

Number <b>2.4.56</b>	
Subject <b>Tensile Behavior of E-Textiles</b>	
Date <b>02/2025</b>	Revision
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Originating Task Group: D-74b E-Textiles Exposure and Durability Test Methods Task Group	

# IPC-TM-650 TEST METHODS MANUAL

## 1 SCOPE

This test is used to evaluate the tensile behavior of parts of an e-textile system. The tensile behavior is a quality/property of the tested material.

This test determines the maximal elongation before functional failure, the elongation regions for plastic and elastic deformations and the tensile strength. It can also be used to determine the behavior of functional parameters as a function of elongation.

**1.1 Principles of Test** E-textile specimens are stretched until break while measuring one or more relevant functional parameters. A specimen of defined size is cut from the e-textile and put under tensile strain.

### 1.2 Terms and Definitions

**1.1.1 Critical Area** The areas of e-textiles that have a higher tendency of failure compared to other areas (e.g., joints, connection points, textile electrodes) or that if affected will negatively impact product functionality or the product capability to operate as intended.

**1.1.2 Data Recorder** A measuring device used to record electrical resistance or electrical continuity.

## 2 APPLICABLE DOCUMENTS

### 2.1 International Organization for Standardization (ISO)<sup>1</sup>

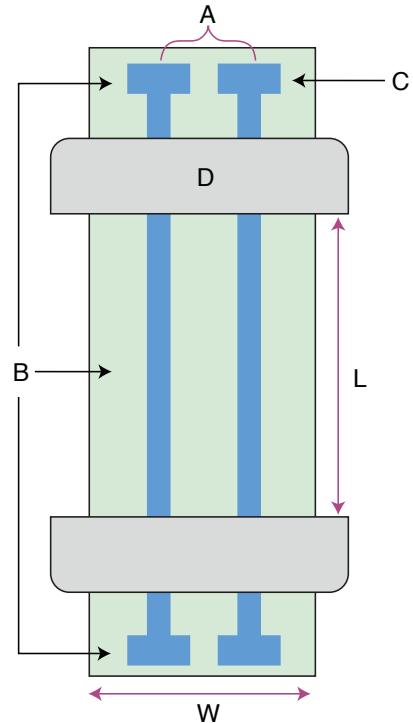
**ISO 139** Textile Standard atmosphere for conditioning and testing

**ISO 13934-1** Textiles – Tensile properties of fabrics – Part 1: Determination of maximum force and elongation at maximum force using the strip method

## 3 TEST SPECIMENS

### 3.1 Specimen Preconditioning

All test specimens **shall** be conditioned for  $\geq 24$  hours according to ISO 139. If other conditions are specified, they should be reported with the test results.



**Figure 1 Schematic of Specimen with Integrated Conductors and Data Recorder Attachment**

**Figure key**

- A – Data recorder attachments
- B – Specimen
- C – Integrated conductors
- D – Clamp
- L – Gauge length
- W – Sample width

<sup>1</sup> www.iso.org

IPC-TM-650		
Number 2.4.56	Subject Tensile Behavior of E-Textiles	Date 02/2025
Revision N/A		

### 3.2 Specimen Description

Specimens **shall** be cut from the e-textile according to ISO 13934-1 with the following alterations:

- Specimens **shall** be cut from the same critical areas that are to be tested in subsequent cyclic stretch testing if applicable.
- Specimens **shall** be cut in a way that conductive and functional structures are located in the middle and between the clamps (see Figure 1).
- Specimen length needs to be increased to allow for data recorder attachment (see Figure 1, A).
- Specimen **shall** be cut so that conductive/functional structures run along the length of the specimen (see Figure 1) and the data recorder can be attached at each end. If the course of the conductive structures does not allow for such specimen layout, other scenarios are acceptable but **shall** be reported.

If applicable, remove insulation from conductive structures at both ends of the specimen for data recorder attachment.

### 3.3 Number of Specimens

The number of test specimens **shall** be defined to respect the statistical treatment (at least five per affected critical area).

## 4 APPARATUS

4.1 Data recorder for functionality testing

4.2 Tensile testing machine in accordance with ISO 13934-1

## 5 PROCEDURE

If the tensile behavior of one or more functional parameters is to be tested, the testing protocol provided by ISO 13934-1 **shall** be used with the following alterations.

5.1 The jaws **shall** be capable of clamping the specimen without altering it physically or electrically.

5.2 If the clamps are made of conductive material, a thin dielectric (e.g., polymer sheet or foil) **shall** be placed between specimen and clamps when the specimen is mounted.

5.3 Attach the measuring tips of the data recorder to both ends one or, if applicable, more or all of the integrated conductors / functional structures depending on the measuring capacity of the data recorder.

5.4 Conduct a visual inspection of the specimen prior to testing.

5.5 Conduct the tensile test according to ISO 13934-1 while continuously recording the functional parameter.

IPC-TM-650		
Number 2.4.56	Subject Tensile Behavior of E-Textiles	Date 02/2025
Revision N/A		

## 6 TEST REPORT

The report **shall** contain the following information:

- Date and time of test
- Testing location and name of tester
- Environmental test conditions (if differing from ISO 139)
- Number of test specimens
- Description of test specimens (size, cutting direction (warp/weft (wovens), course/wale (knits)), type of critical area, location of critical area within specimen, etc.)
- Description/Specifications of testing equipment
- Test results (parameter values before, during and after testing, tensile behavior); if applicable: plotting of parameter values over time)
- Results of visual inspection before and after testing
- Any deviations from the presented methods
- Comments

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