



Optical fiber termination is a very process dependent operation. Consideration of the optical terminus, adhesive system and the optical cable/fiber must all be taken into consideration. XiOptics, LLC provides the following document to our customer for reference only. XiOptics encourages trial fiber termination prior termination of final production hardware to ensure process stability.

## Termination for M29504/4, /5, /6 & /7, Style 2 (Tight)

This termination method is for placing a XiOptics XOP or XOS; Style 2, MIL-PRF-29504/4 and /5 terminus onto the end of a tight jacket fiber optic cable.

**CAUTION:** Throughout the termination process, cleanliness is critical to obtaining a high optical quality connector. Make sure that work surfaces and hands are as clean of loose particle contaminate or liquids minimize the ingress of surface contaminates into the finished cable products.

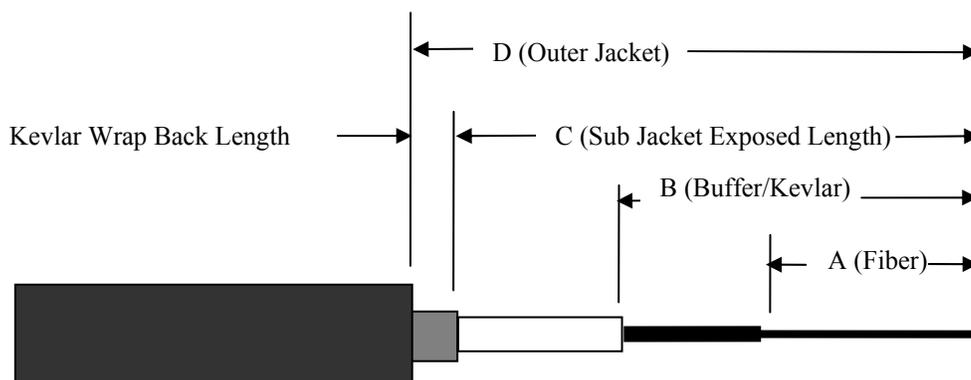
**NOTE:** Verify that the epoxy shelf life has not expired. Do not use epoxy with an expiration date that has passed.

**Safety summary.** The following safety precautions should be observed:

- (1) Safety glasses should be worn at all times when handling bare fibers or dispensing epoxy.
- (2) Bare fiber ends of the fiber should never be handled directly as they may be razor sharp. Wash your hands after handling bare fiber.
- (3) Avoid skin contact with epoxies.
- (4) Do not look into the end of a fiber until verifying that the fiber is not connected to a laser light source or LED.

### **CABLE AND FIBER PREPARATION:**

**NOTE:** Refer to XiOptics website at [www.xioptics.com](http://www.xioptics.com) for the latest fiber cable preparation information.



**NOTE:** "A" Dimension for buffer stripped fiber is only critical for operator handling. The recommended length for exposed fiber is 13mm (.5 inch) minimum. Actual strip back may not appear as shown. Kevlar may extend over buffer region and require back fold during stripping.

Figure 1. Cable stripping dimensions.

- Step 1 - Mark the simplex cable outer jackets to dimension B and to dimension D per XIOptics cable preparation table 1 information below.
- Step 2 - Remove the simplex cable jacket to dimension B using a cable manufacturer specified cable stripper and trim the Kevlar (aramid yarn) to that length using diamond blade Kevlar shears so that it is even with the simplex cable jacket.
- NOTE: The optimum way to remove the simplex cable jackets is to ring cut the jacket with the simplex cable stripper and pull the jacket off by hand. Pushing off the simplex cable jacket with a tightly held simplex cable stripper can lead to fiber breakage.
- Step 3 - Remove the simplex cable jackets back to dimension D in table 1 using the simplex cable stripper. This step will expose the Kevlar to the appropriate length. Pull the Kevlar back over the outer jacket to expose the sub-jacket.
- Step 4 - Mark the exposed sub-jacket to length B and strip it clean of the fiber to that length leaving the buffered glass exposed.

TABLE 1. Cable stripping dimensions (13mm exposed glass)

Terminus	Cable Constr.	Dimensions mm (in) <u>1/</u>					
		M29504/4 Pin Terminus			M29504/5 Socket Terminus		
		B	C	D	B	C	D
XO	Tight jacket	14.8 (0.58)	17.0 (.39)	17.1 (0.67)	16.6 (0.65)	15.61 (0.61)	22.9 (0.90)

1/ Tolerances on all dimensions are  $\pm 1.6$  mm (0.06 in).

Step 5 -**WARNING:** Safety glasses should be worn when removing the fiber buffer and coating to avoid possible eye injury.

Remove the fiber buffers and coatings back to dimension A using a no nick, buffer stripper as recommended by the fiber cable manufacturer. Remove the buffer and coating in small sections (approximately 6 mm (0.25 in) at a time.) (NOTE: Normally, the buffer and coating are tightly adhered to one another and come off of the fiber at the same time.)

NOTE: Some aerospace cables have a silicone buffer which can be remove in one section, using the buffer stripper, instead of having to be removed in 6 mm (0.25 in) increments.

Step 6 -**CAUTION:** When all coatings are removed the glass fiber is in its most vulnerable state. Take extreme care not to damage the fiber. Breakage of any one fiber from this point until the terminus assembled will require repetition of this and potentially all of the following steps in order to maintain approximately equal length of all the fibers in the cables if required.

Remove any residual coating material from the bare fibers with an isopropyl alcohol dampened lint free wipe. Wipe only once from the end of the buffer towards the end of the fiber. (NOTE: Do not repeatedly wipe the bare fiber, as this will weaken the fiber.)

NOTE: To include cleaning the Kevlar, wipe from the Kevlar out to the end of the fiber.

NOTE: Tolerance on the overall length of the cable harness should be  $+13/-0$  mm ( $+0.5/-0.0$  in). Tolerance for each cable in the cable harness shall be  $+9/-0$  mm ( $+0.25/-0.0$  in). One approach to fabricate a cable with this tolerance is given by providing an example of a cable with a face-of-termini to face-of-termini required length of 2.540 m (100 inches). Start with a cut cable length of 2.99 to 2.84 m (108 to 112 inches). This length allows for two to three terminations of the first end in the event the terminus must be cut off and replaced. No leeway can be given for re-termination of the second end. After successful termination of the first end, measure to 2.559 m (100.95 inches) from the face of the terminus to the cut point. Do second end termination. After a 1.5 mm (0.93 inch) length of fiber cleaved

from the end, the face-of-termini to face-of-termini length should be about 2.543 m (100.13 inch). The cable length falls midrange between the allowed cable length of 2.540 to 2.549 m (100 to 100.25 inches).

### **INSTALLATION OF THE TERMINUS ONTO THE OPTICAL FIBER:**

NOTE: This procedure describes the process for installing ceramic ferruled termini onto either multimode or single-mode fibers. Epoxy is used to secure the fiber in the termini for mating purposes. The epoxy is used to secure the Kevlar onto the inside of the termini bonding cup for the required tensile strength. The Teflon tape is used to hold the termini onto the fiber optic cable jacket during the curing process.

NOTE: A socket terminus, unlike a pin terminus, will require the removal of the alignment sleeve assembly (hooded ceramic split sleeve). To remove entire hood assembly hold the socket terminus body and unthread the entire hood assembly. Place the hood assembly in a clean and dry storage location for later use.

NOTE: Verify that the programmable oven is calibrated

NOTE: Most programmable ovens do not have an On/Off switch.

NOTE: Step 1 below needs to be accomplished prior to installing the termini onto the simplex cable.

Step 1 - Plug in the programmable oven. Verify the time/temperature step programmed sequence specified is as specified by the adhesive manufacturer.

Step 2 - Inspect the terminus and verify that the ferrule hole is free and clean of dirt. This can be accomplished by holding the front of the terminus up to a light and verifying that the light is visible from the rear of the terminus. If light cannot be seen through the terminus, push music wire through the terminus hole to clear it. Then blow dry, clean air through the hole to remove any debris. (See note below for tight ferrule hole tolerance applications).

NOTE: For some applications, there may be a tight ferrule hole tolerance requirement. If the application requires a tight ferrule hole tolerance, then several termini with different ferrule hole diameters will need to be kept on hand. Dry fit the termini onto the fiber, to ensure proper ferrule hole clearance, before injecting epoxy into the termini. Try the smaller ferrule hole diameter first; if the termini will not fit then proceed to the next larger ferrule hole diameter.

Step 3 - Remove the epoxy from its shipping container. Remove all air bubbles and mix epoxy to manufacturer's instructions.

Step 4 - Install the syringe tip on the syringe, remove the plunger, and squeeze the epoxy into the syringe. Replace the plunger.

Step 5 - **WARNING:** Wear safety glasses while dispensing the epoxy to avoid possible eye injury.

Remove air pockets in the syringe by holding the tip of the syringe upward and dispensing epoxy onto a wipe until it runs free and clear. Air voids can yield defective fiber cable terminations. Be sure to clear all entrapped air prior to epoxy application.

Step 6 - Slide the terminus, rear first, onto the syringe tip (see figure 2). Keeping the syringe vertical, depress the plunger and slowly inject epoxy into the terminus until it escapes out of the ferrule, forming a very small bead. (NOTE: Do not overfill. Be extremely careful not to get epoxy on the socket spring or other terminus moving parts.)

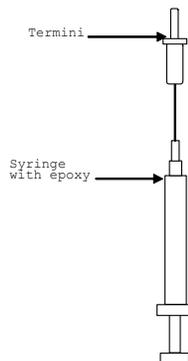


Figure 2. Injecting epoxy into the terminus.

Step 7 - Withdraw the syringe from the terminus. Maintain some pressure on the plunger as the syringe is withdrawn so that the terminus is completely filled with epoxy. Using a wipe dampened with alcohol, wipe away any epoxy on the outer diameter of ferrule without disturbing the epoxy bead.

NOTE: Alternatively, the terminus may be completely filled by maintaining a light pressure on the syringe plunger and allowing the epoxy to push the terminus off of the syringe tip.

Step 8 - Using a six inch piece of non-waxed dental floss wrap the Kevlar strands evenly around the fiber jacket and insert the fiber into the rear of the terminus (see figure 021-08-4). The Kevlar strands should go up inside of the terminus. Work the dental floss back as the Kevlar goes up into the terminus. Gently work the fiber through the terminus until the buffer seats against the rear of the ferrule. (The terminus should be rotated around the fiber as the fiber is inserted to ensure even epoxy coating.) The simplex cable jacket and Kevlar should go up inside of the rear of the terminus. Once inserted, do not allow the fiber to slip back.

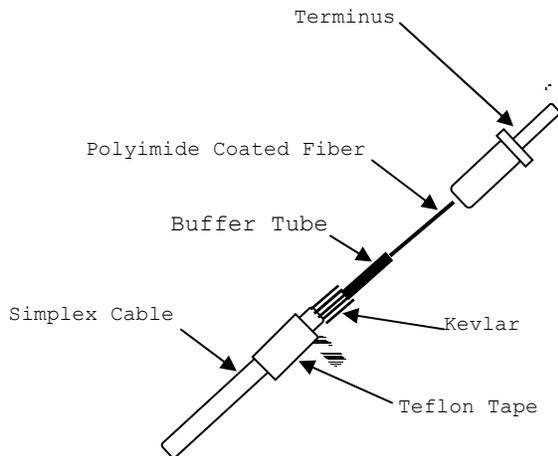


Figure 3. Inserting the fiber into the terminus.

Step 9 - Apply the Teflon tape over the rear portion of the terminus and onto the simplex cable jacket. Make sure to capture both the rear of the terminus and the simplex cable jacket.

Step 10 - Verify that the Kevlar does not protrude excessively from the rear of the terminus. Excessive Kevlar protrusion will cause the terminus to not seat properly in the finished connector.

Step 11 - Verify that there is a small amount of epoxy around the fiber where it protrudes from the ferrule. If it is found that there is no small bead of epoxy on the terminus tip, carefully add a small amount of epoxy around the fiber. (NOTE: There should only be a small amount of epoxy around the fiber to support it later during the polishing process. If too much epoxy is around the fiber during the curing process, it may cause damage to the optical glass fiber (see figure 021-08-5).

Step 12 - Using an isopropyl alcohol dampened lint free wipe, carefully wipe away any excess epoxy on the fiber that is more than 2 mm (0.1 in) from the ferrule tip surface.

Step 13 - Insert the terminus into the cure adapter until it rests against the metal section, behind the ceramic ferrule.(see figure 4).

**WARNING:** Do not get epoxy on the outside of the ceramic ferrule of the terminus. Wipe off any excess epoxy on the outside of the ceramic ferrule using a lint free cloth.

NOTE: Configuration of the cure adapter provided with the oven may be different than that shown. One cure adapter configuration has a loose hole for the ferrule. This cure adapter configuration necessitates that the cure adapters be placed in the oven before terminus insertion into the adapter (and preferably before heating). Next place the terminus into the cure adapter and position the cable vertically over the oven.

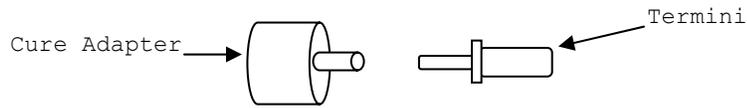


Figure 4. Inserting a terminus into a cure adapter.

Step 14 - Repeat steps 2 through 13 for each fiber to be terminated.

Step 15 - Place the cure adapters in the curing oven, and position the cable vertically over the oven using the cable stand, see figure 5. Cure the epoxy, with the programmable oven, using the curing schedule specified by the adhesive system manufacturer. (NOTE: When the cable is positioned above the terminus, make sure that no bends are placed in the simplex cables. Each simplex cable should enter the terminus parallel to the terminus. Be sure no fiber cable pull back has occurred.)

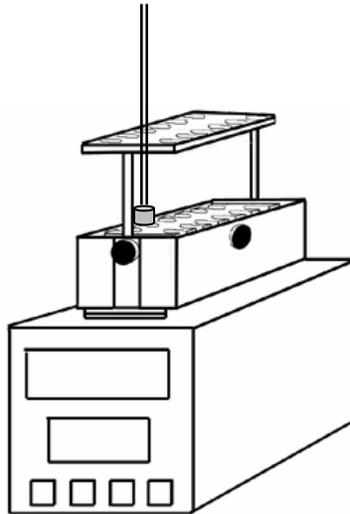


Figure 5. Terminus in the curing oven.

Step 16 The curing program will turn off the oven after the cool down cycle. Remove the cure adapters and termini from the curing oven. Allow the cure adapters and termini to cool for approximately 4 minutes prior to terminus removal from the cure adapter.

### **POLISHING THE FIBER ENDS:**

NOTE: This procedure will produce a PC polish on a ceramic terminus with a domed end face on the ferrule. This procedure is typically used for single mode applications with a minimum return loss requirement of 40 db.

NOTE: Procedures for hand polishing are contained herein. Machine polishing may be used as an alternate method, provided the following requirements are satisfied:

- (a) The manufacturer's instructions will be rigidly adhered to.
- (b) The machine polished terminus shall undergo the same quality check used for the manually polished terminus as described herein.

Step 1 - **WARNING:** Wear safety glasses when scoring the fiber to avoid possible eye injury.

Remove the terminus from the cure adapter and score the fiber close to the terminus tip at the epoxy interface using one short light stroke with cleaving tool (see figure 021-08-9). (NOTE: Do not break the fibers with the cleaving tool.) Pull off each fiber with a gentle, straight pull. Deposit the waste fiber in a trash container.

NOTE: The termini not being polished should be left in the cure adapters during the polishing process to protect the fibers from breakage.

NOTE: The ceramic ferrule of the termini may become epoxied to the cure adapter. Use a pair of needle nose pliers to hold behind the metal shoulder of the termini and then slowly rotate the cure adapter to break the termini free of the cure adapter.

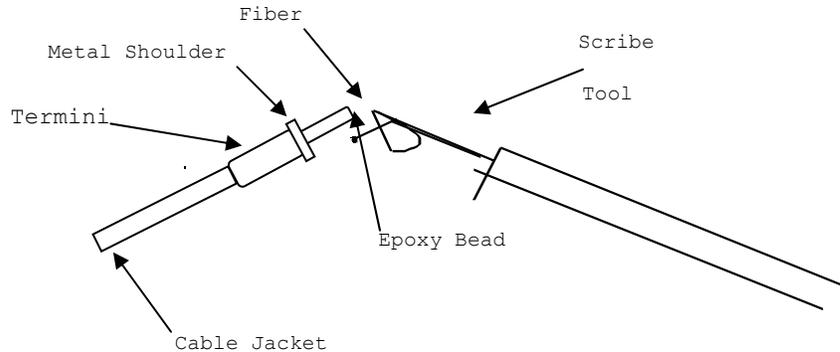


Figure 6. Scoring the fiber.

NOTE: Before inserting the terminus into the polishing tool, the terminus may be held vertically and the end of the fiber polished off by lightly running the 5 um polishing paper over the top of the terminus tip. (This is referred to as air polishing the terminus.) The movement of the fiber on the air polish media should be "figure 8" in nature. Only the spring force of the media should be applied to the terminus tip during air polishing.

NOTE: There are two polishing pucks for the termini. One puck is for termini sockets and the other is for termini pins. It is indicated on the polishing puck.(see figure 7)

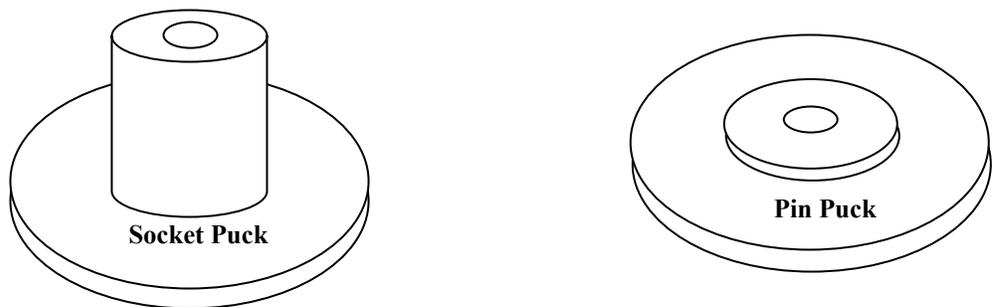


Figure 7. Polishing pucks for M29504/4 & /5 termini.

Step 2 - Clean the glass polishing plate, the backs of the polishing papers and the surface of the polishing tool using a lint free wipe dampened with isopropyl alcohol. Blow all of the surfaces dry with clean, dry air.

Step 3 - Insert the terminus into the polishing tool (8).

NOTE: Difficulty in inserting the connector ferrule into the polishing tool may indicate epoxy on outside of the ferrule that must be removed before proceeding.

NOTE: Clean the terminus and polishing tool prior to terminus insertion.

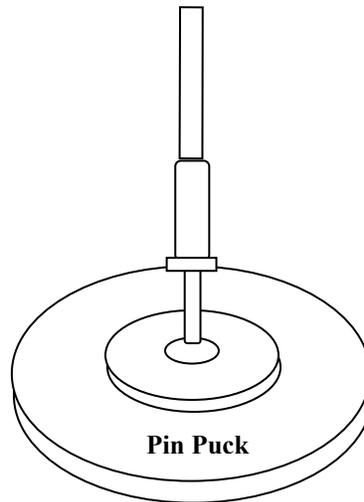


Figure 8. Inserting the terminus into the polishing tool.

Step 4 - Place the 5 um aluminum oxide foam backed polishing paper on the glass plate and start polishing the terminus with very light pressure (the weight of the tool) using a figure-8 motion. Do not overpolish the terminus. (NOTE: The first polish is complete when almost all of the epoxy is gone from the tip of the terminus.) Since the polishing time varies with the amount of epoxy present on the tip of the terminus, inspect the terminus tip frequently. Whenever the polishing tool is lifted, remove the grit from the tool and the terminus with a wipe dampened with alcohol or with air. When polishing is complete, clean the terminus and the polishing tool using a wipe dampened with alcohol and blow them dry with air. Perform a rough inspection of the ferrule end using the eye loop.

Step 5 - Remove the 5 um aluminum oxide foam backed paper and place the resilient pad on top of the glass plate. Place with the 1 um aluminum oxide mylar backed paper on the resilient pad and polish the terminus with light pressure using a figure-8 motion until all of the epoxy is removed from the tip of the terminus. Inspect the terminus endface with the 400X inspection scope to verify that all of the epoxy has been removed. When polishing is complete, clean the terminus and the polishing tool using a wipe dampened with alcohol and blow them dry with air.

NOTE: The 1 um aluminum oxide polish is complete when all of the epoxy is removed from the tip of the terminus.

NOTE: The polish tool should hydroplane above the paper surface during of both the 0.1 um diamond paper and the ultrafine paper.

- Step 6 - Replace the 1 um aluminum oxide paper with the 0.1 um diamond paper and polish the terminus with light pressure using a figure-8 motion for 20 to 30 complete motions or until the endface is free of scratches. When polishing is complete, clean the terminus and the polishing tool using a wipe dampened with alcohol and blow them dry with air.
- Step 7 - Replace the 0.1 um paper with the ultrafine paper and replace the glass plate with a resilient pad. Wet the paper and polish the terminus with no pressure using a figure-8 motion for 10 to 30 complete motions.
- NOTE: Clean per step 3 of standard polish procedure prior to placing the terminus on the polishing paper.
- NOTE: The glossy side of the ultrafine paper should be placed facing the resilient pad.
- NOTE: The polish tool should hydroplane above the paper surface during this polish.
- Step 8 - Clean the terminus and the polishing tool with a wipe dampened with alcohol then dry.
- Step 9 - Repeat steps 1 through 6 for all of the termini.

#### QUALITY VERIFICATION:

XiOptics works in partnership with Westover Scientific and recommends consulting with Westover regarding quality inspection equipment. For single mode fiber termination a minimum 400x magnification must be used, for single mode termination a recommended magnification level of 200x is recommended. Westover Scientific can supply a fully automated fiber terminus quality validation system.

- Step 1 - Examine the terminus with the optical microscope to ensure that the optical surface is smooth and free of scratches, pits, chips, and fractures (see figure 9). If any defects are present, repeat the polish with the 0.1 um paper or re-terminate the fiber. (NOTE: Do not polish the terminus more than necessary to pass the quality check.) A high intensity back light may be used to illuminate the fiber during the quality check.

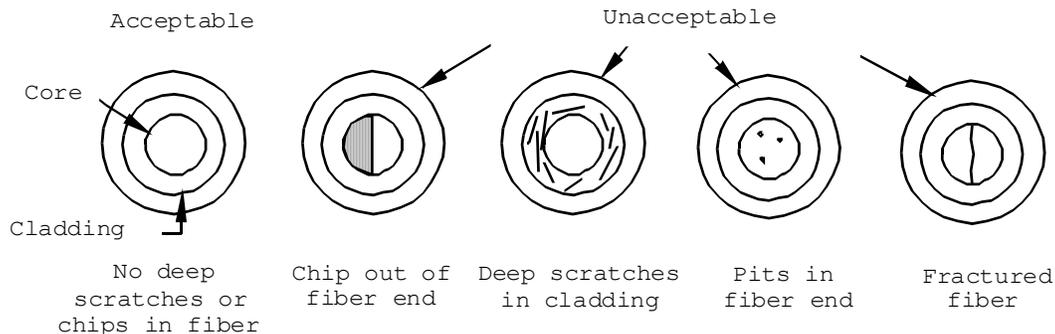


Figure 9. Quality verification.

#### INSTALLATION OF THE TERMINUS INTO THE CONNECTOR:

- Caution:** A socket terminus, unlike a pin terminus, will require the reinstallation of the alignment sleeve hood before installing the socket terminus into the connector. Hood installation is accomplished by threading the hood onto the front of the optical terminus. XiOptics socket terminus design uses a retained ceramic split sleeve. Although fragile the hood assembly provides features that prevent stubbing of the ceramic sleeve during hood installation. Locking compounds are not typically required on hood assemblies.

NOTE: Any connector fitting or backshell must be installed onto the cable, prior to the installation of the termini into the connector.

NOTE: Ensure tube on insertion tool is not bent. A bent tube could cut the grommet inside the connector.

NOTE: Either a plastic or a metal insertion tool is acceptable for use.

Step 1 - Place the termini into the insertion tool around the rear of the terminus and up to the shoulder on the terminus body.

Step 2 - Place the terminus in the proper cavity in the rear of the connector insert. Apply pressure with the insertion tool until the terminus snaps into place. Remove the tool by pulling straight back. (NOTE: A properly inserted terminus will have some axial "play" within the insert cavity. CAUTION: Be careful not to rip or tear the rubber grommet at the rear of the M38999 connector.