AEROSPACE, DEFENSE & MARINE

RK-6048 Revision 7

Raychem brand CONVOLEX

SCOPE

This Quality Assurance Specification establishes the quality standard for an irradiated, thermally stabilized, non-heat shrinkable, convoluted, flexible, non-burning, modified polyvinylidene fluoride sleeving.

Approved Signatories*

Tyco Electronics : **Approved electronically via DMTec**

*** This document is electronically reviewed and approved - therefore no signatures will appear.**

1. REVISION HISTORY

Revision Number	Change Request	Date	Incorporated By
6	CR98-DM-0199	September 1998	Linda Abrams
7	CR10-DM-009	3 August 2010	Paul Dixon

2. REQUIREMENTS

2.1 Composition, Appearance and Colour

The sleeving shall be homogeneous and essentially free from pinholes, bubbles, cracks and inclusions. The standard colour shall be black. Other colours may be possible by special contract.

2.2 Dimensions

Size	Minor Inside Diameter mm	Major Outside Diameter mm	Pitch mm	Wall Thickness mm
9/32	7.1 + 0, -1.1	10.0 ± 0.6	3.3 ± 0.6	0.33 ± 0.20
3/8	9.4 + 0, -1.1	12.6 ± 0.6	3.3 ± 0.6	0.33 ± 0.20
7/16	11.2 + 0, -1.1	14.6 ± 0.6	3.8 ± 0.7	0.38 ± 0.20
1/2	12.7 + 0, -1.3	16.0 ± 0.8	3.8 ± 0.7	0.38 ± 0.20
5/8	15.8 + 0, -1.3	19.0 ± 0.8	3.8 ± 0.7	0.38 ± 0.20
3/4	19.1 + 0, -1.6	23.1 ± 0.8	4.2 ± 0.7	0.38 ± 0.20
7/8	22.1 + 0, -1.6	26.4 ± 1.0	4.2 ± 0.7	0.38 ± 0.20
1	25.4 + 0, -1.8	29.5 ± 1.0	3.8 ± 0.7	0.38 ± 0.20
1-1/4	31.8 + 0, -1.8	35.6 ± 1.0	3.8 ± 0.7	0.46 ± 0.20
1-5/8	41.4 + 0, -1.8	46.0 ± 1.0	3.8 ± 0.7	0.51 ± 0.20

2.3 Test Requirements

The test requirements shall be as specified in Table 1.

3. TEST METHODS

3.1 Preparation of Test Specimens

Unless otherwise specified, tests shall be carried out on specimens of sleeving in the as received condition.

3.2 Dimensions

The test method shall be as specified in ASTM D876.
Three specimens shall be measured for minor inside diameter, major outside diameter, pitch and wall thickness.

3.3 Breaking Load and Ultimate Elongation

The test method shall be as specified in ASTM D638.
For sizes 7/16 and smaller, three specimens of whole sleeving 150 mm in length shall be tested. For sizes larger than 7/16, three strip specimens 150 mm long and 5 mm wide shall be cut and tested. The specimens shall be tested using an initial jaw separation of 50 mm and a rate of jaw separation of 50 mm per minute. Mean values for ultimate elongation as established from jaw separation and the mean load to break shall be recorded.

3.4 Specific Gravity

The test method shall be as specified in Method A of ISO 1183.

3.5 Crush Resistance

Three specimens of sleeving of length as specified in Table 2 shall be crushed transversely between parallel plates of diameter 50 mm minimum in a suitable tensile testing machine at a rate of 5 mm per minute. The Crush Resistance shall be recorded as the mean force required to reduce the outside diameter of the sleeving by 25%.

3.6 Compressive Flexibility

Three specimens of sleeving 300 mm long shall be compressed longitudinally in a suitable tensile testing machine at a rate of 5 mm per minute. The sleeving shall slide freely over a supporting mandrel of diameter 90 ± 2% of the sleeving inside diameter. The Compressive Flexibility shall be recorded as the mean value of the force required to compress the sleeving by 25%.

3.7 Flexibility

Three specimens of sleeving 300 mm long shall be secured to a flat horizontal surface such that each specimen extends 150 mm beyond a 90° edge. The free end of each specimen shall be loaded as specified in Table 2 and the vertical displacement shall be measured. The flexibility shall be recorded as the mean value of displacement.

TEST METHODS (continued)

3.8 Flex Life

Three tubular specimens 600 mm long shall be attached at one end to a 76 mm diameter mandrel and at the other end to the load weight as specified in Table 2. The specimens shall then be wound and unwound on the mandrel for 10,000 cycles at a rate of 10 cycles per minute. After cycling the specimens shall be subjected to the dielectric withstand voltage test as specified in Clause 3.13.

3.9 Abrasion Resistance

The abrasion resistance shall be determined using equipment similar to that described in MIL-T-5438. Three tubular specimens shall be tested. Each specimen shall be drawn onto a mandrel of diameter equal to the nominal inside diameter of the sleeving. The lengths of the specimens shall be as specified in Table 2. Each specimen in turn shall be abraded with grade 4/0 abrasive tape at a rate of 1.5m per minute under load and of length as specified in Table 2. After testing each specimen shall be examined visually for holes.

3.10 Low Temperature Flexibility

Three tubular specimens of sufficient length to be wound totally around a cylindrical metal mandrel of 10 times the outside diameter of the sleeving under test shall be conditioned as specified in Table 1. While still at the conditioning temperature the specimens shall be wrapped 360° around the mandrel in approximately 30 seconds. Each specimen shall be visually examined for cracking and after stabilising to room temperature shall be subjected to the dielectric withstand voltage test as described in Clause 3.13.

3.11 Heat Shock

Three tubular specimens 150mm long shall be suspended vertically in a fan assisted air circulating oven as specified in Table 1. After conditioning the specimens shall be allowed to cool naturally in air to ambient temperature and then examined for evidence of splitting, cracking, dripping or flowing.

3.12 Heat Ageing

For sizes 7/16 and smaller, three tubular specimens 150 mm long shall be tested. For sizes larger than 7/16 three strip specimens 150 mm long and 5 mm wide shall be tested. The specimens shall be laid on an oven tray and conditioned in a fan assisted air circulating oven as specified in Table 1. After conditioning the specimens shall be removed, allowed to cool naturally to room temperature and tested for breaking load and ultimate elongation as described in Clause 3.3.

TEST METHODS (continued)

3.13 Dielectric Withstand Voltage Test

The test method shall be as specified in IEC 60243-1 (proof tests).
A conducting wire shall be inserted through each length of three 600 mm long specimens of sleeving which shall be formed into a 'U' shape. The two wire ends of each specimen shall be twisted together. The specimens shall then be filled with a 1% salt water solution serving as an inner electrode and immersed to within 150 mm of their ends in a container of 1% salt water solution serving as an outer electrode. The specimens shall remain immersed for one hour after which a potential of 5 kV shall be applied between the electrodes. The potential shall be gradually increased from zero to 5 kV within approximately 30 seconds and shall be held at that voltage for one minute.

3.14 Copper Mirror Corrosion

The test method shall be as specified in ASTM D2671.

3.15 Flammability

The test method shall be as specified in ASTM D876.

3.16 Water Absorption

The test method shall be as specified in Method 1 of ISO 62.

3.17 Fluid Resistance

The test method shall be as specified in ISO 1817.
Five test specimens prepared as in Clause 3.3. shall be completely immersed in each of the fluids for the times and temperatures specified in Table 1. The volume of the fluid shall not be less than 20 times that of the specimen. After immersion, lightly wipe the specimens and allow to air dry at 23 ± 2°C for 1h ± 15m. The Breaking Load and Ultimate Elongation of each specimen shall be tested according to Clause 3.3. The test shall be repeated on the remaining specified fluids.

3.18 Fungus Resistance

The test method shall be as specified in ISO 846 Method B.
Specimens shall be conditioned for 56 days followed by testing as per Clause 3.3.

4. RELATED STANDARDS & issue

ASTM D638-03	Test Method For Tensile Properties Of Plastics
ASTM D876-09	Standard Test Methods for Non rigid Vinyl Chloride Polymer Tubing Used for Electrical Insulation
ASTM D2671-09	Standard Test Methods for Heat-Shrinkable Tubing for Electrical Use
IEC 60243-1: 1998	Electrical Strength Of Insulating Materials - Test Methods - Tests At Power Frequencies
ISO 62: 2008	Determination of Water Absorption
ISO 846: 1997	Plastics - Evaluation of the action of microorganisms.
ISO 1183-1: 2004	Plastics - Methods For Determining The Density Of Non-Cellular Plastics - Part 1: Immersion Method, Liquid Pyknometer Method And Titration Method
ISO 1817: 2005	Rubber, vulcanized - Determination of the effect of liquids
MIL-T-5438	Tester, Abrasion, Electrical Cable

Subsequent amendments to, or revisions of, any of the above publications apply to this standard only when incorporated in it by updating or revision.

5. SAMPLING

Tests shall be carried out on a sample taken at random from each batch of finished sleeving. A batch of sleeving is defined as that quantity of sleeving extruded at any one time. Testing frequency shall be Production Routine or Qualification. Production Routine tests consisting of Visual Examination, Dimensions, Breaking Load, Ultimate Elongation, Crush Resistance, Compressive Flexibility and Heat Shock shall be carried out on every batch of sleeving. Qualification tests shall be carried out to the requirements of the Design Authority.

6. PACKAGING

Packaging shall be in accordance with good commercial practice. Each package shall bear an identification label showing material quantity, description, size, colour and batch number. Additional information shall be supplied as specified in the contract or order.

TABLE 1 Test Requirements

Test	Test Method	Test Requirements
Dimensions		In accordance with Clause 2.2
Breaking Load	ASTM D638	23 N minimum
Ultimate Elongation	ASTM D638	100 % minimum
Specific Gravity	ISO 1183	1.8 maximum
Crush Resistance	Clause 3.5	31 N minimum
Compressive Flexibility	Clause 3.6	In accordance with Table 2
Flexibility	Clause 3.7	76 mm minimum
Flex Life - Dielectric Withstand Voltage	Clause 3.8	 No breakdown after 10,000 cycles
Abrasion Resistance	Clause 3.9	No breakthrough
Low Temperature Flexibility (4 h ± 15 min at -55 ± 2°C) - Visual - Dielectric Withstand Voltage	Clause 3.10	 No cracking No breakdown
Heat Shock (4 h ± 15 min at 250 ± 5°C)	Clause 3.11	No dripping, cracking, splitting or flowing
Heat Ageing (168± 2 h at 175 ± 5°C) - Break Load - Ultimate Elongation	Clause 3.12	 23 N minimum 75 % minimum
Dielectric Withstand Voltage	IEC 60243-1	No breakdown after 1 minute at 5kV
Copper Mirror Corrosion (16 h ± 15 min at 175 ± 3°C)	ASTM D2671	No corrosion of mirrors
Flammability	ASTM D876	15 seconds maximum
Fungus Resistance - Breaking Load - Ultimate Elongation	ISO 846	 23 N minimum 150 % minimum
Water Absorption (24 ± 2h immersion at 23 ± 2°C)	ISO 62	0.5 % maximum

TABLE 1 Test Requirements (continued)

Test	Test Method	Test Requirements
Fluid Resistance 24 ± 2 h immersion at 23 ± 2°C • Gasoline Fuel to ISO 1817 Test Liquid B • Hydraulic Fluid DTD900/4881 • Hydraulic Fluid H-515 (MIL-H-5606) • Aviation Gasoline (100/130) • Salt Water (5% salt) • Lubricating Oil O-149 (MIL-L-23699) Anti-Icing Fluid (TT-I-735) (S737)	ISO 1817	
- Breaking Load	ASTM D638	13N minimum
- Ultimate Elongation		100% minimum

TABLE 2 - Performance Details

Size	Specimen Size Crush and Abrasion Resistance (Convolutes)	Test Load ± 3 %			Requirement*	
		Flexibility (N)	Flex Life (Kg)	Abrasion Resistance (N)	Compressive Flexibility (N) max	Abrasion Resistance (mm) of Tape min
9/32	8	1.1	0.23	9	63.5	635
3/8	8	2.2	0.34	13	63.5	635
7/16	7	3.3	0.45	18	80.0	1270
1/2	7	4.4	0.45	18	80.0	1270
5/8	7	6.7	0.45	18	89.0	1270
3/4	7	8.9	0.91	18	111	1905
7/8	7	8.9	0.91	18	111	1905
1	7	8.9	0.91	18	111	1905
1-1/4	7	10.0	0.91	18	178	1905
1-5/8	7	11.1	0.91	18	178	1905

*See Table 1 for complete sleeving requirements

In line with a policy of continual product development, Tyco reserves the right to make changes in construction, materials and dimensions without further notice. You are advised, therefore, to contact Tyco Electronics, should it be necessary to ensure that this document is the latest issue.

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