

## SPECIFICATION RW-2524

Document Number: 108-121024

### High Temperature Cable Marker HTCM-SCE-TP

#### SCOPE

**This Quality Assurance Specification establishes the quality standard for HTCM-SCE-TP cable markers. Designed to identify cables, wire bundles, pipes and conduits, in applications of up to 200°C. This system is an automatic method of identifying wire and cable by printing a mark on the cable marker.**

The operating temperature for this product is -55°C to +200°C (-67°F to +392°F).

This system is designed to be applied once cabling has been installed. Each Cable Marker is bound to the assembly by two Cable ties. Cable Markers are made from radiation-cross linked modified polyvinylidene fluoride, offering enhanced temperature and chemical resistance. These Cable Markers are suitable for space applications where low out gassing is critical.

The marker system comprises specific printers and ribbons (refer to Identification Printer Product Ribbon Matrix Document 411-121005). Compliance to this specification can only be guaranteed if TE Connectivity approved printers and ribbons are used.

This specification covers the Cable Marker only. For maximum thermal performance, suitable Cable ties must be used.

#### Approved Signatories:

**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
0	Formerly RW 3024 Revision 3	24.07.2001	Raychem USA
1	AFC 289	03.09.2004	Paul Crofts
2	AFC 509	21.11.2007	Alan Kean
3	See PCN	07.03.2014	Lee Smith
4	Improve drawing quality	06Feb2015	Alan Kean

## 2. REQUIREMENTS

### 2.1 Composition, appearance and color

The Cable Marker shall be fabricated from irradiated, thermally stabilized modified polyvinylidene fluoride compound. Formed into punched organized cable markers. It shall be homogeneous and essentially free from flaws, defects, pinholes, bubbles, seams, cracks or inclusions.

The markers shall be White unless otherwise specified.

The markers shall be supplied as a continuous length of perforated material on a carrier strip as described in Table 1.

### 2.2 Dimensions, available sizes and formats

Refer to figures 1 to 8

Part Description	Marker height mm (in)	Marker length mm (in)	Marker thickness mm (in)	Number of holes
HTCM-SCE-TP-1/4-4H	6.40 (0.250)	50.80 (2.000)	0.51± 0.10 (0.02 ± 0.004)	4
HTCM-SCE-TP-1/2-4H	12.70 (0.500)	50.80 (2.000)	0.51± 0.10 (0.02 ± 0.004)	4
HTCM-SCE-TP-1/2-6H	12.70 (0.500)	50.80 (2.000)	0.51± 0.10 (0.02 ± 0.004)	6





### **2.3 Test Requirements**

The test requirements shall be as specified in Table 2.

## **3. QUALITY ASSURANCE PROVISIONS**

### **3.1. Qualification Tests**

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

Some tests require un-perforated lengths which are not supported by the finished Cable marker format therefore continuous sheet shall be tested. For this document, 'Cable Marker' shall be defined as specimen that represents the finished article; this is the material taken from the end of the production line. 'Continuous strip' is specimen taken from work in progress and is removed from the production line prior to finishing. Other than the format, both of these specimens are identical.

### **3.2. Acceptance Tests**

Acceptance tests are those performed on markers submitted for acceptance under contract. Acceptance tests shall consist of the following: Dimensions, Heat shock and Mark Adherence performance

### **3.3. Qualification Test Samples**

Qualification test samples shall consist of 5m (16 foot) of continuous strip, and at least 500 cable markers and 1kg of material pellets.

Cable Marker, Continuous Strip and Material pellets shall be taken from the same compound batch.

Unless otherwise specified, the Cable Markers shall be removed from the carrier for testing. Where required by test method limitations, testing shall be done on marker material

#### **4. TEST METHODS**

##### **4.1 Preparation of Test Specimens**

Finished Cable Markers for testing shall be printed with TE approved printers and ribbons (TE document 411-121005) and printed with Arial size 10 pt font. The initial print contrast must be C8 or above, reference TE Document 411-121002.

Unless otherwise specified, tests shall be carried out on Cable Markers that have had no pre-conditioning. When required by the test method, testing shall be made with continuous strip. Unless otherwise specified, all tests shall be made under standard ambient conditions according to IEC Publication 60212. In cases of dispute the tests shall be carried out at a temperature of  $23 \pm 2^\circ\text{C}$  and at  $50 \pm 5\%$  relative humidity.

##### **4.2 Print Performance**

###### **4.2.1 Mark Adherence**

Three Cable Markers shall be prepared as detailed in Clause 4.1 and tested in accordance with TE test reference 109-121012. Samples shall be tested using a Crockmeter fitted with an eraser and 1kg load using the number of rubs specified in the requirement table.

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

###### **4.2.2. Solvent Resistance**

Nine Cable Markers shall be prepared as detailed in Clause 4.1 and tested in accordance with TE test reference 109-121014.

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

###### **4.2.3. Fluid Resistance**

Three Cable Markers as prepared as in Clause 4.1 shall be completely immersed in each of the fluids for the times and at the temperatures specified in the requirements table. The volume of the fluid shall not be less than 20 times that of the specimen. After immersion, the markers are lightly blotted with tissue paper to remove excess surface fluid and air dried at  $23 \pm 2^\circ\text{C}$  for  $45 \pm 15\text{min}$ . The print shall be tested in accordance with TE test reference 109-121012. Samples are tested with a Crockmeter fitted with 'Super Twill' cloth and a 1kg load.

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

### 4.3 Physical Testing

#### 4.3.1 Dimensions

Dimensions shall be measured using a calibrated micrometer. A minimum of three markers shall be measured to confirm dimensions.

#### 4.3.2 Tensile Strength and Ultimate Elongation

The test method shall be as specified in TE Document 109-121002. Five 150mm long specimens 6.4mm wide shall be cut from a pre-punched continuous strip. Samples shall be taken from the longitudinal direction. A gauge length of 25mm with a 50mm initial jaw separation and a strain rate of  $500 \pm 5$  mm/m shall be used.

Note: test specimens should not be annealed before testing.

#### 4.3.3 Specific Gravity

Samples of un-printed product shall be tested to the procedure as specified in TE Document 109-121015.

#### 4.3.4 Vacuum Out-gassing

Test one finished marker for percent total weight loss and percent volatile condensable materials. Samples are tested in accordance with ASTM E 595-07

Use and exposure time of 24 hours. Sample temperature  $125 \pm 2^{\circ}\text{C}$  ( $257 \pm 4^{\circ}\text{F}$ ). Condensing surface temperature  $25 \pm 3^{\circ}\text{C}$  ( $77 \pm 5^{\circ}\text{F}$ ). Pressure not greater than  $1 \times 10^{-5}$  torr. The vacuum shall be provided by a diffusion pump and a liquid nitrogen trap. The apparatus shall consist of a glass sample changer, 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.

### 4.4 Thermal Testing

#### 4.4.1 Heat Ageing

The test method shall be as specified in TE document 109-121008. Six Cable Markers shall be prepared as detailed in section 4.1. Specimens shall be conditioned for 168 hours at  $225 \pm 2^{\circ}\text{C}$  ( $437^{\circ}\text{F}$ ) in an air circulating oven. Markers shall be removed and allowed to cool to room temperature for a minimum of 4 hours at  $23 \pm 2^{\circ}\text{C}$ .

After conditioning three samples shall be tested for Mark Adherence, in accordance with section 4.2.1. The marking shall be examined for legibility using normal reading vision. Print contrast shall be measured in accordance with TE Document 411-121002.

The remaining three samples shall be tested for resistance to bending. Specimens shall be bent around a mandrel with a diameter 10 x specimen thickness ( $\pm 10\%$ ).

#### 4.4.2 Heat Shock

The test method shall be as specified in TE Document 109-121007. Six Cable Markers shall be prepared as detailed in section 4.1. Specimens shall be conditioned for 4 hours at  $275\pm 2^{\circ}\text{C}$  ( $527^{\circ}\text{F}$ ) in an air circulating oven. Remove the markers and leave to cool to room temperature for a minimum of 2 hours at  $23\pm 2^{\circ}\text{C}$ .

After conditioning three samples shall be tested for Mark Adherence in accordance with section 4.2.1. The marking shall be examined for legibility using normal reading vision. Print contrast shall be measured in accordance with TE Document 411-121002.

The three remaining samples shall be tested for resistance to bending. Specimens shall be bent around a mandrel with a diameter 10 x specimen thickness ( $\pm 10\%$ ).

#### 4.4.3 Low Temperature Flexibility

The test method shall be as specified in TE Document 109-121006. Six Cable Markers shall be prepared as detailed in section 4.1.

Specimens and an 11mm (7/16 inch) metal mandrel shall be conditioned for 4 hours at  $-55\pm 2^{\circ}\text{C}$  in a cold chamber. While still in the conditioning chamber wrap each strip 360 degrees around the mandrel in approximately 2 seconds. The remaining printed markers are removed from the chamber and allowed to restore to room temperature for a minimum of 2 hours at  $23\pm 2^{\circ}\text{C}$ .

The printed samples shall be tested for Mark Adherence in accordance with section 4.2.1. 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 Environmental Testing

#### 4.5.1 Fungus Resistance

Three Cable Marker specimens shall be printed and prepared as specified in section 4.1.

Care should be taken during handling, printing, and with any packaging used. Product contamination may lead to erroneous results.

The test method shall be as specified in ASTM G21-96. Samples shall be conditioned for 28 days after which Fungus growth is visually assessed using a maximum magnification of 6x.

After exposure to the fungal spores, decontaminate with isopropyl alcohol, three printed samples shall be tested for Mark Adherence in accordance with section 4.2.1. 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 Corrosion

Three Cable Marker specimens shall be printed and prepared as specified in section 4.1.

Test for copper mirror corrosion in accordance with TE work instruction reference 109-121009. Heat the samples for 16 hours at  $200 \pm 2^{\circ}\text{C}$  ( $392 \pm 4^{\circ}\text{F}$ ).



#### **4.5.3 Water Absorption**

Three Cable Marker specimens shall be printed and prepared as specified in section 4.1.

Test for water absorption in accordance with TE work instruction reference 109-121016. Immersion conditions are 24 hours at  $23 \pm 3^{\circ}\text{C}$  ( $73 \pm 5^{\circ}\text{F}$ ).

#### **4.6 Flammability Testing**

##### **4.6.1. Fire Propagation**

Continuous cable marker strip taken from manufacturing prior to punching is printed as stated in section 4.1 'Preparation of test samples', and then tested in accordance with Airbus directive ABD0031, 15 second horizontal test. The conditions used are stated in specification AIM 2.0003.

##### **4.6.2. Flame Spread Index, ASTM E162**

The test is performed in accordance with ASTM E162 on continuous cable marker strip taken from manufacturing prior to punching. All samples tested are printed using the standard TE Identification printing system as stated in section 4.1. 'Preparation of test samples'. Samples are tested in both flaming and non-flaming modes. Measurements are taken at 1.5 and 4 minutes.

##### **4.6.3. Specific Optical Density, ASTM E 662**

The test is performed in accordance with ASTM E662 on continuous cable marker strip taken from manufacturing prior to punching. All samples tested are printed using the standard TE Identification printing system as stated in section 4.1. 'Preparation of test samples'.

##### **4.6.4. Toxic gas generation from material combustion, BSS 7239**

The test is performed in accordance with ASTM E662 on continuous cable marker strip taken from manufacturing prior to punching. All samples tested are printed using the standard TE Identification printing system as stated in section 4.1. 'Preparation of test samples'.

##### **4.6.5. Effective Heat of Combustion, ASTM E1354**

The test is performed in accordance with ASTM E1354 on continuous cable marker strip taken from manufacturing prior to punching. All samples tested are printed using the standard TE Identification printing system as stated in section 4.1. 'Preparation of test samples'. Testing is carried out by oxygen consumption calorimeter using a heat flux of  $50 \text{ kW/m}^2$ . Average heat release rate after 3 minutes and Average Extinguishing area after 3 minutes was measured.

##### **4.6.6. EN45545-2 Flammability Hazard Rating**

The performance of this test is based on the Oxygen Index result. The test method shall be as specified in BS EN ISO 4589-2. Tests shall be carried out on 3mm thick plaques of the material from which the Cable Marker is fabricated. The plaque will be irradiation cross-linked to the same degree as the Cable Marker. 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.

## 5. RELATED DOCUMENTS

### 5.1. Related Standards and Issue

Document, Revision	Description
ABD0031 ISSUE F	FIREWORTHINESS REQUIREMENTS PRESSURIZED SECTION OF FUSELAGE
AITM-0003 ISSUE 2	RESISTANCE OF MATERIALS WHEN TESTED ACCORDING TO THE 15S HORIZONTAL BUNSEN BURNER TEST
ASTM G21-96	STANDARD PRACTICE FOR DETERMINING RESISTANCE OF SYNTHETIC POLYMERIC MATERIALS TO FUNGI
ASTM E 162-13	STANDARD TEST METHOD FOR SURFACE FLAMMABILITY OF MATERIALS USING A RADIANT HEAT ENERGY SOURCE
ASTM E 662-13D	STANDARD TEST METHOD FOR SPECIFIC OPTICAL DENSITY OF SMOKE GENERATED BY SOLID MATERIALS
ASTM E595-07	STANDARD TEST METHOD FOR TOTAL MASS LOSS AND COLLECTED VOLATILE CONDENSABLE MATERIALS FROM OUTGASSING IN A VACUUM ENVIRONMENT
ASTM D882 METHOD A	STANDARD TEST METHOD FOR TENSILE PROPERTIES OF THIN PLASTIC SHEETING
ASTM D792 METHOD A	STANDARD TEST METHODS FOR SPECIFIC GRAVITY (RELATIVE DENSITY) AND DENSITY OF PLASTICS BY DISPLACEMENT
ASTM E 1354-13	STANDARD TEST METHOD FOR HEAT AND VISIBLE SMOKE RELEASE RATES FOR MATERIALS AND PRODUCTS USING AN OXYGEN CONSUMPTION CALORIMETER
EN 45545-2: MARCH 2013	RAILWAY APPLICATIONS - FIRE PROTECTION ON RAILWAY VEHICLES - PART 2: REQUIREMENTS FOR FIRE BEHAVIOUR OF MATERIALS AND COMPONENTS
BS EN ISO 4589-2	PLASTICS - DETERMINATION OF BURNING BEHAVIOR BY OXYGEN INDEX - PART 2: AMBIENT TEMPERATURE TEST
MIL STD 202 METHOD 215	TEST METHODS FOR ELECTRONIC AND ELECTRICAL COMPONENT PARTS. RESISTANCE OF SOLVENTS.
SAE AS5942	MARKING OF ELECTRICAL INSULATING MATERIALS
BSS 7239	TEST METHOD FOR TOXIC GAS GENERATION BY MATERIALS ON COMBUSTION

## 5.2. TE Connectivity Documents

TE Reference	Title	Complies with
109-121002	Tensile Strength and Ultimate Elongation at 23°C	ASTM D882 Method A
109-121003	Dimensions	---
109-121006	Low Temperature Flexibility	IEC 60684-2
109-121007	Heat Shock	---
109-121008	Heat Ageing	---
109-121012	Print Permanence testing using the Mechanical Crockmeter	SAE AS5942
109-121014	Resistance to Solvents	MIL 202 Method 215
109-121015	Specific Gravity	ASTM D792 Method A
109-121016	Water Absorption	ASTM D570

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

## 6. Sampling

Tests shall be carried out on a sample taken at random from a batch of Cable Marker. A batch of Cable Marker is defined as that quantity of product extruded at any one time.

Testing frequency shall be Production Routine or Qualification.

Production Routine tests consisting of Visual Examination and Dimensions shall be carried out on every batch of product.

Qualification tests shall be carried out to the requirements of the Design Authority.

## 7. Storage Conditions

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

## 8. Packing

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.

## REQUIREMENTS

PROPERTY	TEST METHOD	UNITS	REQUIREMENTS	RW-2524 SECTION
<b>PRINT PERFORMANCE</b>				
<b>Mark Adherence</b>	TE Document 109-121012  50 rubs, 1kg load, eraser	---	Legible, minimum print contrast 3	4.2.1.
<b>Solvent Resistance</b>	TE Document 109-121014  50 strokes, tooth brush	---	Legible, minimum print contrast 3	4.2.2.
<b>Fluid Resistance</b> <ul style="list-style-type: none"> <li>JP8 Fuel (MIL-T-83133)</li> <li>Hydraulic Fluid (MIL-H-5606)</li> <li>Aviation Gasoline (100/130)</li> <li>Lubricating Oil (MIL-L-7808)</li> <li>Salt Water (5% salt)</li> <li>Anti-icing Fluid (MIL-A-8243)</li> </ul> Followed by Mark Adherence	24 ± 2hours immersion, 23 ± 2°C          TE test method 109-121012 20 rubs, 1kg load, Cloth.	---	20 rubs, legible Minimum Print Contrast 3	4.2.3.
<b>PHYSICAL</b>				
<b>Visual Inspection</b>	In good lighting, using normal or corrected vision at a distance of 14 inches.	---	In accordance with section 2.1.	2.1.
<b>Dimensions</b>	TE test method 101-121003	---	Figures 1 to 7	4.3.1.

PROPERTY	TEST METHOD	UNITS	REQUIREMENTS	RW-2524 SECTION
<b>Tensile Strength</b>	TE test method 101-121002	MPa (Psi)	20.6 (3000) Minimum	4.3.2.
<b>Ultimate Elongation</b>	TE test method 101-121002	%	100 Minimum	4.3.2.
<b>Specific Gravity</b>	TE test method 101-121015	---	1.8 Maximum	4.3.3.
<b>Vacuum Outgassing</b>	ASTM E595			4.3.4.
TML (Total Mass Loss)		%	1.0 Maximum	
VCM (Volatile Condensable Material)		%	0.1 Maximum	
<b>THERMAL</b>				
<b>Heat Ageing</b> 168 hours at 225°C (437±F), followed by:	TE test method 101-121008			4.4.1.
• Mandrel Bend	Bend around a mandrel (10 x thickness)	---	No damage to the marker and print	
• Mark Adherence	TE Document 109-121012 20 rubs, 1kg load, eraser	---	Legible, minimum print contrast 3	
<b>Heat Shock</b> 4 hours at 275°C (527°F), followed by:	TE test method 101-121007			4.4.2.
• Mandrel Bend	Bend around a mandrel (10 x thickness)	---	No damage to the marker and print	
• Mark Adherence	TE Document 109-121012 20 rubs, 1kg load, eraser	---	Legible, minimum print contrast 3	

PROPERTY	TEST METHOD	UNITS	REQUIREMENTS	RW-2524 SECTION
<b>Low Temperature Flexibility</b> 4 hours at -55°C, followed by: <ul style="list-style-type: none"> <li>Mandrel Bend</li> <li>Mark Adherence</li> </ul>	TE test method 101-121006  Bend around a mandrel (10 x thickness)  TE Document 109-121012 20 rubs, 1kg load, eraser	 ---  ---	 No damage to the marker and print  Legible, minimum print contrast 3	 4.4.3.
<b>ENVIRONMENTAL</b>				
<b>Fungus Resistance</b> Followed by <ul style="list-style-type: none"> <li>Fungus Growth Rating</li> <li>Mark Adherence</li> </ul>	ASTM G21-96  Visual Inspection  TE Document 109-121012 20 rubs, 1Kg load	 ---  ---	 Maximum Rating 1  Legible, minimum print contrast 3	 4.5.1.
<b>Corrosion</b> 16 hours at 200°C (392°F)	TE work instruction 109-121009	---	No Corrosion	4.5.2.
<b>Water Absorption</b> 24 hours at 23°C (73°F)	TE work instruction 109-121016	%	0.5 Maximum	4.5.3.
<b>FIRE SAFETY</b>				
<b>Fire Propagation</b>	Airbus Directive ABD0031 Issue F, Fire worthiness requirements pressured section of fuselage (15 s horizontal test – AITM 2.0003)	mm/s (mm/inch)	Burn rate must not exceed 102mm/min (4 inches/min)	4.6.1.
<b>Surface Flammability,  Flame Spread Index, Is</b>	ASTM E162	---	35 Maximum	4.6.2.

PROPERTY	TEST METHOD	UNITS	REQUIREMENTS	RW-2524 SECTION
<b>Specific Optical Smoke Density, D<sub>s</sub></b>  Flaming Mode Specific Optical Density 1.5 minutes 4 minutes  Non Flaming Mode 1.5 minutes 4 minutes	ASTM E 662	---	100 Maximum 200 Maximum  100 Maximum 200 Maximum	4.6.3.
<b>Toxic Gas Generation from Material Combustion</b>  Carbon Monoxide (CO) Carbon Dioxide (CO <sub>2</sub> ) Nitrogen Oxides (NO <sub>2</sub> ) Sulphur Dioxide (SO <sub>2</sub> ) Hydrogen Chloride (HCl) Hydrogen Fluoride (HF) Hydrogen Bromide (HBr) Hydrogen Cyanide (HCN)	BSS 7239 Measured at maximum smoke density. Flaming mode and non-flaming mode assessed, worst case reported.	ppm	Maxima:  3500 90000 100 100 500 100 100 100	4.6.4.
<b>Effective Heat of Combustion<sup>1</sup></b>  Average Heat Release Rate, 3 minutes  Average Extinction area, 3 minutes	ASTM E1354 50kWm <sup>2</sup> applied heat flux with retainer frame	kW/m <sup>2</sup>  m <sup>2</sup> /kg	≤ 100  Maximum 500	4.6.5.
<b>EN45545-2</b> Flammability Hazard Rating for interior mass 500g (following grouping rules)  <i>Based on the following criteria:</i>  Oxygen Index (OI)	BS EN ISO 4589-2:1999	%	Requirement Set R24, Hazard Rating 3  32 Minimum	4.6.6.

<sup>1</sup> NFPA 130 does not specify a requirement for small electrical components, the figures stated are based on current best practices for US federal rail administration and national fire protection association.

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