

# SPECIFICATION RW-2524

TE 108-121024

HTCM-SCE-TP

## High Temperature Cable Marker

### 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.

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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       |
| 5               | Correction to typos on drawing, update to new template. | April 2018 | 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 6.

**Table 1: Product dimension**

| Part Description   | Printable 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<br>(0.02 ± 0.004) | 4               |
| HTCM-SCE-TP-1/4-6H | 6.40 (0.250)             | 50.80 (2.000)         | 0.51± 0.10<br>(0.02 ± 0.004) | 6               |
| HTCM-SCE-TP-1/2-4H | 12.70 (0.500)            | 50.80 (2.000)         | 0.51± 0.10<br>(0.02 ± 0.004) | 4               |
| HTCM-SCE-TP-1/2-6H | 12.70 (0.500)            | 50.80 (2.000)         | 0.51± 0.10<br>(0.02 ± 0.004) | 6               |

**2.3 Test Requirements**

The test requirements shall be as specified in Table 2.



Supplied format (dimensions in inches)

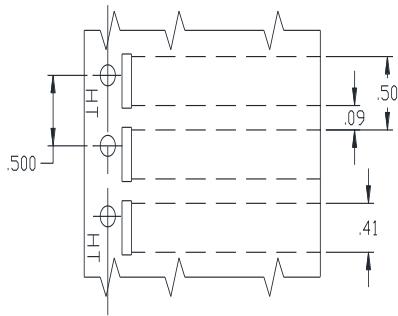


Figure 1  
HTCM-SCE-1/4-INCH

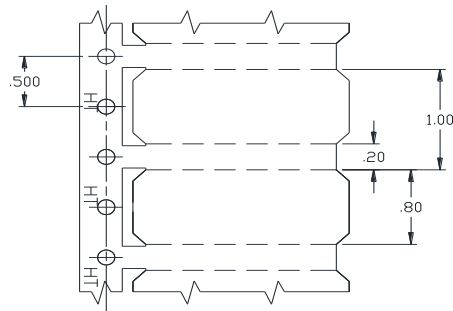


Figure 2  
HTCM-SCE-1/2-INCH

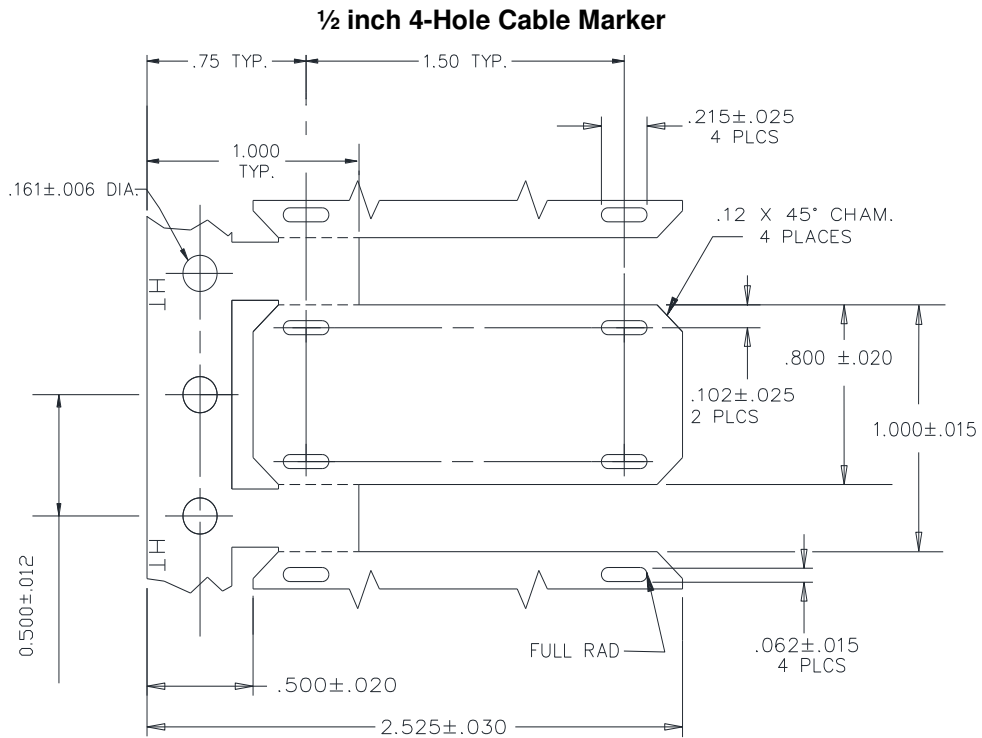


Figure 3: HTCM-SCE-TP-1/2-4H

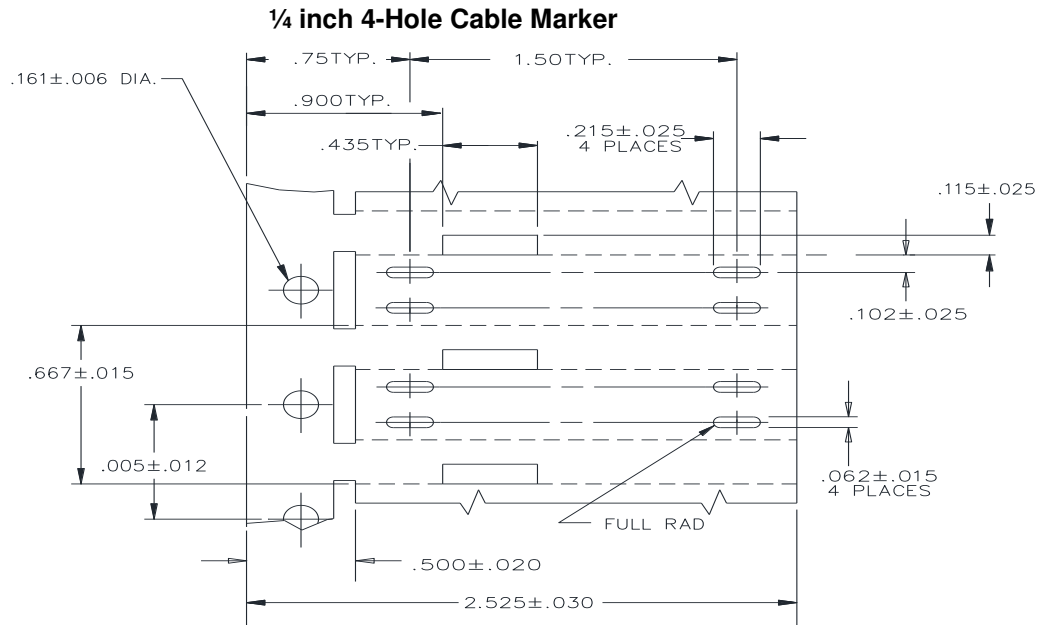


Figure 4: HTCM-SCE-TP-1/4-4H

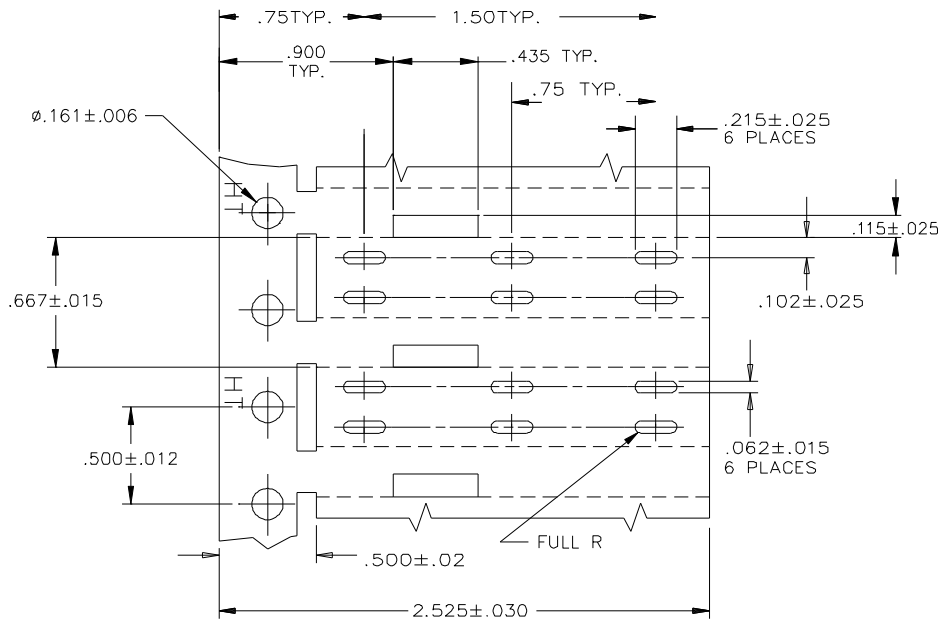
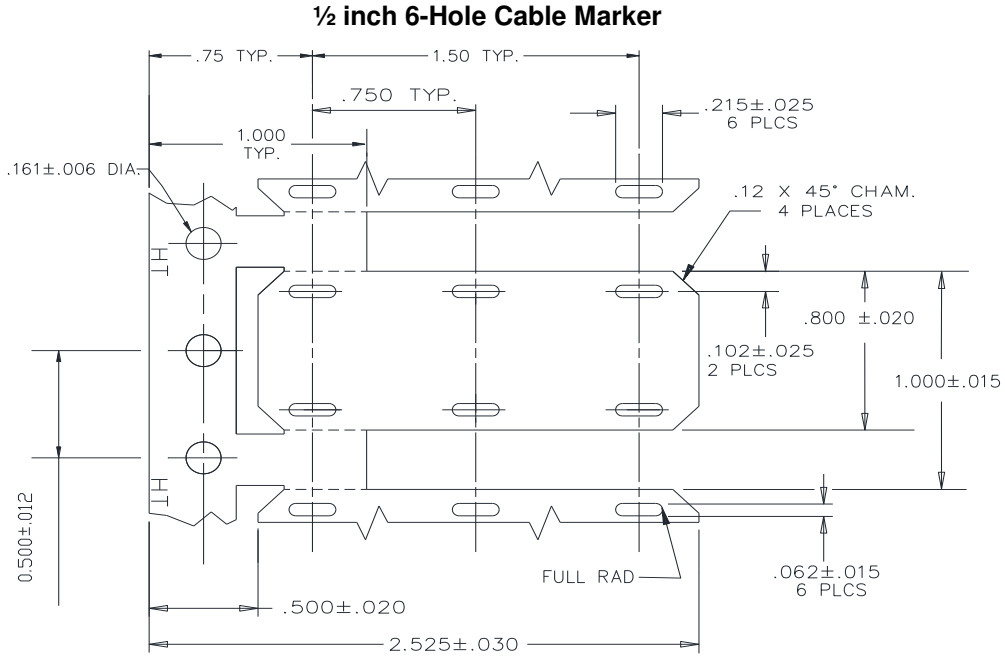


Figure 5: HTCM-SCE-TP-1/4-6H



**Figure 6: HTCM-SCE-TP-1/2-6H**

**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 10pt 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 marker must be fully immersed. 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 at a distance of 255mm (14"). 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

Five 150mm long specimens 6.4mm wide shall be cut from a pre-punched continuous strip. The test method shall be as specified in TE Document 109-121002. 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 7mm 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  $225 \pm 2^\circ\text{C}$  ( $437 \pm 4^\circ\text{F}$ ) 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  $275\pm 2^{\circ}\text{C}$  ( $527\pm 4^{\circ}\text{F}$ ) 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 AITM 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 D792 METHOD A     | STANDARD TEST METHODS FOR SPECIFIC GRAVITY (RELATIVE DENSITY) AND DENSITY OF PLASTICS BY DISPLACEMENT.                            |
| ASTM D882 METHOD A     | STANDARD TEST METHOD FOR TENSILE PROPERTIES OF THIN PLASTIC SHEETING.   |
| ASTM D2671             | STANDARD TEST METHODS FOR HEAT-SHRINKABLE TUBING FOR ELECTRICAL USE.  |
| ASTM E 162-13          | STANDARD TEST METHOD FOR SURFACE FLAMMABILITY OF MATERIALS USING A RADIANT HEAT ENERGY SOURCE.                                    |
| ASTM E595-07           | STANDARD TEST METHOD FOR TOTAL MASS LOSS AND COLLECTED VOLATILE CONDENSABLE MATERIALS FROM OUTGASSING IN A VACUUM ENVIRONMENT.    |
| ASTM E 662-13D         | STANDARD TEST METHOD FOR SPECIFIC OPTICAL DENSITY OF SMOKE GENERATED BY SOLID MATERIALS.  |
| ASTM E 1354-13         | STANDARD TEST METHOD FOR HEAT AND VISIBLE SMOKE RELEASE RATES FOR MATERIALS AND PRODUCTS USING AN OXYGEN CONSUMPTION CALORIMETER. |
| ASTM G21-96            | STANDARD PRACTICE FOR DETERMINING RESISTANCE OF SYNTHETIC POLYMERIC MATERIALS TO FUNGI.   |
| BS EN ISO 4589-2       | PLASTICS - DETERMINATION OF BURNING BEHAVIOR BY OXYGEN INDEX - PART 2: AMBIENT TEMPERATURE TEST.                                  |
| EN 45545-2: MARCH 2013 | RAILWAY APPLICATIONS - FIRE PROTECTION ON RAILWAY VEHICLES - PART 2: REQUIREMENTS FOR FIRE BEHAVIOUR OF MATERIALS AND COMPONENTS. |
| IEC 60684-2            | FLEXIBLE INSULATING SLEEVING – PART 2: METHODS OF TEST  |
| IEC 60212              | STANDARD CONDITIONS FOR USE PRIOR TO AND DURING THE TESTING OF SOLID ELECTRICAL INSULATING MATERIALS.                             |
| MIL STD 202 METHOD 215 | TEST METHODS FOR ELECTRONIC AND ELECTRICAL COMPONENT PARTS. RESISTANCE OF SOLVENTS.   |
| NFPA 130               | STANDARD FOR FIXED GUIDEWAY TRANSIT AND PASSENGER RAIL SYSTEMS.   |
| 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  | ---                      |
| 109-121009   | Copper Mirror Corrosion                                  | ASTM D2671 (Procedure A) |
| 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.





| PROPERTY  | TEST METHOD  | UNITS     | REQUIREMENTS                    | RW-2524 SECTION |
|---|--|-----------|---------------------------------|-----------------|
| <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 109-121003  | ---       | Figures 1 to 6                  | 2.2.            |
| <b>Tensile Strength</b>                           | TE test method 109-121002  | MPa (psi) | 20.6 (3000) Minimum             | 4.3.2.          |
| <b>Ultimate Elongation</b>                        | TE test method 109-121002  | %         | 100 Minimum                     | 4.3.2.          |
| <b>Specific Gravity</b>                           | TE test method 109-121015  | ---       | 1.8 Maximum                     | 4.3.3.          |
| <b>Vacuum Outgassing</b><br>TML (Total Mass Loss) | ASTM E595  | %         | 1.0 Maximum                     | 4.3.4.          |
| VCM (Volatile Condensable Material)               |  | %         | 0.1 Maximum                     |                 |



| PROPERTY  | TEST METHOD  | UNITS | REQUIREMENTS                         | RW-2524 SECTION |
|---|--|-------|--------------------------------------|-----------------|
| <b>THERMAL</b>  |  |       |                                      |                 |
| <b>Heat Ageing</b><br>168 hours at 225°C (437±F),<br>followed by:<br>Mandrel Bend       | TE test method<br>109-121008                           |       |                                      |                 |
|   | Bend around a mandrel<br>(10 x thickness)              | ---   | No damage to the<br>marker and print | 4.4.1.          |
| Mark Adherence  | TE Document<br>109-121012<br>20 rubs, 1kg load, eraser | ---   | Legible, minimum print<br>contrast 3 |                 |
| <b>Heat Shock</b><br>4 hours at 275°C (527°F),<br>followed by:<br>Mandrel Bend          | TE test method<br>109-121007                           |       |                                      |                 |
|   | Bend around a mandrel<br>(10 x thickness)              | ---   | No damage to the<br>marker and print | 4.4.2.          |
| Mark Adherence  | TE Document<br>109-121012<br>20 rubs, 1kg load, eraser | ---   | Legible, minimum print<br>contrast 3 |                 |
| <b>Low Temperature Flexibility</b><br>4 hours at -55°C,<br>followed by:<br>Mandrel Bend | TE test method<br>109-121006                           |       |                                      |                 |
|   | Bend around a mandrel<br>(10 x thickness)              | ---   | No damage to the<br>marker and print | 4.4.3.          |
| Mark Adherence  | TE Document<br>109-121012<br>20 rubs, 1kg load, eraser | ---   | Legible, minimum print<br>contrast 3 |                 |
| <b>ENVIRONMENTAL</b>  |  |       |                                      |                 |
| <b>Fungus Resistance</b><br>Followed by<br>Fungus Growth Rating                         | ASTM G21-96  |       |                                      |                 |
|   | Visual Inspection                                      | ---   | Maximum Rating 1                     | 4.5.1.          |
| Mark Adherence  | TE Document<br>109-121012<br>20 rubs, 1Kg load         | ---   | Legible, minimum print<br>contrast 3 |                 |
| <b>Corrosion</b><br>16 hours at 200°C (392°F)   | TE work instruction<br>109-121009                      | ---   | No Corrosion                         | 4.5.2.          |
| <b>Water Absorption</b><br>24 hours at 23°C (73°F)                                      | TE work instruction<br>109-121016                      | %     | 0.5 Maximum                          | 4.5.3.          |



| PROPERTY   | TEST METHOD  | UNITS                | REQUIREMENTS                                       | RW-2524 SECTION |
|--|--|----------------------|--|-----------------|
| <b>FIRE SAFETY</b>   |  |                      |  |                 |
| <b>Fire Propagation</b>  | Airbus Directive ABD0031 Issue F, Fire worthiness requirements pressured section of fuselage (15s horizontal test – AITM 2.0003) | mm/min<br>(inch/min) | 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.          |
| <b>Specific Optical Smoke Density, Ds</b>                            |  |                      |  | 4.6.3.          |
| Flaming Mode<br>Specific Optical Density<br>1.5 minutes<br>4 minutes | ASTM E 662   | ---<br>---           | 100 Maximum<br>200 Maximum                         |                 |
| Non-Flaming Mode<br>1.5 minutes<br>4 minutes                         |  | ---<br>---           | 100 Maximum<br>200 Maximum                         |                 |



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