The Over Voltage Protector 2 (OVP2)

INTRODUCTION

The Over-Voltage Protector (OVP) design has been established since 1999 as the premier explosion-proof (Division 1) protection device for use on cathodically protected structures, using solid-state technology. DEI now offers a variation of the OVP design in a molded housing, designated as the OVP2, for Division 2 and ordinary locations. The OVP2 package offers the same conservative design and features of the OVP, but in a lighter weight and lower cost package.

The OVP2 functions as an AC and DC isolation device, preventing the flow of any current, up to a predetermined voltage threshold. For voltage that attempts to exceed the threshold, the device instantly switches to the shorted mode, providing over-voltage protection. After the event is over, the device automatically switches back to the blocking mode. This operation can occur an unlimited number of times, and is typically due to AC faults and lightning, which the OVP2 is rated for. While the standard threshold is -2V/+2V, the OVP2 can be supplied with up to a -3V/+1V threshold and several lower threshold combinations. Contact DEI for other threshold options. The threshold is the absolute, or peak, voltage at which switching occurs, and is the sum of the DC and peak AC voltage across the terminals of the device. This results in a very low, and safe clamping voltage across the OVP2 terminals.

As the OVP2 switches based on the DC plus peak AC voltage, care should be taken to apply the device where induced AC voltage is not present or anticipated. In the presence of induced AC voltage, the OVP2 will switch to the shorted mode and could affect the cathodic protection system. Where induced AC voltage is present, apply the DEI model PCR or SSD (Div. 2 locations), or PCRH (Div. 1), depending on the applications and ratings needed.

APPLICATIONS

The OVP2 is designed for:

- Over-voltage protection across insulated joints in pipelines
- Tank isolation from ground
- Decoupling dissimilar metals that must otherwise be bonded for safety

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 withstand level.

The OVP2

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 OVP2 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 OVP2 is packaged and listed for use in Class 1, Div. 2 and Zone 2 hazardous locations.

PRODUCT CAPABILITY OF THE OVP2

The key parameters of the OVP2 are:

- Blocking voltage or threshold voltage
- DC leakage current for a given blocking voltage
- AC fault current rating
- Lightning surge current rating

Blocking Voltage

At a voltage below the blocking voltage selected, the OVP2 is an isolating device and prevents the flow of both AC and DC current. At a voltage above the blocking voltage selected, the OVP2 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 with respect to the positive terminal.

Blocking Voltage Ratings

The choices for A/B are:

-A/+B in volts peak

Recommended for most applications: A/B = -2/+2 (standard)

Other blocking voltage options include -3/+1 and other lower blocking voltage combinations. Contact DEI for options.

The blocking voltage of -2/+2 is usually adequate for most applications, since the voltage difference between the two connected points is usually much less than 2V. For example, an insulated joint on a cathodically protected pipeline either has cathodic protection on both sides of the joint, leaving the voltage difference near zero, or one side has CP and the other is unprotected, with a typical difference of about 1V. For cases where a higher blocking voltage is needed, the model with a -3/+1 threshold is usually adequate. In the model number structure the polarity signs are not shown, but the polarity described above is implied. Polarity marks (+ and -) are provided on the OVP2 only when an asymmetrical blocking voltage is specified. Polarity is irrelevant with a symmetrical blocking voltage.

DC Leakage Current versus Blocking Voltage

The DC leakage current at the maximum blocking voltage for any OVP2 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 OVP2, the leakage current is typically 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 OVP2 was designed to have AC fault current carrying capability. The OVP2 will limit the voltage between its connection points to less than 10 volts AC under the maximum fault current ratings listed in the following table. The values are amperes rms symmetrical.

AC Fault Current Ratings

Cycles	5.0KA	3.7KA	2.0KA	1.2KA
1	8,800	6,500	5,300	2,100
3	6,800	5,000	4,500	1,600
10	5,700	4,200	3,700	1,400
30	5,000	3,700	2,000	1,200

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 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. The OVP2 was tested with a 4x10 waveform.

Lightning Surge Current Rating

Model	Surge Current Rating
5.0KA	100kA crest
3.7KA	100kA crest
2.0KA	100kA crest
1.2KA	75kA crest

Voltage Between OVP2 Connection Points Due to Lightning

The OVP2 is designed to keep the voltage between the device terminals to a limited value. During lightning conditions, a much more important factor than the OVP2 voltage clamping capability is the voltage present developed in the leads or bus used to attach the device. Although the OVP2 solid-state design performs better than any other technology, it is challenging to keep the voltage due to lightning to a low level between the two connection points due to the voltage drop in the leads. This is due to the electrical property of inductance, which is only apparent for fast-rising waveforms such as lightning, and is not a concern for AC fault current. Voltage

due to inductance relates mainly to the total conductor length that has lightning current flowing through it, therefore the conductor length should be kept as short as possible to limit this voltage. This phenomena applies to all technologies used to limit voltage due to lightning, and is relatively independent of the conductor diameter. The OVP2 (or any other device) should be connected between the two attachment points with low inductance bus bars or with conductors ideally less than 6 inches (150 mm) long for optimal results.

OVP2 FEATURES AND CHARACTERISTICS

Certifications

The OVP2 is Underwriters Laboratories (UL) listed as an over-voltage protective device for use in hazardous locations in accordance with NFPA 70, (U.S. National Electrical Code) Articles 500-505 for Class I, Div. 2, Groups A, B, C, and D. The OVP2 is also C-UL listed to the above classifications per Canadian Code C22.2 No. 213-M1987. The listing is valid for ambient temperatures of -45ºC to +65°C. Protection from over-voltage due to lightning complies with the pertinent requirements of ANSI C62.11. The OVP2 is also UL listed as meeting the requirements of an effective grounding path as defined in NFPA 70 (2005 edition) Article 250-2, 250.4 (A) (5), 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 Sections 10-500, 10-806, and CSA C22.2 No. 04-M1982.

For Zone 2 use, the OVP2 has been given a Type Examination by a Notified Body (UL/Demko) for compliance to ATEX directive 94/9/EC using EN50021. The device is marked II 3 G EEx nA II T5.

Solid-State Design

The OVP2 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 OVP2 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 OVP2 will carry rated fault current or lightning surge current and still provide an effective grounding (or conducting) path.

Field Testing/Maintenance

The OVP2 can be field tested with an AC/DC multimeter and clamp-on AC ammeter. Testing procedures are included in the installation instructions. The OVP2 is completely maintenance-free.

Enclosure

The OVP2 is packaged in a molded, non-metallic enclosure which is rated IP68 (to 2m depth) and is suitable for indoor or outdoor use, in submersible and non-submersible applications. See Figure 1 for dimensional data.

Mounting

Several different mounting options are offered depending on the application. Reference Figures 2 through 6 for mounting options.

Polarity/Electrical Connection

The OVP2 is marked for polarity if an asymmetrical blocking voltage was selected. The negative terminal should connect to the more negative structure, or the structure with the cathodic protection applied, while the positive terminal should connect to the grounded or more positive structure. In the case of an OVP2 with a symmetrical threshold, such as -2/+2V, polarity is irrelevant and the OVP2 terminals do not include any polarity marks. Either terminal may be connected to either structure.

Number of Operations

The number of times that the OVP2 can be subject to its rated lightning or AC fault current rating is virtually unlimited, provided the operations are not immediately repetitive.

Energy Requirements

None. The device is totally passive.

Ambient Operating Temperature

-45° C to +65° C

Ordering Information/ Model Number Structure = OVP-A/B-C-D

A/B: Blocking Voltage

-A/+B in volts as measured from the negative terminal with respect to the positive terminal.

Recommended for most applications: A/B = **2/2**

Other made-to-order options for A/B include **3/1**, and **4/1**. Longer lead times may apply to these options.

C: Fault Current

Symmetrical AC-RMS fault current rating at 30 cycles in kA

Standard Ratings =

5.0 @ 50/60 Hz
3.7 @ 50/60 Hz
2.0 @ 50/60 Hz
1.2 @ 50/60 Hz

D: Lightning Current

Surge current rating in kA peak (4 x 10 waveform)

Standard Ratings =
100 for models where C= 5.0, 3.7, 2.0
75 for models where C = 1.2

Example Model Numbers:

OVP2-2/2-1.2-75
OVP2-2/2-2.0-100

OVP2 MOUNTING OPTIONS

Mounting options must be ordered separately. See the appropriate figure for details on each option. Select the most appropriate of the following option or contact DEI if a different mounting method is required.

General Use Mounting Bracket

For general use mounting, order part number MTG-OVP2, shown in Figure 1.

Attachment Leads

Insulated #6 AWG conductors are available from DEI for attachment to the OVP2 terminals. A crimp terminal that accepts a 5/16" bolt (hardware provided with OVP2) is provided at one end for attachment to the OVP2 terminals, while the other end is left unfinished for cutting to the appropriate length. Standard lengths are 12 inches (300mm) and 36 inches (915mm). Specify part number MTL-6-12 or MTL-6-36 for a set of two conductors with 12" or 36" lengths, respectively. For custom lengths, specify MTL-6-"X" and specify the units for "X." If a terminal is required for the unfinished end of the lead, contact DEI.

Note: Whenever the OVP2 is connected with leads, it is recommended that two of the above leads be connected to each OVP2 terminal. For any OVP2 model with an AC fault current rating equal to or greater than 2.0kA, two leads per terminal are required. Therefore, take care to order the correct number of leads for the mounting option selected.

Banding SSD to Test Station or Pipe Wall

The OVP2 is suitable for banding to a test station or steel pipe using stainless steel bands (customer furnished) over the general use mounting bracket (part number MTG-OVP2, ordered separately), as illustrated in Figure 2. Order the necessary leads as described in the previous section.

Pin Brazed Stud Connection to a Pipe Wall

Note: To choose this option, a user must have the required pin brazing equipment and consumable items. Also requires general use mounting bracket, part number MTG-OVP2.

When an OVP2 is used to decouple an above ground section of steel pipe from a gradient control mat (or other grounding system), an ideal method is to pin braze M8 studs to the steel pipe as illustrated in Figure 3 as this minimizes the voltage drop in the lead connections and thereby minimizes touch potential. One terminal of the OVP2 is connected directly to the lower stud using a Hex Coupling Nut with bolt/washer ordered separately from DEI, #HCN-M8. When connecting the other terminal to a gradient control mat or to a grounding system, use two leads from the OVP2 terminal that goes to the mat as illustrated in Figure 3. See DEI information on Gradient Control Mats for connection details.

Flange Mount Using Tapped Holes or Brazed Studs

Mounting the OVP2 to a flange can be accomplished via drilling and tapping the edge of the flange for a 5/16-18x1" or M8-1.25x20mm fully-threaded stud with jam nuts, or by pin brazing an M8 stud to the flange, as shown in Figures 4 and 5. Verify that the dimensions of either of these mounting arrangements are suitable for the flange before ordering. For mounting using tapped holes and studs, specify DEI part number MTT-516 for the 5/16" threaded stud kit or MTT-M8 for the M8 threaded stud kit. To mount using pin brazed M8 studs, specify DEI part number MTP-M8 for the mounting kit required and order the M8 pin brazed studs and ceramic sleeve required from the manufacturer/distributor of the pin brazing equipment being used.

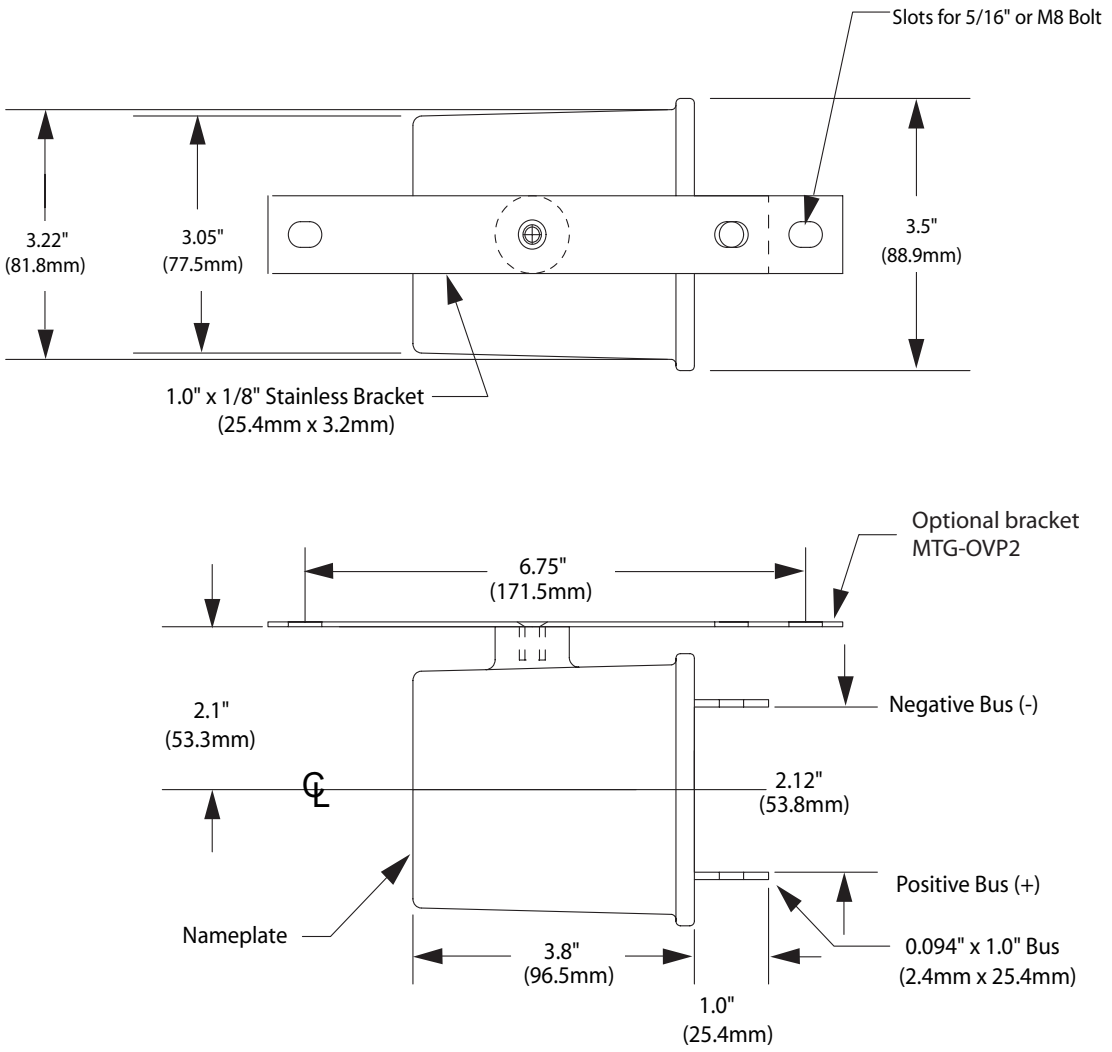
Flange Mount Using Existing Flange Bolts

The OVP2 can be mounted across an insulated flange using an existing flange bolt, usually at the top dead center position on the flange. The flange must have a machined outer face in order to mate to the bus bars. See Figure 6. Specify MTF-A-B-C and provide the values for A, B, and C as described in Figure 6. Also provide the pipe diameter and ANSI LB Class.

Pedestal Mounting

A light green fiberglass pedestal is available for enclosing the OVP2 and all cable connections. When the OVP2 is used in applications where both cable lead connections come from below ground level or where it is desired to provide a second level of protection around the standard OVP2 enclosure, the pedestal can be ordered as a separate item. The pedestal has nominal 3/16" thick fiberglass with 14 mil UV stabilized gelcoat. The internal mounting channel and mounting hardware are all stainles steel. See Figure 7. Order model MTP-42. Also requires general use mounting bracket, part number MTG-OVP2.

Figure 1 OVP2 Outline Drawing



Notes:

1. Only models with an asymmetrical blocking voltage will have polarity marks shown.
2. General use mounting bracket, part number MTG-OVP2, must be ordered separately, if needed.

Figure 2 Banding the OVP2 to a Test Station or Pipe Wall

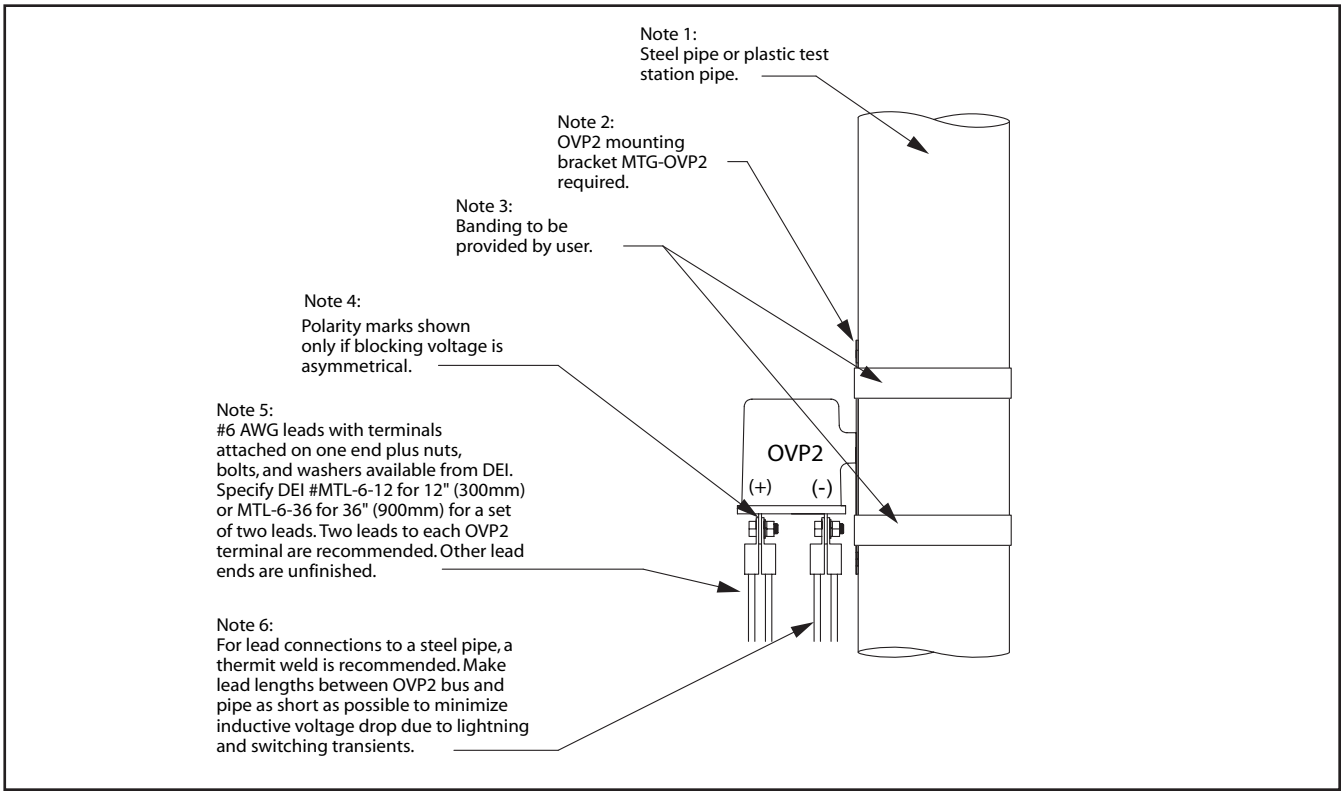


Figure 3 Pin Brazed Stud Connection to a Pipe Wall

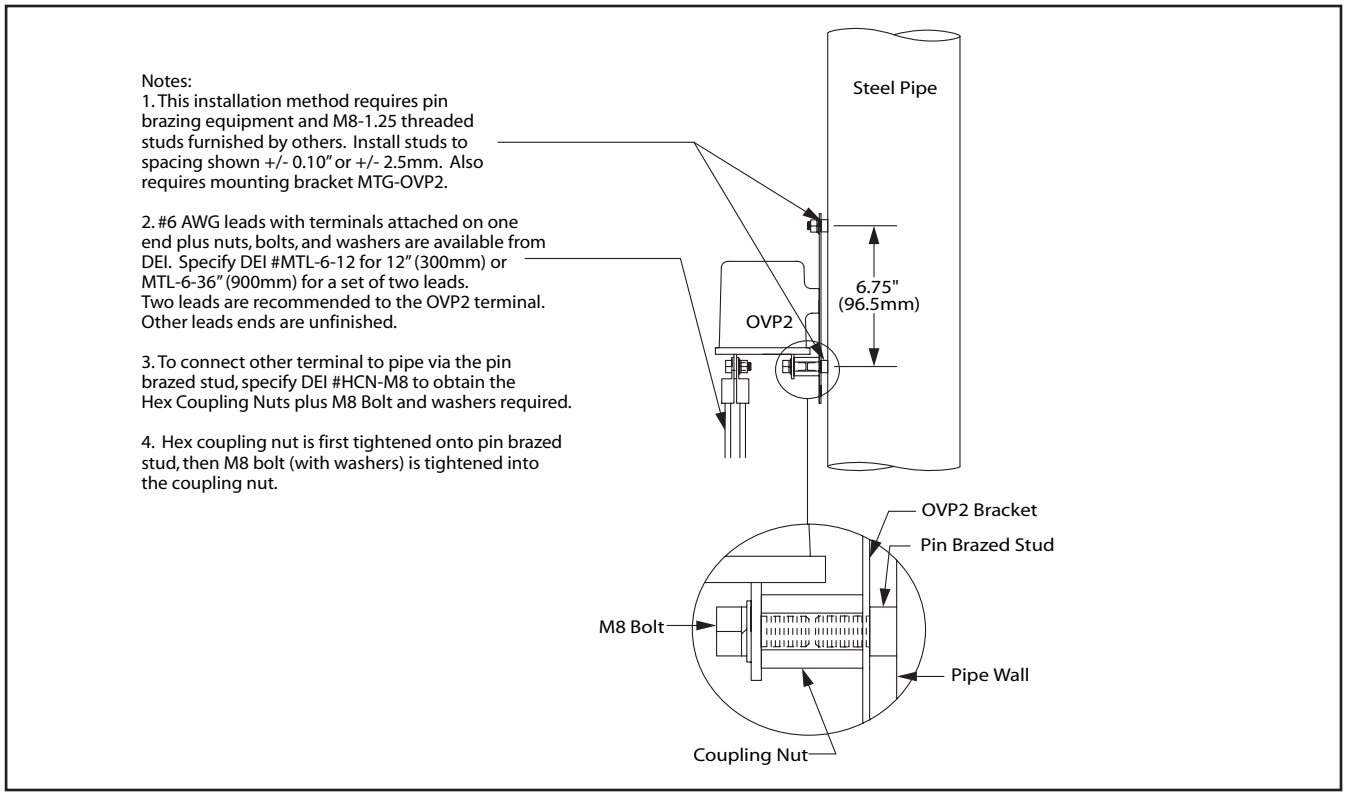
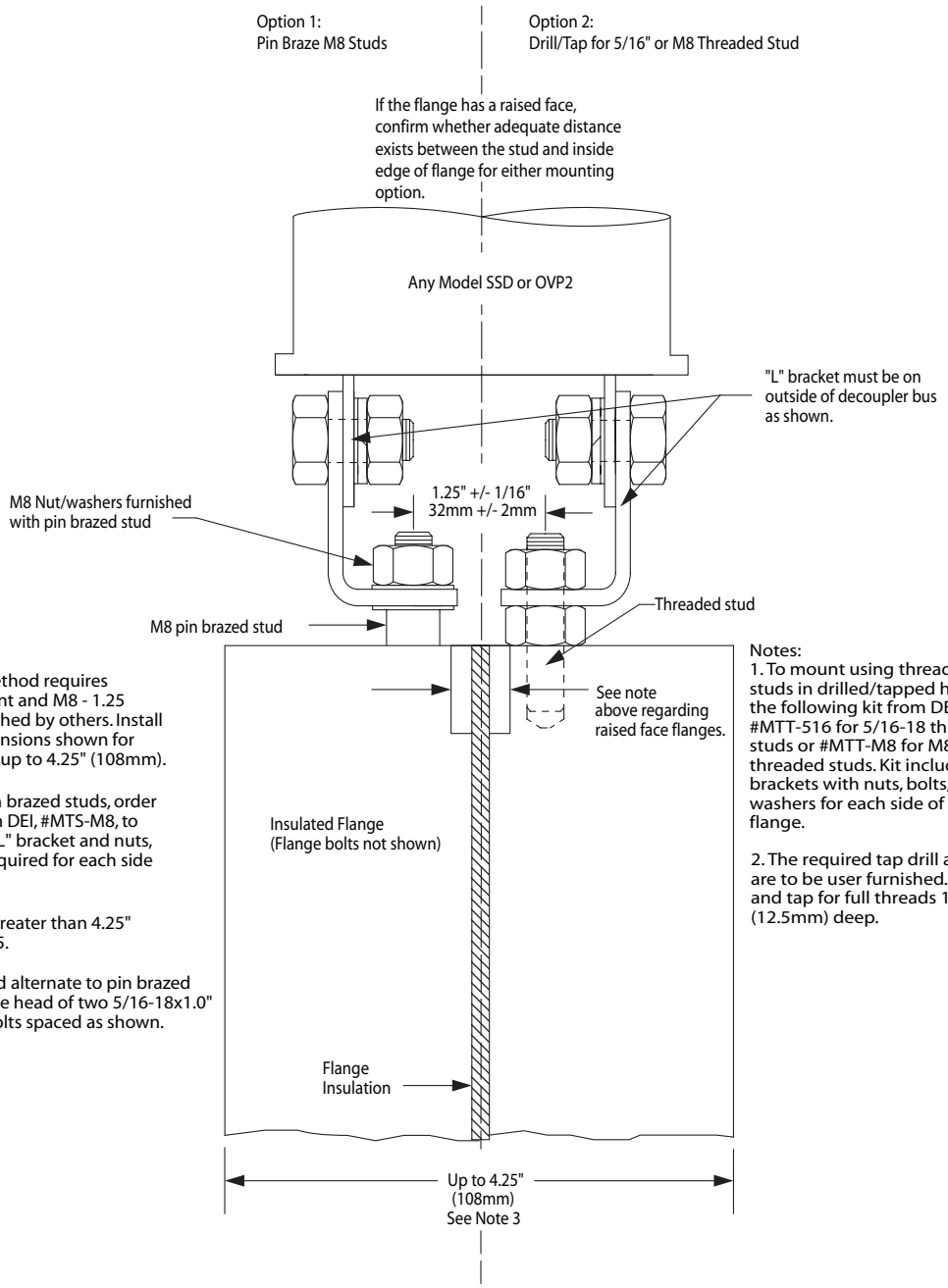


FIGURE 4 Flange Mount Using Tapped Holes or Pin Brazed Studs



Notes :
1. This installation method requires pin brazing equipment and M8 - 1.25 threaded studs furnished by others. Install studs spaced to dimensions shown for overall flange widths up to 4.25" (108mm).

2. To mount using pin brazed studs, order the following kit from DEI, #MTS-M8, to obtain the required "L" bracket and nuts, bolts, and washers required for each side of the flange.

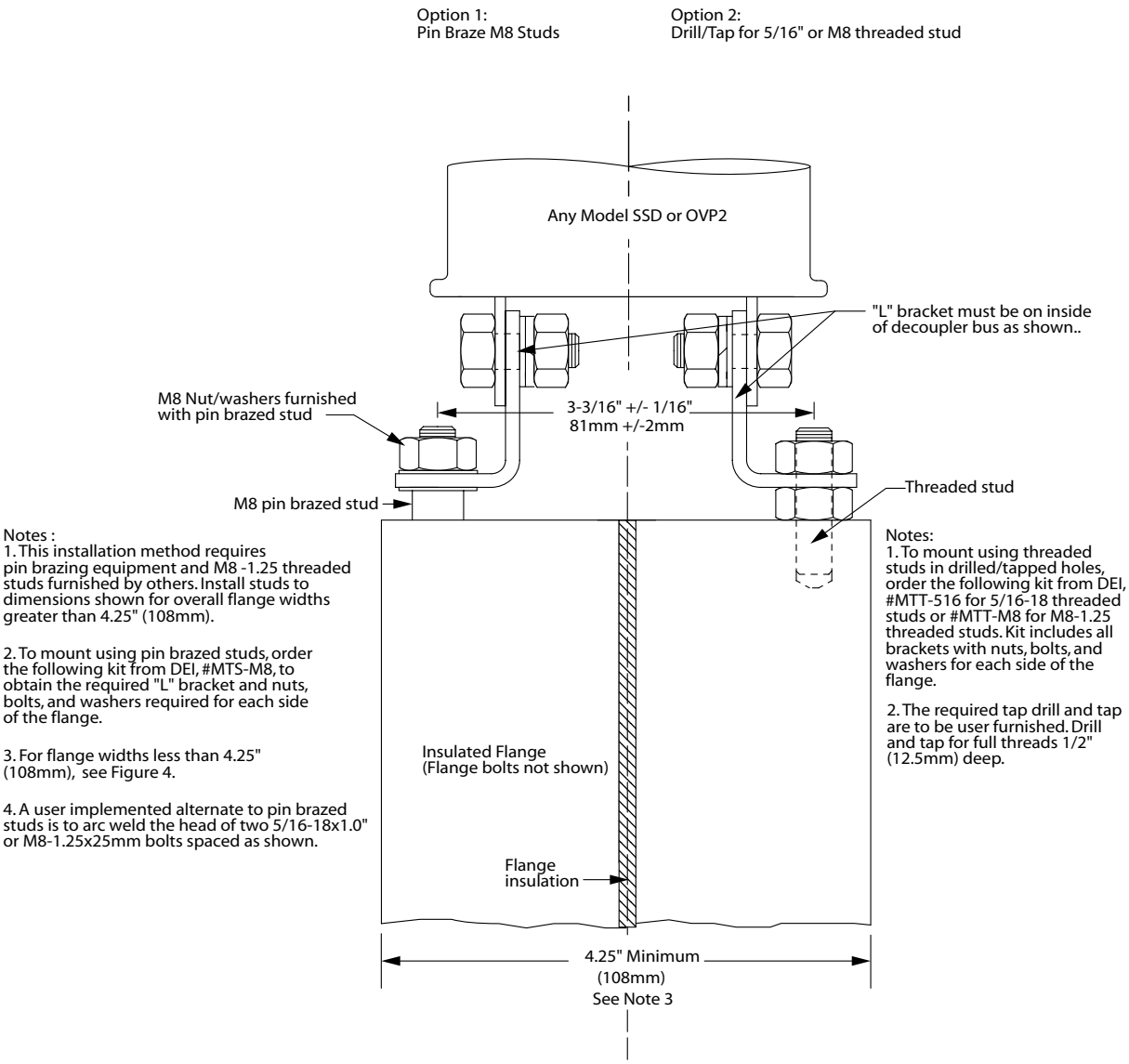
3. For flange widths greater than 4.25" (108mm), see Figure 5.

4. A user implemented alternate to pin brazed studs is to arc weld the head of two 5/16-18x1.0" or M8 -1.25x25mm bolts spaced as shown.

Notes:
1. To mount using threaded studs in drilled/tapped holes, the following kit from DEI is required, #MTT-516 for 5/16-18 threaded studs or #MTT-M8 for M8-1.25 threaded studs. Kit includes all brackets with nuts, bolts, and washers for each side of the flange.

2. The required tap drill and tap are to be user furnished. Drill and tap for full threads 1/2" (12.5mm) deep.

FIGURE 5 Flange Mount Using Tapped Holes or Pin Brazed Studs



Notes :
1. This installation method requires pin brazing equipment and M8 -1.25 threaded studs furnished by others. Install studs to dimensions shown for overall flange widths greater than 4.25" (108mm).

2. To mount using pin brazed studs, order the following kit from DEI, #MTS-M8, to obtain the required "L" bracket and nuts, bolts, and washers required for each side of the flange.

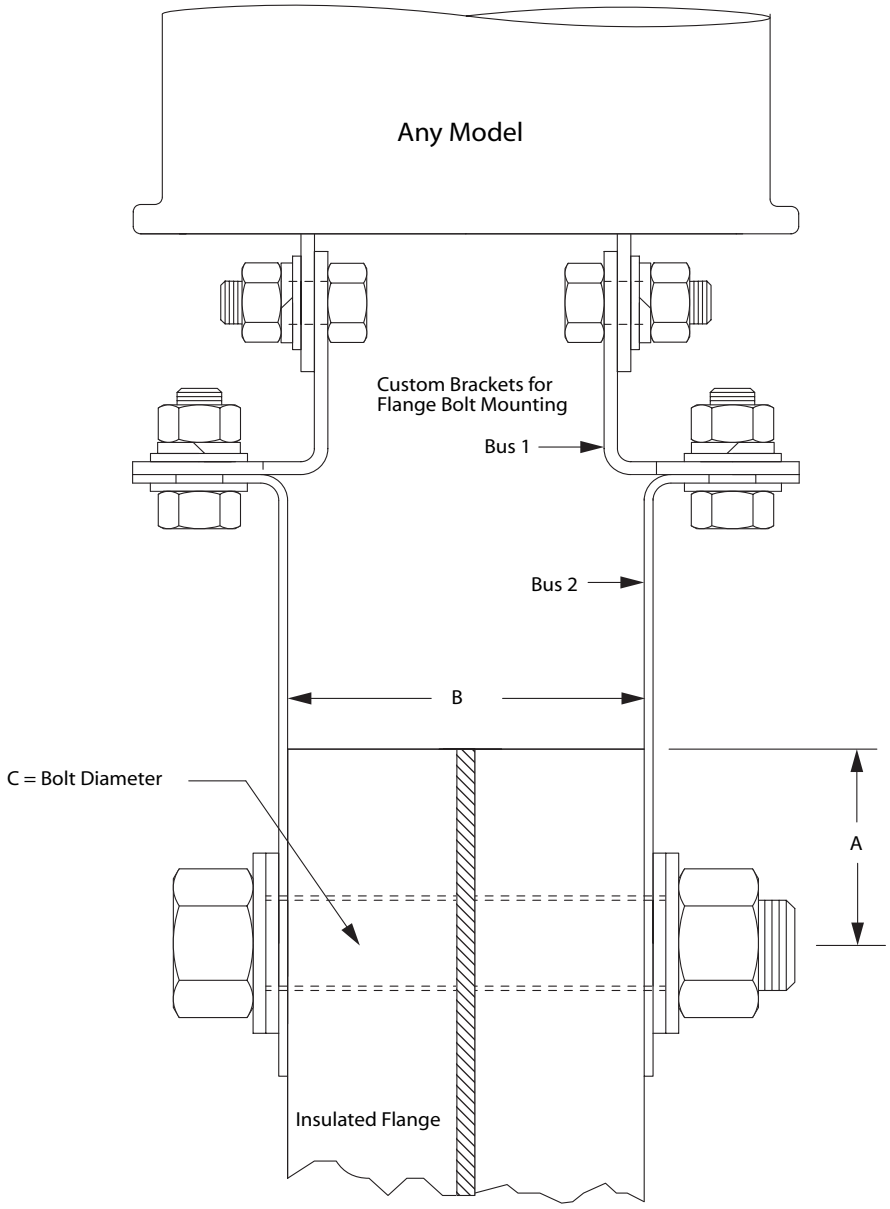
3. For flange widths less than 4.25" (108mm), see Figure 4.

4. A user implemented alternate to pin brazed studs is to arc weld the head of two 5/16-18x1.0" or M8-1.25x25mm bolts spaced as shown.

Notes:
1. To mount using threaded studs in drilled/tapped holes, order the following kit from DEI, #MTT-516 for 5/16-18 threaded studs or #MTT-M8 for M8-1.25 threaded studs. Kit includes all brackets with nuts, bolts, and washers for each side of the flange.

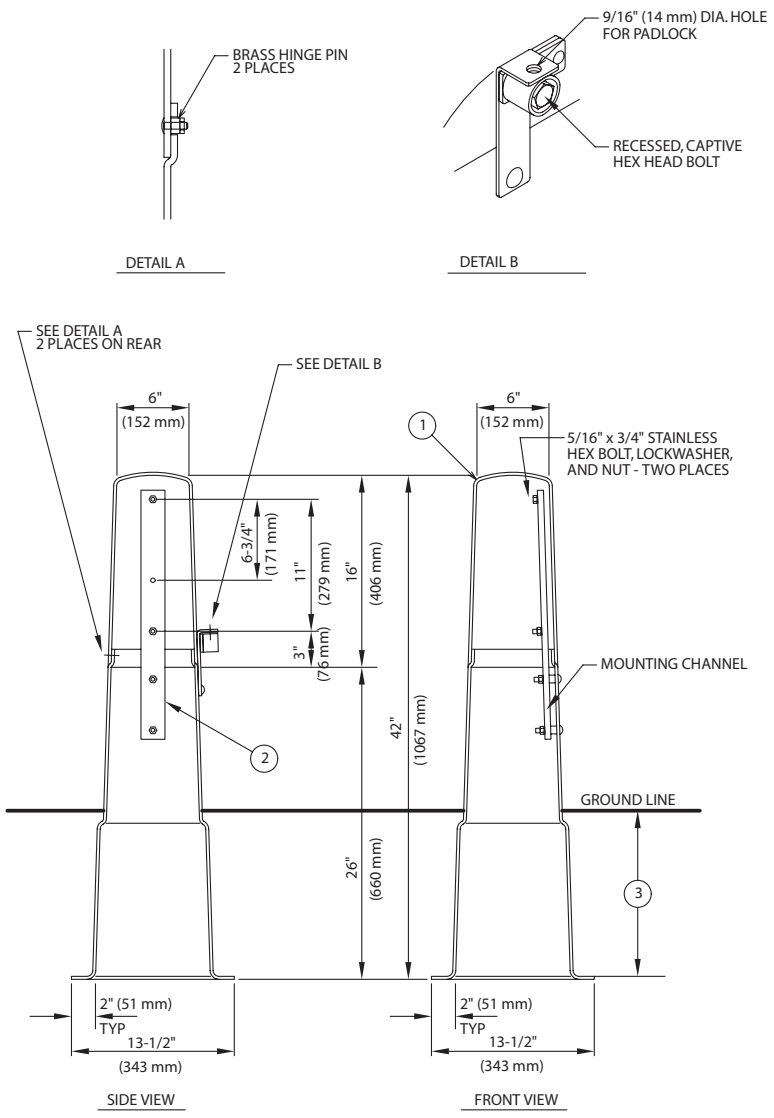
2. The required tap drill and tap are to be user furnished. Drill and tap for full threads 1/2" (12.5mm) deep.

FIGURE 6 Flange Mount Using Existing Flange Bolts



Notes:
1. For complete kit to flange mount using flange bolts, specify MTF-A-B-C and provide values (and units) for A, B, and C as shown above.
2. Provide pipe diameter and ANSI LB. Class.
3. Hole in bracket for flange bolt will be 1/8" (3.18mm) larger than the C dimension provided (to allow for the insulating sleeve) unless other hole size is specified with the order.
4. Orientation and dimensions of of Bus1 and Bus 2 may vary depending on flange dimensions provided. Assembly instructions will be provided with each mounting kit.
5. Due to the numerous combinations of A, B, and C, parts for a specific flange may not be in stock.

FIGURE7 Pedestal Mounted OVP2



Model: MTP-42

1. Fiberglass pedestal, light green.
2. Stainless steel mounting channel.
3. Typical burial depth: 12" to 20" (300 mm to 500 mm)

Notes:

- Nominal fiberglass thickness, 3/16" (4.8 mm).
- Exterior UV stabilized gelcoat, 14 mil (0.36 mm) thick.
- Fire retardant: Does not support combustion.
- Stainless steel hardware.
- For mounting SSD (Solid-State Decoupler) or OVP2 (Over-Voltage Protector 2).