

INTERNATIONAL STANDARD



**Printed electronics –
Part 403-1: Printability – Requirements for reproducibility – Basic patterns for
evaluation of printing machine**

IECNORM.COM : Click to view the full PDF of IEC 62899-403-1:2018



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2018 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

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

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

IEC Catalogue - webstore.iec.ch/catalogue

The stand-alone application for consulting the entire bibliographical information on IEC International Standards, Technical Specifications, Technical Reports and other documents. Available for PC, Mac OS, Android Tablets and iPad.

IEC publications search - webstore.iec.ch/advsearchform

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and also once a month by email.

Electropedia - www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing 21 000 terms and definitions in English and French, with equivalent terms in 16 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary

67 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IECNORM.COM : Click to view the full text of IEC 62599-403-1:2018

INTERNATIONAL STANDARD



**Printed electronics –
Part 403-1: Printability – Requirements for reproducibility – Basic patterns for
evaluation of printing machine**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 31.180; 37.100.10

ISBN 978-2-8322-5806-4

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD.....	4
INTRODUCTION.....	6
1 Scope.....	7
2 Normative references	7
3 Terms and definitions	7
4 Abbreviated terms	8
5 General description of basic pattern	8
6 Basic pattern for evaluation	8
6.1 General.....	8
6.2 PMVT	9
6.3 PMHZ	9
6.4 PMAG	10
6.5 PMAR	11
6.6 PMCR.....	12
7 Register marks	13
7.1 General.....	13
7.2 Design of register mark.....	14
7.2.1 Square register mark	14
7.2.2 Circle register mark	14
7.2.3 Doughnut register mark	14
7.2.4 Triangle register mark.....	15
7.2.5 Diamond register mark.....	15
7.2.6 Cross register mark	15
7.2.7 Double cross register mark	16
7.2.8 X cross register mark.....	16
8 Requirements for evaluation	17
8.1 Evaluation items	17
8.2 Measurement methods and instruments	17
9 Evaluation pattern information	17
9.1 General.....	17
9.2 PMVT	17
9.3 PMHZ	17
9.4 PMAG	17
9.5 PMAR	18
9.6 PMCR.....	18
Annex A (informative) Examples of basic pattern layouts	19
A.1 Example 1.....	19
A.2 Example 2.....	19
Annex B (informative) Use case of basic pattern	20
B.1 General.....	20
B.2 Large variation of cylinder rotation speed with a normal plate	20
B.3 Out-of-roundness of cylinder with a normal plate.....	21
Annex C (informative) Other evaluation patterns	23
C.1 General.....	23
C.2 Example.....	23

Bibliography.....	24
Figure 1 – PMVT.....	9
Figure 2 – PMHZ.....	10
Figure 3 – PMAG	11
Figure 4 – PMAR	12
Figure 5 – PMCR	13
Figure 6 – Register marks.....	14
Figure 7 – Square register mark.....	14
Figure 8 – Circle register mark.....	14
Figure 9 – Doughnut register mark.....	15
Figure 10 – Triangle register mark	15
Figure 11 – Diamond register mark	15
Figure 12 – Cross register mark.....	16
Figure 13 – Double cross register mark.....	16
Figure 14 – X cross register mark	16
Figure A.1 – Example of basic pattern layout in a printing area and a margin area.....	19
Figure A.2 – Example of basic pattern layout in a margin area.....	19
Figure B.1 – Example of use case for PMVT	21
Figure B.2 – Example of use case for PMAR.....	22
Figure C.1 – Semi-arcs and circular doughnuts.....	23

INTERNATIONAL ELECTROTECHNICAL COMMISSION

PRINTED ELECTRONICS –

**Part 403-1: Printability – Requirements for reproducibility –
Basic patterns for evaluation of printing machine**

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 62899-403-1 has been prepared by IEC technical committee 119: Printed Electronics.

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

FDIS	Report on voting
119/214/FDIS	119/223/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.

IECNORM.COM : Click to view the full PDF of IEC 62899-403-1:2018

INTRODUCTION

The IEC 62899-403 series contains basic patterns to evaluate the printability of a printing machine, plating, and applications for printed electronics. The printability is defined as both the quality of printed patterns and the reproducibility of printing designs as the result of the interaction of printing media, inks, and substrates. The documents from the IEC 62899-403 series provide commonly-utilized design patterns for evaluating printability. The quality of printed patterns is satisfied by accurate measuring, with a mechanical, physical, or optical apparatus, the patterns being two-dimensional or three-dimensional. On the other hand, the reproducibility of printing designs is achieved by estimating the reproducibility of replica.

The IEC 62899-402 series assumes a large role in the standardization of measuring methods for these printed patterns, and the IEC 62899-403 series has a key role in standardizing the estimation of the patterns' reproducibility.

In the business field, requests from industry to apply the printing technology to electronics manufacturing have been guarantees for both the quality and reproducibility that have helped facilitate international trade and enhanced user value in the field of printed electronics.

IECNORM.COM : Click to view the full PDF of IEC 62899-403-1:2018

PRINTED ELECTRONICS –

Part 403-1: Printability – Requirements for reproducibility – Basic patterns for evaluation of printing machine

1 Scope

This part of 62899-403 specifies commonly-utilized basic design patterns to evaluate printing machines with pattern reproducibility from the view point of printability in the field of printed electronics. These basic patterns consist of several evaluation patterns and register marks.

Printability is derived from the evaluation of the reproducibility of these printed patterns produced by the printed machine.

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 60050 (all parts), *International Electrotechnical Vocabulary (IEV)* (available at www.electropedia.org)

IEC 62899-402 (all parts), *Printed electronics – Part 402-X: Printability – Measurement of qualities*

ISO 3, *Preferred numbers – Series of preferred numbers*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050 and the following 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

basic pattern

set of two-dimensional figures, which consist of evaluation patterns and register marks, used to inspect the reproducibility of printed patterns

3.2

evaluation pattern

set of fundamental figures to evaluate the printability for printing machines in printed electronics

3.3

register mark

set of marks that correspond to each other's position

3.4

printed pattern

pattern which is printed by a machine

3.5

machine direction

one of the directions in which a substrate is carried by a printing or coating machine

3.6

printing area

imaging or drawing area on a page or substrate made by a printing machine

3.7

margin area

blank border around the printing area on a page or substrate

4 Abbreviated terms

For the purposes of this document the following abbreviated terms apply.

PMVT	Vertical evaluation pattern for printability on machine
PMHZ	Horizontal evaluation pattern for printability on machine
PMAG	Angle evaluation pattern for printability on machine
PMAR	Arrow evaluation pattern for printability on machine
PMCR	Corner evaluation pattern for printability on machine

5 General description of basic pattern

The basic pattern is a collection of two-dimensional graphical figures, which are basic and have various shapes according to the intended use but are kept to the minimum necessary, to estimate the printability for printing machines, plates, and applications. The collection is expected to be commonly-used, for any purpose, by relevant operators, engineers, scientists, and others in the field of printed electronics.

The basic pattern in this document has two types of pattern: evaluation patterns and register marks. Both of them are specified by graphical figures and dimensions.

The basic pattern for evaluation consists of straight lines, diagonal lines, and circular lines. The patterns are used to evaluate printability under the actual use of an electronic circuit.

The basic pattern for registration consists of square, circle, doughnut, triangle, diamond, cross, double cross, and X cross marks. The marks are used for the register.

6 Basic pattern for evaluation

6.1 General

The evaluation patterns consist of the following five patterns. These patterns shall be used for the evaluation of printing. These patterns are described in a uniform way.

- a) PMVT (see 6.2) for vertical printability

- b) PMHZ (see 6.3) for horizontal printability
- c) PMAG (see 6.4) for angle printability
- d) PMAR (see 6.5) for arrow printability
- e) PMCR (see 6.6) for corner printability

See Annex B and Annex C for use cases of evaluation patterns.

Values in 6.2 to 6.6 shall be selected from values specified in ISO 3.

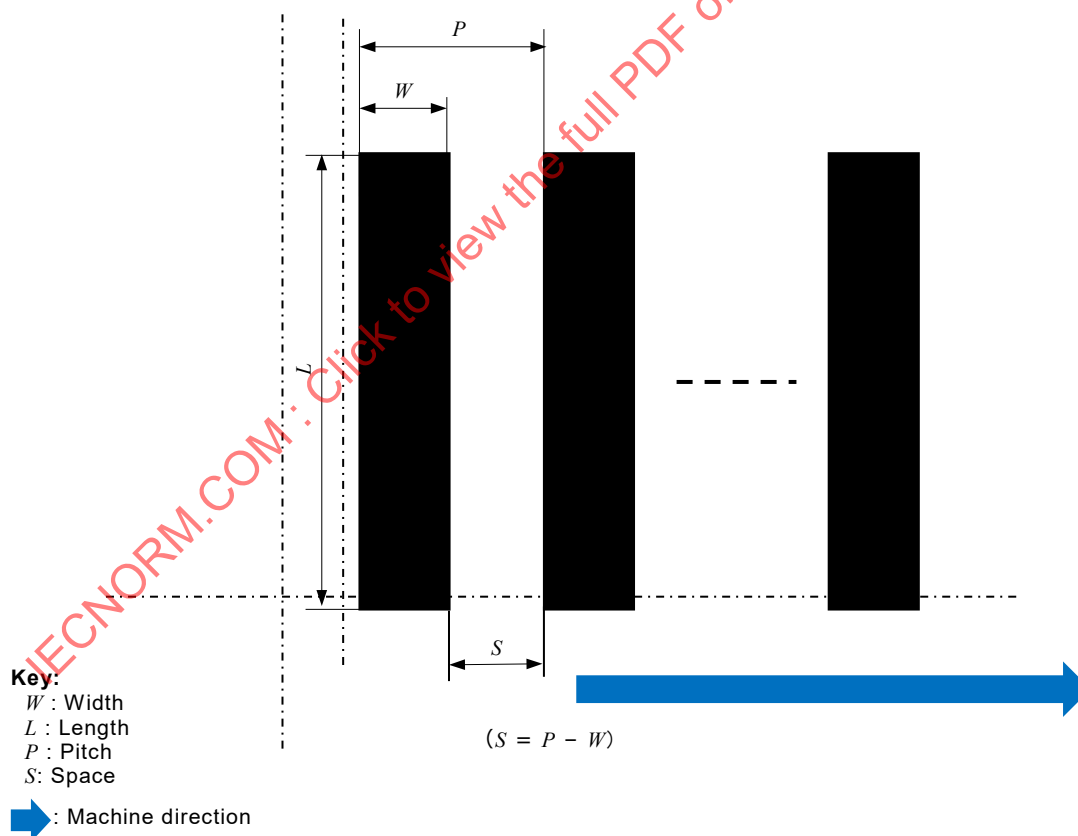
6.2 PMVT

PMVT shall be a set of straight lines perpendicular to the machine direction as shown in Figure 1.

The width may be selected from 3 µm, 5 µm, 8 µm, 10 µm, 20 µm, 50 µm, 80 µm, 100 µm, or 200 µm.

The pitch shall be twice the width.

The length shall be more than ten times the width. When the length is beyond the printing area, the length may be less than ten times.



IEC

Figure 1 – PMVT

6.3 PMHZ

PMHZ shall be a set of straight lines parallel to the machine direction as shown in Figure 2.

The width may be selected from 3 μm , 5 μm , 8 μm , 10 μm , 20 μm , 50 μm , 80 μm , 100 μm , or 200 μm .

The pitch shall be twice the width.

The length shall be more than ten times the width. When the length is beyond the printing area, the length may be less than ten times.

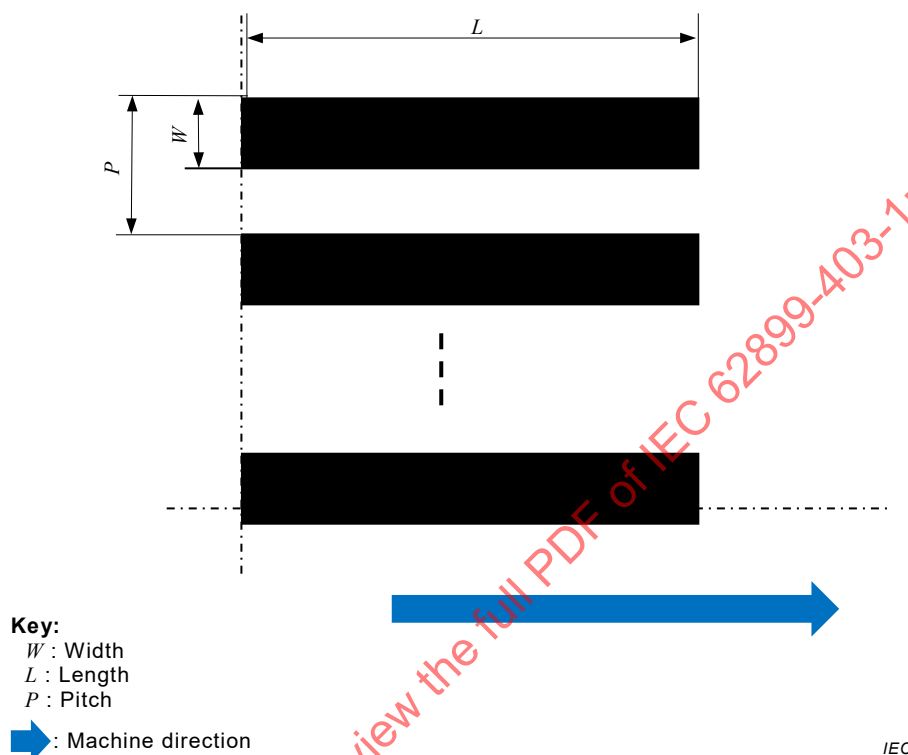


Figure 2 – PMHZ

6.4 PMAG

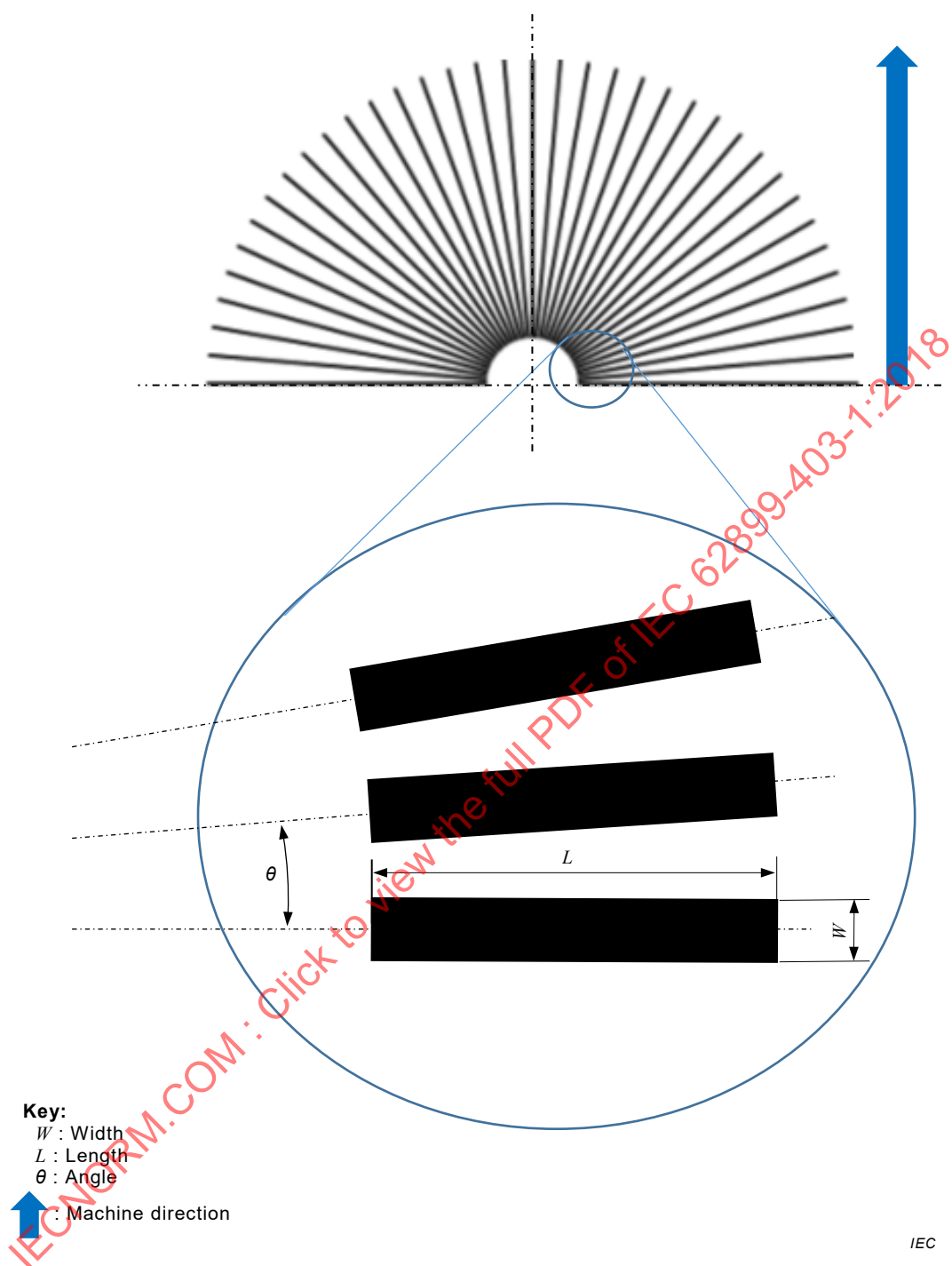
PMAG shall be a set of straight lines diagonal to the machine direction as shown in Figure 3.

The width may be selected from 3 μm , 5 μm , 8 μm , 10 μm , 20 μm , 50 μm , 80 μm , 100 μm , or 200 μm .

The length shall be more than ten times the width. When the length is beyond the printing area, the length may be less than ten times.

The angle θ shall be every 5° from 0° to 180°.

The space between two lines is at least the width of the line.



IEC

Figure 3 – PMAG**6.5 PMAR**

PMAR shall be a set of arrows to the machine direction as shown in Figure 4.

The width may be selected from 3 μm , 5 μm , 8 μm , 10 μm , 20 μm , 50 μm , 80 μm , 100 μm , or 200 μm .

The pitch shall be twice the width.

The length shall be more than ten times the width. When the length is beyond the printing area, the length may be less than ten times.

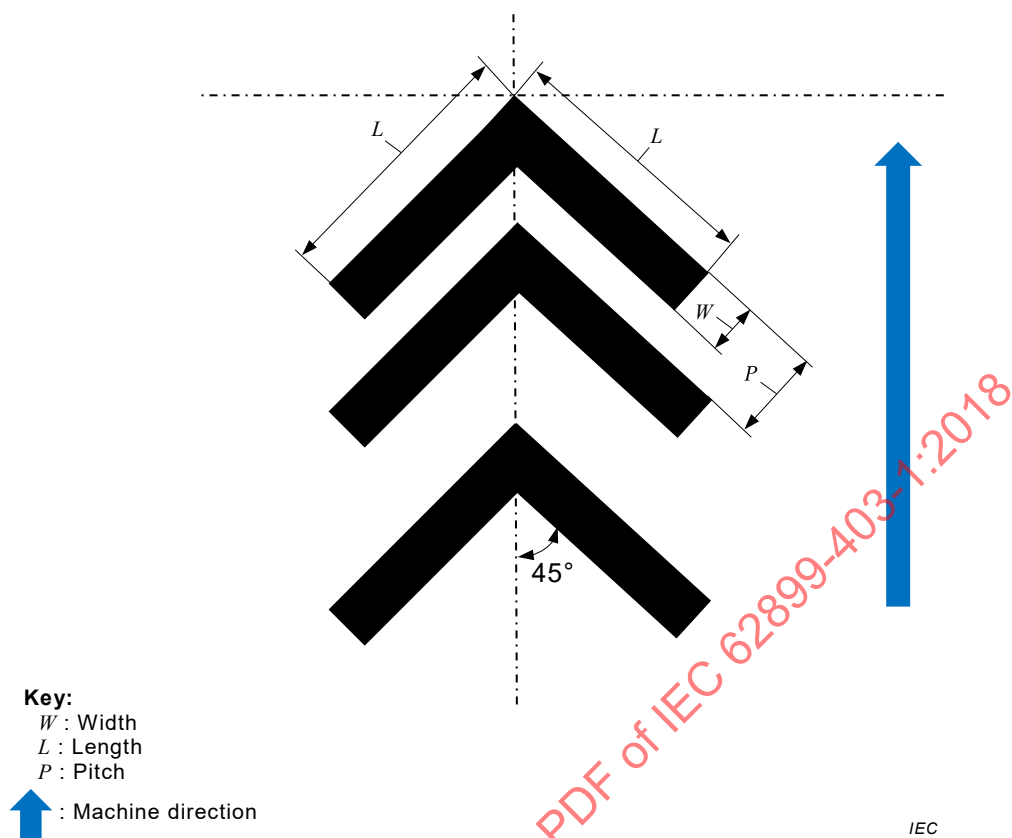


Figure 4 – PMAR

6.6 PMCR

PMCR shall be a set of perpendicular lines connected with an arc to the machine direction as shown in Figure 5.

The width may be selected from 3 μm , 5 μm , 8 μm , 10 μm , 20 μm , 50 μm , 80 μm , 100 μm , or 200 μm .

The pitch shall be twice the width.

The length shall be more than ten times the width. When the length is beyond the printing area, the length may be less than ten times.

The corner radius shall be one-and-a-half times the width.

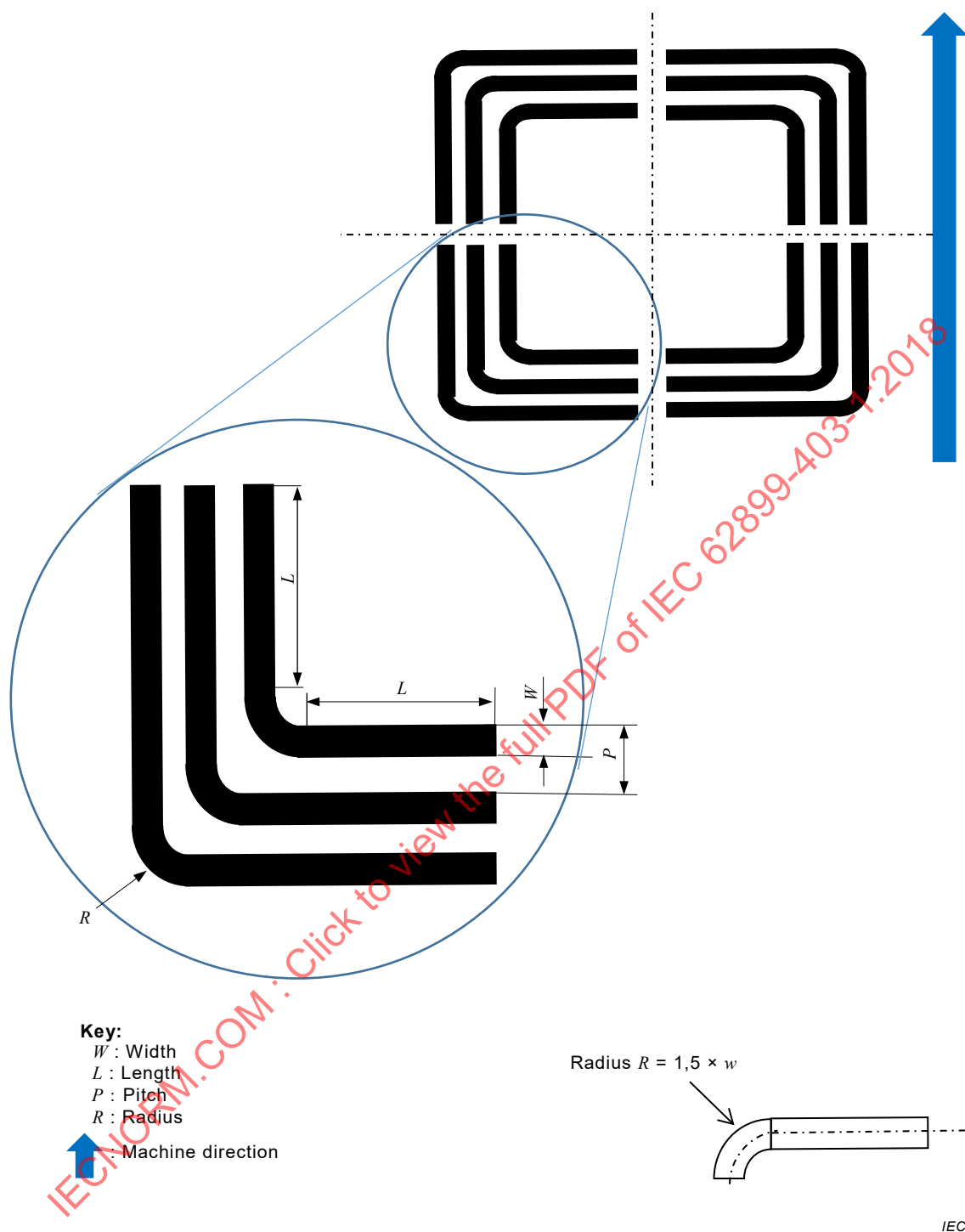


Figure 5 – PMCR

7 Register marks

7.1 General

Register marks consist of the following eight marks (see Figure 6). These patterns shall be used for evaluations.

Each mark shall be recognized when two marks overlap. Size should be agreed between the supplier and the customer.

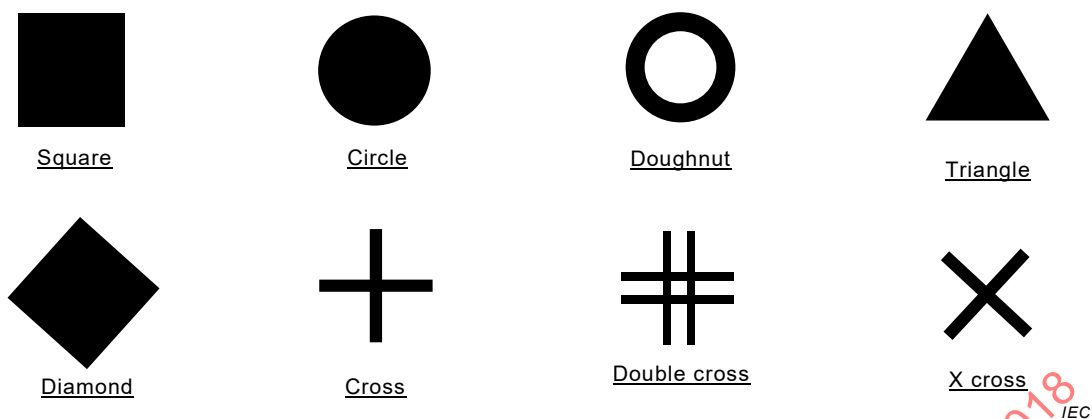


Figure 6 – Register marks

7.2 Design of register mark

7.2.1 Square register mark

A square register mark shall be a square with width W as shown in Figure 7.



Figure 7 – Square register mark

7.2.2 Circle register mark

A circle register mark shall be a circle with diameter D as shown in Figure 8.

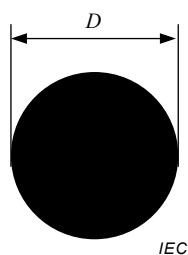


Figure 8 – Circle register mark

7.2.3 Doughnut register mark

A doughnut register mark shall be a doughnut shape with an outer diameter of D_1 and an inner diameter of D_2 as shown in Figure 9. D_2 should be 80 % of D_1 .

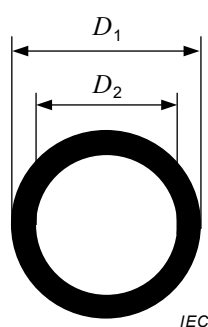


Figure 9 – Doughnut register mark

7.2.4 Triangle register mark

A triangle register mark shall be an equilateral triangle with width W as shown in Figure 10.

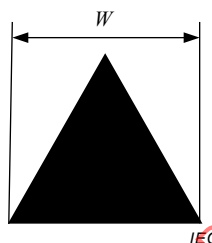


Figure 10 – Triangle register mark

7.2.5 Diamond register mark

A diamond register mark shall be an equilateral quadrangle with width W and length L as shown in Figure 11.

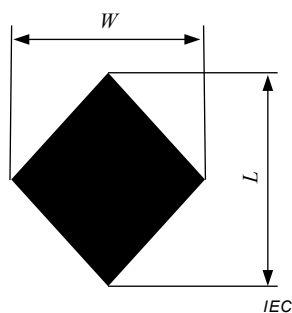


Figure 11 – Diamond register mark

7.2.6 Cross register mark

A cross register mark shall be two lines crossed at the centre of the lines with width W as shown in Figure 12.

The width should be 10 % of the length.

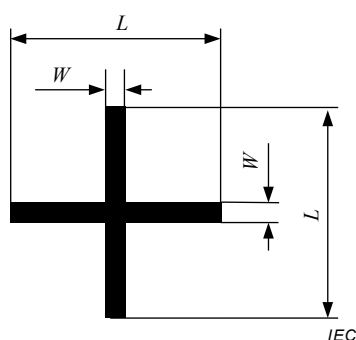


Figure 12 – Cross register mark

7.2.7 Double cross register mark

A double cross register mark shall be four crossed lines with width W and interval I as shown in Figure 13.

Interval I should be 20 % of length L . The width W should be 10 % of the length L .

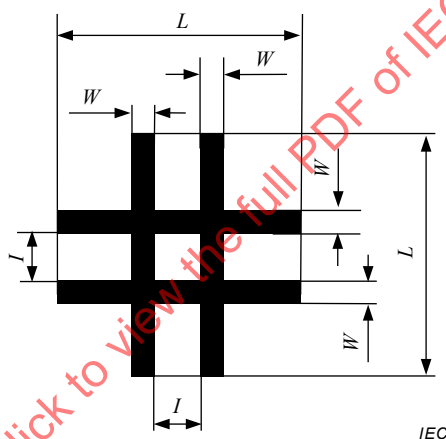


Figure 13 – Double cross register mark

7.2.8 X cross register mark

An X cross register mark shall be two lines crossed at the centre of the lines with width W and length L as shown in Figure 14.

The width should be 10 % of the length L .

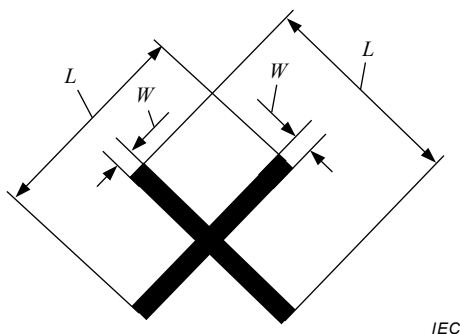


Figure 14 – X cross register mark

8 Requirements for evaluation

8.1 Evaluation items

Each evaluation item shall be agreed between the supplier and the customer.

See Annex A for examples of basic pattern layouts.

8.2 Measurement methods and instruments

Measurements and instruments shall be according to IEC 62899-402 (all parts). Other measurements and instruments should be agreed between the component supplier and the customer.

9 Evaluation pattern information

9.1 General

The reporting items should be agreed between the supplier and the customer. The report should contain the types of evaluation pattern and its parameters.

Values in 9.2 to 9.6 shall be selected from the values specified in ISO 3.

9.2 PMVT

PMVT shall be as follows:

- a) widths selected from 3 μm , 5 μm , 8 μm , 10 μm , 20 μm , 50 μm , 80 μm , 100 μm , or 200 μm
- b) number of lines for every width
- c) length for every width
- d) location

9.3 PMHZ

PMHZ shall be as follows:

- a) widths selected from 3 μm , 5 μm , 8 μm , 10 μm , 20 μm , 50 μm , 80 μm , 100 μm , or 200 μm
- b) number of lines for every width
- c) length for every width
- d) location

9.4 PMAG

PMAG shall be as follows:

- a) widths selected from 3 μm , 5 μm , 8 μm , 10 μm , 20 μm , 50 μm , 80 μm , 100 μm , or 200 μm
- b) number of lines for every width
- c) length for every width
- d) location

9.5 PMAR

PMAR shall be as follows:

- a) widths selected from 3 μm , 5 μm , 8 μm , 10 μm , 20 μm , 50 μm , 80 μm , 100 μm , or 200 μm
- b) number of lines for every width
- c) length for every width
- d) location

9.6 PMCR

PMCR shall be as follows:

- a) widths selected from 3 μm , 5 μm , 8 μm , 10 μm , 20 μm , 50 μm , 80 μm , 100 μm , or 200 μm
- b) number of lines for every width
- c) length for every width
- d) location

IECNORM.COM : Click to view the full PDF of IEC 62899-403-1:2018

Annex A (informative)

Examples of basic pattern layouts

A.1 Example 1

Evaluation patterns are layouts in a printing area of target, and register marks are layouts in a margin area (see Figure A.1).

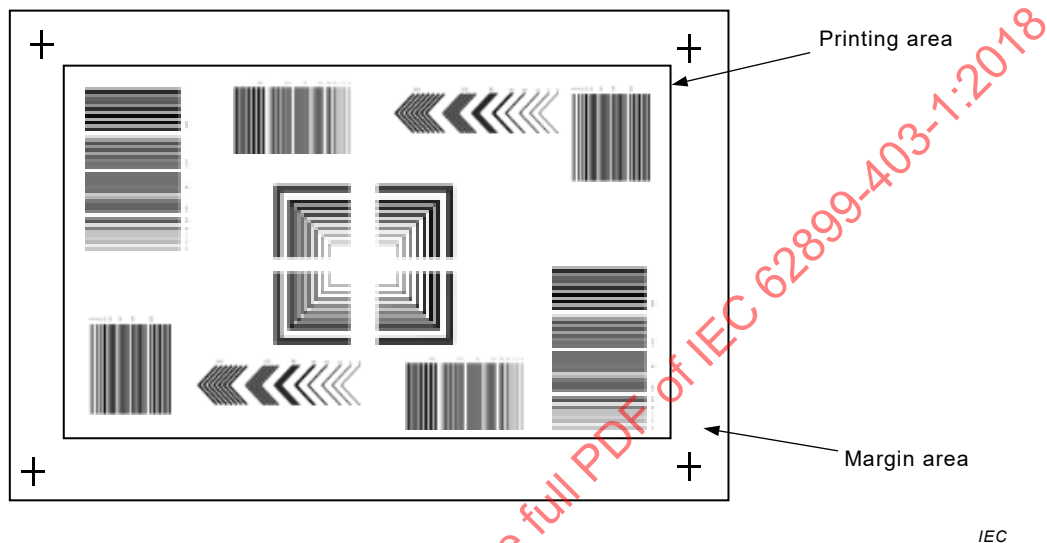


Figure A.1 – Example of basic pattern layout in a printing area and a margin area

A.2 Example 2

All the evaluation patterns and register marks are layouts in a margin area (see Figure A.2).

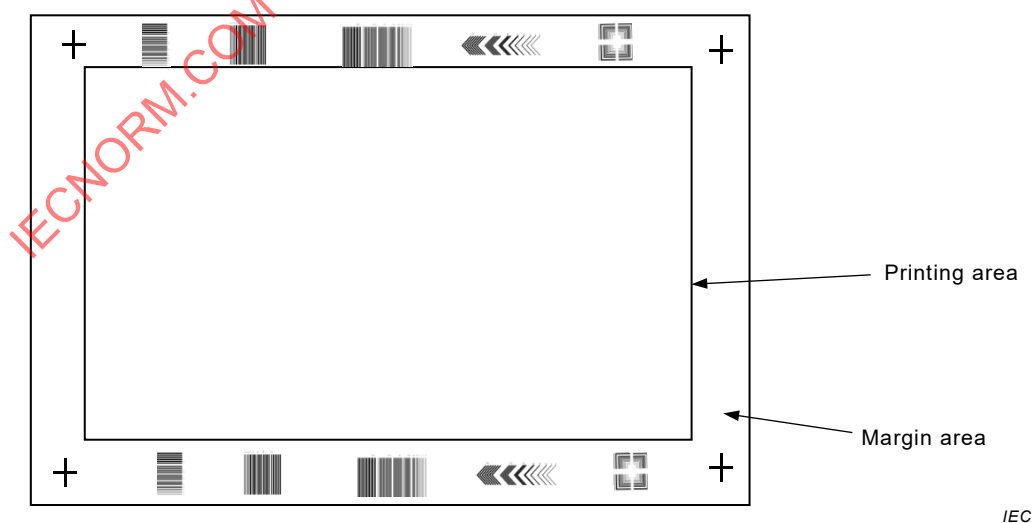


Figure A.2 – Example of basic pattern layout in a margin area

Annex B (informative)

Use case of basic pattern

B.1 General

As the motion of a printing machine is complicated, it is a time-consuming process to identify the specific cause for printing errors, but by reiteration of the hypothesis and test, it will be possible to interpret the specific cause through these kinds of phenomena as a result of the printing process. By using the basic patterns proposed in this document, collective intelligence and transparency for the errors can be accumulated by a user. There are two simple examples shown below.

B.2 Large variation of cylinder rotation speed with a normal plate

Light and dark contrast of the printing pattern are observed (see Figure B.1).

IECNORM.COM : Click to view the full PDF of IEC 62899-403-1:2018