Operating Manual

RiSH PQA

Power Quality Analyzer

DMAN-00IM-0638_Rev_A 03/2017

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CHAPTER 1
GENERAL ASPECTS

1.1 Features of PQA

1.1.1 Touch Screen Function

All functions described below are operable using color LCD touch screen technology. Users may use a finger and/or a PDA stylus to apply pressure to the LCD screen to result in touch screen recognition. Display has resistive touch.

1.1.2 Meter Mode

Meter mode functions as true rms voltmeter and ammeter. Voltage and current measurements, along with other parameters like Demand, power, energy, distortion ,unbalance and system parameter are displayed on meter mode screens in textual format.

1.1.3 Harmonics and Interharmonics

Harmonics display the amplitude and phase of each harmonic up to 63rd order in both graphical and textual format.

1.1.4 Scope Mode and Phasor Diagram

Scope mode functions as an oscilloscope, displaying real-time waveforms of three phase voltage and current simultaneously with one second update rate. The colors of waveform display are user programmable. Scope mode also provides a textual display of rms values, division for axis values and frequency.

The Phasor screen displays a graph that indicates phase relations between voltage and current based upon the angles at the fundamental frequency. Phasor diagram displays voltage and current Phasor for all phases.The phase angle display can be used to verify if monitoring connections have been made correctly. Animated Phasor demo shows inductive resistive and capacitive load on three phase system.

1.1.5 Recording

All the events occurring during particular specified time period is recorded. The analysis of recorded data can be done later by loading data from memory card.

1.1.6 Events

An event occurs when a programmed threshold limit is crossed. An event consists of the pre-trigger cycles, trigger cycles and post-trigger cycles.

1.1.8 Trend

User can generate the plot of all data that is collected into graphical form to get knowledge about trend flow of system.

1.1.9 Reports

User can have report in EN50160 mode. EN50160 displays statistical reports based on an analysis of the voltage as per requirements of the EN50160 standard. Compliance data is presented in statistical tables and graphs. Statistical data is calculated on the required parameters specified in EN50160 over one week interval to produce a pass/fail decision.

1.1.10 Settings

User can perform miscellaneous settings to keep the PQA running efficiently. Setting tab is used to set time, date, PT/CT ratio, communication set up etc.

Home screen is as shown below

CHAPTER 2
ANALYSIS OF REAL TIME DATA

Introduction

PQA allows users to view power quality phenomenon as it happens, when it happens. The instrument is able to capture and process data in real time, and allows users to view it in meter mode, harmonics and scope mode.

Access to Real Time Data

Icons for meter mode, harmonics and Scope mode are displayed on the home screen.

This chapter is divided into three sections

2.1 METER

Meter icon allows you to view real-time meter data. The meter parameters available are logically separated into the following tabs: Basic, Power/Energy, Demand, Distortion, Unbalance and System. Meter screens are displayed in tabular form.

Following topics are considered in this section

2.1.1 Basic

Basic mode can be displayed by pressing parameter tab in the meter icon on the home screen. At start up, meter mode defaults in the basic tab featuring the basic power quality parameters available. The basic mode shows voltage, current, phase angle and crest factor of each phase.Neutral current is measured parameter. details refer table no.1.

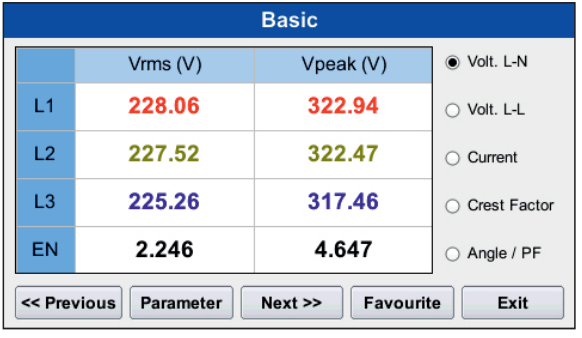


Table 1: Basic

Basic	Parameter	Label
Voltage For 3P4W (L1,L2,L3,EN) For 3P3W and 3P4W (L12,L23,L31)	RMS voltage	Vrms(V)
	Peak voltage	Vpeak(V)
Current (L1,L2,L3,IN)	Rms current	Irms(A)
	Peak current	Ipeak(A)
Creast factor (Phase 1,2,3)	Voltage and current crest factor	Voltage, current
Angle/PF (Phase 1,2,3)	voltage angle	Voltage
	current angle	current
	angle between voltage and current	Volt-Curr
	Power Factor	PF

Note:Volt L-N, EN voltage,IN is not displayed in case of 3P3W.

2.1.2 Power/Energy

Power/energy tab shows active, reactive, apparent power. Active energy(Import and Export),Reactive energy(Import and Export),Apparent energy. It also shows phase angle and power factor. For details refer table no.2.

For example power screen in the Power/Energy tab is shown below.

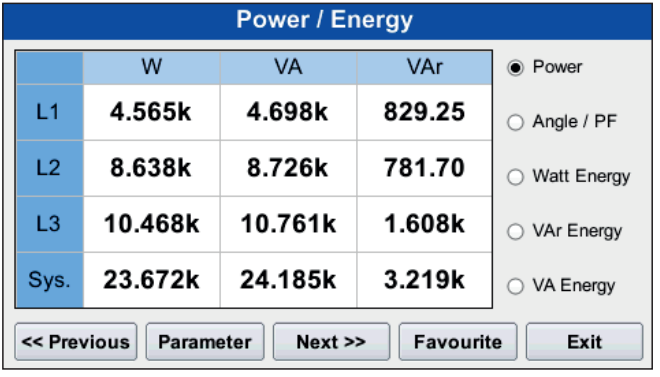


Table 2: Power and energy

Power / Energy Tab	Parameter Name	Label
Power(L1,L2,L3,Sys)	Active/apparent /Reactive Power	W/VA/VAr
Angle / PF (Phase 1, Phase 2, Phase 3)	Voltage Angle	Voltage
	Current Angle	Current
	Angle Between Voltage and Current	Volt -Curr
	Power Factor	PF
Watt Energy (L1, L2, L3, Total, Roll Over Count)	Import and Export Active Energy R.Ovr	Import (Wh / kWh / MWh) & Export (Wh / kWh / MWh)
Var Energy (L1, L2, L3, Total, Roll Over Count)	Import and Export Reactive Energy R.Ovr	Import (VArh / kVArh / MVArh) & Export (VArh / kVArh / MVArh)
VA Energy (L1, L2, L3, Total, Roll Over Count)	Apparent Energy R.ovr	Vah / kVAh / MVAh

Note:L1,L2,L3 power and energy is not displayed in case of 3P3W.
R.Ovr means Roll over count

2.1.3 Demand

Demand tab provides information about Demand parameters. It provides data about current demand for all three phases. It also shows system demand, max demand and coincident demand.

Coincident demand shows demand values of VA ,VAr, Watt demand at maximum values of Watt,VA,VAr demand. For e.g. It shows VA demand which was present at maximum watt demand. Coincident Pf shows PF Avg. values at maximum VA,VAr,watt demand.

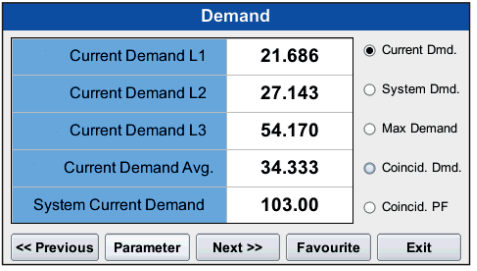


Table 3: Demand

Demand Tab	Parameter Name
Current Demand	Current Demand L1
	Current Demand L2
	Current Demand L3
	Current Demand Average
	System Current Demand
System Demand	Import Active Demand
	Export Active Demand
	Import Reactive Demand
	Export Reactive Demand
	Apparent Demand

Demand Tab	Parameter Name
Max Demand	Import Active Demand
	Export Active Demand
	Import Reactive Demand
	Export Reactive Demand
	Apparent Demand
	System Current Demand
Coincid Dmd (Coincident Demand)	VA Demand At Max Watt Demand
	Var Demand At Max Watt Demand
	Watt Demand At Max VAr Demand
	VA Demand At Max VAr Demand
	VAr Demand At Max VA Demand
	Watt Demand At Max VA Demand
Coincid PF (Coincident Power Factor)	Average Power Factor At Max Watt Demand
	Average Power Factor At Max VAr Demand
	Average Power Factor At Max VA Demand

2.1.4 Distortion Meter Tab

PQA is able to measure distortions or uncharacteristic changes in the waveform of original signals. Distortion calculation measures the deviation of complex wave shape from pure sine waves.

Voltage and Current for each phase can be measured under user frequency meter icon. Frequency can be set and corresponding voltage and current harmonics can be measured. The frequency should be set in multiples of 5 but not greater than 4160.
For details refer table no.4.

THD(Total Harmonic Distortion)

THD is defined as the ratio of the sum of the powers of all harmonic components to the power of the fundamental frequency.
RSS is the root sum square and it is used to express total harmonic distortion.
for formulae refer appendix B.

POWER:
For signed and unsigned power formulae refer Appendix B

For example THD screen is shown below

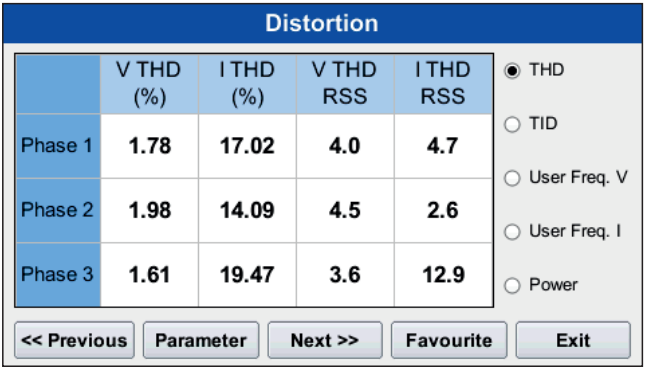


Table 4: Distortion

Distortion Tab	Parameter Name	Label
THD (Phase 1, Phase 2, Phase 3)	Voltage Total Harmonics Distortion	VTHD(%)
	Current Total Harmonic Distortion	ITHD(%)
	Voltage Magnitude of VTHD	VTHD RSS
	Current Magnitude of ITHD	ITHD RSS
TID (Phase 1, Phase 2, Phase 3)	Voltage Total Interharmonics Distrotion	VTID(%)
	Current Total Interharmonics Distortion	ITID(%)
	Voltage Magnitude of VTID	VTID RSS
	Current Magnitude of ITID	ITID RSS
User Frequency Voltage for 3P3W(L1, L2, L3) for 3p4W(L12,L23,L31)	User 1 Frequency and Voltage	User 1
	User 2 Frequency and Voltage	User 2
	User 3 Frequency and Voltage	User 3
	User 4 Frequency and Voltage	User 4
User Frequency Current for 3P4W(L1, L2, L3) for 3P3W(L1, L3)	User 1 Frequency and Current	User 1
	User 2 Frequency and Current	User 2
	User 3 Frequency and Current	User 3
	User 4 Frequency and Current	User 4
Power (Phase 1,2,3)	Signed Power	Signed
	Unsigned Power	Unsigned

Note:Power is not displayed in case of 3P3W.

2.1.5 Unbalance

The Unbalance meter tab shows symmetrical component i.e. positive, negative and zero sequence components for voltage and current. It also indicates the unbalance and imbalance factor of the system.formulaes of sequence, unbalance, imbalance are mentioned in appendix B.for details refer table no.5.

for example V sequence screen is as shown below

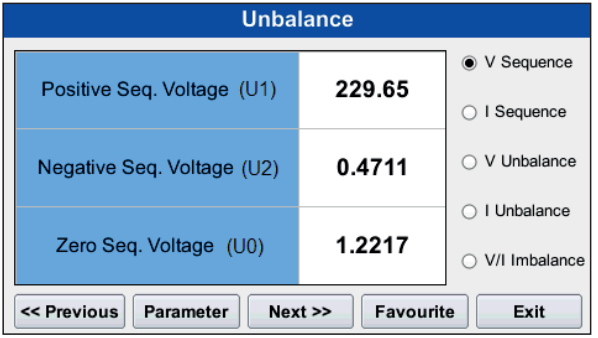


Table 5: Unbalance

Unbalnce Tab	Parameter Name
V Sequence	Positive Sequence Voltage U1
	Negative Sequence Voltage U2
	Zero Sequence Voltage U0
I Sequence	Positive Sequence Current U1
	Negative Sequence Current U2
	Zero Sequence Current U0
Voltage Unbalance	Voltage Unbalance U2 / U1
	Voltage Unbalance U0 /U1
Current Unbalance	Current Unbalance RMS/RMS_Average
	Current Unbalance U2/ U1
	Current Unbalance U0 / U1
Voltage And Current Imbalance	Voltage Imbalance L1,L2,L3,max(3P4W) and L12,L23,L31(3P3W)
	Current Imbalance L1,L2,L3,max(3P4W)

Note:Current unbalance and imbalance is not displayed in case of 3P3W.

2.1.6 System

System meter tab shows the system voltage, system current, system frequency, system power, Total harmonic distortion(system voltage and current) and phase sequence error detection. It provides information about arithmetic and vector sum of PF, DPF, VA. It provides data about minimum and maximum system voltage and current. This helps to analyze the complete system on single screen. for details refer table no.6.

Phase sequence
Normal:
Meter shows normal if phase sequence connected to the meter is correct.

Reverse:
Meter shows reverse if phases are connected reverse order.

Input absent:
Meter shows input absent when either of the phases or all three phases are absent.

Phase error:
If the Phase sequence is not maintained then meter shows Phase error.

For example basic screen is shown below

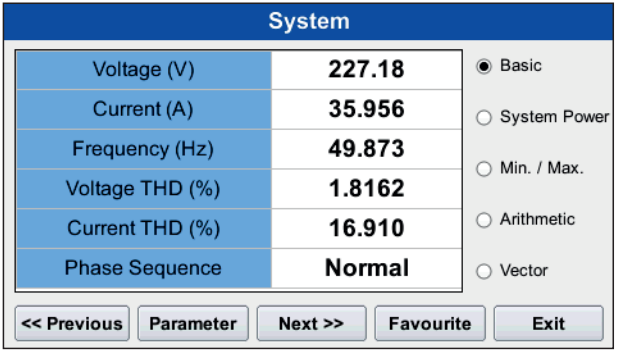


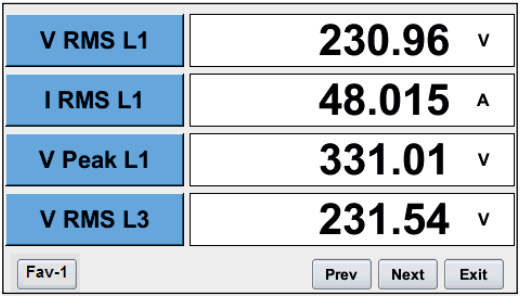
Table 6: System

System Tab	Parameter Name
Basic	System Voltage
	System current
	Frequency
	System Voltage Total Harmonics Distortion(%)
	System Current Total Harmonics Distortion(%)
	Phase sequence
System Power	Active Power(kW)
	Apparent Power(kVA)
	Reactive Power(kVAr)
	Power Factor
Min / Max Values	System Max Voltage
	System Min Voltage
	System Max Current
	System Min Current
Arithmatic	Arithmetic Sum Power Factor
	Arithmetic Sum Displacement Power Factor
	Arithamatic Sum VA
	Fundamental Arithmetic Sum VA
Vector	Vector Sum Power Factor
	Vector Sum Displacement Power Factor
	Vector Sum VA
	Fundamental Vector Sum VA

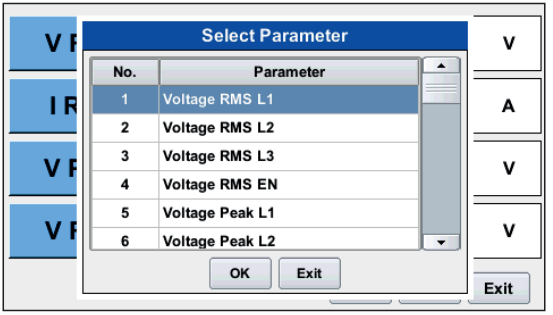
Note:Arithmatic sum is not displayed in case of 3P3W.

2.1.7 Favourite

Favorite Tab shows 20 parameters selected by user. Four parameters will be displayed on screen at a time. Total five favourite screens are available,User can scroll the screen by using Prev and Next button.



After touching parameter name select parameter list will be displayed, User can select parameter out of 143 parameter by touching Ok button.



2.2 HARMONICS

Harmonic screen displays voltage, current, power harmonics and inter-harmonics in graphical and list form. Harmonics are integral multiples of fundamental frequency. The harmonic analysis is done by synchronous window of 10 cycles for 50 Hz and 12 cycles for 60 Hz. This results in interharmonic spacing which 5 Hz wide. The actual interharmonic spacing value is actual frequency divided by 10 for 50 Hz and divided by 12 for 60Hz. Use parameter button to view next channel or next parameters. The number of harmonics that can be displayed are 63. Summary values of odd, even and total distortion are displayed. The summary of harmonics and inter-harmonics distortion values per phase per parameter is displayed.

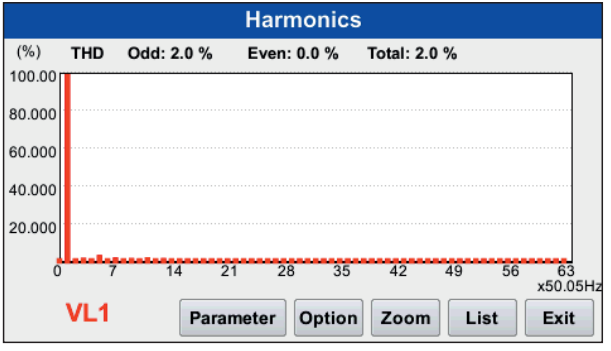
User can view Harmonics,Inter-harmonics,Harmonics group,Interharmonics group,Harmonic sub group, Inter-harmonics sub group.

Harmonic Graph: Harmonics are measured up to 63rd order. Users can choose the unit for display by which harmonic data is graphed based on percentage of the fundamental value or in basic units (volts,amps,watts).Harmonic graphs can be displayed either in Hertz or in harmonic number. The graphs can be zoomed and rescaled.

Harmonic List: The list gives a textual display of magnitude of harmonic parameter(i.e voltage, current or power), weightage(with respect to fundamental)(%), phase angle(in degrees), harmonic number and frequency related to each harmonic number.

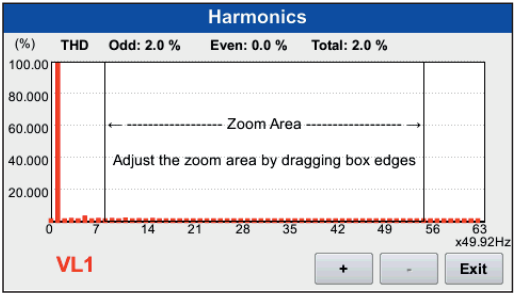
➢ **Harmonic Parameter**

The harmonic parameter can be displayed by pressing harmonics icon on the home screen. The screen defaults to a graphical spectrum display, although users have the option to choose between the graph and list form. The screen will show a spectral graph featuring the amplitude of the harmonics relative to the fundamental frequency. by pressing the options button user can select the vertical & horizontal measurement scale. The percent magnitude of the first 63 harmonics is plotted with respect to fundamental. User can select parameter(Voltage, current & power) and also select phase(1,2,3),by pressing parameter button.



➢ **Harmonic Zoom**

A Black box showing the default zoomed area appears once the Zoom button is pressed. Touch the sides of the zoom box to expand or narrow the area to be covered.



The Zoom button serves as magnifying function, each of which feature a plus sign or minus sign within. Press '+' to display the zoomed area and view harmonic parameter in greater detail. User may repeatedly zoom in on a plot. Press '-' to unzoom graph display.

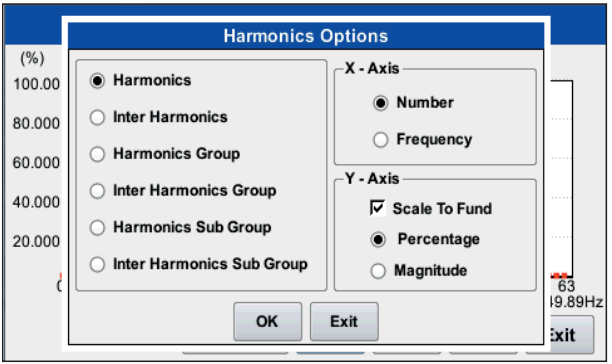
➢ **Harmonic Options**

The voltage and current harmonics and interharmonics for each phase can be plotted using the option button. The properties specified under Harmonic Option apply when harmonic/interharmonic data is viewed in either graph or list form.

User can select harmonics, inter-harmonics ,harmonics group, interharmonic group, harmonic sub group, inter-harmonics sub group. If Interharmonics is enabled then harmonics along with inter harmonics are displayed.

The Y axis can be labeled in **Percent, magnitude or Scale to Fundamental (percetage or magnitude)**. The X axis can be labeled in **Number and frequency**.

If scale to fundamental percentage or scale to fundamental magnitude is selected then graph is plotted with respect to fundamental voltage, and if percentage or magnitude(without scale to fundamental) is selected then graph is plotted with respect to highest magnitude of harmonics.



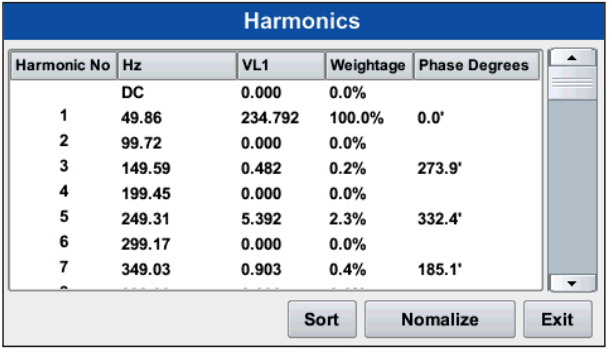
➢ **Harmonic List**

To view the harmonic magnitude text display, press **List** from harmonic graph screen. The harmonic parameters displayed on list include harmonic number, frequency in Hz, parameter (voltage, current or power), weightage (in %) and phase (in degrees).

By default, harmonics and inter harmonics frequency values are arranged in order of increasing frequency. Use the sort tab to organize harmonic text display in order of decreasing magnitude.

Harmonic phase degree values from 1 to 63 are displayed for voltage and current. Harmonic phase angle values can be normalized to the phase of the fundamental of the displayed channel. Use the Normalize button to show the normalized phase angle values. In case of unnormalized all calculations are done with respect to normally phase L1 .While in case of normalized calculations are made with respect to phase selected by user. By default meter shows normalized values. We can toggle between normalized and unnormalized values by pressing normalize button. screen for harmonic list is as shown below.

Note: Sort option is not available during recording is ON.



2.3 SCOPE AND PHASOR

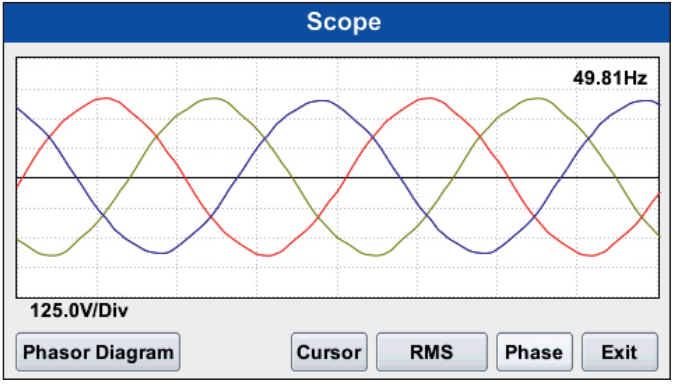
2.3.1 SCOPE

Scope mode allows viewing the real time data of voltage and current on screen for six parameters simultaneously.

Scope Mode Screen

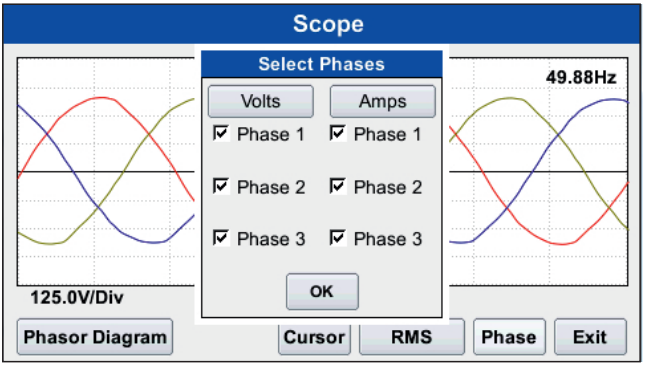
Scope mode can be selected by pressing the scope icon on the home screen.By pressing RMS button user can see RMS voltage and RMS current for each phase along with the waveform.

scope screen is as shown below.



➢ **Select Phases to display**

From scope mode, select the phase button to select phases.

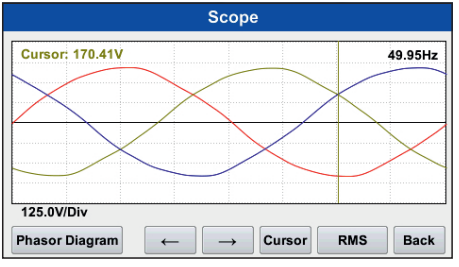


Any of the following will select phases to plot on scope

- Press desired Volts or Amps to select/deselect all phases.
- Press Phase1, Phase2, Phase3 to select particular phase of a parameter.

➢ **Cursor**

By pressing on the cursor button user can set cursor for particular phase. User can move cursor by using Left and Right navigation buttons or by dragging touch. Cursor will display peak value of voltage or current at that point.



Note: I2 is absent in 3P3W

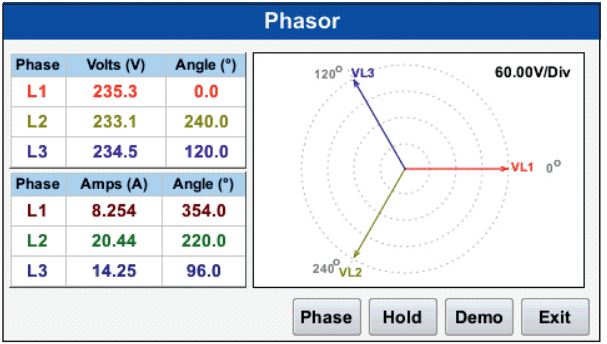
2.3.2 PHASOR

The Phasor screen displays the phase relations between the voltage and current based upon the angles of the fundamentals as per determined by Fourier analysis. Phasor screen shows six phasors auto scaled. Users are allowed to display up to three phases at any one time for either voltage or current or both voltage and current at same instant.

Demo button presents the animated demo for resistive load, inductive load and capacitive load. By pressing Hold button user can pause running condition.

➢ **Phasor Screen**

The Phasor screen is displayed by pressing Phasor diagram on the scope screen. The Phasor screen shows six phasors autoscaled rotation. The screen shows rms values for voltage and current for phases L1, L2 and L3. Phase angle can be seen. An arrow head and Phase label are displayed on the vector.



➢ **Phasor Demo**

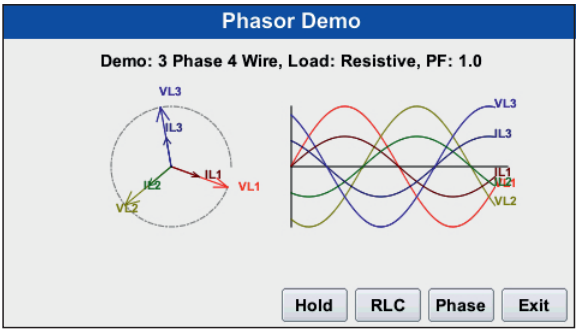
Animated Phasor Rotation

Graphical illustration in the form of rotating Phasors relative to sine wave graph of 3 phase 4 wire circuit and 3 phase 3wire is available by pressing Demo button of Phasor screen. By using phase option user can select phases. User can start/stop rotation at any time by pressing Run/Hold button.

Phasor vectors are displayed using anti-clockwise rotation from zero degree. User can view Demo Phasor rotation for resistive load, inductive load and capacitive load. pressing RLC button user can change Load type.

Sample For Three Phase Four Wire load

The following diagram describes the Phasor rotation for loads(resistive, inductive and capacitive) for three phase four wire connection. The arrow head on the line indicates the direction pointing towards the load.



➢ **Phasor Parameter**

Phasor parameter is selected by using Phase button on Phasor screen. Depending on the number of parameters to be monitored, the six maximum parameters can be selected. Parameters that are selected can be both voltage and current.

Chapter 3
Analysis Of Stored Data

PQA offers a graphical, information-packed and easy to navigate display of event data. The events of sag, swell and interruptions are recorded. It also provides trend data over specified time period. It helps in graphical analysis of data.

Record

Record is the capturing of the data and storing them in external memory card. In recording, the data that occur during running recording is captured.

Event

An event occurs when a voltage or current programmed threshold is crossed. An event consists of pre-trigger cycle(s), trigger cycle(fault) and post-trigger cycle(s). A contiguous collection of cycles caused by events is recorded into memory.

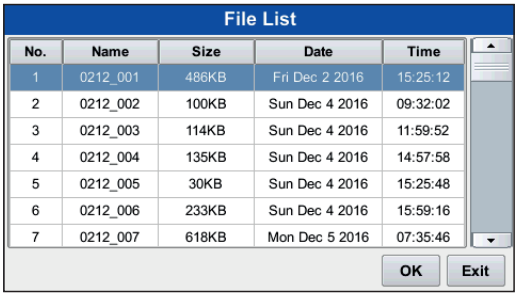
Trend

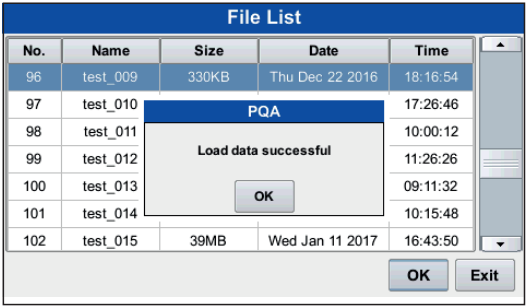
A Trend is a graph of the value of one parameter over time. In trend, instantaneous value of parameter is recorded over a time span. Users can zoom in on trends for a more detailed view.

Report

Meter can generate EN50160 compliance report, for files stored in memory card

After touching Event and trend icon if file is not present, the list of file which are stored on memory card will be displayed , user can select file which is to be loaded. after file is loaded load data successful message will be displayed.





In this chapter there are four parts,

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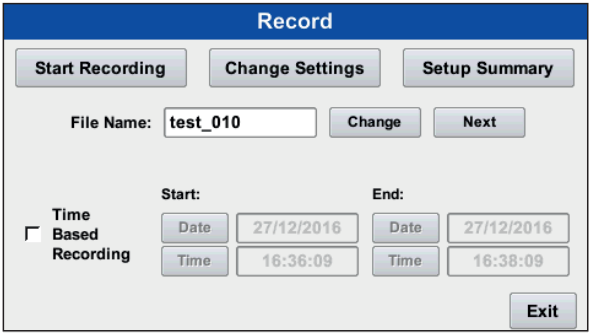
3.1 Record

Record is the capturing of the data and storing them in external memory card. In recording, the data that occur during running recording is captured. The data that is captured can be viewed later. User can change settings before starting recording. Once recording is started then settings cannot be changed. User can get complete overview of setup summary also. Time based recording can also be done in the record tab.User can set file name of 4 letters, which can be character or number.user can also change the name by touching next button. After touching change button file number is incremented and file name is changed . Record Screen is as shown below



In this section, following topics are covered

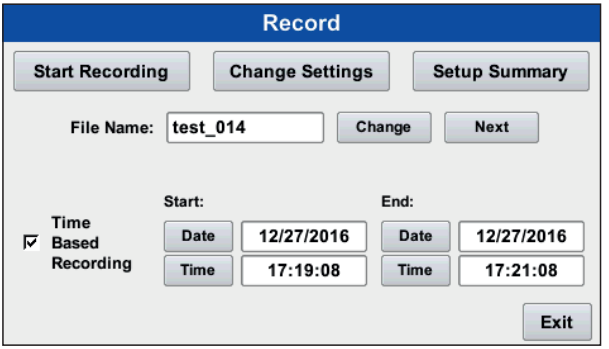
3.1.1 Normal Recording

In normal recording, the start and stop of recording is done manually. The recording once started can be stopped or aborted. Once recording is aborted then data recorded is not saved. In Stop option, the data recorded is saved. User can set file name as per his need.user can set file name of four character or number. on pressing next button file name is changed by incrementing file number.

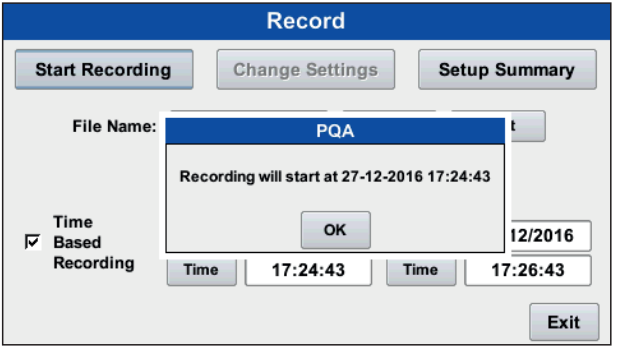
3.1.2 Time Based Recording

Time based recording is one in which start date & time along with stop date & time is specified before starting recording. It is mainly implemented to get data over larger period of time. The duration that can be set can minimum 1 minute to maximum 30 days. User must tick option of time based recording. The start and stop time and date has to be set. The stop time must be greater than start time. The Start Recording option is selected which gives the messageabout start time of recording. The recording is stopped automatically on reaching stop time.

Fig. shows time based recording setting screen



By touching touching start recording button recording will start ,and message will be displayed as shown in fig. below.

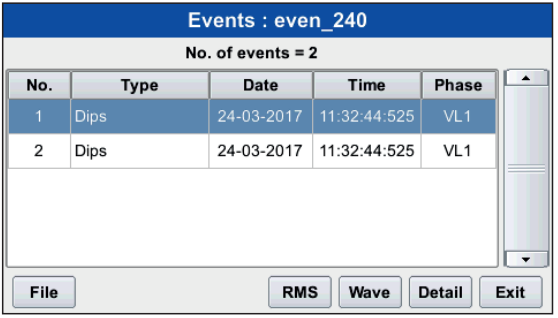


3.2 Event

The event screen displays actual voltage or current waveform that occurred when a certain threshold parameter limit is crossed. Event activity provides event list, waveform display and rms display. The event screen also enables users to customize data plots, allowing users to change and/or add parameters/channels. Zoom box features, wherein users can expand or narrow the size of a zoomed area via touch are also available for more thorough data analysis and interpretation. Users can set number of pre and post cycles of waveform in settings tab for recording.

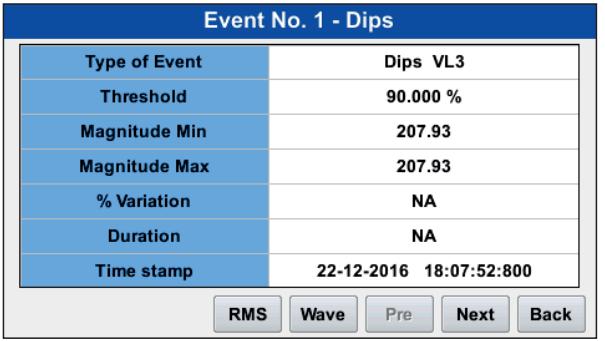
➢ **Event List**

Event list shows number of events occurring, type of event, date and time of event occurrence and channel at which event occurs. By touching File button user can change the file. It also shows RMS wave, text detail.Event list screen is as shown below



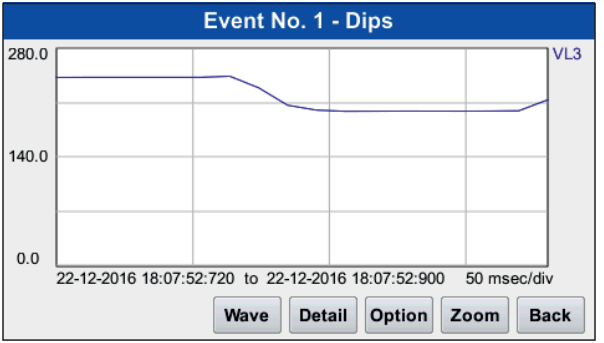
➢ **Event Text Data Display**

On pressing detail button Event data is displayed. Event Text data display is used to display type of event, threshold set for an event, minimum and maximum magnitude of event and time stamp of event.



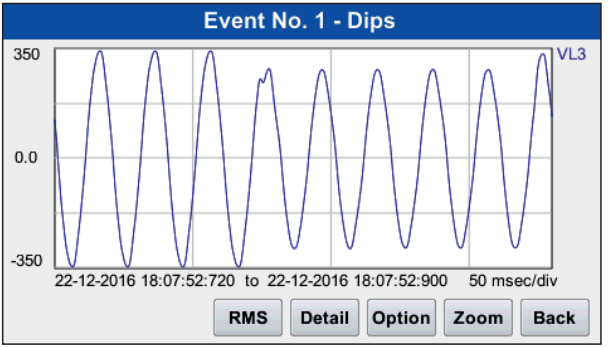
➢ **Event RMS Plot**

Event RMS shows the waveform of selected parameters, half cycle RMS wave details and zoom wave in and out. User can zoom plot by dragging touch on the screen.



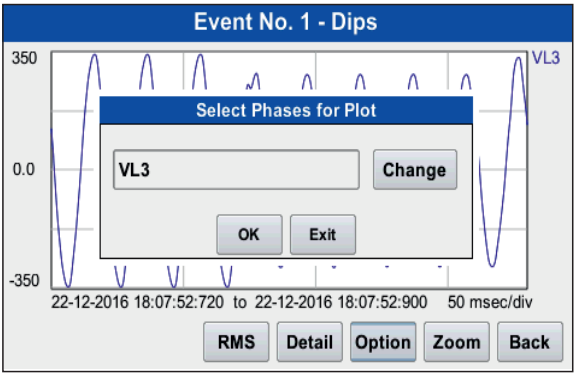
➢ **Event Waveform Plot**

The event waveform gives graphical representation of the actual event waveform over the period. User can analyze the details of waveform from zoom option. User can zoom plot by dragging touch on the screen.



➢ **Event Option**

In event option User can select the parameters to be displayed for plot.

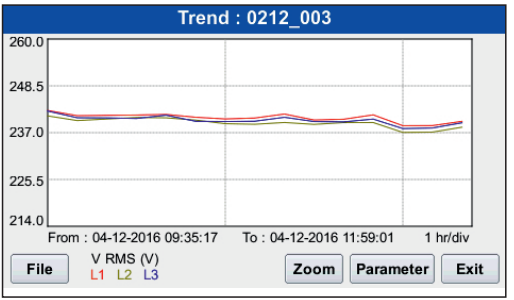


3.3 Trend

A trend consists of the timed and threshold plot for the parameters on display. Users have option to enable /disable phases for trend display. The trend screen also features a zoom box, wherein users can expand or narrow the size of a zoomed area using touch. The zoom feature allows users to view trend instantaneous values in greater detail.

➢ Trend Screen

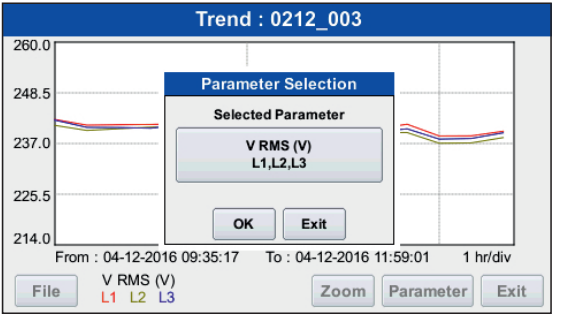
Trend screen is used to display the trend data recorded in graphical form. User can also zoom into the plot for greater details of particular parameter. It also displays the time period of trend recorded. X-axis on the graph shows start/stop time and Y axis shows magnitude of the parameter. By touching File button user can change the file.Trend screen is as shown below.



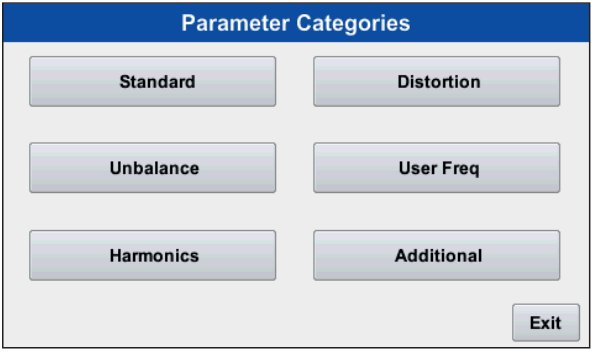
➢ Trend Parameter Selection Screen

In Trend parameter selection, parameter is selected which is to be plotted.User can select the parameters from list of standard, distortion, harmonics, unbalance, user frequency and additional.

After clicking parameter button selected parameter is displayed .



Parameter can be selected through screen as shown below.



3.4 Reports

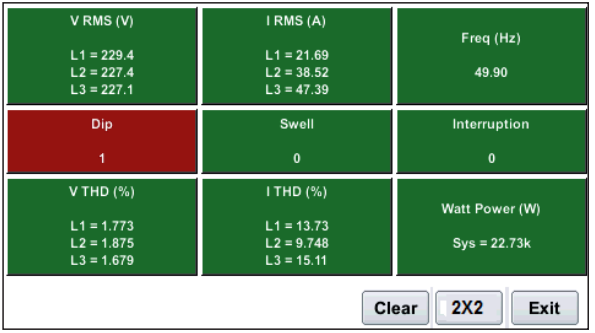
Users have the option to view report in any mode. When recording is completed, user can load file from memory card. If file is recorded in EN50160 mode then it is possible to view the report.

Also when recording is ON, the user can view the status of various real time parameters on the screen.

3.4.1 Status Report In Annunciator Panel

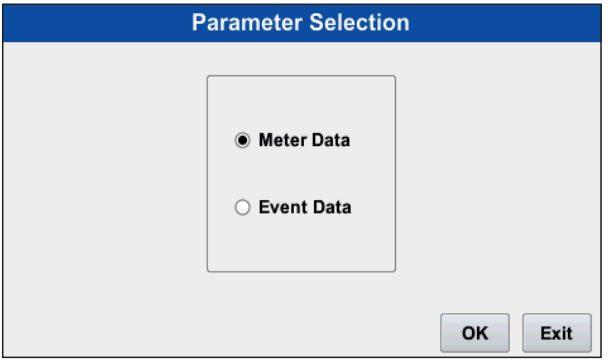
Status summary can be displayed via the annunciator panel. User can change number of parameter displayed on annunciator panel by touching 2X2 or 3x3 button. Real time data, event count is available in the matrix display of the annunciator panel. When monitoring is ON, the annunciator panel displays the status of a parameter using a color scheme. Meter data and events can be directly viewed from the annunciator panel. By clicking on particular parameter the user can select meter data or event data to be displayed on annunciator panel.

annunciator panel will be displayed only when recording is ON.



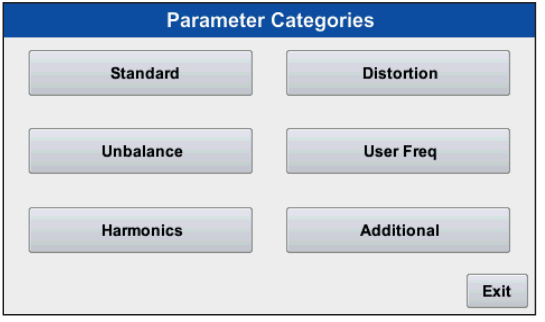
➢ **Parameter Selection**

Meter data and events can be directly viewed from the annunciator panel. By clicking on particular parameter the user can select meter data or event data to be displayed on annunciator panel.



➢ **Parameter Categories**

Meter data to be displayed on annunciator panel is selected from parameter categories like standard, distortion, harmonics, unbalance, user frequency and additional. The selected parameters are displayed on particular cell.



➢ **Event Data Display Option**

Event data to be displayed on the annunciator panel is selected from display option under Event data. The options available are Dip, Swell and Interruption count.

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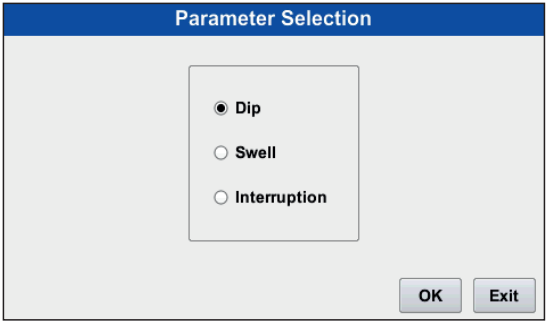
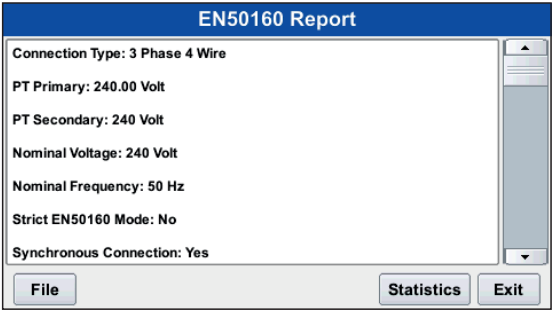
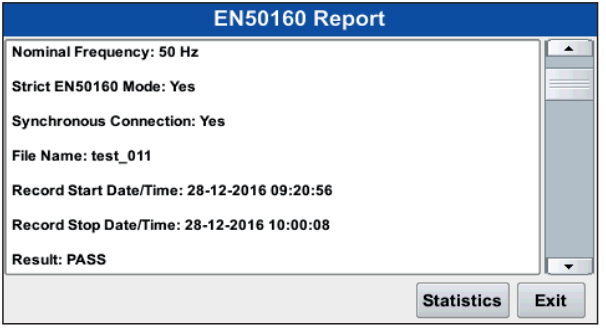


3.4.2 EN50160 Report

EN50160 compliance report is generated only if the file is recorded in EN50160 mode. The report consist of parameters according to EN50160 compliance. The report can be viewed by loading the file from memory card using Load From Card option in setting. Recording must be done in EN50160 mode only for generation of report.



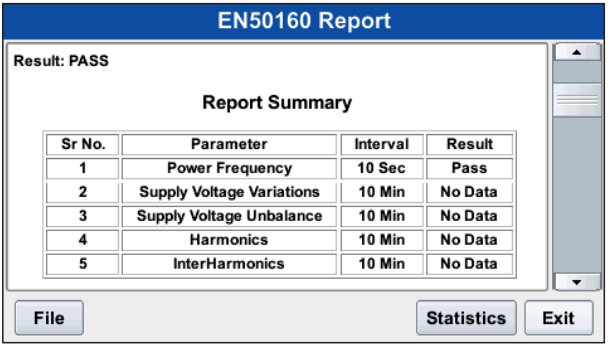
The above screen displays the basic settings of meter such as connection type, PT primary, PT secondary, nominal voltage, nominal frequency and whether strict compliance mode of EN50160 is enabled or not.



The screen shows whether synchronous connection is present or not. If not then it is in Islanded Mode. It also displays start time and stop time of recording. If all parameters are within specified range then result shown is Pass.

- **Report Summary**

The parameters shown under report summary are Power Frequency, Supply Voltage Variations, Supply Voltage Unbalance, Harmonics and Inter Harmonics. Summary shows the interval of test and result i.e., whether pass or fail. Each above parameters have their own detailed table.



- **Power Frequency**

Power frequency table indicates the limits of frequency, required %, actual % and result of recording. For e.g. if 60480 readings are acquired then 57456 reading must be in limit range of frequency and as per standard all reading must be in limit range of frequency which is 47 to 52 Hz, otherwise result will be fail. user can program Required percentage of week and frequency range in setting, but for standard Required percentage of week is fixed to 100%.

- **Supply Voltage**

Supply Voltage Variations table indicates the limits of voltage, required %, actual % of each phase and result of recording.

for e.g. if 1008 readings are acquired then 957 reading must be in limit range and as per standard all reading must be in limit range of voltage which is 204 to 264 V, otherwise result will be fail. user can program Required percentage of week and voltage range in setting, but for standard Required percentage of week is fixed to 100%.

➢ **Supply Voltage Unbalance**

Supply Voltage Unbalance indicates limits of supply voltage unbalance, required %, actual % and result of recording.User can program Required percentage of week and limit range in setting.

➢ **Harmonic Voltage**

Harmonic Voltage up to 25th order is recorded in report and compared with limit of each phase and corresponding Fail/Pass result is indicated.limit is applied to individual phase. user can program Required percentage of week and limit range in setting.

➢ **Inter Harmonic Voltage**

Inter Harmonic Voltage up to 25th order is recorded in report and compared with limits of each phase and corresponding Fail/Pass result is indicated.limit is applied to individual phase. user can program Required percentage of week and limit range in setting

Note:Interharmonic data is recorded only if strict compliance option is disabled.

➢ **Dips, Interruption, Swell**

Dip table shows the voltage measured as percentage of nominal and corresponding duration of particular magnitude also called blocks. For example, an voltage variation with a magnitude of 80-90% of nominal and 10-200msec cycles in duration is one block, whereas 80-90% and 0.2 to 0.5 sec is another and so on. Each time that the characteristics of an voltage variation match the criteria of the block, the counter is incremented.

This type of phenomena are typically found in block groupings such as:

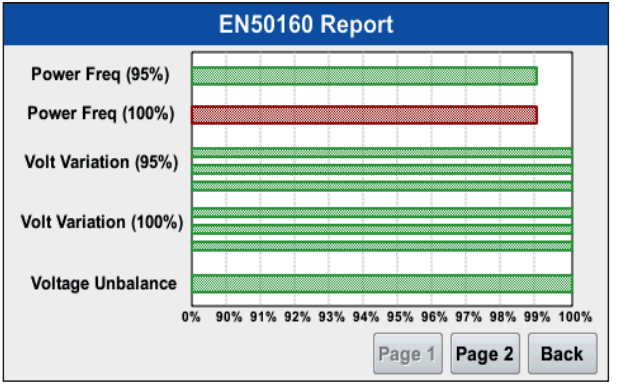
- Dips - classified in 5 Magnitudes x 6 Durations
- Interruptions - classified in 1 Magnitude x 2 Durations
- Swells - classified in 2 Magnitudes x 4 Durations

➢ **Statistics in Report**

Statistics in report indicate bar graph of parameters that are recorded. The parameters like Power Frequency, Supply Voltage Variation, Supply Voltage Unbalance, Harmonic Voltage and Inter Harmonic Voltage are displayed in bar graph form.

➢ **Statistics Graphs**

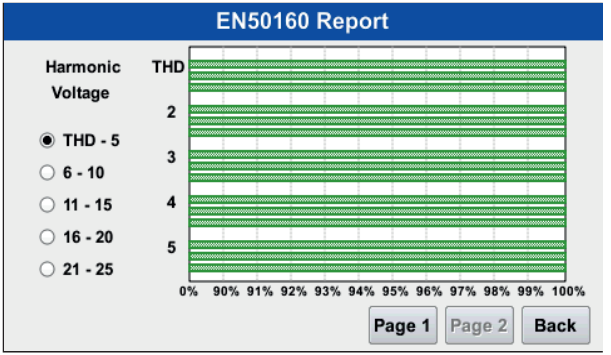
Data recorded in EN50160 report is displayed in graphical format.The red color in the graph indicates that the particular parameter is not within limits(For required % of time) and hence result is fail. The green color indicate that the particular parameter is within specified limits(For required % of time) and result is pass. The X-axis indicate the % of actual time and Y-axis indicate the parameters mentioned above.



In above figure, the red color of power frequency indicate that frequency is below preset limits for required % of time. Hence result of frequency is fail. Green color of supply voltage unbalance indicate that the voltage unbalance is within preset limits for required % of time and hence result is pass for that particular parameter.

➢ **Harmonic Voltage Screen**

By clicking on the page 2 , button harmonic data(from 2nd order to 25th order) stored in report is shown in graphical format.



➢ **Inter Harmonic Voltage Screen**

If inter harmonic data is present then page 3 option will be enabled.By clicking on page 3 interharmonic data recorded in report is shown in graphical format.

CHAPTER 4
PQA SETTINGS

4.1 Introduction

This chapter describes the miscellaneous settings that users can perform to keep the PQA running efficiently. These are settings that user might perform only occasionally. This is used to set time, date, PT/CT ratio, communication set up etc.

This chapter covers following topics.

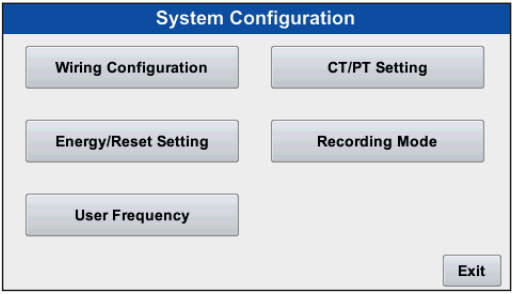
Settings Screen

4.2 System Configuration

System configuration tab includes wiring configuration, CT/PT setting, Energy/Reset setting, recording mode and user frequency. It helps to configure above parameters of meter for required application.

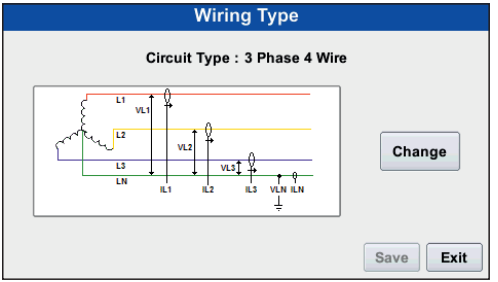
Following configuration options are available for this section

System Configuration Screen



➢ **Wiring Configuration**

Wiring configuration tab provides flexibility to change wiring type. Two wiring configuration are mainly employed which are: Three Phase Four Wire and Three Phase Three Wire connection. By pressing change button user can switch between two configuration. Configuration is selected by pressing Save button.



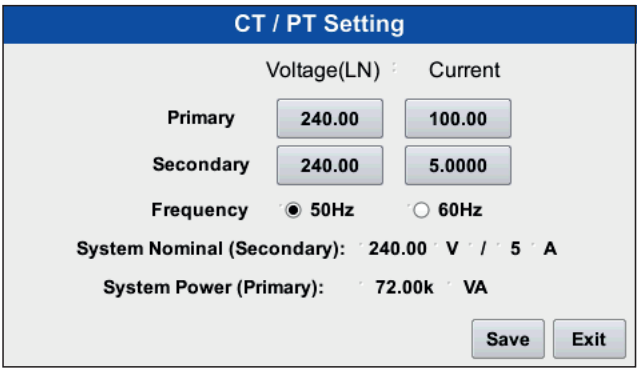
➢ **CT/PT Setting**

CT/PT setting option is used to set primary and secondary of PT/CT, nominal frequency of system and It also display system nominal voltage and current. It also displays System Power in VA. Frequency can be set to 50 Hz or 60 Hz.

Parameter Range Limit

System Type	PT Primary	PT Secondary	CT Primary	CT Secondary
3 Phase, 4 Wire	57 V to 9999 KV	57 VLN to 500 VLN	1 A to 9999 A	1A or 5A
3 Phase, 3 Wire	100 V to 9999 KV	100 VLL to 867 VLL	1 A to 9999 A	1A or 5A

Note: PT or CT limits can vary depending on locking of 5100 MVA System Power.



➢ **Energy /Reset Setting**

This setting allows one to reset parameters, Energy Digit Reset Count & to change energy resolution unit and impulse assignment.

➢ **Reset**

This option is used to reset energy, reset demand, reset maximum & minimum and reset all parameters.

➢ **Energy Digit Reset Count**

Energy Digit Reset Count can be set for 7 digit, 8 digit and 9 digit. According to set value, for e.g. for 7 digit, the reset roll over occurs at 9999999. According to set digit,Roll over occurs. By default Energy reset count is set to 8.

➢ **Energy Resolution Unit**

Energy resolution units can be set for three settings:

- W/VAr/VA
- KW/KVAr/KVA
- MW/MVAr/MVA

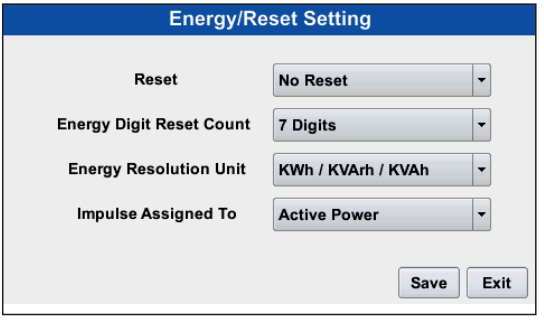
For system power 30 MVA or above, the resolution unit can only set to KW/KVAr/KVA. By default energy resolution is set as KW/KVAr/KVA.

➢ **Impulse Assigned To**

Depending on nominal system power, the numbers of impulses are created to measure the energy. The number of impulses for particular nominal power is set which indicates 1KWh energy. Energy can be Watt, VA or Var. Following table shows the impulses corresponding to nominal system energy by default impulse operates on Active energy.

System nominal power	Impulse constant
<=400	16000
<=800	8000
<=1600	4000
<=3200	2000
>3200	1000

➢ **Energy/Reset Setting Screen**

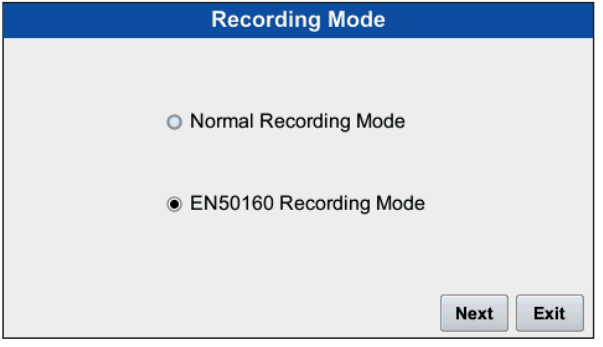


➢ **Recording Mode**

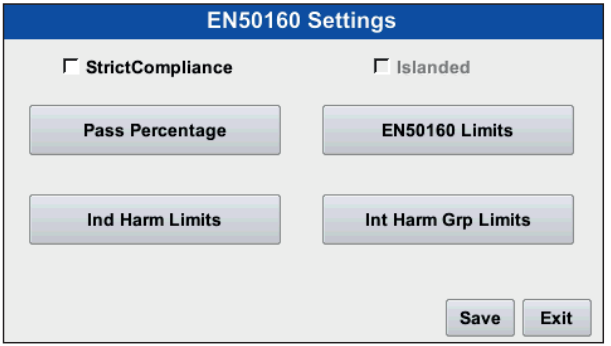
Recording mode can be set either as Normal Power Quality or EN50160 Power Quality. EN50160 has further two settings which are Strict Compliance and Islanded mode.

In strict compliance, the limits of parameters specified under EN50160 are fixed. User cannot change the limits of the parameters.

Recording Mode Selection Screen



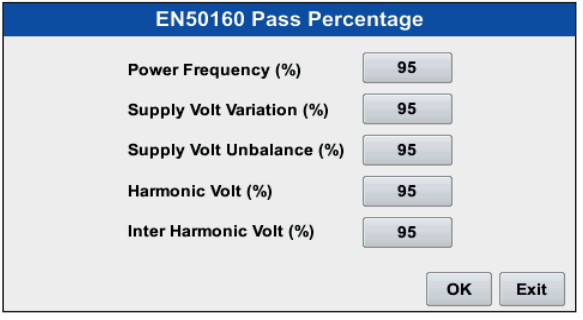
En50160 Mode Selection Screen



The nominal frequency of the supply voltage is 50/60 Hz. But for system with no synchronous connection to an interconnected system(Eg: supply system on certain islands) there is certain relaxation on limits of frequency. When strict compliance Mode is disabled user can set pass percentage, EN50160 limits, individual harmonic percentage and group inter harmonic limits.

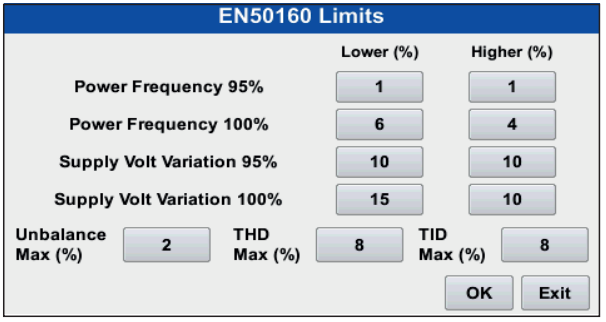
➢ **Pass Percentage**

Pass Percentage values for various parameters are specified. In this user can set the values of various parameter which will determine in report whether test is pass or fail.



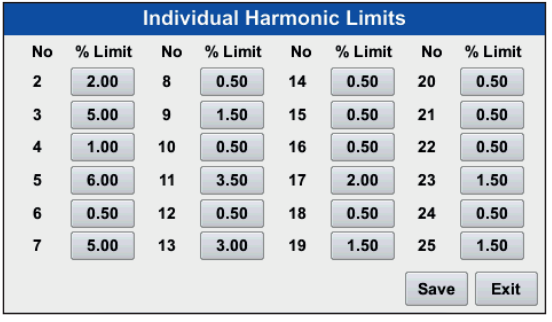
➢ **EN50160 Limits**

An EN50160 limit specifies the power frequency, voltage variation, unbalance voltage maximum and minimum deviation value. User can also specify the THD and TID maximum value limits. The limits of parameters should be greater than 0.01 and less than 100.



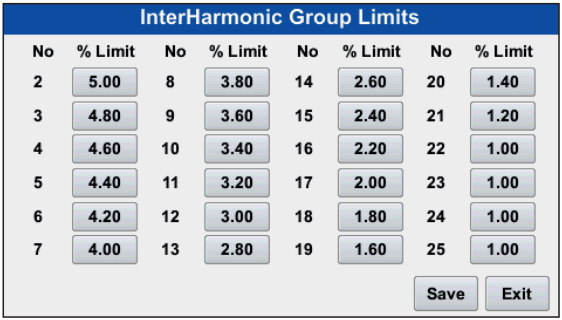
➢ **Individual Harmonic Limits**

It can set using following option. User can set individual harmonics limit up to 25th order. Eg: limits for 2nd harmonic is set to 2% then value measured should not exceed it's set limit. The limits of parameters should be greater than 0.01 and less than 100.



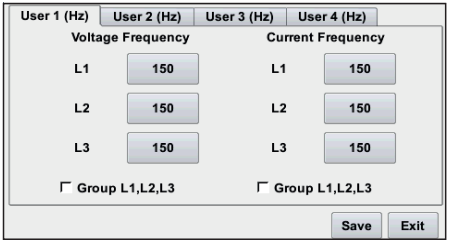
➢ **Inter Harmonic Group Limits**

Inter harmonics group limit is used to set inter harmonics group limit for group using this option. User can set value up to 25th number. option. The limits of parameters should be greater than 0.01 and less than 100. Eg: limits for 2nd harmonic group is set to 5% then value measured should not exceed it's set limit.



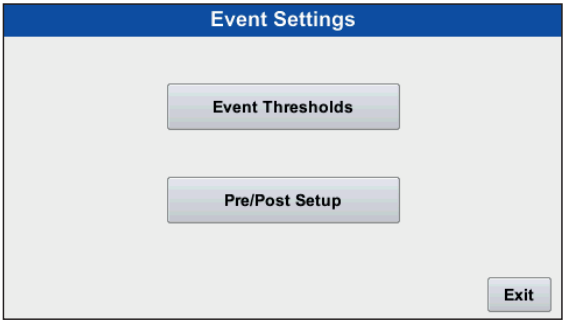
➢ **User Frequency**

User frequency setting is provided to set different frequencies for Voltage and Current of each phase. Four different configuration for frequencies can be set. User can click on Group L1,L2,L3 to set same frequency for each phase. This will provide voltage and current values for particular set frequencies in User Frequency tab in Meter. The value to be entered should be a multiple of 5 and should not be greater than 4160 value.



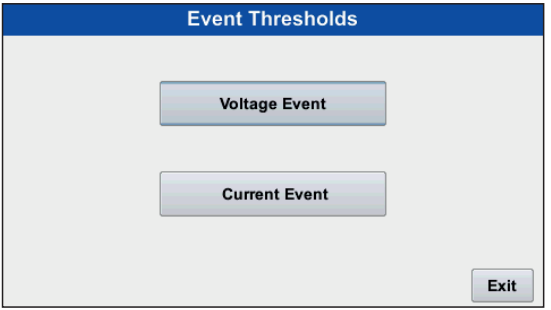
4.3 EVENT SETTINGS

Event setting enables the user to set threshold values for various events such as sag, swell and interruption. User can also configure pre-post waveform cycle which needs to be recorded when event occurs.



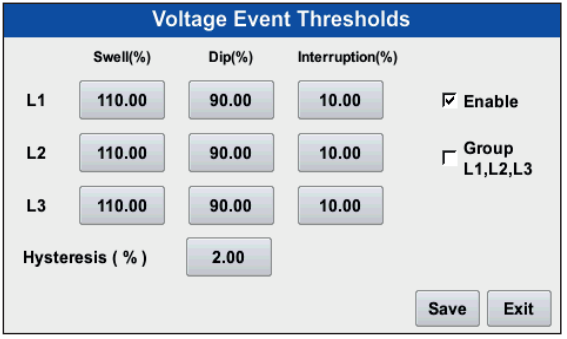
➢ **Event Thresholds**

In event thresholds, user can set voltage and current threshold for events. User can set threshold values for swell, dip and interruption event. User can set hysteresis for events.



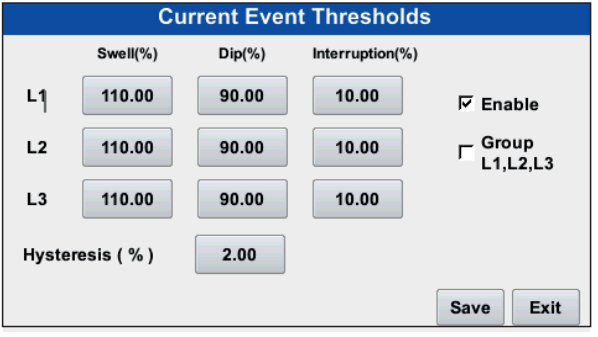
➢ **Voltage Event**

For voltage event, user can set threshold values for voltage dip, voltage swell and voltage interruption with hysteresis in percentage. Group L1,L2,L3 option is used to set common threshold values for all phases by selecting it. User can also disable all events threshold by unselecting Enable option. The threshold for particular event for particular phase can also be disabled.



➢ **Current Event**

For current event, we can set threshold values for current dip, current swell and current interruption with hysteresis in percentage. All features are same as voltage event.



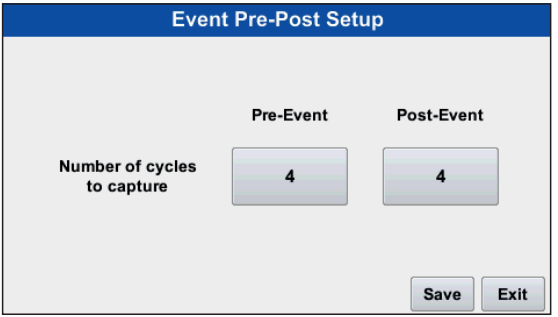
➢ **Limits of parameter**

Parameter	Limits
Interruption	1 to 10%
Dip	1 to 90%
Swell	110 to 150%
Hysteresis	1 to 20%

Note:
Swell(%)> Dip(%)>Interruption(%)

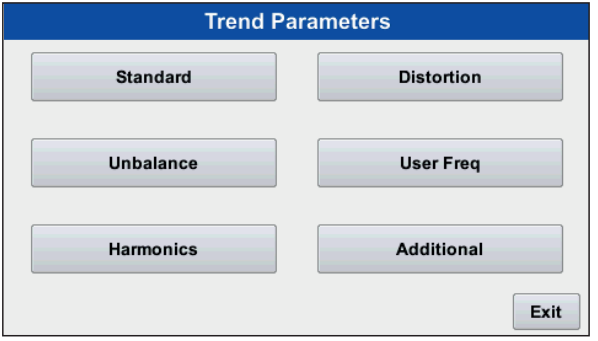
➢ **Pre/Post Setup**

In Pre/Post Setup, the number of cycles and RMS to be captured is determined. The pre count shows number of cycles before event occurance and post shows count after event occurance. Pre-Event count can be between 1 to 30 and Post-Event count can be between 1 to 30.



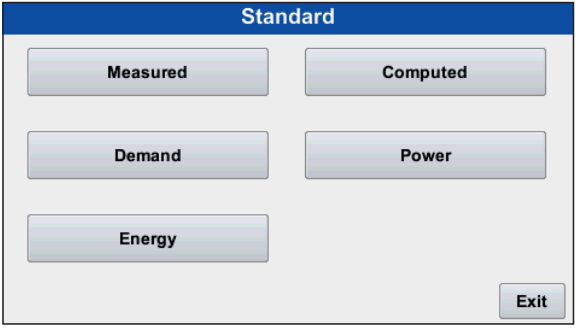
4.4 Trend Parameters

Trend parameters are enable/disable by using trend parameters setting. It consist of standard, distortion, harmonics, unbalance, user frequency and additional sub menus to set parameters.



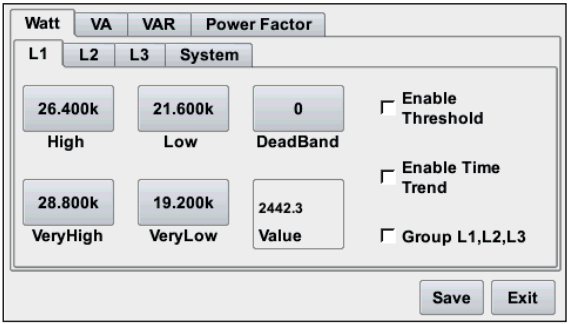
➢ **Standard**

In Standard tab of trend parameters, the parameters such as measured voltage, current, frequency, power, demand and energy can be set.



➢ **Power**

Power tab of standard parameter is used to set threshold for active, reactive and apparent power. User can set threshold for power factor also. **Enable Threshold** is used to enable threshold based trend display. **Enable Time Trend** is used to enable time based trend display. In this, based on trend interval set the trend graphs are generated after specified time interval. **Group L1,L2,L3** is used to set common limits for all phases. Very High, High, Low, Very Low and dead band specifies the trend limits for threshold based trend setting. Based on set limits the threshold based trend is plotted. Refer table no. 10 for trend parameters limit.



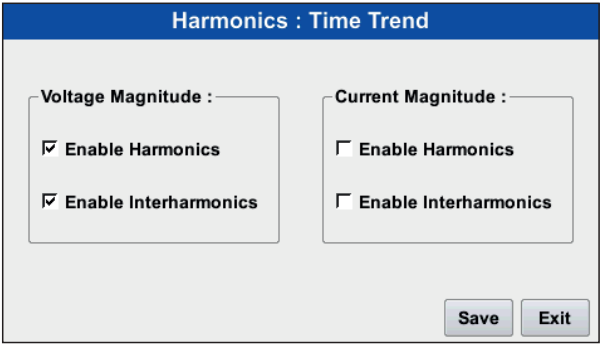
Note: Similarly the other parameters under

- Standard tab -Measured,computed, demand etc.
- Distortion tab - THD,TID,Crest factor,power
- Unbalance tab- V/I sequence,V/I unbalance,V/I imbalance
- User Frequency- Voltage ,Current
- Additional- Arithmetic sum,Vector sum,Coincident demand,Coincident PF

can be explained

➢ **Harmonics**

Harmonics and inter harmonics voltage and current magnitude time based trend can be enable or disable using this tab.



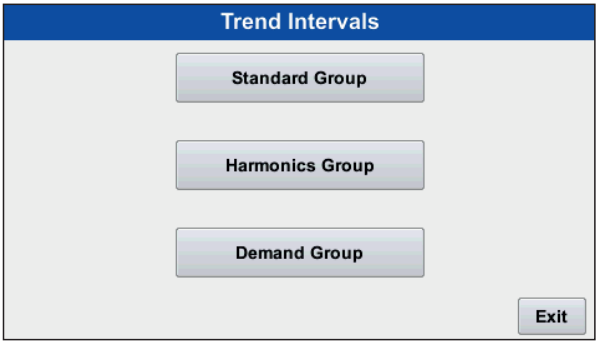
User can enable/ disable Harmonics and Inter Harmonics of Voltage and Current for trend display from Harmonics option in Trend Parameter Selection.

4.5 Trend Intervals

Trend interval is used to set the time period to capture the data to represent the trend of data over period of time.Trend interval is set for standard group,harmonic group and demand group.

Trend Interval screen

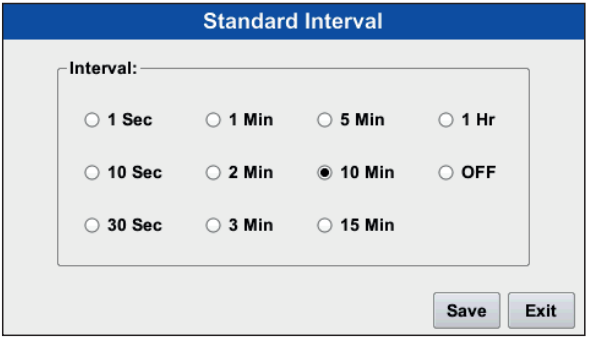
Trend interval is set for various group through this screen.



➢ **Standard Group**

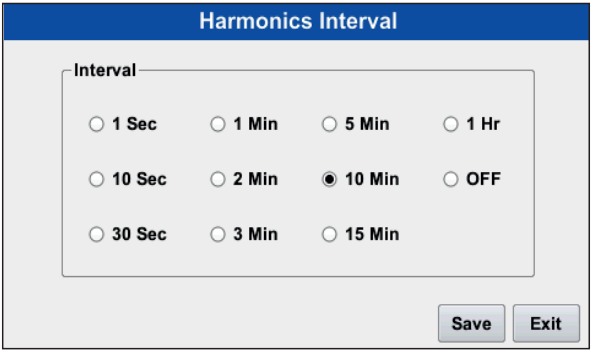
In standard group, the basic parameter such as voltage, current, power, energy etc are included. Using standard group trend interval, the trend interval can be set. It can be set to 1 Sec, 10 Sec, 30 Sec, 1 Min, 2 Min, 3 Min, 5 Min, 10 Min, 15 Min and 1 Hr. User can keep trend interval OFF too.

Standard Interval Screen



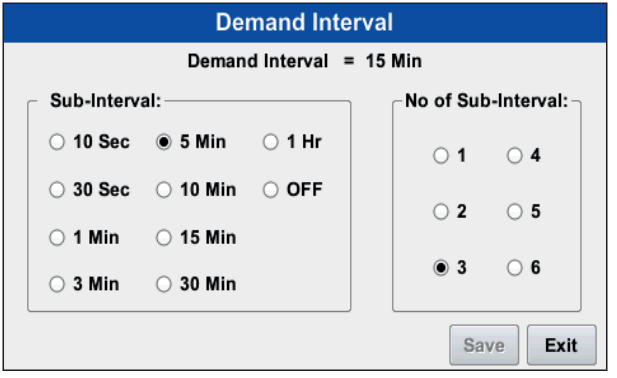
➢ **Harmonics Group**

In harmonic group, the trend interval can be set for THD, TID etc. for the harmonics trend. Similarly trend interval can be 1 Sec, 10 Sec, 30 Sec,1 Min,2 Min,3 Min, 5 Min, 10 Min, 15 Min and 1 Hr. User can keep trend interval OFF too.



➢ **Demand Group**

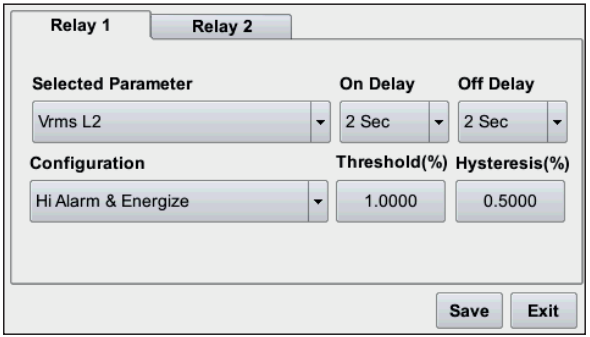
In demand group, the current or power demand are considered. So the trend interval for various demand can be set. User can set number of sub-interval for demand group. Based on the calculation from sub-interval and number of sub-interval, the demand trend interval is set.



4.6 Relay Setting

Relay setting is used to configure the relays for limit action. Parameters for which relay limit action is provided. It includes basic parameters, harmonic parameters, demand parameters. Relay limit action can be disabled by selecting 'None' as Selected Parameter. ON delay and OFF delay can be set for both relays. Hysterisis and threshold value for selected parameter can also be set. There are four different configuration for both relays.

Relay Setting Screen



- **Selected Parameter**
  In selected parameter, user can select the parameter depending on which relay limit action is required. User can select required parameter from specified list which include standard basic parameters, harmonic parameters and demand parameters using this option.
- **ON Delay**
  ON delay of the relay can be set between 1 Sec to 10 Sec. User can set different ON delay for both relays.
- **OFF Delay**
  OFF delay of the relay can be set between 1 Sec to 10 Sec. User can set different OFF delay for both relays.

- **Configuration**

  In configuration, we can configure relays to various configuration such as:

1. Hi Alarm & Energize
2. Hi Alarm & De-Energize
3. Low Alarm & Energize
4. Low Alarm & De-Energize.

- **Threshold**

  User can set threshold value for relays using this option.

- **Hysteresis**

  Hysteresis for parameters can be set from this option. Based on set hysteresis, the relay would energize or de-energize.

- **Hi Alarm**

  If Hi-Alarm Energized or Hi Alarm De-Energized option is selected then relay will get energized or De-Energized, if selected parameter is greater than or equal to trip point.

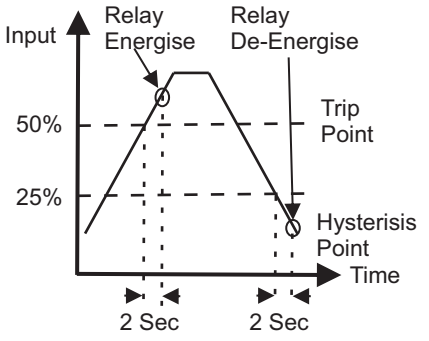
- **Lo Alarm**

  If Lo-Alarm Energized or Lo Alarm De-Energized option is selected then relay will get energized or De-Energized, if selected parameter is less than or equal to trip point.

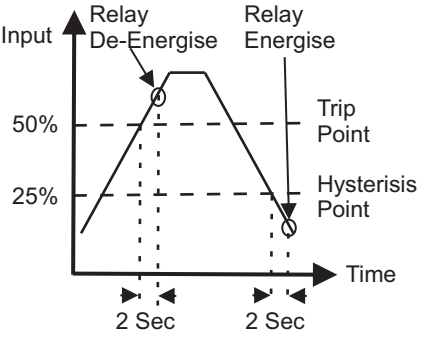
Note: Threshold and Hysteresis value depends on the selected parameter, for this refer table no.15.

Example of different configuration:
Parameter: Current
Trip Point = 50%
Hysteresis = 50% of trip point
Energising Delay= 2 Sec
De-Energising Delay = 2 Sec

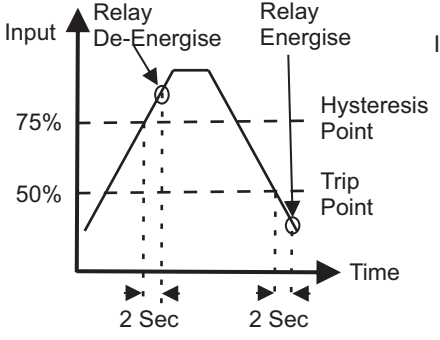
High Alarm & Energise Relay



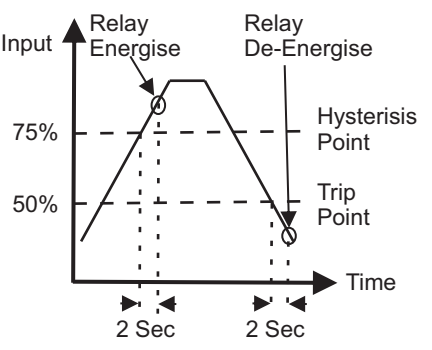
High Alarm & De-energise Relay



Low Alarm & Energise Relay



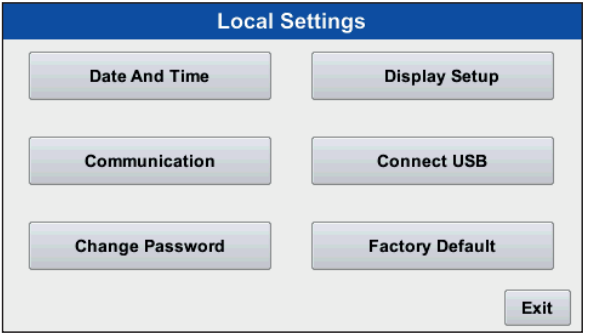
Low Alarm & De-energise Relay



4.7 Local Settings

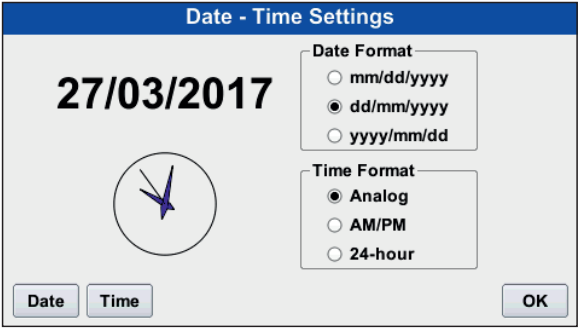
Local Settings is used to set Date & Time, Display configuration, Communication settings, factory default, Change Password and Connect USB as shown below.

Local Settings Screen



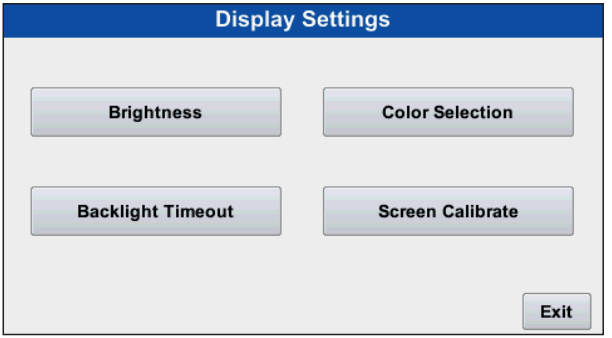
➢ **Date And Time**

User can set date and time from this option. User can set date and time format both.



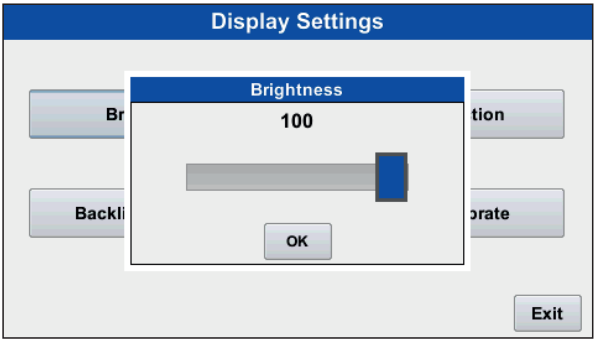
➢ **Display Settings**

Display settings are used to set back light timeout, brightness of screen, color selection for each phase for current and voltage and touch screen calibration.



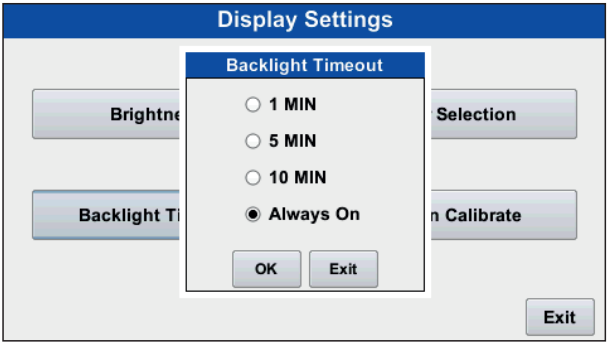
➢ **Brightness**

Brightness of the screen can be set using this option of display setting. It can be varied from 5 to 100 %.



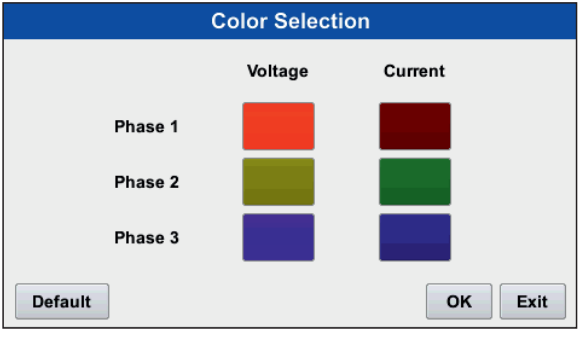
➢ **Back light Timeout**

In back light timeout, user can set back light timer for screen. User can set back light time as 1 Min, 5 Min, 10 Min and can keep it always ON. After set time the screen back light is turn OFF. User can turn ON screen by just touching it.

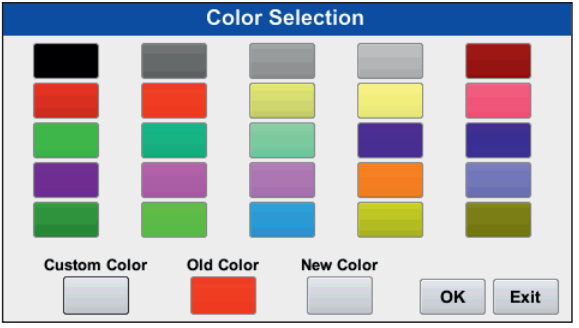


➢ **Color Selection**

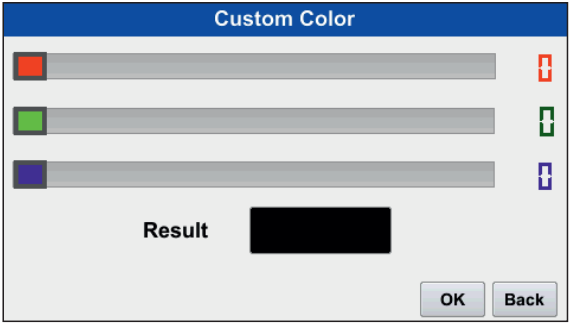
Color selection tab is used to assign color for each phase. The color effect is seen in Meter, Harmonics, Scope, Phasor, Events. The parameters associated with respective phases are represented with that particular color.



User can select particular color for each phase from some fix ed defined colors by clicking on the phase color tab on previous screen. It displays the old and new color also.

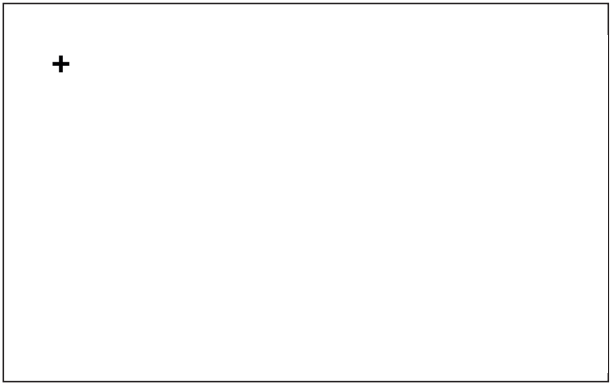


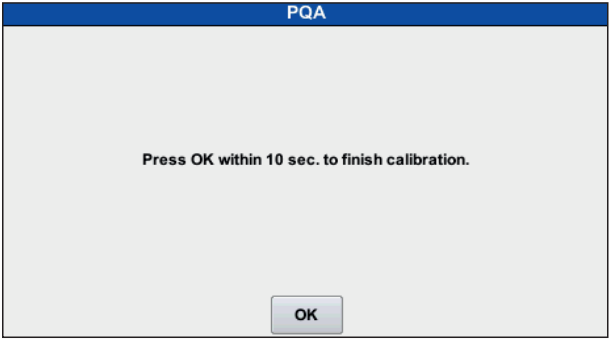
User can also customize the color by clicking on Custom Color. In custom color, the user can set the R-G-B value to obtain particular color.



➢ **Screen Calibrate**

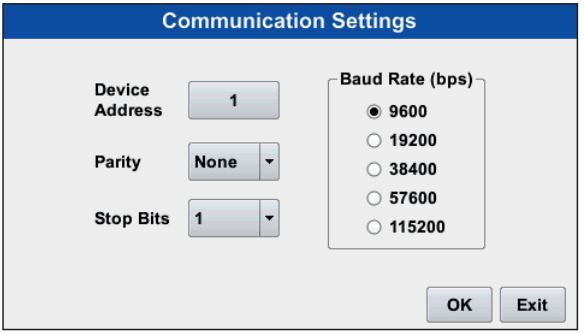
In screen calibrate, the touch screen calibration is done by touching each + mark on the screen. The '+' mark appears 5 times. If calibration is done properly then message box appears. The user has to press OK within 10 seconds to complete calibration.





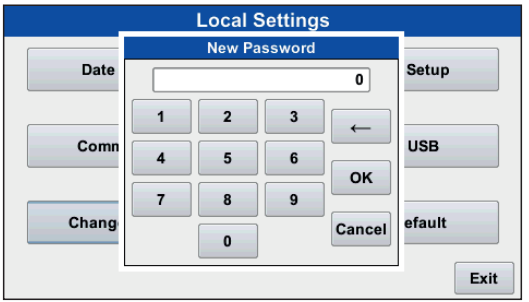
➢ **Communication**

In communication setting, user can assign device address(1 to 247), parity(even or odd), number of stop bits(1 or 2) and baud rate of data transfer.



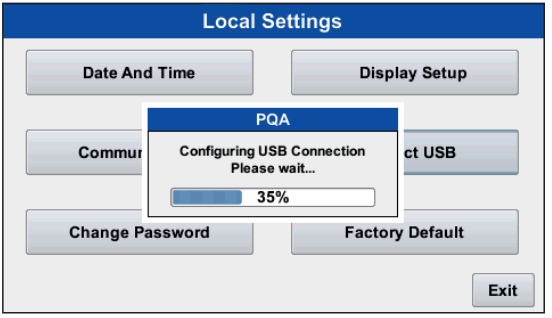
➢ **Change Password**

Change password is used to change the password to enter the settings or record tab. By default the password is”0000”.password must be of 4 digits.



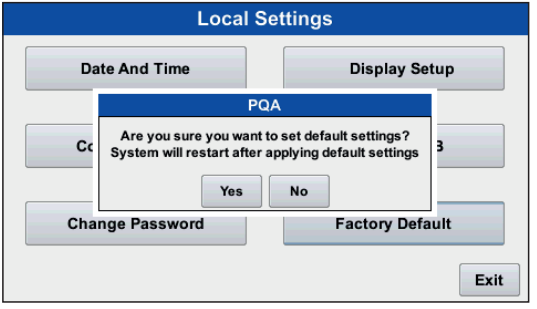
➢ **Connect USB**

For USB communication, user has to click on connect USB option. After that configuration window will be displayed, when it reaches to 100% USB is configured and connection between computer and meter is established.



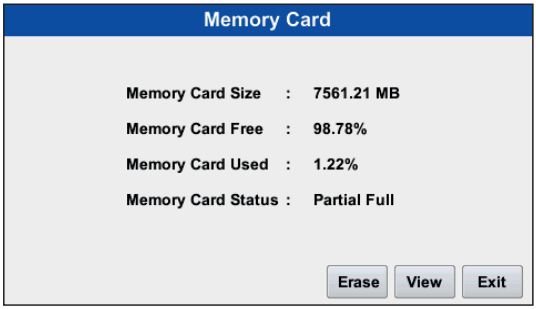
➢ **Factory Default**

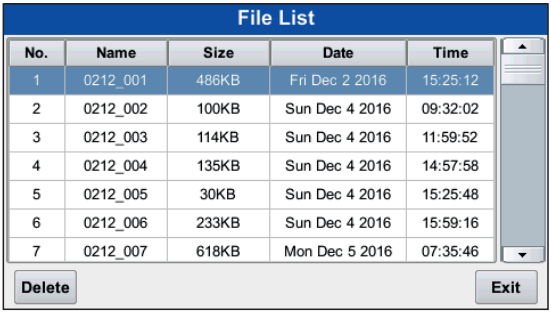
Factory default is used to factory reset the device. After selecting default option, the device automatically restarts. The stored data on memory card is retained.



4.8 Memory Card

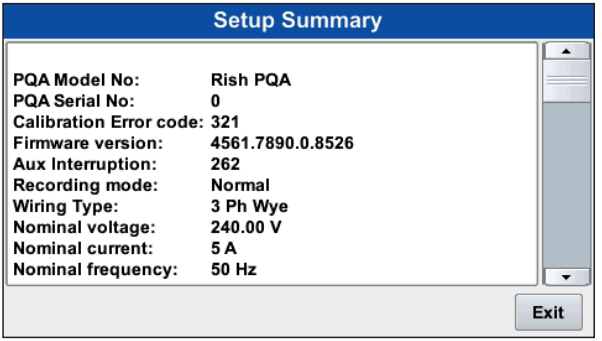
Memory card option shows the total memory card size, free memory space, memory space used and memory card status. User can erase the complete data of the memory card. User can also view files recorded in memory card. User can delete particular file from view option.





4.9 Setup Summary

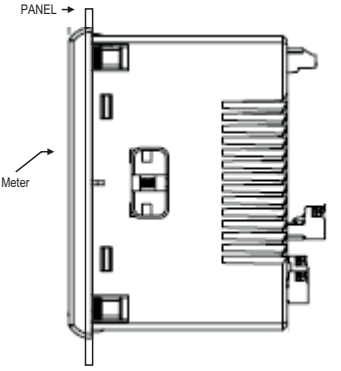
Setup summary provides information about our device configuration. User gets information about PQA Model No, Recording mode, Wiring Type, Nominal Voltage, Nominal Current and Nominal frequency. It also gives data about CT/PT setting, Event threshold, trend interval etc. It provides complete setting configuration summary in a single pack.



Chapter 5
Installation Settings

5.1 Installation

Mounting is by four side clamps, slide the side clamps through side slot till side clamp gets firmly locked in a groove (Refer fig.) Consideration should be given to the space required behind the instrument to allow for bends in the connection cables.



As the front of the enclosure conforms to IP54 it is protected from water spray from all directions, additional protection to the panel may be obtained by the use of an optional panel gasket. The terminals at the rear of the product should be protected from liquids. The instrument should be mounted in a reasonably stable ambient temperature and where the operating temperature is within the range -10 to 55 ^{0}C . Vibration should be kept to a minimum and the product should not be mounted where it will be subjected to excessive direct sunlight.

Caution

1. **In the interest of safety and functionality this product must be installed by a qualified engineer, abiding by any local regulations.**
2. **Voltages dangerous to human life are present at some of the terminal connections of this unit. Ensure that all supplies are de-energised before attempting any connection or disconnection.**
3. **These products do not have internal fuses therefore external fuses must be used to ensure safety under fault conditions.**

5.2 EMC Installation Requirements

This product has been designed to meet the certification of the EU directives when installed to a good code of practice for EMC in industrial environments, e.g.

1. Screened output and low signal input leads or have provision for fitting RF suppression components, such as ferrite absorbers, line filters etc., in the event that RF fields cause problems.

Note: It is good practice to install sensitive electronic instruments that are performing critical functions, in EMC enclosures that protect against electrical interference which could cause a disturbance in function.

2. Avoid routing leads alongside cables and products that are, or could be, a source of interference.

3. To protect the product against permanent damage, surge transients must be limited to 2kV pk. It is good EMC practice to suppress differential surges to 2kV at the source. The unit has been designed to automatically recover in the event of a high level of transients. In extreme circumstances it may be necessary to temporarily disconnect the auxiliary supply for a period of greater than 5 seconds to restore correct operation.

   The Current inputs of these products are designed for connection in to systems via Current Transformers only, where one side is grounded.

4. ESD precautions must be taken at all times when handling this product.

5.3 Wiring

Input connections are made directly to screw-type terminals with indirect wire pressure. Numbering is clearly marked in the plastic moulding. Choice of cable should meet local regulations. Terminal for both Current and Voltage inputs will accept upto $3mm^2$ x 2 diameter cables.

Note : It is recommended to use wire with lug for connection with meter.

5.4 Auxiliary Supply

The instrument should ideally be powered from a dedicated supply, however it may be powered from the signal source, provided the source remains within the limits of the chosen auxiliary voltage.

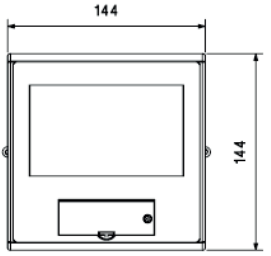
5.5 Fusing

It is recommended that all voltage lines are fitted with 1 amp HRC fuses.

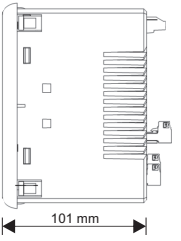
5.6 Earth/Ground Connections

For safety reasons, CT secondary connections should be grounded in accordance with local regulations.

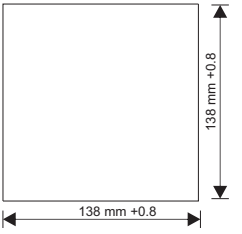
5.7 Case Dimension and Panel Cut Out



Front View

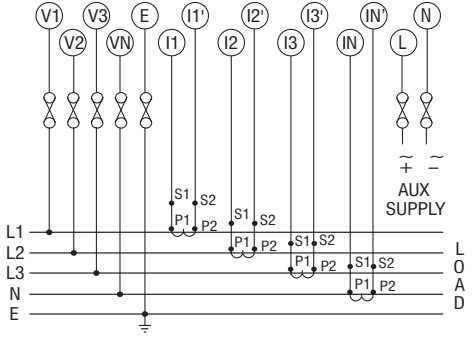


Side View

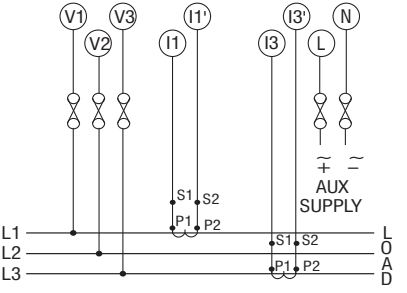


Panel Cutout

5.8 Connection diagram

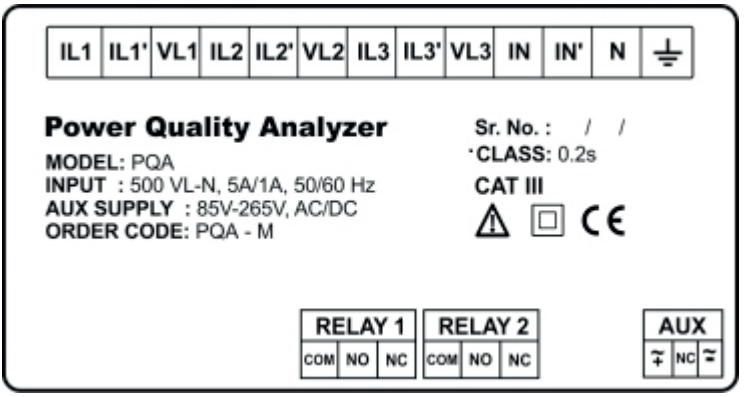


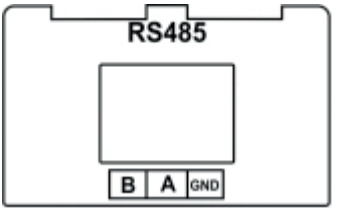
a) 3 Phase 4 Wire



b) 3 Phase 3 Wire

5.9 Terminal diagram





APPENDIX A: Technical Specification

Parameter	Measurement Method	Uncertainty	Measuring Range
Power Frequency	1 s and 10 s	±10 mHZ	42.5 Hz ~ 57.5 Hz / 51 Hz ~ 69 Hz
Magnitude of the supply voltage	10 / 12 cycle	±0.1% of Udin	10 % ~ 150 % of Udin
Input Current	10 / 12 cycle	±0.2% of Nominal	0.1-200% of Nominal
Dips and swells	Urms (1/2)	Amplitude: ±2% of Udin Duration: 1 + 1 cycle	+/- 0.2% of Nominal
Interruptions	Urms (1/2)	Duration: 1 + 1 cycle	duration > 2.5 cycles
Voltage/Current Unbalance	10 / 12 cycle	±0.15%	0% - 5% of U1
Voltage harmonics 1 to 63rd(Harmonics Grouping)	10 / 12 cycle	IEC 61000-4-7 class II ±5% Um ±0.15% Unom	10% ~ 200% of class 3 of IEC 61000-2-4 Um ≥ 3%Unom Um < 3% Unom
Current harmonics 1 to 63rd(Harmonics Grouping)	10 / 12 cycle	IEC 61000-4-7 class II ±5% Im ±0.5% Inom	10% ~ 200% of class 3 of IEC 61000-2-4 Im ≥ 10% Inom Im < 10% Inom
Voltage interharmonics 1 to 63rd(Interharmonics Grouping)	10 / 12 cycle	±10% Um ±0.30% Unom	10% ~ 200% of class 3 of IEC 61000-2-4 Um ≥ 3% Unom Um < 3% Unom

Parameter	Measurement Method	Uncertainty	Measuring Range
Current interharmonics 1 to 63rd(Harmonics Grouping)	10 / 12 cycle	±10% Im ±1% Inom	10% ~ 200% of class 3 of IEC 61000-2-4 Im ≥ 10% Inom Im < 10% Inom

Note: Unom / Inom : Nominal Voltage / Current (TRMS),
Um / Im : Measured Harmonic Voltage / Current
10 cycle for 50 Hz and 12 cycle for 60 Hz.
Reference channel for frequency detection is U1.

Parameter	Range	Accuracy
Nominal Input Voltage	100-866V(L-L),57.7-500V(L-N)	
System PT Primary Values	100V(L-L) to 9999kV(L-L)	On site Programmable
Measuring Range	10V for 500V(L-N)	
Volts (AC)	10-150% of Nominal	+/- 0.2% of Nominal
Vpeak	7Vpk to 707.1 (L-N)	+/- 5% of Nominal
Max. continuous input voltage	750V(L-N),1.3kV(L-L)	
Crest Factor (Voltage)	2.12 at Nominal	
Nominal Input Current	1A / 5A	
System CT Primary Values	1A to 9999A	On site Programmable
Starting Current	1mA for 1A, 5mA for 5A	
Amps (AC)	0.1 -200 % of Nominal	+/- 0,2% of Nominal
Apeak	0.0014Ipk to 14.14Ipk	+/- 5% of Nominal
Crest Factor (Current)	2.8 at Nominal	
Frequency (50 / 60 Hz)	45 Hz to 66 Hz	+ / 0.15%
Power Active (W) Apparent (VA) Reactive (VAr) Power Factor		 +/- 0.2 % of Nominal +/- 0.2 % of Nominal +/- 1% of Nominal 1

Parameter	Range	Accuracy
Eight Channel Sampling Rate	50kHz Per Channel	
Udin	230V L-N / 400V L-L	
Unbalance Volts Amps	 0 to 5% 0 to 20 %	 +/- 1% +/- 1%
Energy kWh kVArh kVAh		Class 0.2S as per IEC 62053-22 Class 2 as per IEC 62053-23 0.2

Parameter	Range
Applicable Standards Power Quality EMC Immunity Safety IP for Water & dust Pollution Degree Installation Catagory High Voltage Test	 EN50160 IEC 61326-1 IEC 61000-4-3 IEC 61010-1-2010(Permanently Connected) (IP 54 for Front) IEC 60529 2 CAT III 300V 3kV AC (1 minute between all circuit)
Auxiliary Supply External Aux Aux Supply Frequency	 85 - 265 AC-DC 50 / 60 Hz (+ / - 10%)
VA Burden Nominal Input Voltage Burden Nominal Input Current Burden Auxiliary Supply Burden	 < 0.2 VA approx per phase < 0.2 VA approx per phase <15 VA approx
Enviromental Conditions, Other Info Operating Temperature Storage Temparature Relative humidity Shock Vibration Temparature Co-efficient	 -20 to 70 Degree Celcius -40 to 85 Degree Celcius 0-95 % Non Condensing 15g in 3 planes 10...150...10 Hz, 0,15mm amplitude 0.05% per Degree Celcius

Parameter	Range
Real Time Clock (RTC) uncertainty:	±1 Sec/Day (23°C ± 1°C) (Trimmable through display or Modbus)
Display update rate: Response time to step input	 1 sec approx.
Interfaces: Impulse Led Relay Output Load Capacity Contact ModBus / RTU USB SD card interface	 At front of the instrument. Configured as limit. 240 V AC ,5 A Change over contact, bistable RS485, max. 1200m Baud rate: 9.6k, 19.2k, 38.4k, 57k, 115.2k bps At front side of instrument MicroSD Up to 8 GB (Maximum event recorded per file is 4000)

APPENDIX B: PQ Parameter Calculations

Description	Abbreviation	Formula	Units
Zero Sequence	U0	$V0_a = \frac{1}{3}[V_1 + V_2 + V_3]$	None
Positive Sequence	U1	$V1_a = \frac{1}{3}[V_1 + aV_2 + a^2V_3]$	None
Negative Sequence	U2	$V2_a = \frac{1}{3}[V_1 + a^2V_2 + aV_3]$	None
Unbalance	U2/U1	$\frac{U2}{U1}$	None
Unbalance	U0/U1	$\frac{U0}{U1}$	None
Imbalance	RMS/Avg RMS	*Max of imbalance*	%
Imbalance	V/I Imbalance	$\frac{\lvert V_{aRms\_avg} - RMS\rvert}{RMS_{Avg}} * 100$	%

where, $a = -\frac{1}{2} + j\frac{\sqrt{3}}{2}$

Description	Abbreviation	Formula	Units
VA Vector Total Fund	Vector Sum VA	$VA_{vect\_fund\_total} = \sqrt{W_{fund-tot}{}^2 + VAR_{fund-tot}{}^2}$	VA
VA Arithmetic Fundamental Total	Fund Arithmetic Sum VA	$VA_{1\ fund} + VA_{2\ fund} + VA_{3\ fund}$	VA
Vector Sum Power Factor	Vect Sum PF	$\frac{W_{tot}}{VA_{tot\ -\ vector}}$	None
Arithmetic Sum Power Factor	Arithmetic Sum PF	$\frac{W_{tot}}{VA_{tot\ -\ arithmetic}}$	None
Arithmetic Sum Displacement Power Factor	Arithmetic Sum DPF	$\frac{W_{tot}}{VA_{tot\ -\ arithmetic\_fund}}$ VA derived from DFT fundamental	None
Vector Sum Displacement Power Factor	Vector Sum DPF	$\frac{W_{tot\_fund}}{VA_{tot\ -\ vector\_fund}}$ VA derived from DFT fundamental	None

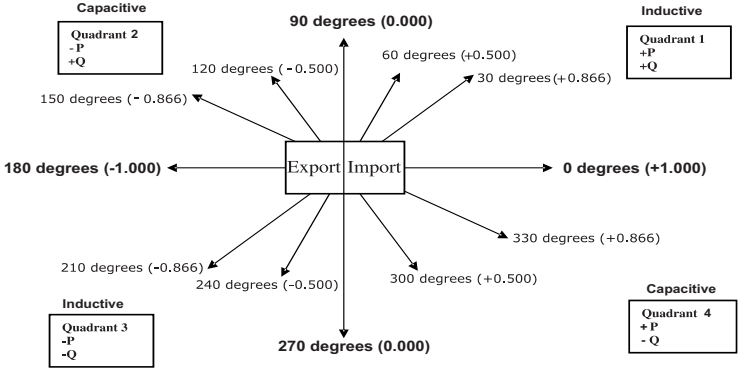
Description	Abbreviation	Formula	Units
Total Voltage Harmonic Distortion Normalized to the fundamental	VTHD Fund (%)	$\frac{\sqrt{V_{H2}^2 + V_{H3}^2 + \ldots\ldots V_{H63}^2}}{V_{Hfund}} * 100$ Per 61000-4-7	%
Total Current Harmonic Distortion Normalized to the fundamental	ITHD Fund (%)	$\frac{\sqrt{I_{H2}^2 + I_{H3}^2 + \ldots\ldots I_{H63}^2}}{I_{Hfund}} * 100$ Per 61000-4-7	%
Total Voltage Inter Harmonic Distortion Normalized to the fundamental	VTID Fund (%)	$\frac{\sqrt{V_{Hig2}^2 + V_{Hig3}^2 + \ldots\ldots V_{Hig63}^2}}{HV_{fund}} * 100$ HigV is voltage Inter-Harmonic Group	%
Total Current Inter Harmonic Distortion Normalized to the fundamental	ITID Fund (%)	$\frac{\sqrt{I_{Hig2}^2 + I_{Hig3}^2 + \ldots\ldots I_{Hig63}^2}}{HI_{fund}} * 100$	%
Total Voltage Harmonic Distortion Root Sum of Squares(RSS)	VTHD RSS (%)	$\sqrt{V_{H2}^2 + V_{H3}^2 + \ldots\ldots V_{H63}^2}$	%
Total Voltage Inter Harmonic Distortion Root Sum of Squares(RSS)	VTID RSS (%)	$\sqrt{V_{Hig2}^2 + V_{Hig3}^2 + \ldots\ldots V_{Hig63}^2}$	%

Description	Abbreviation	Formula	Units
Total Odd Voltage Harmonic Distortion Normalized to the fundamental	VOHD	$\frac{\sqrt{V_{H3}^2 + V_{H5}^2 + \ldots\ldots V_{H63}^2}}{V_{Hfund}} * 100$	%
Total Even Voltage Harmonic Distortion Normalized to the fundamental	VEHD	$\frac{\sqrt{V_{H2}^2 + V_{H4}^2 + \ldots\ldots V_{H62}^2}}{V_{Hfund}} * 100$	%
Total Current Odd Harmonic Distortion Normalized to the fundamental	IOHD	$\frac{\sqrt{I_{H3}^2 + I_{H5}^2 + \ldots\ldots I_{H63}^2}}{V_{Hfund}} * 100$	%
Total Current Even Harmonic Distortion Normalized to the fundamental	HIEHD	$\frac{\sqrt{I_{H2}^2 + I_{H4}^2 + \ldots\ldots I_{H62}^2}}{V_{Hfund}} * 100$	%
VA Power Vector sum	VA_{vector_tot}	$VA_{Arith\_tot} = \sqrt{W_{tot}^2 + VAR_{tot\_fund}^2}$	VA
VA Power Arithmetic sum	VA_{arith_tot}	$VA_{vect\_Tot} = VA_1 + VA_2 + VA_3$	VA

Description	Abbreviation	Formula	Units
Total Harmonic Unsigned Power	Unsigned(W)	$\sum_{2}^{63} \lvert V_n * I_n * Cos\varnothing \rvert$	Watts
Total Harmonic signed Power	Signed(W)	$\left\lvert \sum_{2}^{63} [V_n * I_n * Cos\varnothing] \right\rvert$	Watts

APPENDIX C: Phasor diagram

Quadrant 1: 0° to 90°
Quadrant 2: 90° to 180°
Quadrant 3: 180° to 270°
Quadrant 4: 270° to 360°



Connections	Quadrant	Sign of Active Power (P)	Sign of Reactive Power (Q)	Sign of Power Factor (PF)	Inductive / Capacitive
Import	1	+ P	+ Q	+	L
Import	4	+ P	- Q	+	C
Export	2	- P	+ Q	-	C
Export	3	- P	- Q	-	L

Inductive means Current lags Voltage
Capacitive means Current leads Voltage

When the instrument displays Active power (P)with " + " (positive sign) , the connection is " **Import** " .

When the instrument displays Active power (P)with " - " (negative sign) , the connection is " **Export** " .