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### Installation Considerations

Installation and maintenance of the ASCO 5010 Remote Display Unit should only be performed by qualified, competent personnel that have appropriate training and experience with high voltage and current devices. The meter must be installed in accordance with all Local and National Electrical Codes and regulations.

This equipment has no user serviceable parts.

### Important Symbols Used in This Manual

#### **DANGER**

DANGER is used in this manual to warn of a hazardous situation which, if not avoided, will result in death or serious injury.

#### **WARNING**

WARNING is used in this manual to warn of a hazardous situation which, if not avoided, could result in death or serious injury.

#### **CAUTION**

CAUTION is used in this manual to warn of a hazardous situation which, if not avoided, could result in minor or moderate injury.

#### **NOTICE**

NOTICE is used in this manual to address practices not related to physical injury.

### Acronyms

A	Ampere
CT	Current Transformer
DHCP	Dynamic Host Configuration Protocol
IP	Internet Protocol
OPC	(formerly OLE for Process Control), a series of standards specifications
PF	Power Factor
PoE	Power over Ethernet
PT	Potential Transformer
RDU	Remote Display Unit
SCADA	Supervisory Control and Data Acquisition
SMTP	Simple Mail Transfer Protocol
SNTP	Simple Network Time Protocol
SSL	Secure Sockets Layer
Subnet masking	Local Internet subnet masking determined usually by IP admin
THD	Total Harmonic Distortion

### ASCO Analytics

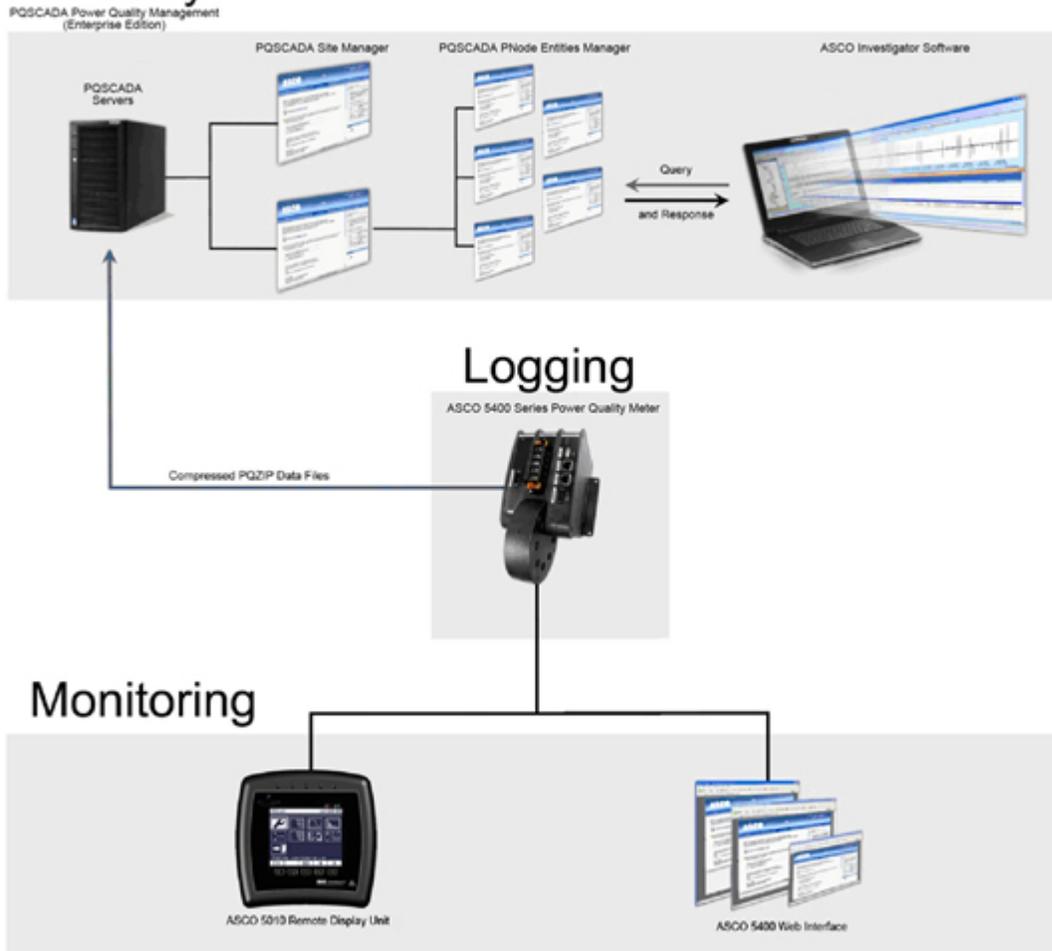


Figure 1: The ASCO 5400 Series Basic Module Unit

## Section 2. Introduction

This manual is the last chapter in a series of seven, and will instruct the user in the installation, configuration and use of the Remote Display Unit to monitor and configure any Power Quality Data Center, using a direct connection or through a LAN/WAN. The seven chapters comprising the ASCO manual set for the Power Quality Data Center series are listed as follows:

1. **ASCO 5400 Series Power Quality Data Center Installation and Wiring Manual-** This manual instructs the user on installing the Power Quality Meter into an electric panel and how to begin using the Power Quality Data Center.
2. **ASCO 5400 Series Power Quality Meter Operation Manual-** This manual describes the interface for monitoring and configuring the ASCO 5400 Series Power Quality Meter using the onboard WEB server as it is accessible from a standard web browser from any PC connected to the Internet (or LAN).
3. **PQSCADA Site Manager Installation Manual-** This manual instructs the user in installing the server based Site Manager Software that will manage the Nodes that will collect, store and analyze the compressed data produced by the ASCO 5400 Series Power Quality Meter.
4. **PQSCADA Site Manager User Manual-** This manual instructs the user in setting up the server based Site Manager with Nodes that will collect, store and analyze the compressed data from the ASCO 5400 Series Power Quality Meter. The manual instructs the user in surfing to the Site Manager, adding and removing Nodes and operating the ASCO Power Quality Reporting Tool.
5. **Investigator Installation Manual-** This manual instructs the user in installing the Investigator software used to access, load and analyze data from different ASCO 5400 Series Power Quality Meters in order to understand the cause for power quality events that occurred in the system.
6. **Investigator User Manual-** This manual instructs the user in the use of the Investigator software to load and analyze data from different ASCO 5400 Series Power Quality Meters in order to understand the cause for power quality events that occurred in the system.
7. **ASCO 5010 Remote Display Installation and Operation Manual-** This manual instructs the user in the installation, configuration and use of the Remote Display to monitor and configure any Power Quality Meter, using a direct connection or through a LAN/WAN.

### 2.1 Overview

The ASCO 5010 LCD Remote Display Unit is an integral part of the ASCO Power Quality Meter system, allowing interconnectivity with the ASCO 5400 Series Power Quality Meter for configuring and monitoring the electrical distribution system.

The ASCO 5010 Remote Display Unit (RDU) connects and communicates with the ASCO 5400 Series Power Quality Meter directly via RJ45 network cable or through IP communication from anywhere in the world. One RDU can be used to monitor and configure many ASCO 5400 Series Power Quality Meters.

The ASCO 5010 RDU enables configuring all aspects of the ASCO 5400 Series Power Quality Meter and displays all monitored real time values. Figure 1 describes the role of the ASCO 5010 RDU in managing power quality data in a power distribution system.

The ASCO 5400 Series Power Quality Meter (1) is connected to the electrical system via current and potential transformers. These instruments constantly record the voltage and current waveforms at a resolution of up to 1024 samples per cycle. This data is compressed on board using the ASCO PQZip technology. The PQZip files are transferred to a PNode (4) running on a server managed by the Site Manager. The PNode stores the data collected from the instrument and responds to requests from client workstations running ASCO Investigator software (5). When an engineer using the Investigator software wishes to analyze the data collected by the instrument from a certain time frame, the PNode decompresses the requested data, performs the necessary mathematical calculations to display the electrical parameters requested by the client and then arranges and configures the data to be displayed on the specific screen used by the client.

Every ASCO 5400 Series Power Quality Meter hosts an onboard Website allowing access to data from any web browser. Inputting the IP address of the instrument in the address window of an internet browser will bring the ASCO 5400 Series webpage to the browser with current real time monitored values (2). Configuration of the ASCO 5400 Series may also be achieved via the Website.

The ASCO IP Address Search Tool (6) is an important element in the ASCO Power Quality Meter System. This utility allows all ASCO 5400 Series Power Quality Meter and ASCO 5010 RDU connected to a LAN to be found and identified on line.

The ASCO 5010 (3) Remote Display LCD is used to both configure and monitor the ASCO 5400 Series Power Quality Meter achieving much the same effect as when using a web browser but with the added tactile feedback only a dedicated LCD display can offer. The ASCO 5010 RDU can be used as a hand held monitoring and configuring tool connecting to each ASCO 5400 Series Power Quality Meter in turn using a CAT 5e/6 network cable with a RJ45 plug, or optionally plugging into a network connection and alternately inputting the IP addresses of the different instruments.

## Section 2. Getting Started

### 2.1 Unpacking

The ASCO 5400 Series Power Quality Data Center is shipped with the following:

#	Description	Quantity	
1	ASCO 5010 LCD Remote Display Unit (RDU)	1	
2	LAN cable	1	
3	ASCO 5010 Display Installation & Operation Manual	1	
4	RS485/422 Communication terminal block connector - BL3.5/4/90LF SW- 4p Black Clamping yoke,	1	
5	48DC terminal block connector - BL3.5/2/90LF SW – 2p Black Clamping yoke	1	
6	Screws for mounting to wall metal plate	2	
7	Flat fastening disk for mounting with screws	2	
8	Screw-nut	2	

## 2.2 Safety Precautions

### **WARNING**

### **NOTICE**

Before working with the ASCO 5010 Remote Display Unit, please read this User Manual carefully. The manufacturer will not be responsible for damage or injury due to misuse.

The following general safety guidelines apply to ASCO 5010 RDU installation and operation. When performing any operation with the ASCO 5010, 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 ASCO 5010 RDU, verify that the 48VDC supply is disconnected.
-  To prevent shock or fire hazard, do not expose the ASCO 5010 RDU to rain or moisture.
-  Do not make unauthorized modifications to the ASCO 5010.
-  Always operate the ASCO 5010 RDU within the specified power tolerances.
-  To use and operate the ASCO 5010 RDU, strictly follow the specifications of this manual. ***The manufacturer will not be responsible for any damage or injury resulting from equipment misuse and/or unsafe work practices.***

### Section 3. Hardware Description

#### 3.1 ASCO 5010 Remote Display Unit Overview

The ASCO 5010 Remote Display Unit shown in Figure 2 can be divided into three conceptual sections. The upper section contains the Status LEDs, the middle section contains the visual interface; a header and the monitor screen and the lower section contains the input interface; 5 Function keys and a Network key.



Figure 2: The ASCO 5010 Remote Display Unit

The Status LEDs indicate as follows:



**Green LED – External power indication**



**Red LED – Failure or indication of incomplete configuration**

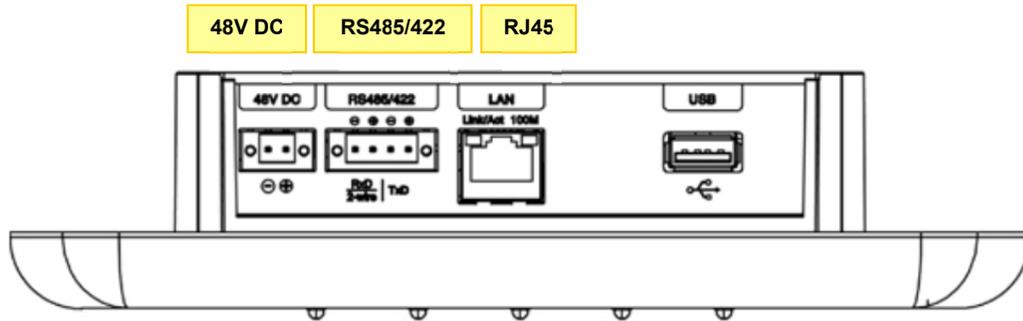
The Header contains the name of the instrument currently connected and the time of day.

The five Function keys are context sensitive, offering dynamic functionality as the unit is used, with the current function appearing above the key.

The Network key is used to disconnect with the current instrument, enabling connectivity with another instrument.

**Figure 3** shows the ASCO 5010 RDU connectors as follows:

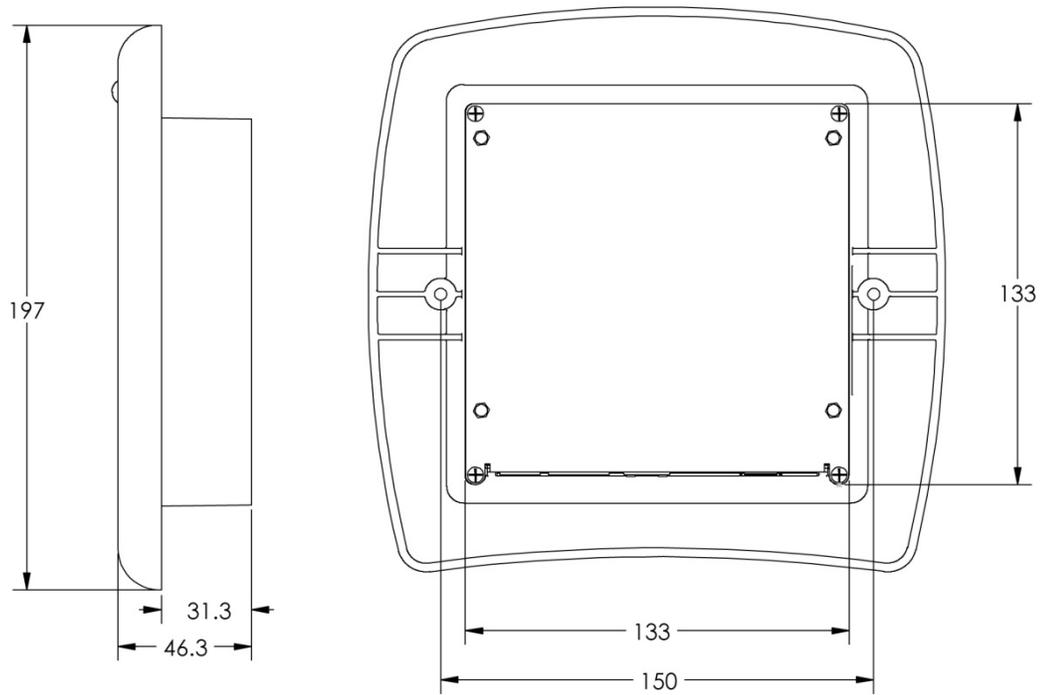
- a. RJ45 – used for both communication & power sourcing the unit (PoE – power over the Ethernet cable coming from ASCO 5400 Series Power Quality Meter). By factory default, the ASCO 5010 RDU is ready for connecting to any ASCO 5400 Series unit at the LCD port. A simple CAT5e/6 cable connecting directly between the ASCO 5010 RDU and ASCO 5450 and 5490 LAN2/LCD port will automatically power up, connect and open the main menu screen relevant for that specific ASCO 5400 Series PQM currently connected. Remote connectivity (through an IP network) is also applicable but requires configuration as described later in this manual.
- b. DC 48V – Used for alternative power source (for remote connectivity when PoE is not available)
- c. RS485/422 – Used in industrial applications for multi-drop series communication when IP networking is not available.



**Figure 3: The ASCO 5010 Remote Display Unit – Rear View**

### 3.2 ASCO Technical and Environmental Specifications

#### 3.2.1 Physical Specifications



**Figure 4: ASCO 5010 RDU - Technical Drawing**

**3.2.1.1 ASCO 5010 Remote Display Specifications**

<b>Dimensions (H×W×D)</b>	197×200×46 mm
<b>Panel cutout:</b>	135×135 mm
<b>Power supply</b>	48 VDC
<b>LAN1</b>	PoE in
<b>LED backlight</b>	160×128 pixels graphic screen

**3.2.2 Environmental Specifications**

<b>Intended use</b>	Indoor- mounted in a low voltage electrical distribution panel
<b>Altitude</b>	Up to 2000 meters
<b>Operating temperature range</b>	-4° to +140° F (-20° to +60° C )
<b>Maximum relative humidity</b>	95%
<b>Power requirements</b>	10 VA
<b>Fuse rating</b>	2 A fuse mounted in line with the AC power supply phase wire
<b>Installation Category</b>	Class III
<b>Pollution Degree</b>	Degree 2

### Section 4. Mounting

The ASCO 5010 Remote Display Unit is designed for mounting on a flat panel through a 138x138mm cutout with two 5mm holes. Two screws are supplied for fixing the display unit to the panel from behind. A typical location for mounting the ASCO 5010 RDU is on the front panel of an electrical distribution panel. Figure 5 and Figure 6 aid in describing the method of attaching the RDU to a panel.

A 138 x138 hole is cut out from the panel and the RDU is slid in to place from in front. The RDU is then fixed in place using two screws from behind.

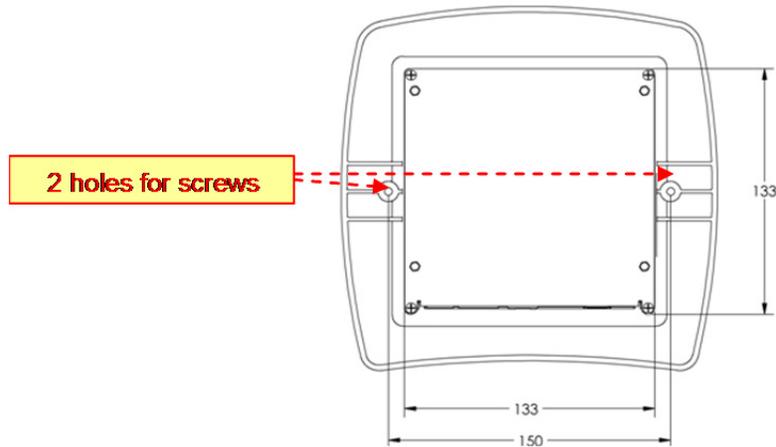


Figure 5: Screw Holes for Affixing RDU to a Panel

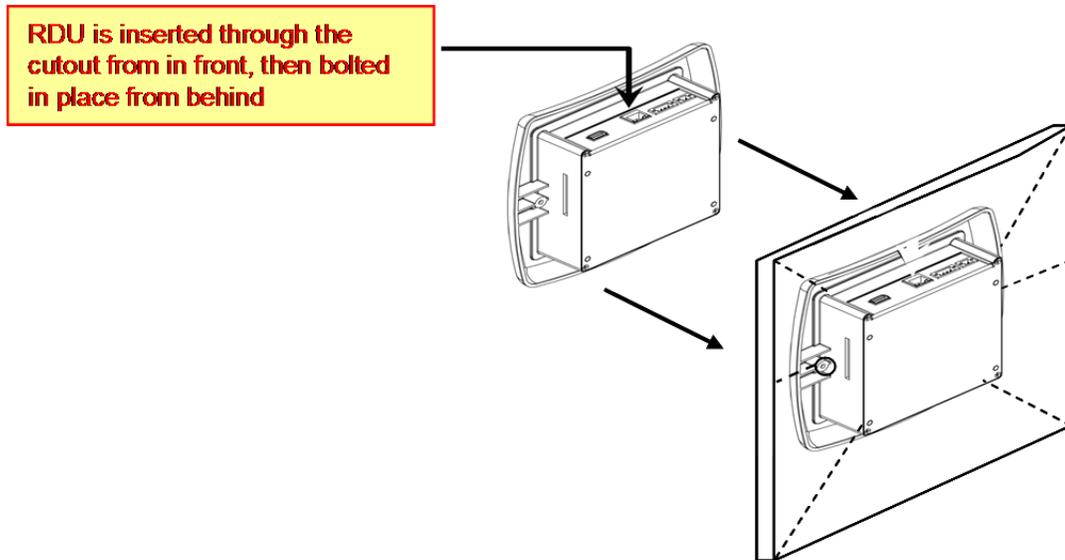


Figure 6: Mounting the Remote Display Device to a Panel

## Section 5. Wiring

### 5.1 Connecting the Power Supply and LAN

The ASCO 5010 Remote Display Unit requires 48V DC to operate. The unit can receive this power from one of two inputs:

1. 48V DC power input terminal
2. The LAN jack using PoE (Power over Ethernet) from the ASCO 5400 Series Power Quality Meter labeled LAN2/LCD.

When both inputs are in use, the primary source of power is from the 48V DC input terminal, with the PoE offering backup redundancy.

### 5.2 Connecting the 48V DC Terminal

For safely connecting 48V DC follow these instructions:

-  Ensure the panel under work is de-energized.
-  Prepare the 48V DC terminal block connector provided with the ASCO 5010 Package
-  Attach lugged ends of wires to the terminal block using a properly sized screw driver
  - ✓ The positive wire is to be attached to the terminal marked +
  - ✓ The negative wire is to be attached to the terminal marked -
-  Insert the 48VDC terminal block into the socket marked "48V DC" as shown above in
- 
- 

### Figure 3.

The ASCO 5010 Remote Display Unit will operate efficiently using a voltage range from 24-51V DC, however only 48V DC may be used through the PoE input (LAN2/LCD socket on the ASCO 5450 and 5490 Power Quality Meters).

### 5.3 Power over Ethernet (PoE)

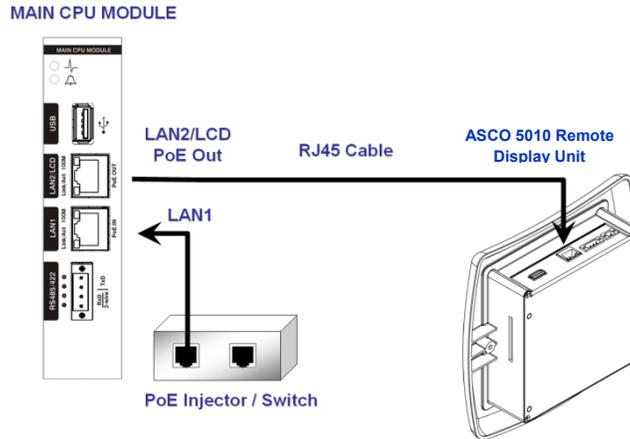
POE is a standard for feeding DC power to an RTU (Remote Terminal Unit) using the network RJ45 cable without the need for additional external power.

The ASCO 5010 contains a single LAN port with support for receiving PoE (In) but not for providing PoE (Out) to other devices.

To take advantage of the PoE option, connect the RJ45 jack to the port marked "LAN2/LCD" on the ASCO 5400 Series Power Quality Meter as shown in Figure 7.

### 5.4 Recommended Mode of LAN Connection for ASCO 5400 Series

It is suggested that the ASCO 5010 RDU be connected to the port marked LAN2/LCD on the ASCO 5450/5490 Power Quality Meter and that the LAN1 port on the 5410 be used to connect to the LAN for communicating PQZip files to the Node on the power quality server.



**Figure 7: Power Over Ethernet PoE Connection**

### 5.5 USB Connection

Follow accepted USB protocol connection procedures.

### 5.6 RS485/422

The RS485/422 serial communications hardware protocol is an industrial standard using 2 or 4 wires for communication. The wires are to be connected to the terminals marked RS485/422 on the ASCO 5010 RDU as shown in **Figure 8** and to the marked terminals on the CPU module of the ASCO 5400 Series Power Quality Meter.



**Figure 8: Terminals for RS485/422 on the Rear Side of the ASCO 5010 RDU**

To enable understanding of the protocol for the purpose of enabling efficient communication, basic elements of the protocol are described here:

- ✓ Voltage is typically 5V DC
- ✓ Cable is comprised of 2 shielded twisted pairs
- ✓ Typical length of cable is < 1000 meter with no repeater
- ✓ Units are connected in multi-drop (“daisy chain”) configuration. In 2 wire mode, the wires coming in and going out share the same terminal on the instrument
- ✓ Shield MUST be grounded, but ONLY at one point in the chain.

## Section 6. Navigating Through the Screens

All ASCO 5010 Remote Display Unit functions are accessible through the 5 function keys located at the bottom of the panel. These function keys are context sensitive and will change functions depending on the screen being viewed. The function performed by the key at any time will be displayed on the Function Key Tag immediately above the function key.



**Figure 9: The ASCO 5010 Remote Display Unit Main Menu**

Figure 9 presents the Main Menu. The chapters of the menu are displayed graphically in the center of the display and described textually just above the function key tags. Navigation is achieved by pressing the function key under the arrows. Entering a chapter is accomplished by pressing the key under the  (F3) symbol. The ASCO 5010 Remote Display Unit displays three distinct types of screens:

- Numeric Display - This type of display emulates an electrical panel power meter display comprising three rows of electrical parameters presented in large digits. Clicking on the appropriate function key toggles through all the electrical parameters and pages of electrical parameter summaries
- Graphic Display - This type of display is used to present waveforms, phasors and harmonics
- Text Display - This type of display is use to display textual information such as reports, alarms and warnings

### **Favorites List**

The Favorites list contains monitored parameters often accessed by the operator. The Favorite parameters most interesting an operator are easily toggled through the F5 key from any measurement screen displaying electrical parameters, as opposed to going back to the previous menu and entering the next page of parameters.

### **Menu Key**

The F4 key is used to get to the main menu from any of the display modes.

### **Help Function**

The Help function is activated by pressing the F1 key where ever the help function is relevant.

### **Cancel and Back Functions**



In order to activate the CANCEL and BACK Functions, use the F2 key. CANCEL will close the menu and will return to the previous display mode, while BACK will close the current submenu and return to the previous menu.

### **Enter, Next, Select and Close Functions**



The F3 key is used for ENTER, NEXT, SELECT or CLOSE. All these functions accept the entered information.

ENTER is also used to open a submenu and to select a menu item.

At the Installation Wizard, NEXT will accept the entered data and move to the next screen. SELECT will toggle between the selected inputs, and CLOSE will accept data and close the page.

### **UP and DOWN Functions**

In most screens the F4 and F5 keys activate the ▲ (up) and ▼ (down) functions. When in a Large Digit screen (see section 9.1.1 on page 35), the Down key will toggle through the "Favorites List".

At the data entry windows, the ▲ (up) button will increment the value by 1, while the ▼ (down) button will decrement the value by 1. Holding the button down continuously will change the value in steps of 10.

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

## Section 7. Basic Configuration

When powered up after being installed into an electrical panel, or powered up by being connected to the ASCO 5450 and 5490 Power Quality Meters via the LAN2/LCD socket, the ASCO 5010 is ready to be configured before being used to configure, set up and monitor a ASCO 5400 Series PQM.

When the LAN and power cables are first connected, the device boots up, first showing the ASCO welcome screen and then arriving at the Connection Configuration page shown in Figure 10, from where the ASCO 5010 RDU can be configured. After a few seconds (configurable- see below "Auto connect page"), the page changes to the ASCO 5400 Series Power Quality Meter's main entry menu page, from where the ASCO 5400 Series PQM is to be configured (Figure 9). To return to the ASCO 5010 RDU configuration page, simply push the Network Key or use the right arrow (▶) and left arrow (◀) to navigate to and select the Log Off  option, that will return to the 'Connection Configuration' page.



**Figure 10: The ASCO Welcome Screen followed by the Connection Configuration Page**

As seen from Figure 10, the Connection Configuration screen displays the following headings:

- IP address: This heading displays the last ASCO 5400 Series Power Quality Meter to which the ASCO 5010 RDU was connected. Entering here allows the user to connect to any ASCO 5400 Series PQM on the network.
- Password: The default password is 123. An administration password is supplied separately by ASCO. From this heading, the administrator may input his password and freely change parameters on the ASCO 5400 Series Power Quality Meter being configured until he presses the Network key or the keypad is idle for 5 minutes. There is no need for any password to change the parameters of the ASCO 5010 RDU from these pages.
- Language: From this screen the user chooses the interface language.
- Configuration: Navigate to this heading using the F4 and F5 keys in order to configure the ASCO 5010 Remote Display Unit with the following options:
  - √ General information- this screen offers the serial number and version information for all software resident in the ASCO 5010 RDU
  - √ Auto connect configuration- In this page the time for presenting the Connection Configuration page is set. After this time, the ASCO 5010 RDU will automatically connect to the last ASCO 5400 Series instrument to which it was connected.
  - √ LCD Contrast- the contrast ratio between black and white for the LCD is set in this screen
  - √ LCD Backlight timeout- this screen allows for setting a time until the backlight extinguishes automatically
  - √ Network configuration- this screen is used to configure the network parameters for the ASCO 5010 Remote Display Unit in order that it may be plugged into the LAN/WAN and communicate with any ASCO 5400 Series anywhere in the world. The parameters that must be configured are as follows (these parameters are explained in section 7.1- Network Parameters- Table 1):

- ◇ DHCP- This value may be toggled ON or OFF. If this parameter is toggled on, then the IP address, Subnet mask and Gateway cannot be configured manually. The ASCO 5010 RDU is factory set with the DHCP set to off, and the network parameters set as defined in the following sections.
- ◇ IP address: The factory default address for the ASCO 5010 RDU is 192.168.168.100
- ◇ Subnet mask: The factory default subnet mask for the ASCO 5010 RDU is 255.255.255.0
- ◇ Gateway: The factory default Gateway for the ASCO 5010 is 192.168.168.168 (which is the default address for the ASCO 5450 and 5490 LAN2/LCD port.
- ◇ NTP address: this is the address for taking the UTC.
- ◇ SMTP address- in the event that this parameter is used by the system.
- √ Firmware upgrade- the ASCO 5010 RDU firmware can be updated from this screen by using the following sub menus:
  - ◇ FTP address- input the FTP address from where the firmware is to be downloaded
  - ◇ FTP login- input the user name required to enter and download from the FTP site
  - ◇ FTP password- input the password required to enter and download from the FTP site
  - ◇ FW filename- input the filename to be downloaded from the site

These procedures will be described and explained in the following sections.

### 7.1 Network Parameters

This section will explain the Network Parameters necessary to enable the configuring and monitoring of the ASCO 5400 Power Quality Meter using the ASCO 5010 Remote Display Unit.

The network parameters are defined in Table 1.

**Table 1: Network Parameters**

No	User network parameter	Definition
1	DHCP Status toggle	DHCP – <a href="#">Dynamic Host Configuration Protocol</a> . ASCO enables 2 run modes: DHCP enable and disable.  DHCP enabled: The ASCO 5400 Series network configuration is automated by the Internet server, the ASCO 5400 Series will not keep user input network parameters; rather the Internet server configures the network parameters automatically.  DHCP disabled: The ASCO 5400 Series network parameters are input by the user, and remain static
	Parameters affecting DHCP disabled	
2	IP address	Internet address of the ASCO 5400 Series Power Quality Meter. Configuring an IP Address for ASCO 5010 RDU – refer to section 7.2
3	Subnet Mask	A local bit mask (set of flags) that specifies which bits of the IP address specify a particular IP network or a host within a sub-network. An IP address of 128.66.12.1 with a subnet mask of 255.255.255.0 specifies host 1 on subnet.128.66.12.0 The subnet mask determines the maximum number of hosts on a sub-network
4	Gateway	A Gateway is a computing node on the local Internet network that allows or controls access to that network.
5	SNTP address	SNTP – Simple Network Time Protocol. A PC server or an ASCO 5400 Series Power Quality Meter can be used as a time reference (UTC). SNTP is a protocol used to reference that time to the local machine. Example: An ASCO 5400 Series Power Quality Meter with IP address <a href="#">100.100.100.69</a> is configured as the NTP address. The ASCO 5400 Series that is being configured by the ASCO 5010 device is IP address <a href="#">100.100.100.63</a> . The configured device will relate to <a href="#">100.100.100.69</a> as the reference UTC server clock. That clock is essential to the generation of coherent PQZIP files.

6	SMTP address	SMTP - Simple Mail Transfer Protocol. Currently not in use. A protocol which controls the transfer of e-mail messages between two mail servers.
---	--------------	---

Table 2, shown below, presents the factory default values for the ASCO 5400 Series Power Quality Meter and the ASCO 5010 RDU.

**Table 2: Factory Default Network Parameters**

No	Parameter	ASCO 5010	ASCO 5450/5490 LAN2/LCD	ASCO 5400 Series LAN1
1	DHCP Status toggle	OFF	OFF	ON
2	IP address	192.168.168.100	192.168.168.168	169.254.249.247
3	Subnet Mask	255.255.255.0	255.255.255.0	255.255.0.0
4	Gateway	192.168.168.168	169.254.249.254	169.254.249.254

**7.2 Changing the ASCO 5010 RDU IP Address**

Changing the IP address of the ASCO 5010 RDU is necessary to connect to a network in order to enable connection to one or more ASCO 5400 Series Power Quality Meter via the network.

Changing the IP address of the ASCO 5010 RDU will disable direct communication via the LAN2/LCD port on the ASCO 5400 Series Power Quality Meter. To re-enable this direct communication requires changing the IP address of the ASCO 5010 RDU back to the factory default of 192.168.168.100 with subnet mask 255.255.255.0

Navigate to the 'Connection Configuration' page, shown in Figure 10 on page 15, by pressing on the Network key or logging off from the main menu:

- ☞ Navigate to the "Configuration" chapter and press enter
- ☞ Navigate to the Network Configuration and press enter
- ☞ Select 'DHCP status toggle' and ensure that the DHCP is disabled. If DHCP is not disabled, then any change to the network IP address will not stay.
- ☞ If the screen asks: "Do you want to enable DHCP?" press X; if the screen asks "Do you want to disable DHCP?" press OK.
- ☞ Select 'IP address' and the following screen will appear:



Navigate between the 4 address elements using the right arrow. Change the address elements using the up and down arrows. Lock in the address by pushing the OK button.

- ☞ Select 'Subnet mask' and change as necessary using the right, up and down arrows
- ☞ Select the 'Gateway' and change as necessary using the right, up and down arrows

## Section 8. Using the ASCO 5010 Remote Display Unit

After the ASCO 5010 Remote Display Unit has been configured, it may be used to configure and display the measured parameters of the ASCO 5400 Series Power Quality Meter. One RDU can be used to configure and monitor a number of ASCO 5400 Series PQM by changing the IP address of the instrument to be monitored.

The setup and configuration procedure of the ASCO 5400 Series instrument includes:

- ASCO 5400 Series Unit setup:
  - √ Administration authorization
  - √ Site name
  - √ Operator name
  - √ Site description.
- Electrical system parameters:
  - √ Phase configuration (Y,  $\Delta$ )
  - √ Nominal values (V, I, f)
  - √ CT/PT ratios (Configuring these parameters must not precede the configuration of the Nominal values)
  - √ Polarity of input waveforms (normal/reverse)
- Network setup
  - √ Assign IP address
  - √ other internet relevant configuration parameters
- Firmware upgrade

These procedures will be described and explained in the following sections.

### 8.1 Connecting for the First Time

Connecting to the ASCO 5400 Series Power Quality Meter with the ASCO 5010 Remote Display Unit is accomplished differently depending on the manner in which the connection is made, and the purpose of the connection.

Connecting a ASCO 5010 RDU as a static display for a single ASCO 5400 Series PQM requires less configuration than connecting a single ASCO 5010 unit to multiple ASCO 5400 Series PQM's over the internet, though this configuration is not overly complicated requiring only a basic understanding of IP addressing and system parameters from the LAN administrator.

When attempting to make changes to the ASCO 5400 Series configuration, the user will be asked to enter an administrative password.

### 8.1.1 Admin Access Privilege

Modifying setup parameters requires administrative or Admin authorization. When the user attempts to modify the first parameter, an access level modification page will appear:



Pressing on X will return to the previous menu, pressing OK will bring up the Admin authorization page:



Delete the default user password, 123, by navigating to the "Del" key and pressing SELECT three times. Enter the password supplied by ASCO to authorize Admin level access by using the arrows to navigate to each character of the password and pressing SELECT. When the whole password is displayed on the screen, press OK. The previous configuration screen will appear, with "write" authorization.

## 8.2 Connecting and Communicating

### 8.2.1 Connecting a Single ASCO 5010 RDU to a Single ASCO 5400 Series Power Quality Meter

If the ASCO 5010 RDU is to be used as a permanent display for a single ASCO 5400 Series Power Quality Meter, the connection is made simply from the ASCO 5010 RDU port to the ASCO 5400 Series LAN2/LCD port using a regular LAN Cat5e/6 cable with RJ45 plugs on both ends. No configuring is necessary; the communication is "plug and play". Both the ASCO 5400 Series and the ASCO 5010 RDU are factory programmed with default IP addresses and subnet masks to enable immediate communication between them. These default values are listed in Table 1 on page 16.

### 8.2.2 Using the ASCO 5010 RDU for the ASCO 5400 Series Power Quality Meter LAN Configuration Before Initialization

If the ASCO 5010 is to be used to configure an ASCO 5400 Series Power Quality Meter offline before connecting to a LAN, the factory defaults can be used to enhance the communication configuration task.

- ☞ Before allowing connection to the LAN, connect the ASCO 5010 RDU to the LAN2/LCD port on the ASCO 5450 and 5490 Power Quality Meter

- Due to the plug and play feature, the Main menu appears allowing configuration of all ASCO 5400 Series Power Quality Meter parameters including the network parameters:



- Navigate to System configuration using right (▶) and left (◀) and then  (select-F3):



- Navigate to System information (i) using right (▶) and left (◀) and then  (select-F3):

- Navigate to Network information using the ▲ (up) and ▼ (down) and then  (select-F3):



- ☞ Navigate to DHCP status toggle using the ▲ (up) and ▼ (down) and then  (select-F3):



The following screen appears:



- ☞ Press F3 (OK) to disable DHCP. This is in order to allow the configuring of prepared and previously mapped IP addresses manually in the following steps. If the DHCP is not disabled, the manually input address will not remain, since the enabled DHCP will allocate random IP addresses, subnet masks, and gateways.
- ☞ Navigate to the IP address using the ▲ (up) and ▼ (down) and then  (select-F3):



- ☞ Use the right (▶) to navigate between the groups and the ▲ (up) and ▼ (down) to increase and decrease the value of the group. Press OK (F3) when the IP address is complete.
- ☞ Repeat the previous steps for the Subnet mask and the Gateway.

When the IP address, subnet mask and gateway are configured, the ASCO 5400 Series Power Quality Meter can be connected to the network from the LAN1 port, and the ASCO 5010 RDU can be used from any network port to communicate, monitor and configure the ASCO 5400 Series via the LAN1 port now configured and mapped by the administrator.

### 8.2.3 Using the ASCO 5010 RDU for ASCO 5400 Series Configuration across a LAN

If a number of ASCO 5400 Series Power Quality Meters are installed and connected to the LAN before Network parameters are configured, the Network Server will automatically allocate IP addresses, subnet masks and gateways to these instruments, since the ASCO 5400 Series Power Quality Meter ships from the factory with DHCP enabled.

In order to configure and monitor the ASCO 5400 Series Power Quality Meter using the ASCO 5010 RDU across a LAN, the IP address for the ASCO 5400 Series PQM must be input to the RDU. Since the Network Server randomly allocated addresses to each ASCO 5400 Series PQM, the IP address for the ASCO 5400 Series PQM may not be readily available. For this purpose, ASCO supplies an Automatic Search Utility to find and list all ASCO devices, ASCO 5010 RDU and ASCO 5400 Series, across a LAN. The Automatic Search Utility is described in section 8.3 on page 24.

Once a list of ASCO 5400 Series Power Quality Meters is compiled, it is possible to plug the ASCO 5010 RDU into a network port and to configure and monitor these instruments one by one as follows:

- ☞ Change the IP address of the ASCO 5010 RDU by following the directions in section 7.2 on page 17.
- ☞ Press on the Network Key to arrive at the Connection Configuration screen:



- ☞ Navigate to the IP address Field and press Enter. A list of previously visited ASCO 5400 Series instruments will appear:



- One of the displayed instruments can be chosen by navigating to the instrument and pressing Select, or a new instrument can be added by pressing ADD:



- Input the new IP address using the right arrow to move between groups and the up and down arrows to increment and decrement the value of the group.
- Press OK and the 'Add a Name' screen appears:



- Input a name by choosing letters via the left and right arrows for navigation and the Select (F1) key for inserting. When the name is complete, press OK (F3)
- After pressing OK, the instrument list appears again with the new added instrument. Navigate to the new instrument and press on Select (F3).
- The Connection configuration Screen appears again, navigate to 'connect' and press Enter (F3).

The ASCO 5010 RDU and the ASCO 5400 Series PQM are now communicating and configuration and monitoring of the ASCO 5400 Series can continue.

### 8.3 Automatic Search Utility

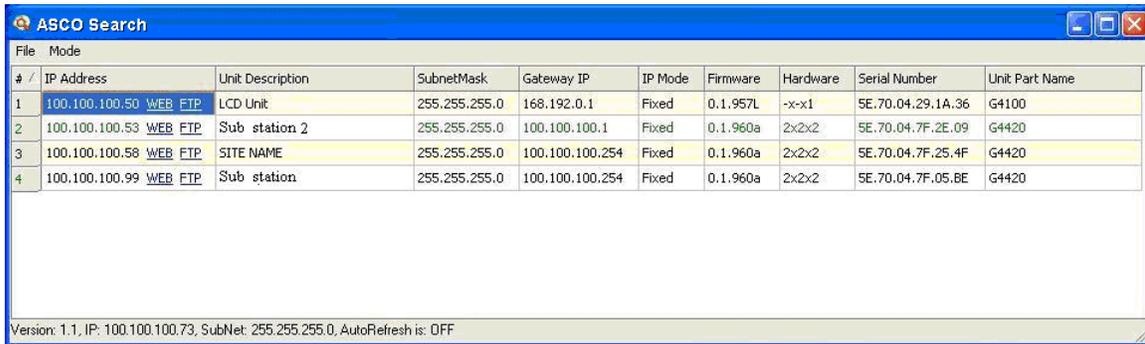
One of the applications of the ASCO 5010 Remote Display Unit is to plug into a network outlet in a LAN and to communicate with any ASCO 5400 Series Power Quality Meter on the network. It could come to pass that the IP addresses for one or more of the ASCO 5400 Series PQM may become unknown. Since knowing the address of the target ASCO 5400 Series PQM is necessary for communicating with the instrument, ASCO supplies a PC search utility that automatically finds the ASCO 5400 Series and ASCO 5010 Display on the LAN.

The utility is an executable file requiring no installation named: "ASCOSearch.exe" and connects through WEB browser or FTP.

The utility is located on the CD packaged with the ASCO 5400 Series Power Quality Meter or contact [CustomerCare@asco.com](mailto:CustomerCare@asco.com). A simple double click on the file name launches the utility.

Figure 11 shows the user interface. Functionality includes:

- Search
- Refresh
- Export to Excel spread sheet



**Figure 11: The ASCO Search Utility for Finding ASCO Elements on the LAN**

**NOTICE**

*The Utility broadcasts "Discovery" transmissions over the LAN to which every unit responds with its configuration. The search cannot extend beyond the LAN area. The broadcast will extend across most hubs and switches, but will not pass gateways, routers or firewalls.*

**8.3.1 Using the Search Utility**

After copying the utility from the CD or downloading from [CustomerCare@ASCO.com](mailto:CustomerCare@ASCO.com), double click on the file name (or tool icon if the program was equipped with one).

1. From the File menu, select "Refresh List" to identify all device IPs on the network
2. From the Mode menu, choose between AutoRefresh ON and OFF.

**8.4 Setup Menus**

This section will describe the various Menus necessary to configure the electrical parameters of the ASCO 5400 Series Power Quality Meter. The first section will introduce the menu structure after which the parameters will be explained.

### 8.4.1 The Setup Menu Screens

This section will describe the setup menus. From the main menu:



Press on the  to enter the Configuration sub menu:



This screen offers two menus, the  is the configuration menu and the (i) is an information menu. Press on the  once more to enter the 2 page Configuration menu:



**Figure 12: The Two Page Configuration Menu**

Press on the (i) to enter the information menu as displayed in Figure 13. The Information page allows unlimited access to read the parameters configured in the previous  menu without requiring an administrative password. The Information pages are equipped with an Edit button allowing parameter changes to be made from this Information page without having to exit the page and entering the Configuration page. Pushing the Edit button in the Information mode will, however, trigger the access level modification page.



Figure 13: The Information Page

All the pages available for viewing from the Information page are configured in the configuration menu except for one page-General Information. This page displays the version numbers for the elements of the ASCO 5400 Series Power Quality Meter as shown in Figure 14.



Figure 14: Read-only "About" Information

### 8.4.2 The Setup Menu Parameters Explained

- **Site Setup:** This page is used to define the site where the instrument is installed. Information available for input includes:
  - √ Site name
  - √ Operator name
  - √ Site description
- **Power Configuration:** This page is used to input the type of electrical distribution system. The configurations available include:
  - √ Single line-neutral
  - √ WYE 4 wires
  - √ Single line-line
  - √ Delta (WYE) 3 wires

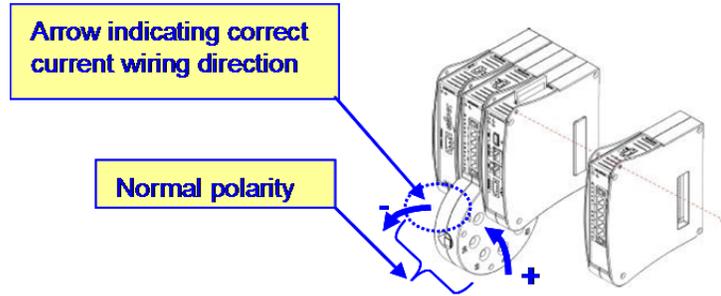
These wiring configurations are explained in the manual accompanying the ASCO 5400 Series Power Quality Meter.

- **Display Formats:** This page allows the user to configure the terminology used by the ASCO 5400 Series Power Quality Meter to fit local terminology. The interface supports changing between naming conventions for naming phases and describing reactive behavior:
  - √ Phase nomenclature:
    - ◇ 123
    - ◇ ABC
    - ◇ RST
    - ◇ XYZ
    - ◇ RYB
    - ◇ RWB
  - √ Reactive behavior:
    - ◇ Cap/Ind (Capacitive or Inductive)
    - ◇ LD/LG (Lead or Lag)
- **Polarity Configuration:** This page allows for the mathematical (software) reversal of the current flow through the ASCO 5400 Series Power Quality Meter.

Both current direction and voltage polarity is a matter of importance in measuring electrical parameters. The ASCO 5400 Series Power Quality Meter must be installed properly with the current transformer wires directed correctly through the instrument as shown in Figure 15. When this is not the case, it is possible to configure the instrument through the software to reverse the direction mathematically.

The user can identify instances where the polarity is not acceptable through the following signs:

- √ The power factor deviates strongly from the expected range
- √ Negative power factors coexist with positive power factors dispersed between the three phases
- √ Values for one phase or more are exceptionally low
- √ The phasor diagrams for voltage are not the anticipated 0°, 120° and 240°



**Figure 15: Current transformer conductor inserted correctly through the ASCO 5400 Series Power Quality Meter**

- Nominal values:** This page allows the user to input the nominal values necessary for internal calculations and for comparison purposes in calculating power quality compliance to the EN50160 standard. Nominal values are to be input only after configuring PT/CT ratios. The nominal values to be input are:
  - √ Frequency- 50 or 60 Hz
  - √ Voltage- Phase to phase value
  - √ Current- Phase to neutral
- PT/CT Configuration:** This page accepts the required transformation values for measuring the electrical system. The ASCO 5400 Series Power Quality Meter can monitor all AC voltages and all currents. This is achieved by using measuring transformers. The CT or Current Transformer is comprised of a coil fitted around the current carrying conductor with the secondary conductors designed to carry no more than 5 amperes (in some cases 1 ampere secondary conductors are used). A CT designed for a 500A load with a 5A secondary will have a CT ratio of 500:5. The PT or Potential Transformer operates under a parallel methodology; a voltage transformer is designed to transform the rated network voltage to a secondary output with a typical value of 110V. For example, a PT for a 22000V network will have a PT ratio of 22000:110.

Figure 15 illustrates the interface. Each value has a separate page. PT phase primary is input on its own page, as is the PT phase secondary. The ASCO 5400 Series supports different inputs for the phase and for the neutral lines.



**Figure 16: PT/CT Settings- inputting the Primary PT Value**

NOTE: When the PT/CT ratio is modified, the ASCO 5400 Series automatically recalculates the nominal values for voltage and current and replaces the existing values. Therefore, nominal values must be input only after PT/CT values.

- **Reset counters:** The ASCO 5400 Series Power Quality Meter stores extreme values for selected parameters. This page allows the user to reset these values. The parameters for resetting are:
  - √ Current and voltage Min/Max
  - √ Flickering Min/Max
  - √ Energy demand
  - √ Energy
  - √ Compliance (EN50160)
  - √ System event logger (not recommended)
- **Network Setup:** This page is used to define the network parameters. The relevant network parameters are explained in Table 1 on page 16. When accessing an energized ASCO 5010 RDU, the network parameters referred to are those of the LAN1 socket of the ASCO 5400 Series Power Quality Meter to which it is connected. For more on accessing and configuring both the ASCO 5010 RDU and the ASCO 5400 Series PQM, go to 7.2 and 8.2 respectively.
- **Auto connect page:** This parameter is the time it takes for the ASCO 5010 RDU to switch automatically from the 'Connection Configuration' page where network parameters for the RDU itself may be configured (see Section 7) to the Network Menu, where the network parameters for the last connected ASCO 5400 Series Power Quality Meter are changed (see Section 8.2).
- **Auto logoff configuration:** This parameter sets the time to log off automatically after the last button was pushed.
- **Password configuration:** This is where the access control takes place, allowing modification to viewer, user and admin passwords.
- **Set demand and energy intervals:** This page allows the user to determine the demand and energy demand intervals.
- **Set metering energy time:** Not currently in use.
- **Set time zone:** The user must input the local offset to UTC (Greenwich Mean Time).
- **Set regional settings:** Not currently in use.
- **Set averaging intervals:** This parameter allows the user to input an interval time for averaging the RMS values that appear on the screen, this is to avoid an illegible display due to overly frequent display update. Default value is 30 seconds.
- **Firmware update:** This submenu enables updating firmware of the ASCO 5400 Series Power Quality Meter.

## 8.5 PQZip Setup

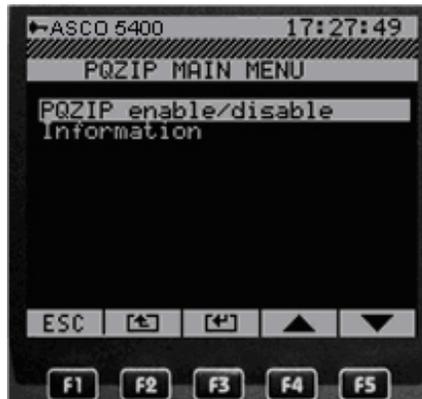
PQZip is the ASCO patent that enables total power quality information. Instead of proactively setting triggers to capture and photograph the waveform of a power quality event that may or may not happen again, and may or may not be of the expected magnitude according to which the trigger was set, PQZip enables the ASCO 5400 Series Power Quality Meter to constantly record the waveform at a high resolution. This is possible due to the high compression ratio achieved by PQZip. Depending on the electrical system being monitored, compression ratios as high as 1:1000 and even 1:10000 are achieved.

### 8.5.1 Enabling PQZip

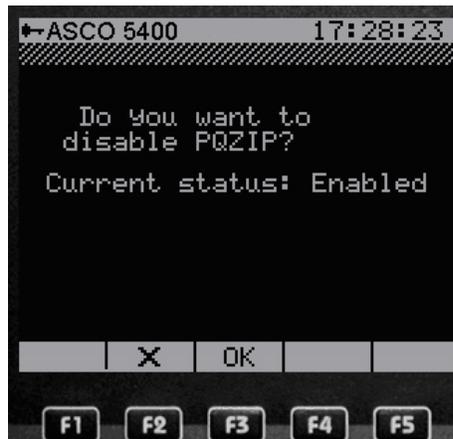
After all electrical system and communication network parameters have been configured it is necessary to enable the PQZip compression software before the instrument begins recording. Without enabling PQZip, the instrument monitors but does not record. To enable PQZip, navigate to the PQZip button on the main menu:



Press the  button and arrive at the PQZip main menu:



Navigate to PQZip enable/disable and press on Press the  button:



Press OK to enable/disable PQZip.

### 8.5.2 PQZip Information

The PQZip information page is read only and offers pertinent information on the current status of PQZip. The page is reached by choosing "Information" from the PQZip Main Menu shown above in section 8.5.1 and pressing on the  button. The Information page appears:



The following information is offered by the Information menu

- PQZip State: enable/disable
- Free Disk Space: this refers to the free disk space available on the ASCO 5400 Series Power Quality Meter
- Compression Mode: there are two modes of compression:
  - √ Fixed quality- the resolution is set according to the accuracy desired; this being a function of the measuring accessories. If the CTs and PTs are of a specific accuracy, it is not necessary to save to the highest resolution.
  - √ Fixed rate- in this mode, the user sets the amount of memory to be used per unit time, and the instrument sets the resolution accordingly
- Current Session: Debugging information
- Current File name: the name of the file currently being written by PQZip
- Current Tolerance: This is the percentage of data compression

## Section 9. Monitoring

The ASCO 5010 Remote Display Unit is used for configuring and monitoring the ASCO 5400 Series Power Quality Meter. This section will describe and instruct on monitoring the ASCO 5400 Series Power Quality Meter using the ASCO 5010 RDU.

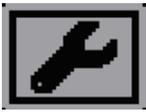
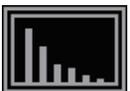
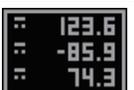
The default start up menu when powering up the ASCO 5010 RDU is the Main Menu shown in Figure 17. This menu is comprised of icons pointing to the monitoring and configuration sub menus. Navigation between the icons is accomplished using the navigation buttons as explained in Section 6 on page 13. When an icon is reached using the navigation buttons, an explanatory description appears just above the function key tabs. For example, in Figure 17, the first icon from the upper left is activated, and its name, "System Configuration" appears above the function key tabs. Table 3 explains each icon and what it accesses.

The following sections will describe the monitoring screens.



Figure 17: The Main Menu- Default on Power Up

Table 3: Main Menu Icon Key

Icon	Menu Name	Functionality
	System configuration	Enter the configuration sub menus. See 8.4.1 on page 26
	Meters	Enter the metering sub menus: Voltage, current, powers, and other electrical parameters of interest
	Oscilloscope	Enter the voltage and current waveform sub menu
	Harmonics display	Enter the voltage and current harmonics sub menu
	Phasors display	Enter the voltage and current phasor page
	Energy measurement	Enter the Energy sub menu

Icon	Menu Name	Functionality
	PQZip Information	Enter the PQZIP sub menu
	Flickering information	Enter the Flicker-meter sub menu
	Logoff	Logoff from the Main menu

### 9.1 Meters

This menu, when entered, is labeled the Large Digits Menu and lists the displays available for presentation on the ASCO 5010 Remote Display Unit. These displays are the real time RMS values of measured parameters that are required by electricians and engineers on a day to day basis.

Upon entering the Meters icon, the following menu appears:



The pages available are explained as follows:

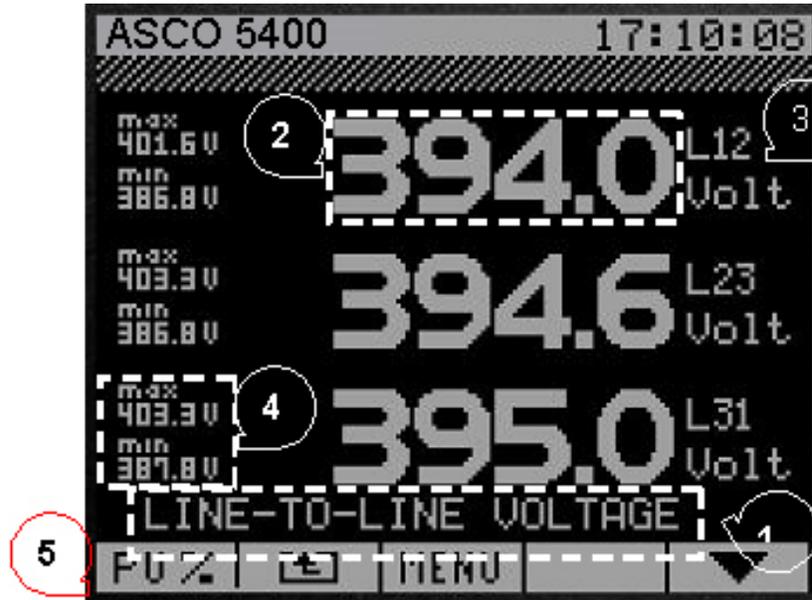
No.	Sub menu name	Functionality
1	Power Totals	Displays the sum of 3 phases: Active, Reactive and Apparent powers
2	Volt-Ampere-PF	Displays an average of the 3 phases for voltage and current, and system PF
3	Line-to-Line voltages	Displays phase to phase voltages
4	Line currents	Displays phase currents
5	Factors summary	Displays crest and K factors
6	Volt/Ampere summary	Displays a page of voltage and current values including: L-L and L-N voltages, Neutral-Ground voltage, Unbalanced voltage(%), Current, Average of phase currents, Neutral current, Unbalanced current(%), Phase order and Frequency
7	Power summary	Displays a page of power values including phase and total values for Active, Reactive and Apparent power, as well as Power Factor for each phase and the system (average) power factor
8	THD summary	Displays THD values for each phase in voltage (L-L and L-N) and current, as well as THD values for the neutral conductor

**9.1.1 Meters- Large Digit Display**

A typical Large Digits page is arranged to display pertinent data for the selected electrical parameter in an efficient manner. Figure 18 represents an example of the Large Digits display, in this case Line to Line voltages are displayed. This type of display is used for most of the Meter menu and much of the Energy Measurement menu.

Table 4 explains the various displayed fields.

The Down arrow- F5- will toggle the other Large Digit pages, producing the Favorite list.



**Figure 18: Large Digits Display- A Typical Page Layout**

**Table 4: Displayed Page Elements**

No.	Element
1	The Parameter being measured
2	Measured value
3	Units of the measured value
4	Minimum and Maximum values
5	Toggle between empirical and % Per Unit Values

Table 4 is further explained as follows:

1. This field is used in the following pages for these measured parameters:
  - √ Power Totals show:
    - ◇ Apparent power in KVA or PU
    - ◇ Active power in KW or PU
    - ◇ Reactive power in KVA<sub>r</sub> or PU
  - √ Volt-Ampere-PF shows:
    - ◇ The average voltage of the three phases in volts or PU
    - ◇ The average current of the three phases in amperes or PU

- ◇ The System or average power factor with Lag/Lead (Cap/Ind)
  - √ Line to Line Voltage shows:
    - ◇ Voltage L1/L2 in volts or PU
    - ◇ Voltage L2/L3 in volts or PU
    - ◇ Voltage L3/L1 in volts or PU
  - √ Line Currents show:
    - ◇ Current Line 1 in amperes or PU
    - ◇ Current Line 2 in amperes or PU
    - ◇ Current Line 3 in amperes or PU
2. This is the Large Digit- the actual measured real time RMS value. In fact, the value displayed is an average of previous number of measurements. Since the ASCO 5400 Series Power Quality Meter calculates the RMS value for each cycle, it is not practical to display every value measured. The amount of cycles averaged for display is configurable.
  3. The measured value is displayed along with the element measured, for example line to line voltage as opposed to line to neutral voltage or line current.
  4. Extreme values- minimum and maximum values- are constantly replaced as new values are generated. These values will continue to increase or decrease until they are reset by the user.
  5. This key (F1) is used to toggle between the actual empirical measured value, volts or amperes, for example, and Per Unit values. The PU value is the percentage of the base value defined by the Nominal Values input as explained in section 8.4.2.

9.1.2 Meters- The Summary Pages

The last 4 meters listed on the Large Digits meter page are summaries. The following figures display the screens in the order of their appearance.



Figure 19: The Factors Summary Page: K-factor and Crest Factor



Figure 20: Volt/Amp Summary



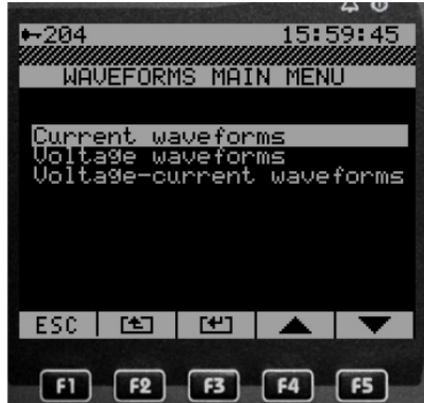
Figure 21: The Power Summary Page



Figure 22: The THD Summary Page

## 9.2 Oscilloscope

The Oscilloscope page allows the user to see the real time current and voltage wave forms. Upon entering the Waveforms Main Menu, as shown in Figure 23, the user can select to view current, voltage or both current and voltage waveforms together on the same screen.



**Figure 23: Waveforms Main Menu**

From the Waveforms Main Menu the submenus are:

- Current waveforms
  - √ L1 Current waveform
  - √ L2 Current waveform
  - √ L3 Current waveform
  - √ L1+L2+L3 Current waveforms
- Voltage waveforms
  - √ L1 Voltage waveform
  - √ L2 Voltage waveform
  - √ L3 Voltage waveform
  - √ L1+L2+L3 Voltage waveforms
  - √ L1-L2 Voltage waveform
  - √ L2-L3 Voltage waveform
  - √ L3-L1 Voltage waveform
  - √ L12+L23+L31 Voltages
- Voltage + Current waveforms
  - √ L1 voltage + current
  - √ L2 voltage + current
  - √ L3 voltage + current
  - √ Neutral voltage + current

### 9.2.1 Navigating the Oscilloscope

The Oscilloscope screen shown in Figure 24 as an example for navigating the screen is the L1 voltage + current page.

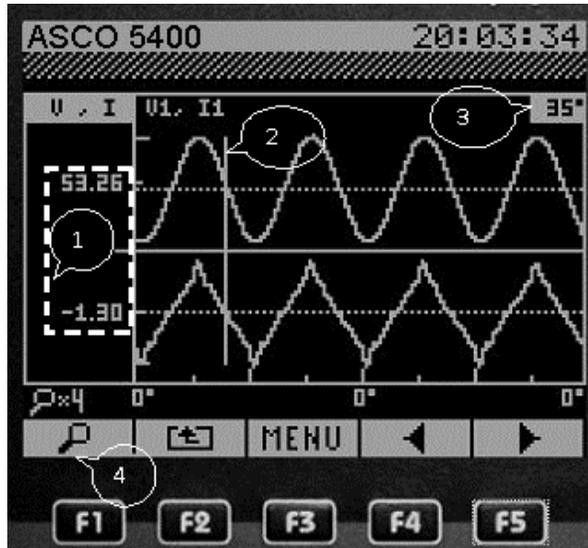


Figure 24: Navigating the Oscilloscope

No.	Element
1	These are the values of the voltage and current at the position ruler (#2)
2	The position ruler; allows observation of simultaneous voltage and current. The ruler is moved left and right using the F4 and F5 arrows. The ruler remains in the same position when moving from screen to screen.
3	The position in degrees from the origin of the sine cycle
4	Pushing on the magnifying glass key increases the cycles presented in the screen. x4 implies 4 cycles presented in the screen.

### 9.3 Harmonics Display

The Harmonics Display allows the user to examine the harmonic breakdown of each measured waveform.

From the Main menu, navigate to the harmonics icon and press Enter:



From this submenu, the Current harmonic spectrums that may be chosen are:

- ✓ L1 current
- ✓ L2 current
- ✓ L3 current

The Voltage harmonic spectrums that may be chosen are:

- ✓ L1-L2 voltage
- ✓ L2-L3 voltage
- ✓ L3-L1 voltage
- ✓ L1 voltage
- ✓ L2 voltage
- ✓ L3 voltage

Figure 25 models a typical Harmonics Analysis screen as it is described in the table below.

No.	Element
1	These are the values of the Harmonic pointed out by the arrow (#3). H5- the 5 <sup>th</sup> Harmonic; the amplitude is 3.14 amperes; it composes 6.1% of the fundamental current; the frequency is 250 Hz and it is in phase at -174°
2	The magnifier expands the harmonics. x1 shows the first 31 harmonics; x2 shows up to 63 harmonics; and x3 shows up to 120 harmonics
3	This arrow points to the harmonic explained in #1. It is manipulated with the right an left arrows (F4 and F5)
4	The Screen label- Current Line 1
5	These bar graphs portray the relative value of each harmonic to the fundamental.

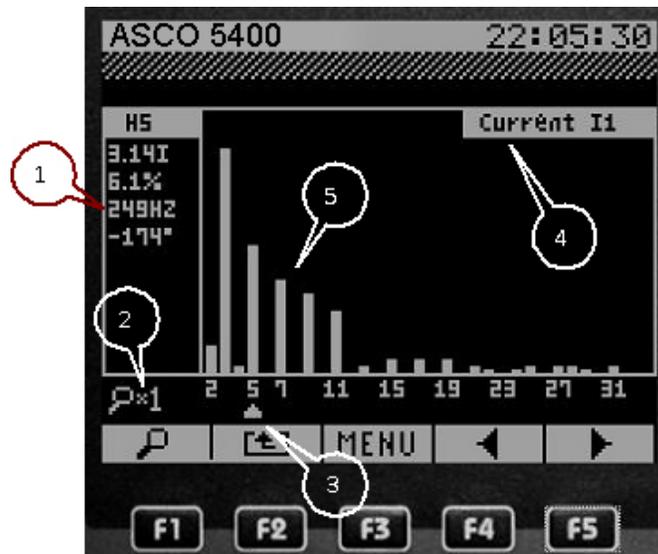


Figure 25: A Harmonic Spectrum Screen

### 9.4 Phasor Display

The Phasor Display is a powerful tool for both ensuring correct installation and as a simple graphic device to act as an alarm for failed power correction equipment.

As seen in Figure 26, the screen is divided in two. On the left side of the screen are the RMS values and their angles from the origin of the sine cycle. On the right side of the screen is the graphic representation of the voltage and current vectors. The base value from which all the others are compared is the Line-Neutral voltage input on V1. Neutral voltage is referenced to ground.



Figure 26: The Phasor Display

The phasor diagram is useful for diagnosing incorrect installation.

- If the three voltages are not arranged at 0°, 120°, and -120°, the voltage polarity may not be correct.
- If the phase angles of the currents are not as would be expected the following possibilities should be checked:
  - √ Current polarity
  - √ Miss match between voltage and current

### 9.5 Flicker Measurement

Flicker is a cyclic or quasi-cyclic RMS voltage fluctuation whereby the RMS voltage fluctuates 0.25-4% of nominal voltage at a frequency in the range of 0.4-25 Hz. This type of disturbance has been historically defined as causing distress to workers due to flickering lighting.

The EN50160 defines two types of calculations for arriving at values to be considered unacceptable to human perception of flickering light due to voltage flickering. P<sub>ST</sub> (Perceptivity- short time) is a calculation over a period of 10 minutes, and P<sub>LT</sub> (Perceptivity- long time) is calculated from 12 consecutive values of P<sub>ST</sub>, for a 2 hour averaged value.

ASCO has developed algorithms that approximate the EN50160 values, but in a fraction of the time. The ASCO calculation named Real-time PST is the same as the EN50160 P<sub>ST</sub> calculation, but is averaged over a period of 2, 10 and 60 seconds as opposed to 10 minutes. Similarly, ASCO offers long time values of 1, 10 and 24 hours, as well as a 7 day long time value in addition to the EN50160 two hour value for P<sub>LT</sub>.

The ASCO 5010 RDU displays the EN50160 values of P<sub>ST</sub> and P<sub>LT</sub> as well as the ASCO Real-time P<sub>ST</sub> of 2 seconds and ASCO P<sub>LT</sub> values of 10 hours and 10 days, as shown in the Flickering Measurement screen shown below.

Selecting and entering the screens in the menu will produce a Large Digit Display as explained in section 9.1.1 portrayed in Figure 18 on page 35, or a summary as described below.



The parameters displayed in Large Digit Display include the following:

- The ASCO Real Time  $P_{ST}$
- EN50160 Flickering  $P_{ST}$
- EN50160 Flickering  $P_{LT}$

Two summaries are also available, the Flickering Summary shown in Figure 27 and a detailed summary.

	250C	10min	2H	10H	7D
(U1)	0.580	0.587	0.356	0.350	0.000
(U2)	0.584	0.586	0.361	0.346	0.000
(U3)	0.644	0.588	0.360	0.347	0.000
(U12)	0.606	0.577	0.352	0.342	0.000
(U23)	0.585	0.575	0.355	0.343	0.000
(U31)	0.592	0.582	0.355	0.348	0.000

Figure 27: The Flickering Summary

The Detailed summary is organized by voltage type, as shown below. When the voltage type is selected, the detailed summary is displayed, as shown in Figure 28.

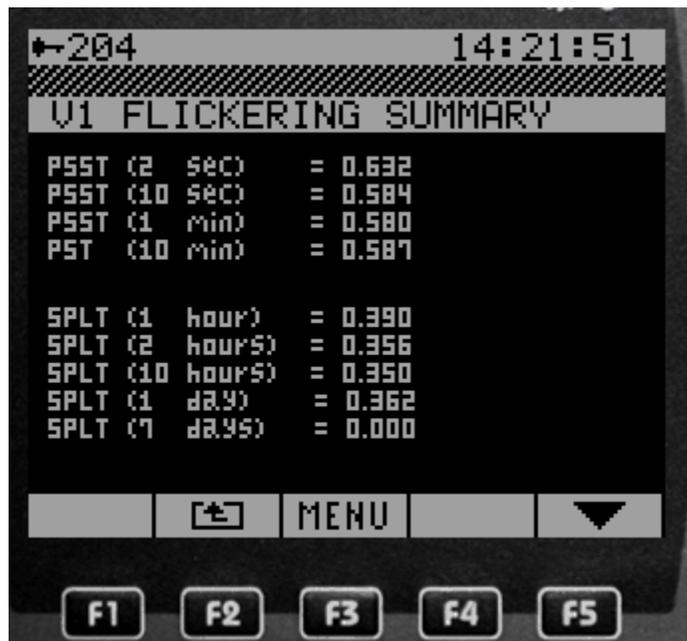
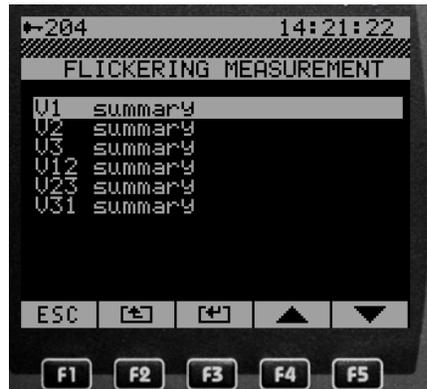


Figure 28: A Detailed Flicker Summary

## Section 10. Troubleshooting

The following table lists the various error messages issued by the ASCO 5010 Remote Display unit.

	<b>Error</b>	<b>Explanation</b>	<b>Troubleshooting</b>
1	Invalid parameter→ Invalid password	Wrong password, Not the Admin password provided by ASCO	Re enter admin password. If problem persists, Call ASCO
2	Authentication error→ Bad password	Wrong password, Not the Admin password provided by ASCO	Re enter admin password. If problem persists, Call ASCO
3	Network error→ Communication failed	Wrong network page parameters DHCP incorrectly toggled or bad physical network connection	Modify network page parameters  Check whether LAN2/LCD LED-s are on and if not disconnect and reconnect cable, or replace socket at wall.
4	Authentication error→ Connection failed	Failed to connect	Re enter admin password If problem persists, Call ASCO
5	Reset successful→ Min/Max reset	Min/Max of all V,I measurements successfully reset	
6	Reset failed→ Min/Max reset	Matching error. "Min/Max reset" failure	Call ASCO.
7	Reset successful → Demand reset	Demand accumulator successfully reset	
8	Reset failed→ Demand reset	Matching error. "Demand reset" failure	Call ASCO.
9	Reset successful → Energy reset	Energy accumulator successfully reset	
10	Reset failed→ Energy reset	Matching error. "Energy reset" failure	Call ASCO.
11	Reset successful→ Compliance reset	EN50160 event counters successfully reset	
12	Reset failed→ Compliance reset	Matching error. "Compliance EN50160 module reset" failure	Call ASCO.
13	Erase successful → Logger erase	successful erasing of system log events buffer. Not a recommended action.	
14	Erase failed → Logger erase	Matching error. logger erase failure.	On-Board Flash problem. Call ASCO
15	Reset successful → Flickering reset	Flickering Min/Max successfully reset.	
16	Reset failed → Flickering reset	Matching error. "Flickering Min/Max reset" failure	Call ASCO

**Section 11. Technical Definitions**

No	Subject group, Term	Explanation
1	V, I	<p>RMS values of voltage (V) and current (I) parameters. The values are calculated from the measured discrete sampling of the waveform at the declared resolution of the instrument.</p> <p>For Current: 256 samples per 50 Hz cycle</p> <p>For Voltage: depending on the model number; from 256-1024 samples per 50 Hz cycle</p>
2	Voltage Flickering	<p>A cyclic or quasi-cyclic RMS voltage fluctuation whereby the RMS voltage fluctuates 0.25-4% of nominal voltage at a frequency in the range of 0.4-25 Hz. This type of disturbance has been historically defined as causing distress to workers due to flickering lighting, and is described and defined in the IEC 61000-4-15 standard. ASCO offers parameters that reflect this standard as well as some variations that ASCO has found to be useful.</p>
3	P <sub>ST</sub>	<p>Perceptivity- Short Time: The perception of the flicker over a period of 10 minutes. P<sub>ST</sub>=1 is the threshold of perceptivity. The P<sub>ST</sub> value is calculated according to the formula dictated by the EN50160 standard</p>
4	P <sub>LT</sub>	<p>Perceptivity- Long Time: The perception of the flicker over a period of 2 hours, calculated from a sequence of 12 consecutive P<sub>ST</sub> values according to the following formula: <math>P_{LT} = \sqrt[3]{\sum_{i=1}^{12} \frac{P_{sti}^3}{12}}</math></p>
5	P <sub>SST</sub>	<p>An ASCO measurement designed to get quicker results regarding Flicker evaluation. This measurement reaches a very close approximation of the EN50160 values, but in a fraction of the time.</p> <p>The P<sub>SST</sub> is calculated the same as P<sub>ST</sub> but averaged over 2, 10 and 60 seconds. This ASCO defined value is valuable in that it enables faster assessment of the flicker. ASCO P<sub>SST</sub> converges to a real value within 3min from a drastic flicker change, or immediately for periodic steady state flicker.</p>
	SP <sub>LT</sub>	<p>An ASCO measurement designed to get quicker results regarding Flicker evaluation. This measurement reaches a very close approximation of the EN50160 values, but in a fraction of the time.</p> <p>The SP<sub>LT</sub> is calculated the same as P<sub>LT</sub> but averaged over 1 hour. This ASCO defined value is valuable in that it enables faster assessment of the flicker.</p>
	LP <sub>LT</sub>	<p>A measurement designed to give better results regarding Flicker evaluation by using a longer averaging time.</p> <p>The LP<sub>LT</sub> is calculated the same as P<sub>LT</sub> but averaged over 1 day and 7 days, as per EN50160 parts 4-15. ASCO adds another averaging period of 10 hours to allow a quicker "long term" average.</p>
6	Phasor	<p>A graphic vector rendition of voltage and current magnitude and phase shift between the three currents and their respective voltages. The phasor diagram is displayed with respect to V<sub>1</sub> (Y) or V<sub>12</sub> (Δ)</p>
7	PF – Power Factor	<p>The efficiency of power consumption by a load. The ratio between the Apparent Power (Volt-Ampere) and the Active Power (Watt) described simply as P/S.</p> <p>A simple representation is offered by calculating the P/S ratio for the first (fundamental) harmonic: PF<sub>Displacement</sub> = P<sub>H1</sub>/S<sub>H1</sub>.</p> <p>The more accurate PF is defined as the sum of the P/S ratio over all the harmonics: PF<sub>True</sub> = P<sub>Total</sub>/S<sub>Total</sub> = Cos(θ).</p> $PF_{True} = \frac{\sum P}{\sqrt{\sum P^2 + \sum Q^2}}$ <p>Where the sums are over N harmonics.</p>
8	E – Energy	<p>Energy is defined as the power in kW consumed over 1 hour. It is measured in kWh.</p>

9	THD	<p>Total Harmonic Distortion. The contribution of all harmonic frequency currents to the delta between the fundamental harmonic- a pure sine wave- and the actual wave form.</p> <p><math>THD = \sqrt{\sum n(h_n^2)}</math>; where n is the order of the harmonic and h is the value of the measured parameter.</p>
10	Line or phase Voltage, Current $V_{Li}, I_{Li}$	<p>The voltage between a phase and GND or Neutral.</p> <p>The current flowing from the phase to Neutral in a Y configuration. A phase is marked as Li i=1,2,3,N</p>
11	Line-to-Line Voltage, Current $V_{Lij}, I_{Lij}$	<p>The voltage between two phases.</p> <p>The current flowing from one phase to another.</p>
12	Crest factor	<p>Ratio of peak to peak waveform value to its RMS nominal value. Signifies the quality of a sine waveform.</p> $C = \frac{x_{peak}}{x_{rms}}$
13	K factor	<p>The weighting of the harmonic load currents according to their effects on transformer heating. A K-factor of 1.0 indicates a linear load (no harmonics). The higher the K-factor, the greater the harmonic heating effects.</p> $K = \frac{\sum_1^{25} (i_h \times h)^2}{\sum_1^{25} i_h^2}$
15	Active power - P	<p>The amount of power consumed as usable energy. Sometimes referred to as Real power.</p> <p>ASCO calculates the Active power accurately by taking all harmonics up to the 40<sup>th</sup> into account using the following formula:</p> $P = \frac{1}{2} \sum_i V_{i,j} \cdot I_{i,j} \cdot \cos \theta_{i,j} \text{ [Watt]}$ <p>Where i is the harmonic and j is the phase.</p>
16	Reactive power- Q	<p>The amount of power consumed as un-usable energy.</p> <p>ASCO calculates reactive power using the following formula:</p> $Q = -P_q = - V  I  \sin \theta = -\vec{V} \times \vec{I} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ V_x & V_y & 0 \\ I_x & I_y & 0 \end{vmatrix} = k(-V_x I_y + I_x V_y) \text{ [VAr]}$ <p>ASCO calculates the sign of Q using the following formula:</p> <p>Sign of Q = sign of <math>(\sum_i (-V_{xi} \cdot I_{yi} + V_{yi} \cdot I_{xi}))</math></p>
17	Aparent power- S	<p>The total power supplied to the load, a vector addition of the Active and Reactive power.</p> <p>ASCO uses formula: <math>S = V_{RMS} \cdot I_{RMS}</math> [VA]</p>
18	10/12 or Long measurements	<p>The EN50160 and IEC61000-4-30 standards require that certain parameters be sampled and averaged over 10/12 cycles (50/60Hz). ASCO displays these terms on the ASCO 5400 Series as 10/12 or Long or IEC 61000-4-30.</p>
19	Cycle-by-cycle	<p>ASCO displays RMS parameters down to a resolution of one cycle. These measurements are referred to as cycle-by-cycle values.</p>

20	Harmonics (hn)	<p>Harmonics refer to the inherent elements of a cyclic wave that exist as multiples of the fundamental harmonic frequency. In electrical power distribution systems, the fundamental frequency is usually 50 or 60 hertz, delivered in a sine wave. In practice, this sine wave gets distorted. The distorted sine wave can be analyzed by breaking it down to the pure sine wave at the fundamental frequency and a collection of superimposed pure sine waves of different frequencies, all calculated at multiples of the fundamental.</p> <p>h- the value of the measurement at the harmonic frequency n- the order (number) of the harmonic</p>
21	Energy	Energy is the amount of active power consumed over a set period of time. Electrical energy is defined as the amount of active power consumed over the period of one hour.
22	Delivered Energy	Imported energy
23	Received Energy	Exported energy
24	Energy Demand	The <u>accumulative</u> energy over all intervals since reset demand. There is Delivered, Received energy demand, and there is {Active, Reactive, Apparent} energy Demand.
25	Peak Delivered\Received Energy demand	The peak over all energy intervals of Delivered\Received Energy (according to sign).

## Section 12. ASCO 5400 Series Website Reference

The LCD allows for monitoring and configuring the ASCO 5400 Series Power Quality Meter on site or across a LAN/WAN. Each ASCO 5400 Series PQM is equipped with an internal web server and can be assigned an IP address that allows internet communication with the instrument using any internet browser in the world connected to the World Wide Web.

The website on each ASCO 5400 Series Power Quality Meter acts as both a monitoring and configuring interface through the internet connectivity. The following table cross references the actions performed through the ASCO 5010 Remote Display Unit and the website on the ASCO 5400 Series PQM.

No	Information type	ASCO 5010 page (menu→ sub menu...→ sub menu →page)	ASCO 5400 Series page (menu→ sub menu...→ sub menu →page)
		Main→ System configuration	
1	Configuration: versions S.N. for software and hardware	Main→ System configuration→ System Information→ General Information	Service→ Unit setup
2	Configuration: Y, Δ load connection	Main→ System configuration→ System Information→ Power Configuration	Service→ Power setup
3	Configuration: format RST, PF Cap/Ind	Main→ System configuration→ System Information→ Format labels	Service→ Display setup
4	Configuration: input voltages, currents polarity (intended to software resolve inverse polarity connection)	Main→ System configuration→ System Information→ Voltage/Current polarity	Service→ Power setup
5	Configuration: set nominal f, V, I for computation reference	Main→ System configuration→ System Information→ Nominal values	Service→ Power setup
6	Configuration: PT/CT primary/secondary coils ratio for Voltage, Current transformers accordingly	Main→ System configuration→ System Information→ PT/CT state	Service→ Power setup
7	Configuration: Internet communication parameters (IP address, DHCP, SNTP, other)	Main→ System configuration→ System Information→ Network information	Service→ Network setup
8	Configuration: ASCO contact person, local site parameters	Main→ System configuration→ System Information→ Site parameters	Service→ Unit setup
		<b>Main→ Large digits menu</b>	
9	Measurement: Powers P,Q,S total over all phases	Main→ Large digits menu→ Power totals	Monitoring→ Power
10	Measurement: Average over phases V,I,PF	Main→ Large digits menu→ V,I,PF	Monitoring→ Summary
11	Measurement: VLi,j	Main→ Large digits menu→ Line-to-Line voltages	Monitoring→ Voltage/Current

12	Measurement: li	Main→ Large digits menu→ Line currents	Monitoring→ Voltage/Current
13	Measurement: Crest factors V,I; K-factors I	Main→ Large digits menu→ Factors summary	Monitoring→ Voltage/Current
14	Measurement all V,I	Main→ Large digits menu→ Volt/Ampere summary	Monitoring→ Voltage/Current
15	Measurement: power P,Q,S,PF table	Main→ Large digits menu→ Power summary	Monitoring→ Power
16	Measurement: THD of V,I	Main→ Large digits menu→ THD summary	Monitoring→ Voltage/Current
17	Measurement: I waveforms	Main→ Waveforms main menu→ Current waveforms	Monitoring→ Waveforms
18	Measurement: V waveforms	Main→ Waveforms main menu→ Voltage waveforms	Monitoring→ Waveforms
19	Measurement: V,I waveforms	Main→ Waveforms main menu→ Current-Voltage waveforms	Monitoring→ Waveforms
		<b>Main→ Harmonics menu</b>	
20	Measurement: I harmonics	Main→ Harmonics menu→ Currents spectrum	Monitoring→ Cycle by cycle harmonics
21	Measurement: V harmonics	Main→ Harmonics menu→ Voltages spectrum	Monitoring→ Cycle by cycle harmonics
22	Measurement: In harmonics	Main→ Harmonics menu→ Neutral current	Monitoring→ Cycle by cycle harmonics
23	Measurement: Vn harmonics	Main→ Harmonics menu→ Neutral voltage	Monitoring→ Cycle by cycle harmonics
24	Measurement: phasors	Main→ Phasors display	Monitoring→ Phasors
		<b>Main→ Energy measurement</b>	
25	Energy measurement: Delivered	Main→ Energy measurement→ Delivered	Energy→ Detailed Info→ table: Delivered Energy
26	Energy measurement: Delivered demand	Main→ Energy measurement→ Delivered demand	Energy→ Detailed Info→ table: Delivered energy, column Demand
27	Energy measurement: peak Delivered demand	Main→ Energy measurement→ Peak Delivered demand	Energy→ Detailed Info→ table: Delivered energy, column Peak Demand
28	Energy measurement: Received energy	Main→ Energy measurement→ Received	Energy→ Detailed Info→ table: Total , Energy→ Consumption and Demand
29		<b>Main→ Energy measurement→ Received demand</b>	Energy→ Detailed Info→ table: Received energy, column Demand
30	Energy measurement: Peak Received demand	Main→ Energy measurement→ Peak Received demand	Energy→ Detailed Info→ table: Received energy, column Peak Demand

		Main→ PQZIP information	
31	PQZIP enable/disable	Main→ PQZIP information→ PQZIP enable/disable	Service→ PQZIP status
32	PQZIP information	Main→ PQZIP information→ Information	Service→ PQZIP status
		<b>Main→ Flickering measurement</b>	
33	Flickering Psst2sec	Main→ Flickering measurement→ Real-time Pst	Power Quality→ Voltage Flickering→ column Psst2sec
34	Flickering Pst10min	Main→ Flickering measurement→ Flickering Pst	Power Quality→ Voltage Flickering→ column Pst10min
35	Flickering PLT 2H	Main→ Flickering measurement→ Flickering PLT	Power Quality→ Voltage Flickering→ column PLT 2H
37	Flickering table	Main→ Flickering measurement→ Flickering summary	Power Quality→ Voltage Flickering entire table
38	Flickering table	Main→ Flickering measurement→ Detailed summary	Power Quality→ Voltage Flickering