Installation Guide | Rev. A

Surface Mount Strain Sensor | os3610

MICRON OPTICS

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Introduction:

The os3610 Surface Mount Strain Sensor measures average strain over the length of the sensor while providing integrated temperature compensation. It is based on fiber Bragg grating (FBG) technology. The os3610 is intended exclusively for surface mounting. Each end of an os3610 is attached to a structure via rigid brackets that are either welded, bolted, epoxied, or grouted to the surface of a concrete, rock, steel, composite, or other structure. The os3610 strain sensor measures the relative movement of the two mounting brackets along the axis of the sensor. It is important that the mounting brackets be securely attached to the surface to be tested if accurate results are to be obtained. Several installation tools are available from Micron Optics to aid in installation. Note that tools are available for Grout-in and Bolt-on applications of gage length 25.4 cm and 100 cm.

Installation Tools:

Grout-in Drill Guide (25.4 cm)
Grout-in Drill Guide (100 cm)

Bolt-on Drill Guide (25.4 cm)
Bolt-on Drill Guide (100 cm)

Setting Bar (25.4 cm)
Setting Bar (100 cm)

Mounting To Steel (Weldable Brackets):

The first step in installing the os3610 strain sensor is welding the two mounting brackets to the surface to be measured. The end brackets are made of 316 stainless steel. Each mounting bracket has two ¼-20 set screws installed as shown in Figure 1. Use a 1/8 inch Hex-Key to tighten set screws.

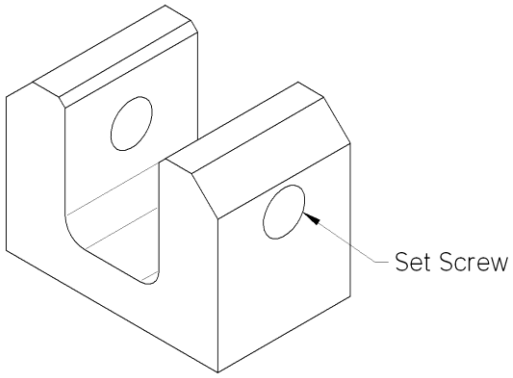

Figure 1 – Mounting Bracket

It is important that mounting brackets are properly spaced and axially aligned prior to welding. If axial alignment is not maintained, the sensor may bind leading to reduced sensor accuracy. The setting bar shown in Figure 2 is used to hold the mounting brackets in alignment and properly

spaced during welding. The Setting Bar has flats cut into each end that properly position the end brackets.

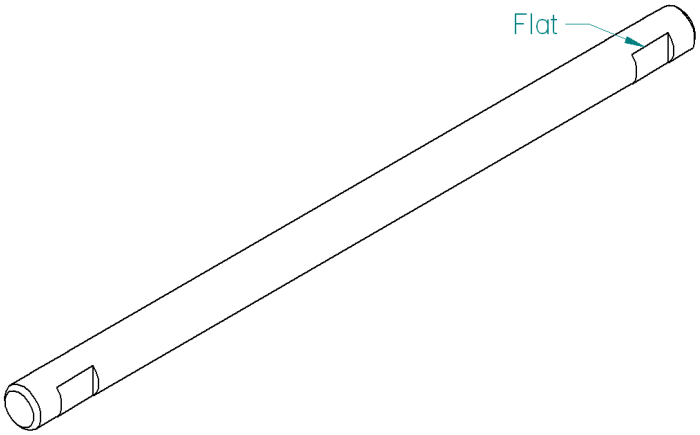

Figure 2 – os3610 Setting Bar

The Setting Bar is inserted in both mounting bracket and held in place with the set screws shown in Figure 3.

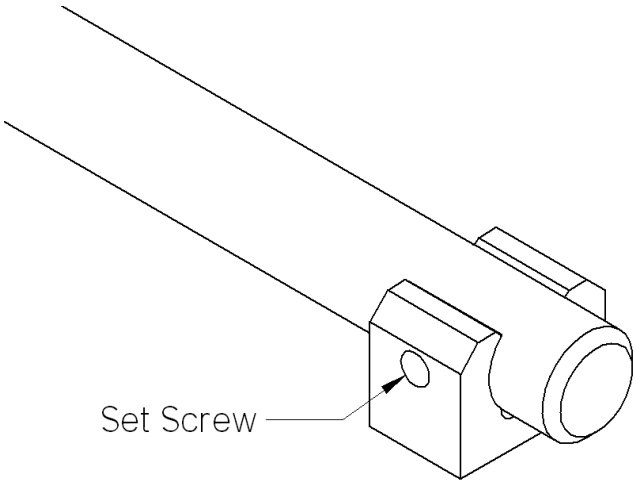

Figure 3 – Close up of mounting bracket & Setting Bar

The steel surface should be cleaned to remove scale, rust, dirt, and oil. Position the Setting Bar with the attached mounting brackets on the steel surface to be measured. Align the axis of the Setting Bar with the axis of strain to be measured. While holding the mounting brackets firmly against the surface, weld the edges shown in Figure 4 in the indicated sequence.

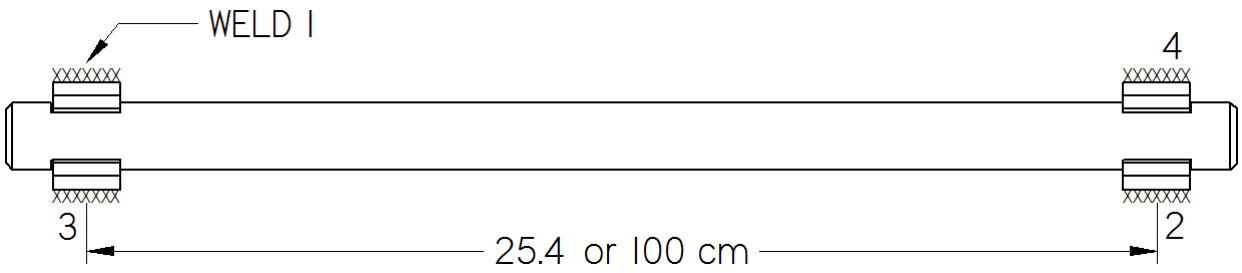

Figure 4 – Weld Location / Sequence

Allow the weld to cool and remove the Setting Bar. Clean off welding slag and inspect weld.

Mounting To Steel (Bold-On Brackets):

An alternative mounting bracket shown in Figure 5 is available as an option that can be fastened to the test specimen using two ¼-20 screws. Button head cap screws are recommended to allow clearance for set screw Hex-Key. It is important that mounting brackets are properly spaced and axially aligned prior to mounting. If axial alignment is not maintained, the sensor may bind leading to reduced sensor accuracy. The Setting Bar shown in Figure 2 is available to hold the mounting brackets in alignment and properly spaced while the mounting holes are transferred to the specimen surface. The Setting Bar has flats cut into each end that properly position the end brackets. Alternatively, the Bolt-on drill guide listed in the "Installation Tools" section can be used. To use the Drill Guide, securely clamp it to the surface. Drill the four holes using the Drill Guide to guide the drill bit. After both brackets are bolted securely to the surface, check the alignment by verifying that the Setting Bar will drop into the brackets.

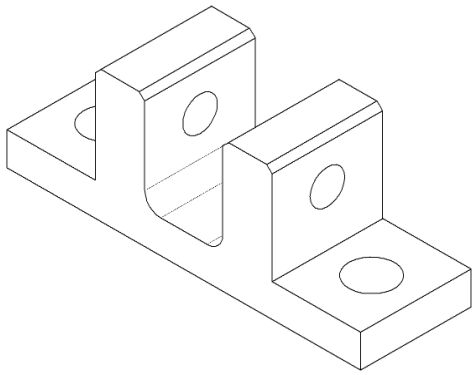

Figure 5 – Bolt-On Mounting Bracket

Mounting To Concrete:

The concrete mounting brackets shown in Figure 6 may be attached to concrete by inserting the concrete mounting bracket stud into a drilled hole and securing with anchoring cement or epoxy.

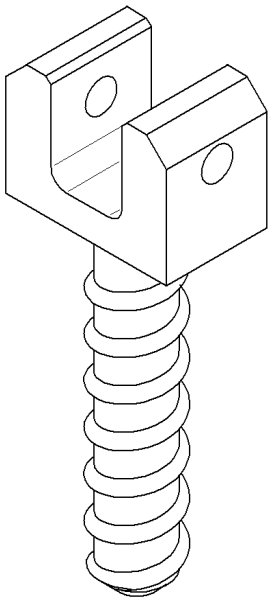

Figure 6 – Concrete Mounting Bracket

Prepare the test surface by drilling two ½ inch [13mm] diameter holes properly spaced. To maintain hole spacing and alignment it is necessary to use the Grout-in Drill Guide listed in the "Installation Tools" section. The distance between the holes is determined by the gage length purchased. The distance between the holes is equal to the gage length. Standard gage lengths are 25.4 cm and 100 cm. The holes should be a minimum of 3 ½ inches [64 mm] deep. To use the Drill Guide, clamp it to the surface. Place hammer-drill in hole on one end of drill guide and drill hole. Place 1/2 inch round bar through drill guide into hole just drilled. This will help hold Drill Guide in place while second hole is drilled. Now Place hammer-drill in hole on other end of Drill Guide and drill hole. Clean out holes with vacuum or compressed air. Attach the mounting brackets to the Setting Bar as shown in Figure 3 to maintain proper alignment and spacing. Grout the mounting bracket studs into place in the drilled holes using an anchoring cement or high strength epoxy. Allow the grout or epoxy to cure before removing the Setting Bar.

Sensor Installation:

Once the mounting brackets are attached to the surface to be studied, the sensor may be set in place and pre-tension adjusted. An interrogation unit attached to the sensor may be helpful in adjusting pre-tension.

Notice that one end of the sensor has two windows cut into the steel tube (Active-end). The other end has a hex crimp (Fixed-end). Set the sensor in place by placing by aligning the sensor flats into the mounting brackets as shown in Figure 7.

Figure 7 – Mounted Sensor

Using a torque wrench fitted with a 1/8 hex key, torque the two set screws on the Fixed-end of the sensor. Tighten the two screws to a torque of 75 inch-pounds [8.5 Nm]. The two set screws on the Active-end of the sensor should remain loose.

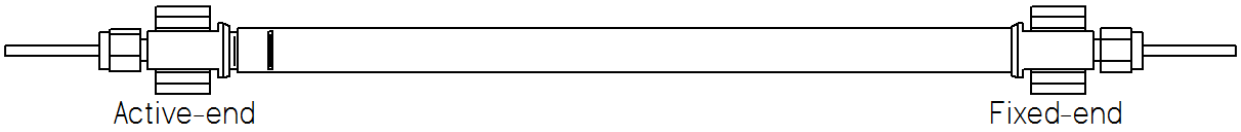

Figure 8 – Sensor

Adjust pretension as required for the particular application. For example, if the application requires the sensor to operate equally in tension and compression, the sensor should be installed centered within its range. The pre-Strain can be visually adjusted by monitoring the two gaps shown in Figure 9. The sensor can be centered or biased to one side of its range.

The sensor pretension and corresponding wavelength can be adjusted by gently grasping the Active-end of the sensor and sliding it in the mounting bracket.

If desired, the sensor can also be connected to an interrogator and adjusted while observing the interrogated wavelength. For example to center the sensor, adjust the Active-end until the wavelength is halfway between the minimum and maximum wavelength value. The wavelength should increase as the sensor is extended. The wavelength should decrease as the sensor is compressed.

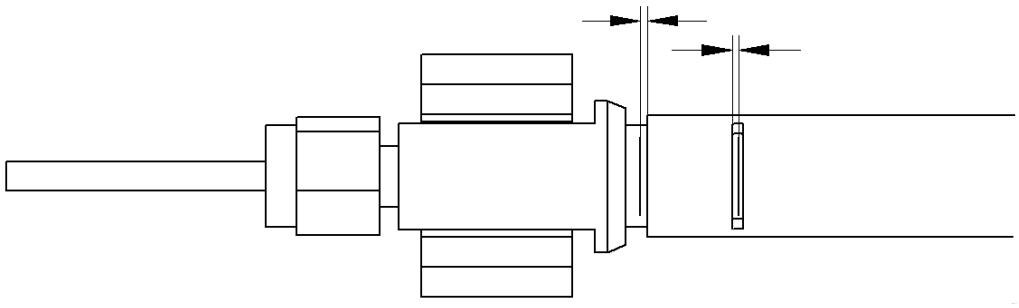

Figure 9 – Pre-Strain Adjustment

While holding the sensor in position, torque the remaining two set screws on the Active-end of the sensor. Continue tightening the two screws to a torque of 75 inch-pounds [8.5 Nm].

Sensor Protection:

When installing a strain sensor it is important to consider how to insulate and physically protect the sensor in order to improve the accuracy and longevity of the sensor. There are many ways to insulate and protect a sensor depending on the particular installation. One method that may be applicable to civil structures is detailed here. This method utilizes expanded polystyrene (EPS) foam insulation and a stainless steel cover shown in Figure 10. These parts are available from Micron Optics as an accessory.

Sensor Accessories:

os3610 Protective Cover and Insulation Kit (25.4 cm)
Universal Connector Protection Fitting "PF" Kit

This method may not be applicable to all installations due to size or other considerations; however, the general principles demonstrated here can be adapted for the particular installation. Figure 10 also shows a Non-metallic conduit and fitting. (Hubbell Part Numbers: G1050, P050NGYA)

Figure 10 – Sensor Cover

Figure 11 show the EPS foam insulation that is part of the kit. The insulation is designed to thermally insulate the sensor from the effects of wind and sun exposure. Notice the "stepped"

interior of the foam insulator. The insulation is designed so that the fiber can be spliced and excess fiber coiled and stored above the sensor.

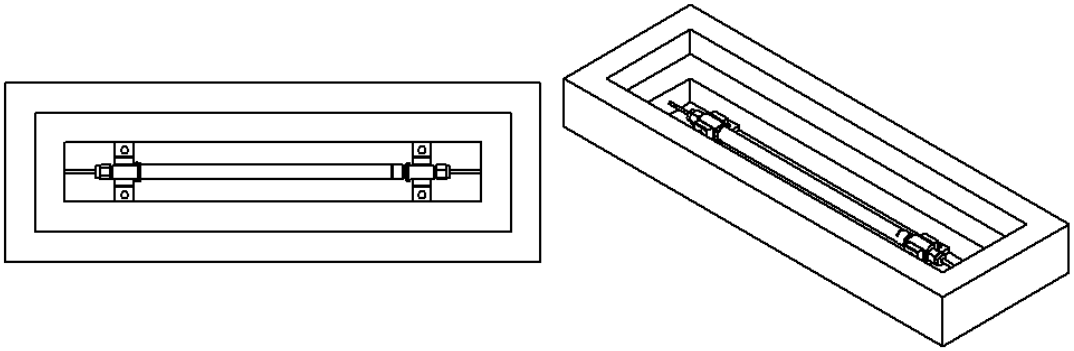

Figure 11 – EPS Frame

Plan ahead and determine where the fiber will enter and exit the stainless steel cover shown in Figure 13. The foam insulation can be cut with a knife as needed to provide fiber access. The EPS foam insulation can be attached to a variety of surface materials using a silicone sealant (such as 3M Super Silicone Sealant, Part No. 08663), or other compatible adhesive. Complete the insulation assembly by attaching the EPS foam cover to the base using silicone sealant or other compatible adhesive. The completed foam insulation is shown in Figure 12.

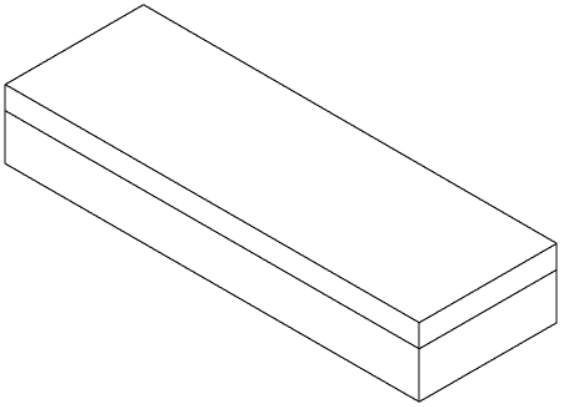

Figure 12 – EPS Lid

The kit also contains the stainless steel cover shown in Figure 13. This cover provides additional protection to the sensor from weather and physical damage. Notice the cover is supplied with 4 knockout holes to provide a variety of fiber routing configurations. The knockout holes are .88 inch [22.4 mm] in diameter and will accept conduit fittings such as Hubbell Part Numbers P050NGYA.

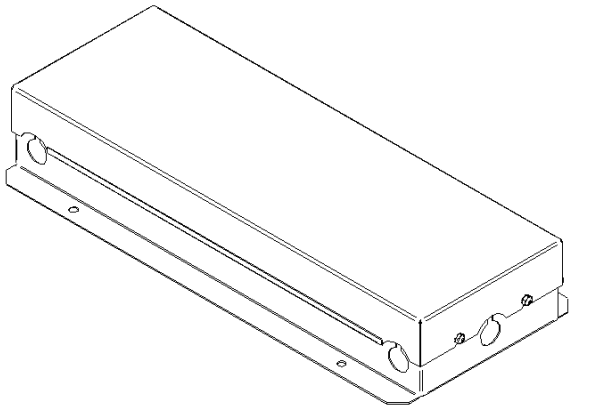

Figure 13 – Stainless Steel Cover

The drawings for the stainless steel cover and EPS insulation are provided for those preferring to modify or provide their own covers.

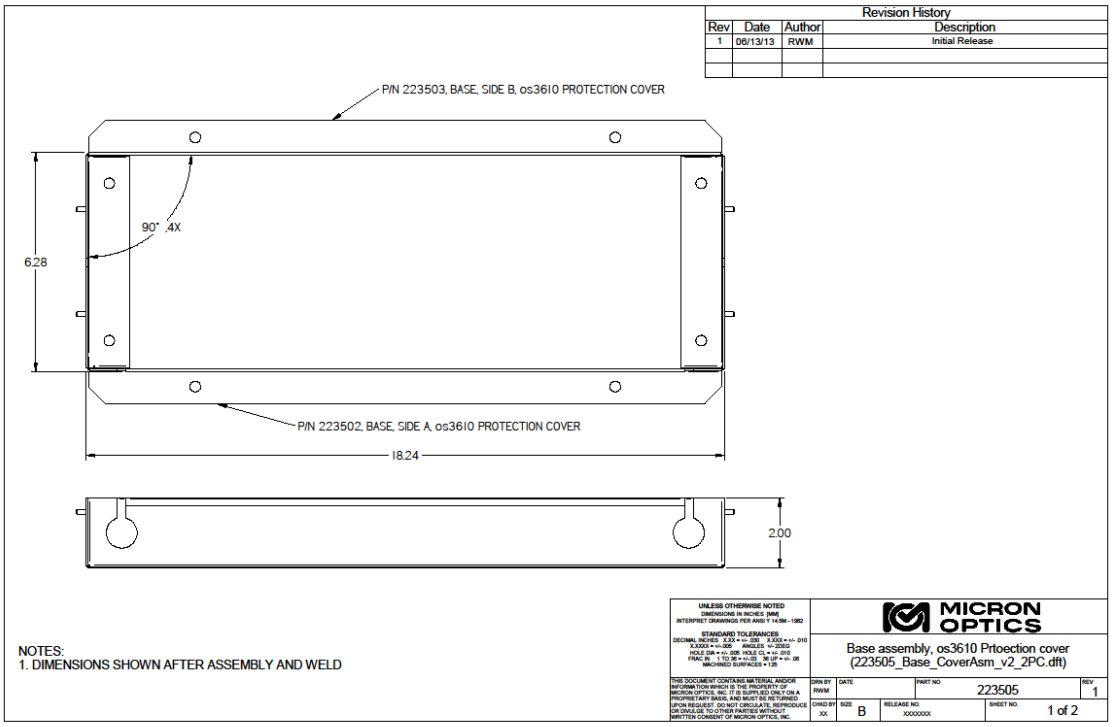

Figure 14 – Cover Lid Drawing

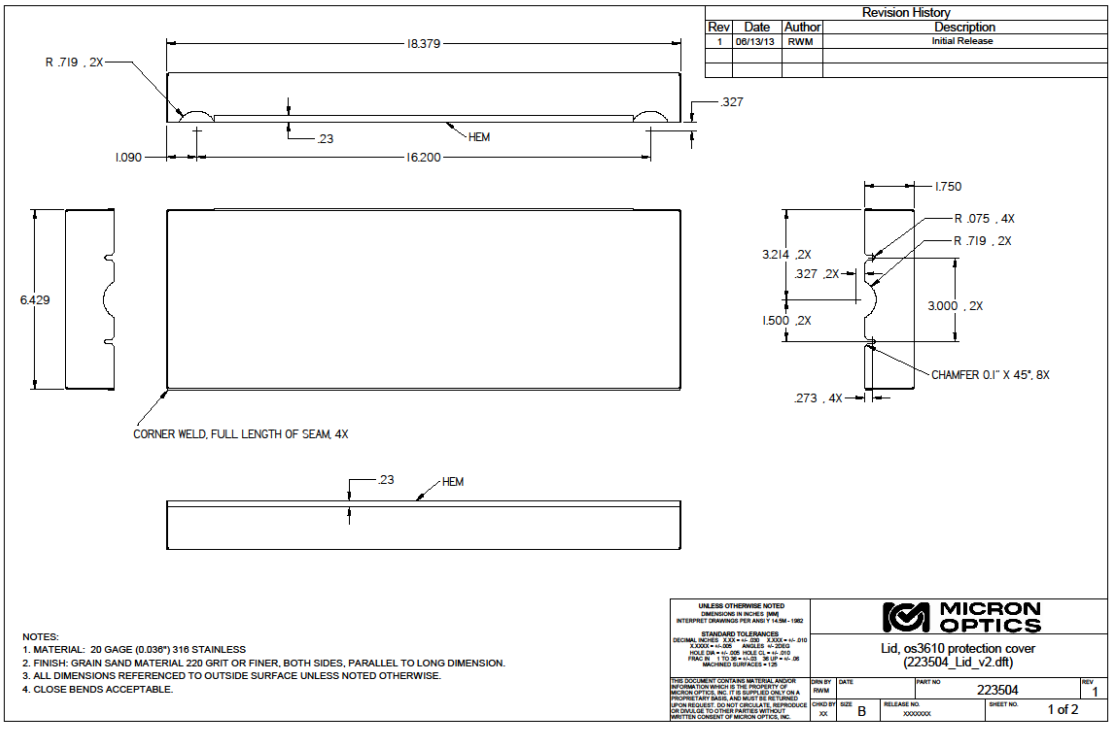

Figure 15 – Cover Base Drawings

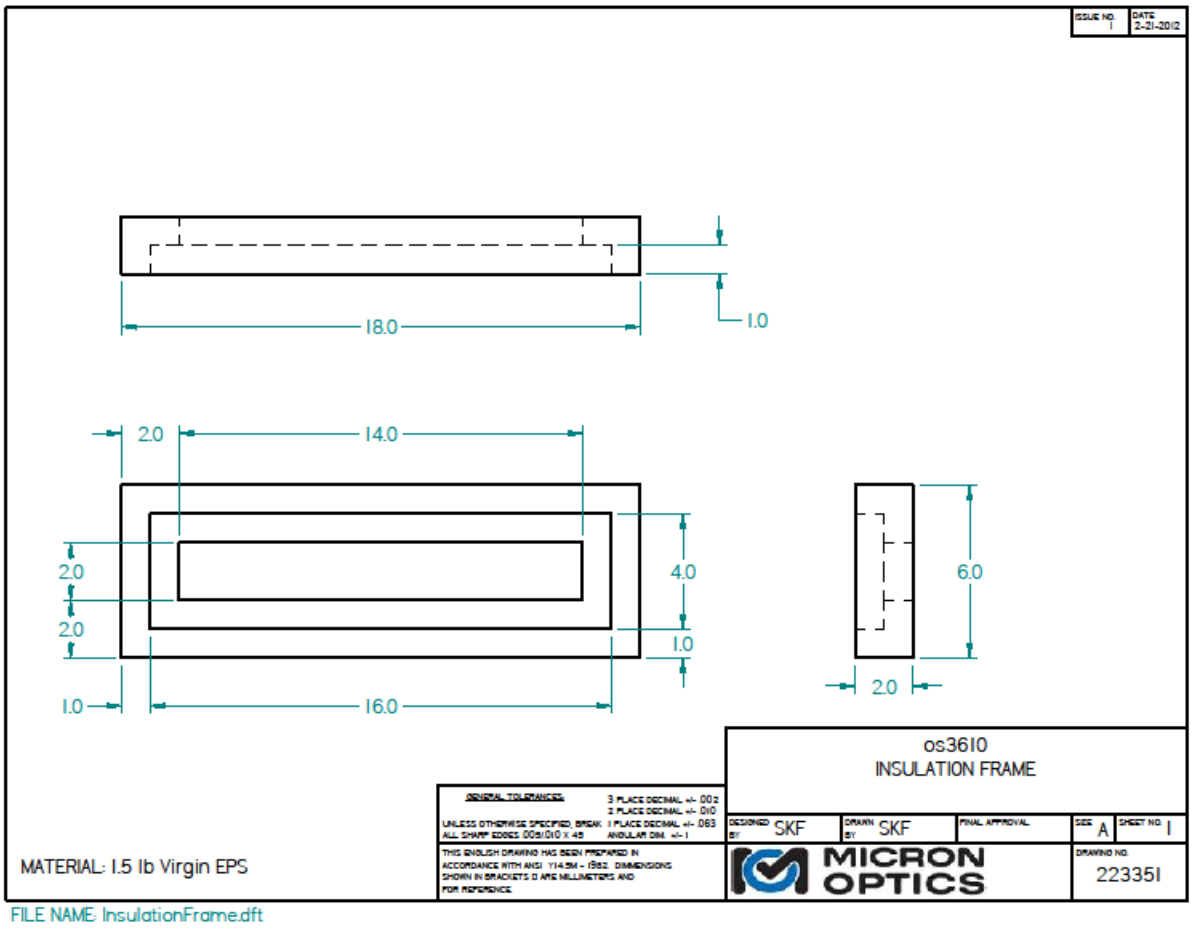

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Figure 16 – Insulation Frame

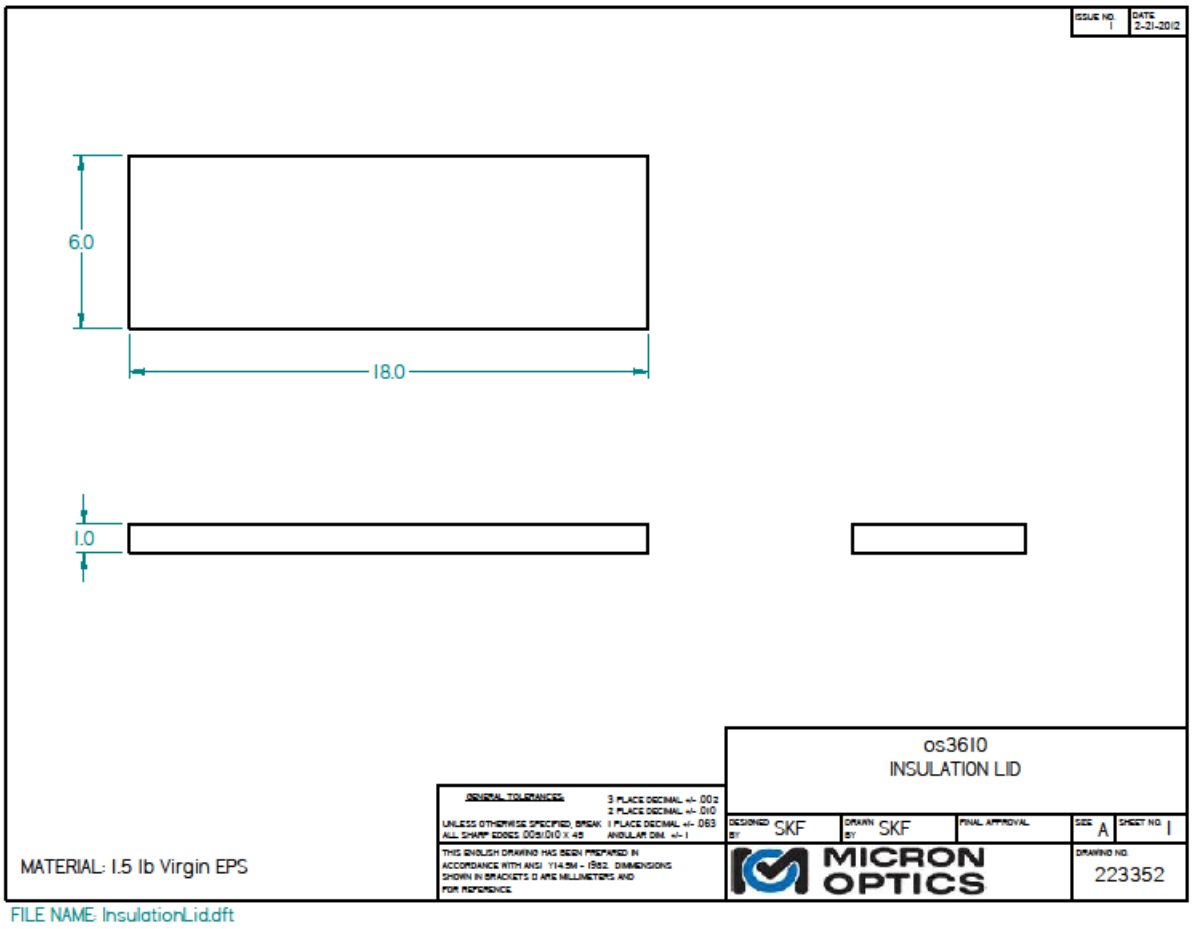

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Figure 17 – Insulation Lid

In addition to the sensor itself, the connector or splice on the end of the sensor cable also needs to be protected from the elements. If the cable end is not protected, the cable could become a path for moisture to enter the sensor. One method of protecting sensors supplied with FC/APC connectors is to use the Universal Connector Protection Fitting "PF" Kit from Micron Optics. The Kit shown in Figure 18 contains everything needed to protect an FC/APC connection.

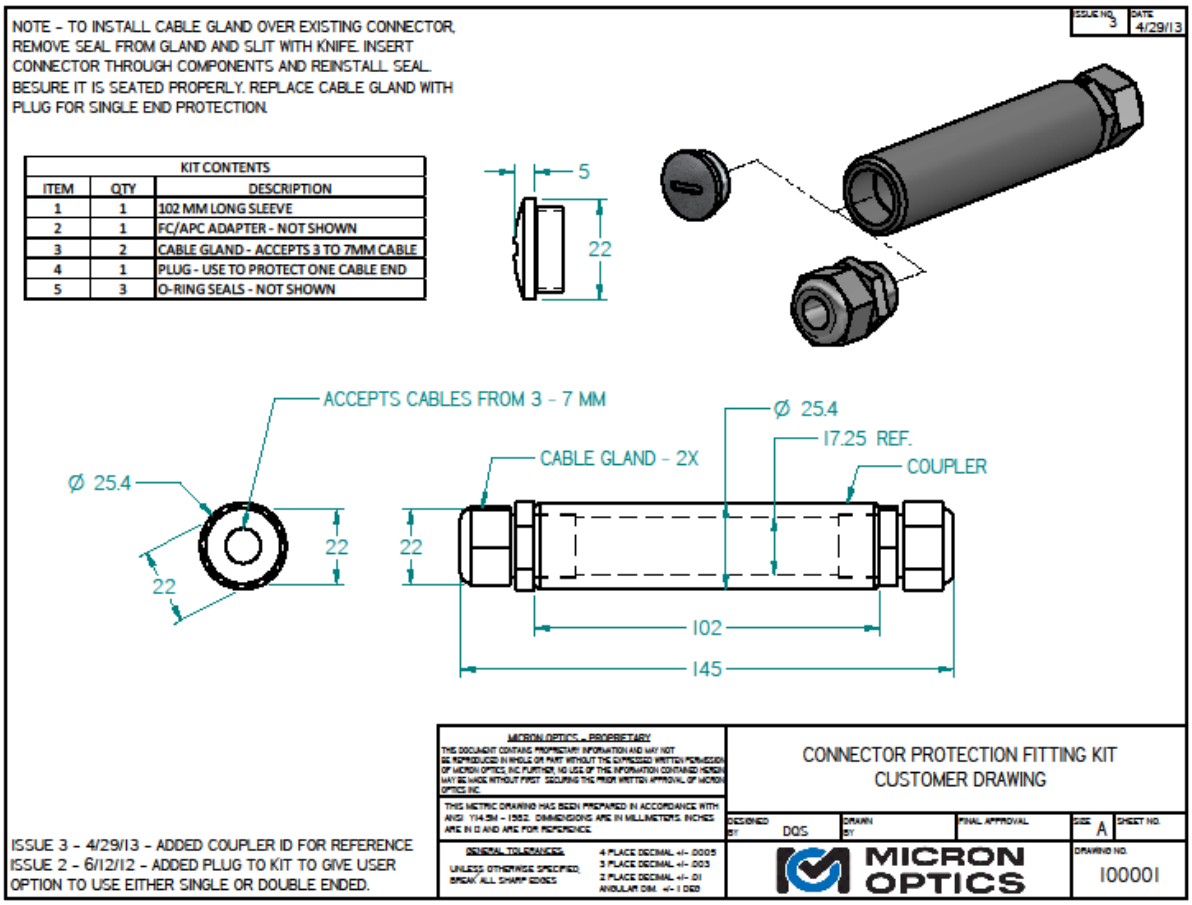

Figure 18 – Universal Connector Protection Fitting