The POWER QUALITY ANALYZER

Introduction, Installation, Operation and Troubleshooting

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Revision 03

UM-PQAXXX-0602-03-EN

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1. OVERVIEW

1.1 Introduction

The Power Quality Analyzer (PQA) is a state-of-the-art device serving for electrical network analysis.

The PQA features:

- Ultra-rapid (cycle by cycle,) advanced electrical network analysis
- Complete network harmonics analysis, up to the 63rd harmonic
- High visibility, 5" graphic LCD screen with backlight
- Dual load model - 6 current inputs
- Display of neutral voltage and current
- Comprehensive data logging
- Feeder transformer analysis
- Compliance monitoring of international power quality standards
- Flexible design, allowing for system customization
- Up to 2048 KB of flash memory
- User-friendly PC software (PowerIQ)
- A variety of isolated digital and analog inputs and outputs
- Multiple communication protocols (see detail in Appendix B)
- Menu driven operation
- Easy installation, configuration and use

The PQA offers a choice of models ranging from essential measurements only (voltages, currents, frequencies and powers) to over 2000 electrical parameters (see product specifications in Appendix A).

This manual describes installation and operation procedures for all PQA models.

1.2 Safety Precautions

Before working with the PQA, please read this User Manual carefully. The manufacturer will not be responsible for any misuse.

The following general safety guidelines apply to PQA installation and operation. When performing any operation with the PQA, always observe these safety precautions.

- The instructions contained in this manual are intended for qualified personnel only. To avoid personal injury, do not perform any activity other than as contained herein unless you are qualified to do so.
- Before connecting cables to the PQA, verify that the mains supply is disconnected.
- To prevent shock or fire hazard, do not expose the PQA to rain or moisture.
- Avoid making unauthorized modifications to the PQA.
- Always operate the PQA within the specified power tolerances.
- The output of current transformers may be affected by high voltage due to cutout on the secondary coil. Throughout installation, check all transformer outputs for connection to loads and perform the procedure systematically as specified. ***Failure to comply with this instruction may result in life-threatening situations***.
- To use and operate the PQA, follow the specifications of this manual strictly. ***The manufacturer will not be responsible for any damage or injury resulting from equipment misuse and/or unsafe work practices***.

2. INSTALLATION

2.1 Mounting

The PQA is designed for mounting in a 140×140 mm hole on a cabinet door. To mount, secure to the door with two fixing clamps as shown in Figure 1.

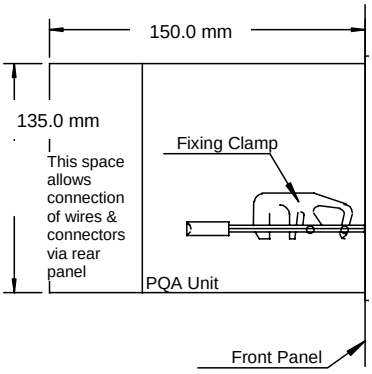


Figure 1: PQA Mounting Diagram (Left Side View)

2.2 Connection

The rear panel of the PQA, as shown in Figure 2, houses all the connectors required to hook up the PQA. The PQA may carry one or two optional cards, e.g. RS-485/422 communication card or I/O card. The functions of the standard rear panel connectors are described below for a PQA carrying one RS-485/422 communication card. The actual connections depend on the cards installed in the specific unit.

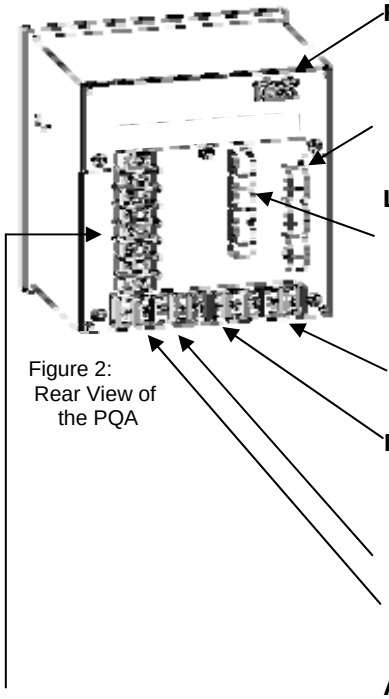


Figure 2: Rear View of the PQA

RS-485 RS-485/422 serial communication port, comprising differential Transmit and Receive ports. Connector type: Phoenix MSTB-2.5/4-ST.

Load2 CT (option) Connection of the optional load2 CTs, made without electrical contact. To connect, insert cable through the hole in the red ring. The phases are sequenced from top to bottom: L1, L2, L3.

Mains CT Connection of the network CTs, made without electrical contact. To connect, insert cable through the hole in the red ring. The phases are sequenced from top to bottom: L1, L2, L3.

Alarm Relay Outputs Alarm relay outputs. Maximum rating: 250VAC, 24VDC, 2A.

Voltage Measurements Connection of the measured voltages. In delta networks, there is no need to connect the neutral (N). In single-phase networks, connect either L1 and N, or L1 and L2.

GND Connection to the protective earth.

Power Supply Single-phase power supply. Connect to 115V or to 230V, as applicable to the PQA type. Both voltages work with either 50 or 60 Hz.

Supporting Connectors These connectors have no electrical connection to the controller. They serve to support the connection of the CTs, which is normally made by means of two cables (K and L). To connect, insert one cable

through the red ring and tie both cables with one of the supporting connectors.

2.3 Communication Cable Connection (optional)

To allow remote communication with the PQA, a communication link must be established between the system and the PC. To connect, follow the procedure below:

(1) Install a communication cable (2 twisted pairs, shielded) between the PC and the PQA.

(2) Connect an RS-485/422 to RS-232C converter (e.g. ATEN model IC-485/SI) to the computer end of the communication cable. Set converter's DIP switches to TxON/RxON (i.e. Transmit and Receive are always on) and DCE (i.e. cconnecting directly to the PC).

(3) Connect a PHOENIX contact KGG-MSTB 2.5/4-ST connector to the system end of the communication cable as shown in Figure 3.

(4) To connect multiple systems, use a PHOENIX connector in parallel for each system.

For communication protocols supported, see Appendix B.

For PowerIQ installation and operation, see Section 6.

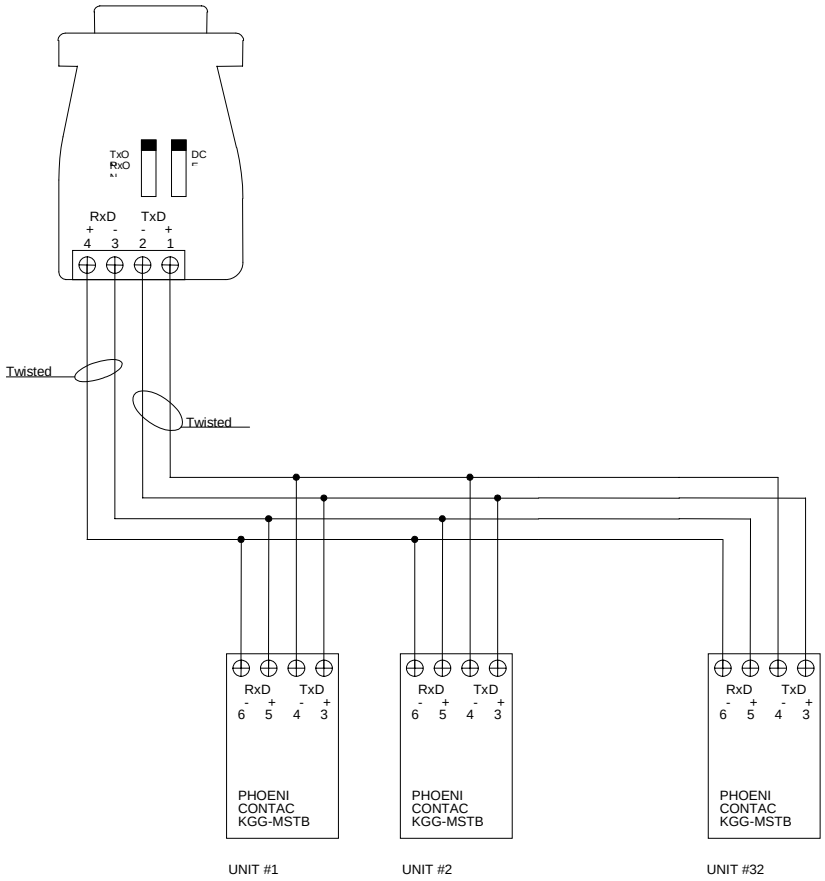


Figure 3: RS485 Connection Diagram

2.4 Preliminary Inspection

To prepare the PQA for initial power-up, run preliminary inspection. To inspect, follow the procedure below:

(1) Verify that the unit is disconnected from the main supply.

(2) Inspect all electrical and mechanical connections visually for mechanical damage and for integrity of components and accessories.

(3) Inspect current transformer wiring for proper phase marking and for proper connection into the terminal block.

(4) Pull-test all control wiring to ensure secure seating in terminals.

3. OPERATION

3.1 Front Panel

The front panel of the PQA is divided into the following functional areas (see Figure 4):

- Header – listing product type and current time.
- Main Display.
- Function Keys & Tags.

The functions of the controls and indicators in each of these display areas are as described in the subsections below.

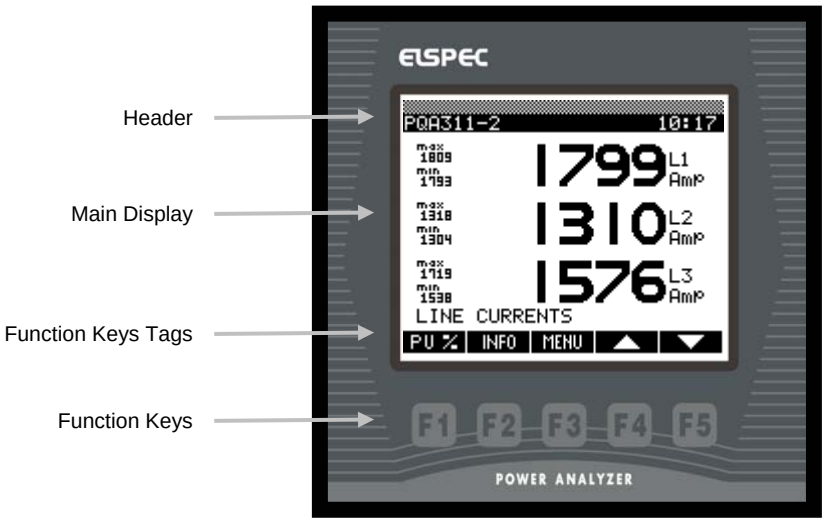


Figure 4: Functional Display Areas

3.2 Function Keys & Tags

3.2.1 General

All PQA functions are accessible from five function keys at the bottom of the front panel. The function of each key changes according to the display mode and the information on the function key tag.

Three different display modes are available (see Section 5):

- Numeric display, comprising three large-set numbers with minimum and maximum values for the current measurement
- Graphic display, comprising waveforms and harmonics.
- Text display, comprising menus, system information, energy and events

Figure 5 summarizes the various functions of the keys in each display mode and submode.

Note that in Energy Display mode (see 5.4.2), key functions are identical to those in Numeric Display mode.

Key	Display	Tag	Function	Section
F1	Numeric	PU%	Displays the value as a fraction of its nominal value	5.2
	Graphic	---	None	---
	Text	HELP	Displays a short help text for the specific screen, where available	3.2.3
F2	Numeric	INFO	Displays the System Information screen	3.2.4
	Graphic	INFO	Displays the System Information screen	3.2.4
	Text	CANCEL	Cancels the last operation and returns to the previous state	3.2.3
		CLOSE	Closes the current window and returns to the previous one	3.2.3
		BACK	Moves back one step in a setup procedure	3.2.3
F3	Numeric	MENU	Opens system's Main Menu	3.2.3
	Graphic	MENU	Opens system's Main Menu	3.2.3
	Text	ENTER	Opens the selected item	3.2.3
		CLOSE	Closes the current window and returns to the previous one	3.2.3
		NEXT	Accepts the value entered and moves to the next step in a setup procedure	3.2.3
F4	Numeric	▲	Moves to the previous window on the Favorites list	3.2.2
	Graphic	◄	Moves the cursor one step to the left	5.3
	Text	▲	Moves the selection line one line up	3.2.3
F5	Numeric	▼	Moves to the next window on the Favorites list	3.2.2
	Graphic	►	Moves the cursor one step to the right	5.3
	Text	▼	Moves the selection line one line down	3.2.3

Figure 5: Key Functions in Different Display Modes

3.2.2 The Favorites List

The PQA contains a pre-defined list of favorite display windows. In Numeric Display mode, **F4** and **F5** function as ▲ (up) and ▼ (down) keys, respectively, and serve to scroll up or down a screen displayed from the Favorites list. Screen position on the list remains unchanged, therefore these keys will always move to the next or previous screen on the Favorites list whether the currently displayed screen was selected from the list or from another menu.

3.2.3 Menu Key

System's Main Menu serves both to select display screens and to program the system. To open, use **F3** in one of the reading display modes.

See full menu description in Appendix C.

Menu operations are effected through key functions as listed below:

HELP Function

Use **F1** to activate the HELP function, where a help screen is available for the menu displayed. Where no help screen is available, this key is disabled.

CANCEL & BACK Functions

Use **F2** to activate the CANCEL or the BACK functions. CANCEL will close the menu and return to the previous display mode, while BACK will close the current submenu and return to the previous one.

Note that, in either case, all changes made will be ignored.

ENTER, NEXT, SELECT & CLOSE Functions

Use **F3** to ENTER, NEXT, SELECT or CLOSE. All these functions are basically similar, serving to accept the information entered.

ENTER will open a submenu and select a menu item. In the Installation Wizard, NEXT will accept the data entered and move to the next screen. SELECT will toggle between selected inputs (see CT Polarity screen), and CLOSE will accept data and close the screen.

UP & DOWN Functions

Use **F4** and **F5** to activate the ▲ (up) and ▼ (down) functions (for ▲ and ▼ functions in the reading modes, see Section 3.2.2).

In data entry windows, ▲ (up) will increase the value by one while ▼ (down) will decrease it by one. Hold down to change the value in steps of 10.

In all other windows, ▲ (up) will move the selection bar one line up and ▼ (down) will move it one line down.

3.2.4 System Information

Use **F2** (info) to open the System Information screen as shown in Figure 6, with information as listed below:

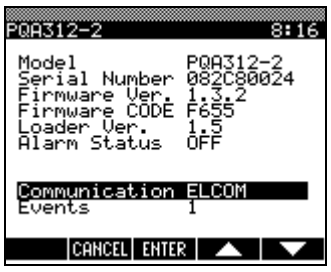


Figure 6: System Information Screen

Model	PQA model type.
Serial Number	PQA serial number.
Firmware Ver.	Firmware (internal software) version.
Firmware Code	Firmware build code.
Loader Ver.	The version of the firmware loader used for initial firmware booting and for firmware upgrading.
Alarm Status	Alarm relay status - activated (On) or inactivated (Off).
Communication	Communication protocols (if the PQA carries at least one communication card). If a single communication card is installed, it will be listed as "Communication". If two communication cards are installed, they will be listed as "Upper ComCard" and "Lower ComCard". Select this option to open a Communication Information screen displaying current baud rate, protocol and communication statistics.

Events	Total number of logged events. Select this option to display more details on the events (see also Section 5.4.3).

4. PROGRAMMING

4.1 General

Figure 7: System Setup Menu

PQA programming involves discrete parameters and the Installation Wizard. The Installation Wizard is a complete procedure designed to set up the PQA and, together with the discrete parameters, manage the PQA setup.

To initiate the Setup (programming) Menu, first open the Main Menu (Section 3.2.3), then select “More...” and “Setup Parameters >>”. System’s Setup Menu will be displayed, as shown in Figure 7.

4.2 Setup Parameters

Display Contrast Set this parameter to establish the display contrast. Contrast is affected by the ambient temperature, lighting condition, viewing angle and user preferences.

Display Refresh Rate The controller measures all the data once per cycle and displays an average over several cycles, for easier reading. Set this parameter to establish the number of cycles to be used in averaging. Note that the minimum and maximum values are checked for every cycle, regardless of the refresh value.

MODBUS Slave address Set this parameter to establish the slave address for Modbus communication. This address will serve to identify the specific unit among all the units connected on the same Modbus line.
Note: This menu will only appear if the Modbus communication option is installed.

Installation Use this option to invoke the Installation Procedure (see 4.3).

4.3 Installation Procedure

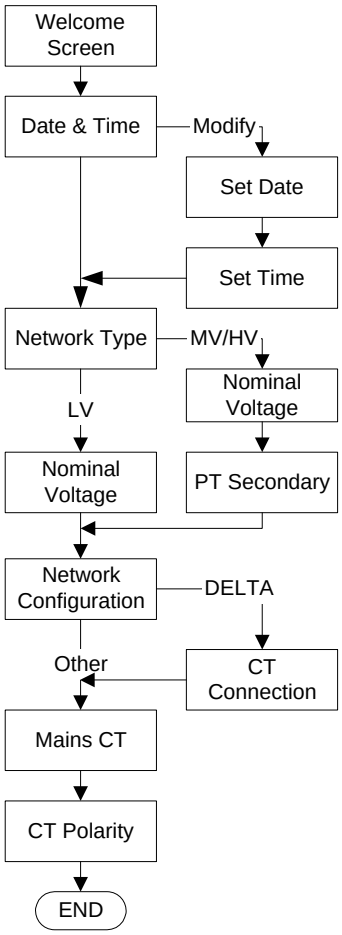


Figure 8: Installation Procedure

System installation is done with the Installation Wizard, which leads you through all parameter setups required and helps you install the unit quickly and easily.

To install, follow these steps (see also flowchart in Figure 8):

1. **Welcome Screen:** Select Installation Wizard.
   The Welcome Screen will open to remind you to read this manual before installation.
2. **Date & Time:** In this field, select "Modify the above". The system will prompt you to set the year, month, day, hour and minute.
3. **Network Type:** Select low voltage network (LV) or medium/ high voltage (MV/HV).
4. **Nominal Voltage:** Set system's nominal voltage.
   In a three-phase system, the voltage is line-to-line.
   For network type LV, skip to step 6.
5. **PT Secondary:** Set the secondary rating of the step-down transformer. Where the primary of the PT transformer is other than the nominal voltage, set the PT secondary to a value where the ratio between the PT primary to the actual PT secondary will equal the ratio of nominal to programmed PT secondary.
6. **Network Configuration:** Select 3-phase Wye, 3-phase Delta or single phase (L-N or L-L).
   For network configurations other than Delta, skip to step 8.
7. **CT Connection:** Set up the existing CTs in a Delta configuration. Where a CT is not connected, its current will be calculated from the other two, assuming L1+L2+L3 equals 0.
8. **Mains CT:** Set the mains CT. If you use a …/1A CTs, set the ratio of the CTs rather than the primary value, however this will have an adverse effect on accuracy.
9. **CT Polarity:** Set the polarity of each CT. In most cases, the kW should be positive if the polarity is set correctly (positive kW means power flow from the utility company to the network).
   To set, highlight the phase (L1, L2 or L3) you wish to change, then press **F3** (Select).

5. MONITORING

5.1 Introduction

To monitor, use system displays as applicable:

- Numeric display, comprising three large-set numbers with their minimum and maximum values (Figure 9).
- Graphic display, covering harmonics (Figure 10) and waveforms (Figure 11).
- Text display, covering menus, system information, energy (Figure 12) and events (Figure 13).

5.2 Numeric Display

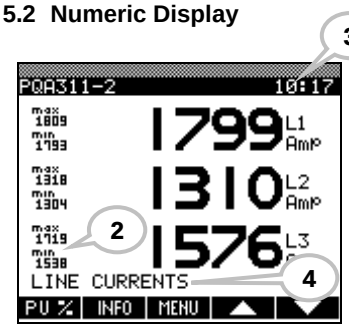


Figure 9: Typical Numeric Display

System's Numeric Display consists of three values. For each value, a large-set number is displayed with the current value (1) and its minimum and maximum (2). The minimum and maximum values are reset whenever the display is changed. This parameter includes phase and units indication (3) as well as screen description (4).

Use **F4** (▲) and **F5** (▼) to select the next or previous display screen from the Favorites list (see Section 3.2.2).

Click **F1 (PU%)** to display the value in a "Per Unit" format whereby the full scale of the parameter is displayed as 1.00 and the value itself is displayed as a fraction. For example, 392V in a 400V network will be displayed as 0.98 (392/400=0.98), and 408V will be displayed as 1.02 (408/400=1.02).

Use the PU% display mode to estimate a parameter when its full scale is unknown.

5.3 Graphic Display

5.3.1 Harmonics Spectrum

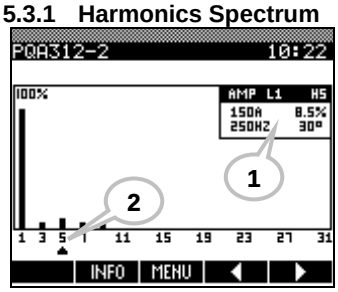


Figure 10: Typical Harmonic Spectrum Display

In a typical Harmonic Spectrum Display, the specific harmonic information (1) shows the type, phase and number of the harmonic, as well as its level (in amperes/volts or in percent), angle and frequency.

Use **F4** (◀) and **F5** (▶) to decrease or increase the number of the displayed harmonic (2). The harmonics are divided into two separated displays: 1st through 31st harmonic and 32nd through 62nd. The displays are switched automatically according to the number of the selected harmonic. For example, when the cursor is on the 31st harmonic, click **F5** (▶) to move the cursor to the 32nd harmonic and display the 32nd through 62nd harmonics.

5.3.2 Waveform Display

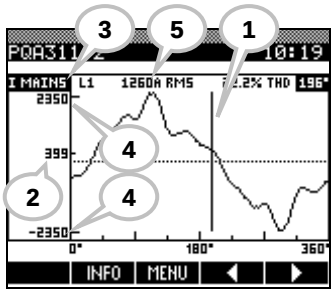


Figure 11: Typical Waveform Display

The Waveform Display includes a cursor (1) and the waveform value at this position (2), waveform type (3), and lower and upper peak values (4). In addition, specific waveform information (5) shows the type, phase and number of the waveform, as well as its RMS value, THD and angle of cursor position.

Use **F4** (◀) and **F5** (▶) to change cursor position.

5.4 Text display

5.4.1 General

System's Text Display comprises menus, system information, energy and events.

See detailed menu descriptions in Section 3.2.3 and System Information in Section 3.2.4.

5.4.2 Energy Display

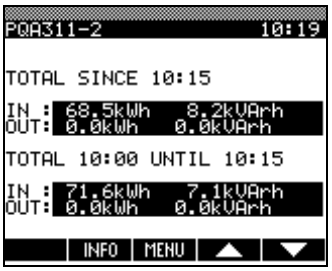


Figure 12: Typical Energy Display

The Energy Display comprises 15-minute meters and monthly totals, each showing the previous period total (15-minutes or month) and the value accumulated since the start of last period. The values include active energy (kWh) and reactive energy (kVAr) for both incoming and outgoing energy. The information is stored in the flash memory every 15 minutes, and the PowerIQ software can retrieve the information for easy display and calculation of Time-Of-Use.

5.4.3 Events

The total number of events is displayed on the System Information screen (Section 3.2.4).

Figure 13: Typical Event Display

Select an event on this screen to display each event-information on a separate screen as shown in Figure 13.

The event types available depend on the product type.

6. POWERIQ SOFTWARE

6.1 General

The PowerIQ software is an application run under Microsoft Windows, providing a graphical user interface for ELSPEC products.

To use PowerIQ, equipment is required as listed below:

- Computer system: Pentium 166 MHz or higher, with minimum of 32 MB of memory and 50 MB of free space on the hard disk.
- Operating system: Microsoft Windows 95 or higher, with TCP/IP installed.
- Communication: A communication cable between the PC and the units. See detailed description of hardware connection and unit setup under 2.3.
- Software: PowerIQ.

For best performance, use Pentium III 600 MHz or higher, with 128 MB of memory and Microsoft Windows 2000 Professional.

6.2 Packages

The PowerIQ comes in either one of two packages:

PowerIQ Professional	Including the entire PowerIQ functionality for a single computer.
PowerIQ Network	Including the entire PowerIQ functionality for multiple computers connected on a TCP/IP network or modem, as illustrated in Figure 14.

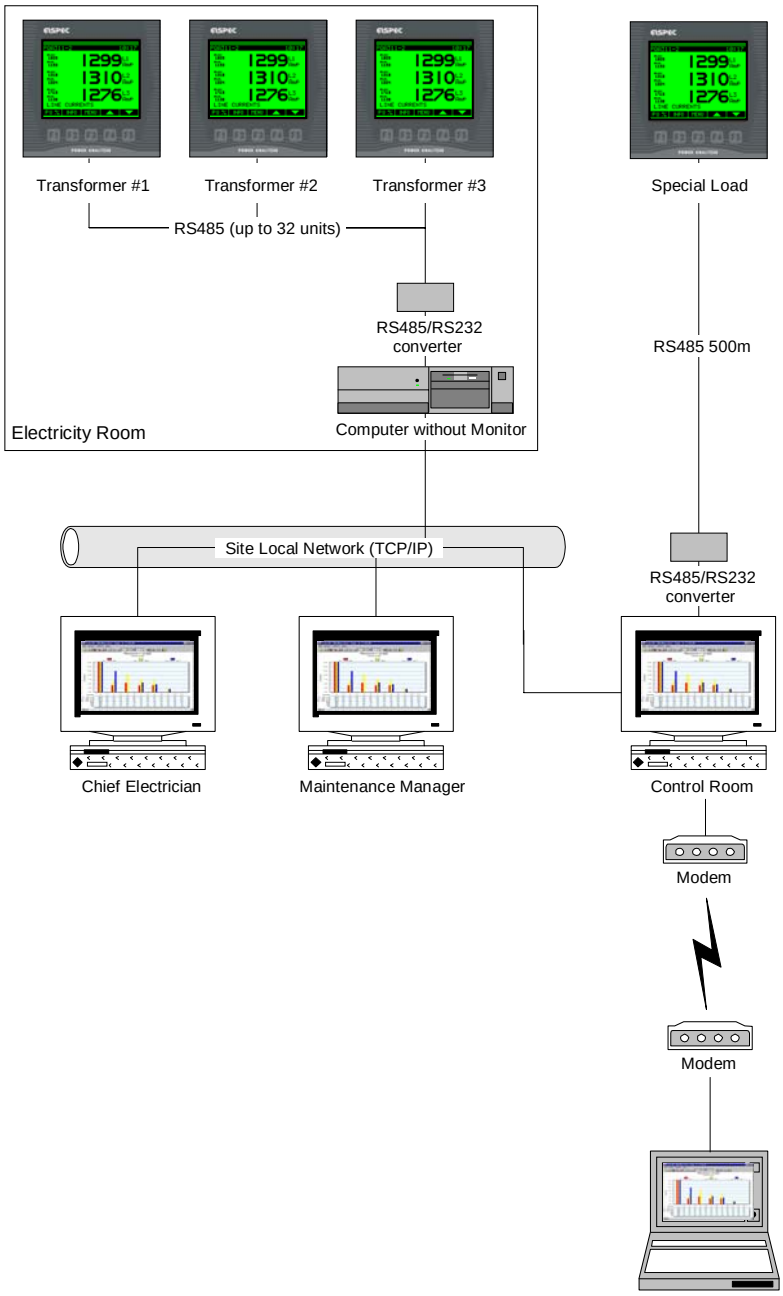


Figure 14: PowerIQ Network Installation Example

6.3 Installation

To install PowerIQ, follow the procedure below:

(1) PowerIQ uses Windows' TCP/IP both for network and for stand-alone installations. If your system does not have the TCP/IP installed, see Windows Help under "TCP/IP protocol, installing", to install.

(2) If you have another version of PowerIQ installed on your computer, reboot the computer before starting the installation procedure.

(3) Insert the installation CD-ROM into the CD-ROM drive.

(4) Click "Start" and select submenu "Run...".

(5) Type "D:SETUP", then click OK. Replace D: with your CD-ROM drive letter.

(6) Follow installation program instructions as they appear on the screen.

6.4 Operation

The software includes an application toolbar and client applications. The application toolbar also serves as a communication server for the clients and for

other computers (in the network version). The server collects all the data requests from all clients and delivers the required information to all the clients. As many clients may be opened simultaneously as required, whether of different or of the same type.

All clients are accessible through the PowerIQ Main Taskbar.
To activate, select “Start” » “Programs” » “PowerIQ” » “PowerIQ”.

6.5 Help System

For additional information on PowerIQ, seek PowerIQ on-line help.

To access on-line help, do one of the following:

(1) Use **F1** to open the Help system for the specific function.

(2) Select “Help” from the PowerIQ Main Taskbar.

(3) Select “Start” » “Programs” » “PowerIQ” » “Help”.

7. TROUBLESHOOTING

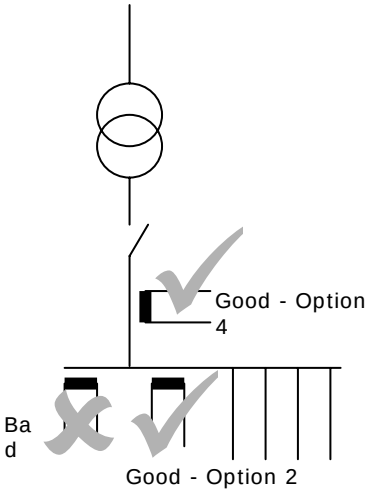


Figure 15: CT Connection Example

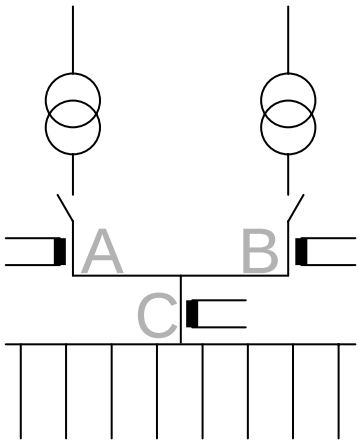


Figure 16: Parallel CT connection

The secret to troubleshooting is to examine the evidence you have, gain as much information as you can, and eliminate the possibilities one by one. In most cases, the source of the problem will soon become clear.

See common problems and solutions below:

The PQA doesn't power up

Make sure that the PQA is connected to the power supply. Note that the power supply connection is separated from the measurement voltage connection (see Section 2.2).

The PQA displays a zero current reading

Check CT connections.

Make sure that the cable or bus bar measured carry current.
Tip: The PQA may be measuring the edge of the bus bar where no current is flowing (see Figure 15).

The current RMS readings of all phases are similar, but they are different from those expected

Check for improper setting of the CT ratio, or verify that ALL the power input is surrounded by the CTs. A typical bad connection is one with two parallel transformers or multiple feeders. For example, in Figure 16, if the CT is set to position "A", the current will read 50% of the actual value.

How to measure two parallel transformers?

There are four ways to measure two parallel transformers (Figure 15):

Option 1 Use the Dual-Load PQA version and install CTs on "A" and "B" or on "A" and "C". The PQA will add ("A"+"B") or subtract ("C"-"A") the current and display the readings on all three points. This is the best solution for parallel transformers.

Option 2 Install CTs on both "A" and "B" and connect them to the PQA using a summary CT. Unlike option 1, this option does not provide information on the imbalance between the transformers.

Option 3 Install CTs on "C". Unlike option 1, this option does not provide information on the imbalance between the transformers.

Option 4 Verify that the currents on "A" and on "B" are identical, then install CTs on either "A" or "B". Now set the CT ratio to twice the actual ratio. However, this option is not recommended since, if the current is not identical or if one of the transformers is disconnected, the readings will be incorrect.

The voltage and current readings are OK, but the power and the power factor are not

Check for a mismatch between the phases of the voltage connections and the CT.

To fix, switch between phases L1 and L3 on either the voltage or the CT (but not on both).

The PQA displays negative active power

Negative active energy indicates that the load supplies energy back to the network.

If the energy flows to the load, the connection of one or more of the CTs is reversed, or the set-up parameter of CT polarity is not properly set.

To fix, either change CT polarity or repeat the installation procedure (Section 4.3).

APPENDIX A: SPECIFICATIONS

LCD Display Size	94x76 mm
LCD Display Resolution	Graphic 160x128 pixels
LCD Display Type	FSTN, LED backlight
Overall Dimensions	144x144x120 mm [HxWxD]
Panel Cutout	138x138 mm
Weight	1.4 kg
Ambient Temperature	-20˚C - +55˚C
Storage Temperature	-25˚C - +65˚C
Direct Voltage Measurement	347/600 VAC Max.
Current Measurement	../5A (1A)
Relay Alarm	Max. 2A 250VAC
EMC Compatibility	EN61000-4-2/3/4/5, ENV50204, ENV50141
Safety Standards	EN61010-1, EN50439-1, UL508
Protection Class	IP40
Analog Channels	7 or 10 4 x Voltage Channels 3 x Current Channels 3 x Current Channels (optional Load2)
Communication (optional)	ElCom (Elspec's protocol), ModBus RTU
Power Supply	110 or 230V, 50/60 Hz
Power Consumption	15 VA
Harmonics Analysis	1st through 63rd

Ordering Information

PQA-3122-2

Product Series (1-4)

Number of Loads (1 or 2)

Communication:
0 – None
1 – Single Elcom Port
2 – Single Elcom/Modbus Port
3 – Dual Elcom/Modbus Port

Power Supply:
1 – 110V 50/60 Hz
2 – 220V 50/60 Hz

APPENDIX B: COMMUNICATION

B.1 General

The PQA supports two communication protocols:

Elcom Elspec's unique high-speed communication protocol, enabling the fastest serial communication using the PowerIQ software.

Modbus Standard communication protocol, used for communicating with software other than the PowerIQ. This protocol requires a PQA with the PQA □□**2**-□ or PQA □□**3**-□ option.

The PQA can carry up to two communication cards and accommodate completely separated communication channels.

Since the PQA contains a "self-configuration" function, no protocol type and baud rate settings are required.

B.2 Modbus Protocol

The PQA communicates using MODBUS/RTU with 8 data bits, No Parity and 1 stop bit. The baud rate is set automatically between 9600 to 115200 bps and the Slave ID is set from the front panel (see Section 4.2).

All the parameters are 4x registers and read using either function 3 (Read Holding Registers) or function 4 (of the same functionality). The format of all data is float in real values (e.g. Volts, Amperes).

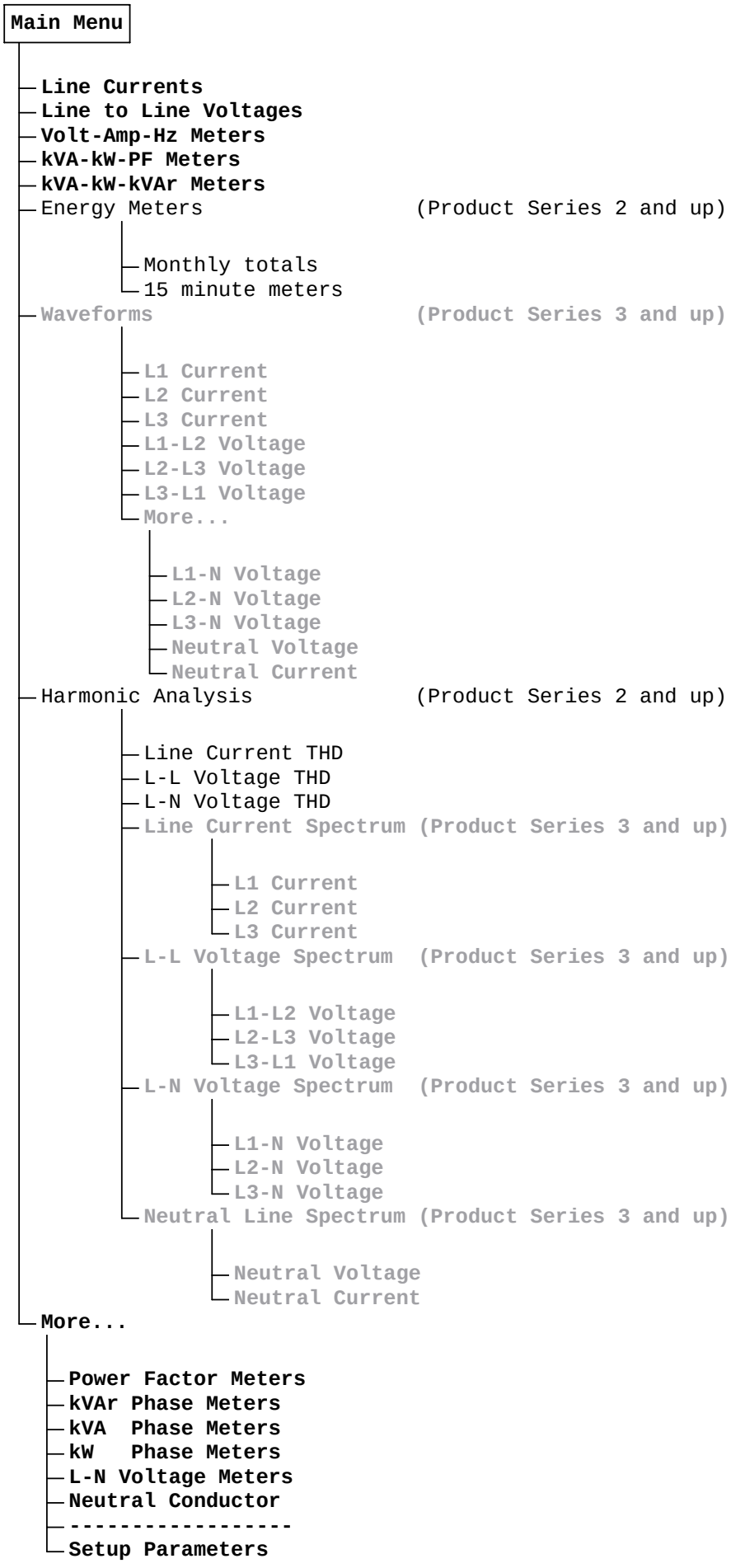
Major parameters are as listed below. Other parameters are available for more detailed information. An address starting with "0x" represents a hexadecimal address. Ir1 represents the Load1 current in phase R (L1). Ir2 represents Load2 current in phase R. VrH1 represents the value of first phase-to-neutral harmonic in phase R. The following harmonics are in the consecutive address (in steps of 2), i.e., the 2nd harmonic is in address 0x302.

Parameter	Address
Frequency	16
VrRMS	0
VsRMS	2
VtRMS	4
VavgRMS	6
VrsRMS	8
VstRMS	10
VtrRMS	12
VVavgRMS	14
Ir1RMS	20
Is1RMS	22
It1RMS	24
I1avgRMS	26
Ir2RMS	28
Is2RMS	30
It2RMS	32
I2avgRMS	34
Pr1RMS	50
Ps1RMS	52
Pt1RMS	54
Ptot1RMS	56
Qr1RMS	58
Qs1RMS	60
Qt1RMS	62
Qtot1RMS	64
Sr1RMS	66
Ss1RMS	68
St1RMS	70
Stot1RMS	72
Qr2RMS	88
Qs2RMS	90
Qt2RMS	92
QTot2RMS	94

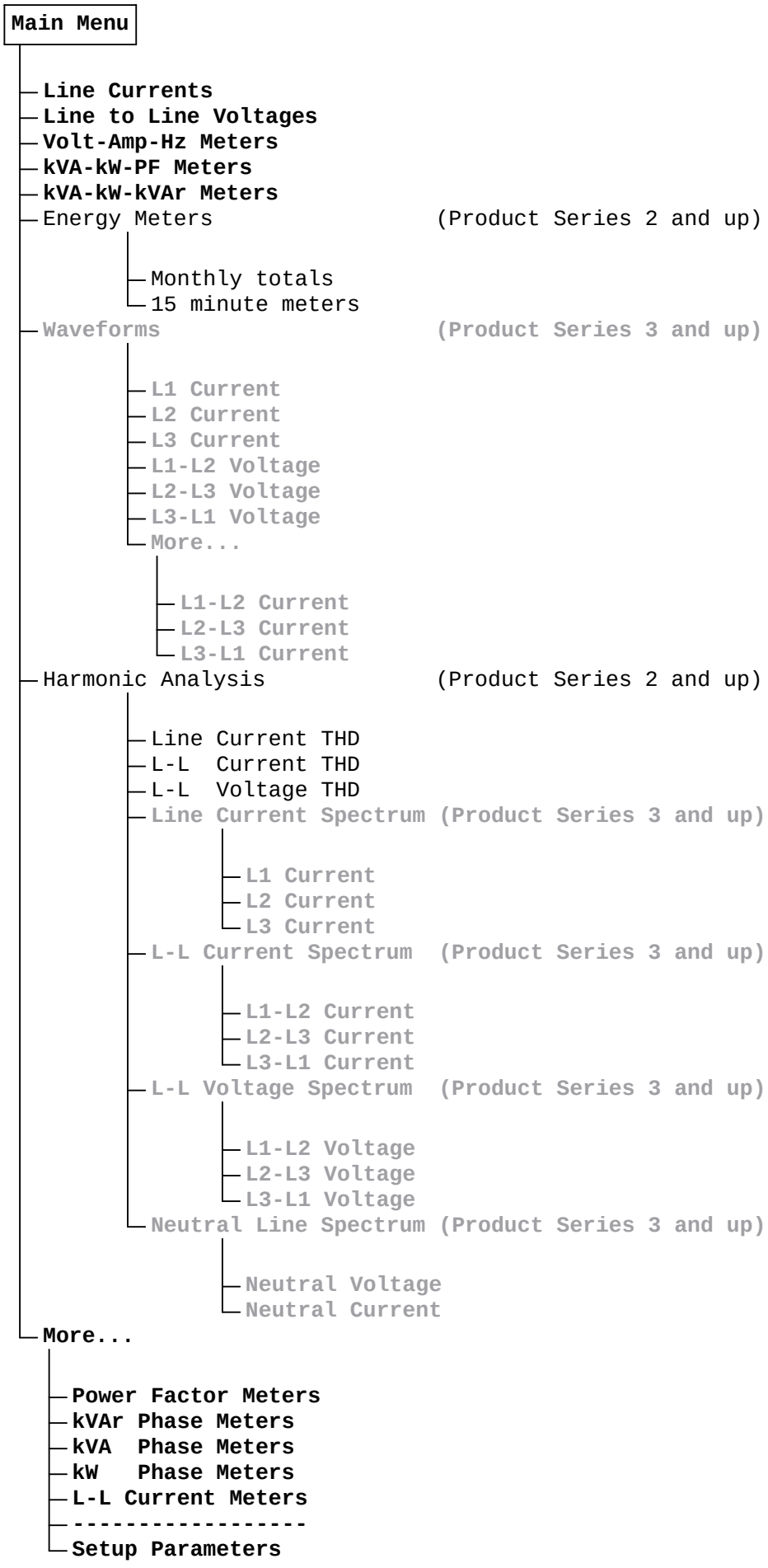
Parameter	Address
CosR1RMS	140
CosS1RMS	142
CosT1RMS	144
CosTot1RMS	146
THDVr	200
THDVs	202
THDVt	204
THDV_max	206
THDVrs	208
THDVst	210
THDVtr	212
THDVV_max	214
THDIr1	220
THDIs1	222
THDIt1	224
THDI1_max	226
THDIr2	230
THDIs2	232
THDIt2	234
THDI2_max	236
VrH1	0x0300
VsH1	0x0400
VtH1	0x0500
VrsH1	0x0600
VstH1	0x0700
VtrH1	0x0800
Ir1H1	0x0900
Is1H1	0x0A00
It1H1	0x0B00
Ir2H1	0x0C00
Is2H1	0x0D00
It2H1	0x0E00

APPENDIX C: DETAILED MENU DESCRIPTION

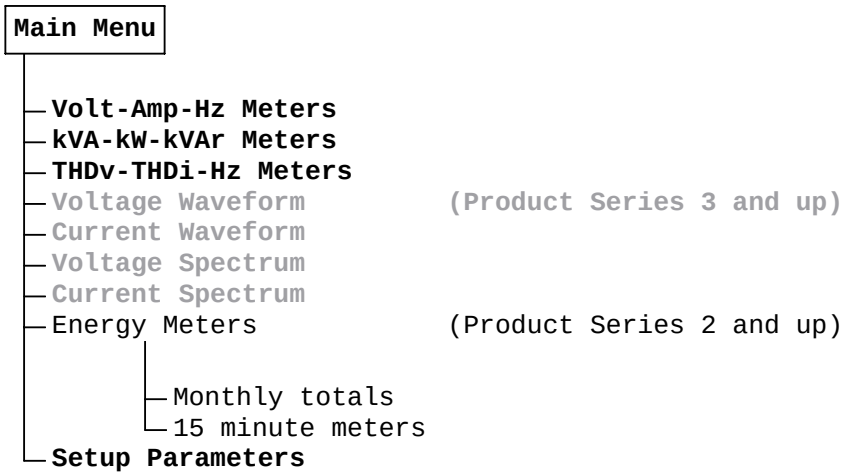
C.1 3-phase WYE configuration



C.2 3-phase DELTA configuration



C.3 Single-Phase configuration



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