Cable Penetrator

A Guide to Fabrication

by
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Disclaimer

This fabrication procedure is based upon my experiences using the Loctite Marine epoxy while potting the cable penetrator and from 20+ years molding assemblies for use outboard submarine pressure hulls using various polymer systems.

This procedure is not an official document of Blue Robotics and they are not liable for the technical content herein. I have authored the document on my own. In addition, this guide is just that ... it is a guide and each individuals results may vary based upon numerous conditions. I am not liable for flood out, cable failure or any other failure that one might by assumption or empirical evidence blame on the Cable Penetrator or the potting material used.

Figure 1 - Blue Robotics Cable Penetrator

The Cable Penetrator shown in Figure 1 is simple device that provides a pressure proof pathway for cables when used correctly with potting compounds. Figure 2 shows a cut-away of the device with a cable stripped, inserted and potted for pressure proof use.

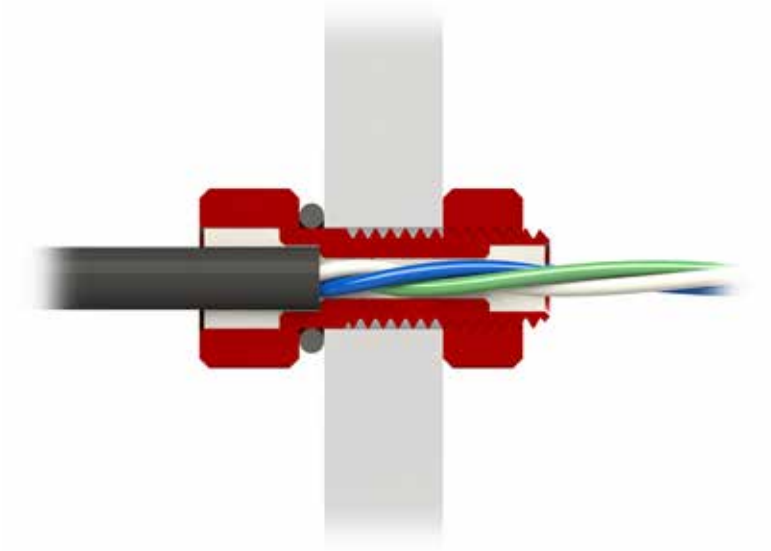

Figure 2 - Cut-away of penetrator and cable

Basic Tools

Xacto knife
Scribe
Mixing Tray
Syringe with 18 gauge needle

This basic tools that I used during the potting of a cable penetrator were what I had available. The Xacto knife was used to remove the cable jacket. The scribe was used as a mixing tool and later ended up being used to ensure that the epoxy compound was filling the penetrator around the cable correctly. The syringe / needle was used for potting; however, after an initial try, I removed the needle because of the viscosity of the mixed material.

The following is a basic guideline for preparing and potting the cable penetrator.

WARNING

Proper protective equipment should be used during any operation involving chemicals. This equipment is not limited to Safety glasses, Latex gloves, Apron, and gloves (while using cutting tools). Please refer to the Safety Data Sheets for any chemicals being used and thoroughly read all instructions before use.

1. First step, obtain all materials, tools and equipment required to perform preparation and potting.

2. Using 80 grit sandpaper, roughen the inside surface of the penetrator on both ends. The area that should be sanded is the wall and the bottom area of the holes on both ends does not have to be sanded.

80 grit is only recommended and whatever roughness you decide to use, as long as it gets the job done, is no issue. The reason that I suggest sanding the side walls is to remove the anodize layer from the Aluminum. The epoxy that is recommended for use, Loctite Marine, will have a better bond to the base metal vice the anodized surface.

Tensile Shear Strength:	
Cold Rolled Steel, Sandblasted	
6 hours:	863 ± 170 psi (5.95 ± 1.17 N/mm²)
24 hours:	3000 ± 110 psi (20.68 ± 0.76 N/mm²)
7 days:	3586 ± 268 psi (24.72 ± 1.85 N/mm²)
Aluminum 6061-T6, Sandblasted	
24 hours:	2751 ± 175 psi (18.97 ± 1.21 N/mm²)
Underwater Bonding (Applied & cured underwater):	
Aluminum, Sandblasted, 7 days, Tensile:	551 ± 78 psi (3.80 ± 0.54 N/mm²)
FRP (dull side), 7 days, Compression:	2201 ± 377 psi (15.18 ± 2.60 N/mm²)

Figure 3 - Excerpt from Loctite Epoxy Marine Technical Data Sheet

4. Sand the cable jacket up to the point that it will be sticking outside of the penetrator. The reason for sanding the jacket, lightly, is to increase the surface area that the epoxy will bond to. The jacket of the Blue Robotics cable is a thermal plastic urethane and is considered a flexible material. Epoxies will have a tendancy to breakaway from the surface of urethanes when the substrate material flexes.

Since the cable penetrators are for low pressure (100 - 200 psi) applications and because the bonding region for the cable jacket is small enough with a restricted opening, a quality bond can be formed that is pressure proof to at least 100 meters.

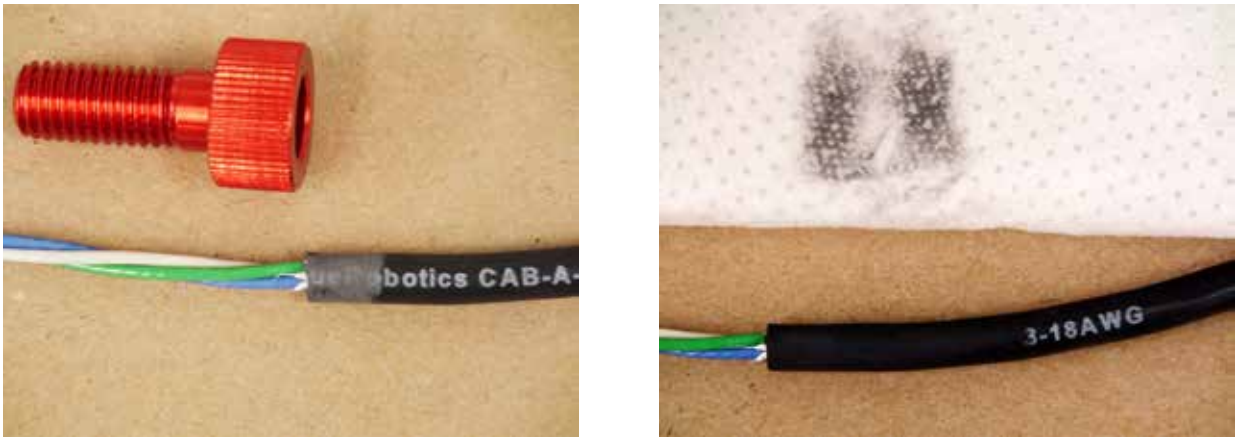

Figure 4 - Sanded and Cleaned Cable

Figure 4 shows the cable jacket after it has been roughened up with sandpaper and cleaned with Acetone. Note the residue on the wipe after a single pass with the solvent. It is recommend, if you are able to use solvents, to wipe the jacket with Acetone after sanding. This does multiple things.

First, the sanding helps to increase the surface area and porosity of the polyurethane. Just like sanding the metal itself, we want a mutual surface on the other side of where the epoxy will bond. The Acetone will remove fine particles created by the sanding and strip the surface of contamination such as oils from your fingers.

5. After the cable surface has been prepared, place the cable into the penetrator until it bottoms out. It should be noted that it is easier to insert the wires through the hole in the penetrator if the wire has a twist similar to the natural lay when the jacket was removed.

As noted in the Blue Robotics tutorial, Super Glue or something similar can be used to try and hold the cable in place within the penetrator. I recommend that you jig the cable in such a manner that you can keep it centered. The Super Glue can break free since polyurethane has low bond strength to that type of material. In the picture a Pano-Vise has been used with the cable coiled over and masking tape used to hold the coil to allow the bended cable to stay centered.

6. When you are ready to using the epoxy to pot the assembly, it is recommended that you use Latex gloves or some other similar gloves.

It should be noted that this epoxy when mixed does not flow readily. The mixture flows about as well as thick ketchup.

Open the ends of the two part epoxy syringe and secrete an even quantity of both parts. The hardener is white in color while the resin is tan. From experience with other two part systems, I recommend using the entire container. The reason behind this recommendation is the epoxy is supposed to be a 1:1 mix by volume and the error in the mix is reduced as the volume goes up. Since it is highly recommended not to use a mechanical mixer because air can be blended in at a higher rate, the larger volume will ensure less chances of not having a good blend.

When mixing, use an item that does not have a porous surface. I used a metal scribe and for large volume in the half-pint and above range, I will use a plastic spoon.

Figure 5 - Umixed and Mixed Epoxy

7. In the list of materials I had a syringe and an 18 gauge needle shown. After I mixed the material and tried to inject it into the void between the cable and penetrator, I had very little luck. I removed the needle and just squirted the mixture into the area on one spot. The mixture does not like to flow well at all and I ended up using the scribe to push the material down into the penetrator body.

The one thing that I would recommend getting besides what I listed and spoken about so far is Q-Tips. You can use the item to clean up after yourself.

After waiting for about five minutes, the mixture did not settle out from the area that I injected. I used the scribe while injecting into new spots while trying to leave an open gap for air to escape.

Continue repeating this process of injection and “smoothing” out the areas until you have completely filled the void in the penetrator.

You can use the Q-Tips to clean up any overflow and to make the are nicer.

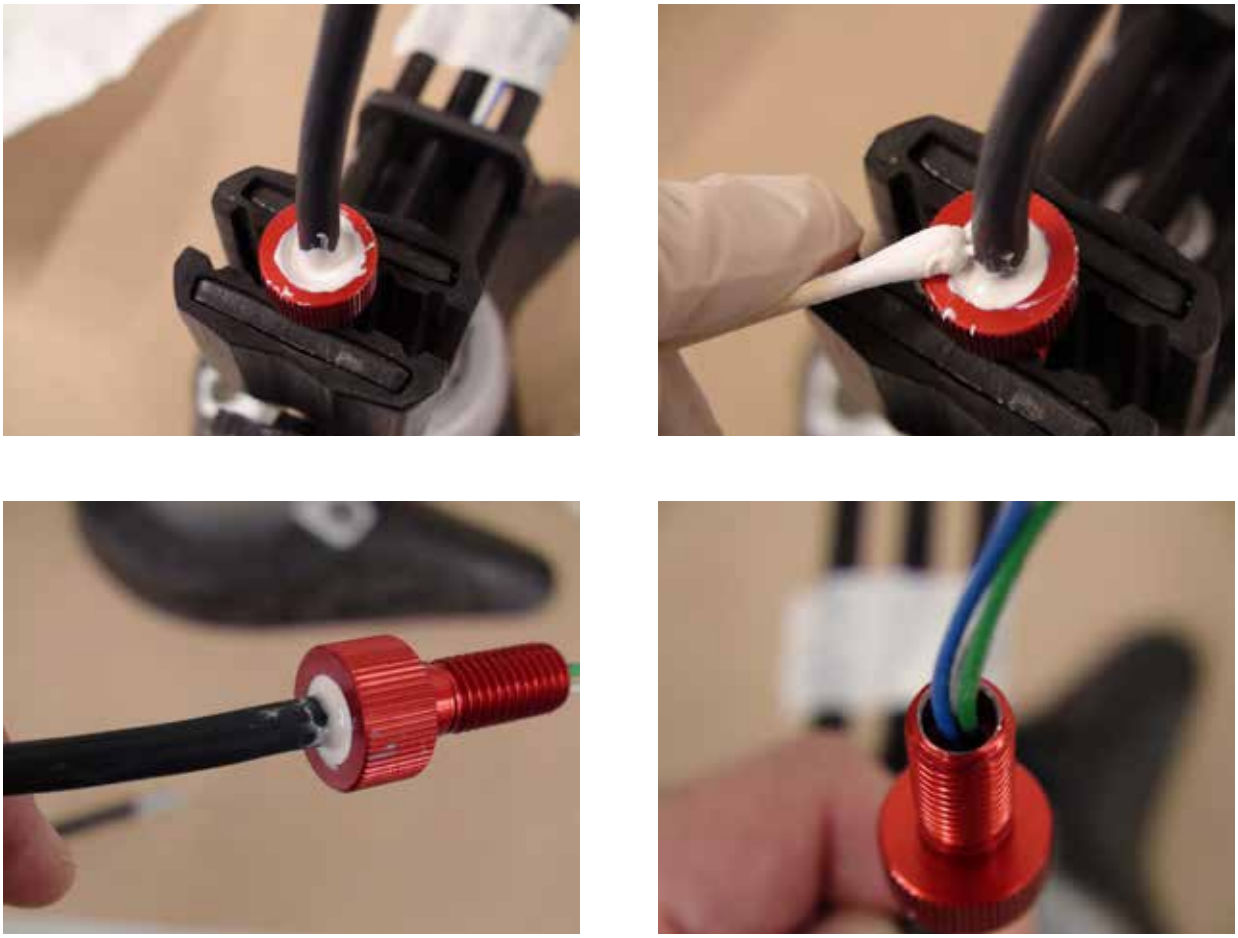

Figure 6 - Various Potting Steps

In case you are wondering, I did not pot the reverse side of the penetrator for a couple of reasons.

One reason is it doesn't matter. From a perspective of pressure intrusion, the outside seal is the most critical point in this design. If the seal is broken and water leaks to the region where the wire is broken out, watertight integrity is history. This epoxy, as with 99% of epoxy, does not like or will not bond to Teflon. The individual wire insulation is Teflon to impart maximum electrical properties for this cable with a limited amount of space.

Sealing the backside is at the discretion of the individual. Mechanically, the cable jacket is acting as a "soft" seal to a certain extent. With the jacket and penetrator surfaces treated as indicated in previous steps, your chances of having a long and happy dive with your ROV are almost certain.

The following images were obtained from the Blue Robotics website and are the property of Blue Robotics.

1. Blue Robotics logo on the Title page.
2. Figure 1 - This is a combination of two images from the site
3. Figure 2 - Cut-away image.