

Number 2.4.56.3	
Subject Bending Durability of E-Textiles	
Date 02/2025	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 method is used for determining the change of one or more functionally relevant parameters in e-textiles as a result of cyclic bending.

1.1 Principles of Test E-textile specimens are exposed to cyclic bending up to a given number of cycles while observing a change of one or more relevant functional parameters throughout the cycles or at regular intervals. A specimen of custom size is cut from the e-textile and is cycled at a constant rate.

1.2 Terms and Definitions

1.2.1 Bending Angle The angle of the specimen at the maximum bending position along the horizontal axis is set upon the application (see Figure 1).

1.2.2 Bending Radius The radius of bending areas the specimens experience during bending is set upon the application (see Figure 1), measured from the center to the bottom line of the fabric.

1.2.4 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.

1.2.5 Cycle When a sample returns to its original state after single reciprocation.

1.2.6 Cycle Rate The number of cycles per time unit.

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

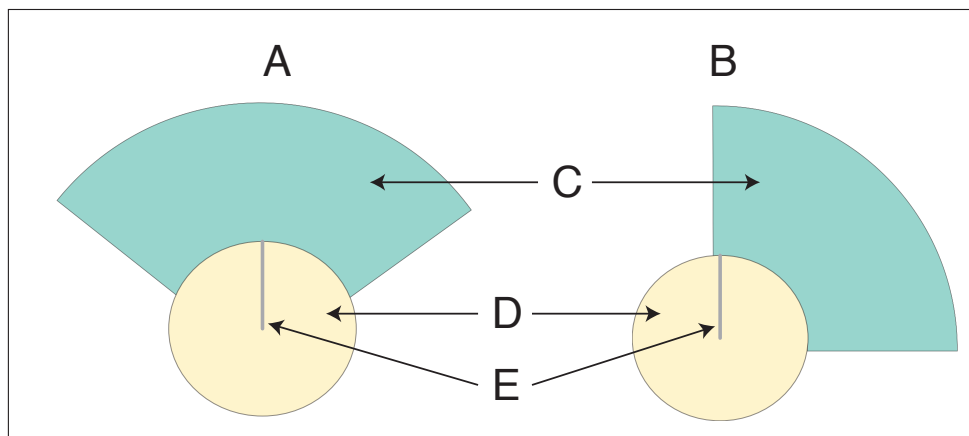


Figure 1 Bending Radius and Bending Angle

Figure key

- A – Bending at obtuse angles
- B – 90° bending
- C – E-textile
- D – Bending rod/Mandrel
- E – Bending radius

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2 APPLICABLE DOCUMENTS

2.1 International Organization for Standardization (ISO)¹

ISO 139 Textiles Standard atmospheres for conditioning and testing

3 TEST SPECIMENS

3.1 Specimen Preconditioning All test specimens **shall** be conditioned for ≥ 24 hours according to ISO 139. If other conditions are specified, they should be reported with the test results.

3.2 Specimen Description Prepare the samples in accordance with the testing apparatus. Specimens **shall** be cut from the e-textile according to the following specifications:

- Specimens **shall** be cut from the e-textile in a way that the critical area(s) are located in the middle of the specimens (area between clamps) and are exposed to bending.
- The specimens **shall** be cut in rectangular shape. The width of the specimens **shall** be defined as W and the testing length as L.
- The specimen **shall** be able to clamp onto the bending machine within its dimensions. The specimen length (L) **shall** be chosen according to test device dimensions.
- The specimen width (W) **shall** be chosen according to clamp width. Clamp width **shall** be larger or equal to specimen width and the specimen **shall** be able to clamp onto the machine so that the specimen is completely secured along its width without deforming the specimen. Specimen width **shall** be appropriate for the width of critical area(s).

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 AND MATERIAL

4.1 Bending machine The bending machine **shall** be able to perform cyclic bending motion of the specimen with the given number of cycles for the radius and the angle.

4.2 Data recorder for functionality testing

5 TEST PROCEDURE

5.1 Using the data recorder, measure the initial value of the relevant functional parameter(s). Conduct a visual inspection of the specimen prior to testing.

5.2 The specimen should be clamped in a way that the specimen is free from additional tension and without altering it physically or electrically. The specimen **shall** be clamped evenly and flat against the clamping surfaces. The specimen **shall** be free of wrinkles or folds when mounted into the machine.

5.3 Set maximal bending angle and bending radius to reflect use-case conditions or other target values.

¹ www.iso.org

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5.4 Conduct the target number of cycles.

5.5 Continuously or periodically monitor the resistance or functionality of the specimen.

5.6 After the test is performed, conduct a visual inspection of the specimen.

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
- Testing parameters/specifications if variation is possible (e.g., number of test cycles, climate conditions, test length, etc.)
- Cycle count/time intervals for intermediate testing
- Test results (parameter values before, during (if applicable) and after testing); if applicable: plotting of parameter values over time / cycle count) or other types of measurements (e.g., tensile behavior)
- Results of visual inspection before, during (if applicable) and after testing
- Any deviations from the presented methods
- Comments

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