



SPECIFICATION RW-2511  
THIS REVISION 4  
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## RW-2511

# TMS-SCE-2X and TMS-SCE-3X Heat Shrinkable Sleeves

### SCOPE

This quality assurance specification covers the requirements and performance of the TMS-SCE System 6 Marker System. This system is an automatic method of identifying wire and cable by printing a mark onto TE Connectivity TMS-SCE Markers.

The sleeving is made from durable, flame retardant, radiation cross-linked, heat-shrinkable polyolefin.

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.

TMS-SCE marker sleeves are designed to meet the wire and cable marking needs of manufacturers with high performance requirements, particularly in applications covering Military, Aerospace, Defense, and Mass Transit.

TMS-SCE-3X meets the performance requirements of SAE-AMS-DTL-23053/5 class 1. TMS-SCE-2X meets the performance requirements of SAE-AMS-DTL-23053/5 classes 1 and 3.

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**1. REVISION HISTORY**

Revision Number	Description of change	Date	Incorporated By
1	AFC 256	14 Apr 2004	Alan Kean
2	AFC 366	10 Aug 2005	Lee Smith
3	AFC 554	02 Dec 2009	Alan Kean
4	Ref DMTEC	14 Jan 2013	Lee Smith

**2. REQUIREMENTS**

**2.1. Composition, appearance and color**

The markers shall be fabricated from irradiated, thermally-stabilized, modified polyolefin compound. They shall be homogeneous and essentially free from flaws, defects, pinholes, bubbles, seams, cracks or inclusions.

**2.2. Color**

Markers shall be supplied as White, Yellow as standard. Non standard colors are Red, Pink, Orange, Green, Blue, Violet, Grey, and Black. Excluding Black, sleeving colors are pastel to provide enhanced mark contrast<sup>1</sup>.

**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 2.

<sup>1</sup> The pastel shades used in TMS-SCE do not meet the requirements of MIL STD 104 class 1 which relate to the Munsell color chart. This does not change the supplied product. Note the color pigments used have not changed since the product was launched.

### 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.

Some tests require lengths which are not supported by the TMS System 6 format; therefore sleeving and tubing shall be tested. For this document, 'sleeving' shall be defined as specimen that represents the finished article; this is the material taken from the end of the production line. 'Tubing' is specimen taken from work in progress and is removed from the production line prior to finishing. This tubing is supplied in continuous form. Other than the format, both of these specimens are identical.

##### 3.1.2. Acceptance Tests<sup>ii</sup>

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

- Dimensions
- Expanded Concentricity
- Longitudinal Change
- Tensile strength
- Ultimate Elongation
- 2% Secant Modulus
- Low Temperature Flexibility
- Heat Shock
- Print Adherence
- Flammability, ASTM D2671 Procedure B for TMS-SCE-2X
- Flammability, ASTM D2671 Procedure C for TMS-SCE-3X

#### 3.2. Sampling Instructions

##### 3.2.1. Qualification Test Samples

Qualification test samples shall consist of 15 m (50 feet) of continuous marker material and the appropriate number of finished markers necessary to run all tests. In all tests except for specific flammability tests listed below, qualification shall be carried out on size 6.4mm (1/4 inch) white sleeving. For ASTM E162, ASTM E662, ASTM 1354, and Boeing BSS 7239, 25.4mm continuous yellow sleeving shall be used. For UL224 Flammability – All tubing test, TMS-SCE-3/32-4 shall be used. Material sleeves and tubes shall be taken from the same compound batch.

<sup>ii</sup> Physical property tests performed at this time qualify subsequent sleeving lots produced from the same compound batch

### 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.

## 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 approximately 6mm (1/4 inch) of both ends using font type Arial 10 bold. Remove the markers from the carrier and test in both 'as received' and 'fully 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, sleeves or tubing will be recovered 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.

Unless otherwise specified, all tests shall be made at a temperature of  $23 \pm 2^{\circ}\text{C}$  ( $73 \pm 5^{\circ}\text{F}$ )

### 4.2. Print Performance

#### 4.2.1. Print Adherence<sup>iii</sup>

Three as supplied and three fully recovered specimens are tested in accordance with IEWI-012 using the 'Eraser Preparation for Mark Adherence testing' set up. Samples shall be rubbed 50 times using a Crockmeter with a 1kg load.

The marking shall be examined for legibility using normal reading vision. Print contrast shall be measured in accordance with TE Document 411-121002.

#### 4.2.2. Solvent Resistance

Three as supplied and three fully recovered specimens are tested for Solvent Resistance at least 24 hours after marking and preparation as required. Test in accordance with MIL STD 202G Method 215, except examine the specimens for legibility at a distance of 356mm (14 inches).

The marking shall be examined for legibility using normal reading vision. Print contrast shall be measured in accordance with TE Document 411-121002.

<sup>iii</sup> IEWI-012 describes the procedure TE use to achieve SAE-AS5942 'Adherence' using a weight of one kilogram



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### 4.3. Physical Properties

#### 4.3.1. Expanded and Recovered Dimensions

Measure the expanded inside diameter, recovered inside diameter, and recovered wall thickness of two assembled marker sleeves in accordance with SAE AMS-DTL-23053 sections 4.6.3.1.1, 4.6.3.1.2, and 4.6.3.2 respectively

#### 4.3.2. Expanded Concentricity

Test two finished sleeves. Measure the expanded concentricity in accordance with SAE AMS-DTL-23053 section 4.6.3.3

#### 4.3.3. Longitudinal Change

Mark two gauge marks 44.5mm (1.75 in.) apart on two finished sleeves. Recover the sample and measure the distance between gauge marks. The longitudinal change shall be expressed as a percentage of the original gauge mark distance in accordance with SAE AMS-DTL-23053 section 4.6.4.

#### 4.3.4. Tensile Strength and Ultimate Elongation

Measure the tensile strength and ultimate elongation of recovered tubing in accordance with SAE AMS-DTL-23053 section 4.6.13. Five samples shall be tested. The jaw separation speed shall be 508mm (20 inches) per minute.

#### 4.3.5. Secant Modulus

Measure the secant modulus of as received (expanded) tubing at 2 percent strain in accordance with SAE AMS-DTL-23053 section 4.6.12.1. Five samples shall be tested.

#### 4.3.6. Specific Gravity

Measure the specific gravity of three recovered sleeves in accordance ASTM D 792.

#### 4.3.7. Color

Measurement shall be made on three as received and three fully recovered sleeves.

Color of sleeving shall be supplied as TE standard White and Yellow, and non-standard Red, Pink, Orange, Green, Blue, Violet, Grey, and Black.

Color shall be checked using human vision and measured using a spectrophotometer against Lab (CIELAB) color space using a 10° aperture in D65 luminance. The color shall be representative and clearly recognizable.

In this document revision, the color measurement is taken for information only.

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**4.3.8. Color Stability**

Testing shall be made on 3 sleeves, in accordance with SAE AMS-DTL-23053 section 4.6.15. Product shall be printed as detailed in 4.1.

Condition the specimens for 24 hours at  $175 \pm 2^{\circ}\text{C}$  ( $347 \pm 4^{\circ}\text{F}$ ) in a convection oven, with an air velocity of 30 to 60m (100 to 200ft) per minute past the specimens. Remove the specimens from the oven, and allow cooling to room temperature.

The sample shall be checked by human eye and by spectrophotometer. The print contrast shall be clear, and the print shall be legible at normal reading distance. Colour shall not change significantly and be clearly recognizable.

The color shall be measured using a spectrophotometer against Lab (CIELAB) Colour space using a  $10^{\circ}$  aperture in D65 luminance.

In this document revision, the color measurement is taken for information only.

**4.4. Electrical Properties**

**4.4.1. Restricted Shrinkage**

Test three tubes for restricted shrinkage in accordance with SAE AMS-DTL-23053 section 4.6.6 Procedure A. No cracks should be visible after 30 minutes at  $175 \pm 2^{\circ}\text{C}$  ( $347 \pm 4^{\circ}\text{F}$ ).

**4.4.2. Voltage Withstand**

After testing for Restricted Shrinkage, further prepare the samples for voltage withstand testing in accordance with SAE AMS-DTL-23053 section 4.6.6.3.

**4.4.3. Dielectric Strength**

Test three tubes for dielectric strength in accordance with ASTM D 2671.

**4.4.4. Volume Resistivity**

Test three tubes for volume resistivity in accordance with ASTM D 876

#### 4.5. Thermal Properties

##### 4.5.1. Low Temperature Flexibility

Test three printed sleeves and three 150mm (5 inch) long tubes. The printed sleeves shall be shrunk onto 3.2mm metal mandrels and prepared using the regime described in 4.1.

Test the sleeving in accordance with SAE AMS-DTL-23053/5 section 4.6.7.1. Condition the specimens for 4 hours at  $-55 \pm 1^\circ\text{C}$  ( $-67 \pm 2^\circ\text{F}$ ). While at this temperature, bend the tubular specimens 360 degrees, in  $10 \pm 2$  seconds, over a similarly conditioned  $9.5\text{mm} \pm 0.08\text{mm}$  ( $3/8 \pm 0.003$  inch) metal mandrel.

Test the printed samples for print adherence as specified in 4.2.1 using 20 rubs.

The marking shall be examined for legibility using normal reading vision. Print contrast shall be measured in accordance with TE Document 411-121002.

##### 4.5.2. Heat Shock

Test three printed sleeves and three 150mm (5 inch) long tubes. The printed sleeves shall be shrunk onto 3.2mm metal mandrels and prepared using the regime described in 4.1.

All samples shall be tested for heat shock in accordance with SAE AMS-DTL-23053 section 4.6.8. Condition the specimens for 4 hours at  $250 \pm 3^\circ\text{C}$  ( $482 \pm 5^\circ\text{F}$ ) in a convection oven, with an air velocity of 30 to 60m (100 to 200 ft) per minute past the specimens. Remove the specimens from the oven, and allow cooling to room temperature.

Bend the tubes through 360 degrees, in 2 to 4 seconds, over a  $9.5\text{mm} \pm 0.08\text{mm}$  ( $3/8 \pm 0.003$  inch) metal mandrel. Disregard any side cracking caused by flattening of the specimens on the mandrel.

Test the printed samples for print adherence as specified in 4.2.1 using 20 rubs.

The sleeve marking shall be examined for legibility using normal reading vision. Print contrast shall be measured in accordance with TE Document 411-121002.

#### 4.5.3. Heat Resistance

Test three printed sleeves and five 150mm (5 inch) long tubes. The printed sleeves shall be shrunk onto 3.2mm metal mandrels and prepared using the regime described in 4.1.

In accordance with SAE AMS-DTL-23053 section 4.6.9, condition the specimens for 168 hours at  $175 \pm 2^{\circ}\text{C}$  ( $347 \pm 4^{\circ}\text{F}$ ) in a convection oven, with an air velocity of 30 to 60m (100 to 200 ft) per minute past the specimens. Remove the specimens from the oven, and allow cooling to  $23 \pm 2^{\circ}\text{C}$  ( $73 \pm 5^{\circ}\text{F}$ ).

Test the tubes in accordance with SAE AMS-DTL-23053 section 4.3.10, Ultimate Elongation. Test the printed samples for print adherence as specified in 4.2.1 using 20 rubs.

The sleeve marking shall be examined for legibility using normal reading vision. Print contrast shall be measured in accordance with TE Document 411-121002.

#### 4.6. Flammability

##### 4.6.1. Flammability, ASTM D2671 Procedure B

(TMS-SCE-1/4 and TMS-SCE-2X-1/4 only)

460mm long samples shall be installed onto 530mm long mandrels. The mandrel diameter in each case shall be equal to the maximum recovered diameter of the tube. After heat recovery, assemblies shall be allowed to condition at  $23 \pm 2^{\circ}\text{C}$  ( $73 \pm 5^{\circ}\text{F}$ ) for at least 24 hours before testing. Ensure samples have not scorched (by coming into contact with the oven frame) as this may affect flammability performance. Each sample should have a paper flag indicator 250mm above the flame impingement point. The flame should be applied to the sample at  $70^{\circ}$  angle. The flame should be applied five times for 15s on and 15s off.

After the fifth cycle of flame application, record the duration of the burning and percentage of the burnt or charred area. Ignore any soot that can be removed by wiping. Observe whether flaming or glowing particles fall from the specimen during the test. The burnt area on the indicator flag shall be measured using a rule.

##### 4.6.2. Flammability, ASTM D2671 Procedure C (TMS-SCE-2X-1/4 only)

Use the procedure outlined in 4.6.1. (procedure B) except that 460mm long samples should be installed onto 530mm long 0.7mm diameter steel wires.

##### 4.6.3. Limited Oxygen Index , BS EN ISO 4589-2

The test method shall be as specified in IEWI-054. Tests shall be carried out on 3mm plaques of material from which the sleeving is fabricated. The plaque will be irradiation cross-linked to the same degree as the sleeving. Test piece dimensions shall be  $6.5 \pm 0.5\text{mm} \times 80 \pm 1\text{mm} \times 3 \pm 0.5\text{mm}$  cut from the plaques and shall be conditioned for at least 24hrs at  $23 \pm 2^{\circ}\text{C}$  prior to testing. A new test piece shall be used for each determination.



**4.6.4. UL224 Flame Test – All Tubing (TMS-SCE-3/32 only)<sup>iv</sup>**

The test method is as specified in CSA C22.2 No. 198.1-99 (UL224). 460mm long samples shall be installed onto 530mm long steel mandrels, 0.8mm in diameter. During recovery, ensure samples have not scorched (by coming into contact with the oven frame). Each sample should have a paper flag indicator 250mm above the flame impingement point. The flame should be applied to the sample at 70° angle. The flame should be applied five times for 15s on and 15s off.

Record the duration of burning and percentage of the burnt area as described in 4.6.1.

**4.6.5. Flame Spread Index, ASTM E162 (TMS-SCE-1 only)<sup>v</sup>**

This test is performed in accordance with ASTM E162 with the following modification: The heat shrink sleeve is preshrunk onto 12mm by 457mm fiberglass reinforced cement board. Ten sections are placed side by side vertically for each test in order to create the required test specimens.

**4.6.6. Specific Optical Density, ASTM E 662 (TMS-SCE-1 only)**

The test is performed in accordance with ASTM E662 with the following modification: The heat shrink tube is preshrunk onto 12mm by 457mm fiberglass reinforced cement board. The preshrunk sleeve material is further cut to 76mm lengths. Five sections are placed side by side vertically for each test in order to create the required test specimens. Testing is carried out using an NBC smoke chamber.

Smoke density (Ds) is measured in flaming and non-flaming mode at 1.5 and 4 minutes.

**4.6.7. Maximum average rate of heat emission (MARHE), ASTM E1354 (TMS-SCE-1 only)**

This test is performed in accordance with ASTM E1354 with the following modification: The heat shrink tube is preshrunk onto 12mm x 457mm fiberglass reinforced cement board. The assemblies are further cut to 100mm lengths, and 7 sections are placed together side by side for each test to create the required test specimens. Testing is carried out by oxygen consumption calorimeter using a heat flux of 50 kW/m<sup>2</sup>.

**4.6.8. Toxic gas generation from material combustion, BSS 7239 (TMS-SCE-1 only)**

This test is performed in accordance with BSS 7239 with the following modification: The heat shrink sleeve is preshrunk onto 12mm x 457mm fiberglass reinforced cement board. The assemblies are further cut to 76mm lengths, and 5 sections are placed together side by side for each test to create the required test specimens. This test is carried out during ASTM E662 evaluation.

Gases are extracted and analyzed using the techniques described in BSS 7239.

<sup>iv</sup> Carried out by Menlo Park Facility due to chamber requirements

<sup>v</sup> To be externally tested by Exova© Canada. Exova have been working closely with the end user of this product, and it has been agreed that the sample configuration should match the installed product.

#### 4.7. Environmental Properties

##### 4.7.1. Corrosion

Test three tubes for copper corrosion in accordance with SAE AMS DTL 23053 section 4.6.10.1. Heat the samples for 16 hours at  $175 \pm 2^{\circ}\text{C}$  ( $347 \pm 4^{\circ}\text{F}$ ).

Test three tubes for copper mirror corrosion in accordance with SAE AMS DTL 23053 section 4.6.10.2. Heat the samples for 16 hours at  $175 \pm 2^{\circ}\text{C}$  ( $347 \pm 4^{\circ}\text{F}$ ).

##### 4.7.2. Fungus Resistance

Test six printed sleeves and ten 150mm (5 inch) long tubes. Half of the printed sleeves shall be shrunk onto 3.2mm metal mandrels using the regime described in 4.1. Prepare the tubes for tensile strength, ultimate elongation (section 4.3.4.) and dielectric strength (section 4.4.3.)

Fungus resistance testing shall be conducted in accordance with ISO 846 B with an incubation time of 56 days. Pre-cleaning is not required by the test lab. Ensure the samples are handled using non vinyl gloves to prevent contamination, and the samples are placed in PE bags during transit to the test laboratory.

Test five tubes for tensile strength and ultimate elongation as specified in section 4.3.4. and five samples for dielectric strength as specified in section 4.4.3. Test printed sleeves for print adherence, using 20 rubs, as specified in section 4.1.

After the print adherence test, marking shall be examined for legibility using normal reading vision. Print contrast shall be measured in accordance with TE Document 411-121002.

##### 4.7.3. Water Absorption

Test three tubes for water absorption in accordance with ASTM D 570. Immersion conditions are 24 hours at  $23 \pm 3^{\circ}\text{C}$  ( $73 \pm 5^{\circ}\text{F}$ ).

##### 4.7.4. Fluid Resistance

Prepare sixty-six printed sleeves in accordance with section 4.1 and one hundred and ten 150mm (5 inch) long tubes for tensile strength and dielectric strength.

Test for fluid resistance in accordance with SAE AMS-DTL-23053 section 4.6.11, using the fluids detailed in table 1.

Test tubes for tensile strength (4.3.4) and dielectric strength (4.4.3). Test printed sleeves for print adherence, using 20 rubs, as specified in section 4.1.

After the print adherence test, marking shall be examined for legibility using normal reading vision. Print contrast shall be measured in accordance with TE Document 411-121002.

**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 Storage Conditions**

Markers should be stored in a clean dry location. Maximum storage temperature is 40 °C (104 °F).

**6.2. Storage Life**

Storage Life shall be in compliance with SAE AMS-DTL-23053/5 section 3.5.1. 5 years when stored between 18°C to 35°C (64°F to 95°F)

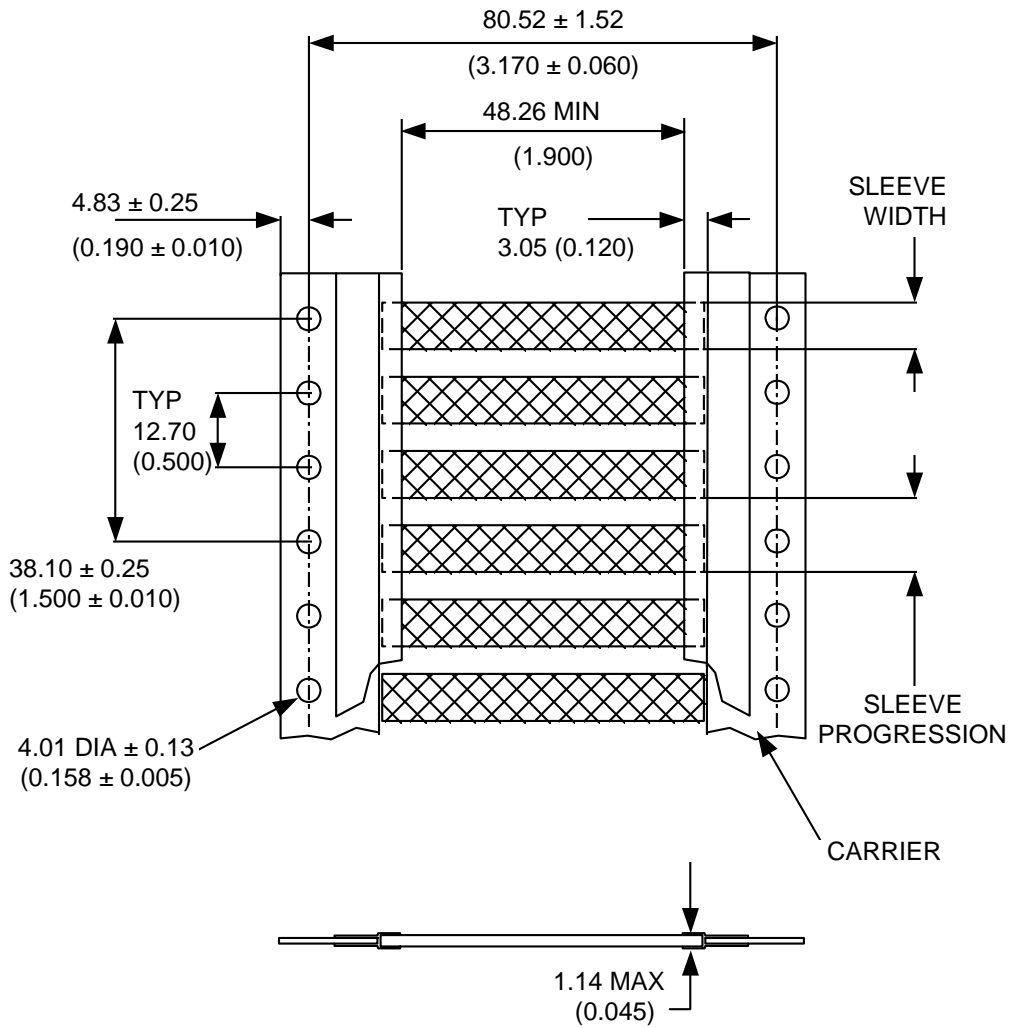
**6.3. Packaging**

Packaging shall be in accordance with good commercial practice

**6.4. Marking**

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

Figure 1



Dimensions in mm (Inches)



**TABLE 1  
 REQUIREMENTS  
 (DIMENSIONS IN mm, (INCHES))**

Part Number	Minimum Expanded inside Dia.	Maximum Recovered inside Dia.	Recovered Wall Thickness	Sleeve Progression	Nominal Weight (g/pc)
TMS-SCE-3/32	2.36 (0.093)	0.79 (0.031)	0.58 +/- 0.08 (0.023 +/- 0.003)	12.70 +/- 0.89 (0.500 +/- 0.035)	0.150
TMS-SCE-2X-3/32	2.36 (0.093)	1.17 (0.046)	0.51 +/- 0.08 (0.020 +/- 0.003)	12.70 +/- 0.89 (0.500 +/- 0.035)	0.204
TMS-SCE-1/8	3.18 (0.125)	1.07 (0.042)	0.58 +/- 0.08 (0.023 +/- 0.003)	12.70 +/- 0.89 (0.500 +/- 0.035)	0.203
TMS-SCE-2X-1/8	3.18 (0.125)	1.58 (0.062)	0.51 +/- 0.08 (0.020 +/- 0.003)	12.70 +/- 0.89 (0.500 +/- 0.035)	0.275
TMS-SCE-3/16	4.75 (0.187)	1.57 (0.062)	0.58 +/- 0.08 (0.023 +/- 0.003)	12.70 +/- 0.89 (0.500 +/- 0.035)	0.268
TMS-SCE-2X-3/16	4.75 (0.187)	2.36 (0.093)	0.51 +/- 0.08 (0.020 +/- 0.003)	12.70 +/- 0.89 (0.500 +/- 0.035)	0.362
TMS-SCE-1/4	6.35 (0.250)	2.11 (0.083)	0.58 +/- 0.08 (0.023 +/- 0.003)	16.94 +/- 0.89 (0.667 +/- 0.035)	0.351
TMS-SCE-2X-1/4	6.35 (0.250)	3.18 (0.125)	0.64 +/- 0.08 (0.025 +/- 0.003)	16.94 +/- 0.89 (0.667 +/- 0.035)	0.594
TMS-SCE-3/8	9.53 (0.375)	3.18 (0.125)	0.58 +/- 0.08 (0.023 +/- 0.003)	25.40 +/- 1.14 (1.000 +/- 0.045)	0.504
TMS-SCE-2X-3/8	9.53 (0.375)	4.75 (0.187)	0.64 +/- 0.08 (0.025 +/- 0.003)	25.40 +/- 1.14 (1.000 +/- 0.045)	0.850
TMS-SCE-1/2	12.70 (0.500)	4.22 (0.166)	0.61 +/- 0.08 (0.024 +/- 0.003)	29.64 +/- 1.14 (1.167 +/- 0.045)	0.681
TMS-SCE-2X-1/2	12.70 (0.500)	6.35 (0.250)	0.64 +/- 0.08 (0.025 +/- 0.003)	29.64 +/- 1.14 (1.167 +/- 0.045)	1.145
TMS-SCE-3/4	19.05 (0.750)	6.35 (0.250)	0.61 +/- 0.08 (0.024 +/- 0.003)	42.34 +/- 1.14 (1.667 +/- 0.045)	1.203
TMS-SCE-2X-3/4	19.05 (0.750)	9.53 (0.375)	0.76 +/- 0.08 (0.030 +/- 0.003)	42.34 +/- 1.14 (1.667 +/- 0.045)	2.063
TMS-SCE-1	25.40 (1.000)	8.46 (0.333)	0.64 +/- 0.08 (0.025 +/- 0.003)	50.80 +/- 1.14 (2.000 +/- 0.045)	1.535
TMS-SCE-1-1/2	38.10 (1.500)	19.05 (0.750)	0.51 +/- 0.08 (0.020 +/- 0.003)	71.96 +/- 1.14 (2.833 +/- 0.045)	2.751
TMS-SCE-2	50.80 (2.000)	25.40 (1.000)	0.64 +/- 0.08 (0.025 +/- 0.003)	101.60 +/- 1.14 (4.000 +/- 0.045)	4.727
TMS-SCE-2-1/4	57.15 (2.250)	19.05 (0.750)	0.76 +/- 0.08 (0.030 +/- 0.003)	101.60 +/- 1.14 (4.000 +/- 0.045)	4.206

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**7. Related Standards<sup>vi</sup>**

A A 694	SODIUM CHLORIDE, TECHNICAL
MIL-STD-202 METHOD 215: FEB 2002	PRESSURE-SENSITIVE ADHESIVE PLASTICS LABELS FOR PERMANENT USE
SAE AS5942	MARKING OF ELECTRICAL INSULATING MATERIALS
ASTM D 570	TEST METHOD FOR WATER ABSORPTION OF PLASTICS
ASTM D 792	TEST METHODS FOR DENSITY AND SPECIFIC GRAVITY (RELATIVE DENSITY) OF PLASTICS BY DISPLACEMENT
ASTM D 876	TEST METHOD FOR NONRIGID VINYL CHLORIDE POLYMER TUBING, USED FOR ELECTRICAL INSULATION
ISO-846	PLASTICS – EVALUATION OF THE ACTION OF MICRO ORGANISMS
SAE AMS-DTL- 23053	INSULATING SLEEVING, ELECTRICAL, HEAT SHRINKABLE, GENERAL SPECIFICATION FOR
SAE AMS-DTL- 23050/5	INSULATION SLEEVING, ELECTRICAL, HEAT SHRINKABLE, POLYOLEFIN, FLEXIBLE CROSS-LINKED
TE DOCUMENT 411-121002	TE PRINT CONTRAST REFERENCE SCALE
TE DOCUMENT 411-121005	TE IDENTIFICATION PRINTER PRODUCT RIBBON MATRIX.
IEWI-012	PRINT PERMANENCE TESTING USING THE MECHANICAL CROCKMETER

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



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TABLE 2 TEST REQUIREMENTS			
PHYSICAL			
PROPERTY	UNIT	REQUIREMENT	TEST METHOD
Dimensions 3 minutes at 200 ± 2°C (392 ± 4°F)	mm (inches)	In accordance with Table 3	Section 4.3.1 SAE AMS- DTL-23053
Concentricity (Expanded)	Percent	50% minimum 70% minimum (2X sizes)	Section 4.3.2 SAE AMS-DTL 23053
Longitudinal Change	Percent	TMS-SCE Range 0 to -20 TMS-SCE-2X Range 0 to -5	Section 4.3.3 SAE AMS-DTL-23053
Tensile Strength	MPa (psi)	10.3 (1,500) minimum	Section 4.3.4 SAE AMS-DTL-23053
Ultimate Elongation	Percent	200 minimum	Section 4.3.4 SAE AMS-DTL-23053
Secant Modulus (Expanded) 2 percent strain	MPa (psi)	172.4 (25,000) maximum	Section 4.3.5 SAE AMS-DTL-23053
Specific Gravity	---	1.35 maximum	Section 4.3.7 ASTM D 792
Color	---	Measure and record only.	
Color Stability 24 hours at 175 ± 2°C (347 ± 4°F)	---	No significant visual change and still recognizable as color.  Measure and record only	Section 4.3.13 SAE AMS DTL 23053
ELECTRICAL			
Restricted Shrinkage 30 minutes at 175 ± 2°C (347 ± 4°F)	---	No Cracking	Section 4.3.6 SAE AMS-DTL-23053 Procedure A
Followed by test for: Voltage Withstand 2000 Vac for 1 minute	---	Pass	Section 4.3.6.1 SAE AMS DTL 23053
Dielectric Strength	kV/mm (V/mil)	19.7 minimum (500) minimum	Section 4.3.14 ASTM D 2671
Volume Resistivity	Ohm-cm	10 <sup>14</sup> minimum	Section 4.3.15 ASTM D 876

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**TABLE 2 TEST REQUIREMENTS (continued)**

<b>THERMAL</b>			
<b>PROPERTY</b>	<b>UNIT</b>	<b>REQUIREMENT</b>	<b>TEST METHOD</b>
Low Temperature Flexibility 4 hours at $-55 \pm 1^{\circ}\text{C}$ ( $-67 \pm 2^{\circ}\text{F}$ ), followed by:  Tubing bend test Sleeve print adherence	---  ---	No cracking Legible, minimum print contrast 3	Section 4.5.1;  SAE AMS-DTL-23053 clause 4.6.7.1.
Heat Shock 4 hours at $250 \pm 3^{\circ}\text{C}$ ( $482 \pm 5^{\circ}\text{F}$ ), followed by:  Tubing bend test  Sleeve print adherence	---  ---	No dripping, flowing, or cracking  Legible, minimum print contrast 3	Section 4.5.2; SAE AMS-DTL-23053 clause 4.6.8.
Heat Resistance 168 hours at $175 \pm 2^{\circ}\text{C}$ ( $347 \pm 4^{\circ}\text{F}$ ) Followed by:  Ultimate Elongation Print Adherence	---  Percent Rubs	100 minimum 50 minimum, legible	Section 4.5.3. SAE AMS-DTL-23053 Clause 4.6.9.

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**TABLE 2 TEST REQUIREMENTS (continued)**

<b>FIRE SAFETY</b>			
<b>PROPERTY</b>	<b>UNIT</b>	<b>REQUIREMENT</b>	<b>TEST METHOD</b>
Resistance to Burning ASTM D2761, Procedure B (TMS-SCE and TMS-SCE-2X)	---	Burn time shall not exceed one minute, and not more than 25% of indicator flag shall be burned or charred. No dripping or flowing. No burning of cotton.	Section 4.6.1.
Resistance to Burning ASTM D2761, Procedure C (TMS-SCE-2X only)	---	Burn time shall not exceed one minute, and not more than 25% of indicator flag shall be burned or charred. No dripping or flowing. No burning of cotton.	Section 4.6.2.
Limited Oxygen Index <sup>vii</sup>	%	Minimum 28%	Section 4.6.3.
UL 224 – All tubing flame test		Burn time shall not exceed one minute, and not more than 25% of indicator flag shall be burned or charred. No dripping or flowing. No burning of cotton.	Section 4.6.4. CSA C22.2 No.198.1-99 (UL224)
Flame Spread Index	---	Is 35 Maximum, no flame running or flame dripping	Section 4.6.5. ASTM E162
Specific Optical Density (flaming/non-flaming)	---	100 maximum (1.5 minutes), 200 maximum (4 minutes)	Section 4.6.6. ASTM E662
Maximum Average Rate of Heat Emission	---	300 kW/m2 Maximum	Section 4.6.7. 50kW/m2 Irradiance, ASTM E 1354
Toxic gas generation from material combustion	---	Toxic gas generation from material combustion parts per million (ppm), maxima:  Carbon 3500 Nitrogen 100 Sulphur 100 Hydrogen 500 Hydrogen 200 Hydrogen 100 Hydrogen 150	Boeing BSS 7239 (SMP 800-C)

<sup>vii</sup> 28% LOI is equivalent to Hazard Level 1 as defined by EN 45545-2:2012

**TABLE 2 TEST REQUIREMENTS (continued)**

<b>PRINT ENDURANCE</b>			
<b>PROPERTY</b>	<b>UNIT</b>	<b>REQUIREMENT</b>	<b>TEST METHOD</b>
Mark Adherence	Rubs	50 minimum, legible	Section 4.2.1. IEWI-012 (AMS AS5942)
Solvent Resistance	Strokes	30 minimum, legible	MIL-202G Method 215
<b>ENVIRONMENTAL</b>			
Fluid immersion <sup>viii</sup> , 24 hours at 21°C (70°F):			
<b>Industrial Grade:</b> <ul style="list-style-type: none"> <li>• Water (De-ionised)</li> <li>• Detergent</li> <li>• (Tepol in water, 1% by weight)</li> <li>• MIL-L-7808 Lubricating oil</li> <li>• MIL-L-23699 Lubricating oil</li> <li>• MIL-T-83133 Aircraft Fuel (JP-8)</li> <li>• Sodium Chloride, (in water, 5% by weight)</li> <li>• MIL-H-83282 Hydraulic Fluid</li> <li>• Propylene Glycol de-icing Fluid, (in water, 50% by volume)</li> <li>• Isopropyl Alcohol</li> </ul>			Section 4.7.4.
<b>High Performance Grade:</b> <ul style="list-style-type: none"> <li>• Aviation Gasoline 100/130</li> <li>• Skydrol 500 B4<sup>ix</sup></li> </ul>			
Followed by test for:			
Dielectric Strength	kV/mm (V/mil)	15.8 (400) minimum	Section 4.4.3. ASTM D 2671
Tensile Strength	MPa (psi)	6.9 (1000) minimum	Section 4.3.4. SAE AMS-DTL-23053
Print Adherence	Rubs	20 minimum, legible	Section 4.2.1.

<sup>viii</sup> Industrial grade fluids have been standardized by TE, and are those most likely to be found in application; the high performance grade fluids are designed for aerospace use.

<sup>ix</sup> Skydrol is a trademark of Solutia



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TABLE 2 TEST REQUIREMENTS (continued)			
ENVIRONMENTAL			
PROPERTY	UNIT	REQUIREMENT	TEST METHOD
Corrosive Effect 16 hours at 175 ± 2°C (347 ± 4°F)			
Copper Contact	---	Non corrosive	Section 4.3.16.1
Copper Mirror	---	No pitting or blackening of copper	Section 4.3.16.2
Fungus Resistance, followed by:			Section 4.7.2. ISO 846B, 56 days
Tensile strength	MPa (psi)	10.3 (1,500) minimum	Section 4.3.4. SAE AMS-DTL-23053
Ultimate Elongation	%	200 minimum	Section 4.3.4. SAE AMS-DTL-23053
Dielectric Strength	kV/mm (V/mil)	19.7 minimum (500) minimum	Section 4.4.3. ASTM D 2671
Print Adherence	---	20 rubs, legible	Section 4.2.1.
Water Absorption	Percent	0.5 maximum	Section 4.3.19 ASTM D 570

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