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TECHNICAL REPORT

Printed electronics –
Part 550-1: Quality assessment – Framework document on durability testing – Mechanical and thermal testing

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IEC Secretariat
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

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FOREWORD

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IEC TR 62899-550-1 has been prepared by IEC technical committee 119: Printed Electronics. It is a Technical Report.

The text of this Technical Report is based on the following documents:

Draft	Report on voting
119/384/DTR	119/388/RVDTR

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this Technical Report is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC 62899 series, published under the general title *Printed electronics*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

INTRODUCTION

The purpose of this document is to describe a framework for evaluating the mechanical and thermal durability of printed and/or flexible electronics components and products.

Durability testing helps to improve the product and create greater revenue through customer satisfaction and retention, since it provides the means to identify and ensure a robust product. Therefore, the standardization and sharing of a consistent method for durability test is an effective way to facilitate the commoditization and raise the confidence and performance bar of the relevant industry.

IEC TC 119 has previously published several documents relating to the durability of flexible electronics components and products. Examples include IEC 62899-201, IEC 62899-501-1, IEC 62899-502-1, and IEC 62899-505. Although they cover a variety of flexible components and products, there are many similarities in methods and procedures for durability testing. More documents will continue to be published in this way. Hence, a general framework is necessary to ensure solid consistency in the test methods and procedures of printed and/or flexible electronics. Specifying the consistent methods for durability testing will help users, including businesses, developers, vendors, and end users, to select a suitable method for durability test and make consistent test procedures for printed electronics.

Among various durability tests, mechanical and thermal tests are the most common for printed and/or flexible electronics components and products, since these devices are capable of undergoing deformation under various mechanical and environmental conditions. The functional properties will be unaffected by the serious mechanical and environmental changes. Thus, this document, which is the first framework document for durability testing, addresses mechanical and thermal durability tests. Further, the types of testing and test method will be continuously updated and extended to push the growth of the printed electronics industry.

For consistency of the framework, the IEC 62899 series is preferentially referred to for mechanical and thermal tests. For example, the bending test methods and procedures are made with reference to IEC 62899-201, IEC 62899-501-1, and IEC 62899-502-1. In the case of thermal testing, the methods and procedures are prepared based on IEC 62899-505, whereas the temperature and humidity conditions refer to IEC 60721-3-7, which includes the environmental parameters for portable use.

This framework is intended to assist in making documents relating to the mechanical and thermal durability of printed and/or flexible electronics components and products consistent.

For a general applicability of this framework, other durability tests such as humidity, altitude and radiation will be considered.

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1 Scope

This part of IEC 62899, which is a Technical Report, provides a framework for evaluating the mechanical and thermal durability of printed and/or flexible electronics components and products. This includes the bending test, torsion test, stretching test, steady heat test as well as the thermal cycle test. These are typical conditions that are easily encountered in daily life for printed and/or flexible electronics components and products.

This document gives guidance for use for technical committees in the preparation of consistent standards relating to the quality assessment of printed and/or flexible electronics components and products. Consistent standards for durability testing will help users, including businesses, developers, vendors, and end users to select suitable methods for durability testing and make consistent test procedures for printed electronics.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
device
material element or assembly of such elements intended to perform a required function

3.2
bending
deformation caused by external stress applied in a direction perpendicular to the device plane

3.3
torsion
deformation caused by external stress which twists the device, pulling each edge in different directions

3.4
stretching
deformation caused by external stress to extend or lengthen the device beyond the original length

3.5
temperature cycle
process of changing from a starting temperature to relatively higher and relatively lower temperatures, and then reaching the starting temperature again

4 Default items applicable to the test methods

4.1 Selection of test methods

The selection of the appropriate tests depends on the flexibility and application of the printed electronics device. Documents of TC 119 are preferentially considered as potential references. The testing conditions and the modification of the methods can be defined between customer and supplier.

4.2 Performance measurement

Before the start and after the end of each test, the measurement of the device performance can be performed in accordance with the manufacturer's instruction, unless otherwise stated.

The performance can be one or more of functional properties, electrical properties, and optical properties.

The typical test is performed without an electric power supply attached to device. If desired, it is possible to have a test with an electric power supply attached to the device during the next test.

5 Mechanical test methods

5.1 Bending test

5.1.1 General

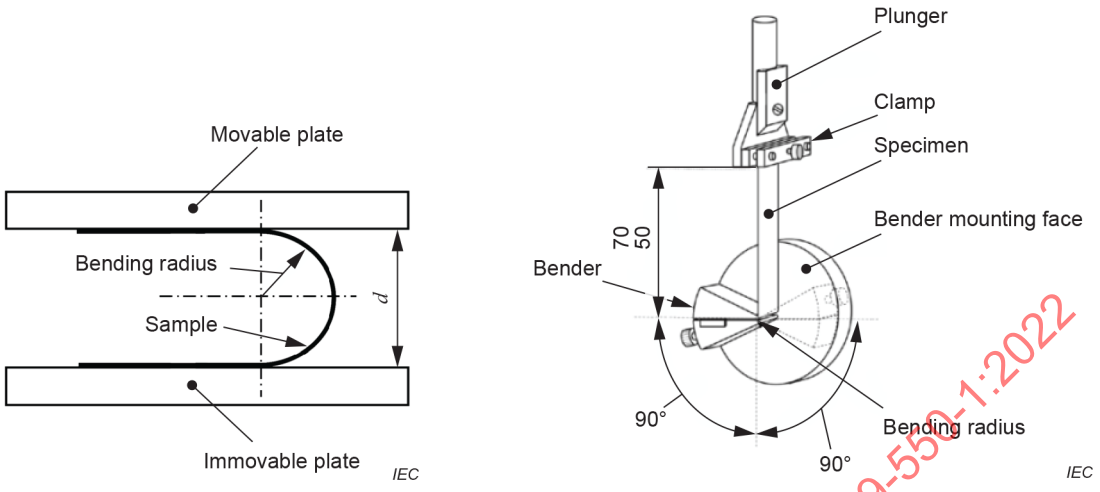
The purpose of this test is to evaluate the stability and endurance of the printed electronics device against the dynamic bending stress which happens for a flexible movement.

The IEC 62899 series already has three kinds of bending test methods in IEC 62899-501-1, IEC 62899-201 and IEC 62899-502-1.

5.1.2 Test apparatus

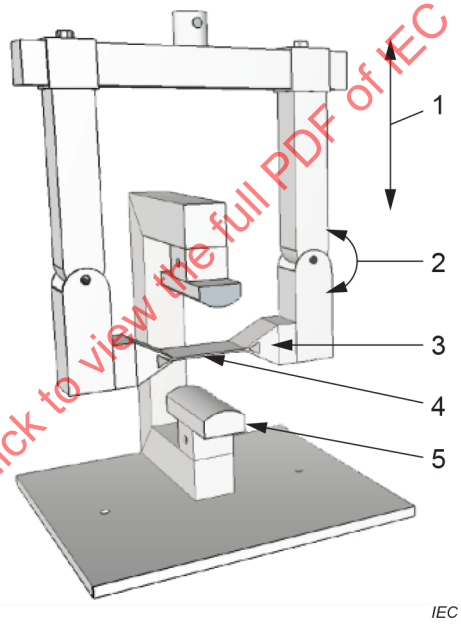
The apparatus for bending the device can be selected from the bending tests specified in IEC 62899-201, IEC 62899-501-1 and IEC 62899-502-1 with their specific requirements (see Figure 1, Figure 2, and Figure 3). The bending cycle is performed by bending and returning to the neutral position with a predetermined radius.

Dimensions in millimetres



a) Flex resistance tester **b) MIT instrument**

Figure 1 – Bending apparatuses of IEC 62899-201



Key:

1 direction of the upwards and downwards movements
2 right hinge
3 right parallel vice for device clamping
4 device
5 lower bending radius, which can be varied

Figure 2 – Bending apparatus of IEC 62899-501-1

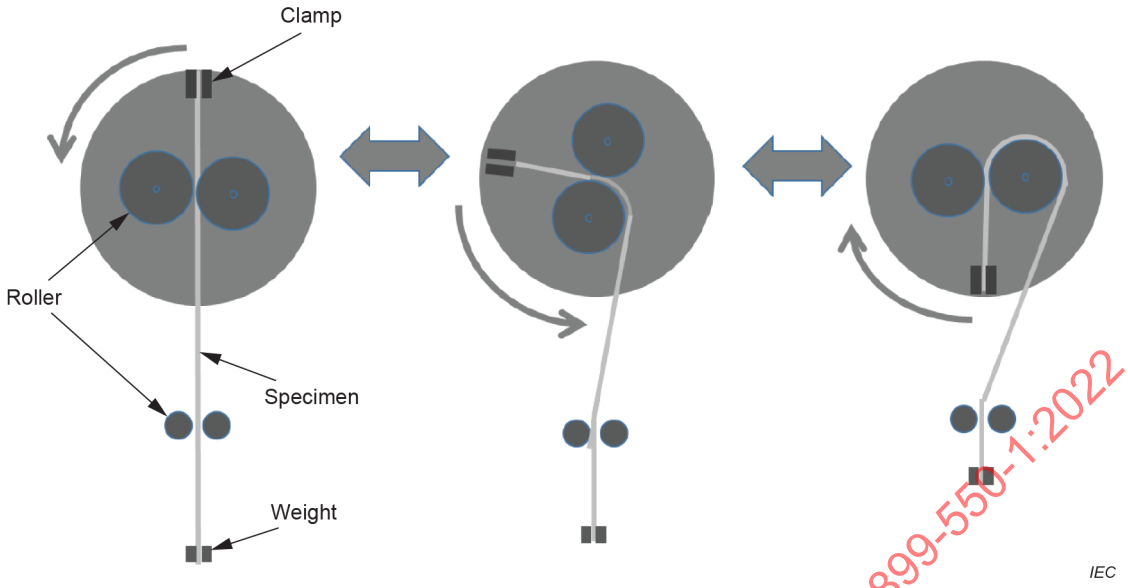


Figure 3 – Bending apparatus of IEC 62899-502-1

5.2 Torsion test

5.2.1 General

The purpose of this test is to evaluate the stability and endurance of the printed electronics device against the dynamic torsion stress which happens for a flexible movement.

The IEC 62899 series already has a torsion test method in IEC 62899-502-1.

5.2.2 Test apparatus

The apparatus for the twisting device can follow the torsion test specified in IEC 62899-502-1 with its specific requirements (see Figure 4). The torsion cycle is performed by rotating through an angle up to the predetermined value and returning to the neutral position.

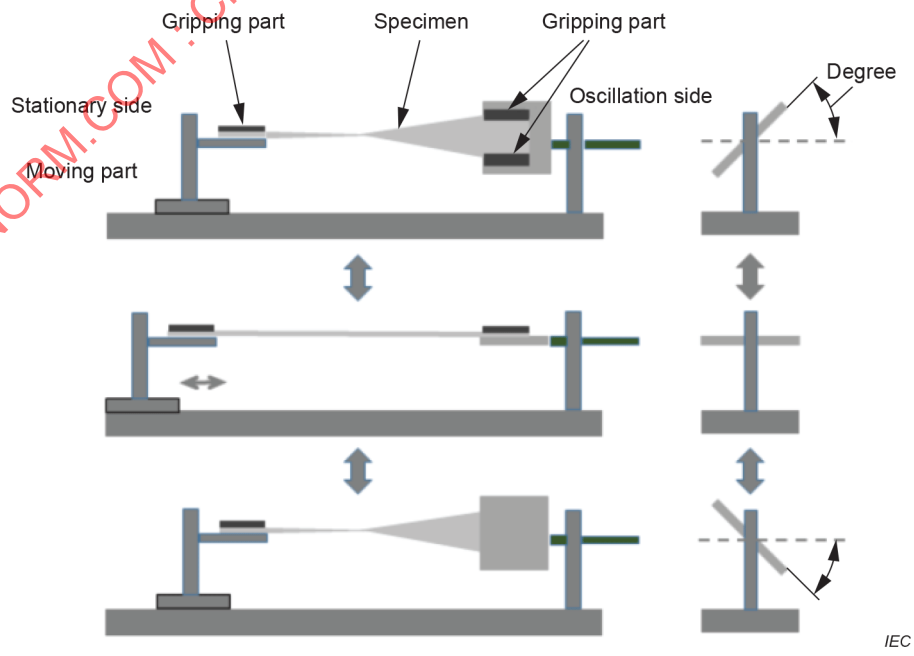


Figure 4 – Torsion apparatus of IEC 62899-502-1

5.3 Stretching test

5.3.1 General

The purpose of this test is to evaluate the stability and endurance of the printed electronics device against the dynamic stretching stress which happens for a flexible movement.

The IEC 62899 series already has a torsion test method in IEC 62899-502-1.

5.3.2 Test apparatus

The apparatus for the stretching device can follow the procedure specified in IEC 62899-502-1 with its specific requirements (see Figure 5). The stretching cycle is performed by extending along the longitudinal axis until the distance reaches the predetermined value and returning to the neutral position.

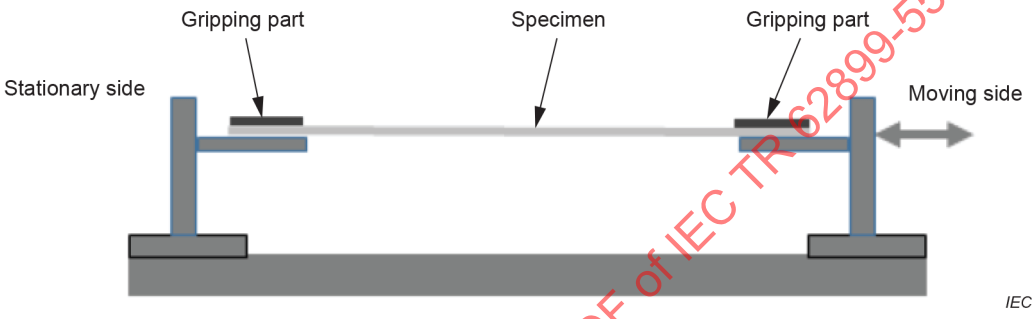


Figure 5 – Stretching apparatus of IEC 62899-502-1

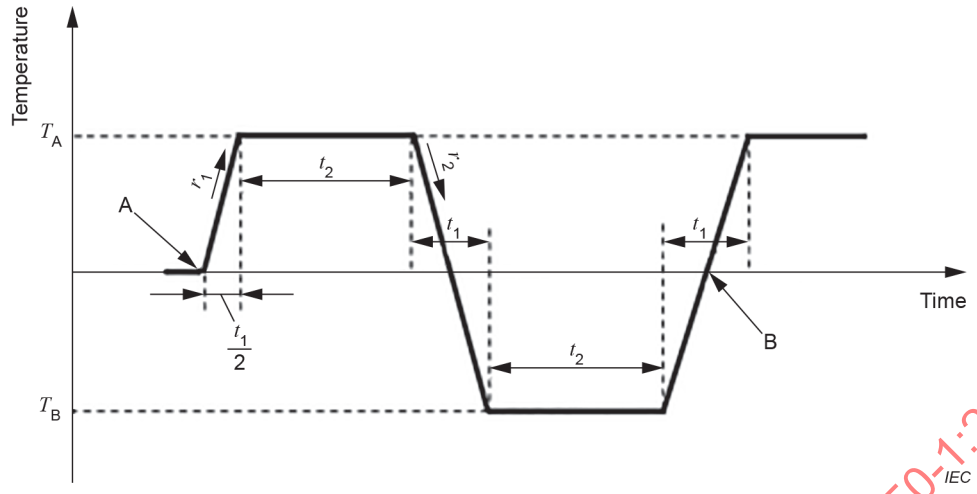
6 Thermal test methods

6.1 Thermal cycle test

6.1.1 General

The purpose of this test is to evaluate the stability and endurance of the printed electronics device against the change of temperature which happens in mobile application.

The IEC 62899 series already has a thermal test method in IEC 62899-505 (see Figure 6).



Key:

A start of first cycle

B end of first cycle and start of second cycle

Figure 6 – Temperature cycle of IEC 62899-505

6.1.2 Tolerances

The temperature of the incident air delivered to the device can be within ±2 °C of the test temperature.

6.1.3 Conditioning

The temperature and relative humidity can be stabilized at an ambient temperature of 23 °C ± 2 °C and a relative humidity of 50 % ± 10 %, and by conforming to standard atmosphere class 2 specified in ISO 291.

6.1.4 Temperature cycle

The temperature cycle can be based on the test cycles specified in IEC 60068-2-14. The various types of test cycles of IEC 60068-2-14 can be combined with the specific requirements.

The upper and lower temperature can be in accordance with IEC 60721-3-7 and IEC 62899-505 with specific modifications. The relative humidity can be chosen in the range between 0 % RH and 100 % RH.

6.2 Steady heat test

6.2.1 General

The purpose of this test is to evaluate the stability and endurance of the printed electronics device against the hot or cold environment which happens during handling, transportation or storage.

6.2.2 Tolerances

The temperature of incident air delivered to device can be within ±2 °C of the test temperature.

6.2.3 Conditioning

The temperature and relative humidity can be stabilized at an ambient temperature of 23 °C ± 2 °C and a relative humidity of 50 % ± 10 %, and by conforming to standard atmosphere class 2 specified in ISO 291.

6.2.4 Heating

The heating can be based on the descriptions specified in IEC 60068-2-2. The various types of test cycles of IEC 60068-2-2 can be combined with the specific requirements.

The range of the temperature can be in accordance with IEC 60721-3-7 and IEC 60068-2-2 with specific modifications. The relative humidity can be chosen in the range between 0 % RH and 100 % RH.