General Installation Procedure for PD-CAP Products

NB: The recommendations presented here are based on general industry information.

Since TE Connectivity does not have knowledge of the specific application and the end use conditions of all users, each user should determine the correct size of tubing together with the installation conditions for their own application and evaluate against their individual requirements.

Note: The size and colour of the product may be different from the images in this document. The images mentioned in this document are for representation purpose only.

Contents Page

1. SCOPE

This document details the important aspects of splice design together with general installation guidelines when using TE Raychem PD-CAP products.

2. REVISION HISTORY / REASON FOR CHANGE / RELATED DOCUMENTS

Rev	Date	Prepared By	Doc Approved By	Remarks
A	July 2024	Kamalasaravanan	Alice Hollier	New Document

2.1. Customer Assistance

Reference Product Base Part Number and Product Code are representative of. Use of these numbers will identify the product line and help you to obtain product and tooling information when visiting www.te.com or calling the number at the bottom of page 1.

2.2. Drawings

Customer drawings for product part numbers are available from www.te.com. Information contained in the customer drawing takes priority.

2.3. Specifications

Product Specification for product part numbers available from www.te.com provides product performance and test results.

2.4. Shelf Life

Refer document Global Dimensional Life for Heat Shrink Tubing Standard Size Products 408-32191 for details regarding the shelf life.

2.5. Safety

Appropriate Personal Protective Equipment (PPE) should be worn, and installation should take place with fume extraction or in a well-ventilated area.

3. INTRODUCTION

This guide has been produced to aid the splice designer and user of TE Raychem PD-CAP product to select the most appropriate installation conditions to produce optimum results in an environmentally sealed splice.

The document has three main sections:

Section 4. Splice Design and Preparation Guidelines
Section 5. Installation Guidelines
Section 6. Sealing Verification Guidelines

NB: The recommendations presented here are based on general industry information. Since TE Connectivity does not have knowledge of the specific application and the end use conditions of all users, each user should determine the correct size of tubing together with the installation conditions for their own application and evaluate the splice against individual requirements.
(Refer to TE Connectivity to ensure latest issue of this document)

4. SPLICE DESIGN AND PREPARATION GUIDELINES

4.1. Splice Design

Generally, for splices having no more than 4 wires the installation and sealing characteristics are excellent. For splices having 5 to 7 wires the configuration is more complex and corresponding installation times are likely to be longer and the installation window smaller. Consequently, these splices may require additional work in establishing production installation conditions. For optimum performance and compatibility, it is recommended that T3 (125°C) rated wire be used.

4.2. Splice Preparation Guidelines

The splice can be constructed by conventional techniques such as resistance welding, ultrasonic welding, crimping, or 'clip and dip'. There should be no loose strands, especially those pointing upwards which can cause 'poke-through' of the component material during installation. It is important to ensure that the distance from the nugget/crimp to the wire insulation be 3.5 + 1.5mm to allow the adhesive sufficient space to flow and seal between the wires (see Figures 1 and 2).

Figure 1

Splice Preparation Guidelines
(Ultrasonic welded Splices)

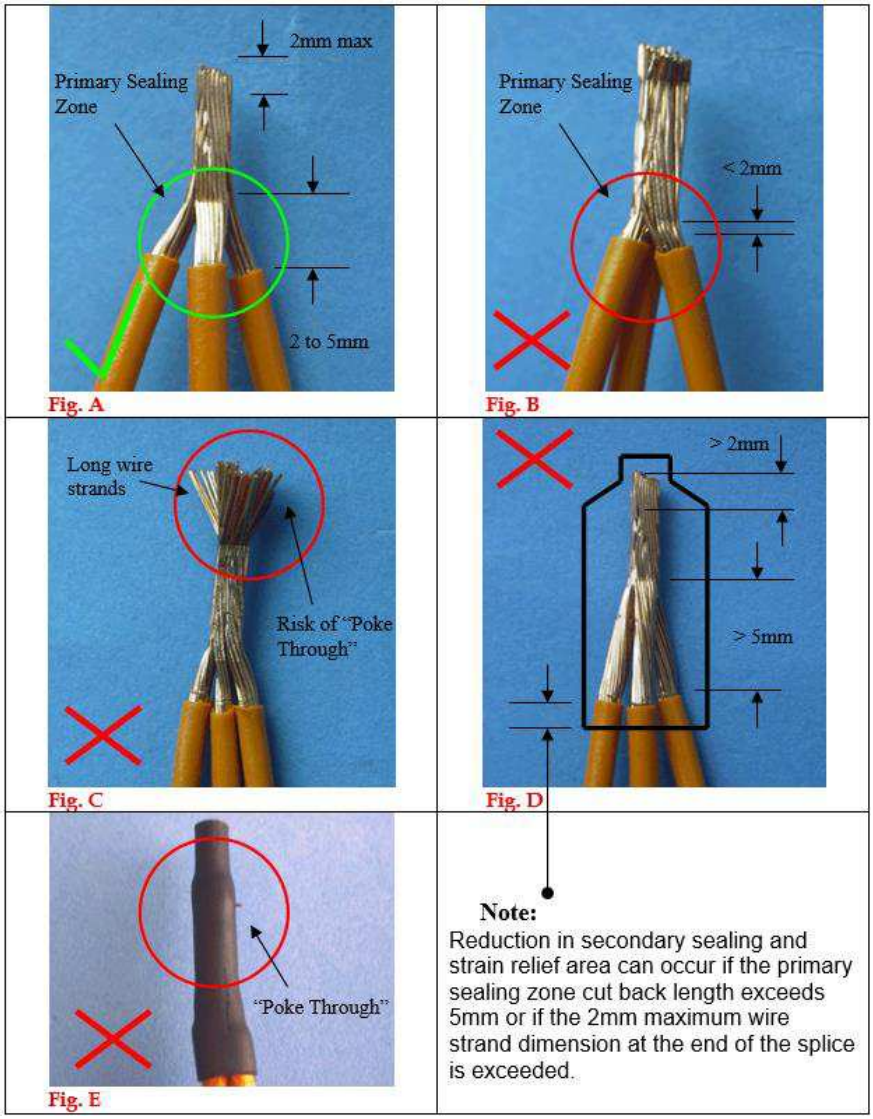
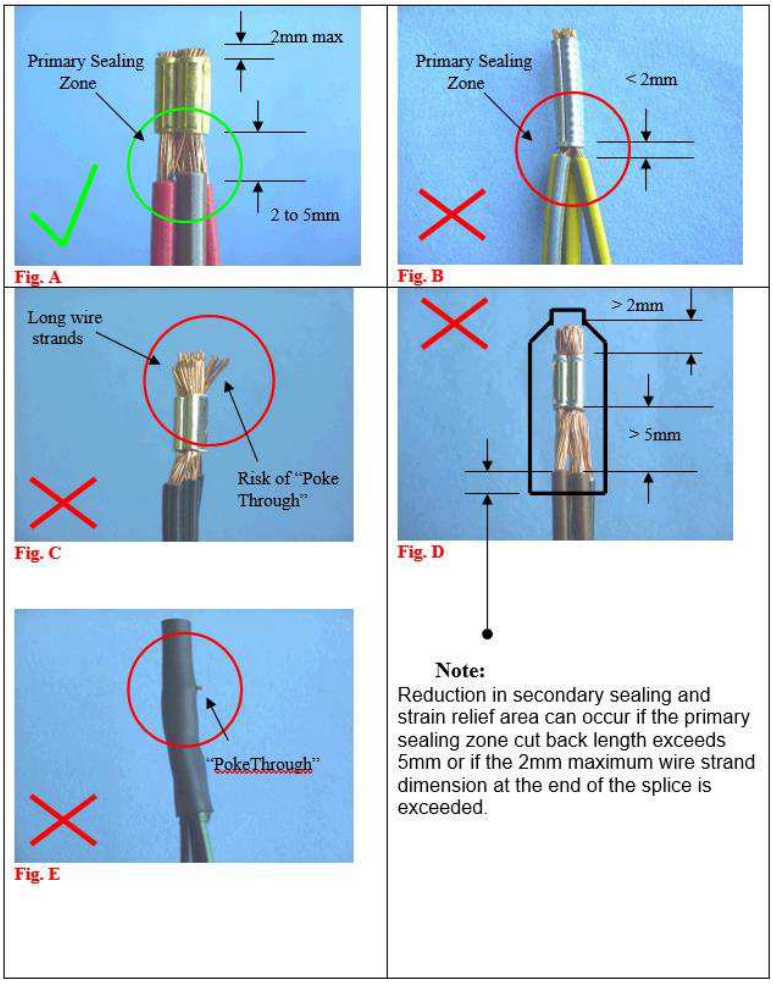


Figure 2

Splice Preparation Guidelines
(Crimped Splices)



5. INSTALLATION GUIDELINES

Installations can be carried out using various techniques including discrete Infra-Red or Hot Air heating equipment, the selected method being dependent on production area layout and required throughput. It is important that Raychem Infra-Red installation equipment be maintained in a state of calibration using a UHI-250A Thermal Probe as described in the RBK-ILS Processor Operation and Maintenance Manual – 412-94334-1.

NB: It will be necessary to use a location fixture to position the PD-CAP onto the splice during installation.

The installation "window" will be dependent on the set point temperature of the equipment, geometry and preparation of splice and the size of tubing. Generally, the installation window will be small if the splice geometry is complex, and the equipment set point high. For lower set points the window will be larger, but the corresponding installation time will be longer. Generally, it is recommended that discrete heaters such as the Raychem RBK-Processor be set at 450 - 500°C.

It is recommended that "heat" input as seen by the splice to be installed be measured via a UHI-250A Thermal Probe. (Tyco Electronics PCN-288869-000, CLT-EQUIP-UHI-250A-PROBE. Refer to Appendix 2 for explanation of the Thermal Probe.)

Installation Method:

a. Determine the cap size according to the cross-section area of wires. Ensure installation equipment has been switched on for a minimum of 30 minutes to stabilise.
b. Recheck splice for loose wire strands and wire insulation cut back.
c. Locate the component onto the splice and position centrally within the heating zone of the application equipment. Use purpose made locating fixtures to support the component during installation.
d. Run the splice through the heating equipment and record the installation conditions, i.e., time/set point. Run the UHI probe through at the same conditions to obtain the UHI temperature.
e. Increase the heating time in 2 second increments (i.e. increase the UHI temperature by approximately 5-10°C) until the wire insulation or the tubing jacket material shows visual signs of damage. (This is the upper limit of the installation window)
f. Check all splices for sealing efficiency per Section 6. If the sample installed at the fastest time (i.e. lowest UHI temperature) passes, then reduce the time further in 1-2 second increments until a sealing failure occurs.
g. Prepare 5 sample splices at the fastest time (i.e. lowest UHI temperature) that gave a pass result when tested per Section 6. If all 5 passes, this can be regarded as the lower limit of the installation window. If failure occurs, increase the installation time in 1-2 second increments (i.e. increase the UHI temperature), until 5 from 5 pass to give the lower limit.
h. In order to optimise sealing efficiency in a production environment, it is recommended that the midpoint between upper and lower limit be used.

Note: Sealing time for a given splice will depend on its complexity, number of wires and the wire type.

6. SEALING VERIFICATION / VISUAL STANDARDS

6.1. Test Methods

A variety of test methods exist which are incorporated by many major Automotive OEMs to determine the environmental integrity of an installed splice. For speedy determination of splice installation windows, it is recommended that an air pressure test be used. Experience has shown excellent correlation between this method and Insulation Resistance / Current techniques for most types of splices.

TE Connectivity Seal Test equipment AD 3050 has been found to be acceptable (for details see TE Connectivity Flier No TFAE00017 07/95). It can also be used to monitor sealing efficiency periodically throughout a production run. Final verification should be per OEM specification.

6.2. Visual Standards

Visual Standards after Installation

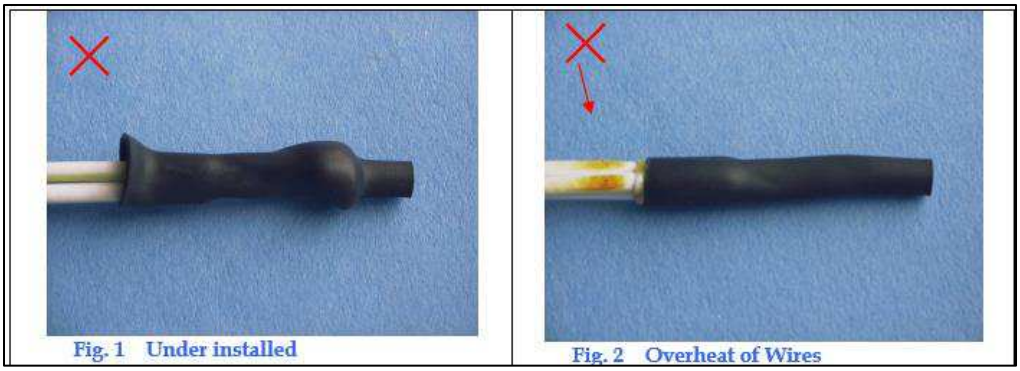


Fig. 1 Under installed

Fig. 2 Overheat of Wires

Appendix 1: General Wire Chart

Nominal OD (mm)	Approximate Cross-Sectional Area mm^2 based on wire insulation diameter						
	Number of Wires						
	1	2	3	4			
1.4	2	3	5	6			
1.5	2	4	5	7			
1.6	2	4	6	8			
1.7	2	5	7	9			
1.8	3	5	8	10			
1.9	3	6	9	11			
2.0	3	6	9	13			
2.1	3	7	10	14			
2.2	4	8	11	15			
2.3	4	8	12	17			
2.4	5	9	14	18			
2.5	5	10	15	20			
2.6	5	11	16	21			
2.7	6	11	17	23			
2.8	6	12	18	25			
2.9	7	13	20	26			
3.0	7	14	21	28			
3.1	8	15	23	30			
3.2	8	16	24	32			
3.3	9	17	26	34			
3.4	9	18	27	36			
3.5	10	19	29	38			
3.6	10	20	31	41			
3.7	11	22	32	43			
3.8	11	23	34	45			
3.9	12	24	36	48			

Appendix 1: General Wire Chart (continued.)

Nominal OD (mm)	Approximate Cross-Sectional Area mm^2 based on wire insulation diameter						
	Number of Wires						
	1	2	3	4			
4.0	13	25	38	50			
4.1	13	26	40	53			
4.2	14	28	42	55			
4.3	15	29	44	58			
4.4	15	30	46	61			
4.5	16	32	48	64			
4.6	17	33	50	66			
4.7	17	35	52	69			
4.8	18	36	54	72			
4.9	19	38	58	75			
5.0	20	39	59	79			
5.1	20	41	61	82			
5.2	21	42	64	85			
5.3	22	44	66	88			
5.4	23	46	69				
5.5	24	48	71				
5.6	25	49	74				
5.7	26	51	77				
5.8	26	53	79				
5.9	27	55	82				
6.0	28	57	85				
6.1	29	58	87				
6.2	30	60					
6.3	31	62					
6.4	32	64					
6.5	33	66					
6.6	34	68					
6.7	35	70					
6.8	36	73					
6.9	37	74					
7.0	38	77					
7.1	40	80					
7.2	41	81					
7.3	42	84					
7.4	43	86					
7.5	44	88					
7.6	45						
7.7	46						
7.8	48						

Appendix 2: UHI-250A THERMAL PROBE

UHI-250A (PCN 288869)

The heat applied to a splice is conveniently measured by a TE Connectivity UHI-250A Thermal Probe. This Thermal Probe has a known mass of aluminium with fixed dimensions and a thermocouple embedded in the aluminium. The theory of use of the Probe is derived from the equation for calculating the quantity of heat required to raise a mass from one temperature to another.

$$Q = Mkc\ (t_2 - t_1)$$

Where
- Q = Quantity of Heat
- M = Mass
- k = units constant
- c = specific heat
- t_1 = ambient temperature
- t_2 = final temperature

When using the probe, M, k, c and t_1 are constant so that the final temperature (ignoring heat loss) is proportional to the quantity of heat.

$$t_2 = \propto Q$$

The temperature rise of the aluminium is proportional to the heat received during the time the Probe is in the heat zone of the heater. By relating this temperature to the sealing performance of a given splice the window for this splice can be defined. The lower point is the lowest temperature at which the splice seals and the upper point the highest temperature at which no thermal damage is observed. The best probe temperature (quantity of heat) for a given splice is normally set at the midpoint of the window. This midpoint temperature is best determined in the manufacturing environment where the splice is to be sealed.

The UHI-250A Thermal Probe is available through your local TE Connectivity Office (PCN: 288869).

Appendix 3: Trouble Shooting

Fault	Possible Cause	Solution
Component not fully shrunk onto splice	Insufficient heat Insufficient time Wrong component size	Increase heat. Check UHI-250A reading. Check calibration. Increase time in heater element Consult component Selection
Component mislocated after installation (milk-off)	Incorrect location prior to installation Wrong component size	Locate correctly Use alignment fixture Consult component selection
Component or wire overheated	Excessive heat Excessive time	Reduce heat Reduce time in heater Check calibration
Component scorched on one side	Excessive wire curvature Splice located incorrectly in machine	Use straightened wire Reposition splice. Use alignment fixture.
Component splits	Sharp edge of welded nugget/crimp Wire strand loose Splice overheated Wrong component size selected	Check welder tooling Reduce heat/time Re-assess. Consult component selection.
Wire strand pokes through component	Wire strand loose from welding or crimp	Check welder/crimp tooling Check splice construction
Wire damage at component edge but component visually OK	Overheat Excessive time Splice not centered in machine Mismatch of component/wire Temperature rating	Reduce heat Reduce time Use alignment fixture Reduce heat/time
Component not fully shrunk onto splice	Insufficient heat Insufficient time Wrong component size	Increase heat. Check UHI-250A reading. Check calibration. Increase time in heater element Consult component Selection