DAIRYLAND ELECTRICAL INDUSTRIES

ISOLATE. GROUND. PROTECT.

The Over-Voltage Protector (OVP)

Technical Literature

INTRODUCTION

The Over-Voltage Protector (OVP) is a solid-state device primarily designed to provide over-voltage protection from lightning and AC fault current in insulated joint applications; however, it also addresses many other cathodic protection applications. It also serves as an effective grounding (or coupling) path if the voltage across its terminals attempts to exceed a predetermined value selectable from 1.0 to 4.0 volts.

The OVP is UL and C-UL listed by Underwriters Laboratories: (1) as an over-voltage protective device, (2) as meeting the requirements of an effective grounding path, and (3) for isolation of objectionable DC current from cathodically protected systems to ground. The OVP is packaged in a NEMA 6P rated (IP68) explosion-proof enclosure suitable for indoor or outdoor, submersible or non-submersible applications. It is certified by UL and UL/DEMKO for Zone 1 and Div 1 hazardous locations.

The OVP functions as an AC and DC isolation device (i.e., it prevents the flow of both DC and AC current) up to a predetermined voltage blocking level and as an effective grounding (or coupling) path when the voltage attempts to exceed this level. If the voltage attempts to exceed the voltage blocking level selected, the device immediately begins to clamp (i.e., limit) the voltage by allowing current to readily flow between its two connection points.

The OVP should only be used where the steady-state DC voltage plus the peak AC voltage (if any AC voltage is present) is less than the blocking voltage selected; otherwise AC rectification will occur, possibly affecting cathodic protection levels. Where over-voltage protection is required and induced AC voltage is present, it is recommended that PCR, PCRH, or SSD models be used because these can conduct AC current while blocking the flow of DC current. Refer to the product pages on www.dairyland.com.

COMMON APPLICATIONS

Insulated Joint Protection

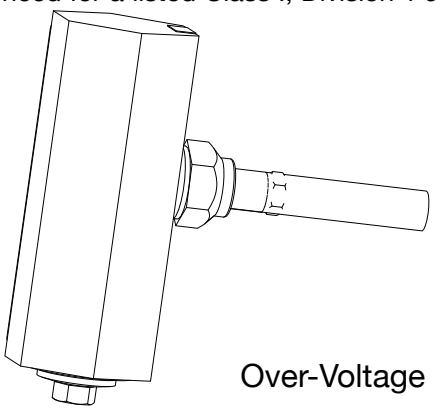
Insulated joints often need over-voltage protection against lightning and AC fault current. Due to the small clearance between opposite sides of the insulated flange, a protective device must provide a low clamping voltage, including the voltage effects of the conductors or bus bars used to connect the product (See the DEI technical articles on conductor length relating to lightning effects.)

- Provide over-voltage protection (e.g., insulated joints).
- Provide AC and DC isolation for voltages below the voltage blocking level selected and an effective grounding (or coupling) path whenever the voltage attempts to exceed the voltage blocking level (e.g., to eliminate objectionable DC current paths).

Airport Fueling Stations

Airports utilize underground piping to transport large amounts of jet fuel, and this critical infrastructure requires cathodic protection to prevent corrosion. Since cathodic protection systems utilize insulated joints to sectionalize the piping, arcing at insulated joints presents a hazard to system operation and personnel, whether due to AC fault current, lightning, or static buildup.

Most commonly, over-voltage protection of the insulated joints can be accomplished using the OVP, which was developed in conjunction with the US Army Corp of Engineers to meet their need for a listed Class I, Division 1 and 2 product.



OVP

Over-Voltage Protector

PRODUCT OVERVIEW

Background
Most cathodically protected pipelines have insulated joints which are installed for various reasons, such as: (1) where pipeline ownership changes, and (2) to segment cathodically protected pipelines from facilities, within which the piping or equipment is normally grounded (e.g., metering stations, power plants, storage tanks, etc.).

Insulated joints fall into two major categories: field-fabricated insulated joints which are field assembled using insulating materials furnished in a prepackaged kit, and factory-fabricated monolithic insulated joints which are furnished in a short section of pipe to enable welding the joint into the pipeline.

Of these two types, the most common is the field-fabricated version. Most insulated joint kits do not come with a published voltage withstand capability for the finished joint, primarily due to the many variables involved in a field assembly, and the fact that they were initially intended to only block DC cathodic protection voltage. Without voltage withstand data for the joint, a user cannot be completely sure that any device selected to provide over-voltage protection would in fact provide the desired protection.

Manufacturers of factory-fabricated insulated joints do publish voltage withstand data and such joints can be ordered to withstand a specified voltage level.

To provide the highest level of over-voltage protection for any application, it is necessary to: (1) utilize a device that clamps the voltage to the lowest allowable level and, (2) install the device with the shortest possible lead length to minimize the voltage created by lead inductance. The OVP was designed to these criteria, thereby providing the highest level of over-voltage protection possible.

Since insulated joints in many pipelines are by definition a "hazardous location" (depending on the material being transported), the OVP is packaged and listed for use in hazardous locations.

Blocking Voltage
At a voltage below the blocking voltage selected, the OVP is an isolating device and prevents the flow of both AC and DC current. At a voltage above the blocking voltage selected, the OVP is a bi-directional conducting device which readily allows current to flow, thereby limiting the voltage.

The blocking voltage choices are designated as "A/B" in the model number structure where "A" is the (-) blocking voltage and "B" is the (+) blocking voltage as measured from the negative terminal (i.e., the exit lead) with respect to the positive terminal (i.e., the enclosure).

Blocking Voltage Ratings
The choices for A/B are:
-A/+B in volts peak
Recommended for most applications: A/B = -3/+1, -2/+2
Other voltage blocking options, ranging from -2/+2 to -4/+4 volts, are available upon request.

The reasons for symmetrical and asymmetrical choices are best described with an example. If both sides of an insulated joint are cathodically protected, the DC voltage across the joint will be the difference in voltage between the two cathodic protection systems, normally near zero volts. For this application it may be desirable to select A/B = -2/+2 (symmetrical voltage blocking). In the event that the cathodic protection system is OFF on one side of the joint, the device can block 2.0 Vdc in either direction.

If one side of the insulated joint is cathodically protected and the other side is grounded, then it may be preferable to select the asymmetrical version with A/B = -3/+1 since DC current flow only needs to be blocked in one polarity. Whenever one side of the OVP is referenced to ground, B = +1 should always be selected because this initiates voltage clamping when any positive voltage on the cathodically protected structure attempts to exceed +1.0 volt. In the model number structure the polarity signs are not shown, but the polarity as described above is implied.

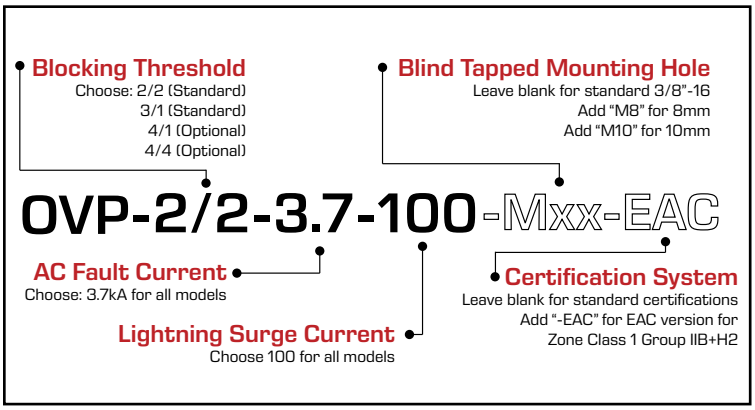
DC Leakage Current versus Blocking Voltage
The DC leakage current at the maximum blocking voltage for any OVP model is normally less than 10 milliamperes at 20°C and less than 100 milliamperes at 65°C. With normal cathodic protection voltage across the OVP, the leakage current is well under 1 milliampere under either temperature condition, a value that is insignificant to a cathodic protection system.

AC Fault Current Rating
There are applications where an over-voltage protective device may be subject to fault current, even though no induced AC voltage is present. For this reason the OVP was designed to have AC fault current carrying capability. The OVP will limit the voltage between its connection points to less than 7 volts AC under the maximum fault current ratings listed in the following table.

AC Fault Current Ratings (Amps AC-RMS Symmetrical)	
Cycles	**50/60 Hz**
1	6500
3	5000
10	4200
30	3700

Lightning Surge Current Rating
The lightning surge current rating should not be confused with the AC fault current rating. Lightning has a very different waveform, with a faster rise time, a shorter duration, and much less energy than an AC current waveform of the same peak current. Lightning current ratings are established by subjecting the over-voltage protective device to representative lightning current in

ORDERING INSTRUCTIONS



NOTE: *The EAC version is a separate product from standard models, with a Cyrillic nameplate and instruction manual, and references GOST standards only. To purchase, order model with "EAC" suffix. See separate Russian/English EAC manual.*

a high power test laboratory. The waveforms most commonly used are the 8 x 20 microsecond waveform and the 4 x 10 microsecond waveform. The first number represents the time it takes the lightning surge to reach its crest value and the second number represents the time it takes for the current to decrease to 1/2 its crest value.

Lightning Surge Current Rating	
Peak Amperes	100,000
Note: 8x20 microscecond waveform	

Voltage Between OVP Connection Points Due to Lightning

Voltage measurements were taken between the OVP connection points in a high power test laboratory at 50,000 amperes crest to establish the resulting voltage. The clamping voltage (i.e., the maximum voltage that occurred between the two connection points) was primarily due to conductor inductance. Therefore, the voltage clamping capability of the OVP is almost entirely dependent on how short the conductor can be cut during installation. On most insulated joints, the OVP can, and should be installed with no more than 6"(150 mm) of conductor for most effective results.

Following is a summary of the OVP clamping voltage values that can be expected at 50,000 amperes crest based on actual test results.

OVP clamping voltage for a 50kA 8 x 20 microsecond waveform:

≤ 100V with zero conductor length (i.e., at bushing terminal)

≤ 1.25kV with 6" (≈ 150 mm) conductor

≤ 1.50kV with 12" (≈ 300 mm) conductor

Under field conditions, the actual clamping voltages may be more or less than the above values due to the wide range of lightning surge current magnitudes and wave shapes that can occur.

The primary contributor to clamping voltage is the voltage caused by the very rapid rate of rise of current flowing through conductors which inherently have inductance. This voltage is V = L (di/dt) where L is the inductance per unit of conductor length in microhenries and di/dt is the rate of change of current in amperes per microsecond. Since di/dt is determined by the characteristics of the lightning strike, the only option to minimize the clamping voltage is to limit the inductance L by keeping the conductor length as short as possible during installation. This phenomenon applies to all devices used to limit voltage due to lightning and is relatively independent of conductor size.

FEATURES AND CERTIFICATIONS

Certifications

The OVP is Underwriters Laboratories (UL) listed as an over-voltage protective device for use in hazardous locations in accordance with NFPA 70, (U.S. National Electric Code) Articles 500-505 for Class I, Div. 1 and Div. 2, Groups B, C, and D. The OVP is also C-UL listed to the above classifications per Canadian Code C22.2 No. 30-M1986 (R2012). The listing is valid for ambient temperatures of -45ºC to +85ºC. The operating temperature code is T5 (85ºC). Protection from over-voltage due to lightning complies with the pertinent requirements of ANSI C62.11.

The OVP is also UL listed as meeting the requirements of an effective grounding path as defined in NFPA 70 Article 250.2, and as suitable for the isolation of objectionable DC current from cathodically protected systems to ground as defined in Article 250.6(E). Similarly, it is C-UL listed for meeting the effective grounding path requirements of Canadian Electrical Code C22.1-12 sections 10-500, 10-806 (1), and bonding per CSA C22.2 No. 0.4-04(2009).

The OVP is certified to the ATEX Directive and IECEx for Zone 1 use for Gas Group IIB+H2 under protection method "d". The ambient temperature range is -45°C to +85°C. The standards used in the evaluation are: IEC60079-0:6th Edition, IEC60079-1:6th Edition, EN60079-0:2012, and EN60079-1:2007.

The EAC version of the OVP, available by ordering a model number with a "-EAC" suffix, is certified to the EAC requirements of the Customs Union (Russia, Kazakhstan, etc) for use in Zone Class 1, Group IIB+H2 hazardous locations by NANIO-CCVE to: GOST R IEC 60079-15-2010, GOST R IEC 60079-0-2011.

Solid-State Design

The OVP uses 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 OVP is that if subject to AC fault current or lightning surge current such that failure occurs, failure will occur in the shorted mode. In the shorted mode, the OVP will carry rated fault current or lightning surge current and still provide an effective grounding (or conducting) path.

Field Testing/Maintenance
The OVP can be field tested with an AC/DC multimeter and clamp-on AC ammeter. Testing procedures are included in the installation instructions. The OVP is completely maintenance-free.

Enclosure
The OVP is packaged in an explosion-proof, hexagonal, nickel-plated brass enclosure which is rated NEMA 6P and IP68 and is suitable for indoor or outdoor use, in submersible and non-submersible applications. See the OVP outline drawing for dimensional data.

Polarity/Electrical Connection
The enclosure is the positive (+) terminal, and a single #4 AWG (≈ 25 mm^2) conductor, which exits the side of the enclosure through an electrical feed-through bushing, is the negative (-) terminal. It is recommended that the conductor always be cut to the shortest possible length during installation to minimize voltage caused by conductor inductance.

Number of Operations
The number of times that the OVP can be subject to its rated lightning or AC fault current rating is virtually unlimited, provided the operations are not immediately repetitive.

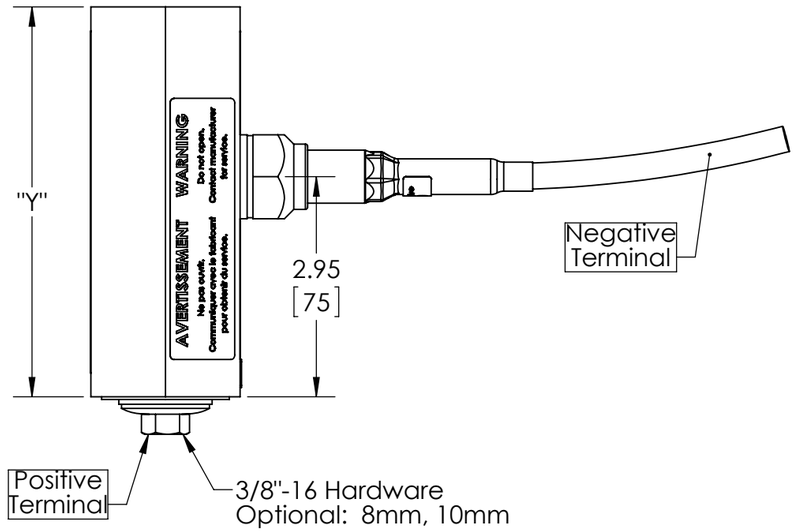
Energy Requirement
None. The device is totally passive.

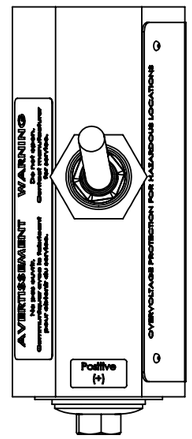
Ambient Operating Temperature
-45° C to +85° C

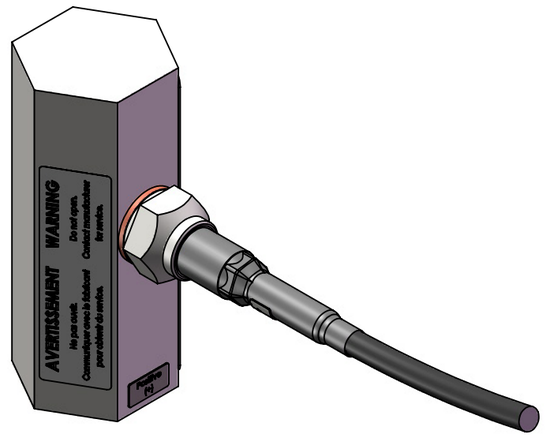
MOUNTING OPTIONS

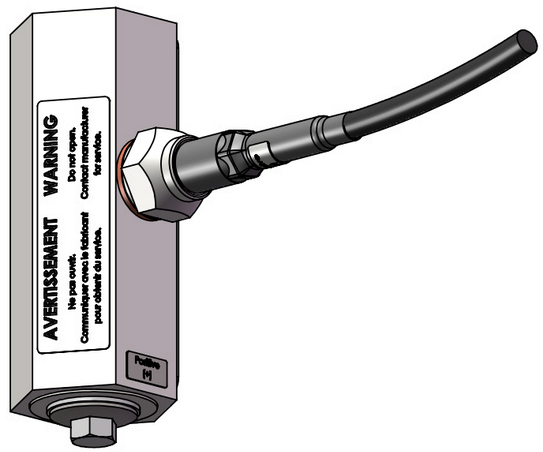
Mounting Accessories
Numerous mounting accessories are available from Dairyland to aid in the proper installation of the OVP. Detailed accessory information, including complete installation instructions are available on the Dairyland website here: Dairyland Accessories.

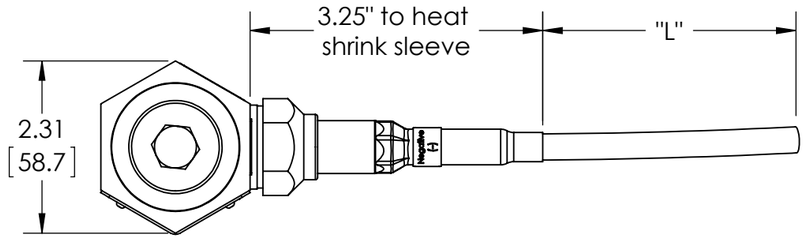
Specific Installation Guidance
The Dairyland website contains detailed information on the installation methods specific to a given application. For wiring diagrams and/or application guidance, see Dairyland Applications.











NOTES:

1. Applies to all OVP models
2. Bolted terminal and hardware provided with OVP
3. Attach conductor to terminal after cutting conductor to shortest allowable length
4. Standard conductor length: "L" = 12" (305mm) #4 AWG. (25mm squared)
5. For OVP-2/1, 2/2, 3/1, 4/1 & 4/2: "Y" = 5.23" (133mm)
6. For OVP-3/3, 4/4: "Y" = 6.06" (154mm)

ANSI Y14.5M 1994 APPLIES

UNLESS NOTED 63
UNITS: INCHES
3-PLACE: ±.005
2-PLACE: ±.015
1-PLACE / FRAC: ±.03
ANGULAR: ±1

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DESCRIPTION
OVP All Models Outline Drawing

DOCUMENT #	REV	DATE DRAWN	DWG SIZE	DATE APPROVAL
100076		2015-04-08	B	2015-04-13

SCALE 1:2	DRAWN: JPW	SHEET: 1 OF 1	DWG APPROVAL: HNT