



# Lightning & OVP Protection to Pipelines AUCSC 2019

Tim Bechtel

Dairyland Electrical Industries Inc.



**DAIRYLAND**  
ELECTRICAL INDUSTRIES

ISOLATE. GROUND. PROTECT.

# Outline



1. Introduction to Dairyland
2. Why are decouplers needed?
3. What is a decoupler and how does it work?
4. Where are decouplers used?
5. How to select the right decoupler for the application
6. How to specify decoupler models
7. How to test a decoupler



# Dairyland Electrical Industries



- Disciplined product engineering and manufacturing company
- Established 1983
- Financially sound, long management tenure
- ISO 9001 certified to 2015 requirements
- Extensive international product certifications



# Outline

1. Introduction to Dairyland
- 2. Why are decouplers needed?**
3. What is a decoupler and how does it work?
4. Where are decouplers used?
5. How to select the right decoupler for the application
6. How to specify decoupler models
7. How to test a decoupler



# Why are Decouplers Needed?

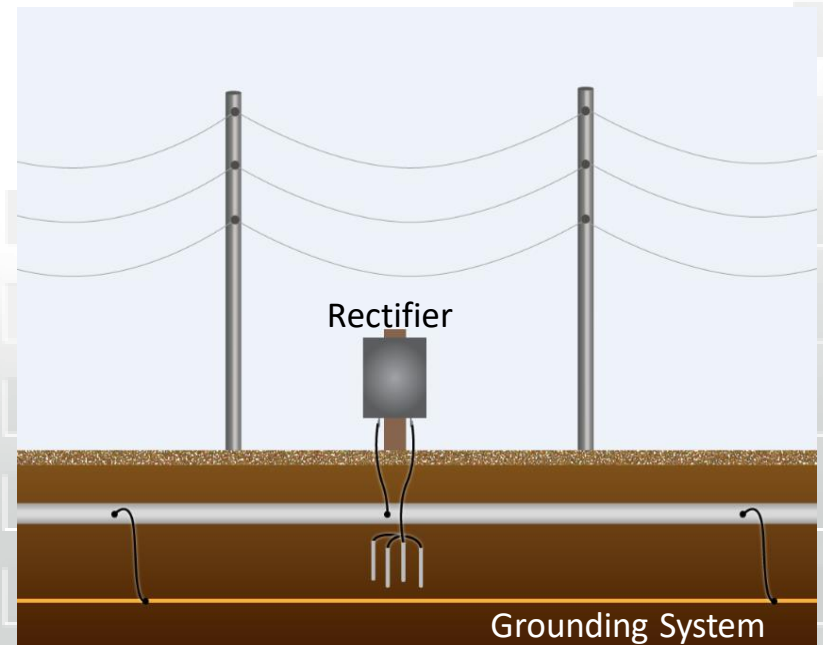
## Conflicting Requirements

- Cathodically Protected (CP) structures require DC isolation from ground
- All electrical equipment must be AC grounded
- The conflict: DC Isolation + AC Grounding

# Why are Decouplers Needed?

## Without Decoupling:

- CP systems attempts to protect grounding system
- CP coverage area is reduced
- CP current requirements are increased
- CP voltage may not be adequate



# Outline

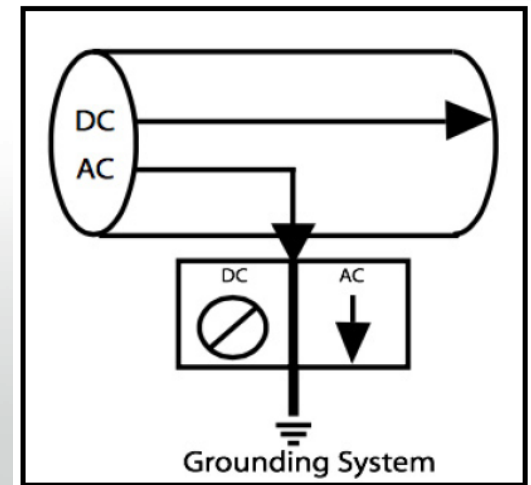
1. Introduction to Dairyland
2. Why are decouplers needed?
- 3. What is a decoupler and how does it work?**
4. Where are decouplers used?
5. How to select the right decoupler for the application
6. How to specify decoupler models
7. How to test a decoupler



# What is a Decoupler?

A device that acts as an open switch for low voltage DC and a closed switch for AC and higher voltages

- Blocks DC up to a predetermined voltage level, typically 2 to 3 volts
- Very low impedance to AC





# What is a Decoupler?

Blocks CP current from passing through to grounding system → **Maintains efficiency of CP system**

Continuously passes steady state AC current → **Keeps induced AC voltage low as part of AC Mitigation system**

Maintains an effective ground path for AC faults and lightning → **A must for safety**

# Dairyland Solid State Decouplers

- Rated for AC faults & lightning
- Continuously pass steady state AC current induced from nearby power transmission lines
- Provide lowest clamping voltages feasible
- No maintenance
- “Fail-safe” design
- Automatically reset after fault event
- 3<sup>rd</sup> party certified for hazardous locations use and safety grounding/bonding

# Dairyland Solid State Decouplers



**Dairyland PCR**



**Dairyland SSD**



# Other Protective Devices

## Polarization Cells

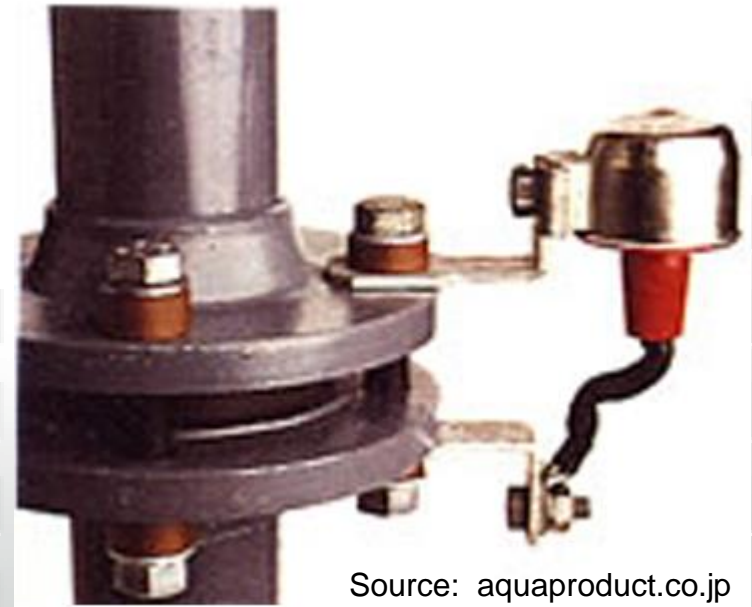
- Electrochemical switch – steel plates in potassium hydroxide solution.
- Plates become polarized and block flow of low voltage DC current and pass AC faults and lightning.
- Fluid levels must be maintained
- Fail open – not fail-safe



# Other Protective Devices

## Spark Gap Arresters

- Current passes by arcing across internal electrodes
- Provides lightning protection only. Not intended to protect against AC faults
- Not suitable for induced AC
- Relatively low cost
- Fail open – not fail-safe
- High voltages required for conduction – potential safety hazard



# Outline

1. Introduction to Dairyland
2. Why are decouplers needed?
3. What is a decoupler and how does it work?
- 4. Where are decouplers used?**
5. How to select the right decoupler for the application
6. How to specify decoupler models
7. How to test a decoupler



# Where are Decouplers Used?

## Typical Applications



**AC Voltage Mitigation**

**Decoupling From Power Utilities**

**Grounding Systems**

**Insulated Joint Protection**

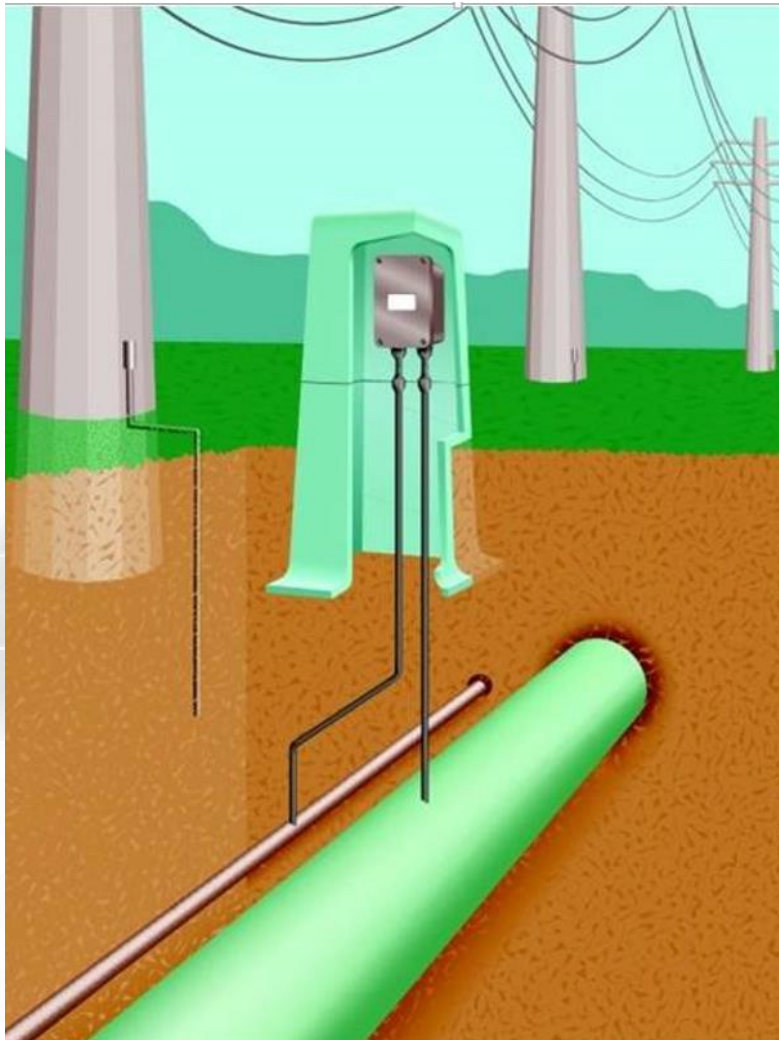
**Decoupling Electric Equipment**

**Decoupling Power Transmission Cables**



# Where are Decouplers Used?

## Pipeline AC Mitigation



# Where are Decouplers Used?

## Pipeline AC Mitigation

As part of an effective AC mitigation system, Dairyland decouplers ...

- Create a low impedance AC path to ground
  - Provide safety during abnormal conditions
  - Reduce the risk of AC corrosion
- 
- Any grounding material may be used, since decoupled and not part of the CP system
  - Decouplers have no detrimental effect on the CP system
  - Any pipe-to-ground connection should use a decoupler

# Where are Decouplers Used?

Insulated Joint Protection



Prevent arcing  
at insulators



# Where are Decouplers Used?

## Insulated Joint Protection

- Excessive voltage across the insulator leads to arcing
- Arcing leads to insulation and/or steel damage
- Can create shorts across the insulation
- Can ignite product in the pipe
- Best practice is to install protection device at every isolation joint
- Minimize conduction path length – bus bar mounting
- Use decouplers instead of Over-Voltage Protectors if steady state AC is present

# Where are Decouplers Used?

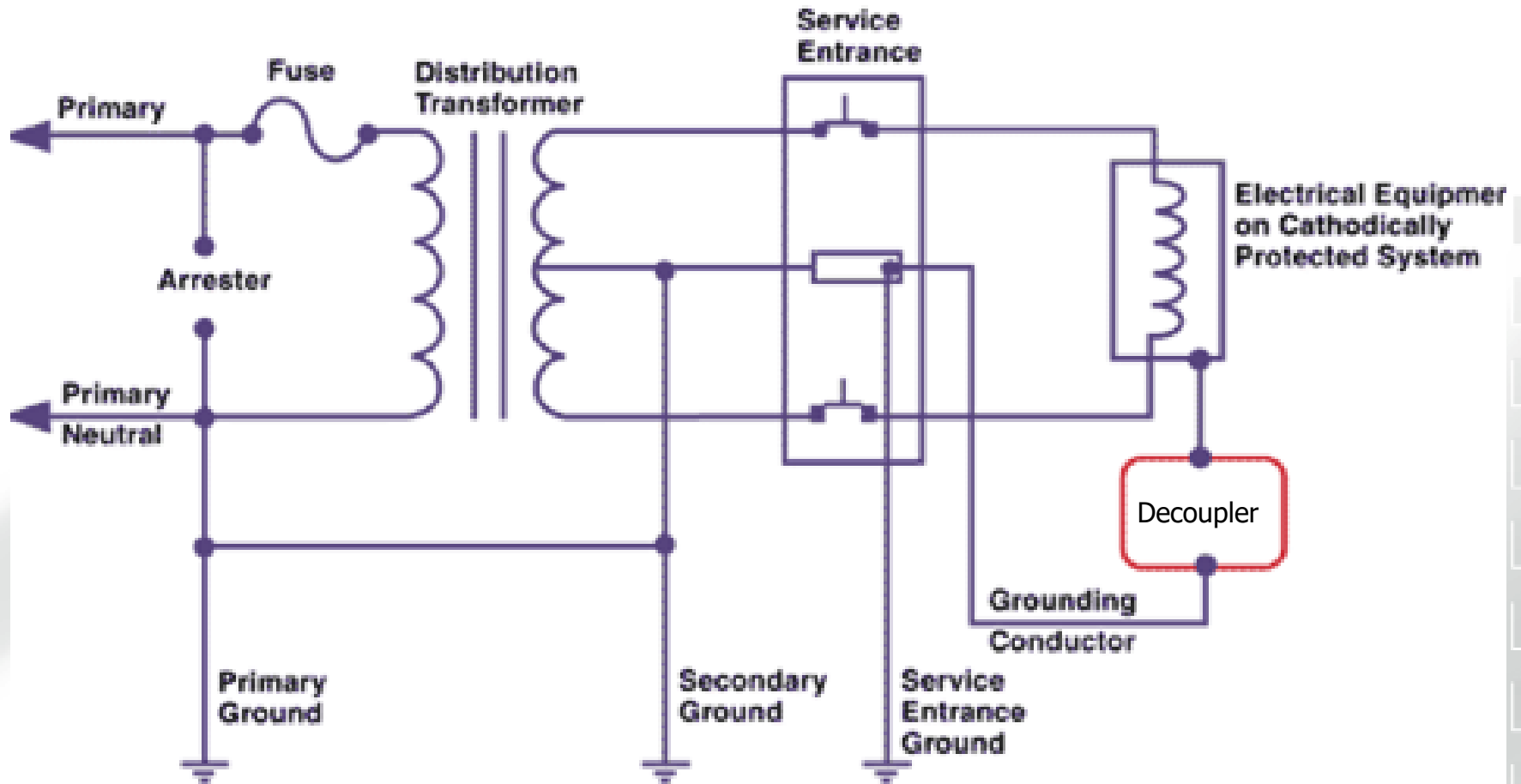
## Equipment Decoupling

- Decouplers can be used in-series in grounding conductors of electrical equipment not isolated from CP (i.e., MOVs, sensors, etc.)
- This approach may be easier than installing isolation joints around the equipment
- Dairyland products are certified as an “effective grounding path” for AC current



# Where are Decouplers Used?

## Equipment Decoupling



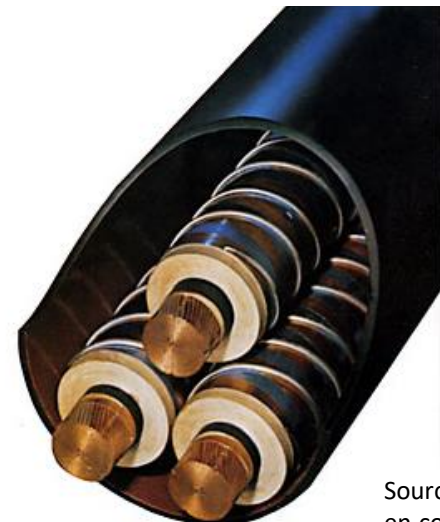
# Where are Decouplers Used?

## High Voltage Cable Systems

### Power utility transmission pipe-type cable grounding

- Uses Dairyland ISP product to ground transmission cable sheath/pipe for AC faults, blocks CP
- Very high AC fault current rating
- Involves utility transmission engineer or specialized cable contractor as client

High Pressure Liquid-Filled Pipe-Type Cables



Source:  
[en.coppercanada.ca](http://en.coppercanada.ca)

# Where are Decouplers Used?

High Voltage Cable Systems





# Where are Decouplers Used?

## Utility-Customer Decoupling

- In some cases it may be necessary to isolate an entire facility from the utility ground to ensure DC isolation
- Electrical codes require AC bonding between the utility and customer ground
- Two options for decoupler installation:
  1. At transformer
  2. At customer service panel

# Where are Decouplers Used?

## Utility-Customer Decoupling

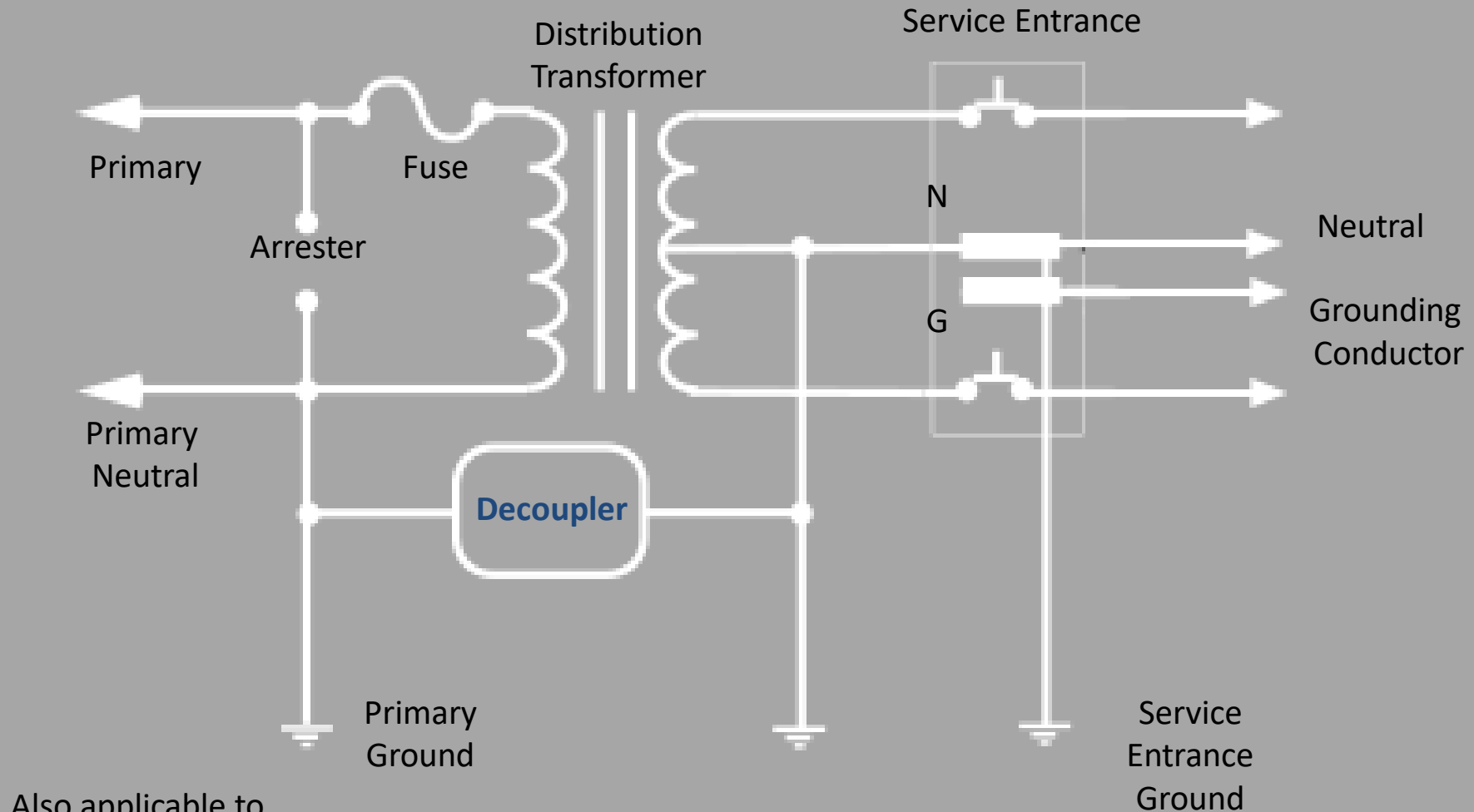
### Decoupler Location:

1. Utility decoupling at the transformer - less chance of bypass. But must be installed by utility.
2. Utility decoupling at the customer's disconnect panel – No utility involvement. But higher fault current involved.



# Where are Decouplers Used?

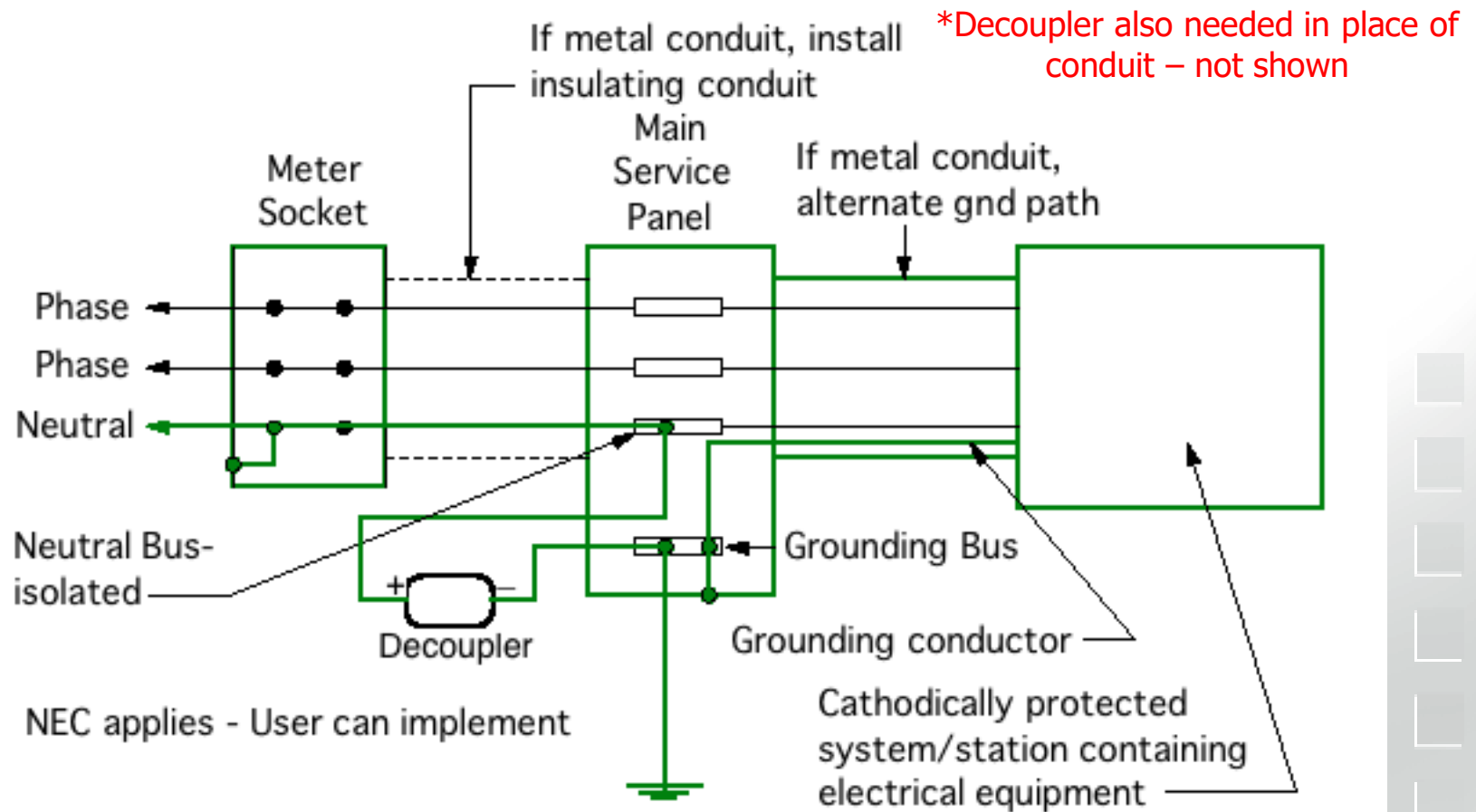
## Utility Decoupling at the Transformer



Also applicable to  
three-phase  
installations

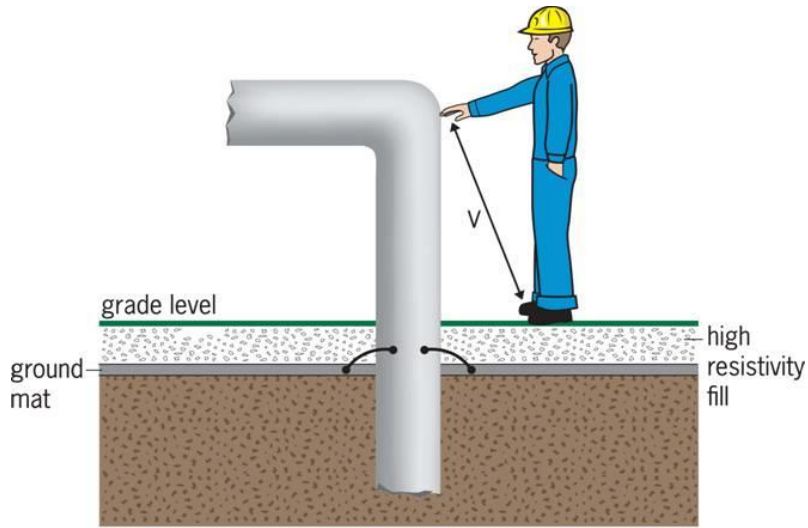
# Where are Decouplers Used?

## Utility Decoupling at the Service Panel



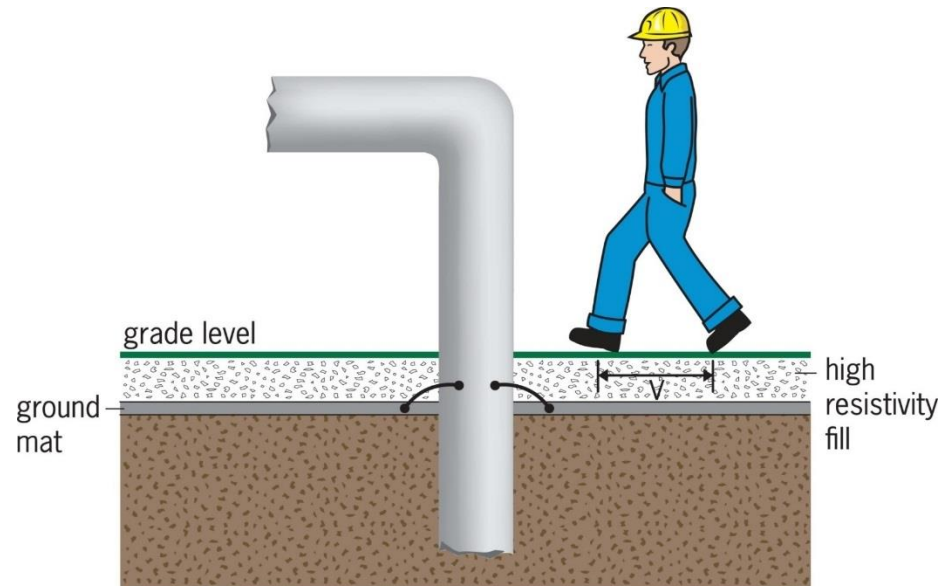
# Where are Decouplers Used?

## Gradient Control Mats



Reduce touch voltage – the potential between the pipe and the ground where a person is standing.

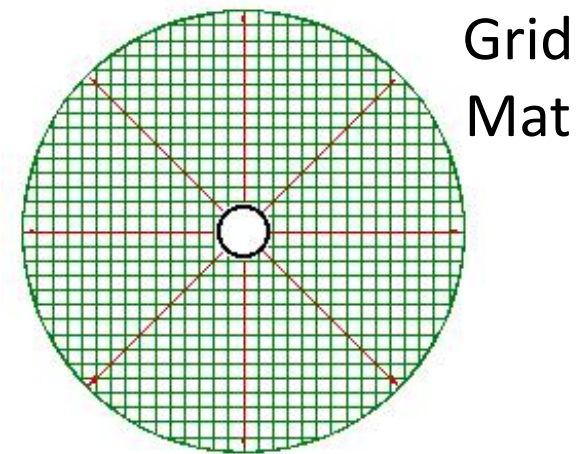
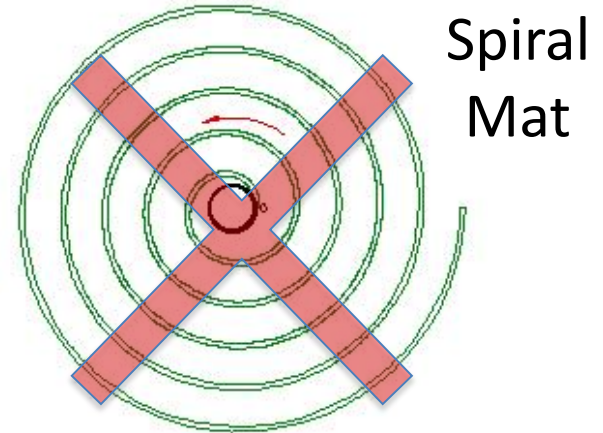
Reduce step voltage – the potential between a person's feet where they contact the ground.



# Where are Decouplers Used?

## Gradient Control Mats

- Dairyland gradient control mats use a grid-type design – providing much lower step and touch voltage than spiral or zig-zag designs
- Connect mats to pipe with short conductors (important for lightning) and decouplers



# Where are Decouplers Used?

Gradient Control Mats



# Outline

1. Introduction to Dairyland
2. Why are decouplers needed?
3. What is a decoupler and how does it work?
4. Where are decouplers used?
- 5. How to select the right decoupler for the application**
6. How to specify decoupler models
7. How to test a decoupler





# How to Select the Right Device for the Application

## Hazardous Location Ratings

### Class I, Division 1 / Zone 1

An environment where the accumulation of explosive gases and vapors can *normally* occur.

#### Examples:

- Petroleum refineries, gasoline dispensing and storage areas
- Spray painting areas
- Aircraft hangars and fuel servicing areas
- Utility gas plants, especially near gas vents

# How to Select the Right Device for the Application

## Hazardous Location Ratings

### Class I, Division 2 / Zone 2



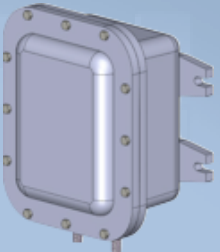

An environment where the accumulation of explosive gases and vapors is an *abnormal* condition.

#### Examples:

- Accidental rupture of a gas line
- Breakage of a storage vessel
- Faulty plant operations

# How to Select the Right Device for the Application

## Device Types

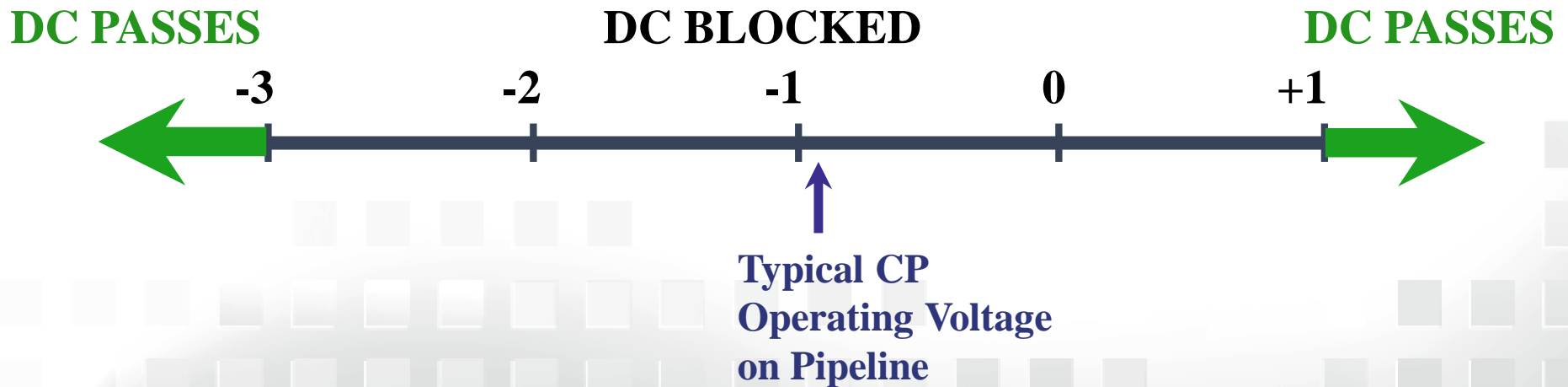
AC PRESENT	AC NOT PRESENT
<p data-bbox="285 382 846 488">Decoupler Division 2/Zone 2 Rated</p>  <p data-bbox="467 753 807 788">PCR      SSD</p>	<p data-bbox="892 382 1445 488">Over-Voltage Protector Division 2/Zone 2 Rated</p>  <p data-bbox="1174 753 1290 788">OVP2</p>
<p data-bbox="285 859 846 965">Decoupler Division 1/Zone 1 Rated</p>  <p data-bbox="633 1210 749 1245">PCRH</p>	<p data-bbox="892 859 1445 965">Over-Voltage Protector Division 1/Zone 1 Rated</p>  <p data-bbox="1143 1216 1240 1250">OVP</p>

Area Classification  
Class I, Division 2  
Zone 2

Area Classification  
Class I, Division 1  
Zone 1

# How to Select the Right Device for the Application

## Blocking Voltage Threshold



Integrated electronics ensure no DC current flows in blocked voltage zone

# How to Select the Right Device for the Application

## AC Fault Rating

- All Decouplers and Over-Voltage Protectors have a time limit as to the amount of current they pass
- Rating of the Decoupler must exceed the maximum current produced by the fault
- Typical AC fault rating is given at 30 cycles
- Common fault ratings are 3.7kA – 15kA

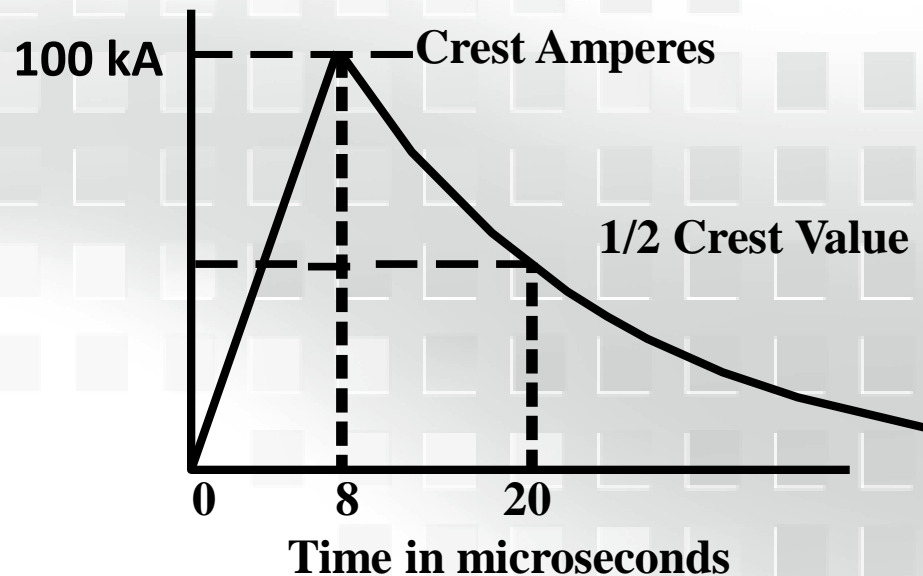
AC Fault Current (amperes-rms) 50 Hz

Model	1 cycle	3 cycles	10 cycles	30 cycles
PCR-3.7KA	6,500	5,000	4,200	3,700
PCR-5KA	8,800	6,800	5,700	5,000
PCR-10KA	19,000	14,000	11,000	9,000
PCR-15KA	33,000	25,000	19,000	14,000

# How to Select the Right Device for the Application

## Lightning Surge Current Rating

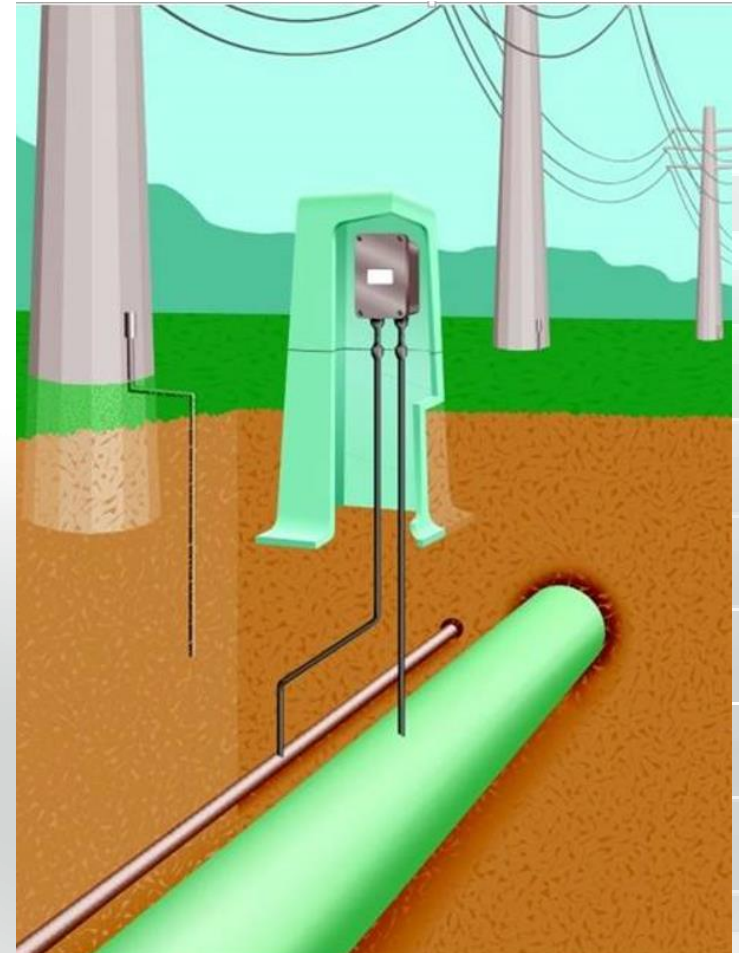
- Lightning surge current is very high but for a very short period of time
- A common Decoupler lightning surge current rating is 100kA crest (8 x 20  $\mu$ s waveform)



# How to Select the Right Device for the Application

## Steady State AC Current Rating

- Typically applies to AC mitigation applications
- Source of steady state AC current is what is induced onto the pipe
- Decouplers have limits to the level of steady state current they can pass, commonly 45-80 Arms. Well above what is typically found on pipelines



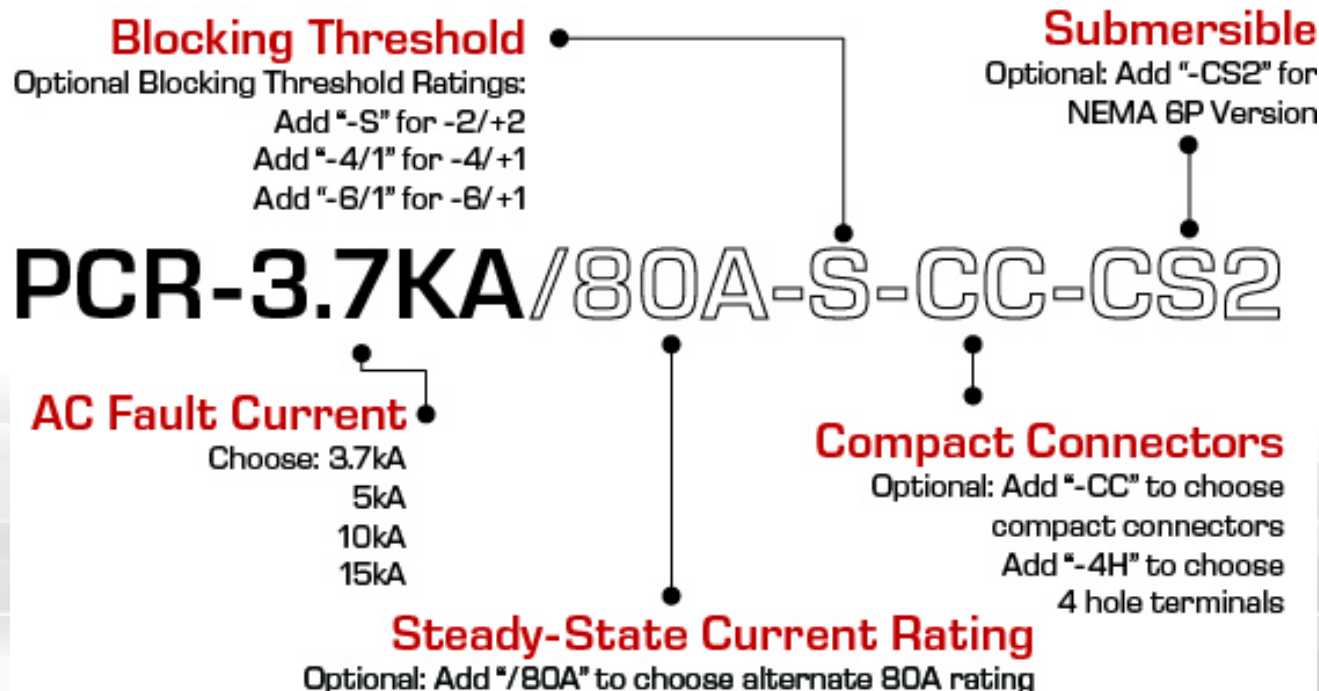
# Outline

1. Introduction to Dairyland
2. Why are decouplers needed?
3. What is a decoupler and how does it work?
4. Where are decouplers used?
5. How to select the right decoupler for the application
- 6. How to specify decoupler models**
7. How to test a decoupler





# How to Specify Decoupler Models



Each product family has a slightly different model number format. See the model number description chart on the respective product page at Dairyland.com or call Dairyland for assistance.

# Outline

1. Introduction to Dairyland
2. Why are decouplers needed?
3. What is a decoupler and how does it work?
4. Where are decouplers used?
5. How to select the right decoupler for the application
6. How to specify decoupler models
- 7. How to test a decoupler**



# How to Test a Decoupler

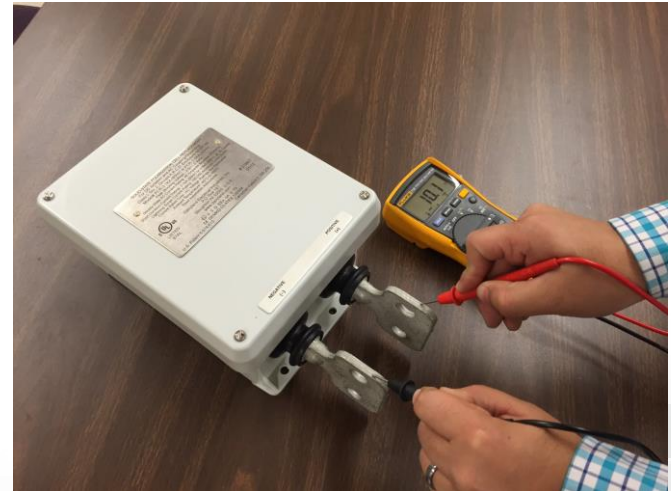
## In-Circuit Test:

- Measure structure CP voltage to reference cell
- “Normal” CP readings indicate correct decoupler operation. i.e., the decoupler is not conducting DC and is not shorted.
- However, “Abnormal” CP readings can also be due to a bypass elsewhere in the system

# How to Test a Decoupler

## Out-of-Circuit Test:

- Disconnect one conductor from decoupler
- Short decoupler terminals momentarily
- Measure resistance between terminals. Value should increase from zero for a functional unit.
- A low ( $<1\Omega$ ), unchanging resistance value indicates the unit has failed shorted.



# How to Test a Decoupler

## Other indications of functional device:

- Zero direct current flow
- Presence of AC current flow (this is not decisive, however, since there may not be significant AC current available)



# How to Test a Decoupler

## Don't Be Tricked...

- Insulated joint testing with a decoupler present
- RF testers use high frequency signal to test joint insulation. The joint will appear shorted since the decoupler passes AC.
- Instead:
  1. Test the insulated joint with the decoupler disconnected
  2. Test the decoupler separately using the out-of-circuit ohm test



# Website Resources

**DAIRYLAND ELECTRICAL INDUSTRIES** PRODUCTS APPLICATIONS PROJECT GALLERY KNOWLEDGE BASE CUSTOMER SERVICE

Home > Products > Products

Search

## SSD

### Solid-State Decoupler

The Solid-State Decoupler (SSD) uses proven, solid-state construction combined with innovative production and packaging techniques, to offer exceptional performance while lowering the cost of applying protection products to industry. With ratings for AC fault current and lightning, and the ability to pass steady-state AC current, the device outperforms other technologies such as metal oxide varistors, gapped arrestors, and polarization cells. Now proven over many years, the SSD is the most commonly used Dairyland decoupler in the world.

#### FEATURES AND CHARACTERISTICS

- Compact, lightweight package
- Range of AC Fault Ratings
- Higher Blocking Voltage than Polarization Cells
- UL and C-UL Listed for Grounding Electrical Equipment
- UL, C-UL Listed for Class I, Division 2 Locations
- Certified by UL/DEMKO for Meeting ATEX Directive for Zone 2; CE Marked
- Certified by UL for IECEx Zone 2 locations
- Submersible Design
- EAC Certified Products Available - Learn More Here

[REQUEST A QUOTE](#)
[CONFIGURE YOUR PRODUCT](#)

#### BASIC RATINGS

**THRESHOLD VOLTAGE**  
 -2/+2V (standard)  
 -3/+1V (optional)  
 For other product options, contact Dairyland

**AC STEADY-STATE CURRENT** (amperes - rms) 50/60Hz  
 45A (standard)

**LIGHTNING SURGE CURRENT**  
 100kA crest [4 x 10 µs waveform] for 5.0kA, 3.7kA and 2.0kA models  
 75kA crest [4 x 10 µs waveform] for 1.2kA models

**ENVIRONMENTAL RATING**  
 IP6B - submersible (to 2m depth)

**HAZARDOUS (CLASSIFIED) AREAS**  
 ANSI/ISA 12.12.01, CSA C22.2 No.213 M1987 (R200B): Class I, Division 2, Groups A, B, C, D  
 ATEX: EN60079-0: 2012, EN60079-15: 2010 - Zone 2, Group IIC  
 IECEx: IEC60079-0: 6th Ed., IEC60079-15: 4th Ed. - Zone 2, Group IIC  
 EAC: GOST R IEC 60079-15:2010, GOST R IEC 60079-D-2011

**THIRD-PARTY LISTINGS AND APPROVALS**  
 Underwriter's Laboratories (UL)  
 Underwriter's Laboratories - Canada (C-UL)  
 UL/DEMKO  
 NAN10-CCVE

[SEE FULL CERTIFICATIONS/LISTINGS FOR THE SSD](#)

#### PACKING SPECIFICATIONS

AC Fault Current (amperes-rms) 50/60 Hz				
Model	1 cycle	3 cycles	10 cycles	30 cycles
1.2kA	2,100	1,600	1,400	1,200
2.0kA	5,300	4,500	3,700	2,000
3.7kA	6,500	5,000	4,200	3,700
5.0kA	8,800	6,800	5,700	5,000

[VIEW MODEL NUMBER DESCRIPTION CHART](#)

- Product specifications
- Application Notes
- Installation Instructions
- Training videos
- Technical articles
- Installation photos

# For application discussions...

Dairyland Electrical Industries, Inc.

Stoughton, WI

[www.dairyland.com](http://www.dairyland.com)

[techsupport@dairyland.com](mailto:techsupport@dairyland.com)

Phone: 608-877-9900