D-5203 Specification, Pre-Insulated Crimp Splices

1 Introduction

1.1 Scope

This specification covers a series of one-piece pre-insulated crimp splices having a heat-shrinkable polyolefin sleeve lined with a meltable adhesive coating.

1.2 Classification

Pre-Insulated Crimp Splice shall be as specified in the applicable Tyco Electronics Specification Control Drawing (SCD). The splice is designed to meet the requirements of UL 486C.

1.3 Temperature Rating

The continuous operating temperature range shall be from -55°C to 125°C (-67°F to 257°F).

2 Applicable Documents

The latest issue of those specifications and standards referenced below or in the applicable Raychem SCD shall form part of this document to the extent specified.

ASTM B-187	Standard Specification for Copper Rods, Bars and Shapes
ASTM B-545	Electrodeposited Coating of Tin
P-D-410	Detergent, synthetic, anionic (Alkyl Benzene Sulfonate)
MIL-STD-202	Test Methods for Electronics and Electrical Components Parts
ANSI/ASQC Z1.4-1993	Sampling Procedures and Tables for Inspection by Attributes
SAE-J-1128	Low Tension Primary Cable, Standard
UL 486C	Standard for Splicing Wire Connectors
CEI IEC 60529	International Standard. Degrees of protection provided by enclosures

3 Requirements

3.1. Detail Requirements

Detail requirements or exceptions applicable to a particular style of Pre-Insulated Crimp Splice shall be as specified on the applicable SCD. In the event of any conflict between requirements of this specification and the SCD, the latter shall take precedence.

3.2. Qualification

A Pre-Insulated Crimp Splice furnished under this specification, or a minor modification of this part, shall be one, which has passed the qualification test specified herein or on the applicable SCD. A minor modification shall be one, which uses the same materials as the qualified part in a different size.

3.3. **Material**
The material used in the construction of a Pre-Insulated Crimp Splice shall be as specified on the applicable SCD and shall meet the requirements set forth herein.

3.3.1. **Insulation Sleeve**
The insulation sleeve shall be a tubing of the type and color specified in the applicable SCD and shall be free from functional defects.

3.3.2. **Metals**
The metal crimp splice shall be fabricated from copper conforming to ASTM B-187.

3.3.3. **Plating**
Unless otherwise specified, the metal crimp splice shall be tin-plated

3.3.4. **Sealing Material**
The sealing material shall be a thermally stabilized polyolefin, thermoplastic, homogenous, and essentially free from flaws, defects, pinholes, seams, cracks and inclusions. The material shall have a melt viscosity suitable to meet the performance requirements when using the recommended installation tooling.

3.4. **Design and Construction.**
The splice shall consist of a metal crimp, insulated with pre-installed sealing sleeve. The splice shall conform an all respects to the design, dimension and construction specified herein and on the applicable SCD. Each splice size shall be designed for attachment to the wire size range specified on the applicable SCD by having the metal crimp splice reshaped around the conductor and the sealing sleeve recovered over the splice assembly. It shall be possible to perform these operations by means of tooling as specified on the applicable SCD. The splice shall be capable of being crimped in any radial plane and shall exhibit no evidence of fracturing, spalling, or protruding sharp edges as a result of the reshaping operation.

3.4.1. **Wire Acceptance**
Each size splice shall be designed for attachment to the conductor diameter range specified on the applicable specification sheet. The wire insertion shall be facilitated by a bell mouth or chamfer on the metal crimp barrel.

3.4.2. **Insulation**
The sealing sleeve shall exhibit no evidence of splitting or cracking as a result of crimping or heating.

3.5. **Performance**
Pre-Insulated Crimp Splice shall conform to the following requirements:

3.5.1. **Sealing Sleeve**

The sealing sleeve component of the splice assembly shall conform to the dimensions of the applicable SCD.

3.5.2. **Splice Assemblies**

The splice assemblies shall conform to the following requirements when attached to each of the specified wire sizes with the applicable tooling specified (see paragraph 3.4). Test conditions for each wire size are shown in Table I.

Table I. Test Requirements

WIRE SIZE		STATIC HEATING [AMP]	HEAT CYCLING [AMP]	TENSILE STRENGTH	
[mm^2]	AWG			[POUNDS]	[N]
0.32	22	9	12	8	35
0.52	20	12	16	10	44
0.82	18	17	19	10	44
1.30	16	18	20	15	66
2.10	14	30	33	25	111
3.30	12	35	39	35	155
5.30	10	50	56	40	178

3.5.2.1. **Insulation Resistance**

When tested as specified in paragraph 4.8.1, the insulation resistance shall be no less than 1000 MΩ.

3.5.2.2. **Dielectric Withstanding Voltage**

When tested as specified in paragraph 4.8.2, an insulated splice shall withstand the applied voltage. No splice is to be subject to more than one test. Splice shall show no sign of damage, arcing, or breakdown. Leakage current shall be less than 2 mA.

3.5.2.3. **Tensile Strength**

When tested as specified in paragraph 4.8.3, wire shall not become separated from splice attached to it as a result of being subjected to the test.

3.5.2.4. **Heat Cycling Test**

When tested as specified in paragraph 4.8.4, the temperature rise of a connector shall not exceed 125 ^{o}C (257 ^{o}F) above ambient temperature for any of the cycles performed. Stability Factor (S_i) shall not exceed ±10 ^{o}C.

3.5.2.5. **Static Heating Test**
When tested as specified in paragraph 4.8.5, the temperature rise of a connector shall not exceed 50 ^{o}C (90 ^{o}F) above ambient temperature.

3.5.2.6. **Secureness Test**
When tested as specified in paragraph 4.8.6, the joint between a connector and the wire shall be intact after being subjected to the test. Conductors size AWG 20 - 30 are not subjected to Secureness Test.

3.5.2.7. **Secureness of Insulation Test.**
When tested as specified in paragraph 4.8.7, the insulation of the splice shall not be damaged or shall not become detached from the crimp barrel of the splice when a pull is applied for 1 minute between the insulation and the crimp barrel.

3.5.2.8. **Flexing**
When tested as specified in paragraph 4.8.8, insulation shall not crack when subjected to the flexing test.

3.5.2.9. **Environmental Conditioning**
When tested as specified, splices shall meet the applicable performance requirements listed in Table III. Discoloration of the sealing sleeve materials during these tests shall not be cause of rejection.

3.6. **Identification of Product**
The splice shall be color coded in accordance with the applicable SCD for identification purposes.

3.7. **Workmanship**
The metal crimp splice shall be free from blistering, pitting, or peeling of plating, cracks, or other defects, which may affect service ability. Slight burr is permitted on parted surfaces. The metal crimp shall be held within the sleeve with sufficient force to withstand dislodging during normal installation.

4. Quality Assurance Provisions

4.1. **Responsibility for Inspection**
Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as stated. Except as otherwise specified, the supplier may utilize his own facilities or any other commercial laboratory.

4.2. **Classification of Inspection**
The examination and testing of Pre-Insulated Crimp splices shall be classified as follows:
Component-Materials inspection (see 4.3)
Qualification inspection (see 4.5)

Quality conformance inspection (see 4.6)

4.3. **Component-Materials Inspection**

Component-materials inspection shall consists of verification that the component materials listed in Table II used in fabricating the splices are in accordance with the applicable specifications or requirements prior to such fabrication.

Table II. Components-Materials Inspection

COMPONENT MATERIAL	REQUIREMENT PARAGRAPH	APPLICABLE SPECIFICATION OR REQUIREMENT
Metals	3.3.2, 3.3.3	ASTM B-187, ASTM B-545
Insulation Sleeve	3.3.1	As listed
Sealing Inserts	3.3.4	As listed

4.4. **Inspection Conditions**

Unless otherwise specified herein, all inspections shall be made at ambient temperature, and humidity as specified in the general requirements of MIL-STD-202.

4.4.1. **Assembly to Conductors**

The splices shall be attached to wire conforming to SAE J1128 SXL, having a temperature rating of 125°C, by the testing activity using the specified tooling (see 3.4). The test specimens shall be one to one inline splices made in accordance with the specified assembly technique. This specified number of sample units for testing shall be selected and divided between the minimum and maximum wire size within the wire range listed on the applicable SCD for he size to be qualified. Unless otherwise specified, the leads shall be at least 12 inches in length.

4.4.2. **Water Bath**

Unless otherwise specified in the applicable test method, a water bath containing 0.5% of an anionic wetting agent (P-D-410) and 5.0% sodium chloride shall be used whenever immersion is specified. Free ends of the leads shall be a minimum of 4 inches from the top surface of the water.

4.5. **Qualification Inspection**

4.5.1. **Sample**

All of the splices for each size of each specification sheet (see 3.1), for which qualification is sought, shall be submitted for qualification testing.

4.5.2. **Test Routine**
Sample units shall be subjected to the qualification inspection specified in Table III in the order shown. All sample units shall be subjected to the inspection of Group I. The samples shall then be divided into Groups II through VII as shown in Table III and subjected to the inspection for their particular group.

4.5.3. **Qualification Test Reports**
The Qualification Test Report shall be available to purchases of Pre-Insulated Crimp splice products.

4.5.4. **Failures**
Any failure shall be cause for refusal to grant qualification

4.5.5. **Retention of Qualification**
A Pre-Insulated Crimp splice, once qualified under this specification, shall remain qualified as long as no significant change is made in the materials or design of the splice (see paragraph 6.3)

4.6. **Quality Conformance Inspection**

4.6.1. **Inspection of Product for Delivery**
Inspection of product for delivery shall consist of visual and dimensional examination.

4.6.1.1. **Inspection Lot**
An inspection lot, as far as is practical, shall consist of all Pre-Insulated Crimp splices of a single size and type, manufactured under essentially the same conditions and offered for inspection at one time.

4.6.1.2. **Sampling Plan**
Quality conformance sampling shall be in accordance with ANSI/ASQC Z1.4 for normal inspection. The inspection level shall be Level I and the acceptable quality level (AQL) shall be 4.0 for all defects.

4.6.1.3. **Non-conforming Lots**
Disposition of non-conforming lots shall be in accordance with ANSI/ASQC Z1.4.

Table III: Test Sequences

GROUP	NUMBER OF SPLICES	EXAMINATION OR TEST GROUP	REQUIREMENT PARAGRAPH	METHOD PARAGRAPH
I	56 (a)	Visual and Dimensional Examination	3.4	4.7.1 4.7.2
II	4	Heat Cycling	3.5.2.4	4.8.4
III	4	Static Heating Secureness Static Heating Tensile Strength	3.5.2.5 3.5.2.6 3.5.2.5 3.5.2.3	4.8.5 4.8.6 4.8.5 4.8.3
IV	4	Secureness Tensile Strength	3.5.2.6 3.5.2.3	4.8.6 4.8.3
V	12 (b)	Heat Ageing Dielectric Withstanding Voltage	3.5.2.9 3.5.2.2	4.8.9 4.8.2
VI	16 (c)	Heat Ageing Secureness of Insulation	3.5.2.9 3.5.2.7	4.8.9 4.8.7
VII	12 (d)	Heat Ageing Flexing Insulation Resistance Dielectric Withstanding Voltage	3.5.2.9 3.5.2.8 3.5.2.1 3.5.2.2	4.8.9 4.8.8 4.8.1 4.8.2
VIII	4	Immersion Insulation Resistance Dielectric Withstanding Voltage	3.5.2.9 3.5.2.1 3.5.2.2	4.8.10 4.8.1 4.8.2

(a) Number of splices to be tested shall be for each splice size.
(b) Splices shall be divided in three groups and tested as follows:
    4 assembled as-received condition splices
    4 splices assembled before Heat Ageing conditioning
    4 splices assembled after Heat Ageing conditioning
(c) Splices shall be divided in four groups and tested as follows:
    4 un-assembled and 4 assembled as-received condition splices
    4 un-assembled and 4 splices assembled after Heat Ageing conditioning
(d) Splices shall be divided in three groups and tested as follows:
    4 assembled as-received condition splices
    4 splices assembled after Heat Ageing conditioning
    4 splices assembled after conditioning at –10 ^{o}C for 2 a period of hours.

4.7. **Examination**

4.7.1. **Pre-Insulated Crimp Splice, Uninstalled**

The splice shall be examined to verify that the material's design, construction, and physical dimensions are in accordance with the applicable SCD.

4.7.2. **Visual Examination of Assemblies**

Each assembly shall be examined to check that the crimping of the splice has been achieved without damage to the insulation sleeve and that the desired degree of shrinkage of the tubing has been obtained.

4.8. **Test Methods, Assemblies**

4.8.1. **Insulation Resistance (See 3.5.2.1)**

Splices shall be tested in accordance to Method 302 of MIL-STD-202. Test conditions shall be as follows:
Test Condition: A
Splices shall be immersed as specified for at least 30 minutes prior the test is performed.
Electrification time: 1 minute.
Points of measurement: between splice leads and water bath.

4.8.2. **Dielectric Withstanding Voltage (See 3.5.2.2)**

Splices shall be tested in accordance to Method 301 of MIL-STD-202. Test conditions shall be as follows:
Magnitude and nature of potential: 2200 VAC (RMS) for conductors rated to 300 volts, and 3400 VAC (RMS) for conductors rated to 600 volts.
Electrification time: 1 minute.
Points of measurement: between splice leads and water bath.

4.8.3. **Tensile Strength (See 3.5.2.3)**

Test shall be run on a tension-testing machine or the equivalent so there will be no sudden application of force or jerking during the test. Force may be applied using deadweights. Each installed splice shall be separately subjected for 1 minute to the force specified on Table I. Breakage or tearing of insulation is acceptable in the Tensile Strength Test.

4.8.4. **Heat Cycling Test (See 3.5.2.4)**

Pre-Insulated Crimp Splices shall be divided on equal parts and installed on the maximum and minimum wire sizes specified on the applicable SCD. Insulation shall be removed from installed part before testing. Samples and the control conductor shall be connected in series and to a current source.

The sample test are to complete 500 cycles of "on" and "off" current operations, by carrying the current values specified for each wire size on Table I. Temperatures are to be measured and recorded for at least one cycle of each working day. Temperature measurements are to be made at approximately 25, 50, 75, 100, 125, 175, 225, 275, 350, 425, and 500 cycles.

Each cycle consists in one hour "on", and one hour "off ". After 25 cycles, "off" time shall be reduced to 5 minutes more than the time it takes any connector to reach a stable temperature during the "off" cycle.

Stability Factor (S_i) for each of the 11 measurements shall be determinated by the following equations:

$$D = \frac{\sum_{i=1}^{11} d_i}{11}$$

$$S_i = d_i - D$$

$$d_i = T_s - T_c$$

D: Average Temperature Deviation
di: Temperature deviation of each temperature measurement
T_s: Splice Temperature
T_c: Control Conductor Temperature

Temperatures shall be measured within the last 5 minutes of the normal current "on" time. If not all of the measures can be completed within the last 5-minutes, current "on" cycle shall be extended as necessary to complete the measurements.

4.8.5. **Static Heating Test (See 3.5.2.5)**
Pre-Insulated Crimp Splices shall be divided on equal parts and installed on the maximum and minimum wire sizes specified on the applicable SCD. Samples are to be prepared as described for Heat Cycling Test.

Samples are to carry continuously the current value specified on Table I for the wire size tested until stable temperature is reached. Test sample is considered to reach a stable temperature when three readings taken at not less than 10-minute intervals, show a variation no more than 2 ^{o}C (3.6 ^{o}F) between any two of the readings.

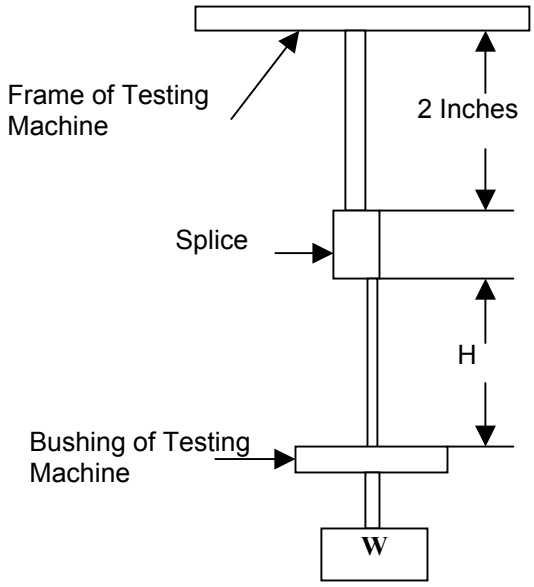
4.8.6. **Secureness Test (See 3.5.2.6)**

Set up is to be as shown in Figure 1. Splice shall be installed in a wire at least 3 inches longer than the values specified on Table IV. As shown in Figure 1, the free end of the wire is to be passed through a bushing of the size specified on Table IV. The bushing is to be attached to an arm driven by a motor in such a manner that the center of the bushing describes a 3-inches diameter circle. The distance between the upper side of the bushing and the connector is to be within half an inch of the distance specified in Table IV, column titled Height. The bushing is to be lubricated. A weight specified in Table IV is to be suspended on the free end of the wire. Testing machine is to be operated at a rate of 9 RPM. Splice shall be subjected to the test described above for a period of 30 minutes.

Table IV. Secureness Test Values

WIRE SIZE		DIAMETER OF BUSHING		HEIGHT		WEIGHT	
AWG	mm^2	INCHES	mm	INCHES	mm	kg	POUNDS
18	0.82	1/4	6.4	10-1/4	260	1	0.45
16	1.30	1/4	6.4	10-1/4	260	1	0.45
14	2.10	3/8	9.5	11	279	1.5	0.68
12	3.30	3/8	9.5	11	279	2.5	1.20
10	5.30	3/8	9.5	11	279	2.5	1.20

Figure 1. Secureness Test Arrangement



4.8.7. **Secureness of Insulation Test (See 3.5.2.7)**
The test is to consist on apply 1-pound on un-assembled splices, or 5-pound pull on assembled splices. Oven conditioning shall be performed prior the Secureness of Insulation test as specified on Table III.

4.8.8. **Flexing Test (See 3.5.2.8)**
The flexing test is to be conducted in the as-received condition, after conditioning at minus 10 ^{o}C for a period of 2 hours, and after Heat Ageing conditioning (See paragraph 4.8.9). Splices conditioned at minus 10 ^{o}C are to be allowed to attain room temperature after conditioning. Six splices assembled with the larges wire specified on the SCD shall be tested for each condition. Each sample shall be wrapped around a 2-inch diameter mandrel, bending 5 times clockwise, and 5 times counter-clockwise.

4.8.9. **Heat Ageing (See 3.5.2.9)**
Splices shall be placed on an air–circulating oven at a temperature specified in Table V, for a period of 168 hours.

Table V. Oven-conditioning Specifications

INSULATION TEMPERATURE RATING		OVEN TEMPERATURE	
^{o}C	^{o}F	^{o}C	^{o}F
75	167	113	235
90	194	121	250
105	221	136	277
125	257	158	316
150	302	180	356

4.8.10. **Immersion (See 3.5.2.9)**
Splices shall be tested in accordance to paragraph 14.2.7 of CEI IEC 60529 Specification. The following conditions shall be satisfied:
Lowes point of the splice shall be located at least 1000 mm below the surface of the water.
Test duration: 30 minutes.

5. Preparation For Delivery

5.1. **Packaging and Packing**
Pre-Insulated Crimp splices shall be packaged and packed in accordance with standard commercial practices.

5.2. **Marking**
Packages shall be identified in accordance with MIL-STD-129 with the following information:
Tyco Electronics part number
Lot control number
Quantity

6. Notes

6.1. Intended Use

Splices covered by this specification are for use in making one-to-one environmentally protected permanent joints on conductors falling within the size range listed on the applicable SCD having insulations compatible with the sealing material. They may be used in applications where the total temperature of the wire insulation does not exceed 125°C.

6.2. Ordering Data

Procurement documents should specify:
Tyco Electronics part number
Quantity
Any special marking or packaging requirements

6.3. Design Modifications

Tyco Electronics reserves the right to make minor product design modifications which do not affect the shape, fit, or primary function of a Pre-Insulated Crimp splice as measured by his specification and the appropriate SCD, without notification.