

# Specification RW-2511

Document Number: 108-121014

## TMS-SCE and TTMS(-MP)

3:1 Shrink Ratio

## TMS-SCE-2X & TTMS-2X

2:1 Shrink Ratio

### Heat Shrinkable Identification Products

#### SCOPE

**This quality assurance specification establishes the quality standard for heat shrinkable identification markers, for use in multipurpose and military applications. The special requirements for military applications are detailed in Table 8.**

The operating temperature for this product is -55°C to +135°C (-67 to +275°F).

This system is an automatic method of identifying items by printing a mark on TMS-SCE and TTMS product ranges. The mark is permanent upon printing. This system is not recommended where strain relief properties are required.

Products are available in both 2:1 (e.g. TMS-SCE-2X) and 3:1 (e.g. TMS-SCE) shrink ratio (refer to Tables 1-3 for more details).

The marker system comprises specific printers and ribbons (refer to Identification Printer Product Ribbon Matrix Document 411-121005). Products printed with black or silver ribbons as specified in 411-121005 fully comply with this specification. Products printed with white ribbon may not fully meet the specified performance when exposed to some aggressive fluids, details on page 12. Compliance to this specification can only be guaranteed if TE Connectivity approved printers and ribbons are used.

Laser markable using industrial standard YAG lasers.

The tube size for qualification testing is 6.4mm as supplied internal diameter with both 2:1 and 3:1 shrink ratio unless otherwise specified.

**Approved Signatories: This document is electronically reviewed and approved by TE Connectivity.**

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## 1. REQUIREMENTS

### 1.1 Composition and Appearance

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

### 1.2 Dimensions

The product shall be supplied in one of the following formats:

TMS-SCE(-2X) as shown in figure 1 and to the dimensions of table 1 and table 2

TTMS or TTMS-MP continuous tubing to the dimensions of table 3,

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2. PRODUCT DRAWINGS

2.1 TMS-SCE System 6

Note: Dimensions in mm (inches)

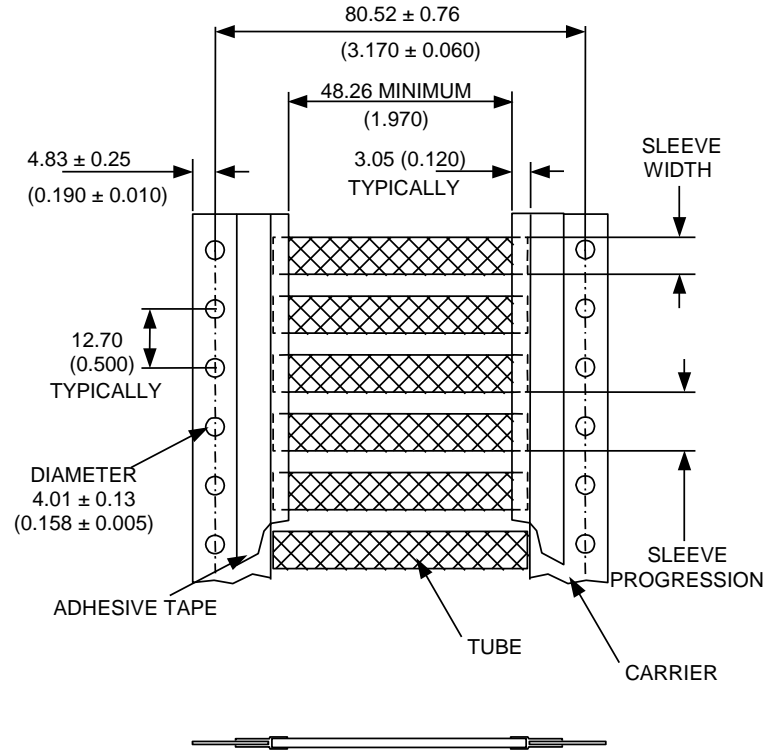


Figure 1. TMS-SCE System 6 format

2.2. Heat Shrink Product in as Supplied “D” (Expanded) and in the Recovered State “d”.

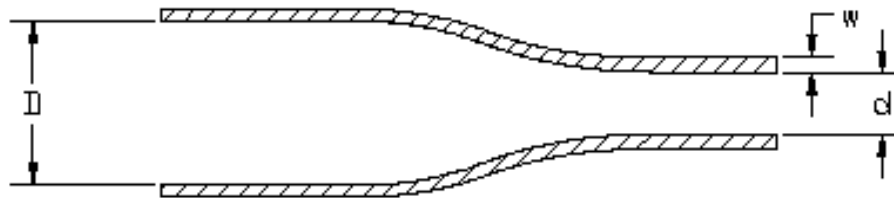


Figure 2. Product Dimensions Change During Recovery

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Table 1. Product Dimensions TMS-SCE- 2X

Part Description	Minimum Supplied Inside Diameter mm (inches)	Maximum Recovered Inside Diameter mm (inches)	Wall Thickness After Recovery mm (inches)	Minimum Sleeve Flattened Width mm (inches)	Sleeve Progression mm (inches)	Nominal Weight of single sleeve (~50mm long) grams
TMS-SCE-2X-3/32	2.36 (0.093)	1.17 (0.046)	0.51 ± 0.08 (0.020 ± 0.003)	4.45 (0.18)	12.70 ± 0.89 (0.500 ± 0.035)	0.20
TMS-SCE-2X-1/8	3.18 (0.125)	1.58 (0.062)	0.51 ± 0.08 (0.020 ± 0.003)	5.84 (0.23)	12.70 ± 0.89 (0.500 ± 0.035)	0.28
TMS-SCE-2X-3/16	4.75 (0.187)	2.36 (0.093)	0.51 ± 0.08 (0.020 ± 0.003)	8.00 (0.32)	12.70 ± 0.89 (0.500 ± 0.035)	0.36
TMS-SCE-2X-1/4	6.35 (0.250)	3.18 (0.125)	0.64 ± 0.08 (0.025 ± 0.003)	10.67 (0.42)	16.94 ± 0.89 (0.667 ± 0.035)	0.59
TMS-SCE-2X-3/8	9.53 (0.375)	4.75 (0.187)	0.64 ± 0.08 (0.025 ± 0.003)	15.49 (0.61)	25.40 ± 1.14 (1.000 ± 0.045)	0.85
TMS-SCE-2X-1/2	12.70 (0.500)	6.35 (0.250)	0.64 ± 0.08 (0.025 ± 0.003)	20.45 (0.81)	29.64 ± 1.14 (1.167 ± 0.045)	1.15
TMS-SCE-2X-3/4	19.05 (0.750)	9.53 (0.375)	0.76 ± 0.08 (0.030 ± 0.003)	30.48 (1.2)	42.34 ± 1.14 (1.667 ± 0.045)	2.06

Table 2. Product Dimensions TMS-SCE

Part Description	Minimum Supplied Inside Diameter mm (inches)	Maximum Recovered Inside Diameter mm (inches)	Wall Thickness After Recovery mm (inches)	Minimum Sleeve Flattened Width mm (inches)	Sleeve Progression mm (inches)	Nominal Weight of single sleeve (~50mm long) grams
TMS-SCE-3/32	2.36 (0.093)	0.79 (0.031)	0.58 ± 0.08 (0.023 ± 0.003)	4.45 (0.18)	12.70 ± 0.89 (0.500 ± 0.035)	0.15
TMS-SCE-1/8	3.18 (0.125)	1.07 (0.042)	0.58 ± 0.08 (0.023 ± 0.003)	5.84 (0.23)	12.70 ± 0.89 (0.500 ± 0.035)	0.20
TMS-SCE-3/16	4.75 (0.187)	1.57 (0.062)	0.58 ± 0.08 (0.023 ± 0.003)	8.00 (0.32)	12.70 ± 0.89 (0.500 ± 0.035)	0.27
TMS-SCE-1/4	6.35 (0.250)	2.11 (0.083)	0.58 ± 0.08 (0.023 ± 0.003)	10.67 (0.42)	16.94 ± 0.89 (0.667 ± 0.035)	0.35
TMS-SCE-3/8	9.53 (0.375)	3.18 (0.125)	0.61 ± 0.08 (0.024 ± 0.003)	15.49 (0.61)	25.40 ± 1.14 (1.000 ± 0.045)	0.50
TMS-SCE-1/2	12.70 (0.500)	4.22 (0.166)	0.61 ± 0.08 (0.024 ± 0.003)	20.45 (0.81)	29.64 ± 1.14 (1.167 ± 0.045)	0.68
TMS-SCE-3/4	19.05 (0.750)	6.35 (0.250)	0.61 ± 0.08 (0.024 ± 0.003)	30.48 (1.2)	42.34 ± 1.14 (1.667 ± 0.045)	1.20
TMS-SCE-1	25.40 (1.000)	8.46 (0.333)	0.64 ± 0.08 (0.025 ± 0.003)	40.39 (1.59)	50.80 ± 1.14 (2.000 ± 0.045)	1.54
TMS-SCE-1-1/2	38.10 (1.500)	19.05 (0.750)	0.51 ± 0.08 (0.020 ± 0.003)	60.33 (2.38)	71.96 ± 1.14 (2.833 ± 0.045)	2.75
TMS-SCE-2	50.80 (2.000)	25.40 (1.000)	0.64 ± 0.08 (0.025 ± 0.003)	80.01 (3.15)	101.60 ± 1.14 (4.000 ± 0.045)	4.73
TMS-SCE-2-1/4	57.15 (2.250)	19.05 (0.750)	0.76 ± 0.08 (0.030 ± 0.003)	88.90 (3.50)	101.60 ± 1.14 (4.000 ± 0.045)	4.21

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Table 3. Product Dimensions TTMS and TTMS-MP

Part Description	Minimum Supplied Inside Diameter mm (inches)	Maximum Recovered Inside Diameter mm (inches)	Wall Thickness After Recovery mm (inches)	Minimum Sleeve Flattened Width mm (inches)	Nominal Weight of single sleeve (~50mm long) grams
TTMS-2.4 TTMS-MP-2.4	2.36 (0.093)	0.79 (0.031)	0.58 ± 0.08 (0.023 ± 0.003)	4.45 (0.18)	0.15
TTMS-3.2 TTMS-MP-3.2	3.18 (0.125)	1.06 (0.042)	0.58 ± 0.08 (0.023 ± 0.003)	5.84 (0.23)	0.20
TTMS-4.8 TTMS-MP-4.8	4.75 (0.187)	1.57 (0.062)	0.58 ± 0.08 (0.023 ± 0.003)	8.00 (0.32)	0.27
TTMS-6.4 TTMS-MP-6.4	6.35 (0.250)	2.11 (0.083)	0.58 ± 0.08 (0.023 ± 0.003)	10.67 (0.42)	0.35
TTMS-9.5 TTMS-MP-9.5	9.53 (0.375)	3.17 (0.125)	0.61 ± 0.08 (0.024 ± 0.003)	15.49 (0.61)	0.50
TTMS-12.7 TTMS-MP-12.7	12.70 (0.500)	4.21 (0.166)	0.61 ± 0.08 (0.024 ± 0.003)	20.45 (0.81)	0.68
TTMS-19.0 TTMS-MP-19.0	19.05 (0.750)	6.35 (0.250)	0.61 ± 0.08 (0.024 ± 0.003)	30.48 (1.2)	1.20
TTMS-25.4 TTMS-MP-25.4	25.40 (1.0)	8.45 (0.333)	0.64 ± 0.08 (0.025 ± 0.003)	40.39 (1.59)	1.54
TTMS-38.1 TTMS-MP-38.1	38.10 (1.5)	19.00 (0.750)	0.51 ± 0.08 (0.020 ± 0.003)	60.33 (2.38)	2.75
TTMS-50.8 TTMS-MP-50.8	50.80 (2.0)	25.40 (1.00)	0.64 ± 0.08 (0.025 ± 0.003)	80.01 (3.15)	4.73
TTMS-60	57.3 (2.265)	19.0 (0.75)	0.76 ± 0.08 (0.030 ± 0.003)	88.9 (3.50)	4.21

### 3. TEST REQUIREMENTS

This specification details the requirements for the TMS-SCE and TTMS family of products. Table 7 lists the general tests for Identification Products and Table 8 lists the specific tests which reflect the performance of TMS-SCE and TTMS.

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#### 4. RELATED DOCUMENTS

##### 4.1 Identification Engineering Work Instructions IEWI

TE Doc. Number	TE reference	TE Title	Complies with
109-121002	IEWI-002	Tensile Strength and Ultimate Elongation at 23°C	ASTM D2671 (section 44-48) ASTM D412
109-121003	IEWI-003	Dimensions	ASTM D2671 (section 8-13) ASTM D876
109-121005	IEWI-005	Dielectric Strength	ASTM D2671 (section 20-25) ASTM D149
109-121006	IEWI-006	Low Temperature Flexibility	SAE-AS-23053 (section 36 -43) IEC 60684-2
109-121007	IEWI-007	Heat Shock	SAE-AS-23053 ASTM D2671 (section 26-30)
109-121008	IEWI-008	Heat Resistance	SAE-AS-23053 ASTM D2671 (section 49-54)
109-121009	IEWI-009	Copper Mirror Corrosion	ASTM D2671 (section 93 procedure A)
109-121012	IEWI-012	Print Permanence Testing Using the Mechanical Crockmeter	SAE AS5942
109-121015	IEWI-015	Specific Gravity	ASTM 2671, ASTM D792
109-121016	IEWI-016	Water Absorption	ASTM 2671, ASTM D570
109-121017	IEWI-017	Volume Resistivity	ASTM D2671 (section 75-78) ASTM D257
109-121021	IEWI-021	UV Testing	ASTM G154
109-121031	IEWI- 031	Split Testing	
109-121039	IEWI- 039	Fluid Resistance at Room Temperature	
109-121046	IEWI-046	Thermal Cycling	
109-121052	IEWI-052	External Test House Matrix	
109-121053	IEWI-053	Flammability Testing	ASTM D2671 (section 71 procedure B)
109-121054	IEWI-054	Limiting Oxygen Index	LOI EN 45545-2 , BS6853

**Table 5. Test References**

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## 4.2. Reference Documents

ASTM D2671: 1999	Standard Test Methods for Heat-Shrinkable Tubing for Electrical Use
ASTM G 154:	Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Non-metallic Materials
ASTM E162	Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source
ASTM E662	Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials
ASTM E1354	Standard Test Method for Heat and Visible Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter
BSS 7239	Toxicity Test - Fire test to Aircraft material - Boeing Standard
IEC 60684-2: 1997	Flexible insulating sleeving - Part 2: Methods of test
BS EN ISO 4589-2: 1996	Plastics – Determination of burning behavior by oxygen index - Part 2: Ambient temperature test
SAE AS 23053 SAE AS 23053/5	Insulation Sleeving, Electrical, Heat Shrinkable, Polyolefin, Flexible, Cross-linked.
EN 45545-2	Railway applications- Fire protection on railway vehicles
SAE AS5942	Marking Of Electrical Insulating Materials
TE Doc. No: 411-121002	TE Connectivity Print contrast reference scale
TE Doc. No: 411-121005	TE Identification Printer Product Ribbon Matrix
TE Doc. No: 411-121008	Installation of Heatshrink Marker Sleeves
<b>(Subsequent amendments to, or revisions of, any of the above publications apply to this standard only when incorporated in it by updating or revision.)</b>	

Table 6. Reference Documents

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## 5. SAMPLING

Tests shall be carried out on samples taken at random from a batch of product.

A batch of markers is defined as that quantity of tubing extruded at any one time.

Testing frequency shall be production routine or qualification.

Production routine tests consisting of visual examination, dimensions and longitudinal change, print quality and adherence of marking shall be carried out on every batch of product.

## 6. PACKAGING

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

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## 7. General Tests for Identification Products

PROPERTY	TEST METHOD	UNITS	REQUIREMENTS
<b>PHYSICAL</b>			
<b>Visual Examination</b>		---	RW-2511 Section 1.1
<b>Dimensions</b> 3 min at 200±3°C (392±5°F)	IEWI-003	mm (inch)	In accordance with Table 1, 2, 3 or 4 above
<b>Longitudinal Change</b>	IEWI-003	%	Shrink ratio: 3:1 = 0 to -20 2:1 = ± 5
<b>Tensile Strength</b> Speed 508mm/min (19.7"/min)	IEWI-002	MPa (psi)	10.3 (1500) minimum
<b>Ultimate Elongation</b> Speed 508mm/min (19.7"/min)	IEWI-002	%	200 minimum
<b>Specific Gravity</b>	IEWI-015	g/cm <sup>3</sup>	1.35 maximum
<b>Split Testing</b>	IEWI-031	%	100 pass
<b>THERMAL</b>			
<b>Heat Ageing</b> 168hr 175±2°C (347±4°F) followed by: Mandrel Bend Mark Adherence	IEWI-008  IEWI-012	---	No damage to the marker and print legible after 20 rubs. Minimum Print Contrast 3.
<b>Heat Shock</b> 4hr at 250±3°C (482±5°F) followed by: Mandrel Bend Mark Adherence	IEWI-007  IEWI-012	---	No damage to the marker and print legible after 20 rubs. Minimum Print Contrast 3.
<b>Thermal Cycling</b> 4 cycles of 1hr at -55±2°C (-67±4°F) and 1hr 135±2°C (275±4°F) followed by: Mandrel Bend Mark Adherence	IEWI-046  IEWI-012	---	No damage to the marker and print legible after 20 rubs. Minimum Print Contrast 3.
<b>Low Temperature Flex</b> 4hr at -55±2°C (-67±4°F) Mandrel Bend Mark Adherence	IEWI-006  IEWI-012	---	No damage to the marker and print legible after 20 rubs. Minimum Print Contrast 3.

**Table7. General Tests for Identification Products**

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PROPERTY	TEST METHOD	UNITS	REQUIREMENTS
<b>ELECTRICAL</b>			
<b>Dielectric Strength</b>	IEWI-005	kV/m (V/mil)	20.0 (500) minimum
<b>Volume Resistivity</b>	IEWI-017	Ohm cm	10 <sup>14</sup> minimum
<b>CHEMICAL</b>			
<b>Copper Mirror Corrosion</b> 16hr at 175±2°C (347±4°F)	IEWI-009	%	8 maximum
<b>Water Absorption</b>	IEWI-016	%	0.5 maximum
<b>ENVIRONMENTAL</b>			
<b>UV-A 1000hr</b> 1.35 W/m <sup>2</sup> /nm irradiance. One cycle includes 8 hours of exposure at 60±2°C (140±4°F) followed by 4 hours of condensation at 50±2°C (122±4°F) Mandrel Bend Mark Adherence	IEWI-021  IEWI-012	---	No damage to the marker and print legible after 20 rubs. Minimum Print Contrast 3.
<b>UV-B 1000hr</b> 1.35 W/m <sup>2</sup> /nm irradiance. One cycle includes 8 hours of exposure at 60±2°C (140±4°F) followed by 4 hours of condensation at 50±2°C (122±4°F). Mandrel Bend Mark Adherence	IEWI-021  IEWI-012	---	No damage to the marker and print legible after 20 rubs. Minimum Print Contrast 3.

Table 7. General Tests for Identification Products - continued

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PROPERTY	TEST METHOD	UNITS	REQUIREMENTS
<b>FLAMMABILITY</b>			
<b>Flammability</b> Procedure B	IEWI-053	s %	Burn time, after last flame application, shall not exceed one minute, and not more than 25% of indicator flag shall be burned or charred. No dripping or flowing.
<b>LOI</b>	IEWI-054	%	28 minimum
<b>Surface Flame</b>	ASTM E162	-	Maximum 35
<b>Smoke</b>	ASTM E662	-	Ds 1.5 minutes 100 max. Ds 4 minutes 200 max.
<b>Heat Release</b> Average Rate of Heat Emission – 50kW/m <sup>2</sup> Irradiance	ASTM E1354	kW/m <sup>2</sup>	300 max.
<b>Toxicity</b>	BSS 7239	ppm, max	Carbon monoxide 3500 Nitrogen oxides 100 Sulphur dioxide 100 Hydrogen chloride 500 Hydrogen fluoride 200 Hydrogen bromide 100 Hydrogen cyanide 150

Table 7. General Tests for Identification Products - continued

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PROPERTY	TEST METHOD	UNITS	REQUIREMENTS
<b>PRINT PERFORMANCE</b>			
<b>Print Quality</b>	TE Doc. 411-121002	---	Initial contrast score C8 minimum
<b>Mark Adherence</b>	IEWI-012	---	Print legible after 50 rubs, minimum contrast C3 <sup>1</sup>
<b>Fluid Resistance</b> 24hr fluid immersion at 23±3°C (74±5°F) Print Permanence IRM902 MIL-PRF-23699 Skydrol LD-4 MIL-H-83282 Jet Fuel JP-8 Diesel Fuel Kilfrost DF Plus Tap Water 5% Sodium chloride solution 1% Teepol solution	IEWI-012	---	Print legible after 20 wipes, minimum contrast C3 <sup>1</sup>
Isopropyl alcohol	IEWI-012 Soaked "Super Twill" cloth	---	Print legible after 20 wipes, minimum contrast C3

Table 7. General Tests for Identification Products - continued

<sup>1</sup> For optimum performance black ribbons should be used where possible, see 411-121005, White ribbons do not fully meet these requirements in the harsher fluids; for example Skydrol LD4, Diesel and JP-8.

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## 8. Specific Tests for TMS-SCE and TTMS product range

PROPERTY	TEST METHOD	UNITS	REQUIREMENTS
<b>PHYSICAL</b>			
<b>Concentricity (Expanded)</b>	IEWI-003	%	50% minimum (3X) 70% minimum (2X)
<b>2% Secant Modulus (Expanded)</b>	IEWI-004	MPa (psi)	172.4 (25,000) maximum
<b>Color</b>		---	
<b>Color Stability</b> 24hr at 175±2°C (347±4°F)	SAE AMS DTL 23053	---	No significant visual change, recognizable as a color. Measure and record only.
<b>THERMAL</b>			
<b>Heat ageing</b> 168hr 175±2°C (347±4°F)		%	
Ultimate Elongation	IEWI-002		100 minimum
<b>ELECTRICAL</b>			
<b>Restricted Shrinkage</b> 30 min at 175±2°C (347±4°F)			
Visual examination	SAE AMS DTL 23053	---	No Cracks.
Voltage Withstand		V	2000 Vac for 1 minute
<b>CHEMICAL</b>			
<b>Copper Contact</b>	SAE AMS DTL 23053	---	No pitting or blackening of the copper
<b>ENVIRONMENTAL</b>			
<b>Fungus Resistance</b>	ISO 846 Method B		
Tensile Strength		MPa (psi)	10.3 (1500)
Ultimate Elongation	IEWI-002	%	200 minimum
Dielectric Strength	IEWI-005	kV/mm	19.7 minimum
Print Adherence (20 rubs)	IEWI-012	---	Print legible, minimum contrast C3

Table 8. Specific Test Requirements for TMS-SCE and TTMS product range

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PROPERTY	TEST METHOD	UNITS	REQUIREMENTS
<b>FLAMMABILITY</b>			
<b>Flammability</b> Procedure C  Only 2X product	IEWI-053	s %	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
<b>PRINT PERFORMANCE</b>			
<b>Fluid Resistance</b> 24hr fluid immersion at 23±3°C (73±5°F) Tensile Strength Dielectric Strength MIL-PRF-23699 MIL-H-5606 JP-8 Kilfrost DF Plus MIL-L-7808 5% Sodium chloride solution	IEWI-002 IEWI-005	MPa (psi) kV/mm (V/mil)	6.9 (1000) minimum 15.8 (400)

**Table 8. Specific Test Requirements for TMS-SCE and TTMS product range, continued**

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## 9. Tests Fluids

Fluid	Description
<b>Standard test fluids</b>	
IRM902	Reference Oil
MIL-PRF-23699	Synthetic lubricating oil STD class (NATO Code 0-156). Has replaced MIL-L-7808 oil at temperatures above 25°C.
Skydrol LD-4	Widely used aviation phosphate ester hydraulic fluid.
MIL-H-83282	The principal hydraulic fluid used in military aircraft. It replaces MIL-H-5606.
MIL-T-83133 (JP-8)	Kerosene based jet fuel, replacement for JP-4. NATO code is F-34. It's specified by MIL-DTL-83133 and British Defense Standard 91-87.
Diesel Fuel (BS EN 590:2009+A1)	General automotive fuel
Kilfrost DF Plus (SAE-AMS-1424)	Anti-icing, De-icing fluid
Tap Water	Universal solvent
5% Sodium chloride solution	Sodium chloride is a universal component of many chemicals and deicing fluids
Detergent (1% Teepol)	Commonly used detergent
IPA - Isopropyl alcohol	Widely used as a solvent and cleaner
<b>Specific test fluids</b>	
MIL-PRF-5606	Hydraulic Fluid
MIL-PRF-7808	Turbine Oil

**TABLE 9. Test Fluids Description**

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