



Specification RW 2060 Revision 4

Heat-Shrinkable Fabric Tubing

SCOPE

This Quality Assurance Specification establishes the quality standard for TE Connectivity Heat-shrinkable Fabric Tubing (HFT) which consists of heat shrinkable members in the hoop direction (weft) and protective fibres in the longitudinal direction (warp). The product is intended for use in applications where protection of a substrate, for example rubber hoses, from wear due to abrasion is required. For this reason functional characteristics are described in this specification in terms of product installed onto a rubber hose.

Approved Signatories*

This document is electronically reviewed and approved and so no signatures will appear.

1. REVISION HISTORY

Revision Number	Change Request	Date	Incorporated By
1	Initial	08 Mar 99	M. Priddle
2	CR00-DM-0119	13 June 2000	P. Hammond
3	CR00-DM-0148	9 August 2000	P. Hammond
4	Via DMTEC	4 March 2014	C. Diss

2. REQUIREMENTS**2.1 Composition, Appearance and Colour**

Heat Shrinkable, cross-linked, modified polyolefin monofilament weft fibres and polyester, multifilament warp fibres.

The longitudinal fibres shall be black.

The product shall be essentially black in colour after installation.

2.2 Dimensions

Dimensions shall be as specified in the relevant SCD

2.3 Test Requirements

The product when installed onto specified vulcanised rubber hoses shall meet the test requirements of Table 1.

3. TEST METHODS**3.1 Preparation of Test Specimens**

Unless otherwise specified, tests shall be carried out on fabric samples installed onto the appropriate diameter, fully vulcanised rubber hose, in a hot air oven at $180 \pm 5^\circ\text{C}$ for 10 minutes.

Product	Fabric Size	Hose Diameter (OD)	Length (unless otherwise specified)
HFT2000 HFT4000 HFT5000	40/20	22mm to 24mm	100mm
HFT3000	60/20	22mm to 24mm	100mm

After cooling the installed samples shall be subjected to the tests described in this specification.

3.2 Visual

The installed samples shall be examined with the naked eye for any signs of splitting or damage.

TEST METHODS (Cont'd)**3.3 Dimensions and Longitudinal Change**

The dimensions as supplied and after fully unrestricted recovery shall be measured using a suitable plug gauge and shall comply with the appropriate specification control drawing. For recovered dimensions the samples shall be conditioned in a fan assisted air circulating oven at $180 \pm 5^\circ$ for 10 minutes, removed from the oven and allowed to cool to ambient temperature. The longitudinal change shall be expressed as a percentage of the original length.

3.4 Abrasion Resistance

Three installed samples prepared as in Clause 3.1 shall be fixed horizontally to the sample carriage of the abrasion rig (see Figure 1). The abrasion probe shall be fixed to the moving probe assembly such that the probe and sample are positioned at an angle of 45° to each other.

The conditions of the test shall be as follows:

Temperature = as specified in Table 1

Frequency = 10 Hz

Load = 200g

Test duration (no of cycles) = as specified in Table 1

Abrasion probe = Radius blade (see Figure 2)

Blade stroke = 10mm (ie ± 5 mm)

After the specified duration the sample is removed from the abrasion rig and the fabric protection sleeve removed from the hose. The hose shall then be examined by eye for any signs of wear or damage.

Note: The abrasion rig must be in good condition, running smoothly with the minimum amount of vibration. The middle section of the probe shall be used and inspected for wear prior to each test (see Figure 2.)

3.5 Accelerated Ageing

Three installed samples prepared as in Clause 3.1 shall be conditioned in a fan assisted air circulating oven as specified in Table 1. On removal from the oven the samples shall be allowed to stabilise at ambient conditions, visually examined and tested for abrasion resistance according to Clauses 3.2 and 3.4.

3.6 Low Temperature Flexibility

Three 300mm lengths of fabric tubing shall be installed onto suitable lengths of hose as described in clause 3.1.

The mandrel diameter shall be 10 x installed diameter of the product $\pm 10\%$.

The samples and mandrel shall be conditioned as specified in Table 1. After conditioning and whilst still in the cold chamber the samples shall be wound around the mandrel.

The samples shall be removed from the cold chamber, allowed to stabilise to room temperature and examined visually for signs of cracking or damage.

TEST METHODS (Cont'd)**3.7 Low Temperature Impact Resistance**

The test apparatus shall be essentially as shown in figure 3 and the test method based on ISO 6722/1. Three installed samples prepared as in Clause 3.1 shall be conditioned together with the test apparatus in a suitable cold chamber as specified in Table 1. The apparatus shall be pre-conditioned for a minimum of 4 hours prior to commencement of testing. Each sample shall be subjected to a drop of a 200g weight from a height of 100mm whilst still in the cold chamber ensuring that the weight centrally impacts the sample. The samples shall be removed from the cold chamber, allowed to stabilise to room temperature and examined visually for signs of cracking or damage.

3.8 Temperature/Humidity Cycling

Three installed samples prepared as in Clause 3.1 shall be conditioned for 16 hours \pm 15 minutes at $40 \pm 2^\circ\text{C}$ and $95 \pm 2\%$ relative humidity. After this period the samples shall be transferred to a cold chamber within 30 seconds at $-40 \pm 3^\circ\text{C}$ for 2 hours \pm 15 minutes. On removal the samples shall be transferred within 30 seconds to an air circulating oven at $125 \pm 3^\circ\text{C}$ for 2 hours \pm 15 minutes. The cycle shall be completed by storing the samples at ambient conditions for 4 hours \pm 15 minutes. The 24 hour cycle shall be repeated a further nine times. On completion of these 10 cycles the samples shall be visually examined and tested for abrasion resistance according to Clauses 3.2 and 3.4.

3.9 Thermal Shock

Three installed samples prepared as in Clause 3.1 shall be suspended in an air circulating oven at $125 \pm 3^\circ\text{C}$ for 15 minutes. Following this period the samples shall be immediately transferred to a cold chamber at $-40 \pm 3^\circ\text{C}$ for 15 minutes. The time taken for oven and cold chamber to recover back to the desired temperature shall be no longer than 10% of the time required in each part of the cycle. This cycle shall be repeated 100 times. On completion of these 100 cycles the samples shall be visually examined and tested for abrasion resistance according to Clauses 3.2 and 3.4.

3.10 Fluid Resistance

Three installed samples prepared as in Clause 3.1 shall be totally immersed in the appropriate fluid, for the time and temperature specified in Table 1. After immersion the samples shall be lightly wiped and allowed to dry for 45 ± 15 minutes. The samples shall be visually examined and tested for abrasion resistance according to Clauses 3.2 and 3.4.

3.11 Flame Resistance

The test method shall be in accordance with MVSS 302.
The product shall be freely recovered in an air circulating oven at 180°C for 10 minutes prior to testing.

4. RELATED STANDARDS & issue

ISO 6722-1: 1996	Road vehicles -- Unscreened low-tension cables -- Part 1: Test methods
MVSS 302: 1975	Flammability of Materials - Passenger Cars, Multiple Passenger Vehicles, Trucks and Buses (Docket N. 3-3;Notice 4)
Subsequent amendments to, or revisions of, any of the above publications apply to this standard only when incorporated in it by updating or revision.	

5. SAMPLING

Tests shall be carried out on a sample taken at random from each batch of finished product. A batch of product is defined as that quantity manufactured at any one time from the same component batches.

Testing frequency shall be Production Routine or Qualification. Production Routine tests consisting of Visual Examination, Dimensions and Longitudinal Change shall be carried out on every batch of product.

Qualification tests shall be carried out to the requirements of the Design Authority and shall be carried out on the specified size which shall qualify all sizes in the range.

6. PACKAGING

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

Figure 1 - Abrasion Rig

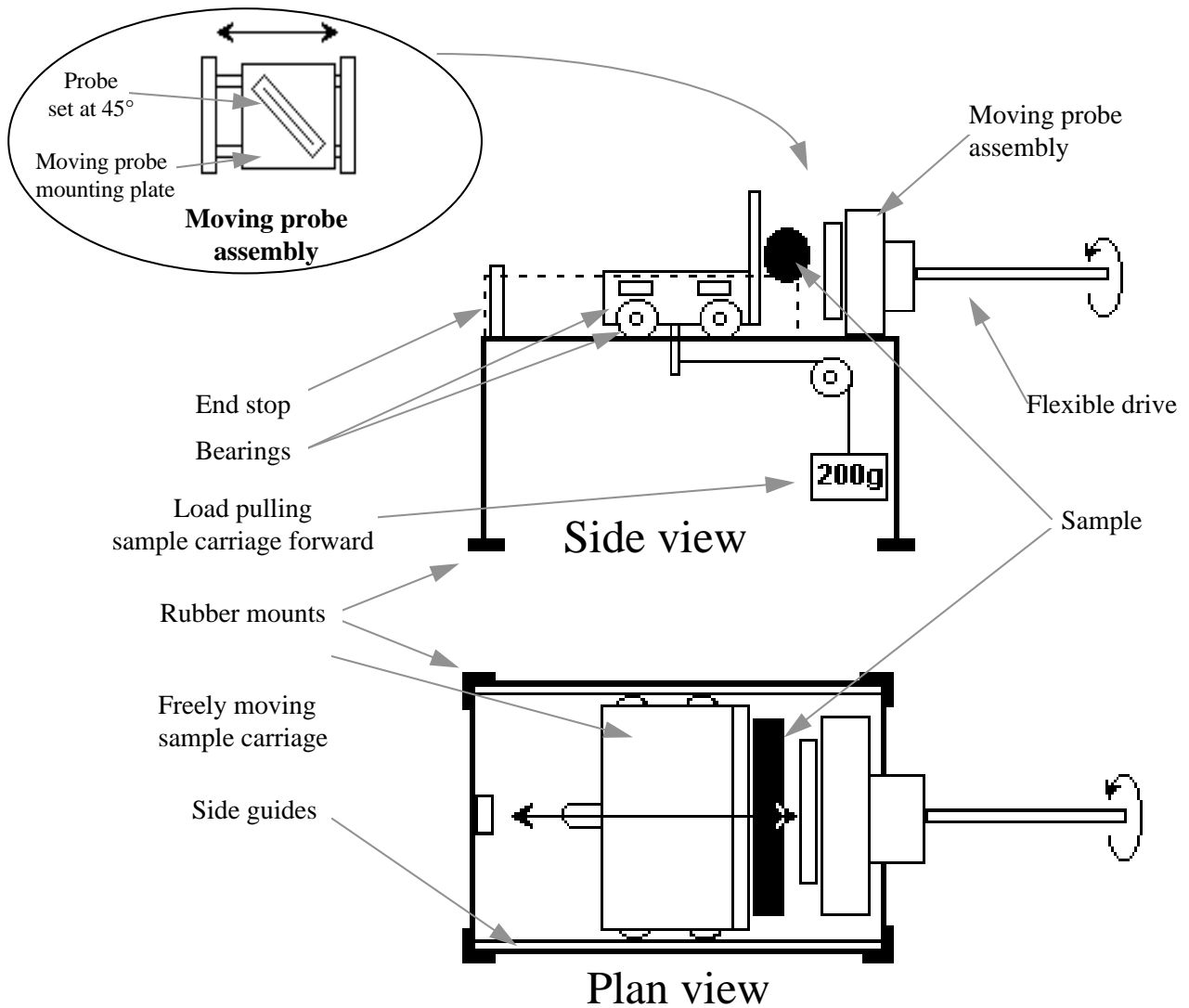


Figure 2 - Abrasion Rig Probe

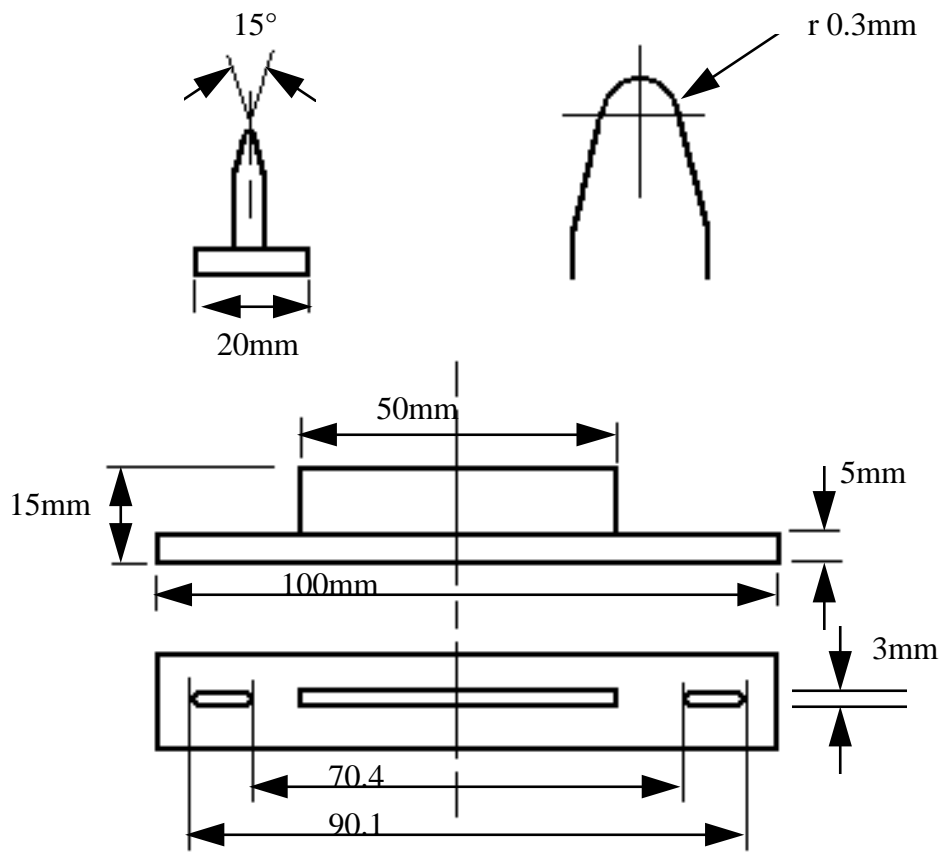


Figure 3 - Cold Impact Rig

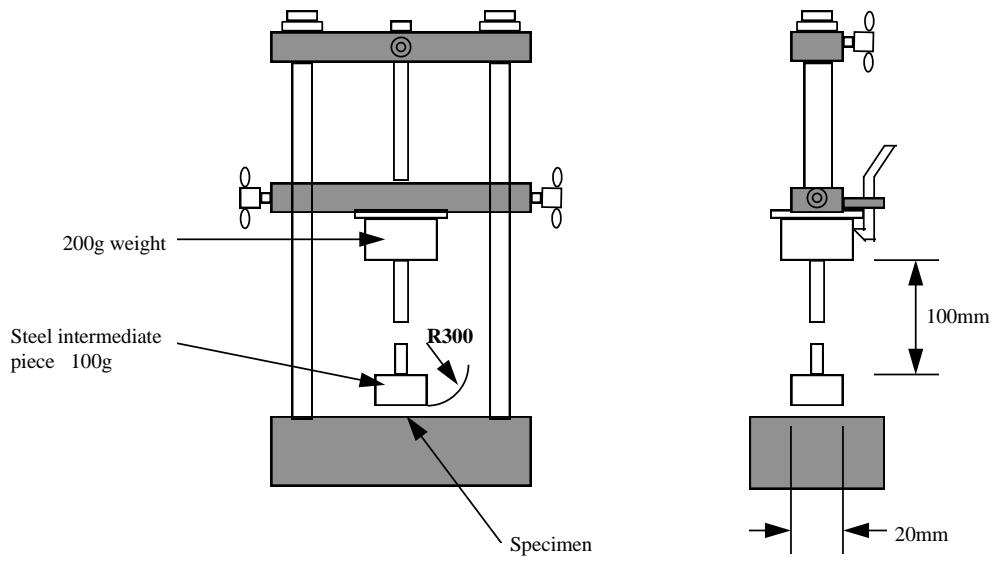


TABLE 1 Test Requirements

Test	Test Method	Test Requirements
Visual		As per Clause 2.1 and 3.2
Dimensions	Clause 3.3	As per relevant SCD
Longitudinal Change	Clause 3.3	As per relevant SCD
Abrasion Resistance at : <ul style="list-style-type: none"> • 23°C • 80°C • 135°C 	Clause 3.4	No damage to underlying hose after 144000 cycles
Accelerated Ageing HFT2000, 3000 and 4000 - 240 hrs at 150°C HFT5000 - 1000 hrs at 150°C <ul style="list-style-type: none"> - Visual - Abrasion Resistance at 80°C 	Clause 3.5 Clause 3.2 Clause 3.4	No splitting or damage No damage to underlying hose after 144000 cycles
Low Temperature Flexibility (4 hrs at -40°C)	Clause 3.6	No cracking or damage
Low Temperature Impact (4 hrs at -40°C)	ISO 6722-1 Clause 3.7	No cracking or damage
Temperature / Humidity Cycling <ul style="list-style-type: none"> - Visual - Abrasion Resistance at 80°C 	Clause 3.8 Clause 3.2 Clause 3.4	No splitting or damage No damage to underlying hose after 144000 cycles
Thermal Shock <ul style="list-style-type: none"> - Visual - Abrasion Resistance at 80°C 	Clause 3.9 Clause 3.2 Clause 3.4	No splitting or damage No damage to underlying hose after 144000 cycles
Flame Resistance	MVSS 302	100 mm/minute maximum

TABLE 1 Test Requirements (Cont'd)

Test	Test Method	Test Requirements
Fluid Resistance (24 ± 2 hrs immersion at 23 ± 2°C) <ul style="list-style-type: none">• Antifreeze (Ethylene Glycol/Water 50/50 v/v)• Lubricating Oil, Engine SAE 10W/30• Hydraulic Fluid, Mineral Base• Car Wash Detergent (1% Teepol)• Brake Fluid, Automotive (DOT 4)• Unleaded Petrol• Diesel Fuel to BS 2869 Class A1• Battery Acid to BS 3031<ul style="list-style-type: none">- Visual- Abrasion Resistance at 80°C	Clause 3.10	
	Clause 3.2	No splitting or damage
	Clause 3.4	No damage to underlying hose after 144000 cycles

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