

The Solid-State Decoupler (SSD)



INTRODUCTION

The Solid-State Decoupler (SSD) series continues the DEI tradition of offering innovative protection products to the corrosion prevention industry, while building off of proven solid-state technology developed by DEI. With a lightweight, non-metallic housing and lower cost, the SSD can be economically applied throughout a cathodically protected system.

The SSD functions as a DC isolation and AC coupling device (a "decoupler"), preventing the flow of CP current up to a predetermined voltage threshold, while passing any induced AC current. 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 DC blocking mode. This operation can occur an unlimited number of times, and is typically due to AC faults and lightning, which the SSD is rated for. While the standard threshold is $-2V/+2V$, the SSD 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 SSD terminals.

Similar to most DEI products, the SSD has been certified by independent laboratories for compliance to all known

U.S., Canadian, and European standards and codes. Testing and certification was performed by Underwriters Laboratories and Demko, with resulting UL, C-UL (Canadian UL to CSA requirements) listings, and CE marking. The SSD is certified for use in hazardous locations (Div. 2 and Zone 2). See the "Certifications" section for more information.

APPLICATIONS

The SSD is designed for:

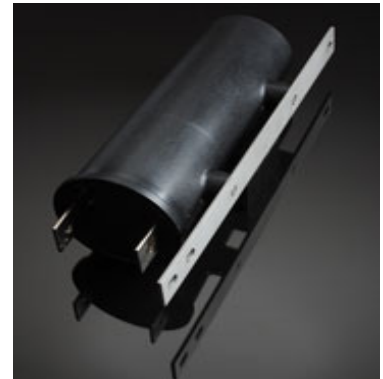
- Decoupling gradient control mats (grounding mats) from pipelines
- Over-voltage protection of equipment from AC faults, lightning, and switching transients (e.g. insulated joints)
- Decoupling dissimilar metals that must otherwise be AC bonded for safety
- AC grounding and DC isolation of electrical equipment integral to a cathodically protected system
- Mitigation of induced AC voltage

With the introduction of the lower cost SSD, decoupling gradient control mats is now an affordable and attractive option. With a decoupled gradient control mat: (a) the potential of the mat material is irrelevant, (b) the mat can be made from less costly materials than pure zinc, (c) interaction between the mat and CP system is eliminated, and (d) decoupling allows CP readings can be taken on the pipeline in the vicinity of the mat. DEI also offers cost effective gradient control mats designed for worker safety

from both power frequency and lightning/switching transients. Other "ground mat" designs do not address the requirements necessary to provide low touch and step potentials due to lightning and similar transients. See DEI's information on "Gradient Control Mats."

Insulated joints often need over-voltage protection against lightning and AC fault current, and in some cases, steady-state induced AC voltage. 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.) DEI offers superior designs that address voltage clamping issues and also provide secure mounting methods that aid in limiting voltage to low levels.

The Solid State Decoupler (SSD)
(Optional Terminal Arrangement Shown)



As an AC mitigation device, the SSD can also keep the steady-state voltage across the flange to a negligible level.

In decoupling dissimilar metals, the SSD can be used between two grounding systems, or other structures that require AC safety bonding while preventing galvanic corrosion. As grounding codes may apply, the SSD is listed by UL for meeting the requirements of an effective AC grounding path per U.S. and Canadian electric codes.

PRODUCT CAPABILITY OF THE SSD

The key parameters of the SSD are:

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

Blocking Voltage

At a voltage below the blocking voltage selected, the SSD blocks the flow of DC current and allows AC current to pass. At a voltage above the blocking voltage selected, the SSD is a bi-directional conducting device that readily allows all current to flow, thereby limiting the voltage on the structure.

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.

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 other 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 SSD only when an asymmetrical blocking voltage is specified. Polarity is irrelevant with symmetrical blocking voltage.

DC Leakage Current versus Blocking Voltage

The DC leakage current at the maximum blocking voltage for any SSD 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 SSD, the leakage current is typically well under 1 milliampere under either temperature condition, a value that is insignificant to a cathodic protection system.

Steady-State AC Current Rating

This value represents the maximum allowable steady-state AC through the SSD while the device is blocking DC current. The source of this current would be induced from overhead power lines. Measure or otherwise determine the available steady-state current in this intended connection and compare to the SSD rating of 45A AC-rms at 50/60 Hz, leaving margin for varying system conditions.

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 SSD was designed to have AC fault current carrying capability. The SSD 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 ratings are amperes rms symmetrical.

AC Fault Current Ratings (50/60Hz)				
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 SSD was tested with a 4x10 waveform.

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

Voltage Between Connection Points Due to Lightning

The SSD is designed to keep the voltage between the device terminals to a limited value. During lightning conditions, a much more important factor than the SSD voltage clamping capability is the voltage developed in the leads or bus used to attach the device. Although the SSD solid-state design limits voltage to a lower level 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 of importance 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 SSD (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.

SSD FEATURES AND CHARACTERISTICS

Certifications

The SSD is Underwriters Laboratories (UL) listed 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 SSD 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 -45°C to +65°C. Protection from over-voltage due to lightning complies with the pertinent requirements of ANSI C62.11. The

SSD 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 the Canadian Electrical Code Sections 10-500, 10-806, and CSA C22.2 No. 04-M1982.

For Zone 2 use, the SSD 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 SSD 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 SSD 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 SSD will carry rated fault current or lightning surge current and still provide an effective grounding (or conducting) path.

Field Testing/Maintenance

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

Enclosure

The SSD 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 an outline drawing.

Polarity/Electrical Connection

The terminals of the SSD are only 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 SSD with a symmetrical blocking voltage, such as -2/+2V, polarity is irrelevant and SSD terminals do not include any polarity marks. Either terminal may be connected to either structure.

Number of Operations

The number of times that the SSD 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 = SSD-A/B-C-D-E

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 other lower blocking voltage combinations. 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 @ 50/60Hz

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

E: Terminal Arrangement

The SSD comes standard with terminals arranged perpendicular to the mounting bracket and is designated by a "-R" at the end of the model number. See Figure 1. As an option, the SSD is also available with terminals parallel to the mounting bracket for installation with pin brazed studs and the hex coupling nut as shown in Figure 2. This option is chosen by leaving the the "-R" off the catalog number

Example Model Numbers:

SSD-2/2-1.2-75-R (Standard Terminal)

SSD-2/2-2.0-100 (Optional Terminals)

SSD MOUNTING OPTIONS

Mounting options must be ordered separately. See Figures 3 through 7 for options. Select the most appropriate option or contact DEI if a different mounting method is required.

Mounting of SSD

The SSD will be supplied with the bracket shown in the Figure 1 and 2 outline drawings for general use mounting.

This bracket will not be provided if the SSD is ordered with one of the flange mounting kits.

Attachment Leads

When the SSD is mounted using the mounting bracket illustrated in Figure 1 and 2, connection to the SSD terminals will normally be with #6 AWG insulated leads with compression terminals that can be ordered separately from DEI. Each lead will have a factory installed compression terminal on one end with the other lead end left unfinished for cutting to the shortest feasible length during installation. (The required 5/16" bolts, nuts and washers to attach the leads to the SSD are furnished with each SSD.) Standard lengths are 12 inches (300mm) and 36 inches (900mm). 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 SSD is connected with leads, it is recommended that two of the above leads be connected to each SSD terminal.

For any SSD model with an AC fault current rating equal to or greater than 2.0kA or for use with a Gradient Control Mat, two leads per terminal are required. Therefore, take care to order the correct number of leads for the mounting option selected. If one set of leads is to be connected to a DEI furnished gradient control mat, then the lead-to-mat connection will be thermit welded. See DEI information on Gradient Control Mats for connection details.

Banding SSD to Test Station or Pipe Wall

The SSD is suitable for banding to a test station or steel pipe using stainless steel bands (customer furnished) over the supplied bracket as illustrated in Figure 3. 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.

Note 2: When choosing this method, user must also request the optional terminal arrangement as shown in Figure 2 .

When a SSD 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 4 as this minimizes the voltage drop in the lead connections and thereby minimizes touch potential. One terminal of the SSD 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 SSD 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 Pin Brazed Studs

Mounting the SSD 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 M8x16 stud to each 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 studs, or MTT-M8 for the M8 threaded studs. To mount using pin brazed M8 stud kit, specify DEI part number MTS-M8 for the mounting kit required and order the M8 pin brazed stud kit and ceramic sleeve required from the manufacturer/distributor of the pin brazing equipment being used.

The general use mounting bracket shown in Figure 1 and 2 will not be provided if this flange mounting kit is ordered.

Flange Mount Using Existing Flange Bolts

The SSD can be mounted across an insulated flange using an existing flange bolt, usually at the top center position on the flange (as shown in Figure 6). The flange must have a machined outer face in order to mate to the bus bars. To order a complete kit to flange mount using flange bolts, specify MTF-A-B-C where dimensions A, B, and C are provided (in inches or mm) per Figure 7. Also, provide the pipe diameter and the ANSI LB class.

The general use mounting bracket shown in Figure 1 and 2 will not be provided if this flange mounting kit is ordered.

Pedestal Mounting

A light green fiberglass pedestal is available for enclosing the SSD and all cable connections. When the SSD is used in applications where both cable lead connections come from below ground level (e.g. AC voltage mitigation applications) or where it is desired to provide a second level of protection around the standard SSD 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 stainless steel. See Figure 8. Order model MTP-42.

Figure 1 SSD Outline Drawing (Standard Terminal Arrangement)

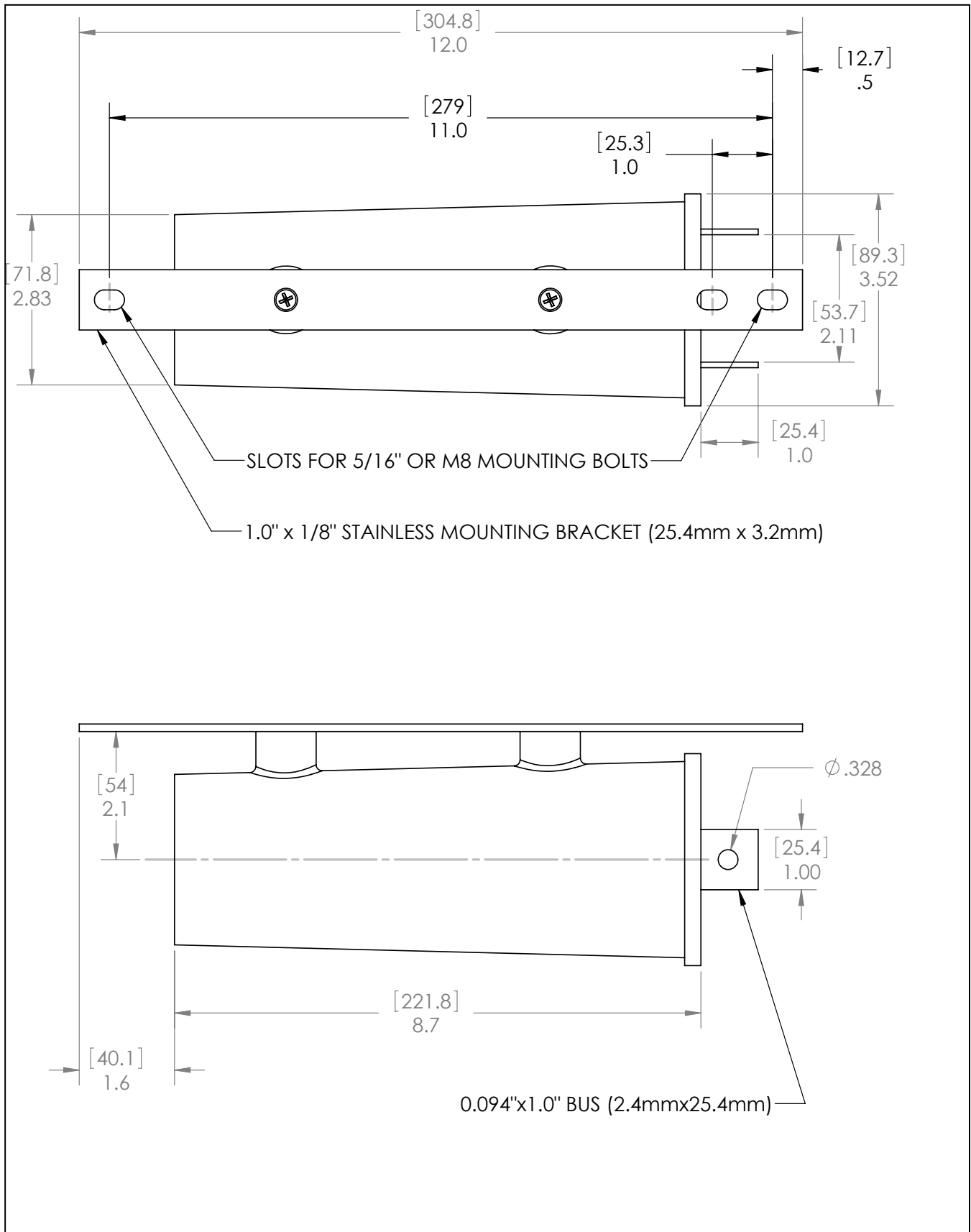


Figure 2 SSD Outline Drawing (Optional Terminal Arrangement)

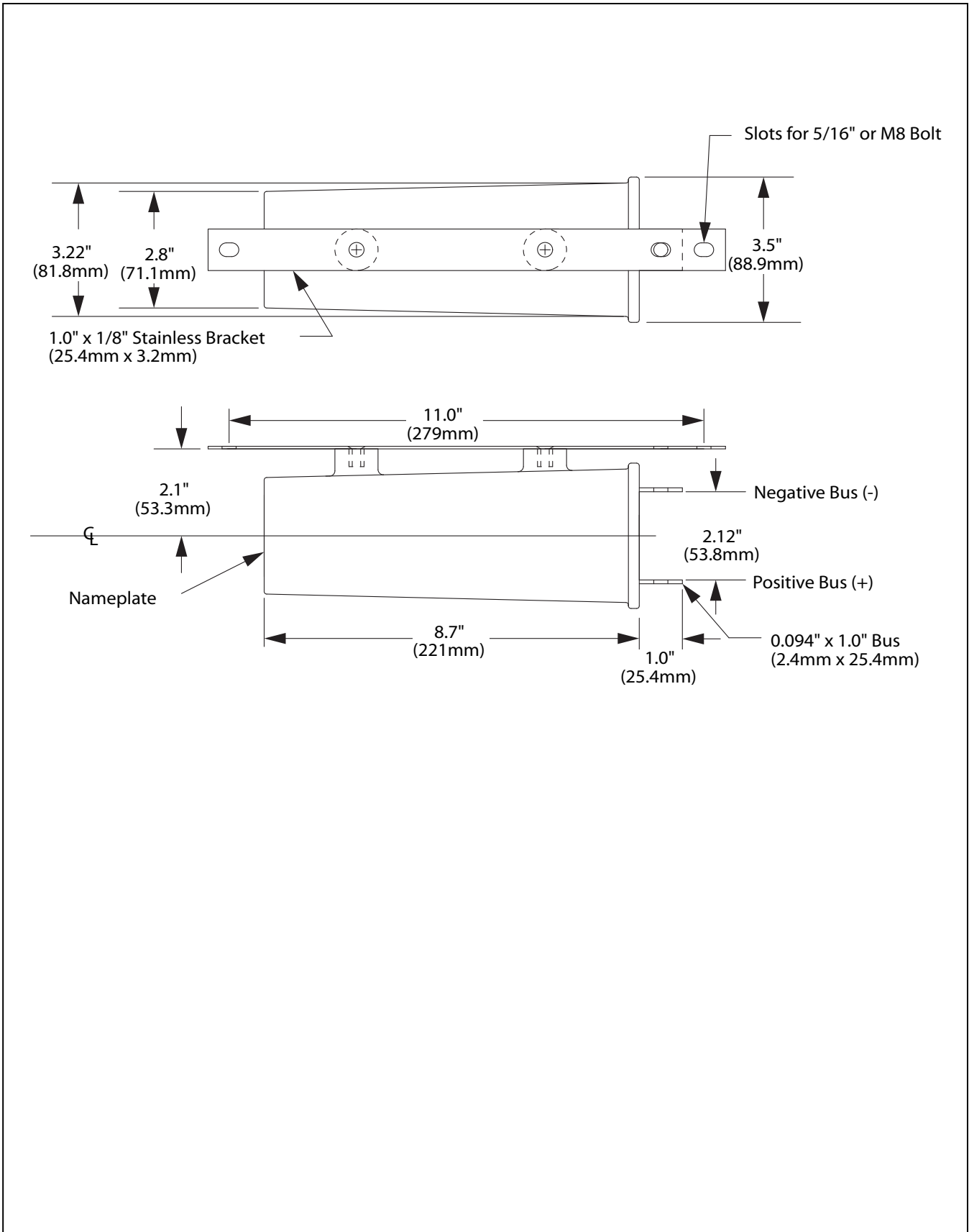


Figure 3 Banding SSD to a Test Station or Pipe Wall

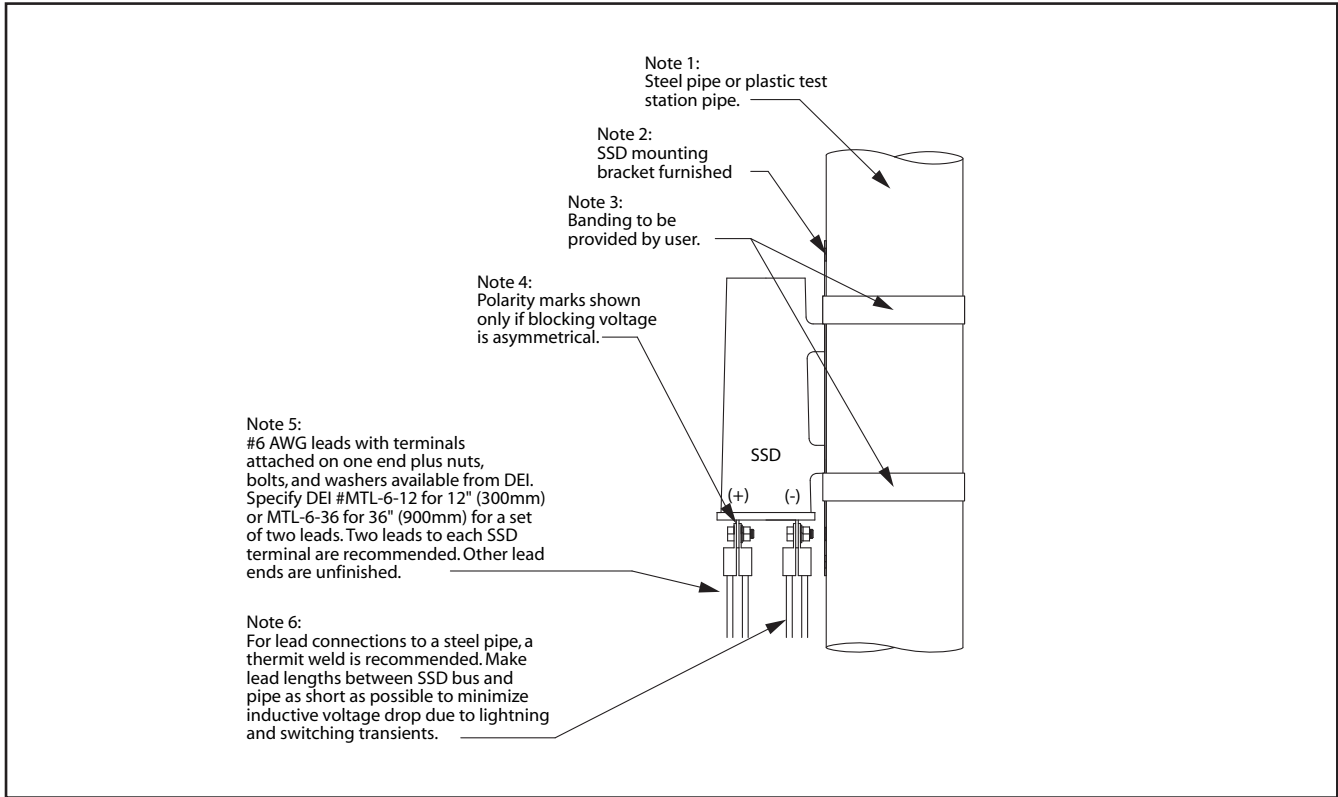


Figure 4 Pin Brazed Stud Connection to a Pipe Wall (Requires Optional Terminal Arrangement)

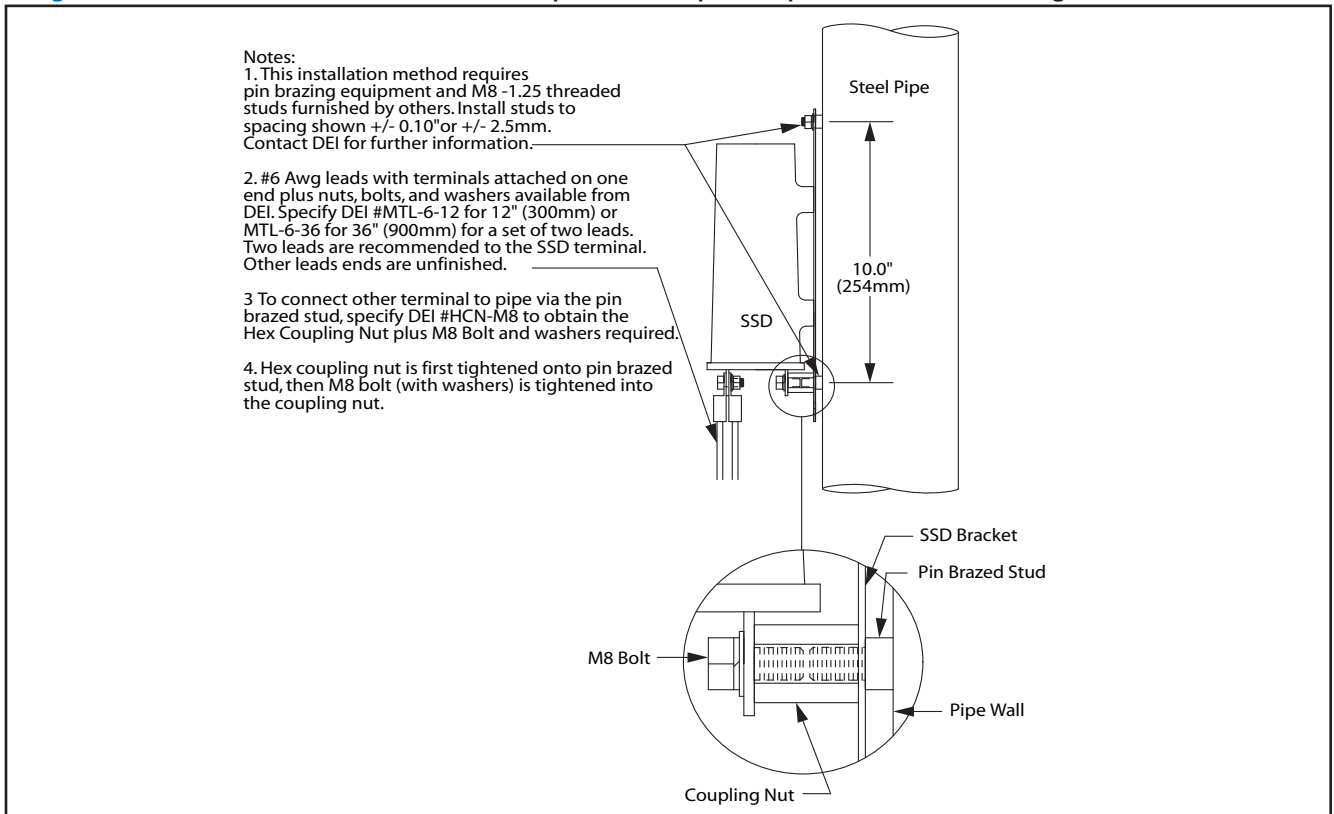


Figure 5 Flange Mount Using Tapped Holes or Pin Brazed Studs

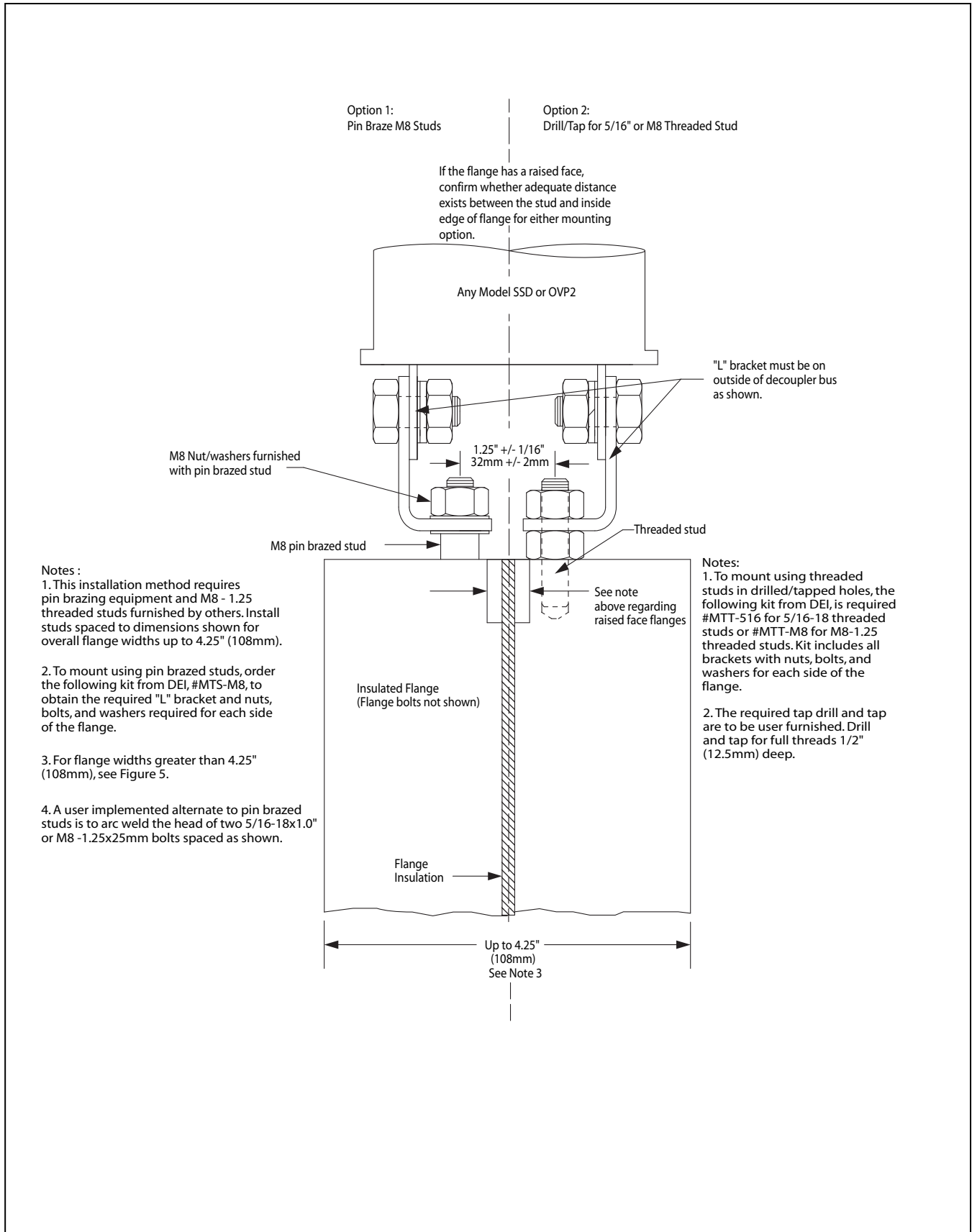


Figure 6 Flange Mount Using Tapped Holes or Pin Brazed Studs

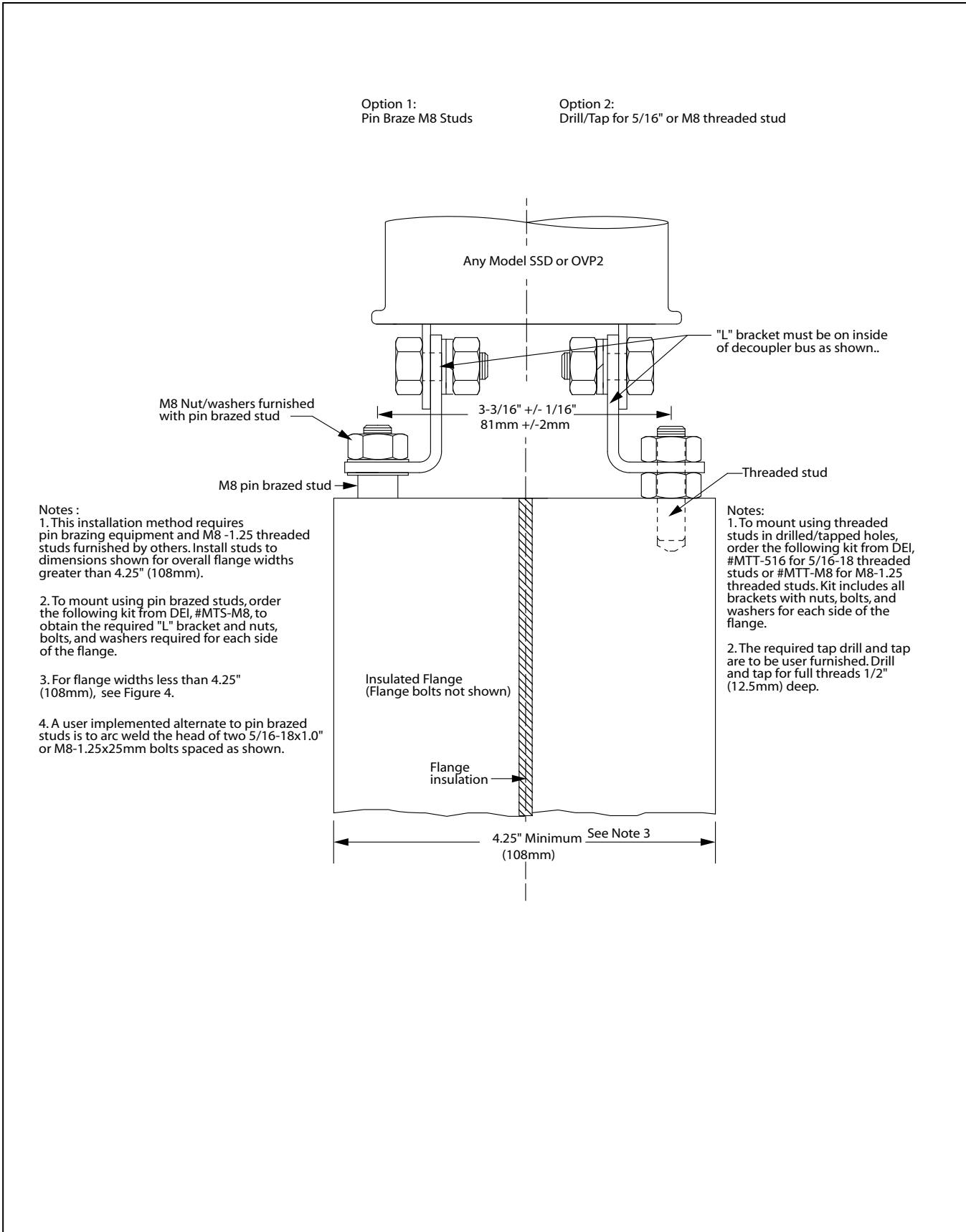
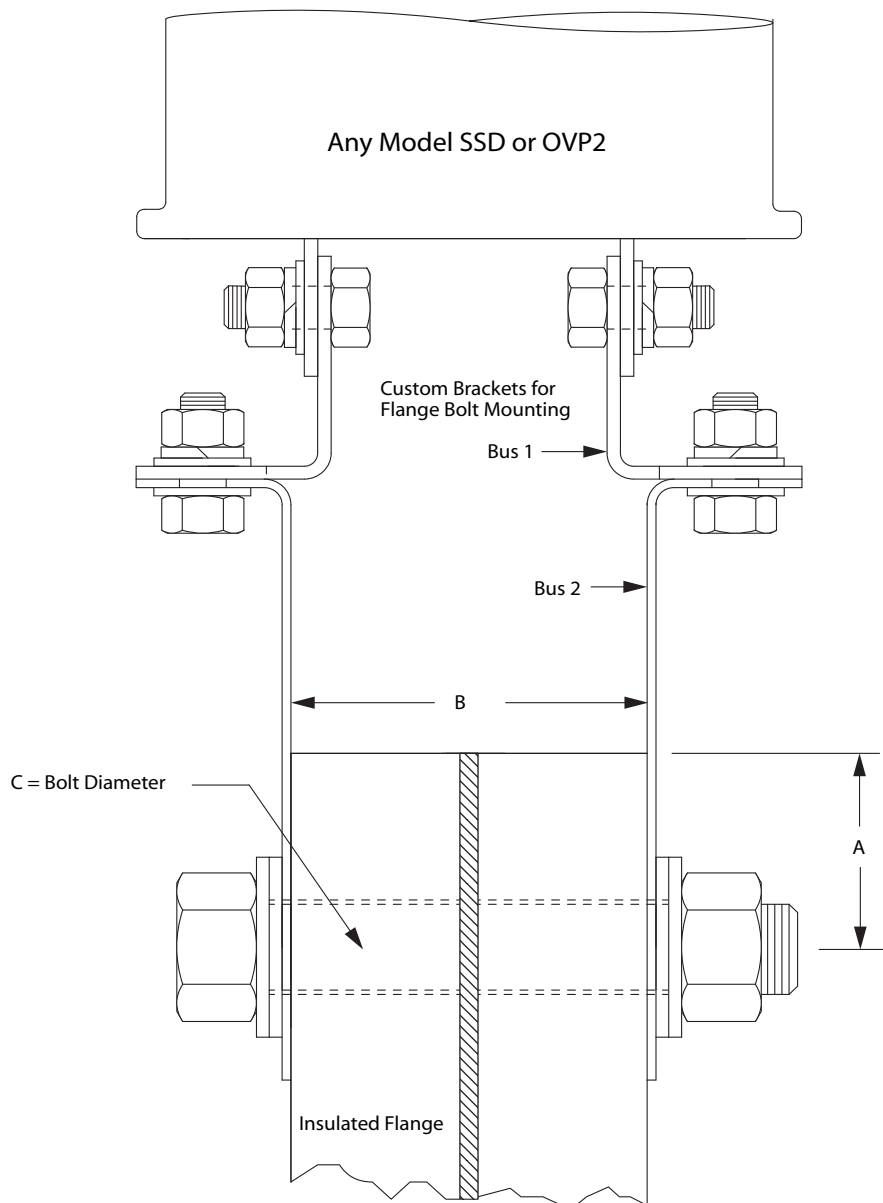


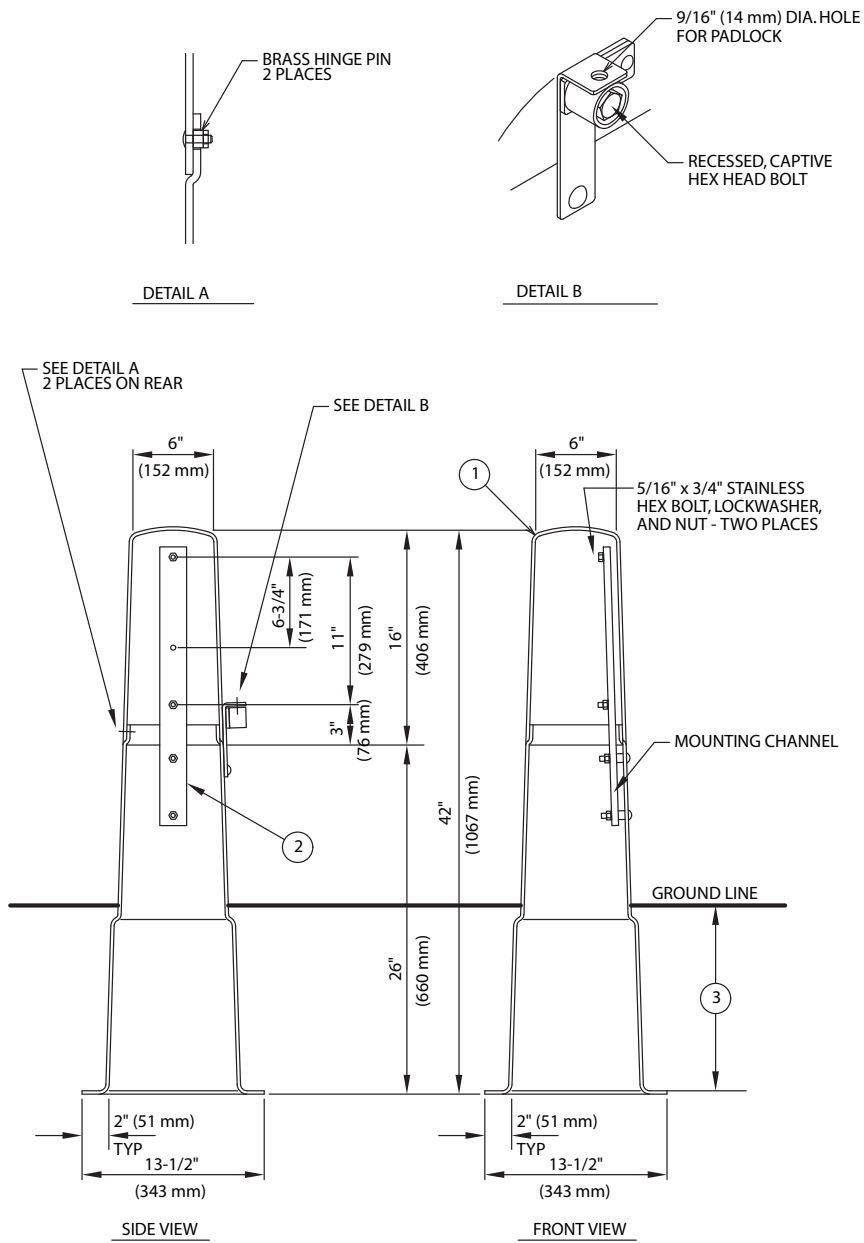
Figure 7 Flange Mount Using Existing Flange Bolts



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 Bus 1 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.

Figure 8 Pedestal Mounted SSD



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).