Chipsmall Limited consists of a professional team with an average of over 10 year of expertise in the distribution of electronic components. Based in Hongkong, we have already established firm and mutual-benefit business relationships with customers from,Europe,America and south Asia,supplying obsolete and hard-to-find components to meet their specific needs.

With the principle of “Quality Parts,Customers Priority,Honest Operation,and Considerate Service”,our business mainly focus on the distribution of electronic components. Line cards we deal with include Microchip,ALPS,ROHM,Xilinx,Pulse,ON,Everlight and Freescale. Main products comprise IC,Modules,Potentiometer,IC Socket,Relay,Connector.Our parts cover such applications as commercial,industrial, and automotives areas.

We are looking forward to setting up business relationship with you and hope to provide you with the best service and solution. Let us make a better world for our industry!

Contact us

Tel: +86-755-8981 8866 Fax: +86-755-8427 6832
Email & Skype: info@chipsmall.com Web: www.chipsmall.com
Address: A1208, Overseas Decoration Building, #122 Zhenhua RD., Futian, Shenzhen, China

Tyco Electronics Corporation
300 Constitutional Drive
Menlo Park, CA 94025 USA

Raychem

Specification	**RT-1301**
This Issue:	Issue 7
Date:	October 3, 2003
Replaces:	Issue 6

THERMOFIT® SCL TUBING
Polyolefin, Selectively Crosslinked, Semirigid, Heat Shrinkable

1. SCOPE

This specification covers the requirements for one type of selectively crosslinked, electrically insulating, encapsulating, extruded tubing whose diameter will reduce to a predetermined size upon the application of heat in excess of 135 °C *(275 °F)*.

2. APPLICABLE DOCUMENTS

This specification takes precedence over documents referenced herein. Unless otherwise specified, the latest issue of referenced documents applies. The following documents form a part of this specification to the extent specified herein.

2.1 GOVERNMENT-FURNISHED DOCUMENTS

Military

MIL-H-5606	Hydraulic Fluid, Petroleum Base, Aircraft, Missile and Ordnance
MIL-T-5624	Turbine Fuel, Aviation, Grades JP-8

2.2 OTHER PUBLICATIONS

American Society for Testing and Materials (ASTM)

D 149	Standard Methods of Test for Dielectric Breakdown Voltage and Dielectric Strength of Electrical Insulating Materials at Commercial Power Frequencies.
D 257	Standard Methods of Test for D-C Resistance or Conductance of Insulating Materials.
D 412	Standard Test Methods for Rubber Properties in Tension.
D 570	Standard Method of Test for Water Absorption of Plastics.
D 638	Standard Method of Test for Tensile Properties of Plastics.
D 746	Standard Method of Test for Brittleness Temperature of Plastics and Elastomers by Impact.
D 792	Standard Methods of Test for Specific Gravity and Density of Plastics by Displacement.
D 876	Standard Methods of Testing nonrigid Vinyl Chloride Polymer Tubing.
D 2671	Standard Methods of Testing Heat-Shrinkable Tubing.
ISO 846	Plastics-Evaluation of the action of microorganisms

(Copies of ASTM publications may be obtained from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.)

3. REQUIREMENTS

3.1 MATERIAL

The tubing shall be fabricated from thermally stabilized, modified polyolefin and shall be selectively crosslinked by irradiation so that:

a. The inner wall of the tubing is capable of melting, flowing, and adhering to itself upon the application of heat in excess of 135 °C (275 °F).

b. The outer wall of the tubing is nonmelting and possesses elastic memory which causes it to reduce its diameter to a predetermined size upon the application of heat in excess of 135 °C (275 °F).

The tubing shall be essentially free from flaws, defects, pinholes, bubbles, seams, cracks and inclusions.

3.2 COLOR

Unless otherwise specified, the tubing shall be black.

3.3 PROPERTIES

The tubing shall meet the requirements of Table 3.

4. QUALITY ASSURANCE PROVISIONS

4.1 CLASSIFICATION OF TESTS

4.1.1 Qualification Tests

Qualification tests are those performed on tubing submitted for qualification as satisfactory product and shall consist of all tests listed in this specification.

4.1.2 Acceptance Tests

Acceptance tests are those performed on tubing submitted for acceptance under contract. Acceptance tests shall consist of the following: dimensions, longitudinal change, tensile strength, ultimate elongation, flow of inner wall and heat shock.

4.2 SAMPLING INSTRUCTIONS

4.2.1 Qualification Test Samples

Qualification test samples shall consist of 50 feet *(15 m)* of tubing of each size. Qualification of any size within each size range specified below will qualify all sizes in the same range.

Size Ranges
1/8 through 1/4
1/2 through 1

4.2.2 Acceptance Test Samples

Acceptance test samples shall consist of not less than 16 feet *(5 m)* of tubing selected at random from each lot. A lot shall consist of all tubing of the same size, from the same production run, and offered for inspection at the same time.

4.3 TEST PROCEDURES

Unless otherwise specified, tests shall be performed on as-supplied specimens. Prior to all testing, the test specimens (and measurement gauges, when applicable) shall be conditioned for 3 hours at 23 ± 3 °C (73 ± 5 °F) and 50 ± 5 percent relative humidity. All ovens shall be of the mechanical-convection type in which air passes the specimens at a velocity of 100 to 200 feet per minute.

4.3.1 Dimensions

Three 6-inch *(150 mm)* specimens of tubing shall be measured for inside diameter in accordance with ASTM D 876. The specimens then shall be placed on mandrels and conditioned for 10 minutes in a 200 ± 3 °C (392 ±5 °F) oven. The diameter of the mandrels shall equal the maximum inside diameter of the recovered tubing as specified in Table 1, plus 0.000, minus 0.002 inch or 2 percent, whichever is greater. After conditioning, the specimens, while still on the mandrels, shall be removed from the oven, cooled for at least 30 seconds in water at less than 35 °C (95 °F), and inspected for wall thickness in accordance with ASTM D 876. If air space is visible between the specimen and the mandrel, the specimen shall be removed from the mandrel, measured for inside diameter and inspected for wall thickness in accordance with ASTM D 876.

4.3.2 Longitudinal Change

Three 6-inch specimens of tubing shall be measured for length to an accuracy of ± 1/32 inch. The specimens then shall be conditioned on aluminum foil for 3 minutes in a 200 ± 3 °C (392 ± 5 °F) oven. After conditioning, the specimens shall be removed from the oven, cooled to 23 ± 3 °C (73 ± 5 °F), and remeasured. The longitudinal change shall be calculated as follows:

$$C = \frac{L_1 - L_0}{L_0} \times 100$$

Where: C = Longitudinal Change (Percent)
L_0 = Length Before Conditioning (Inches) *(mm)*
L_1 = Length After Conditioning (Inches *(mm)*

4.3.3 Flow of Inner Wall

Three 6-inch specimens of tubing shall be conditioned on aluminum foil for 3 minutes in a 200 ± 3 °C (392 ± 5 °F) oven. After conditioning, the specimens shall be removed from the oven and, within 5 seconds, approximately 1/4 inch of one end of each specimen shall be lightly pressed together using a pair of needle-nose pliers. The pressure shall be sufficient to completely close the opening

and shall be applied for 20 to 40 seconds. The specimens then shall be removed from the pliers, cooled to 23 ± 3 °C (73 ± 5 °F), and maintained at that temperature for 10 minutes. The specimens then shall be replaced in the 200 ± 3 °C (392 ± 5 °F) oven for 5 minutes. After conditioning, the specimens shall be removed from the oven, cooled to 23 ± 3 °C (73 ± 5 °F) and examined for openings in the pressed or sealed area.

4.3.4 Tensile Strength and Ultimate Elongation

Three specimens shall be tested for tensile strength and ultimate elongation in accordance with ASTM D 638 using cross head speed of 2-inches per minute, 1-inch bench marks and an initial jaw separation of 2 inches. For sizes 3/8 and smaller, the specimens shall be full sections of tubing. For sizes larger than 3/8, the specimens shall be cut from tubing using die D of ASTM D 412. The die D specimens shall be obtained by cutting the tubing wall along its entire length, flattening the piece, and applying the die with its long dimensions parallel to the longitudinal axis of the tubing.

4.3.5 Heat Shock

Three 6-inch *(150 mm)* specimens of tubing shall be conditioned on aluminum foil for 4 hours in a 250 ± 3°C *(482 ± 5 °F)* oven. After conditioning, the specimens shall be removed from the oven, cooled to 23 ± 3°C *(73 ± 5°F)* and visually examined for evidence of dripping, flowing, or cracking of the outer wall.

4.3.6 Heat Resistance

Three 6-inch *(150-mm)* specimens of tubing shall be conditioned on aluminum foil for 168 hours in a 175 ± 2 °C *(347 ± 4 °F)* oven. After conditioning, the specimens shall be removed from the oven, cooled to 23 ± 3°C *(73 ± 5°F)*, and bent through 180° over a mandrel selected in accordance with Table 2. The specimens then shall be visibly examined for evidence of dripping, flowing or cracking of the outer wall. Any side cracking caused by flattening of the specimen on the mandrel shall not constitute failure.

4.3.7 Dielectric Strength

The dielectric strength of the tubing shall be measured, under oil, in accordance with ASTM D 149. Five 6-inch specimens of tubing shall be recovered over a metal mandrel by conditioning for 10 minutes in a 200 ± 3 °C (392 ± 5 °F) oven. The mandrel diameter shall be slightly larger than the recovered inside diameter of the tubing being tested. The metal mandrel shall serve as one electrode and a 1-inch-wide strip of lead foil wrapped around the outside of the tubing as the other electrode. Thickness measurements for calculating dielectric strength shall be made adjacent to the point of breakdown.

4.3.8 Corrosive Effect

4.3.8.1 Copper Mirror Corrosion

Three specimens shall be tested in accordance with ASTM D 2671, Procedure A. The tubing shall be conditioned for 10 minutes in a 200 ± 3 °C (392 ± 5 °F) oven. For sizes smaller than 3/8, the specimens shall be 1-inch sections of recovered tubing. For sizes 3/8 and larger, the specimens shall be 1 X 1/4-inch strips cut longitudinally from recovered tubing. The specimens shall be conditioned for 16 hours at 121 ± 2 °C (250 ± 4 °F). Evidence of corrosion shall be the removal of copper from the mirror leaving an area of transparency greater than 5 percent of its total area.

4.3.8.2 Corrosion in Contact with Copper

Three 6-inch specimens of tubing which have been conditioned for 10 minutes in a 200 ± 3 °C (392 ± 5 °F) oven shall be tested in accordance with ASTM D 2671, Procedure B. The specimens shall be conditioned for 16 hours at 121 ± 2 °C (250 ± 4 °F).

4.3.9 Fluid Resistance

Six specimens shall be immersed in each of the fluids listed in Table 3 for 24 hours at 23 ± 3 °C (73 ± 5 °F). Three of the specimens in each fluid shall be prepared in accordance with 4.3.7 and three shall be prepared and measured in accordance with 4.3.4. The volume of the fluid shall be not less than 20 times that of the specimens. After conditioning, the specimens shall be removed from the fluids, lightly wiped and air dried for 30 to 60 minutes at 23 ± 3 °C (73 ± 5 °F). Three specimens from each fluid then shall be tested for dielectric strength in accordance with 4.3.7 and the other three for tensile strength in accordance with 4.3.4.

4.4 REJECTION AND RETEST

Failure of any sample of tubing to comply with any one of the requirements of the specification shall be cause for rejection of the lot represented. Tubing which has been rejected may be replaced or reworked to correct the defect and then resubmitted for acceptance. Before resubmitting, full particulars concerning the rejection and the action taken to correct the defect shall be furnished to the inspector.

5. PREPARATION FOR DELIVERY

5.1 LENGTHS

Unless otherwise specified, the tubing shall be supplied in lengths of 48+1/-0 inches.

5.2 PACKAGING

Packaging shall be in accordance with good commercial practice.

5.3 MARKING

Each container of product shall be permanently and legibly marked with size, quantity, manufacturer's identification, specification number, product designation and lot number.

TABLE 1
Tubing Dimensions

Size No.	As Supplied		Recovered Dimensions									
	Inside Diameter Minimum		Inside Diameter Maximum		Wall Thickness						Inner Meltable Wall Thickness	
					Minimum		Maximum		Nominal		Nominal	
	in	*mm*	in	*mm*	in	*mm*	in	*mm*	in	*mm*	in	*mm*
1/8	.125	3.17	.023	0.58	.032	0.81	.044	1.11	.038	0.96	.020	0.50
3/16	.187	4.74	.060	1.52	.037	0.93	.049	1.24	.043	1.09	.025	0.64
1/4	.250	6.35	.080	2.03	.041	1.04	.053	1.34	.047	1.19	.027	0.68
3/8	.375	9.93	.135	3.42	.043	1.09	.057	1.44	.050	1.27	.030	0.76
1/2	.500	12.70	.195	4.95	.048	1.21	.062	1.57	.055	1.39	.035	0.88
3/4	.750	19.05	.313	7.95	.058	1.47	.072	1.82	.065	1.65	.040	1.01
1	1.000	25.40	.400	10.16	.068	1.72	.082	2.08	.075	1.90	.040	1.01

TABLE 2
Mandrel Dimensions

Tubing Size	Mandrel Diameter	
	in	*mm*
1/8 through 1/4	7/16	*11.1*
1/2 through 3/4	1/2	*12.7*
1	9/16	*14.2*

TABLE 3
Requirements

PROPERTY	UNIT	REQUIREMENT	TEST METHOD
PHYSICAL			Section 4.3.1
Dimensions	Inches *(mm)*	In accordance with Table 1	ASTM D 876
Longitudinal Change	Percent	+1,-10	Section 4.3.2
Flow of Inner Wall	---	No openings upon reheating	Section 4.3.4
Tensile Strength	psi *(MPa)*	1500 minimum *(10.3)*	Section 4.3.4
Ultimate Elongation	Percent	200 minimum	ASTM D 638
Low Temperature Brittleness at -55 °C *(-67 F)*	---	No failure	ASTM D 746, Procedure B
Heat Shock 4 hours at 250 °C *(482 °F)*	---	No dripping, flowing, or cracking of the outer wall	Section 4.3.5
Heat Resistance 168 hours at 175 °C *(347 °F)*	---	No dripping, flowing or cracking of the outer wall	Section 4.3.6
ELECTRICAL			Section 4.3.7
Dielectric Strength	Volts/mil	500 minimum	ASTM D 149
Volume Resistivity	ohm-cm	10^{15} minimum	ASTM D 257
CHEMICAL			Section 4.3.8 and
Corrosive Effect 16 hours at 121 °C *(250 F)*	---	Noncorrosive	ASTM D 2671
Fungus Resistance			ISO 846 Method B
Followed by tests for:			
Tensile Strength	psi *(Mpa)* *(10.3.)*	1500 minimum (10.3)	Section 4.3.4
Ultimate Elongation	percent	200 minimum	ASTM D 638
Dielectric Strength	Volts per mil *(volts per mm)*	500 minimum (19,860)	Section 4.3.7 ASTM D 149
Water Absorption 24 hours at 23 °C *(73 °F)*	Percent	0. 5 maximum	ASTM D 570
Fluid Resistance 24 hours at 23 °C (73 °F) in: JP-8 Fuel (MIL-T-5624) Skydrol* 500 Hydraulic Fluid (MIL-H-5606) Aviation Gasoline (100/130) Water			Section 4.3.9
Followed by test for: Dielectric Strength	Volts/mil	400 minimum	Section 4.3.7
Tensile Strength	psi	1000 minimum	Section 4.3.4