



Powerware

**Installation and Operation Manual for Powerware
PXL Series Surge Protective Device**

**Instruction Manual:
IM01005001E**

PXL Installation Manual

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Section 1 Introduction

The PXL series of Surge Protective Devices (referred to as PXL from this point forward) offer surge protection and filtering to provide clean power for sensitive electronic loads. The PXL units shunt high energy induced lightning surges, as well as other formats of transient disturbances. Properly installed PXL units protect critical equipment in hospital, commercial, computer manufacturing, telecommunication, financial and military facilities.

The PXL removes power disturbances from electrical distribution systems using a low impedance shunt path to ground. Surges and electrical line noise are absorbed by the PXL and are prevented from traveling through distribution system wires to sensitive electronic loads. Prior to installing the PXL check the units voltage and configuration to verify it matches your system voltage and wiring configuration.

WARNING

INSTALLING A PROTECTION DEVICE WHICH IS UNDER-RATED FOR THE ELECTRICAL SYSTEM VOLTAGE CAN CREATE A POTENTIALLY HAZARDOUS CONDITION

Section 2 of this manual details the installation procedures for the PXL Series SPDs.

Section 3 of this manual describes the operating features for the PXL Series SPDs.

Section 4 of this manual provides a detailed troubleshooting guide.

Note: Surge Protective Devices and Hi-Potential (Hi-Pot) Testing.

CAUTION

CONDUCTING DIELECTRIC OR HI-POTENTIAL TESTING WILL CAUSE INTERNAL DAMAGE TO SPD UNIT.

DO NOT PERFORM DIELECTRIC OR HI-POTENTIAL TESTING WITH THE SPD INSTALLED.

It is common procedure to test distribution equipment with a form of hi-pot (dielectric or megger) testing. The hi-pot tester outputs a high voltage signal at low current that will shut down if a short circuit occurs. The principle behind hi-pot testing is that the high voltage will find any faults in the distribution system and then quickly shuts down without damaging the distribution equipment. Hi pot testing is usually conducted phase to phase and phase to ground.

1.1 Surge Protective Device

A Surge Protective Device (SPD) acts very quickly to suppress high voltages before they can damage sensitive electronics. An SPD normally acts in the nanoseconds range and can withstand tens of thousands of amps repeatedly. SPDs are not designed to prevent a continued overvoltage without damaged. In order to protect electronics from damage, an SPD must be connected from phase to ground. Lightning surges are almost always shunted to ground and the SPD must be connected this way to provide protection.

1.2 The Problem

During a hi-pot test, the SPD will turn on and shunt the high voltage to ground. The hi-pot tester will continue to supply current until it internally records the fault condition. By this time, the SPD has been exposed to a continues current that can damage the internal components. To prevent damage, it is critical that hi-pot testing not be performed on connected SPDs. From the installers point of view, it is also important that SPDs are not connected while performing a hi-pot test since the SPD will always cause the test to fail, thus defeating the purpose of the test.

1.3 Disconnecting SPDs/ Performing Hi-Pot Testing

The only way to perform a hi-pot test in the presence of an SPD is to disconnect the SPD from the distribution system. If the unit is connected through circuit breaker, the breaker should be shut off as a first step. This is sufficient for a delta system to remove the SPD. On Wye connected systems, the neutral must also be removed so that all paths to ground are isolated. An alternative method is to remove the ground from the SPD before any hi-pot testing is performed. All grounds must be removed: the wired ground, the conduit ground and the case

ground. Because it is easy to miss a ground connection, it is recommended that the line and neutral connection are removed rather than the ground connection.

1.3.1 Eaton Electrical Specific Instruction

Eaton Electrical tests each device and assembly separately for dielectric breakdown. The assembled SPD has already been tested at the factory. Additional tests should not be required. Due to the possible damage that can occur, all SPDs have a caution label applied warning against hi-pot testing of the assembly. We recommend that hi-pot testing not be done on distribution equipment with PXL SPD already mounted. If hi-pot testing is still going to be done, it can be accomplished by following the above instruction and removing the phases and neutral connections from the SPD. If all wires to these terminals are removed, a hi-pot test can be safely performed. It is very important to reconnect all wires after the test. If any wire is left off, it can constitute a serious hazard or can defeat the operation of the SPD rendering it non-functional.

Section 2 Installation Procedures

2.1 Site Preparation

Verify your system application voltage and wiring configuration is the same as the enclosed PXL by checking the voltage rating label located on the PXL enclosure.

Review the site to ensure the physical space required to install the PXL exists. Check the facility grounding system. All grounding, bonding and earthing must meet NEC or CEC, as well as any other applicable national or local codes. A poor ground or grounding/bonding violations affect the suppressor's ability to function as specified.

CAUTION

PXL TO BE INSTALLED OR REPLACED BY A QUALIFIED ELECTRICIAN

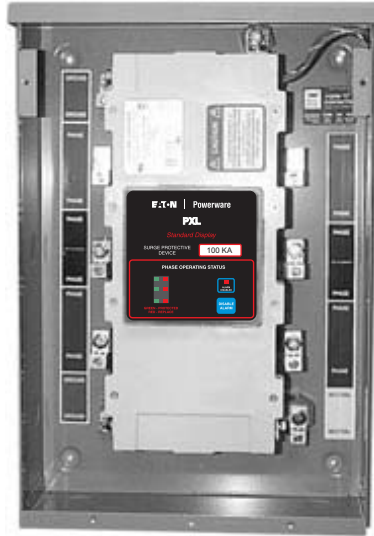
2.2 Installation Recommendation for PXL

Where to Install the PXL?

Service entrance applications (switch boards and switchgear): The optimum location for the PXL unit is on the load side of the main breaker. If this is not possible, select the next closest location. Minimize the lead length between the suppressor and bus bars (including the ground bus).

Panelboards applications: for optimum performance, install the PXL adjacent to the first breaker after the incoming lug/main breaker. If this location is occupied, select the next closest breaker. If no wall space is available at the side of the panelboard, locate the PXL directly above or below the panel.

Remove the five screws from the front of the unit, and lift out the entire front panel. Mount the device to the wall using the convenient holes in the back of the container.



Interior View of the PXL

2.3 Minimize Installation Lead Length

To ensure maximum performance and best possible protection for connected equipment, the PXL must be installed as close to the panel/switchboard/switchgear as possible. The wire length between the PXL and installation breaker should be as short as possible.

Note: For convenience, the PXL is provided with two sets of terminal lugs to permit left or right side installation adjacent to the electrical equipment while minimizing wiring length.

ONE SIDE ONLY OF THE SPD SHOULD BE CONNECTED - AN SPD IS A PARALLEL CONNECTION DEVICE, ADDITIONAL LOADS SHOULD NOT BE CONNECTED IN SERIES

WARNING

TURN OFF POWER SUPPLY BEFORE WORKING INSIDE

2.4 Wiring

Turn OFF the power to the electrical distribution equipment where the PXL SPD is to be installed.

Install a branch circuit breaker to feed PXL for ease of installation. The unit contains UL and CSA approved fusing to protect against short circuit fault conditions within the device. Overcurrent protection is required, (see **Table 1** for required circuit breaker size). Follow NEC, CEC as well as any other applicable national or local codes when connecting the PXL directly to the bus bar.

Note: 30 ampere circuit breaker or fuses with a rating of RK5-30 amperes must be installed ahead of SPD for PXL applications.

Table 1. Required Circuit Breaker & Wire Size

PXL Model	Wire Gauge Required	Circuit Breaker or Fuse Size
PXL	#10 - 2 AWG	30 Amperes

The unit is provided with 8 knockout holes - 3 on each side and 2 on the bottom. Remove the knockout closest to the intended lead-out from the panelboard. Install metal conduit (rigid or flexible) between the unit and the electrical panel. Run wiring from the panelboard to the PXL terminals, which are labeled Phases A, B, C, Neutral and Ground (see **Table 1** recommended wire size).

Note: Twist and bind together all leads. Route the wires such that their overall length is kept to a minimum. This reduces line impedance and optimizes performance.

Strip the ends of the wires and terminate them in the panelboard. Ensure the use of proper color codes and tighten all connections. Green or green/yellow (ground), white (neutral) red (hot), blue (hot), black (hot).

Recheck all connections.

If remote monitoring is employed, connect the Form C contacts to an alarm or building monitoring system (such as an addressable relay). These contact relays will accept up to 220 VAC, 1A (see **Section 3.2.3**).

Note: Form C relay contacts are "fail safe" and only change state when power is applied to the PXL, or if the unit is damaged.

Prior to SPD energization, ensure that the front cover is securely fastened.

Switch the MAIN power to the ON position. Switch the branch circuit breaker supplying the SPD to the ON position. Ensure all status indicator lights are ON (see **Section 3** Operating Features).

2.7.1 Torque Specifications

All installations must adhere to the following torque limits regarding the SPD connection to cable or bus. (See **Table 2**)

Table 2. Torque Connection

Connection type	Lbs.D Inch (Nm)
Phase	55 (6.2)
Neutral/Ground	55 (6.2)

2.7.2 PXL Installation Wiring Diagrams

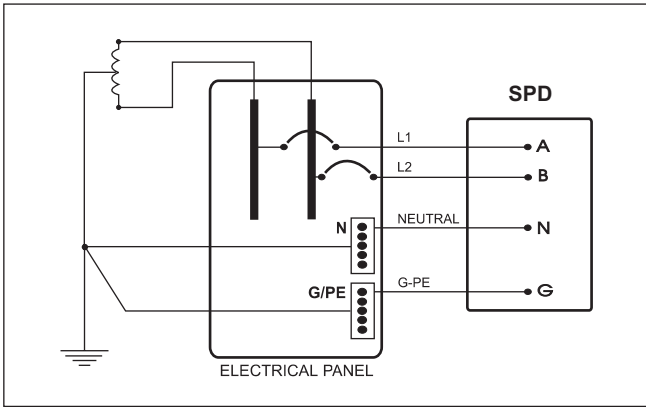


Figure 1. Single Phase (Split-Phase): 3 Wire + Ground/PE - Voltage Code: 240S

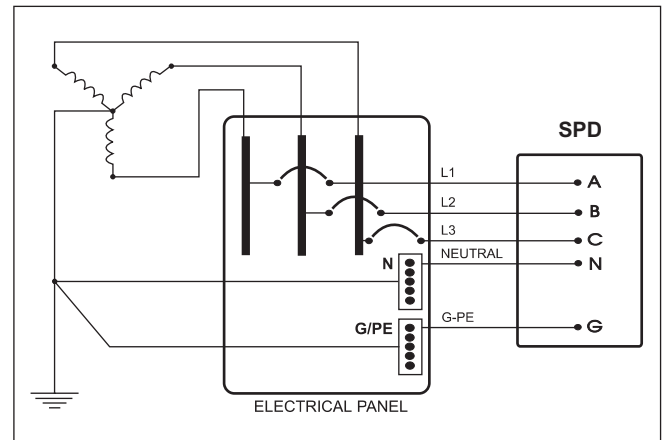


Figure 3. 3 Phase Wye: 4 Wire + Ground/PE - Voltage Codes: 208Y, 480Y

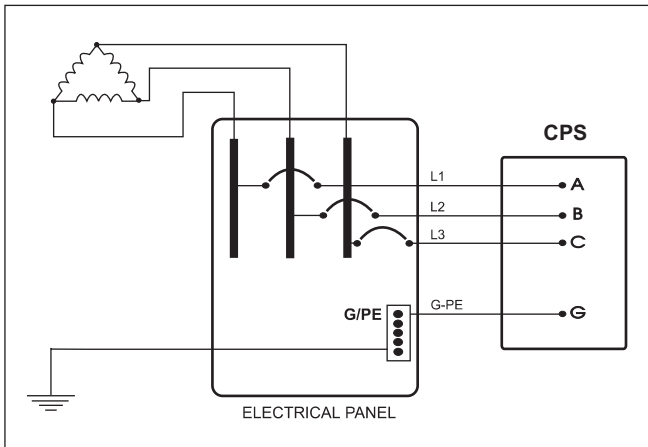


Figure 2. 3 Phase Delta: 3 Wire + Ground/PE - Voltage Codes: 240D, 480D

2.8 Ordering Guidelines

Table 4. PXL Ordering Guidelines

Catalog # PXLXXXYYYYZK

PXL	XXX	YYYY	Z	K
	Surge Rating (kA)	Voltage Configuration	Display Option	NEMA 1, 3R enclosure
	100	208Y	S – Standard Monitor	
120	240D	P – Premium Monitor		
160	240S			
200	480Y			
250	480D			
300				
400				
500				

Example:

Catalog Number	Description
PXL100208YSK	PowerWare PXL, 100kA 208Y Standard Monitor, NEMA 1,3R Enclosure.

Section 3 Operating Features

The SPD is a passive device and does not require regular servicing. To keep you informed of the SPD's operating status, each PXL is equipped with status indicator lights.

3.1 Internal Fusing and Status Indicator Lights

All units are equipped with integral fusing. Should the SPD fail and create a short circuit, the overcurrent will isolate the fault. These integral fuses are not replaceable.

All units are equipped with green/red LED status indicator lights on each phase. When the green light is illuminated, the system is operating properly. In the unlikely case the fuse opens, the LEDs will change to red and an audible alarm will signal a fault.

Form C contacts are used for remote indication of SPD status. Shown in the de-energized state - fail-safe type (See Table 3 for wire size and color code)

Table 3. Size and Color Code for Form C Contacts

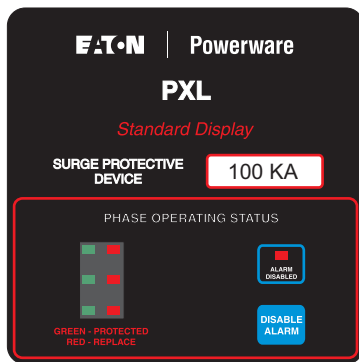
Contact	AWG	Color
NC	14	Orange/White
NO	14	Red/White
NC	14	Blue/White

3.2 Monitoring Options

3.2.1 Standard Display

The Standard display option has the following features:

- Fuse sensing circuitry that identifies a short circuit failure and changes the status indicator lights.
- Audible alarm that can be disabled by a push button.
- An "Alarm Disabled" indicator in the form of red LED



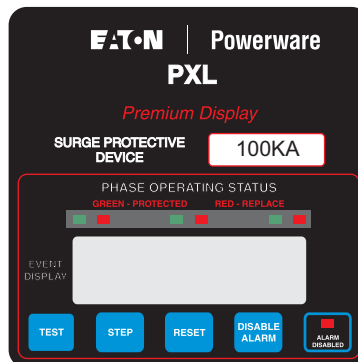
Standard Display

3.2.2 Premium Display

The Premium display option has the same features as the Standard plus a multifunction LCD screen for displaying the following parameters:

- Phase voltages
- Surge counts
- Sag counts
- Swell counts
- Outage counts

The display is controlled by **STEP** and **RESET** push buttons. The **STEP** switch is used to scroll between the above parameters and the **RESET** switch is used to reset the counters to zero. A **TEST** function push button is used to check monitor functioning by inputting a false fuse opening signal and causing the red LED to illuminate.



Premium Display

3.2.3 Remote Status Indication (Standard Feature)

All PXL monitor displays are equipped with isolated single Form C relay contacts. These dry contact terminals are identified as **NO** (normally open) **NC** (normally closed) and **COM** (common). The Form C contacts may be wired to one or more remote locations to identify a change of status. Check the operation of the form C relay monitoring contacts by switching the power **OFF** and back **ON**.

Note: Contact are rated up to 1A/220 VAC

Section 4 Troubleshooting

4.1 Life expectancy

Note: The PXL is not field repairable.

A properly applied SPD is designed to provide over 25 years of life expectancy. These units will not fail due to degradation of internal components, even when exposed to continued high energy induced surges.

PXL unit reliability has been verified by extensive testing at independent lightning laboratories. These tests confirm the suppression circuitry can meet the published surge current ratings.

Note: The PXL unit can withstand thousands or repetitive induced lightning surges on the AC power line. These test levels are significantly higher than IEEE recommended surges (as published by IEEE C62.41)

4.2 What Causes an SPD to Fail?

The PXL is designed and tested to survive thousands of high energy surges. If the unit becomes damaged the failure is typically due to the following causes:

- Inadequate grounding
- Incorrect product application (Wye into a DELTA voltage system)
- Temporary over-voltage (TOV). This rare event occurs when the electrical system experiences a fault that results in RMS over-voltage in one or more phases.

Refer to the following Section 4.4 on trouble shooting.

When the voltage rises over 15% above the nominal operating voltage, the internal suppression components are damaged as they attempt to shunt this prolonged multi-cycle overvoltage event.

4.3 Common Causes of SPD Problems

SPDs are applied to electrical systems to mitigate surges, transients, impulse or spikes. By definition, surges are random high magnitude short-term voltage disturbances. These high impulses can cause havoc to electronic devices if no protection is applied.

See Figure 7 - Voltage Transient. This image represents a transient voltage surge on the 60 Hz AC sine wave. The transient is very short in duration but very high in magnitude from the nominal AC line voltage. Tests have shown that the greater the amplitude of the surge voltage, the greater the risk of damage occurring to downstream electronic systems. Additionally, voltage transients originate from variety of sources, externally from lightning and utility faults, and internally generated from switching loads, electronic power supplies, etc.

4.3.1 Voltage Regulation

Problems associated with voltage regulation are more commonly understood since these events happen over very long time periods. Voltage surges should not be confused with voltage regulation problems. By definition, voltage surges occur in the microsecond range and voltage regulation is defined as having a duration of 1 cycle to many cycles or even hours. Voltage regulation can only damage an SPD if the voltage rises near or above its MCOV (maximum continuous operating voltage).

4.3.2 Temporary Overvoltage (TOV)

Full detailed explanations can be found in the IEEE (Institute of Electrical and Electronics Engineers) publication often referred to us as the "Emerald Book". TOV or swells are 60 Hz voltage events that can occur from 1 cycle to a few seconds. See Figure 10 - Line Voltage Swells (TOV) and Sags. The normal AC sine wave in reference to the swell and sag clearly illustrates the difference in the types of events. TVSS or SPDs are devices that shunt surge events - microseconds events. TOV will often last for cycles and fail MOV-based SPDs.

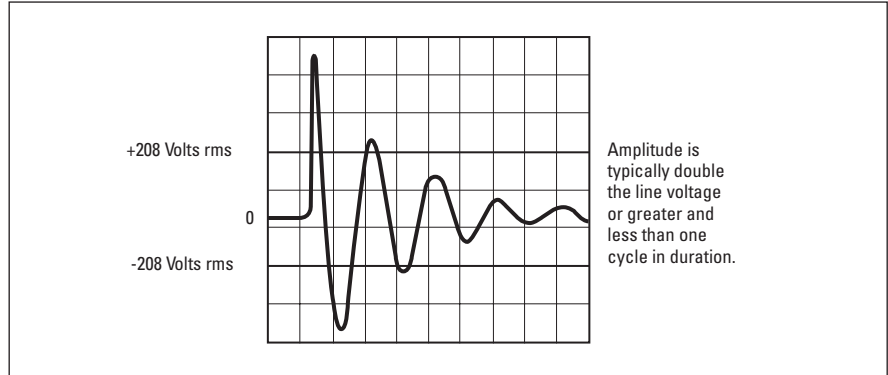


Figure 7. Voltage Transient

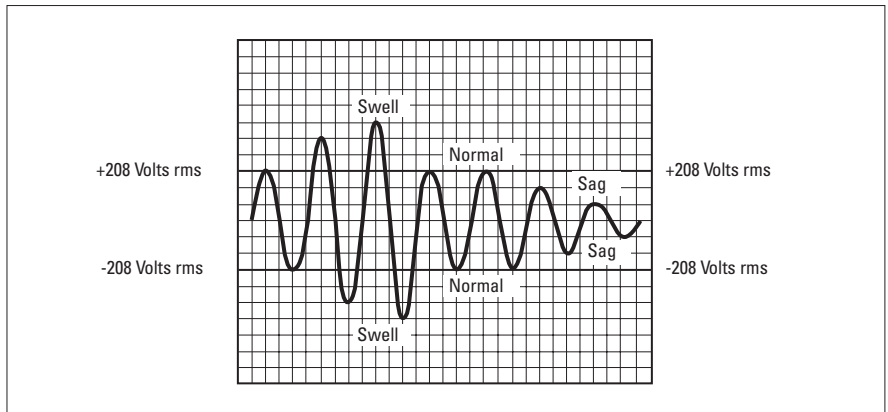


Figure 8. Line Voltage Swells (TOV) and Sags

4.4 Troubleshooting

The PXL is a rugged suppression device. In the unlikely case that the indicator lights change status, audible alarm or remote alarms are activated. First contact our Application Engineers at (800) 809-2772 (option 4, sub-option 2). They will help determine the cause of your problem and direct you to the warranty process if applicable.

4.4.1 PXL Power System Troubleshooting Guide

Improper installation of the SPD at site is the most common application problem. Please follow these instructions carefully for proper SPD operation.

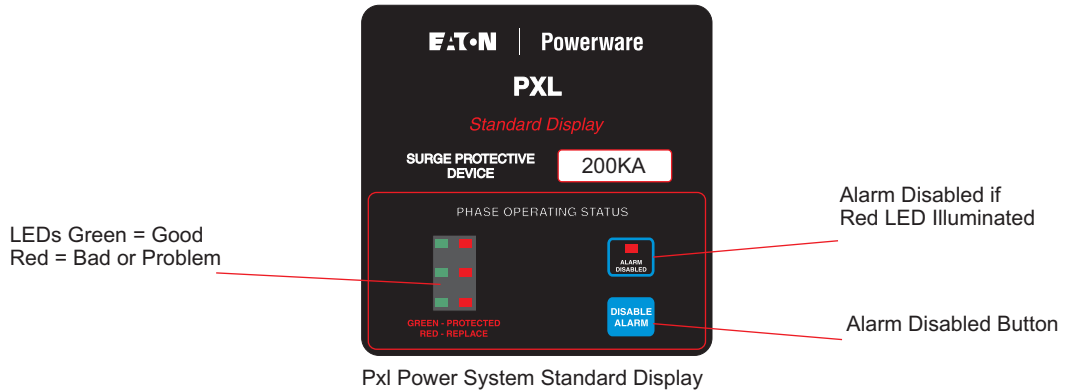


Table 5. PXL Standard Display

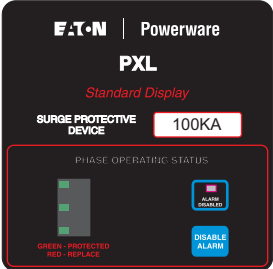
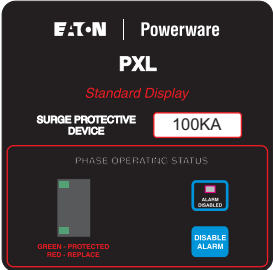
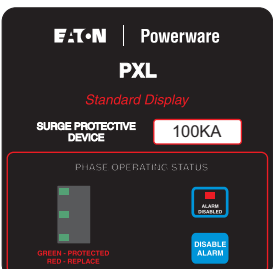
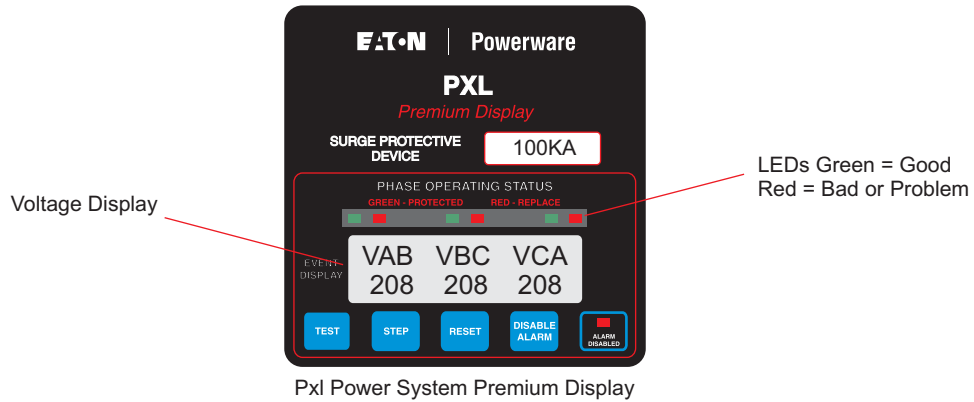
PXL Standard Display	Symptom	Cause	Solution
	All LEDs are green, No alarms.	Normal operation, 3-phase configuration.	<ul style="list-style-type: none"> ■ NA
	Two green LEDs are ON,	Split-phase configuration, Normal operation.	<ul style="list-style-type: none"> ■ NA
	All green LEDs are ON, Alarm disabled LED ON	Normal operation, Alarm disabled	<ul style="list-style-type: none"> ■ NA ■ Press Disable Alarm button to re-enable alarm

Table 5. PXL Standard Display (Continued)

PXL Standard Display	Symptom	Cause	Solution
	Red LEDs ON, buzzer ON.	<p>Lost Neutral (Condition 1)</p> <p>Neutral conductor not connected or poor connection (intermittent).</p>	<ul style="list-style-type: none"> ■ Confirm Neutral connection on SPD on lower left hand side unit. ■ Is Neutral integrity OK? ■ Measure L-G, L-N and N-G voltage. L-N and L-G should be nearly equal and N-G voltage should be less than 3 volts (for 3 phase, 4 wire system).
	All LEDs are OFF, buzzer OFF.	<p>Lost Neutral (Condition 2)</p> <p>Neutral conductor not connected or poor connection (intermittent).</p>	<ul style="list-style-type: none"> ■ Confirm Neutral connection on SPD on lower left hand side unit. ■ Is Neutral integrity OK? ■ Measure L-G, L-N and N-G voltage. L-N and L-G should be nearly equal and N-G voltage should be less than 3 volts (for 3 phase, 4 wire system).
	One or more red LEDs ON, buzzer ON.	<p>Lost phase voltage, no voltage on specified phase</p>	<ul style="list-style-type: none"> ■ Confirm corresponding SPD phase connection terminals are connected. ■ Check breaker output voltage. ■ Check panel (breaker input) voltage.
		<p>Internal fuse blown.</p>	<ul style="list-style-type: none"> ■ Measure terminal voltage with multimeter and if voltage is in spec. ■ Contact Support: <ul style="list-style-type: none"> ● United States support; 1-800-809-2772 ● Australia support: 1-300-877-877 ● South East Asia support; 1-300-322-866 ■ Press DISABLE ALARM button on display.



Note: Refer to the PXL Series installation manual for detailed information on the Premium display menu features.

Table 6. PXL Premium Display

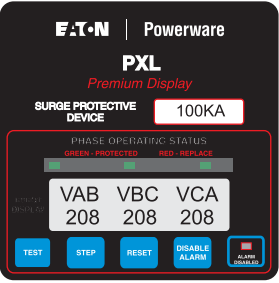
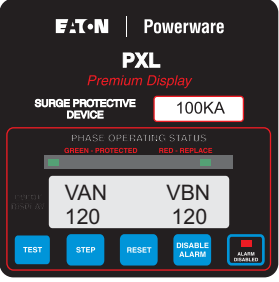
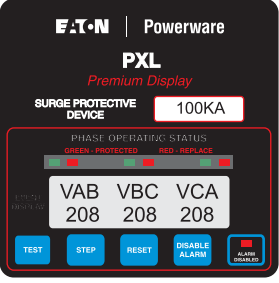
PXL Premium Display	Symptom	Cause	Solution
	All LEDs are green, No alarms.	Normal operation, 3-phase configuration.	<ul style="list-style-type: none"> ■ NA
	Two LEDs are green, No alarms.	Normal operation, split-phase configuration.	<ul style="list-style-type: none"> ■ NA
	All LEDs are green, Alarm disabled, LED ON.	Normal operation, alarm disabled.	<ul style="list-style-type: none"> ■ NA ■ Press DISABLE ALARM button to re-enable alarm

Table 6. PXL Premium Display (Continued)

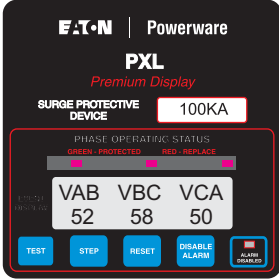
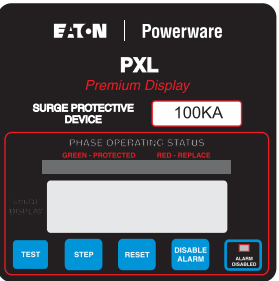
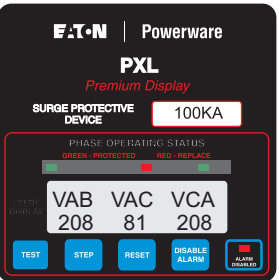
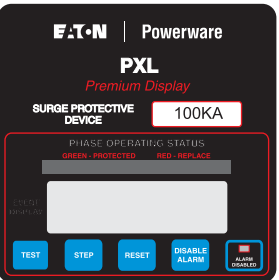
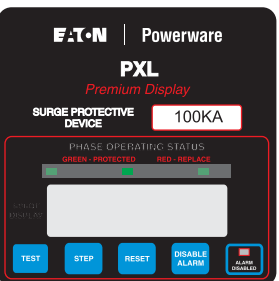
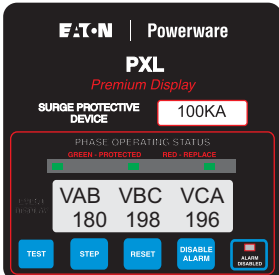
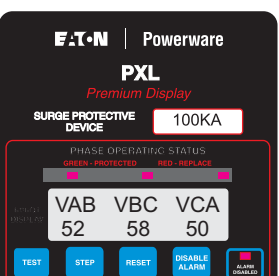
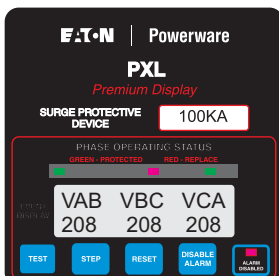
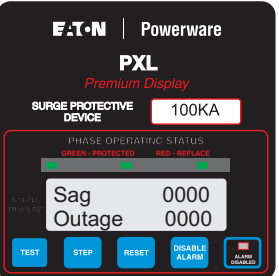
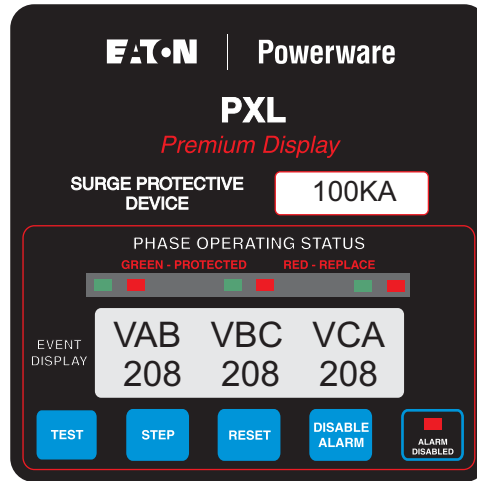
PXL Premium Display	Symptom	Cause	Solution
	All red LEDs ON, incorrect voltage display.	Lost Neutral (Condition 1) Neutral conductor not connected properly or bad Neutral	<ul style="list-style-type: none"> ■ Check Neutral connection on SPD at lower left hand side. ■ Good Neutral?
	All LEDs OFF, buzzer OFF, no voltage	Lost Neutral (Condition 2) Neutral conductor not connected properly or bad Neutral	<ul style="list-style-type: none"> ■ Check Neutral connection on SPD at lower left hand side. ■ Good Neutral?
	One or more red LEDs ON, buzzer ON, incorrect voltage display on affected phase.	Lost phase voltage, No voltage on specified phase.	<ul style="list-style-type: none"> ■ Confirm corresponding SPD phase connection terminals are connected. ■ Check breaker voltage. ■ Check panel voltage.
	All LEDs OFF, buzzer OFF, blank LCD display.	Breaker tripped OFF or no POWER.	<ul style="list-style-type: none"> ■ Check for proper voltage at terminals.
	Blank LCD display and LED lit.	Unknown - possible warranty	<ul style="list-style-type: none"> ■ Contact Support: <ul style="list-style-type: none"> ● United States support; 1-800-809-2772 ● Australia support; 1-300-877-877 ● South East Asia support; 1-300-322-866

Table 6. PXL Premium Display (Continued)

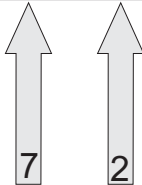
PXL Premium Display	Symptom	Cause	Solution
	All green LEDs ON, Buzzer OFF, incorrect voltage display.	Incorrect calibration	<ul style="list-style-type: none"> Check terminal voltage with digital multimeter, Recalibrate only if measured line voltage is close to nominal. See section on calibration.
	All red LEDs ON, Buzzer ON, incorrect voltage display.	Incorrect calibration	<ul style="list-style-type: none"> Check terminal voltage with digital multimeter, Check Neutral connection.
	One or more red LEDs ON, Buzzer ON, correct voltage display.	Internal fuse blown	<ul style="list-style-type: none"> Measure terminal voltage with multimeter and if voltage is in spec, then call: <ul style="list-style-type: none"> United States support: 1-800-809-2772 Australia support: 1-300-877-877 South East Asia support: 1-300-322-866 Press DISABLE ALARM button on display.
	One or all counters not resettable.	Memory lock-up	<ul style="list-style-type: none"> If pressing the RESET button does not reset the counters, Turn OFF the power to the unit, wait for 5 -10 seconds, turn ON the unit, Press the RESET button for 1 - 2 seconds, then release.



4.5 PXL Premium Display Calibration Procedure

In some rare cases, the line voltages displayed on the Premium display may be incorrect as indicated in the image bellow. The Auto Calibration feature is what we actually use in calibrating the Premium display in the plant. However, this procedure can be done in the field by pressing the STEP button before power is applied to the unit. Then, the operator selects the system voltage from 208Y to 600Y/D to be displayed.

It measures the input voltage and assumes that this is equal to the nominal voltage of the model. So for a 208V model SPD if the actual input is 230 V, the display will still be 208V. It measures and averages a number of cycles then gets a scaling factor that is used in displaying 208V in this case. If this procedure is going to be done in the field, then calibration must be performed when the input voltage is close to nominal to get an accurate display. In the factory, we set the voltage to 208V manually through a variac transformer.



4.5.1 What are the Reasons for the Auto-Calibration Feature?

- To compensate for the differences in the value of the scaling resistors, offset voltage of the amplifiers in the display.
- To allow for field adjustment if necessary.
- Use of one firmware/hardware for all voltages. The Premium display board can display any system voltage from 208 - 600V.

4.5.2 Premium Display Calibration Procedure Steps

- Shut OFF power to the unit.
- Press and hold the STEP button. Do NOT release (arrow 2)
- Apply power to the unit
- The display will show:
 - **Set Voltage** - first row
 - **208 Volts Y** - second row
- Release the STEP button. Press the STEP button once to scroll through the following voltages:

Select Voltage

240V Spt.....	240 V Split Phase
240V D/HG.....	240 V Delta & High Leg
480V Y/D.....	480 V Wye/Delta*
600V Y/D.....	600 V Wye/Delta*
400V Y/D.....	400 V Wye/Delta*
220V Y/D.....	220 V Wye/Delta*

*System Voltages not available for PXL SPD

- If the STEP button is pressed again, selection returns to 208V Wye.
- Press TEST (Arrow 7) button once to accept selected system voltage. Then, the display will go into Auto-Calibration and display the system voltage.
 - Unit is ready to display voltage.
- Note: If selection made is incorrect, repeat all steps starting with STEP 2.

Section 5. Warranty

Eaton Powerware warrants these products for a period of 10 years from the date of delivery to the purchaser to be free from defects in both workmanship and materials. Eaton Powerware assumes no risk or liability for results of the use of the products purchased from it, including but without limiting the generality of the foregoing: (1) The use in combination with any electrical or electronic components, circuits, systems, assemblies or any other materials or substances; (2) Unsuitability of any product for use in any circuit or assembly.

Purchaser's rights under the warranty shall consist solely of requiring Eaton Powerware to repair or at Eaton Powerware's discretion, replace free of charge, FOB factory and defective items received at said factory within said term determined by Eaton Powerware to be defective. The giving of or failure to give any advice or recommendation by Eaton Powerware shall not constitute any warranty by or impose any liability upon Eaton Powerware. The forgoing constitutes the sole and exclusive remedy of the purchaser and the exclusive liability of Eaton Powerware AND IS IN LIEU OR ANY AND ALL OTHER WARRANTIES EXPRESSED, IMPLIED OR STATUTORY AS TO THE MERCHANT ABILITY FITNESS FOR PURPOSE SOLD DESCRIPTION, QUALITY, PRODUCTIVENESS OR ANY OTHER MATTER.

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In no event shall Eaton Powerware be liable for special or consequential damages or for delay in performance of the warranty.

This warranty does not apply if the product has been misused, abused, altered, tampered with or used in applications other than specified on the nameplate. At the end of the warranty period Eaton Powerware shall be under no further warranty obligation expressed or implied.

The product covered by this warranty certificate can only be repaired or replace by the factory. A RETURN MATERIAL AUTHORIZATION NUMBER (RMA) MUST BE OBTAINED.

Please enter a Vista warranty claim or contact CORE (Center of Returns Excellence) at 1-800-410-2910 for help with entering the claim or an update on your claim status. For help on troubleshooting the PXL SPD call:

United States support:
1-800-809-2772

Australia support:
1-300-877-877

South East Asia support:
1-300-322-866

For a detailed failure report, please send an e-mail with the claim number to warrantycalagry@eaton.com. Repair or replacement will be returned to collect. If Eaton Powerware finds the return to be a manufacturers defect, the product will be return prepaid.

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Printed in USA
Publication No. IM01005001E

