IEC 62899-202-8

Edition 1.0 2024-03

INTERNATIONAL STANDARD

colour inside

Printed electronics –
Part 202-8: Materials – Conductive ink – Measurement of difference in resistance of printing direction of conductive film fabricated with wire-shaped materials



IEC 62899-202-8:2024-03(en)



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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 31.180; 87.080

ISBN 978-2-8322-8432-2

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IEC 62899 has been prepared by IEC technical committee 119: Printed electronics. It is an International Standard.

The text of this International Standard is based on the following documents:

Draft	Report on voting
119/476/FDIS	119/483/RVD

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 International Standard 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- withdrawn, or
- revised.

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INTRODUCTION

The printing process for fabricating flexible devices is a very promising technology due to its high conductivity and efficiency. Specifically, a printed metal-based conductive layer on a flexible substrate can be employed as electrode or be interconnected for flexible devices. It can be commercialized as a type of composite material where the conductive layer is formed on the substrate as a conductor.

For metal-based transparent conductive (TC) films, silver or copper nanowires or metal mesh on a flexible substrate are a key component for many recently developed electronic products, ranging from smartphones to keypads of appliances such as refrigerators and washing machines. While indium tin oxide (ITO) is the conventional material for TC films, metal-based TC films fabricated using printed electronics technologies are being increasingly used as an alternative. TC film-fabricated nanowires have superior intrinsic properties owing to their wire shape. Their electrical performance can differ based on the printing direction and ink properties. The alignment of a wire depends on the printing equipment, ink composition, printing process, etc. [1] to [3][1].

In this document, a method to evaluate the difference in electrical properties based on the printing direction is proposed. In particular, the proposed method monitors changes in the resistance of a printed metal-based TC film on a flexible substrate.

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1 Numbers in square brackets refer to the Bibliography.

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1 Scope

This part of IEC 62899 provides a method for measuring the resistance difference of the printing direction of a printed conductive layer with wire-shaped or wire-type conducting materials. The method described in this document offers a measurement method and conditions for solution processed conductive films, fabricated by coating and printing process.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 62899-201, *Printed electronics – Part 201: Materials – Substrates*

IEC 62899-202, *Printed electronics – Part 202: Materials – Conductive ink*

ISO 291*, Plastics – Standard atmospheres for conditioning and testing*

3 Terms and definitions

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

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

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

3.1
conductive material
ingredient of a printing or coating material, which itself is electrically conductive or becomes electrically conductive by post treatment such as heating

Note 1 to entry: The ingredient can be one or more small molecules, precursors, polymers, or particles.

Note 2 to entry: The ingredient might require post treatment to provide electrical conductivity.

[SOURCE: IEC 62899-101:2019, 3.19, modified – the notes have been added.]

3.2
conductive ink
fluid in which one or more conductive materials are dissolved or dispersed, and which is used to form a conducting structure

[SOURCE: IEC 62899-101:2019, 3.17, modified – “chemical precursors, polymers, or particles” have been replaced with “fluid in which one or more conductive materials”, “and which is used to form a conducting structure” has been added to the definition, and Note 1 has been removed.]

3.3
conductive film
substrate (sheet or roll) with a conductive layer

[SOURCE: IEC 62899-101:2019, 3.16]

3.4
flexible substrate
substrate showing reversible (i.e. elastic) mechanical behaviour within a certain range of applied mechanical stress

[SOURCE: IEC 62899-101:2019, 3.60, modified – the example has been removed.]

3.5
wire-shaped material
wire-type material
material with a high aspect ratio of length to diameter or width

3.6
machine direction
MD
direction in which the substrate or stock moves during printing

[SOURCE: IEC 62899-101:2019, 3.80]

3.7
cross direction
CD
direction at right angles to the machine direction of a substrate

[SOURCE: IEC 62899-101:2019, 3.25]

4 Test sample, apparatus and measuring device

4.1 Measurement environmental conditions

The temperature and humidity conditions for evaluation tests shall be at a temperature of 23 °C ± 1 °C, relative humidity of (50 ± 5) %, and an atmospheric pressure in accordance with ISO 291 unless otherwise specified.

4.2 Test apparatus

The difference in resistance based on the printing direction can be evaluated by connecting the metal grip and electrical connection to the silver paste and protective layer.

To measure resistance, the test sample can be placed on a rigid plate that connects to the measuring equipment as in Figure 1. The test sample is connected to the measuring equipment with two or four conductive wires.