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INSTALLATION INSTRUCTIONS

PRT[®] (ES)

⚠ WARNING:
Cancer and Reproductive Harm | www.P65Warnings.ca.gov

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ABOUT ZIPPERTUBING®

Since 1957, Zippertubing® has been solving every type of cable bundling, heat-shielding, EMI-shielding, specialized heat shrink and marine fairing component challenge. From under the sea to outer space, we have prototyped, manufactured, and shipped custom-engineered solutions for every type of industry. We specialize in creating unique custom solutions in-house from beginning to end, so you feel confident you will receive the perfect product every time.

No matter the size, shape, standards, or specifications, Zippertubing® will abide by any requirements to create a custom solution. If the project has material restrictions or weight limitations, we will create a solution to fit your unique application needs, rather than make your application fit the product. We will draw up, prototype, and refine to ensure the solution is exceeding your expectations.



TABLE OF CONTENTS

INTRODUCTION	3
SIZING CHART	4
INSTALLATION: PROCEDURE A	5
INSTALLATION: PROCEDURE B	7
TROUBLESHOOTING	10

INTRODUCTION

PRT® (ES) combines the proven benefits of heat shrinkable tubing, a hot-melt adhesive and the ease of installation using Zippertubing's wrap-around heat shrink products. This PRT® (ES) is designed to provide "Water Blocking"; an environmentally sealed repair patch to wires and cables.

Background

When a heat-shrinkable jacket is applied over a cable, the jacket creates a secondary protective barrier that provides additional mechanical and electrical protection. However, under extreme environmental conditions, moisture and contaminants can seep between the secondary jacket and the cable insulation. The resulting environmental exposure can lead to corrosion of any exposed conductors and potentially cause circuit failure. The most effective way to eliminate this problem is to ensure that there are no voids or gaps between the secondary jacket and the cable jacket. To achieve this condition, semi-liquid sealants and mastics have classically been used. This sealing process is commonly referred to as "water blocking" and the most reliable way to achieve this when using heat-shrinkable parts is to apply a hot-melt adhesive under the tubing material prior to shrinking. The hot-melt adhesive will flow during the heating process and the constricting tubing will drive the molten sealant into all the voids and gaps. Once the gaps have been filled, there will be no air space between the two layers and no pressure differential between the inside and outside of the cable assembly. Changes in external atmospheric pressure or water pressure will not cause moisture or contaminants to migrate into the cable repair area.

Document Sections

- 1. Procedure "A"** describes installing Zippertubing's PRT® (ES-100) and PRT® (ES-135) products. The PRT® (ES) design is a one-piece part containing both the wrap-around shrink tubing and a preinstalled internal layer of hot-melt adhesive. These designs are intended for cables sizes up to 0.250" diameter when using PRT® (ES-100) and up to 1.88" diameter when using PRT® (ES-135). Refer to Table 1A and 1B for sizing and material part numbers.
- 2. Procedure "B"** describes installing Zippertubing's PRT® and Z-Block® hot-melt tape adhesive as two separate components to achieve a similar repair as described in "Procedure A". Refer to Table 2 for sizing and material part numbers.

Troubleshooting describes common installation problems and how to resolve them. PRT® (ES-135) material has an operational temperature range of -55 to 135°C. PRT® (ES-100) material has an operational temperature range of -55 to 100°C.

SIZING CHART

STEP
01

SIZING

Measure the outside diameter of the damaged wire or cable and determine the correct size of PRT® (ES) from [Tables 1A or 1B](#).

TABLE 1A: PRT® (ES-100) Part Numbers

Cable Diameter	Zippertubing P/N
0.040" to 0.075"	ZT11-04-005-01
0.076" to 0.125"	ZT11-04-005-03
0.126" to 0.174"	ZT11-04-005-05
0.175" to 0.250"	ZT11-04-005-07

TABLE 1B: PRT® (ES-135) Part Numbers

Cable Diameter	ZT Part Number	NSN
0.040" to 0.075"	ZT03-04-010-01	5970-01-611-7759
0.076" to 0.125"	ZT03-04-010-03	5970-01-611-8106
0.126" to 0.174"	ZT03-04-010-05	5970-01-611-8111
0.175" to 0.249"	ZT03-04-010-07	5970-01-611-8118
0.25" to 0.37"	ZT03-04-010-09	5970-01-611-8178
0.38" to 0.49"	ZT03-04-010-11	5970-01-611-8206
0.50" to 0.62"	ZT03-04-010-13	5970-01-611-8240
0.63" to 0.74"	ZT03-04-010-15	5970-01-611-8252
0.75" to 0.87"	ZT03-04-010-17	5970-01-611-8263
0.88" to 0.99"	ZT03-04-010-19	5970-01-611-8434
1.00" to 1.12"	ZT03-04-010-21	5970-01-611-8441
1.13" to 1.24"	ZT03-04-010-23	5970-01-611-8504
1.25" to 1.37"	ZT03-04-010-25	5970-01-611-8541
1.38" to 1.49"	ZT03-04-010-27	5970-01-611-8558
1.50" to 1.62"	ZT03-04-010-29	5970-01-611-8570
1.63" to 1.74"	ZT03-04-010-31	5970-01-611-8582
1.75" to 1.87"	ZT03-04-010-33	TBD

Zippertubing® carries a full line of products containing National Stock Numbers.

INSTALLATION: PROCEDURE A

STEP 01

PREPARATION & POSITIONING

1. Use a razor knife to remove any protruding pieces of cable insulation. Clean the repair area of all debris and oil contamination using a mild solvent like isopropyl alcohol (IPA). Refer to [Photo 1](#).
2. Wrap the PRT® (ES) tubing around the damaged wire with the adhesive release liner facing away from the wire. Peel back a portion of the release liner and expose the adhesive. Position the non-adhesive edge of the tubing over the exposed adhesive and align so the edge just covers the entire adhesive area and no more. Begin bonding the tubing overlap edge to the adhesive. Avoid contacting the adhesive with your fingers as much as possible. Remove short sections of the release liner until the entire tubing length is sealed. Rub the overlap seam area firmly using your thumb to work out any wrinkles. Minor wrinkles will disappear when the tubing shrinks ([Photo 2](#)).
3. Center the closed PRT® (ES) tubing over the damaged area of the wire or cable.



Photo 1: Typical wire insulation damage



Photo 2: PRT® (ES) closed around wire

STEP 02

SHRINKING

Tools for installation (recommended): Heat gun (500° to 750°F), reducer nozzle, and gloves.

PRT® (ES) tubing requires the use of a heat gun with a temperature setting of 194°F minimum. For best results, use a heat gun with a 3/8" reducer nozzle that will localize the heat stream ([Photo 3](#)). Generally, a heat gun temperature of 302°F is sufficient to shrink the PRT® (ES-135) material and allow the hot-melt adhesive to flow. 257°F is sufficient to shrink PRT® (ES-100).

Note: You can shrink the tubing in place immediately after sealing. The closure adhesive has no cure time requirements.

1. Begin shrinking the PRT® (ES) tubing by directing the heat source at the adhesive overlap seam area near the center of the repair tubing ([Photo 3](#)). Apply heat to the adhesive overlap area only! The overlap area will tend to curl up into a "U" shape as it is heated. Continue to apply heat in short bursts to this area until the surrounding tubing begins to shrink and pull the "U" shape back down flat. Do not be afraid to apply extra heat to the overlap area, as it will take extra time for the inside layer of the overlap to begin to shrink since this area is double thick. Do not be alarmed if the outer layer of the overlap flap tends to lift off the adhesive and curl back slightly during initial heat exposure. With continued heating this lifted area will generally lay back down on its own, if not, lightly tap the lifted edge as necessary with a wooden popsicle stick. Use caution when touching the tubing as it will be hot and sticky. Shrink the entire overlap seam length before attempting to recover the remaining tubing ([Photo 4 - located on the following page](#)).



Photo 3: Nozzle focused near tubing center on overlap seam

STEP
02
(cont.)

2. Slowly heat the entire overlap seam area length and work from the center towards the ends. Too much heat too quickly in one location will cause the hot-melt adhesive to expand unevenly and possibly rupture the overlap seam. Refer to the **“Troubleshooting”** section at the end of this document (pg 10). The key to a successful installation is to “sneak up” on the tubing with the heat source. Do not be afraid to pull the heat source away and let the tubing cool slightly if it appears that the overlap seam is being pulled apart. Once the overlap seam is fully shrunk allow it to cool for a minute or two. You may find that most of the remaining tubing has also shrunk (especially on small size repairs). Heat the remaining unshrunk tubing areas to smooth out any wrinkles and cold spots. Once the tubing is fully shrunk, apply heat over the entire tubing length and circumference in a smooth and even motion. Ensure that the hot-melt adhesive has flowed and begun to ooze out from under both ends of the tubing. PRT® (ES-100) material will flow quite easily and exhibit a finished part with a bulbous adhesive fillet as shown in **Photo 5**. The PRT® (ES-135) hot-melt adhesive does not flow nearly as easily as the PRT® (ES-100) and will generally create a small tapered fillet as shown in **Photo 6**. On both types of PRT® (ES), the installation is acceptable as long as there is adhesive visible around the entire wire circumference at the end of the shrink tubing.



Photo 4: Overlap seams curled up prior to full shrinkage.



Photo 5: PRT® (ES-100) fillet



Photo 6: PRT® (ES-135) fillet



Photo 7: Residual adhesive ball

3. Do not attempt to remove the hot-melt adhesive fillet! If the adhesive fillets are uneven around the circumference of the wire or undesirable looking cosmetically, you can re-apply heat to the fillet area and address the excess adhesive. This can be done using a popsicle stick or by orientating the repaired wire (if possible) so that gravity causes the molten adhesive to slump and flow to the area where it is needed. In general, a fillet that covers the entire wire/jacket end circumference of the repair sleeve is what’s important and not the cosmetic look of the fillet.

Note: On very small diameter wire repairs you may need to use a magnifying glass or loop to see the fillet properly.

4. While the assembly is still slightly warm to the touch (but the hot-melt adhesive has fully solidified), use your thumb and rub the tubing overlap seam edge to remove any exposed closure adhesive. Excess adhesive will ball up ahead of your thumb (**Photo 7**) and discard.



CAUTION: DO NOT attempt to remove excess closure adhesive using solvents. Tubing and adhesive will be hot. Use gloves to form tubing and remove adhesive or allow tubing to cool before handling.

5. Allow the assembly to cool to room temperature before placing in service.

INSTALLATION: PROCEDURE B

A PRT® (ES) type installation can also be made on wire or cable with diameters greater than .250" using Zippertubing's PRT® shrink tubing and Z-Block® (100) or Z-Block® (135) hot-melt tape applied as two separate components.

STEP 01

SIZING

Measure your wire or cable diameter and select the correct size PRT® Tubing size and Z-Block® hot-melt tape materials from [Table 2](#).

TABLE 2: Material Part Numbers & Sizes

Cable Diameter	PRT® Tubing p/n ZT98-04-016-*	Z-Block® (100) Tape p/n: ZT02-03-002 or Z-Block® (135) Tape p/n: ZT11-03-001 (suggested tape width) (see note a)
0.25" to 0.37"	#3	1/2"
0.38" to 0.49"	#4	1/2"
0.50" to 0.62"	#5	1/2"
0.63" to 0.74"	#6	1.0"
0.75" to 0.87"	#7	1.0"
0.88" to 0.99"	#8	1.0"
1.0" to 1.12"	#9	2.0"
1.13" to 1.24"	#10	2.0"
1.25" to 1.37"	#11	2.0"
1.38" to 1.49"	#12	2.0"
1.50" to 1.62"	#13	2.0"
1.63" to 1.75"	#14	2.0"
1.75" to 1.87" (see Note b)	#15	2.0"

Note:

- Z-Block® tape is available in 2.0" widths only. The tape may be cut to the suggested width using a pair of scissors or a razor knife.
- For cable sizes beyond 1.87" diameter contact our Engineering department for recommendations.

STEP
02

PREPARATION & POSITIONING

1. Use a razor knife to remove any protruding pieces of cable insulation. Clean the repair area of all debris and oil contamination using a mild solvent like isopropyl alcohol (IPA). Refer to [Photo 8](#).
2. Use Zippertubing's Z-Block® hot-melt tape and cut it to the desired width using a pair of scissors or razor knife. Ensure that the white paper release liner has been removed from the amber colored Z-Block® tape prior to wrapping the cable. Helically wrap the tape over the area to be repaired so that each wrap butts up with the next or slightly overlaps and equals the length of the PRT® repair tubing ([Photo 9](#)). Use a soldering iron or a heat gun to melt the last tape wrap overlap so the tape will stick to itself and does not unwind. On larger cables, the damaged cable jacket may have deep nicks or voids. If so, cut extra pieces of the Z-Block® Tape and pack the void areas prior to applying the helically wound tape over that area.



Photo 8: Typical wire insulation damage



Photo 9: Z-Block® Tape wrapped around cable.

CAUTION: Keep the tape wrap build-up to a minimum. A smooth single layer is ideal. Too much tape may cause a seam rupture in the PRT® tubing when heated.

3. Wrap the PRT® (ES) tubing around the damaged wire with the adhesive release liner facing away from the wire. Peel back a portion of the release liner and expose the adhesive. Position the non-adhesive edge of the tubing over the exposed adhesive and align it so the edge just covers the entire adhesive area and no more. Begin bonding the tubing overlap edge to the adhesive. Avoid contacting the adhesive with your fingers as much as possible. Remove short sections of the release liner until the entire tubing length is sealed. Rub the overlap seam area firmly using your thumb to work out any wrinkles. Minor wrinkles will disappear when the tubing shrinks ([Photo 10](#)).



Photo 10: PRT-ES® closed around wire.

STEP
03

SHRINKING

Tools for installation (recommended): Heat gun (500° to 750°F), reducer nozzle, and gloves.

PRT® (ES) tubing requires the use of a heat gun with a temperature setting of 194°F minimum. For best results, use a heat gun with a 3/8" reducer nozzle that will localize the heat stream (Photo 11). Generally, a heat gun temperature of 302°F is sufficient to shrink the PRT® (ES) material and allow the hot-melt adhesive to flow.

Note: You can shrink the tubing in place immediately after sealing. The closure adhesive has no cure time requirements.

1. Begin shrinking the PRT® (ES) tubing by directing the heat source at the adhesive overlap seam area near the center of the repair tubing (Photo 11). Apply heat to the adhesive overlap area only! The overlap area will tend to curl up into a "U" shape as it is heated. Continue to apply heat in short bursts to this area until the surrounding tubing begins to shrink and pull the "U" shape back down flat. Do not be afraid to apply extra heat to the overlap area, as it will take extra dwell time for the inside layer of the overlap to begin to shrink since this area is double thick. Do not be alarmed if the outer layer of the overlap flap tends to lift off the adhesive and curl back slightly during initial heat exposure. With continued heating this lifted area will generally lay back down on its own, if not, lightly tap the lifted edge as necessary with a wooden popsicle stick. Use caution when touching the tubing as it will be hot and sticky. Shrink the entire overlap seam length before attempting to recover the remaining tubing (Photo 12).
2. Slowly heat the entire overlap seam area length and work from the center towards the ends. Too much heat too quickly in one location will cause the hot-melt adhesive to expand unevenly and possibly rupture the overlap seam. Refer to the "**Troubleshooting**" (pg 10) section if you find you are having issues. The key to a successful installation is to "sneak up" on the tubing with the heat source. Do not be afraid to pull the heat source away and let the tubing cool slightly if it appears that the overlap seam is being pulled apart. Once the overlap seam is fully shrunk, allow it to cool for a minute or two. You may find that most of the remaining tubing has also shrunk (especially on small size repairs). Heat the remaining unshrunk tubing areas to smooth out any wrinkles and cold spots. Once the tubing is fully shrunk, apply heat over the entire tubing length and circumference in a smooth and even motion. Ensure that the hot-melt adhesive has flowed and begun to ooze out from under both ends of the tubing. PRT® (ES-100) material will flow quite easily and exhibit a finished part with a bulbous adhesive fillet as shown in Photo 13. The PRT® (ES-135) hot-melt adhesive does not flow nearly as easily as the PRT® (ES-100) and will generally create a small tapered fillet as shown in Photo 14. On both types of PRT® (ES), the installation is acceptable as long as there is adhesive visible around the entire wire circumference at the end of the shrink tubing.



Photo 11: Nozzle focused near tubing center on overlap seam



Photo 12: Overlap seams curled up prior to full shrinkage.



Photo 13: PRT® (ES-100) fillet



Photo 14: PRT® (ES-135) fillet

STEP

03

(cont.)

3. Do not attempt to remove the hot-melt adhesive fillet! If the adhesive fillets are uneven around the circumference of the wire or undesirable looking cosmetically, you can re-apply heat to the fillet area and dress the excess adhesive. This can be done using a popsicle stick or by orientating the repaired wire (if possible) so that gravity causes the molten adhesive to slump and flow to the area where it is needed. In general, a fillet that covers the entire wire/jacket end circumference of the repair sleeve is what's important and not the cosmetic look of the fillet.



Photo 15: Close up of hot-melt adhesive fillet at sleeve end

Note: On very small diameter wire repairs you may need to use a magnifying glass or loop to see the fillet properly (Photo 15).

4. While the assembly is still slightly warm to the touch (but the hot-melt adhesive has fully solidified), use your thumb and rub the tubing overlap seam edge to remove any exposed closure adhesive. Excess adhesive will ball up ahead of your thumb and discard.



CAUTION: DO NOT attempt to remove excess closure adhesive using solvents. Tubing and adhesive will be hot. Use gloves to form tubing and remove adhesive or allow tubing to cool before handling.

5. Allow the assembly to cool to room temperature before placing in service.

TROUBLESHOOTING

1. The most common problem likely to occur when installing a PRT® (ES) part is a seam rupture. This is a condition where the molten Z-Block® hot-melt tape bursts through an area of the overlap seam of the PRT® tubing during installation (Photo 16). Seam ruptures are most likely to occur during the learning phase of PRT® (ES) installations. Once the proper installation technique has been mastered, this problem will disappear. Rushing to complete an installation is a big factor in creating a seam rupture.



Photo 16: Typical seam rupture due to excessive heating.

2. Seam ruptures occur for several reasons and all can be controlled by the installer. Below are the main reasons for seam ruptures;
 - Wrong Size: The PRT® (ES) or PRT® tubing selected was too small for the cable diameter being repaired.
 - Excessive Tape: Too much Z-Block® tape was applied which increased the overall cable diameter beyond what the PRT® (ES) or PRT® tubing could accommodate.

- Excessive Heat: The installer applied too much heat and/or applied the heat too quickly to the PRT® (ES) or PRT® tubing.

3. If a rupture occurs, verify that “wrong size” and “excessive tape” are not the cause. If they are not the cause, then adjust the heating technique by applying the heat more slowly and evenly. Review the “sneak up” on it heating technique described under “Procedure A”, Step 3, Section 2.

Note: “Excessive tape” and “excessive heat” are the most common cause of seam ruptures.

4. Seam ruptures are undesirable and should be avoided. Cable assemblies with a diameter of <0.25” exhibiting a seam rupture should have the jacket removed and replaced to ensure a viable repair. Follow the correct installation technique to eliminate this problem.
5. Cable diameters >0.25” exhibiting a seam rupture, that is away from the actual defect repair area may be re-worked and still maintain a good environmental seal.

Note: Prior to proceeding with any seam rupture rework, consult with your in-house Quality Assurance department and obtain approval to proceed with a repair.

a) If you experience a seam rupture and the hot-melt adhesive is oozing out through the tubing overlap area, stop applying heat in that immediate area and allow it to cool down. Adjust your heating technique as described above and finish installing the assembly.

b) Once the entire assembly is finished and has cooled down to room temperature, return to the seam rupture and re-heat the localized area until the hot-melt adhesive is soft. Use the end of a popsicle stick and work the raised tubing lip down as smooth as possible while it’s hot. Use the radius end of the popsicle stick and scrape off the excess adhesive in a direction parallel to the overlap split line. You may have to repeat this process several times to obtain an ideal appearance. Allow the area to cool to room temperature.

c) The seam rupture area will not likely look quite as good cosmetically as the seam areas that were properly installed. However, that does not necessarily mean that they are defective and cannot be used. As long as there is a thin bead of the Z-Block® hot-melt adhesive present along the overlap split line in the area of the rupture, you have a usable assembly. Because the entire jacket is sealed with the hot-melt adhesive there is no way for liquid to find its way to the repaired defect area. The same condition would exist if the rupture were not repaired. However, repairing a rupture is desirable because it eliminates the raised lip condition (Photo 9) which could create a potential snag problem resulting in further damage.

Installer Note:


Using the PRT® (ES) repair method will generally eliminate a very large amount of cable harness disassembly and rework time. As a result, don’t be in a big rush to complete the installation. Take extra time to plan the installation, heat the sleeve slowly and work the materials as necessary to ensure a good first time repair. The extra time spent doing this will pale in comparison to the time required to perform a classic repair that involves connector disassembly.

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