



INTRODUCTION

The Dairyland PCRX is a solid-state decoupling device commonly used in conjunction with cathodically protected structures.

The PCRX prevents the flow of direct current while simultaneously providing a grounding current path for steady state induced alternating current, if present. Steady state AC current of up to 45A rms can flow through the device with DC voltage applied within the operating voltage range. These products also provide over-voltage protection for both lightning and AC fault current conditions.

The PCRX provides the additional benefit of electronically camouflaging itself from interrupted surveys, including close interval surveys (CIS), preventing the device from contributing to errors in potential readings. Field testing has shown that interrupted surveys can sometimes be impacted by combinations of factors such as pipeline coatings, soil resistivity, and the capacitance of decouplers resulting in excessively electro-negative instant-off values. In most cases the PCRX completely solves this problem. The PCRX camouflages itself to overcome capacitive effects ensuring accurate and timely potential measurements. It does this without sacrificing the rugged over-voltage, AC mitigation, CP isolation, and safety grounding of Dairyland's standard decoupling products. For more information visit www.dairyland.com

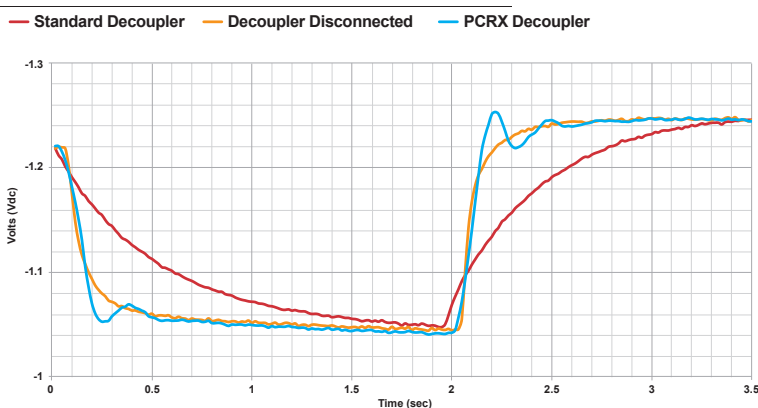
DID YOU KNOW?

The PCRX has been certified by Underwriters Laboratories and is certified for use in Class I, Division 2, Groups A, B, C and D hazardous locations. For more information on certifications and listings, visit dairyland.com



Figure 1 below shows actual field data of a CIS waveform under the conditions of decouplers disconnected, conventional decoupler and PCRX installed on a pipeline. Note that the settling response time of the signal with the PCRX in place is almost identical to the response time with decouplers disconnected.

INSTANT-OFF WAVEFORM COMPARISON Standard Decoupler vs. No Decoupler vs. PCRX



COMMON APPLICATIONS

AC Voltage Mitigation

As an AC mitigation device, the PCRX can collapse the steady-state voltage between the connected points to a negligible level by providing continuous AC grounding for pipelines affected by AC induction while leaving cathodic protection unaffected.

Decoupling Electric Equipment Grounding Systems

When electrical equipment is mounted on a cathodically protected structure, the PCRX can provide DC isolation with fault rated AC continuity. As grounding codes apply, the PCRX is listed by UL for meeting the requirements of an effective AC grounding path per U.S. and Canadian electric codes.

Isolation Joint Protection

Isolation joints often need over-voltage protection against lightning and AC fault exposure, and in some cases, steady-state induced AC voltage. Due to the small clearance between opposite sides of the isolation flange, a protective device must provide a low clamping voltage, including the voltage effects of the conductors or bus bars used to connect the product.

PRODUCT OVERVIEW

AC Fault Current Ratings

Some applications may have conditions where an over-voltage device such as the PCRX is subject to momentary fault current. For this reason, the PCRX was designed to have AC fault current carrying capability. The PCRX will limit the voltage between its connection points to less than 18V peak under the maximum fault current ratings listed below.





Fault current ratings are offered with the following current-time relationship:

AC FAULT CURRENT RATINGS (Amps AC-RMS Symmetrical)			
50/60 Hz Cycles	5kA Model	10kA Model	15kA Model
3	6,800	15,000	27,000
10	5,700	12,000	21,000
30	5,000	10,000	15,000

Note: Verify that the PCRX fault current capability exceeds site conditions. For more information on determining fault current exposure, view our web article: Determining AC Fault Current.

Steady-State AC Current Ratings

This rating represents the maximum steady-state AC 50/60Hz current that is allowed to flow through the device while still blocking the flow of DC current. Exceeding this rating can result in damage to the PCRX.

CONTINUOUS AC CURRENT RATINGS
0 to 45A RMS

The most typical application where a PCRX may be required to block DC current while simultaneously carrying steady-state AC current occurs when a pipeline is in the same corridor as an electrical transmission line, resulting in steady-state AC induction voltage. The PCRX can mitigate this voltage by providing a low AC impedance path for AC current to flow to ground while simultaneously preventing the flow of DC current.

Under an AC fault or lightning current condition, the impedance of the PCRX momentarily becomes virtually zero. For more information on steady-state current view our web article: Measuring Steady-State AC Current.

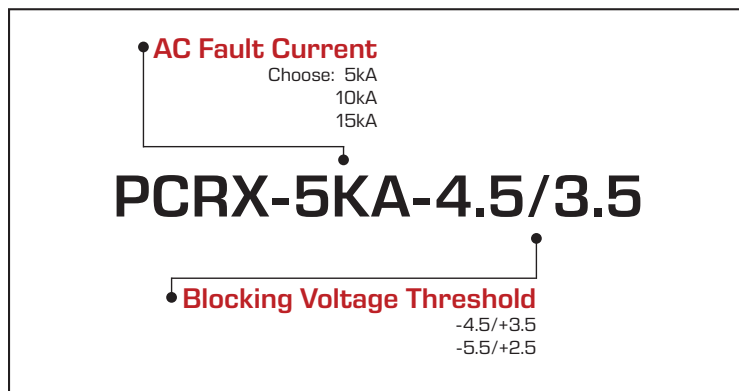
PCRX Blocking Voltage Rating

The PCRX employs proprietary technology to provide the additional benefit of electrically camouflaging itself from interrupted surveys without requiring an external power source. The unique operating characteristics of the PCRX create a distinct difference between the device's fixed blocking voltage and its allowable DC operating voltage range. The fixed blocking threshold voltage is the total voltage limit across the PCRX terminals (Volts AC_{peak} + Volts DC) while the DC Operating voltage range is the allowable DC voltage across the PCRX terminals, after considering the AC voltage present for the given AC current.

The blocking voltage threshold is the voltage at which the device will go into conduction and shunt all current through the PCRX, such as during a fault or lightning event. It is this blocking voltage threshold that is identified via the product model designation (-5.5V/+2.5V or -4.5V/+3.5V are the standard offerings). Generally, a -5.5V/+2.5V would be selected for use with a copper mitigation system while the -4.5V/+3.5V would be for use with a zinc mitigation system or an isolation fitting with CP on both sides. The operating voltage is the allowable range of DC voltage across the device's terminals while still blocking DC current and simultaneously conducting any steady state AC that is present.

The operating voltage is a narrower range than the blocking voltage threshold. Select the appropriate blocking threshold per guidance in Appendix A. Figure 1 shows an example of current flow before and after this DC threshold is reached in a -4.5V/+3.5V configuration.

Ordering Instructions



KEEP THE CONDUCTORS SHORT!

The PCRX is designed to keep the voltage between the device terminals to a limited value. During lightning conditions, a more important factor than the PCRX voltage clamping capability is the voltage developed in the conductors or bus used to attach the device. Use low inductance bus bars or conductors ideally less than 6 inches (150 mm) long for best results. More information on conductor length is available at www.dairyland.com.

Lightning Impulse Current Rating

All models have the same lightning surge current rating which is shown in the following table.

LIGHTNING IMPULSE CURRENT RATING
Peak Amperes: 100kA
8x20 microsecond waveform



FEATURES AND CERTIFICATIONS

Certifications

The PCRX has been tested by Nationally Recognized Testing Laboratories (NRTLs) for compliance to independent standards in its operation, ratings, and construction. This includes compliance to standards for:

Class I, Div. 2, Groups A, B, C, D and Zone 2, Group IIC.

Class & Division System:

UL (United States) and C-UL (Canada)

- Effective Ground Fault Current Path per:
 - NFPA 70 (US National Electric Code – NEC): Article 250.4(A)(5)
 - CSA C22.1 (Canadian Electric Code, Part I): 10-100 & 10-500
- Isolation of Objectionable DC Ground Currents per:
 - NFPA 70: Article 250.6(E)
 - CSA C22.1: 10-100 & 10-500
- Hazardous Location Use:
Class 1, Division 2, Groups A, B,C,D by UL & C-UL per:
 - UL 121201, 9th Ed. and CSA C22.2 No.213-17
- Safety Requirements for Electrical Equipment per:
 - UL 61010-1, 3rd Ed. & CSA C22.2 No. 61010-1
 - Overvoltage Protection from Impulse (Lightning) Current: 100kA (8 x 20µs)
 - Enclosure Rating: NEMA 4X
 - Temperature Range: -40°C to +50°C (-40°F to +122°F)
 - Max Altitude: 2000 meters
 - Ambient Pressure of 80 kPa (0.8 bar) to 110 kPa (1.1 bar)
 - Relative Humidity: 0-100% noncondensing
 - Outdoor use
 - Pollution Degree 2

Zone System: ATEX / IECEx / UKEx (Europe / International / UK). ATEX per directive 2014/34/EU (Equipment for use in Potentially Explosive Atmospheres):

- Zone 2, Group IIC, Increased Safety “ec”
- EN IEC 60079-0: 2018
- EN IEC 60079-7: 2015+A1:2018
- IEC 60079-0: 2017
- IEC 60079-7: 2017
- Overvoltage Protection from Impulse (Lightning) Current: 100kA (8 x 20µs)
- Temperature Range: -40°C to +50°C
- Enclosure Rating: IP66

Solid-State Design

The PCRX is built with proven solid-state components which have an instantaneous response with respect to voltage, thereby initiating voltage clamping immediately when the voltage attempts to exceed the blocking level selected.

Fail-Safe

An important safety feature of the PCRX is that if subject to AC fault current or lightning surge current in excess of its ratings such that failure occurs, failure will occur in the shorted mode. In the shorted mode, the unit can carry greater than rated fault current or lightning surge current and still provide an effective grounding (or conducting) path.

Enclosure

The PCRX enclosure is made of epoxy powder-coated 304 stainless steel suitable for outdoor non-submersible applications and is rated NEMA 4X and IP66.

Terminals

Single-hole compact spade terminal connectors are standard.

PCRX terminals have preinstalled 1/2” stainless hardware (bolts, nuts, washers). See Accessories for various attachment options.

Polarity / Electrical Connection

Polarity marks (+) and (-) are provided near the terminals to aid in proper installation. Connect the (-) to the structure with CP or more negative structure and the (+) to the ground bed, or more positive, system.

Note: The positive terminal is bonded internally to the metallic enclosure.

Size and Weight

Refer to outline drawings for dimensional data. Packaged weight is approximately 35 pounds (16kg).

Number of Operations

Virtually unlimited under maximum ratings, provided the operations are not immediately repetitive.

Energy Requirements

None. The PCRX does not require an external power source.



MOUNTING OPTIONS

The PCRX is made to mount above grade on a flat surface (e.g., a wood post, unistrut, panel) with up to 5/16" bolts furnished by the user. Pedestal mounting is also an option.

Note: Because of the internal bond between the enclosure and positive terminal, mount the PCRX on a structure not in contact with the cathodically protected structure.

Specific Installation Guidance

The Dairyland website contains detailed information on the installation methods specific to a given application. For wiring diagrams and/or application guidance, see Dairyland Applications.

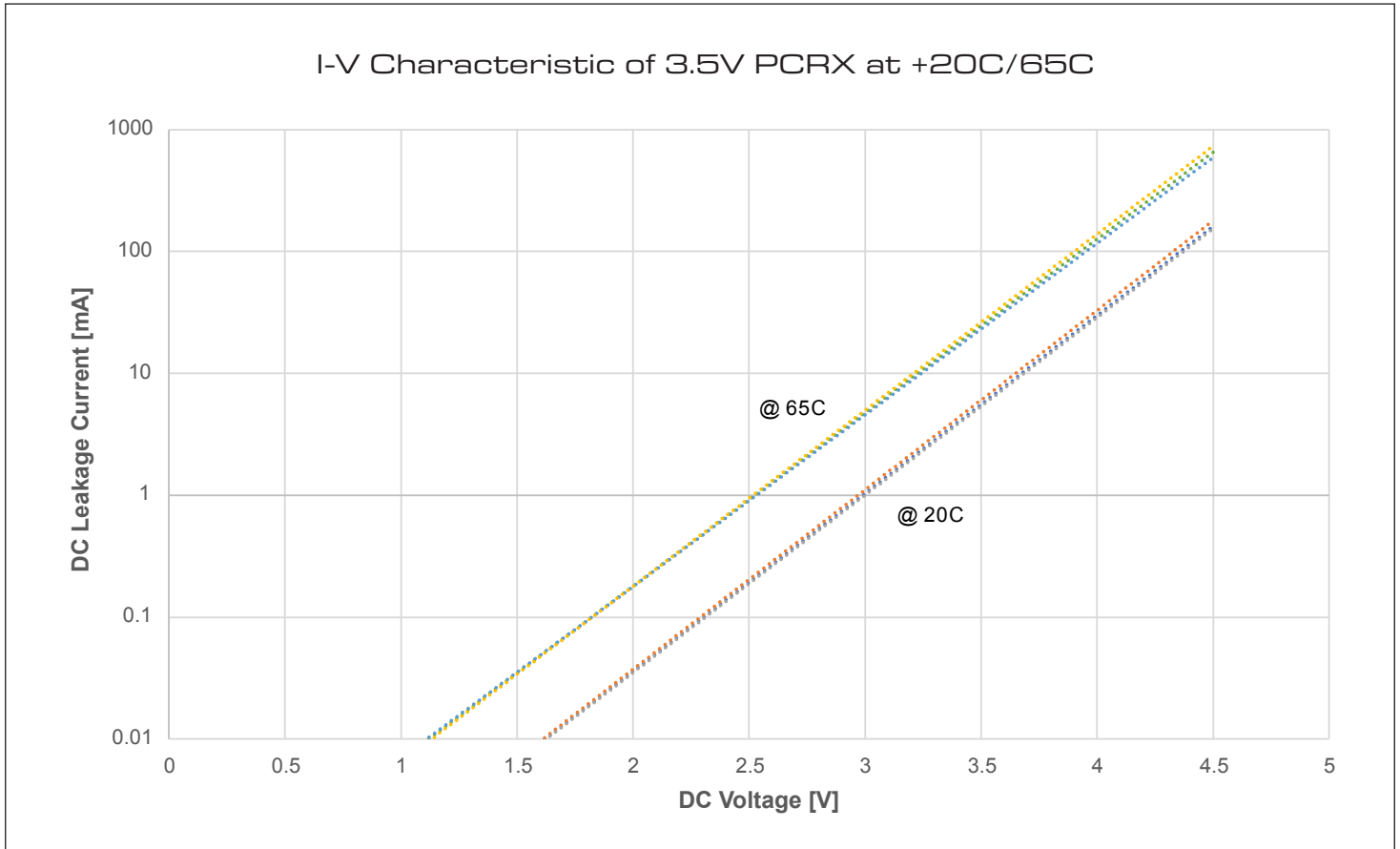
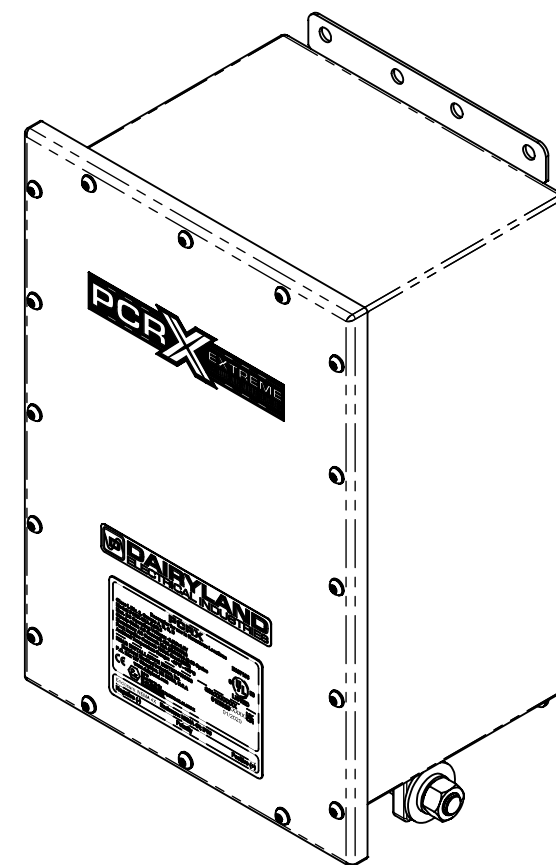
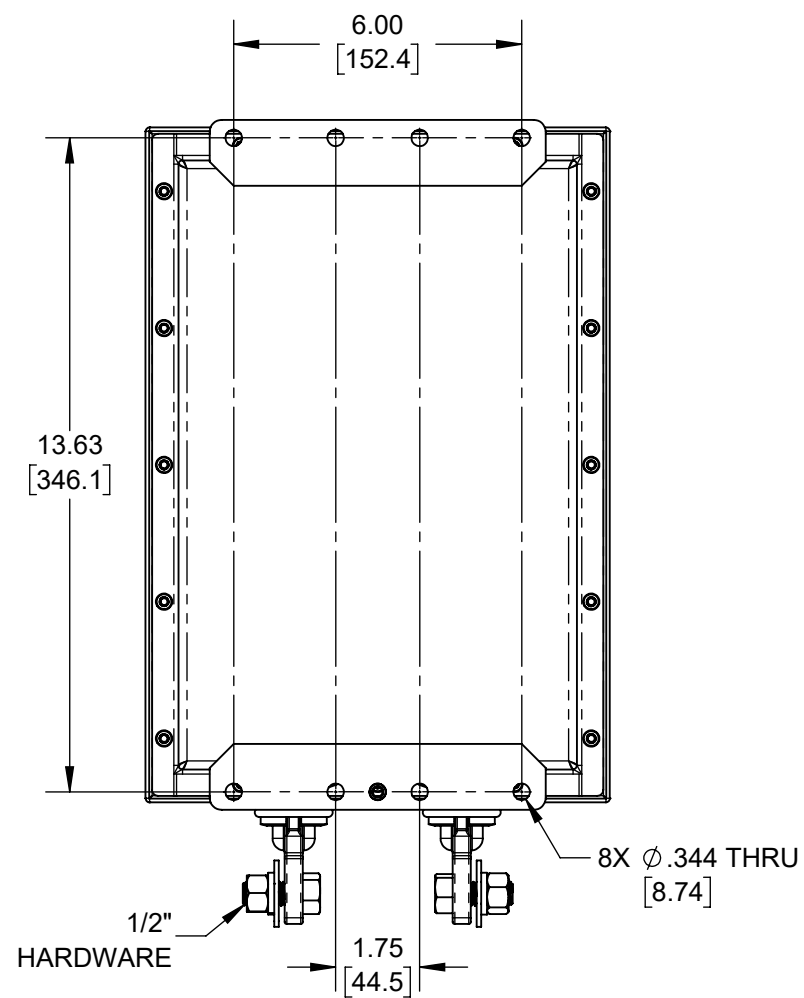
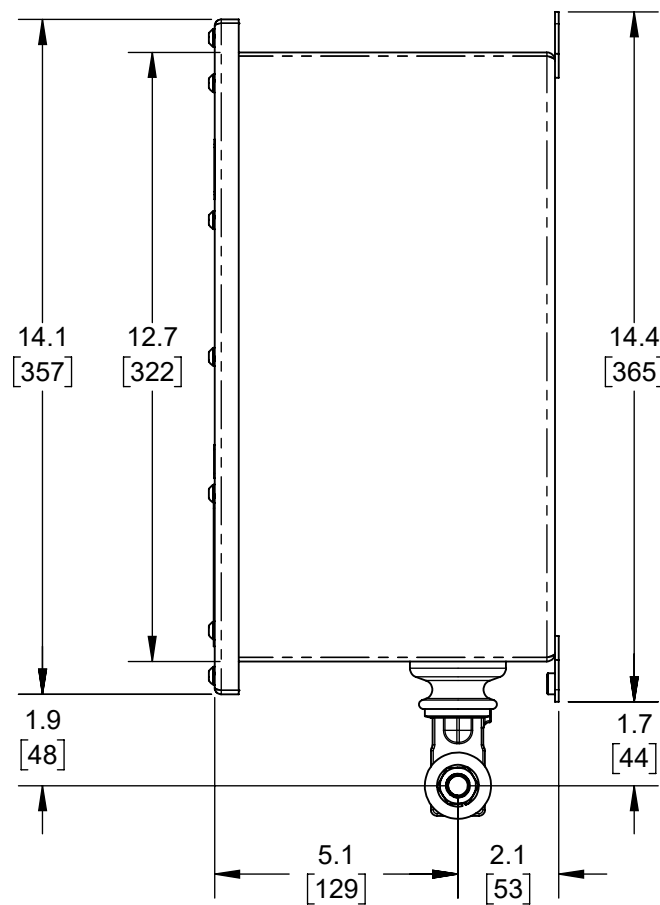
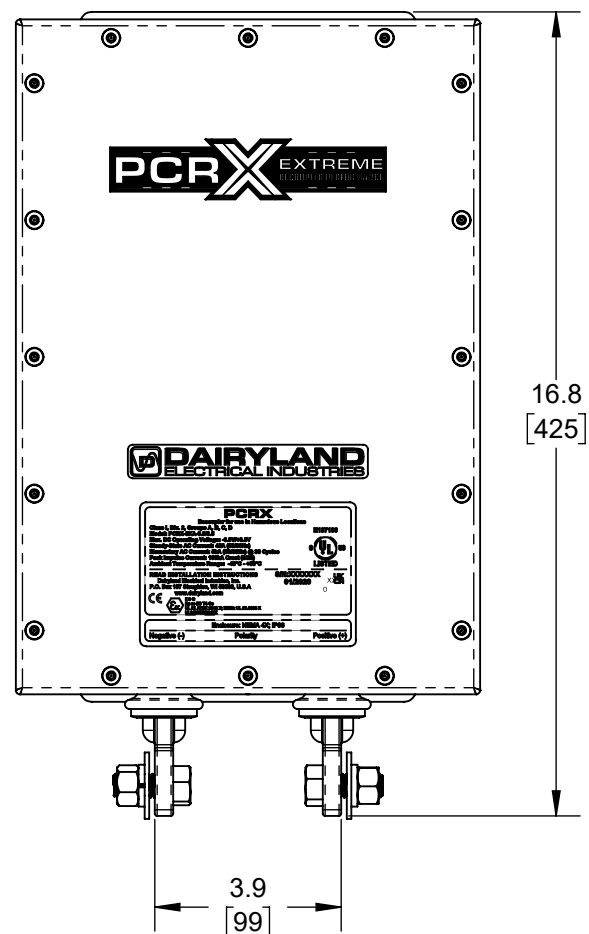
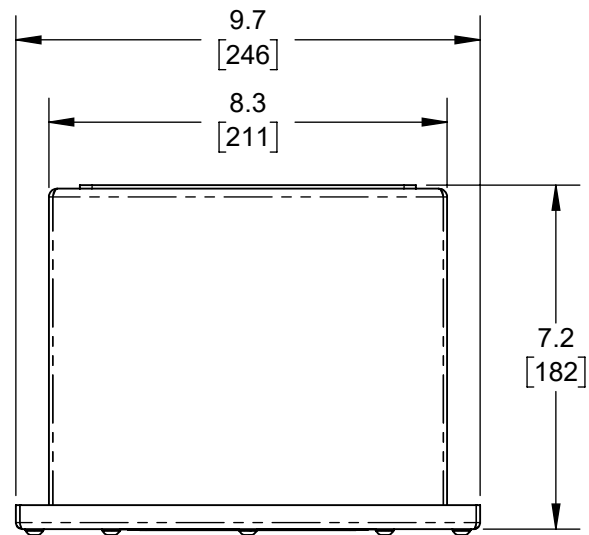
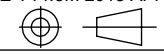



Figure 1: DC Voltage vs. DC Leakage Current
(Standard Asymmetrical PCRX with -4.5V / +3.5V Blocking Voltage)



ISOMETRIC VIEW

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APPENDIX A

CONSIDERATIONS FOR PROPER APPLICATION OF THE PCRX

There are some important factors to consider when choosing the appropriate PCRX blocking threshold. Select the blocking voltage threshold range such that the total voltage across the decoupler terminals throughout normal operating conditions is less than that range. This total voltage consists of the DC voltage difference between the CP protected structure and the grounding system (or between different CP protected structures when used to isolate two different protected structures) plus the peak AC voltage due to AC current flowing through the decoupler.

Total AC and DC voltage at or above the device's blocking threshold, for a given polarity, will put the unit into conduction. The device will begin to pass all current as it performs its protective function of clamping voltage.

The AC impedance of the PCRX varies with AC current as shown in Table 1. As a result, the available DC operating voltage range is also dependent on the AC current as shown in Table 1. Use this table to select a blocking threshold that provides a suitable range of DC operating voltage across the decoupler terminals for the application taking into account the expected AC current.

TABLE 1. Operating characteristics at PCRX Terminals

AC Current Through PCRX (Amperes ACrms)	PCRX Maximum AC Impedance (Ohms)	Maximum AC voltage across terminals (Volts ACrms)	Blocking Threshold -4.5V/+3.5V	Blocking Threshold -5.5V/+2.5V
			DC Operating Voltage Range Across Terminals	
< 0.6	5	≤2	-1.7V / +0.7V	-2.7V / -0.3V
0.7	0.800	<1	-3.7V / +2.7V	-4.7V / +1.7V
1	0.437	<1	-3.9V / +2.9V	-4.9V / +1.9V
2	0.127	<1	-4.1V / +3.1V	-5.1V / +2.1V
5	0.059	<1	-4.1V / +3.1V	-5.1V / +2.1V
15	0.034	<1	-3.8V / +2.8V	-4.8V / +1.8V
25	0.029	<1	-3.5V / +2.5V	-4.5V / +1.5V
35	0.028	<1	-3.1V / +2.1V	-4.1V / +1.1V
45	0.027	≤1.2	-2.8V / +1.8V	-3.8V / +0.8V

NOTES:

- Blocking Threshold** = Total voltage limit across the terminals (Volts AC_{peak} + Volts DC).
- DC Operating Voltage** = The allowable DC voltage across the terminals (noting polarity), after considering the AC voltage present for the given AC current.
- All data in this Appendix A is for 60 Hz applications only.

LOW AC CURRENT – SPECIAL CONSIDERATIONS

An important factor in applying the PCRX is understanding the DC operating voltage range for applications where there is 0.6 Amperes ACrms or less of steady state current and where there are less than 2 Volts ACrms present across the PCRX terminals. At currents less than 0.6 Amperes ACrms, the AC voltage across the PCRX terminals for a given AC current is greater and thus the available DC operating range is reduced for a given blocking threshold, as indicated in Table 1. Based on these reduced operating ranges, Table 2 provides recommended blocking threshold ratings and associated pipe-to-soil potentials for different grounding materials and differential voltage across isolation joints. Additional guidance on low current application is given in the notes following Table 2.

TABLE 2. CP Operating Voltages where AC current is less than 0.6 Amperes ACrms and where AC Voltage is less than 2 Volts ACrms.

	Blocking Threshold -4.5V/+3.5V	Blocking Threshold -5.5V/+2.5V
Copper Grounding Application	Not recommended	CP Range Pipe-to-Soil -3.1V / -0.7V (DC)
Zinc Grounding Application	CP Range Pipe-to-Soil -2.8V / -0.4V (DC)	Not recommended
Isolation Joint Application (CP on Both Sides)**	Operating Range Across Terminals -1.7V / +0.7V (DC)	Not recommended

**For application with CP on both sides. If CP on one side only, see product selection notes below.



PRODUCT SELECTION NOTES:

1. Note that some values shown in Table 2 are measured across PCRX terminals while others are pipe-to-soil values to a Cu/CuSO₄ reference cell. Polarity requires connection of the negative PCRX terminal to the more electro-negative structure and the positive terminal to the more electro-positive structure.
 - a. Polarity of the voltmeter leads is also an important factor in obtaining accurate polarity readings. Therefore, the voltmeter positive lead (the red lead) should be connected to the pipeline side terminal and the negative or common lead (the black lead) should be connected to the grounding side terminal.
2. When a PCRX is connected between a protected structure and ground, the voltage across its terminals is the difference between the structure CP Pipe-to-Soil potential and the potential of the mitigation material.
 - a. Voltage across decoupler terminals = (Structure Potential Volts DC) - (Grounding Material Potential Volts DC). Note that Dairyland has used a pipe-to-soil potential (Cu/CuSO₄) value for copper = -0.4 Volts DC and zinc = -1.1 Volts DC.
 - b. Examples:
 - i. Zinc Grounding:
 1. Structure CP Voltage (Pipe-to-Soil) = -2.0 Volts DC (Cu/CuSO₄)
 2. Zinc Grounding Voltage (Zinc-to-Soil) = -1.1 Volts DC (Cu/CuSO₄)
 3. Voltage Across Decoupler Terminals = (-2.0) - (-1.1) = -0.9 Volts DC
 - ii. Copper Grounding:
 1. Structure CP Voltage (Pipe-to-Soil) = -2.0 Volts DC (Cu/CuSO₄)
 2. Copper Grounding Voltage (Copper-to-Soil) = -0.4 Volts DC (Cu/CuSO₄)
 3. Voltage Across Decoupler Terminals = (-2.0) - (-0.4) = -1.6 Volts DC
 - c. Contact Dairyland for other grounding material scenarios.
3. Isolation joint applications: Where an isolation joint separates a pipeline with CP on one side from a pipe connected directly to a grounded facility, select the PCRX model from the table above based on the applicable grounding material present.
4. PCRX Impedance Transition: In applications where there are AC interference transitions from below 0.6 Amperes ACrms to higher currents the PCRX impedance shifts from a high value to a lower value. This change may take up to about 15 seconds. During this brief transition period, the PCRX will still provide over-voltage protection and a ground path for steady state induced AC. However, the PCRX may affect CP potential values for a limited portion of this transition period. Discard erroneous CP potentials obtained during this brief period.
5. AC Mitigation Voltage and AC Current Density: The PCRX, under steady-state conditions, will mitigate induced AC voltage to low levels. At currents less than 0.6 Amperes ACrms the PCRX will mitigate AC to no more than 2 Volts ACrms across device terminals. Above 0.7 Amperes ACrms, the mitigated AC voltage across device terminals will be no more than 1 Volt ACrms. The AC voltage and AC current density that results from a mitigation system design, which may include a Dairyland decoupling device, is a complex system that involves many factors, including coupon, grounding material, and soil characteristics as well as varying electrical phenomenon. Users should model expected induction conditions, with field measurements following mitigation system installation, to assure that design goals regarding voltage and current density have been addressed. Dairyland PCRX impedance values, shown in Table 1 above, may be helpful during mitigation design and analysis.

Contact Dairyland for any technical guidance needed.

customerservice@dairyland.com