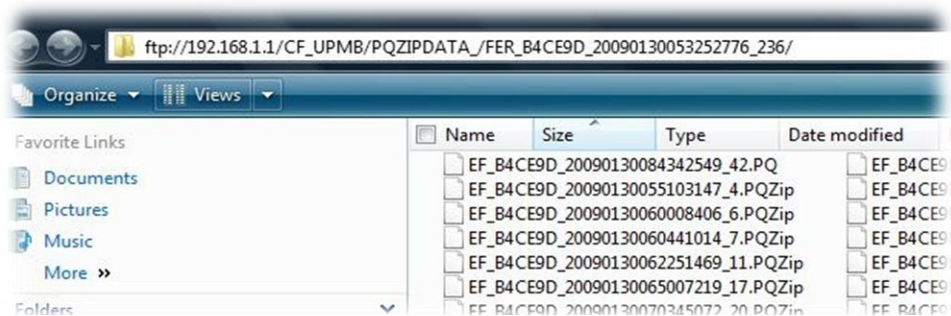
FER_A_B_C

Where:

- **A:** Device serial number
- **B:** The date and time the folder was created. The format is: **YYY-YMMDDHHmmSSmmm**
where **YYYY** = Year, **MM** = Month, **DD** = Day, **HH** = hour, **mm** – Minutes, **SS** = seconds, **mmm** = milliseconds
- **C:** Sequential index of the folder. The index value is started with “1” on the very first PQZip session initialization and incrementing on every new folder creation. When the value reaches 999 it resets to a “1” on with the next folder.



The PQZip folders normally contain no more than 50 PQZip files.



The PQZip files can be further recognized by a “PQZip” or “PQ” file extensions. The “PQZip” extension files are “closed” and ready for download while the “PQ” means that the file is still in a process. The PQZip file names are organized as:

EF_A_B_C

Where:

- **A:** Device serial number
- **B:** The date and time the folder was created. The format is: **YYY-YMMDDHHmmSSmmm** where **YYYY** = Year, **MM** = Month, **DD** = Day, **HH** = hour, **mm** – Minutes, **SS** = seconds, **mmm** = milliseconds
- **C:** Sequential index inside the folder. The index value is started with “1” on the first file created in the folder and increments sequentially with the next files in the same folder.



The Date and Time used to construct PQZip folder and file names are in UTC time format!

Integrated TelNet server

Telecommunications Network (Telnet) is a text-only (non-GUI) user command protocol terminal emulation program for TCP/IP networks such as the internet or a LAN. A Telnet client is often used to connect to a Telnet server in order to diagnose problems without specialized client software. The BLACKBOX Portable device comes enabled from the factory capable of being used as a Telnet server. In much the same way that we can enter the device through the Web as a GUI interface or FTP to transfer files, Elspec supports the use of a Telnet connection in order to perform specific high level administrative functions that are not accessible through other interfaces. In addition, the BLACKBOX Portable uses a Telnet emulation interface over a RS232 port.

Telnet Client Application

The standard Telnet Client Application is available as part of a Windows operation system. The client can be accessed using a command line interface.

1. Type *cmd* on a *run/search* field on windows Vista or *Start>Run* on Windows XP and press *Enter*.



2. On the command prompt type *telnet* and press *Enter*.

```
C:\Windows\system32\cmd.exe
Microsoft Windows [Version 6.0.6001]
Copyright (c) 2006 Microsoft Corporation. All rights reserved.

C:\Users\Elspec>telnet_
```

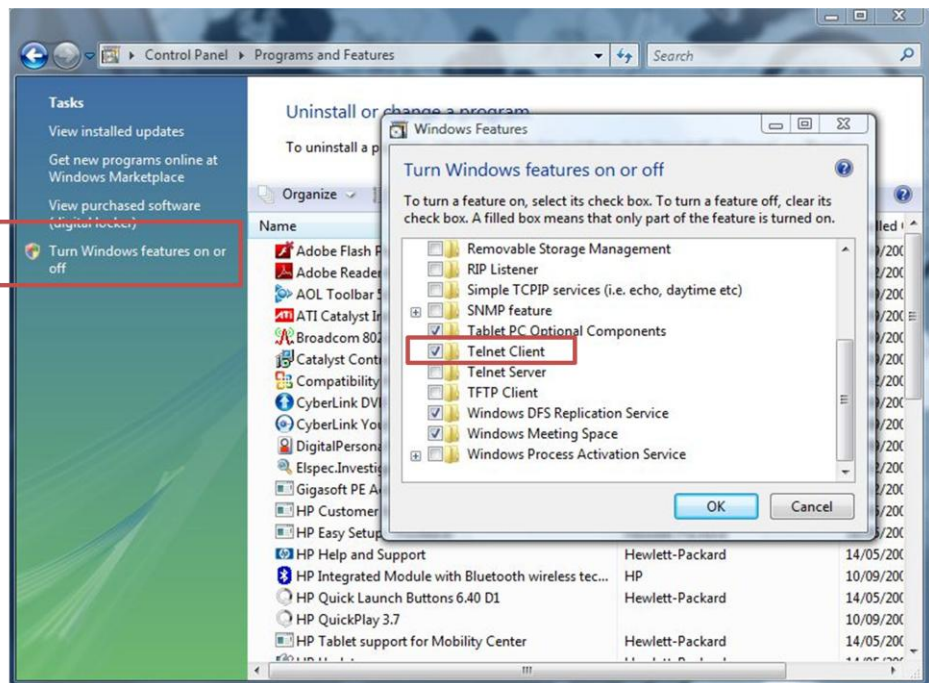
In case of error like below:

```
C:\Windows\system32\cmd.exe
Microsoft Windows [Version 6.0.6001]
Copyright (c) 2006 Microsoft Corporation. All rights reserved.

C:\Users\Elspec>telnet
'telnet' is not recognized as an internal or external command,
operable program or batch file.

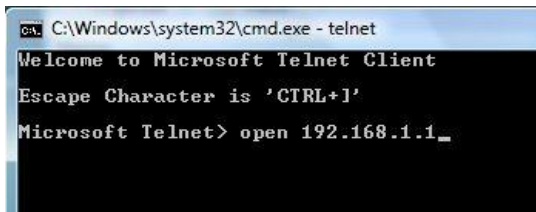
C:\Users\Elspec>
```

The Telnet client is probably not installed on the computer. To enable/install it, launch *Programs and Features* on the control Panel. Then, turn *Windows features on or off* and select *Telnet client* on the list.



Establishing a Telnet Session

1. Type `open [device IP]` on the telnet command line.



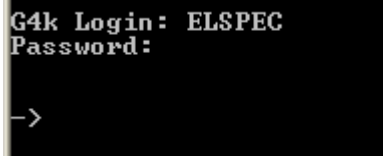
```
C:\Windows\system32\cmd.exe - telnet
Welcome to Microsoft Telnet Client
Escape Character is 'CTRL+I'
Microsoft Telnet> open 192.168.1.1_
```

The login line appears:



```
G4k Login:
```

2. Use login name: **ELSPEC** (all cap letters)



```
G4k Login: ELSPEC
Password:
->
```

3. And password: **elspecelspec**

When `->` line appears, the telnet session is ready for use.

Telnet Commands

The Telnet interface could be useful mainly for an advanced operational procedures such as restoring wireless router factory defaults ([refer to page 145](#)).



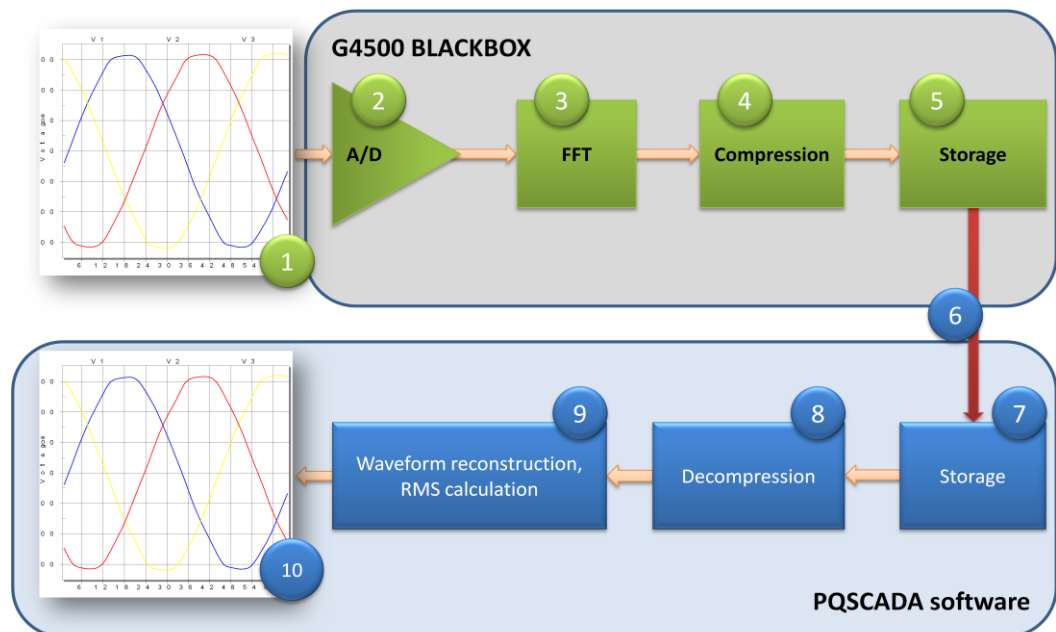
*All Telnet commands and operations
are case sensitive!*

PQZip Recording

The BLACKBOX Portable utilizes a unique compression technology (referred as PQZip) which enables continuous gap-less recording of all electrical parameters-related data for a significant time duration without the need of event thresholds of any kind. The BLACKBOX Portable device with standard 8GB of internal memory can record continuously for a duration of several months or even a year depending on the network pollution level.

Principle of Operation

PQZip compression technology is based on *Lossy Compression Method* which is protected under US Federal Patent Law as well as by patent laws in several other countries.



This figure shows a simplified diagram of the compression/decompression process performed with accordance with Elspec PQZip technology.

- 1 Voltages and currents are being sensed and scaled to achieve a maximum resolution using the following A/D process.
- 2 The waveforms are being sampled at 1024 samples per cycle resolution for voltages and 256 samples per cycle resolution for currents.

- 3 The resulting digital waveform representation is being passed thru FFT computation, resulting 512 spectral components (harmonics) per cycle or voltages and 128 for currents.
- 4 Every harmonic component is being analyzed and compressed individually. Zero value components are being skipped. No zero harmonic components are being evaluated over time and only changes in a value or angle are being recorded. The resulting data is being compressed using industry known lossless compression algorithms.
- 5 The compressed harmonic data is being organized in blocks of up to 5 minutes of concurrent cycles and being stored along with the measured frequency of every cycle and reference time stamps into a PQZip file residing on the onboard flash memory. The typical compression ratio expected as a ratio between incoming data volume on block 3 and the data being stored is 1000:1.
- 6 The PQZip files can be downloaded automatically or manually using the integrated embedded FTP server to the Mobile Analysis Lab or any other computer system for further storage and analysis.
- 7 The compressed data is then reorganized and optimized for fast access while in a compressed state. The resulting data is stored in the SQL database for long term storage.
- 8 When required, the data is decompressed, recovering a full harmonic spectrum for each cycle along with the associated time stamps.
- 9 The spectral data can further be used to reconstruct any individual cycle's waveform in the same resolution as at the input module (1) with accurate time and cycle duration. Any possible electrical parameters can be calculated based on the data by retrieving precise accuracy and wave shape.
- 10 The waveform displayed by the Investigator application is reconstructed based on compressed spectral data of every concurrent network cycle. In addition, virtually any electrical parameter can be calculated based on that data and displayed at any resolution or time span.

Operation

The PQZip recording does not require any site-specific configurations. As default, all units leave the factory with PQZip recording being switched ON, and the instrument will start recording all channels automatically even on the first power on. The PQZip active state is further defined as a normal operation condition ([refer to Operational Status Indicator on page 23](#)).

Configuration

The PQZip status and Configuration page is located under a service section on integrated WEB server interface ([refer to page 28](#))

The screenshot displays the Elspec G4500 BlackBox web interface. The top navigation bar includes tabs for MONITORING, ENERGY, POWER QUALITY, SERVICE, MULTI-IO, and LCD. The main content area is titled 'REMOTE CONTROL' and features a sidebar menu with options like Unit Setup, Network Setup, Power Setup, Events Setup, Display Setup, RS-485/422, Firmware Upgrade, PPP Setup, Diagnostics, System Log, Network Status, Power Status, PQZIP Status, GPS Module, and E-mail Alerts. The 'PQZIP Status' option is selected.

At the top of the configuration page, there are buttons for 'Apply changes', 'Refresh data', and 'Erase PQzip Data'. The 'PQZIP Information' section shows the following details:

| PQZIP Information | | State: Enable |
|-------------------|----------------------------------|---------------|
| Compression | 100.000 % | |
| Start time | 09/12/2008 12:06:51 UTC | |
| Current file | EF_B4CE9D_20090126170659367_9.PQ | |

The 'Compact Flash Information' section provides the following data:

| Compact Flash Information | |
|---------------------------|------------------|
| Free CF space | 991.7 MBytes |
| Total CF space | 8025.1 MBytes |
| CF Model | CF 8GB |
| CF Revision | 20060729CF 8GB |
| CF Serial # | 2008A 0000057429 |

The 'Tolerance (%)' section lists the following values:

| Tolerance (%) | |
|----------------|--------|
| V ₁ | 0.0977 |
| V ₂ | 0.0977 |
| V ₃ | 0.0977 |
| V _N | 0.0977 |
| I ₁ | 0.0977 |
| I ₂ | 0.0977 |
| I ₃ | 0.0977 |
| I _N | 0.0977 |

The 'PQZip Configuration' section includes the following settings:

| PQZip Mode | Quality Thresholds (%) | |
|---------------|------------------------|-------|
| Fixed Quality | V 0.1 | I 0.1 |

| File Capacity | Record Mode | Record Type |
|---------------|-------------|-------------|
| 5 min | FULL | PQSCADA 3.x |

Administrator-user privileges are required to perform any change in configuration ([refer to Login Page on page 41](#)).

When modification is requested and the logged-in user privileges (the login password) are less than administrator, you will be prompted to perform a login with the Administrator password to allow modification.



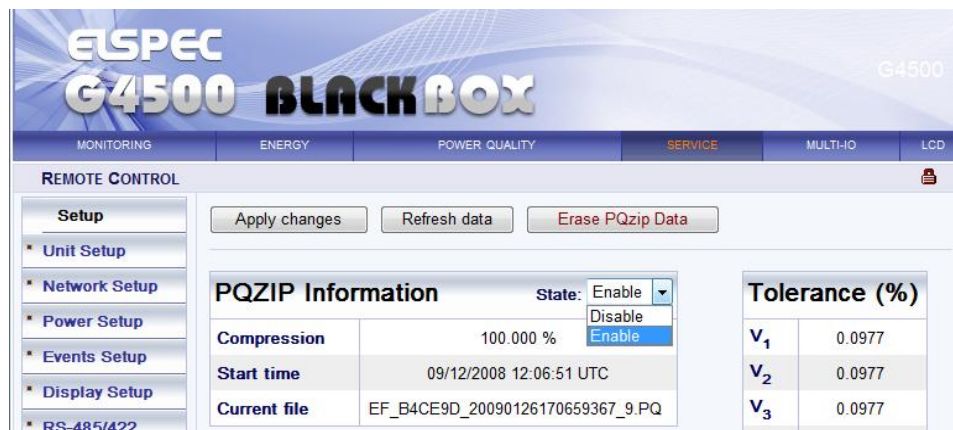
1. Type the *Administrator* password and press *Login*.



2. Press *Apply changes* again to complete the change action.

Enabling/disabling

To disable the recording operation, change state to *Disabled* and press the *Apply changes* button.



FIFO Concept

PQZip files are maintained on a local flash memory in a FIFO (First In First Out) concept. This means that the file storage operation never stops, and when memory becomes full, the oldest files are deleted automatically to free required space for the newest data.

Fixed Quality versus Fixed Ratio

The most important parameter defining the actual compression ratio, (which determines the amount of storage required and maximum time continuous data can be stored) is a PQZip threshold value or Tolerance as it referred on the WEB page.

The Tolerance defines what change in an individual harmonic would be defined as significant enough to store and being reproduced afterwards. The tolerance value is defined in percentage to the full scale or nominal reading for the specific channel.

It is assumed that changes within 0.1% of nominal would have no importance in further power quality investigation, and the values within that range are averaged to store the representative value only. The basic and factory default tolerance value is normally defined as 0.1%. However, on some sites/networks that value can still be considered too tight, for example, a highly fluctuating load or voltage lines.

It is most likely that a user would prefer increasing a tolerance value for currents or voltages or even both in order to achieve better compression ratios on highly polluted network locations. The BLACKBOX Portable provides the possibility of automatic adjustment of the actual tolerance value presuming a compression ratio defined as amount of data being stored per month.

That option is called Fixed Ratio. When selected, the user is requested to define the amount of data to be stored per month (Monthly Ratio) in MB.

| PQZip Configuration | | |
|---------------------|---------------|--|
| PQZip Mode | Monthly Ratio | V/I Relation (%) |
| Fixed Ratio ▾ | 700 MB | <div style="text-align: center;"> <input type="text" value="66"/> </div> |

Usually, slight voltage spectral changes have higher importance than current changes. Therefore, the amount of data which could be stored for voltages may be determined as greater than for currents. The V/I Relation parameter defines the relationship between the data (a part of the Monthly Ratio) reserved for voltage. If the voltage portion is larger than currents, the system will define a tighter tolerance for voltages than for currents.

The alternative way is to define and fix the tolerance values for both voltages and currents to some user preferred value. This option is called Fixed Quality since in that case the data will be stored at the same tolerance/quality at all times.

| PQZip Configuration | | |
|---------------------|------------------------|-------------|
| PQZip Mode | Quality Thresholds (%) | |
| Fixed Quality | V | I |
| | 0.1 | 0.1 |
| File Capacity | Record Mode | Record Type |
| 5 min | FULL | PQSCADA 3.x |

When Fixed Quality mode is selected, you are requested to define the tolerance value for voltages and currents separately were the factory default value is 0.1%.

File Capacity

The File Capacity parameter is used to define the maximum time each PQZip file will comprise. The file can be downloaded and data can be analyzed only when the file is closed, so if you expect to monitor the data on the Investigator application shortly after the data is being collected, you should choose low time durations. For all other cases, longer durations are recommended so compression ratios can be slightly improved.

| PQZip Configuration | | |
|---------------------|---------------|------------------|
| PQZip Mode | Monthly Ratio | V/I Relation (%) |
| Fixed Quality | 700 MB | 66 |
| 5 min | | |
| File Capacity | Record Mode | Record Type |
| 5 min | FULL | PQSCADA 3.x |

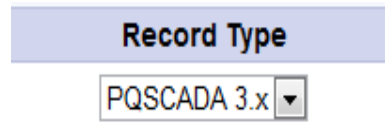
Record Mode

The Record Mode parameter defines whether PQZip files will comprise FULL data or event time stamps only (LIGHT mode). The default setting is FULL.

| Record Mode | |
|-------------|-------|
| FULL | |
| LIGHT | 45:42 |

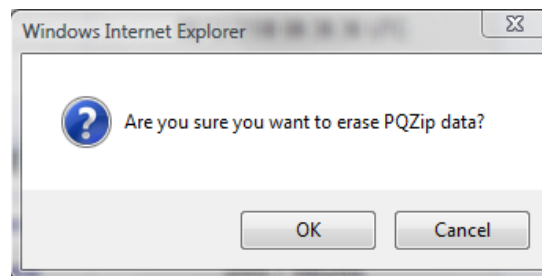
Record Type

Starting from PQSCADA version 3.0, the PQZip file structure and algorithm has been improved to gain better compression and data accuracy. When PQSCADA 3.0 or higher version is used, it is recommended keeping a *PQSCADA 3.x* setting.



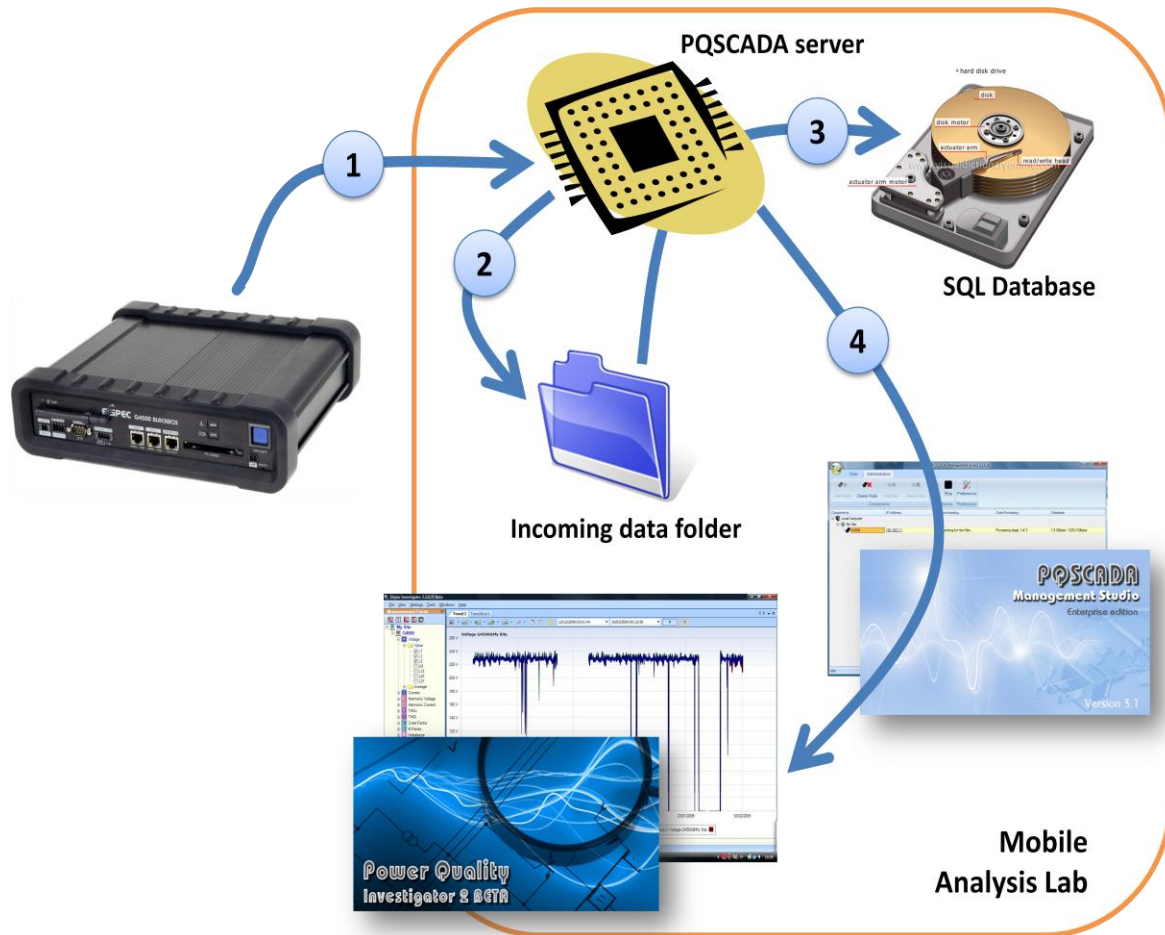
Erasing All PQZip Data

By pressing the *Erase PQZip Data* button it is possible to clean the memory from the all files being recorded. This operation requires Administrator-level privileges and prompts for confirmation to avoid unauthorized data deletion.



The Software

PQSCADA Suite



The PQSCADA Software Suite is installed on a Mobile Analysis Lab computer (or other laptop/computer) providing unparalleled data monitoring and analysis functionality for the BLACKBOX Portable devices. For software installation instructions, please refer to the PQSCADA installation manual or contact your local Elspec distributor.

The PQSCADA software suite:

- PQSCADA server
- PQSCADA Management studio
- Elspec Power Quality Investigator
- MS SQL 2005/2008 database engine

PQSCADA Server

The PQSCADA server is the heart of the BLACKBOX data management and analysis system. The main functionalities of the PQSCADA server are shown in the figure above and further described below with corresponded numbering marks:

1

Data collection (Downloading): The PQSCADA server system is responsible for collecting all continuous data (PQZip files) from a connected device automatically. When the device is connected (wired or wirelessly) the PQSCADA server automatically checks for any new data availability using an FTP⁶ communication protocol.

2

Placing new files into the Incoming data folder: All new PQZip files found on a connected device are copied (the original files remain on device) to a temporary location on a local hard drive “Incoming data folder”.

3

Data processing and storage: The next stage is data processing, in which the data is being organized for storage and quick access (Stage 1) and then a variety of electrical parameters are being calculated (Stage 2) based on the raw PQZip data. The reorganized PQZip data, as well as the calculated parameter statistics are being stored in a local SQL database. The files which have been processed and successfully inserted to the database are then removed from the Incoming folder

4

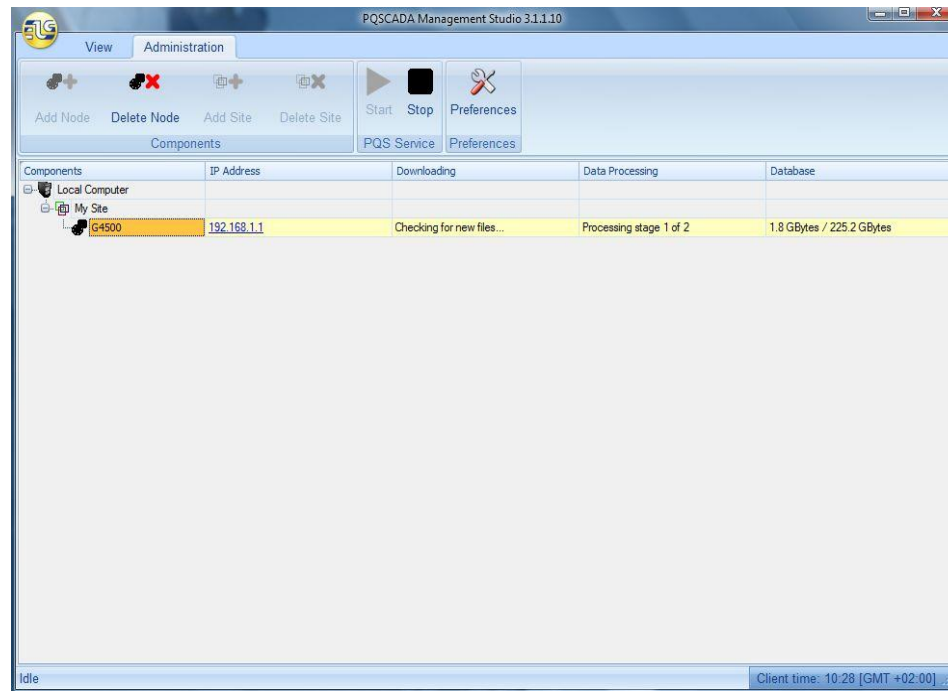
Networking: The PQSCADA server integrates a dedicated HTTP (default port 80) interface that communicates with the PQSCADA Management Studio (interactive management application) and the Elspec Power Quality Investigator (data analysis application) running on either the same or different machine.

PQSCADA Management Studio

The PQSCADA Management Studio is an interactive tool which provides full control and monitoring of all of PQSCADA’s activities.

⁶ Refer to page 96 for more details

Administration Console



The main PQSCADA Management Studio's window is a hierarchical table/grid with following columns:

- Components
- IP Address
- Downloading
- Data Processing
- Database

Components

The PQSCADA suite is designed to operate and manage a virtually unlimited number of BLACKBOX devices, both Portable and fixed. The physical device is represented under the system by the term Node.

The NODE is the software component which represents data taken by a physical device such as BLACKBOX Portable or a fixed G4k model.

The SITE is a software component which represents a group of Nodes. The SERVER is the representation of the physical machine (Analysis lab) on which the PQSCADA server application is installed.

The Node Status Fields

Component

| Status | Description | Right Click Menu |
|-----------------|--|--|
| The name | The given name to the node | <ul style="list-style-type: none"> Refresh Rename Configure Delete |
| "Needs Upgrade" | The node requires upgrade. Use <i>Upgrade</i> on right mouse click menu. | <ul style="list-style-type: none"> Refresh Upgrade Delete |

IP Address

| Status | Description | Right Click Menu |
|---|---|---|
| IP Address or host name in hyperlink format | The IP Address is defined. | <ul style="list-style-type: none"> Open in Explorer Open in FTP IP Setup |
| "No IP defined" | No IP Address is defined, Link is disabled. | <ul style="list-style-type: none"> IP Setup |

Downloading

The Downloading field displays the status of the data downloading process. Below is the list of status variations could be expected on that field.

| Status | Description | Right Click Menu |
|-------------------------------|---|--|
| "Disabled" in light gray | The FTP downloading service is disabled. | <ul style="list-style-type: none"> Schedule operation IP Setup Folders setup Open incoming folder Enable |
| "No IP defined" in light gray | IP address not defined. FTP downloading service is disabled. | <ul style="list-style-type: none"> Schedule operation IP Setup Folders setup Open incoming folder Enable |
| Error: link failure | No communication IP was set. However, device is not reachable. Check physical connection. | <ul style="list-style-type: none"> Refresh Force connection attempt Schedule operation IP Setup Folders setup Open in Explorer Open in FTP Open incoming folder Disable |

| Status | Description | Right Click Menu |
|-------------------------------------|--|--|
| Error: login failure | No communication IP was set. Login failure Use <i>IP Setup</i> to verify/modify FTP user name and/or password. | <ul style="list-style-type: none"> • Refresh • Force connection attempt • Schedule operation • IP Setup • Folders setup • Open in Explorer • Open in FTP • Open incoming folder • Disable |
| "Next attempt in XX seconds" | Waiting for the next communication attempt | <ul style="list-style-type: none"> • Refresh • Schedule operation • IP Setup • Folders setup • Open in Explorer • Open in FTP • Open incoming folder • Disable |
| "Checking for new files..." | Communication established, Checking for new files | <ul style="list-style-type: none"> • Refresh • Force connection attempt • Schedule operation • IP Setup • Folders setup • Open in Explorer • Open in FTP • Open incoming folder • Disable |
| "XXX kB/sec" in normal color | Downloading new files | <ul style="list-style-type: none"> • Refresh • Force connection attempt • Schedule operation • IP Setup • Folders setup • Open in Explorer • Open in FTP • Open incoming folder • Disable |
| Error: Incoming folder full | PQZip folder is full due to folder limitations. Use <i>Folders Setup</i> to modify the Incoming folder quota or free some disk space. | <ul style="list-style-type: none"> • Refresh • Force connection attempt • Schedule operation • IP Setup • Folders setup • Open in Explorer • Open in FTP • Open incoming folder • Disable |

| Status | Description | Right Click Menu |
|---|---|--|
| Error: Disk full | PQZip folder is full due to disk space limitations. | <ul style="list-style-type: none"> • Refresh • Force connection attempt • Schedule operation • IP Setup • Folders setup • Open in Explorer • Open in FTP • Open incoming folder • Disable |
| Error: incoming folder not found | The incoming directory is missing. | <ul style="list-style-type: none"> • Refresh • Force connection attempt • Schedule operation • IP Setup • Folders setup • Open in Explorer • Open in FTP • Open incoming folder • Disable |
| Error: cannot write file | Cannot write the downloaded file to disk | <ul style="list-style-type: none"> • Refresh • Force connection attempt • Schedule operation • IP Setup • Folders setup • Open in Explorer • Open in FTP • Open incoming folder • Disable |

Data Processing

The Data Processing field displays the status of the PQZip data processing engine. Below is the list of status variations could be expected on that field.

| Status | Description | Right Click Menu |
|--|---------------------------------|---|
| "Disabled" in light gray color | The service is disabled. | <ul style="list-style-type: none"> • Folders setup • Define 'time of interest' interval • Configure service • Open incoming folder • Open 'bad files' folder • Open data backup folder • Enable |
| "Processing stage 1 of 2" | Stage 1 (PQZip parsing) | <ul style="list-style-type: none"> • Refresh • Force file parse attempt • Folders setup • Define 'time of interest' interval • Show/ modify data channels configurations • Configure service • Open incoming folder • Open 'bad files' folder • Open data backup folder • Disable • Recalculate data |
| "Processing stage 2 of 2" in normal colors | Stage 2 (Recalculate summaries) | <ul style="list-style-type: none"> • Refresh • Force file parse attempt • Folders setup • Define 'time of interest' interval • Show/ modify data channels configurations • Configure service • Open incoming folder • Open 'bad files' folder • Open data backup folder • Disable • Recalculate data |
| Database error | Database is full or unavailable | <ul style="list-style-type: none"> • Refresh • Force file parse attempt • Folders setup • Define 'time of interest' interval • Configure service • Open incoming folder • Open 'bad files' folder • Open data backup folder • Disable • Recalculate data |

| Status | Description | Right Click Menu |
|---------------------------------|--|--|
| "Waiting for new data" | Idle, no new data found in Incoming folder | <ul style="list-style-type: none"> • Refresh • Force file parse attempt • Folders setup • Define 'time of interest' interval • Show/ modify data channels configurations • Configure service • Open incoming folder • Open 'bad files' folder • Open data backup folder • Disable • Show last day log • Recalculate data |
| Bad files folder is full | "Bad files" folder is full. | <ul style="list-style-type: none"> • Refresh • Folders setup • Define 'time of interest' interval • Configure service • Open incoming folder • Open 'bad files' folder • Open data backup folder • Disable • Show last day log • Recalculate data |

Database

The Database field displays the status of the Node's database. Below is the list of status variations could be expected on that field.

| Status | Description | Right Click Menu |
|----------------------------|---|---|
| Login Error | Login Error. The administrative access to the database was denied. Please select Login setup option on right mouse click menu. | <ul style="list-style-type: none"> • Login setup |
| Database is full | Database is full. The database size has reached its maximum state. Please resolve that issue on Size limitation setup, free more disk space or truncate unnecessary data. | <ul style="list-style-type: none"> • Refresh • Login setup • Size limitation setup |
| XXX MB / YYY MB | Online | <ul style="list-style-type: none"> • Refresh • Login setup • Size limitation setup • Backup • Restore • Delete data • Re-index • Import data • Export data |

Elspec Investigator

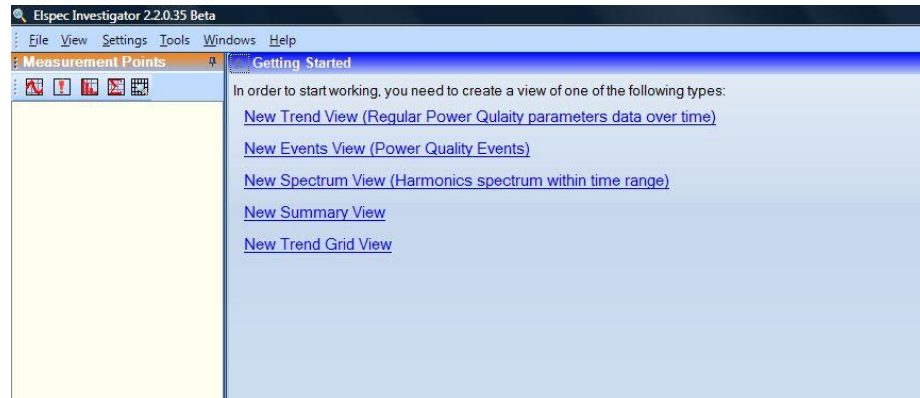
The Elspec Power Quality Investigator is an innovative tool which helps explore electrical network anomalies and investigating power quality issues with mouse-click simplicity.

Elspec Investigator is a client application that communicates, receives, and displays data from the PQSCADA server system ([refer to page 113](#)). The communication performed uses a standard HTTP protocol (port 80), so it is firewall friendly and can be easily used over local LAN and/or over the Internet.



Getting Started

Initially, the Investigator application appears with a window as shown below.

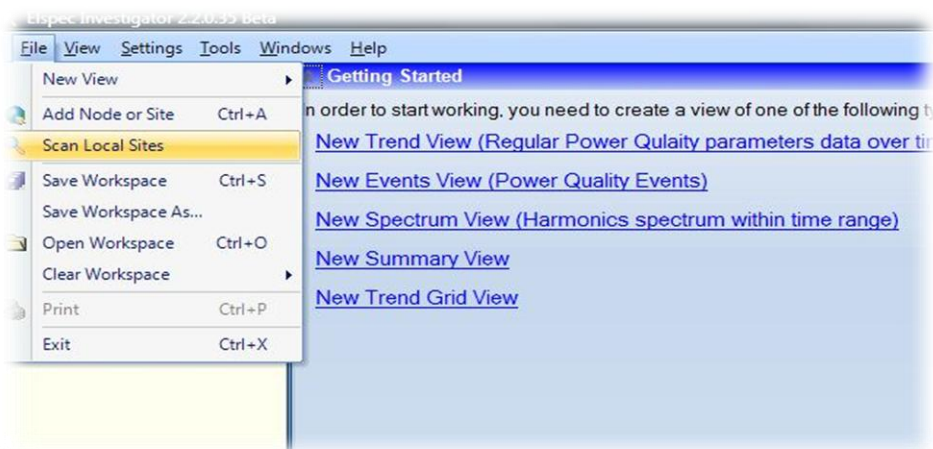


The panel on the left titled Measurement Points appears blank. In order to start working with the tool, you need to add a PQSCADA SITE to work with.

Adding a Measurement SITE

Automatic Scan

When the PQSCADA server application is running on the same machine, such as in the Mobile Analysis Lab, the most convenient way of adding a site is by automatically scanning for local sites functionality. This Scan Local sites procedure is available in the File menu. This tool makes use of UDP broadcasting on port 885 in a similar manner as the Elspec Search utility searches for G4k devices.



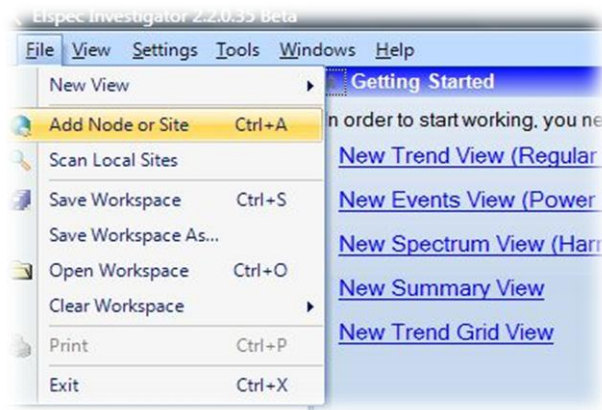
However, in some situations, the tool may fail to discover local sites, due to some of the following reasons:

- The local firewall prohibited UDP broadcasting.
- The Elspec Search tool is running and making use already on UDP 885 port.
- The local site is down or unreachable.

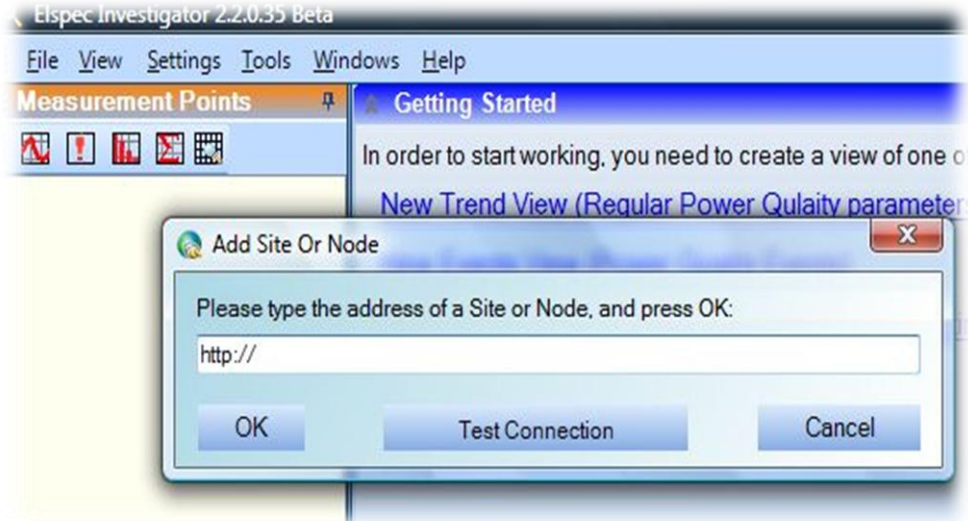
If the automatic scan procedure does not provide sufficient results, it is recommended adding the SITE manually as described below.

Adding a SITE Manually

- To Add a SITE manually, choose *Add Node or Site* option from File menu.



- Type a full URL for the SITE.

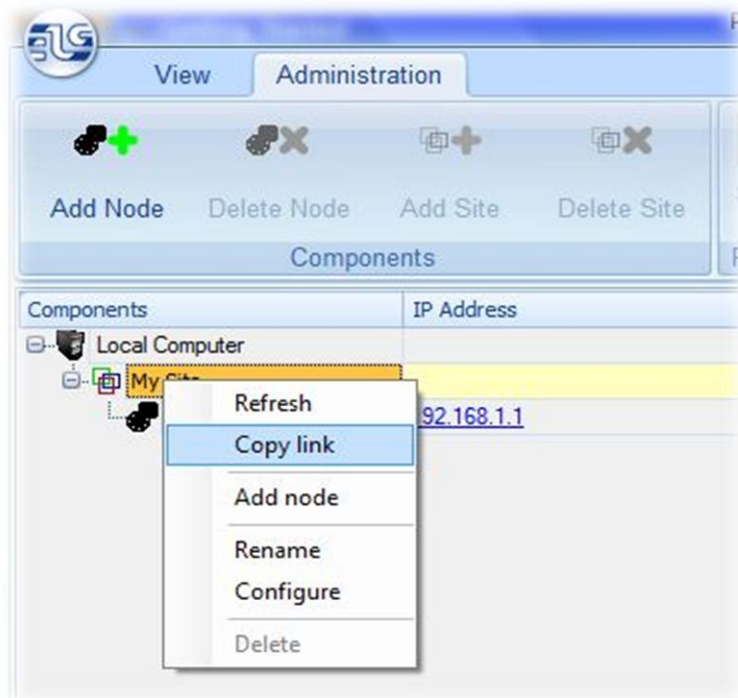


For example: if the computer is connected to Internet, the following site could be added: <http://pqscada.com/demosite>

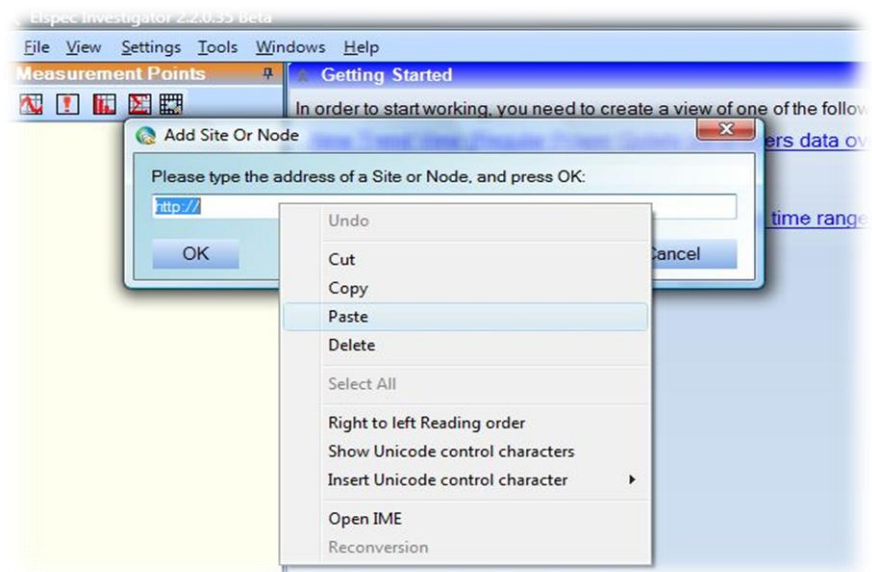
This site is managed by the Elspec computer system and provides continuous measurements from an actual facility with multiple G4k devices.

When PQSCADA server software is running on the same computer, the site URL can be easily obtained from the PQSCADA management studio application by:

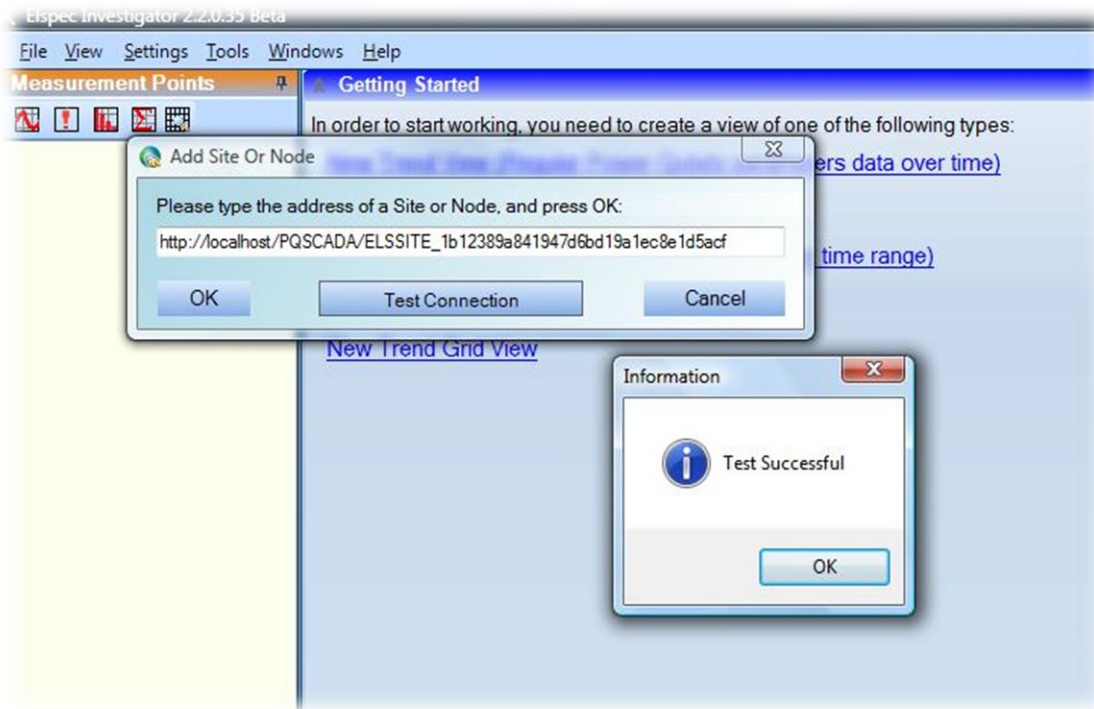
- a) Right mouse clicking on *SITE* under PQSCADA management studio
- b) Choose *Copy Link* as shown below.



c) Then paste the link under *Add Site or Node* window, as shown below:

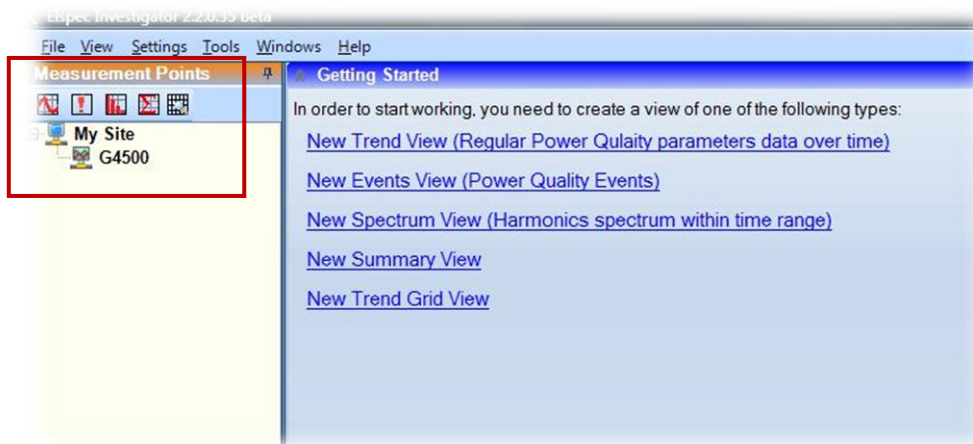


The full URL link to the site managed by a local PQSCADA server will appear.



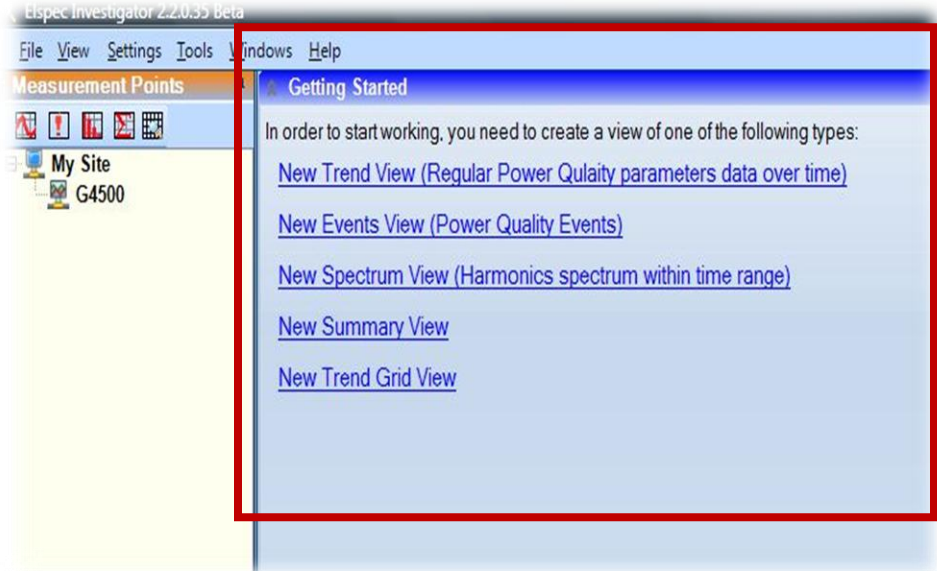
It is recommended that you press the *Test Connection* button before *OK* to ensure that the URL is valid.

When successful, the site will appear on the Measurement Points panel.



Operation

The Investigator application can present the recorded data in 5 different ways. The data representation is called a View. To start work with the data analysis, it is necessary to choose the view type first.

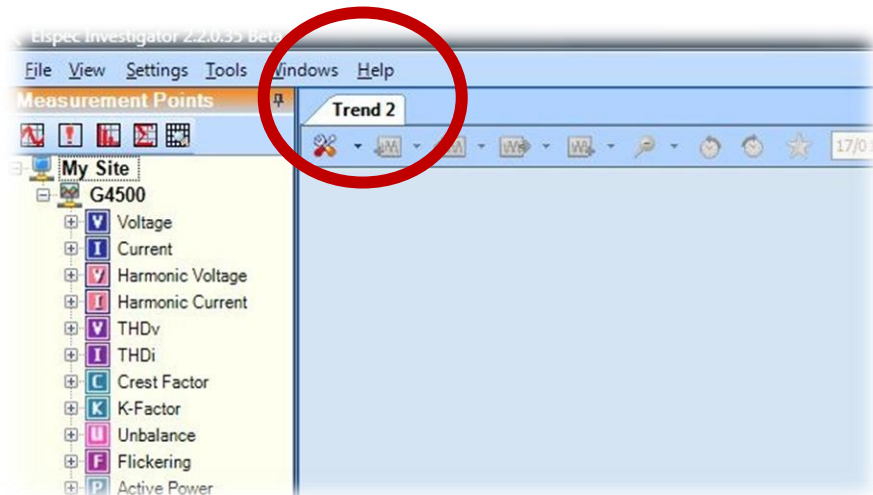


The view types available are:

- **Trend View:** An historic data representation where user-selected electrical parameters are presented as a trend graph in a continuous time frame
- **Events View:** A table of events captured/detected by the device according to the “Power Quality compliance program”
(refer to [Power Quality Section on page 58](#))
- **Spectrum View:** Useful for harmonic spectrum representation including voltages, current and power harmonics
- **Summary View:** Displays summary information over a defined period of time, including maximum, minimum and true mathematical averages of any parameter over a time span defined by the user
- **Trend Grid View:** Similar to the trend view, but with a grid/table style display

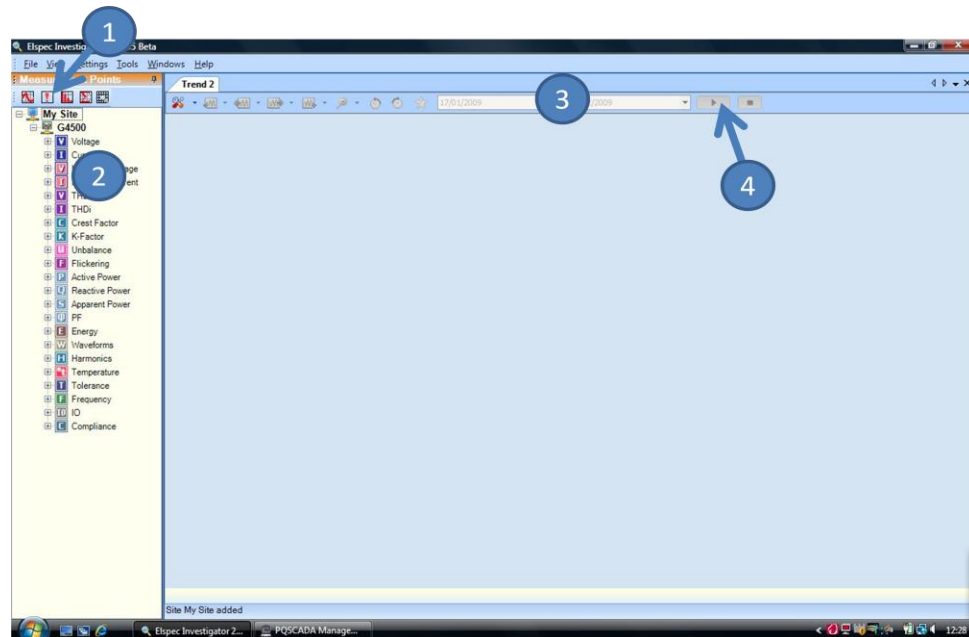
The Multi-View Concept

The Elspec Investigator supports a multi-view operation, which means that you can open and operate a number of views of any type simultaneously. When a new view is created, it appears as a blank screen and is docked as a tab in the working area.

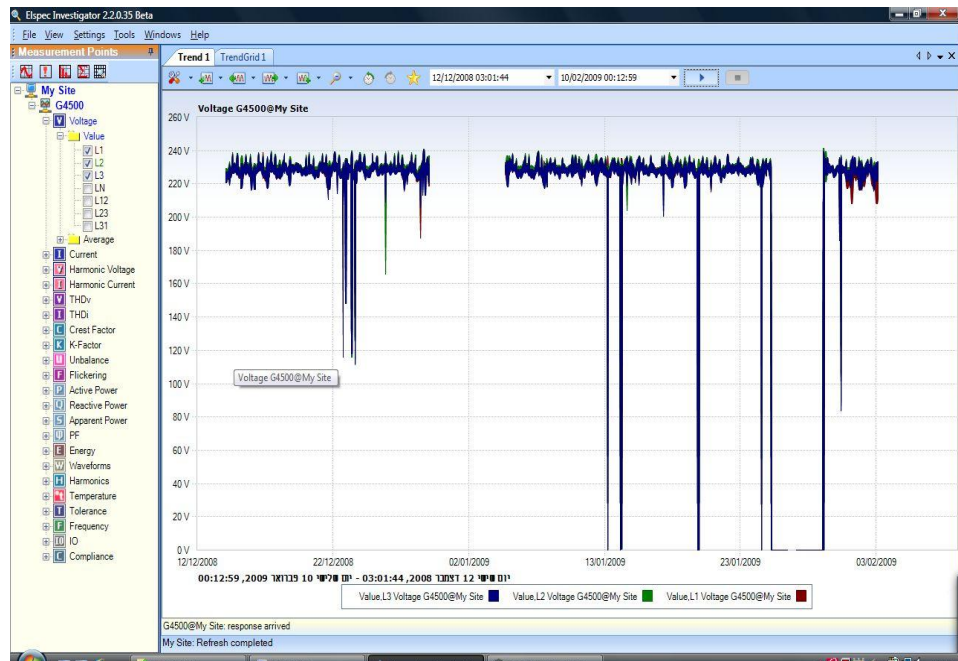


Any open view has its own number of parameters and time span, so it is possible to display different data or different time spans simultaneously using a number of views.

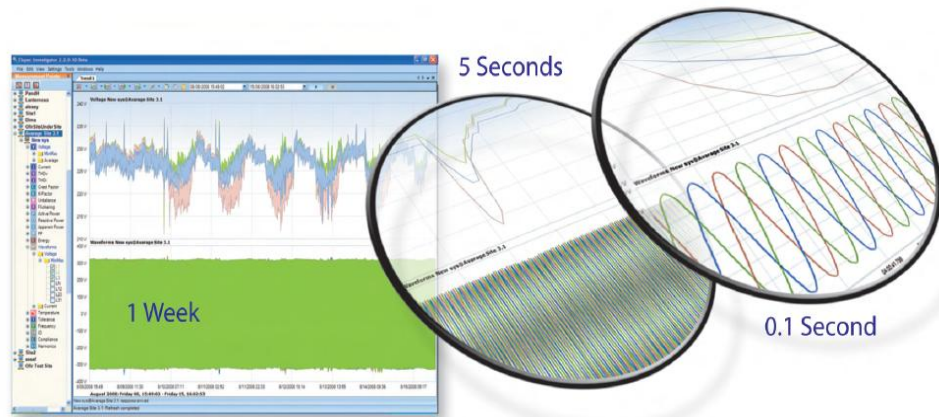
Generally, the operation can be simplified as a 4 stage process:



1. Select the view
2. Select the parameters
3. Select the time span
4. Press a *query* button and receive the data



You can add/remove parameters any time and choose any time intervals.



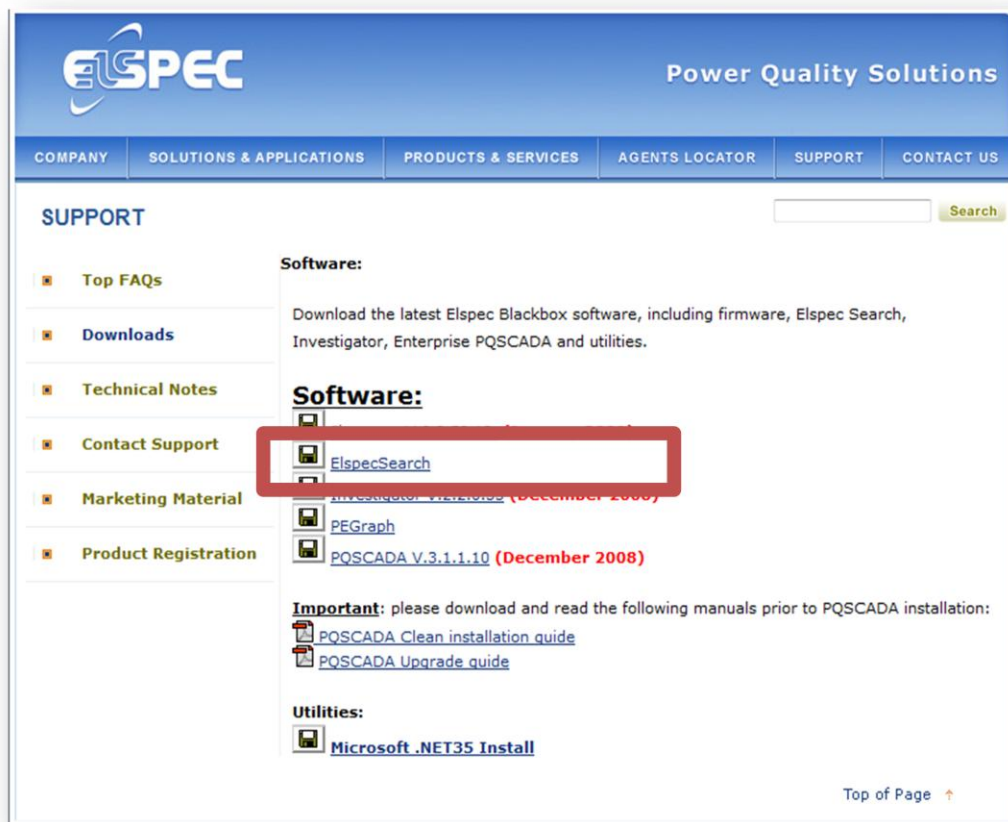
The data can be further zoomed in and out using a mouse from/to any time resolution.

Elspec Search Utility

The Elspec Search Utility is a small yet useful tool that allows searching and the ability to determine BLACKBOX family device IP addresses sharing the same local LAN. The Elspec Search makes use of UDP broadcasting, sending a *please respond* message to all devices on the LAN and displaying the resultant list of all devices responding to it.

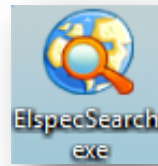
Obtaining the Search Utility

Elspec Search is a small program which does not require installation and is available free on the Support/Downloads section of Elspec WEB site <http://elspec-ltd.com>



Alternatively, it can be downloaded directly from:
<http://www.elspec.biz/ElspecG4k/ElspecSearch13.exe>.

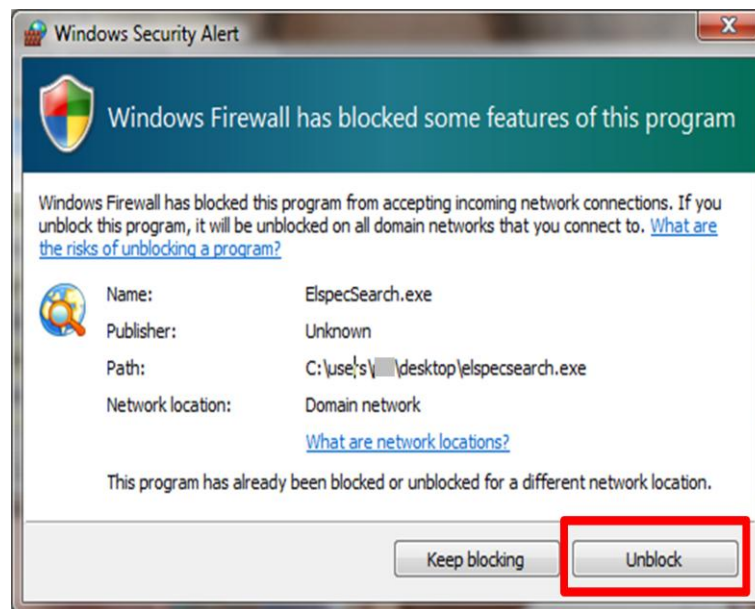
Or, found on the Elspec PQSCADA disk.



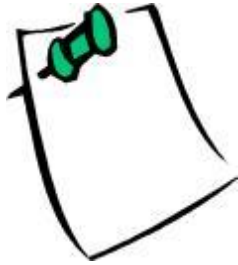
Since the program is small and does not require installation, it is recommended copying it and operating it directly from the computer Desktop.

Operation

Initially, the program will most likely be detected by a firewall system as trying to open UDP port 885.



If so, the above or similar window will appear prompting an operation approval.



It is highly important to enable the operation on the first run by pressing the “Unblock” button. Failure to do so will permanently disable the operation without any further notification.

Some organizations do not allow manual firewall configuration as a part of a corporate policy. Contact your system administrator for assistance in opening UDP port 885 when necessary.

When initiating a scan procedure, the utility appears as a grid displaying all BLACKBOX devices found on the network.

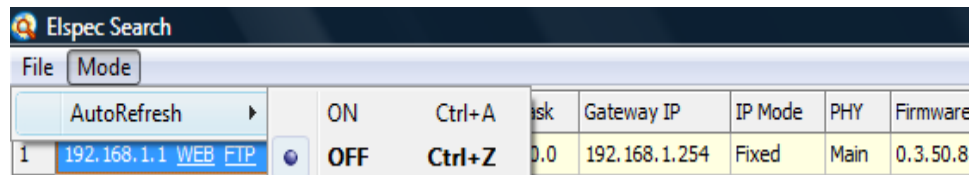
| # | IP Address | Unit Description | SubnetMask | Gateway IP | IP Mode | PHY | Firmware | Hardware | Serial Number |
|---|---------------------|------------------|-------------|---------------|---------|------|----------|----------|-------------------|
| 1 | 192.168.1.1 WEB FTP | G4500 | 255.255.0.0 | 192.168.1.254 | Fixed | Main | 0.3.50.8 | 2x2x1x0 | 5E.70.07.B4.CE.9D |

Version: 1.3, IP: 192.168.1.110, SubNet: 255.255.255.0, AutoRefresh is: OFF

Once open, the scan procedure can be manually prompted by using the *File>Refresh List* menu as shown below.

| File | Mode |
|------------------|----------------------------------|
| Save to csv file | Unit Description SubnetMask Gate |
| Refresh list | G4500 255.255.0.0 192. |
| Exit | |

As an alternative, the scan procedure can be configured to automatically refresh each second. This can be done by setting the *Mode>AutoRefresh* to *ON*. The default state is *OFF*.



| Elspec Search | | | | | | | | | |
|---------------|-------------|------|--------|-----|---------------|---------|------|----------|--|
| File | | Mode | | | | | | | |
| AutoRefresh | | ON | Ctrl+A | ask | Gateway IP | IP Mode | PHY | Firmware | |
| 1 | 192.168.1.1 | WEB | FTP | 0.0 | 192.168.1.254 | Fixed | Main | 0.3.50.8 | |

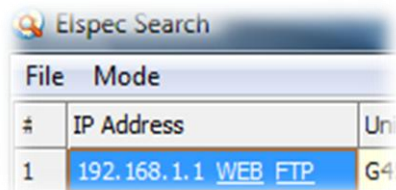
The Elspec Search list shows a variety of important information about every BLACKBOX device found on network; most of it is helpful to identify devices. However, probably the most important information is the IP Address of each device. This allows the initiation of WEB, FTP or Telnet session with the device.

Limitations

The Elspec Search utility can operate only as one single instance at a time, since it uses a single and fixed UDP port. When more than one instance is running at the same time – only the first one will operate correctly, the rest will show no devices.

Useful Features

Launching WEB or FTP Session



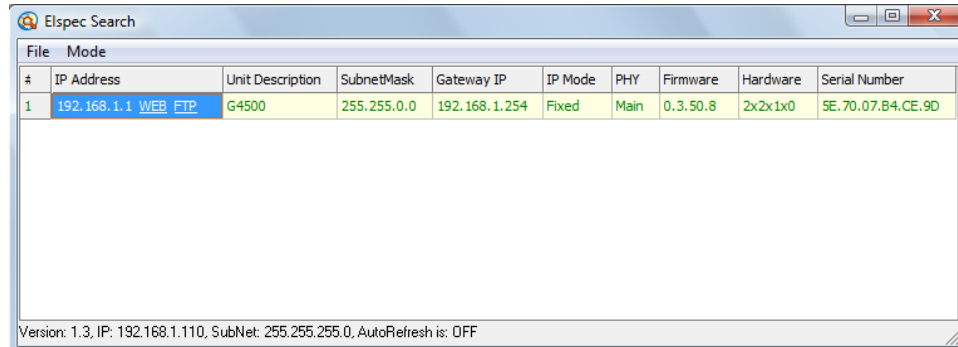
| Elspec Search | | |
|---------------|-------------|-------|
| File | Mode | |
| # | IP Address | Unit |
| 1 | 192.168.1.1 | G4500 |

The WEB and FTP hyperlink buttons on the right of the IP Address string launch WEB or FTP sessions directly from the Elspec Search window.



It is recommended that you define MS Internet Explorer® 7 as the default internet browser application.

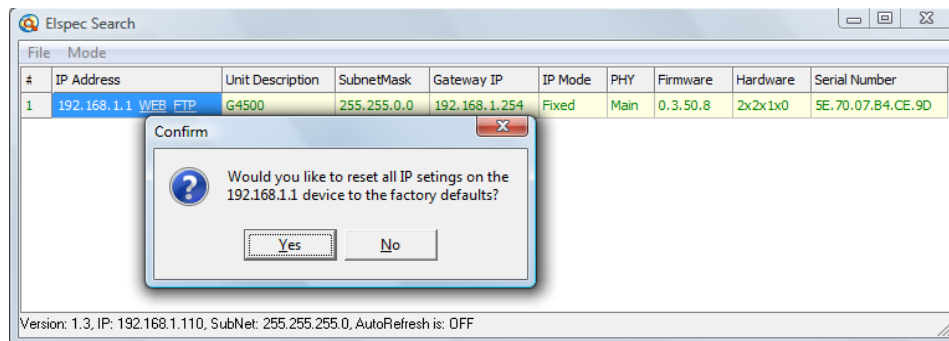
New Device Indication



Every new device – one that wasn't found on the previous refresh is marked in green.

Restoring Factory Defaults

The device can be forced to restore the factory default network configuration through a left mouse button double click.



Please allow a couple of minutes for a change to take effect as the device will automatically reboot, restoring factory default settings upon pressing the *Yes* button.

How to....?

Replacing the Battery



The BLACKBOX Portable contains a lithium battery that will provide up to 2 hours of fully functional operation without an external AC/DC power source. The battery requires no maintenance and is designed for long service life. However, if the battery shows a significant decrease in performance, it should be replaced with a factory original. Please consult with your local Elspec agency for information on how to order a replacement battery. The following procedure takes you step by step through the process of replacing the battery in the BLACKBOX Portable device.

Before You Begin

We recommend that you have all of the following ready and available to complete the battery replacement process:

- BLACKBOX Portable device
- Replacement Battery
- Phillips head screwdriver
- Flat head screwdriver

Removing the Battery



Warning: We strongly recommend that you power down this device and remove all connected power and communication cables before commencing service.

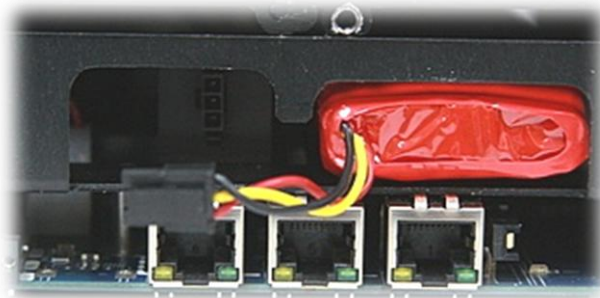
1. Remove the Rubber Cover from the front side of the device.
2. Remove all screws from Front Bracket (6 flat, 2 Phillips).



3. Remove the Front Bracket with Antenna extended straight.



4. Remove Battery Connector from the device terminal.



5. Remove Battery from the Carriage.






Installing the New Battery

1. Place new battery in carriage.
2. Re- connect plug connector from battery to device terminal inside the device (make sure wires are tucked into the device cavity).



3. Replace Front Bracket and secure with screws.
4. Replace Rubber Cover.
5. Re-connect all Power and communication cables.
6. Power up to test connections.



| Status | State | |
|---------------|---|---|
| Flashing blue | Main or auxiliary power applied/Battery charging. |  |
| Solid blue | Main or auxiliary power applied/Battery is fully charged. |  |
| Red | No main or auxiliary power available/Powered by internal battery. |  |

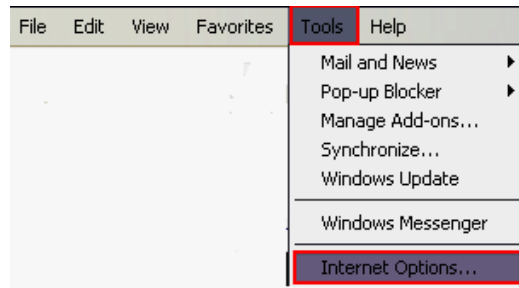
Disabling Proxy Server in Internet Explorer



A Proxy Server is a computer or application that functions as an intermediary between a web browser (such as Internet Explorer) and the Internet or Web Server. Originally proxy servers were designed to help improve web performance by storing a collection cache of frequently used web pages. With the advent of much faster connection speeds to the Internet, proxy servers are now primarily used in corporate networks to help improve security by filtering out some web content and malicious software.

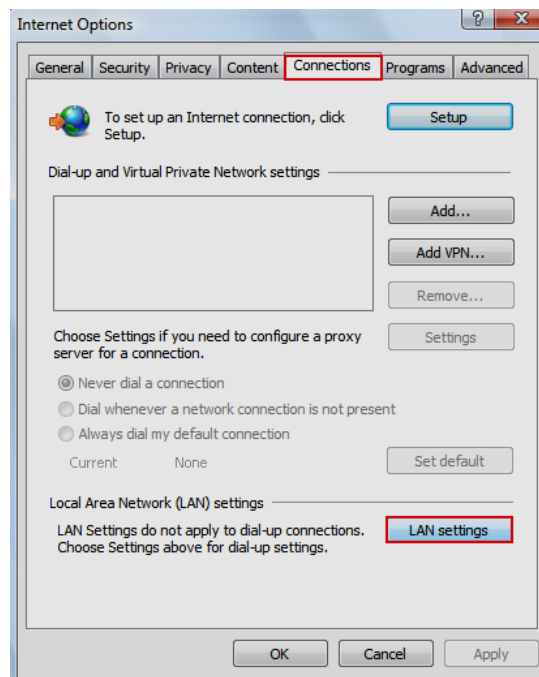
Using a web browser, you connect to the BLACKBOX Portable's web server through HTTP in much the same way you connect to the Internet. To view the web server of the device or embedded router, access to TCP Port 80 is required. Depending on the configuration of your LAN, (please consult your Network Administrator), you may (not) have permissions set to allow direct access to Port 80 on the BLACKBOX Portable device. In such cases, it may be necessary to disable the proxy server in Internet Explorer.

To disable the proxy server:



1. From the main IE main window, select **Tools**→**Internet Options**.

The Internet Options window appears.



2. Select **Connection**→**LAN settings**.

The LAN Settings dialog box appears.

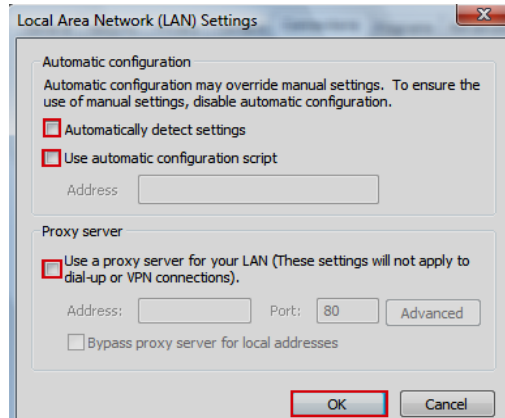


Figure 1: LAN Settings

3. Uncheck all pick boxes.
4. Click **OK**.
5. Press **F5** to refresh the browser window.

The Login screen appears.



Establishing a Security on Wireless Interface

As a factory default setting, a BLACKBOX Portable is supplied with an unsecured wireless (Wi-Fi) interface configuration. This is probably the most convenient way of getting starting and using the device for the first time. However, in practical usage scenarios, it is most likely that some level of security would be required to avoid unauthorized access to configuration screens and/or the data.

The BLACKBOX Portable utilizes an industry standard wireless router which is capable of providing a full list of security measures required for establishing a fully secure and reliable wireless communication even on the most security-sensitive applications.

The most simplified way of enabling a wireless security is using the wireless router's Setup Wizard ([refer to Wireless Router on page 34](#)).

Step 6 of the wizard allows setup of wireless security, turning ON WEP or WPA encryption access and password control.



The main selection is between two most popular security key exchange and encryption methods:

- **WEP** is the one of the oldest and probably still most popular encryption scheme. Some security experts used to believe that this security mechanism it relatively easy to crack, or break into, so it is not the best form of security for the wireless network. The password is defined as a 10 characters HEX number, which is quite easy to remember/use, yet probably easier to break as well.
- **WPA** is a latest wireless security technology that provides significantly stronger wireless data encryption than WEP. WPA uses a 64 character passphrase as a Pre-Shared key and provides a much stronger security level.

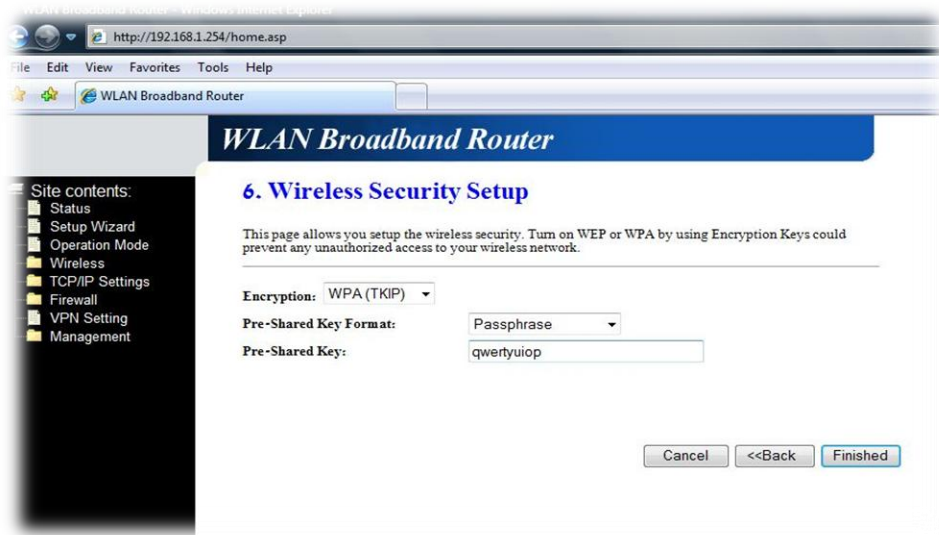
WPA encryption scheme is recommended for all cases when the client device supports this scheme.



Making changes in security configuration while connected by a wireless interface is strongly discouraged.

Establish a LAN connection on port LAN1 to configure the wireless router.

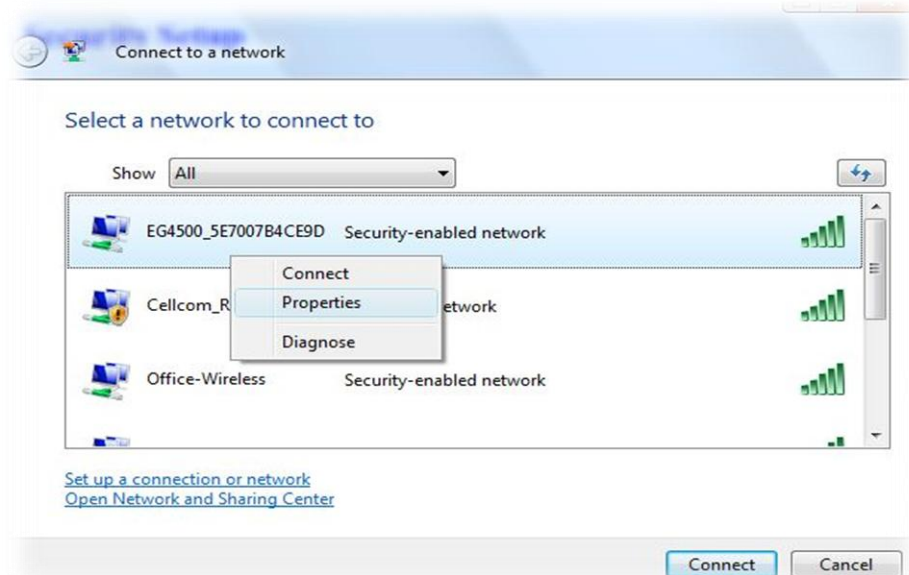
WPA Configuration Example



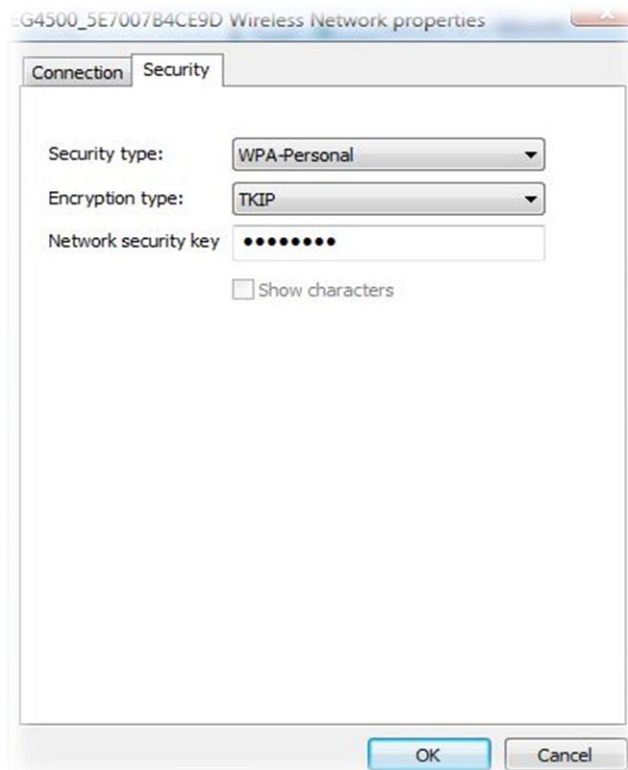
1. To establish a WPA data encryption scheme using TKIP encryption technology, select *WPA(TKIP)* from the list
2. Type a desired security key, then press the *Finished* button.

The BLACKBOX Portable unit is now wirelessly secured.

3. To establish a connection from the Mobile Analysis Lab select Start>Connect to
4. Select the interface from the list and then right mouse click > Properties



5. On the Properties window, select *WPA-Personal* , then *TKIP*.



6. Type the same security key as was used in router configuration and press *OK*.

7. Press the *Connect* button to begin a secure communication session with the instrument.

Restore Wireless Router to Factory Defaults

The wireless router can be reset to the factory setting as a part of a complete instrument reset to default settings using the Reset button ([refer to page 32](#)). However, in some situations, only the wireless router is intended to be reset leaving the instrument's settings without change.

The procedure described below is intended to restore to factory defaults only on the wireless router.

The procedure requires establishing a Telnet session with the instrument. ([Refer to Establishing a Telnet Session on page 104](#)).

1. On the Telnet terminal type the following wireless router reset command:

IO_Int_Reset_Wifi()



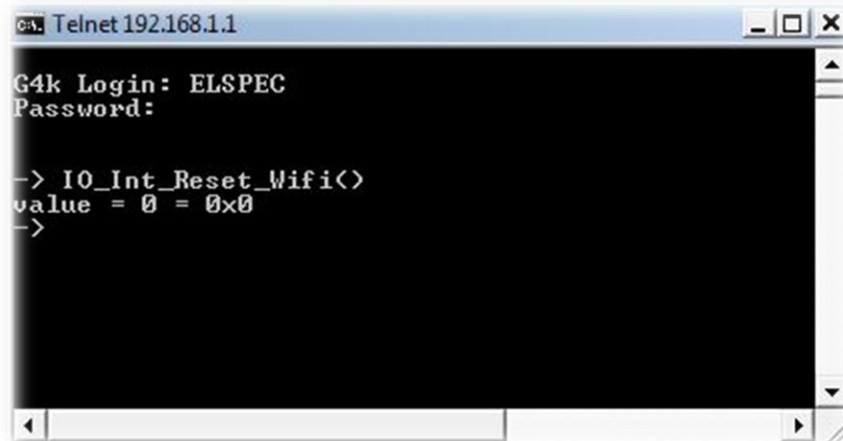
All Telnet commands and operations are case sensitive!

```
ca: Telnet 192.168.1.1
G4k Login: ELSPEC
Password:

-> IO_Int_Reset_Wifi(<)
```

2. Press *Enter* and wait a few seconds for the operation to complete.

When finished the function returns with the following:



```
C:\> Telnet 192.168.1.1

G4k Login: ELSPEC
Password:

-> IO_Int_Reset_Wifi(<)
value = 0 = 0x0
->
```

The wireless router is now reset to its factory default settings.

Simplified Power Curve Verification (PCV) Report

The Power Curve Verification (PCV) Report is typically required by the Wind Turbine Power Performance Measurement procedure, defined per IEC 61400-12-1 standard. The typical report requires a continuous statistical aggregation and periodical recording the following for several electrical and wind related parameters:

- mean value (Avg)
- standard deviation (StDev)
- maximum value (Max)
- minimum value (Min)

The BLACKBOX Portable implements a special reporting feature that performs required statistical analysis onboard, without a need of an external PC or post-processing of data. This feature can be extremely helpful in assisting a final PCV report preparation, as well as in some other non-wind related applications.

The parameters available by default are:

- Total Active power (Avg, StDev, Min, Max)
- Frequency (Avg, StDev, Min, Max)
- Total Reactive power (Avg, StDev, Min, Max)

Please contact your local Elspec distributor if some additional parameters are required.

Configuration

The PVC report Configuration is located in the Service/Power Setup section ([refer to Meter Readings Log on page 75](#)). To enable this automatic reporting feature select *Parameters* on the *Mode* field.

| Meter Readings Log | | |
|--------------------|----------|----------------------------------|
| Mode | Duration | Log restart |
| Parameters ▾ | 1/Day ▾ | UTC: 12 ▾ : 00 ▾ Local: 14:00 |

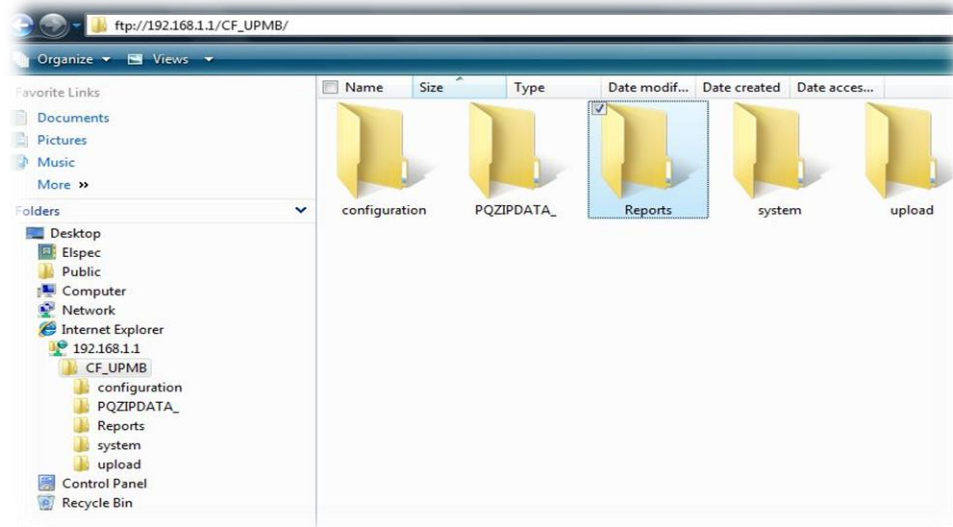
The Duration field defines the way the output files should be recreated. 1/Day selection on file duration will force the system to produce separate files each day, and the time a new file should be created is defined on the Log restart field. In the configuration example above, a new report file will be generated each day at 12:00 (UTC time).

| Duration |
|----------|
| 1/Day ▾ |
| 1/Day |
| 1/Week |
| 1/Month |

The aggregation period for the statistical analysis is defined in the Energy Interval configuration ([refer to Energy Intervals on page 74](#)).

The Outcome

The report Outcome file/s is/are created in the Reports folder on the main flash drive. The files are available through an [FTP interface on page 91](#)).



File Format

The report files are created in MS Excel's Comma Separated Values (CSV) File Format.

The filename's Structure

DL log A to B.csv

Where:

- **A** : Start time stamp in format: YYYY_MM_DD_HH_MM_SS
- **B** : End time stamp in format: YYYY_MM_DD_HH_MM_SS

For example: file “**DL log 2009_02_18 13_10_00 to 2009_02_19 07_40_00.csv**” is a report file was created at 18/02/2009 at 13:10:00 and finalized on 19/02/2009 at 07:40:00

While the file is being processed, the filename consists of only the start time record.

The filename time stamps are in UTC time format (not local time).

The Internal Structure

Below is an example of a typical file generated.

| | A | B | C | D | E | F |
|----|------------------------|---------------------|--------------|----------------|--------------|--------------|
| 1 | Device Name: Demo unit | | | | | |
| 2 | UTC Time | Local Time | kW_Total_Avg | kW_Total_StDev | kW_Total_Max | kW_Total_Min |
| 3 | 18/02/2009 13:10 | 18/02/2009 15:10:00 | 0.000007 | 0.002527 | 0.000029 | -0.000029 |
| 4 | 18/02/2009 13:20 | 18/02/2009 15:20:00 | 0.000007 | 0.002673 | 0.000053 | -0.000053 |
| 5 | 18/02/2009 13:30 | 18/02/2009 15:30:00 | 0.000007 | 0.002205 | 0.000053 | -0.000053 |
| 6 | 18/02/2009 13:40 | 18/02/2009 15:40:00 | 0.000007 | 0.001662 | 0.000053 | -0.000053 |
| 7 | 18/02/2009 13:50 | 18/02/2009 15:50:00 | 0.000003 | 0.006332 | 0.000053 | -0.000053 |
| 8 | 18/02/2009 14:00 | 18/02/2009 16:00:00 | -0.000007 | 0.001534 | 0.000053 | -0.000053 |
| 9 | 18/02/2009 14:10 | 18/02/2009 16:10:00 | -0.000007 | 0.001727 | 0.000053 | -0.000053 |
| 10 | 18/02/2009 14:20 | 18/02/2009 16:20:00 | -0.000007 | 0.001222 | 0.000053 | -0.000053 |
| 11 | 18/02/2009 14:30 | 18/02/2009 16:30:00 | -0.000007 | 0.00155 | 0.000053 | -0.000053 |
| 12 | 18/02/2009 14:40 | 18/02/2009 16:40:00 | -0.000007 | 0.001538 | 0.000053 | -0.000053 |
| 13 | 18/02/2009 14:50 | 18/02/2009 16:50:00 | 0.000002 | 0.006652 | 0.000053 | -0.000053 |
| 14 | 18/02/2009 15:00 | 18/02/2009 17:00:00 | 0.000006 | 0.005164 | 0.000053 | -0.000053 |
| 15 | 18/02/2009 15:10 | 18/02/2009 17:10:00 | -0.000007 | 0.001473 | 0.000053 | -0.000053 |
| 16 | 18/02/2009 15:20 | 18/02/2009 17:20:00 | 0.000002 | 0.006656 | 0.000053 | -0.000053 |
| 17 | 18/02/2009 15:30 | 18/02/2009 17:30:00 | 0.000006 | 0.00187 | 0.000053 | -0.000053 |

The first two columns specify a time stamp in UTC and local area time of the last data included in the statistical analysis presented by the row. The start time for a record is, in actuality, the stop time for the previous record in the file.

Producing a Simple Time of Use (TOU) Energy Report

The BLACKBOX Portable is designed to produce a basic energy report file internally. The report is generated in a MS Excel Comma Separated Values (CSV) file format and intended to be used for further Time of Use (TOU) report generation.

Configuration

The Energy report Configuration is located at a Service/Power Setup section ([refer to Meter Readings Log on page 75](#)). To enable this automatic reporting feature select *Energy* on the *Mode* field.

| Mode | Duration | Log restart |
|--------|----------|----------------------------|
| Energy | 1/Day | UTC: 12:00 Local: 14:00 |

E-70-07-B4 time 19/02/2009 17:01:08 © Elspec Ltd 20

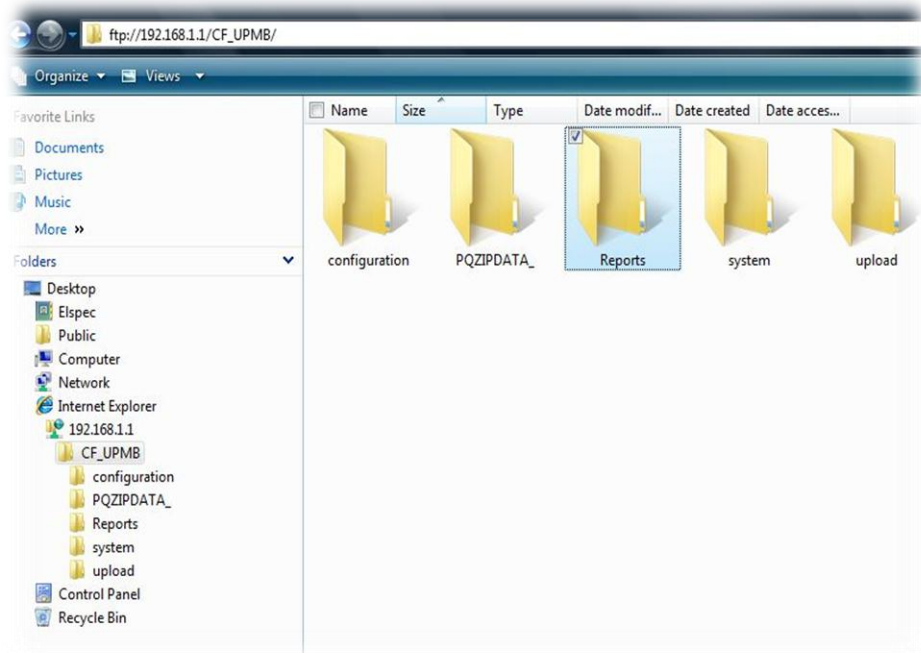
The Duration field defines the way the output files should be created. 1/Day selection on file duration will force the system to produce separate files each day, and the time a new file should be created is defined on the Log Restart field. In the configuration example above, a new report file will be generated each day at 12:00 (UTC time).

| Duration |
|----------|
| 1/Day |
| 1/Week |
| 1/Month |

The aggregation period is as defined as the Energy Interval configuration ([refer to Energy Intervals on page 74](#)).

The Outcome

The report Outcome file/s is/are created in the Reports folder on the main flash drive. The files are available through an FTP interface.



File Format

The report files are created in MS Excel's Comma Separated Values (CSV) File Format.

The Filename's Structure

MR log **A** to **B**.csv

Where:

- **A**: Start time stamp in format: YYYY_MM_DD_HH_MM_SS
- **B**: End time stamp in format: YYYY_MM_DD_HH_MM_SS

For example: file “MR log 2009_02_18 13_10_00 to 2009_02_19 07_40_00.csv” is a report file was created at 18/02/2009 at 13:10:00 and finalized on 19/02/2009 at 07:40:00

While the file is being processed, the filename consists of only the start time record.

The filename time stamps are in UTC time format.

The Internal Structure

Below is an example of the typical file generated.

| | A | B | C | D | E | F | G |
|----|------------------|---------------------|----------|----------|----------|----------|-----------|
| 1 | UTC Time | Local Time | kWh in | kWh out | kVAh | kVArh in | kVArh out |
| 2 | 19/02/2009 07:40 | 19/02/2009 09:40:00 | 0 | 0.000001 | 0.00001 | 0.000009 | 0.000001 |
| 3 | 19/02/2009 07:50 | 19/02/2009 09:50:00 | 0 | 0.000002 | 0.000023 | 0.00002 | 0.000003 |
| 4 | 19/02/2009 08:00 | 19/02/2009 10:00:00 | 0.000001 | 0.000005 | 0.000038 | 0.000031 | 0.000005 |
| 5 | 19/02/2009 08:10 | 19/02/2009 10:10:00 | 0.000001 | 0.000006 | 0.000051 | 0.000041 | 0.000008 |
| 6 | 19/02/2009 08:20 | 19/02/2009 10:20:00 | 0.000001 | 0.000007 | 0.000064 | 0.000052 | 0.00001 |
| 7 | 19/02/2009 08:30 | 19/02/2009 10:30:00 | 0.000002 | 0.000009 | 0.000077 | 0.000063 | 0.000012 |
| 8 | 19/02/2009 08:40 | 19/02/2009 10:40:00 | 0.000006 | 0.000012 | 0.000098 | 0.000079 | 0.000014 |
| 9 | 19/02/2009 08:50 | 19/02/2009 10:50:00 | 0.000008 | 0.000013 | 0.000112 | 0.00009 | 0.000015 |
| 10 | 19/02/2009 09:00 | 19/02/2009 11:00:00 | 0.000011 | 0.000014 | 0.000129 | 0.000103 | 0.000017 |
| 11 | 19/02/2009 09:10 | 19/02/2009 11:10:00 | 0.000012 | 0.000016 | 0.000145 | 0.000116 | 0.000019 |
| 12 | 19/02/2009 09:20 | 19/02/2009 11:20:00 | 0.000013 | 0.000019 | 0.00016 | 0.000128 | 0.000021 |
| 13 | 19/02/2009 09:30 | 19/02/2009 11:30:00 | 0.000017 | 0.000023 | 0.000182 | 0.000145 | 0.000022 |
| 14 | 19/02/2009 09:40 | 19/02/2009 11:40:00 | 0.000017 | 0.000024 | 0.000195 | 0.000156 | 0.000024 |

The first two columns specify a time stamp in UTC and local area time of the last data included in the energy aggregation presented by the row. The start time for a record is, in actuality, the stop time of the previous record in the file.

Available parameters are:

- kWh In
- kWh Out
- kVAh In
- kVArh In
- kVArh Out

International

Elspec Ltd.
Caesarea Industrial Park
POB 3019, 4 HaShoham St.
Zone 23, Israel 38900
Tel: +972 4 6272 470
Fax: +972 4 6272 465
e-mail: info@elspec-ltd.com

North America

Elspec North America Inc.
500 West South Street
Freeport, IL 61032
U.S.A.
Tel: +1 815 266 4210
Fax: +1 815 266 8910
e-mail: info@elspecna.com

Europe

Elspec Portugal Lda.
Zona Industrial - Fase 1
4900-231 Chafe - Viana do Castelo
Portugal
Tel: +351 258 351 920
Fax: +351 258 351 607
e-mail: info@elspecportugal.com