



SPECIFICATION	RW-2512
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HT-SCE

High Temperature Heat Shrinkable Sleeves

SCOPE

This quality assurance specification covers the requirements and performance of the HT-SCE Marker System. This system is an automatic method of identifying wire and cable by printing a mark onto TE Connectivity sleeving.

The Markers shall be fabricated from radiation crosslinked modified polyvinylidene fluoride tubing, flattened and mounted on a carrier in a ladder configuration.

The marker system comprises specific printers and ribbons (refer to IDENTIFICATION PRINTER PRODUCT RIBBON MATRIX 411-121005). Compliance to this specification can only be guaranteed if adequate storage is maintained and TE Connectivity approved printers and ribbons are used.

HT-SCE Markers are designed for use in high temperature applications, or where extreme resistance to cleaning solvents is needed. They are also used in space applications where low outgassing is critical. The mark is permanent upon shrinking the sleeve.

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

TE (Logo) is a trademark.

This document is electronically reviewed and approved by TE Connectivity.

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1. REVISION HISTORY

Revision Number	Description of change	Date	Incorporated By
1	RT-1806 (original)	---	---
2	---	---	---
3	Integrated into RW doc	July 2004	Alan Kean
4	Ref. DMTEC	Jan 2013	Lee Smith

2. REQUIREMENTS

2.1. Material composition and appearance

The sleeving shall be fabricated from irradiated, thermally-stabilized, modified polyvinylidene fluoride compound. It shall be homogeneous and essentially free from flaws, defects, pinholes, bubbles, seams, cracks or inclusions.

2.2. Color

The markers shall be white or black, unless otherwise specified.

2.3. Form

Markers shall be cut lengths mounted on a carrier in accordance with Figure 1.

2.4. Properties

The sleeves and tubes shall meet the requirements of Table 4.



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3. QUALITY ASSURANCE PROVISIONS

3.1. Classification of Tests

3.1.1. Qualification Tests

Qualification tests are those performed on finished sleeve, continuous tube or marker material submitted for qualification as a satisfactory product and shall consist of all tests listed in this specification.

3.1.2. Acceptance Testsⁱ

Acceptance tests are those submitted for acceptance under the contract. Acceptance tests shall consist of the following:

Dimensions
Longitudinal Change
Print performance

3.2. Sampling Instructions

3.2.1. Qualification Test Samples

Qualification test samples shall consist of 50 feet (15 m) of continuous marker material and the appropriate number of finished markers necessary to run all tests. Qualification of any one size shall qualify all sizes

3.2.2. Acceptance Test Samples

Acceptance test samples shall consist of 5 m (16 feet) of tubing and the appropriate number of finished markers necessary to run all tests.

ⁱ Physical property tests performed at this time qualify subsequent sleeving lots produced from the same compound batch

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4. TEST PROCEDURES

4.1. Preparation of Test Specimens

When required by the test procedure, product shall be printed using printers and ribbons specified by TE Connectivity. The full list can be found in document reference 411-121005 TE Identification Printer Product Ribbon Matrix.

Print random characters onto the sleeving to within 6mm (1/4 inch) of both ends using font type Arial 10 bold. Remove the markers from the carrier and test in both expanded and recovered form.

The marking shall be examined for legibility in accordance with TE Document 411-121002 Print Contrast Reference Scale. The initial print contrast must be 8 or above.

As required, finished sleeves will be recovered or tubing specimens will be thermally conditioned by placing them in a forced air oven for 3 minutes at $200 \pm 5^{\circ}\text{C}$ ($392 \pm 9^{\circ}\text{F}$). Specimens will be removed from the oven and allow to cool to $23 \pm 3^{\circ}\text{C}$ ($73 \pm 5^{\circ}\text{F}$) for at least 4 hours before continuing. Use finished markers, as supplied, for all other tests. Where required by test method limitations, testing shall be done on continuous marker material.

Unless otherwise specified, all tests shall be made at a temperature of $23 \pm 2^{\circ}\text{C}$.

4.2. Dimensions, Dimensional Recovery and Longitudinal Change

Test three markers in accordance with ASTM D 2671 for dimensions as supplied, dimensions as recovered and longitudinal change. Recover the specimens for 3 minutes at $200 \pm 5^{\circ}\text{C}$ ($392 \pm 9^{\circ}\text{F}$).

4.3. Tensile Strength and Ultimate Elongation

Test three specimens for tensile strength and ultimate elongation. The specimens shall be in accordance with ASTM D 2671, using 1-inch (25-mm) bench marks and a 1-inch (25-mm) initial jaw separation and a jaw separation speed of 2 inches (50-mm) per minute.

4.4. Specific Gravity

Measure the specific gravity of freely recovered markers in accordance ASTM D 2671

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4.5. Low Temperature Flexibility

Prepare test strips as follows: Recover three 6-inch (150-mm) long sections of tubing, and while they are still hot, slit longitudinally, and flatten between metal plates. Cool to room temperature, remove the metal plates, and cut into 1/4-inch (6-mm) wide strips.

Place the specimens in a cold chamber with a 3/4-inch (19.1-mm) mandrel at $-55 \pm 2^{\circ}\text{C}$ ($-67 \pm 4^{\circ}\text{F}$) for 4 hours. While still in the cold chamber, and at this same temperature, wrap the specimens around the mandrel not less than 360 degrees in approximately 2 seconds.

4.6. Heat Shock

Mark six specimens per section 4.1 and remove from the carrier. Condition the specimens for 4 hours at $275 \pm 3^{\circ}\text{C}$ ($527 \pm 5^{\circ}\text{F}$). Remove the specimens from the oven, cool to room temperature and bend three specimens through 90 degrees, in approximately 2 seconds, over a 3/4-inch (19.1 mm) mandrel. Visually examine the specimens for evidence of dripping, flowing or cracking. Disregard any side cracking caused by flattening of the specimens on the mandrel. Test the other three specimens for print performance in accordance with section 4.8.1.

**TABLE 1
 SUGGESTED STRANDED WIRE SIZE
 FOR HEAT AGING & TEMPERATURE CYCLING**

Tubing Size	Suggested Stranded Wire Size	
	AWG Size -- Stranding	
1/4	12	19/25
1/2	8	7 x 19/29

4.7. Heat Aging

Mark specimens per section 4.1. as follows: For sizes through 1/2, recover six specimens over a stranded wire as described in Table 1. For sizes above 1/2, cut six 1/4-inch (6.35-mm) wide strips from the marked, recovered specimens. Condition all specimens for 168 hours at $225 \pm 3^{\circ}\text{C}$ ($437 \pm 5^{\circ}\text{F}$) and examine for cracks.

Test three specimens shrunk on the stranded wire for print performance in accordance with Section 4.7.1. Bend the other three specimens through 90 degrees, in approximately 2 seconds over a 3/4-inch (19.1-mm) mandrel, and examine for cracks. Test three specimens in strip form for print performance in accordance with Section 4.8.1, and bend three through 90 degrees over a 3/4-inch (19.1-mm) mandrel and examine for cracks.

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4.8. Print Performance - Legibility and Durability

Mark six finished markers with an appropriate TMS Marking System in accordance section 4.1. Print random characters across the length of each marker to within 1/4 inch (6 mm) of both ends. Remove the specimens from the carrier and recover them for 3 minutes at $200 \pm 5^{\circ}\text{C}$ ($392 \pm 9^{\circ}\text{F}$).

4.8.1 Test three specimens for print adherence in accordance with SAE AS 5942ⁱⁱ, clause 3.3. Marking durability. Perform the number of rubs specified in Table 3 of this specification and examine the specimens for legibility at a distance of 14 inches (355 mm).

4.8.2 Test three specimens for solvent resistance in accordance with MIL-STD-202G Method 215, except perform the number of strokes specified in Table 3. Examine the specimens for legibility at a distance of 14 inches (355 mm).

4.9. Vacuum Outgassing

Recover three finished markers for 3 minutes at $200 \pm 5^{\circ}\text{C}$ ($392 \pm 9^{\circ}\text{F}$) and test for percent total weight loss and percent volatile condensable materials. The conditions for testing are: Exposure time, 24 hours; sample temperature, $130 \pm 2^{\circ}\text{C}$ ($266 \pm 4^{\circ}\text{F}$); condensing surface temperature, $18 \pm 3^{\circ}\text{C}$ ($64 \pm 5^{\circ}\text{F}$); and pressure, not greater than 1×10^{-5} Torr.

The vacuum shall be provided by a diffusion pump and a liquid nitrogen trap. The apparatus shall consist of a glass sample chamber, refluxing liquid heat source and a polished stainless steel plate in close contact with a copper cold finger cooled internally by circulating water. The axis of the exit of the sample chamber shall be perpendicular to and approximately 7 mm from the cooled condensing plate. Use a micro balance to weigh the specimens before and after conditioning and calculate total weight loss. Weigh the condensing plate before and after to calculate percent volatile condensable material.

4.10. Temperature Cycling

Mark specimens per Section 4.1, as follows: For sizes through 1/2, recover six specimens over a stranded wire as described in Table 1. For sizes above 1/2, cut six 1/4-inch (6.35-mm) wide strips from the marked, recovered specimens. Subject all specimens to six temperature cycles. One cycle shall be as follows: 0.5 hours immersed in liquid nitrogen at $-196 \pm 5^{\circ}\text{C}$ ($-321 \pm 9^{\circ}\text{F}$) followed immediately by 0.5 hours in a $200 \pm 5^{\circ}\text{C}$ ($392 \pm 9^{\circ}\text{F}$) forced air oven. After the final cycle, allow the specimens to stabilize to room temperature.

Test three specimens shrunk on the stranded wire for print performance in accordance with Section 4.7.1. Bend the other three specimens through 90 degrees, in approximately 2 seconds over a 3/4-inch (19.1-mm) mandrel, and examine for cracks. Test three specimens in strip form for print performance in accordance with Section 4.7.1. and bend three through 90 degrees over a 3/4-inch (19.1-mm) mandrel and examine for cracks.

ⁱⁱ SAE AS 5942 replaces obsolete standard AS81531. This performance of the marker sleeve has not changed.

4.11. Fluid Resistance

Completely immerse three specimens, marked and prepared in accordance with section 4.1, in each fluid listed in Table 3 for 24 hours at $23 \pm 3^{\circ}\text{C}$ ($73 \pm 5^{\circ}\text{F}$). The volume of the fluid shall be not less than 20 times that of the specimens. After immersion, lightly wipe the specimens and allow to air dry for 30-60 minutes at room temperature. Test the specimens for print performance in accordance with section 4.8.1.

5. REJECTION AND RETEST

Failure of any sample to conform to any of the requirements of this specification sheet shall be cause for rejection of the lot represented. Markers which have been rejected may be replaced or reworked to correct the defects and resubmitted for acceptance. Before resubmitting, full particulars concerning previous rejection and action taken to correct the defects shall be furnished to the inspector

6. PREPARATION FOR DELIVERY**6.1. Form**

Markers shall be supplied on a carrier, either wound on spools, or in strips

6.2. Packaging

Packaging shall be in accordance with good commercial practice

6.3. Marking

Each container of markers shall be identified with the product designation, size, quantity, manufacturer's identification and lot number.

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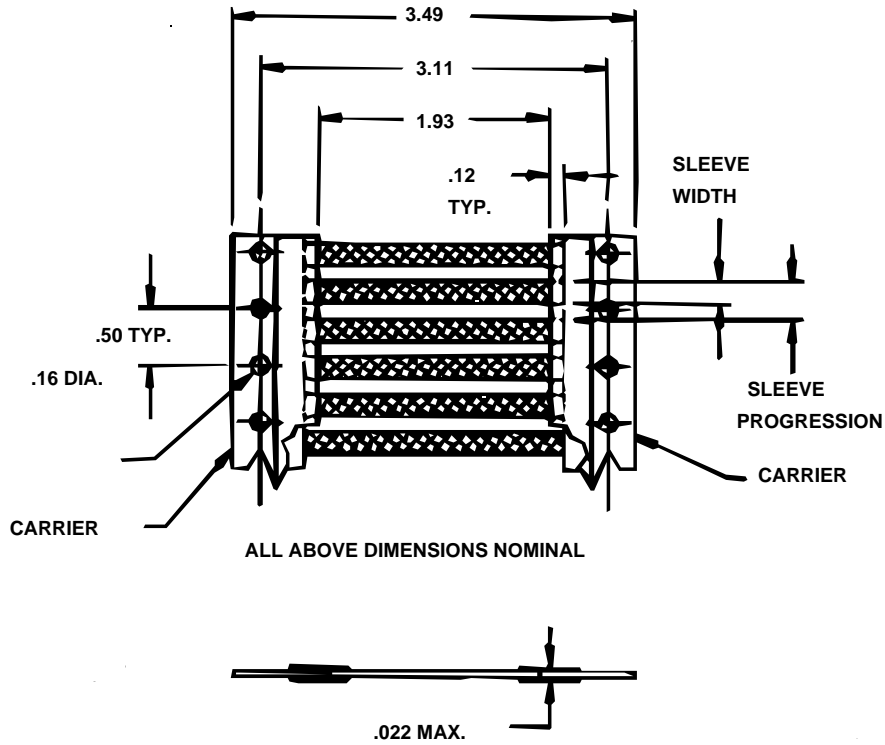


FIGURE 1

TABLE 2
 Marker Dimensions and Configuration

Part Number	Expanded I.D. Minimum		Recovered I.D. Maximum		Expanded Sleeve Width Minimum		Recovered Wall Thickness		Sleeve Progression Nominal	
	in.	mm.	in.	mm.	in.	mm.	in.	mm.	in.	mm.
HT-SCE 3/32	.093	2.36	.031	0.79	0.17	4.32	.015 ± .003	.38 ± .08	0.50	12.70
HT-SCE 1/8	.125	3.17	.062	1.57	0.23	5.84	.015 ± .003	.38 ± .08	0.50	12.70
HT-SCE 3/16	.187	4.74	.093	2.36	0.315	8.00	.015 ± .003	.38 ± .08	0.50	12.70
HT-SCE 1/4	.250	6.35	.125	3.18	0.42	10.7	.015 ± .003	.38 ± .08	0.67	17.0
HT-SCE 3/8	.375	9.52	.187	4.74	0.61	15.49	.015 ± .003	.38 ± .08	1.00	25.40
HT-SCE 1/2	.500	12.70	.250	6.35	0.80	20.3	.015 ± .003	.38 ± .08	1.17	29.7
HT-SCE 3/4	.750	19.05	.375	9.53	1.20	30.5	.015 ± .003	.38 ± .08	1.67	42.4
HT-SCE 1	1.000	25.40	.500	12.70	1.59	40.4	.017 ± .004	.43 ± .10	2.00	50.8
HT-SCE 1-1/2	1.500	38.10	.750	19.05	2.37	60.2	.017 ± .004	.43 ± .10	2.83	71.9

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7. APPLICABLE DOCUMENTS

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

7.1 GOVERNMENT FURNISHED DOCUMENTS

Military

MIL-STD-202 Test Methods for Electronic and Electrical Component Parts
MIL-L-7808 Lubricating Oil, Aircraft Turbine Engine, Synthetic Base
MIL-A-8243 Anti-Icing and Deicing-Defrosting Fluid

SAE International

SAE AS 5942 Marking of Electrical Insulating Materials

7.2 OTHER PUBLICATIONS

American Society for Testing and Materials (ASTM)

ASTM D 876 Testing Non-rigid Vinyl Chloride Polymer Tubing used for Electrical Insulation
ASTM D 2671 Testing Heat-Shrinkable Tubing for Electrical Use
ASTM G 21 Recommended Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi

Underwriter's Laboratories, Inc.

U.L. Standard 224 Extruded Insulating Tubing

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TABLE 3
Requirements

PROPERTY	UNIT	REQUIREMENT	TEST METHOD
PHYSICAL			
Dimensions	Inches (<i>mm</i>)	In accordance with Table 2	Section 4.2 ASTM D 2671
Dimensional Recovery 3 minutes at 200 ± 5°C (392 ± 9°F)	Inches (<i>mm</i>)	In accordance with Table 2	
Longitudinal Change 3 minutes at 200 ± 5°C (392 ± 9°F)	Percent	20 maximum	
Tensile Strength	psi (<i>MPa</i>)	3500 minimum (24.1)	Section 4.3
Ultimate Elongation	Percent	200 minimum	ASTM D 2671
Specific Gravity	---	1.8 maximum	Section 4.4 ASTM D 2671
Low Temperature Flexibility 4 hours at -55 ± 1°C (-67 ± 2°F)	---	No cracking	Section 4.5.
Heat Shock 4 hours at 275 ± 3°C (527 ± 5°F) Followed by test for: Print Performance	---	No dripping, flowing, or cracking	Section 4.6.
	Rubs	50 minimum, legible	Section 4.8.1.
Heat Aging 168 hours at 225 ± 2°C (437 ± 4°F) Followed by test for: Print Performance	---		Section 4.7
	Rubs	50 minimum, legible	Section 4.8.1.
Print Performance (SAE-AS5942)			Section 4.8.
	Rubs	100 minimum, legible	Section 4.8.1
(MIL-STD-202G Method 215)	Strokes	100 minimum, legible	Section 4.8.2
Vacuum Outgassing TML (Total Mass Loss)	Percent	1.0 maximum	Section 4.10.
VCM (Volatile Condensable)	Percent	0.1 maximum	
Temperature Cycling 6 cycles of: 0.5 hr at -196 ± 5°C (-321 ± 9°F) 0.5 hr at 200 ± 5°C (392 ± 9°F) Followed by test for: Print Performance	--	No cracking	Section 4.11.
	Rubs	50 minimum, legible	
ELECTRICAL			
Dielectric Strength	Volts/mil (<i>kV/mm</i>)	600 minimum (23.6)	ASTM D 2671
Volume Resistivity	ohm-cm	10 ¹² minimum	ASTM D 2671

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CHEMICAL			
Corrosive Effect 16 hours at 200 ± 2°C (392 ± 4°F)	---	Non-corrosive	ASTM D 2671 Procedure A
Fungus Resistance	---	Rating of 1 or less	ASTM G 21
Fluid Resistance 24 hours at 23 ± 3°C (73 ± 5°F) in: MIL-L-23699 Lubricating oil MIL-T-83133 Aircraft Fuel (JP-8) Skydrol* 500 Aviation Gasoline (100/130) MIL-L-7808 Lubricating oil Salt Water (5% salt) Anti-Icing Fluid (MIL-A-8243)	--	--	Section 4.3.9
Followed by test for: Print Performance	Rubs	20 minimum, legible	Section 4.3.6.2
Flammability (UL 224) (ASTM D 876) Average time of burning	--- Seconds	Pass VW-1 rating 15 maximum	UL Standard 224 ASTM D 876

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