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INTERNATIONAL STANDARD

colour inside

Printed electronics – Part 301-2: Equipment – Contact printing – Rigid master – Measurement method of plate master pattern dimension

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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FOREWORD

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International Standard IEC 62899-301-2 has been prepared by IEC technical committee TC119: Printed electronics.

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

FDIS	Report on voting
119/178/FDIS	119/187/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

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 "http://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- withdrawn,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.

A bilingual version of this publication may be issued at a later date.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

When dissecting the term "printed electronics", it can be easily understood that this industry involves electronic devices and products that are made using some fashion of printing technique. Printing methods have been widely used in textile and paper type substrates for centuries. In the past, the advent of mass producible printouts has brought huge impacts on how knowledge is stored, transferred and reproduced. At this stage of technological development, printing on either rigid or flexible substrates is considered to supplement or replace traditional electronic device manufacturing processes. The difference between media printing and printed electronics stems from the fact that media print is used to convey information for human to process using eyes while printed electronics requires machine to process electronic information; the level of required resolution and functionality make the differences. Some of the widely used functional materials for printed electronics are, but not limited to nano- or micro-size metal particles, semiconductive polymers, and dielectric materials. Due to the available and required readout resolution, small feature size below 20 μm needs to be printed. Layer thickness and registration accuracy of printed products are closely related to quality control of electronic devices, and ink materials require a high level of quality. Overall, printing tolerance is much smaller in printed electronics.

There are mainly two categories in printing process for the printed electronics. One is a non-contact printing process such as inkjet printing and electrostatic discharge (ESD) printing process. The other is a contact printing process such as gravure printing, gravure offset printing, reverse offset printing and screen printing. This document provides a proposal for measuring and assessing the printing master, therefore the scope is limited to the printing process using the printing master.

The quality of the printing master is important because the ink is transferred from the printing master to the substrate directly in these processes and it means that the quality of the results of the printed circuit depends on the quality of the printing master. For a mass production of the printed electronic devices, many companies such as device manufacturers, printing master manufacturers and printing master manufacturing equipment vendors are related to manufacturing and they need to use the printing master and the standardized measurement and assessment methods.

PRINTED ELECTRONICS –

Part 301-2: Equipment – Contact printing – Rigid master – Measurement method of plate master pattern dimension

1 Scope

This part of IEC 62899 defines measurement terms and methods related to the critical dimension of features and the registration accuracy of features on rigid plate masters.

General critical dimensions are defined to evaluate the shape accuracy of features on the plate master. To evaluate the registration accuracy of features on the plate master, the specification for the registration mark for the plate master is specified. Then, common metrology procedures to measure the critical dimensions and the registration accuracy of the plate master are established for device manufacturers, printing master manufacturers and printing master manufacturing equipment vendors. The measurement terms which are measured by agreement between the user and the supplier are measured using the measurement methods given in this document.

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
plate master
device that carries the image to be printed

Note 1 to entry: The image on the plate may be raised above the surface (relief) or may be carved into the surface.

3.2
machine direction
MD
direction in which the stock flows

3.3
CD
cross direction
direction at right angles to the machine direction of a substrate

3.4
pattern edge detection method
method for determining the edge position of a given pattern by a computer algorithm

3.5
feature
region within a single continuous boundary that is distinct from the region outside the boundary

Note 1 to entry The feature is called "CD feature" if the length of the feature is aligned with the cross direction while the feature is printed.

Note 2 to entry The feature is called "MD feature" if the length of the feature is aligned with the machine direction while the feature is printed.

3.6
nominal feature
intended or designed feature

3.7
actual feature
manufactured feature on the master plate

3.8
critical dimension
dimension of the geometrical features (width of interconnected lines, contacts, trenches, etc.) which can be formed during electronic device/circuit manufacturing and can be of interest for further qualification

3.9
1-D qualification features
features which can be qualified by single directional parameters

3.9.1
feature width
width of feature which will be printed on the substrate

Note 1 to entry Generally, feature width is measured for the line and space pattern. It can be expressed by line width or space width.

3.9.2
pitch
centroid-to-centroid distance between two repeatedly placed features

3.9.3
line edge roughness
LER
perpendicular point-to-point deviation of the feature's edge from the linear fitted feature edge

3.9.4
line width roughness
LWR
deviation of the point-to-point line width from the average width of the specified line width

3.10
2-D qualification feature
feature that is qualified by area-based qualification parameters

3.10.1
contact
rectangular feature whose length-to-width ratio ranges from 0,5 to 2

3.10.2
line-end shortening
deviation of the actual feature from the nominal feature at the nominal line-end

3.10.3
corner rounding
deviation of an actual feature corner from the nominal one

3.10.4
area gain
area in the actual feature contour outside the nominal feature contour

3.10.5
area loss
area outside the actual feature but still inside the nominal feature

3.10.6
area difference
feature area gain minus feature area loss

3.10.7
area deviation
sum of the values of the feature area gain and the feature area loss

3.11
cross-sectional qualification feature
feature which can be qualified by cross-sectional qualification parameters

3.11.1
feature height
feature depth
dimension of feature perpendicular to reference plane

3.11.2
feature model
solid geometrical shape, with well-defined parameters (e.g. length, width, height, centroid, etc), meant to approximate the actual shape of a feature boundary

3.11.3
reference plane
plane which is approximating the un-patterned surface on the master plate

3.12
registration accuracy
deviation of the measured feature position from the nominal feature position

3.12.1
registration accuracy of the reference marks relative to the reference edges
deviation of the measured feature position of the reference registration marks relative to reference edges from their nominal feature position

3.12.2
reference registration marks
registration marks whose distance from two reference edges is measured

3.12.3
reference edges
two edges adjacent to the orientation corner

3.12.4
orientation corner
asymmetric orientation corner specified for the purpose of mechanical orientation and operator's visual confirmation of plate orientation

4 Coordinate system [1] [1]

The coordinate system xyz for this document is defined in Figure 1. It is defined with the patterned mask side upwards. Cross direction is aligned with the x axis, and machine direction is aligned with the y axis. The z axis is the direction perpendicular to the xy plane; z is zero at reference plane and (x, y) = (0,0) is tool or application specific.

Features are called "CD features" when their length is along x, and feature width is then measured in y. The length of MD features is along y, and their feature width is measured in x. The registration accuracy is expressed with this coordinate system.

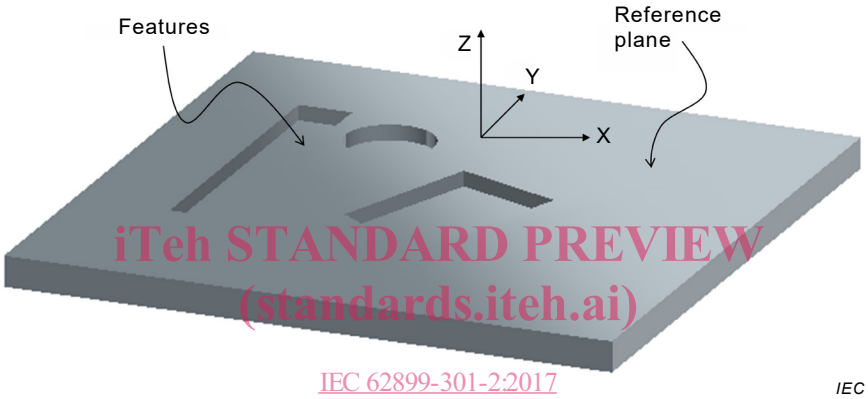

Figure 1 – Coordinate system for measuring patterns on the plate master

5 1-D qualification features [1]

5.1 Measurement instrument

The measurement instrument is as follows.

– Microscope or measurement instrument with sufficient resolution:
  - repeatability: less than 10 % of the tolerance specification of the width;
  - accuracy: less than 10 % of the tolerance specification of the width;
  - calibration: Calibration should be carried out periodically in accordance with the guidelines of the instrument manufacturer.
– Measurement temperature: it is recommended that the measurement is carried out at the temperature of 20 °C which is specified as the standard reference temperature in ISO 1.

5.2 Feature types

The feature types are as follows:

– feature width and pitch;
– line edge roughness (LER) and line width roughness (LWR).

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1 Numbers in square brackets refer to the Bibliography.