
**Optics and photonics — Microlens
arrays —**

**Part 1:
Vocabulary**

Optique et photonique — Réseaux de microlentilles —

Partie 1: Vocabulaire

ITeH Standards
(<https://standards.iteh.ai>)
Document Preview

[ISO 14880-1:2019](https://standards.iteh.ai/catalog/standards/iso/273e5d00-a699-4c6d-b0c1-46b03c9e83d6/iso-14880-1-2019)

<https://standards.iteh.ai/catalog/standards/iso/273e5d00-a699-4c6d-b0c1-46b03c9e83d6/iso-14880-1-2019>



iTeh Standards
(<https://standards.iteh.ai>)
Document Preview

[ISO 14880-1:2019](https://standards.iteh.ai/catalog/standards/iso/273e5d00-a699-4c6d-b0c1-46b03c9e83d6/iso-14880-1-2019)

<https://standards.iteh.ai/catalog/standards/iso/273e5d00-a699-4c6d-b0c1-46b03c9e83d6/iso-14880-1-2019>



COPYRIGHT PROTECTED DOCUMENT

© ISO 2019

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

	Page
Foreword	iv
Introduction	v
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
3.1 Symbols and units of measure.....	2
3.2 Basic definitions of microlens and microlens array.....	2
3.3 General terms and definitions.....	3
3.4 Terms relating to properties of the microlens array.....	6
3.4.1 Geometrical properties.....	6
3.4.2 Optical properties.....	7
4 Coordinate system	8
5 Properties of individual lenses	9
Annex A (informative) Microlens array applications (1) — Telecommunications	11
Annex B (informative) Microlens array applications (2) — Image sensor arrays	12
Annex C (informative) Microlens array applications (3) — LCD projection panels	13
Annex D (informative) Microlens array applications (4) — Wavefront sensors	14
Annex E (informative) Microlens array applications (5) — Stereo displays	17
Annex F (informative) Microlens array applications (6) — 3D imaging and light-field cameras	18
Bibliography	20

Document Preview

[ISO 14880-1:2019](https://standards.iteh.ai/catalog/standards/iso/273e5d00-a699-4c6d-b0c1-46b03c9e83d6/iso-14880-1-2019)

<https://standards.iteh.ai/catalog/standards/iso/273e5d00-a699-4c6d-b0c1-46b03c9e83d6/iso-14880-1-2019>

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 172, *Optics and Photonics*, Subcommittee SC 9, *Laser and electro-optical systems*.

This third edition cancels and replaces the second edition (ISO 14880-1:2016), which has been technically revised.

A list of all parts in the ISO 14880 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The expanded market in microlens arrays has generated a need to agree on basic terms and definitions for microlens arrays and systems and this document aims to satisfy that need.

This document aims to improve the compatibility and interchangeability of lens arrays from different suppliers and to enhance the development of technology using microlens arrays.

Microoptics and microlens arrays are found in many modern optical devices[1]. They are used as coupling optics for detector arrays, the digital camera being an example of a mass market application. They are used to enhance the optical performance of liquid crystal displays, to couple arrays of light sources and to direct illumination for example in 2D and 3D television, mobile phone and portable computer displays. Microlens arrays are used in wavefront sensors for optical metrology and astronomy, lightfield sensors for three-dimensional photography and microscopy and in optical parallel processor elements.

Multiple arrays of microlenses can be assembled to form optical systems such as optical condensers, controlled diffusers and superlenses[2][3]. Furthermore, arrays of microoptical elements such as micro-prisms and micro-mirrors are used[4][5]. Examples of some of these applications are described in [Annexes A to E](#).

iTeh Standards (<https://standards.iteh.ai>) Document Preview

[ISO 14880-1:2019](#)

<https://standards.iteh.ai/catalog/standards/iso/273e5d00-a699-4c6d-b0c1-46b03c9e83d6/iso-14880-1-2019>

Optics and photonics — Microlens arrays —

Part 1: Vocabulary

1 Scope

This document defines terms for microlens arrays. It applies to arrays of very small lenses formed inside or on one or more surfaces of a common substrate. This document also applies to systems of microlens arrays.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

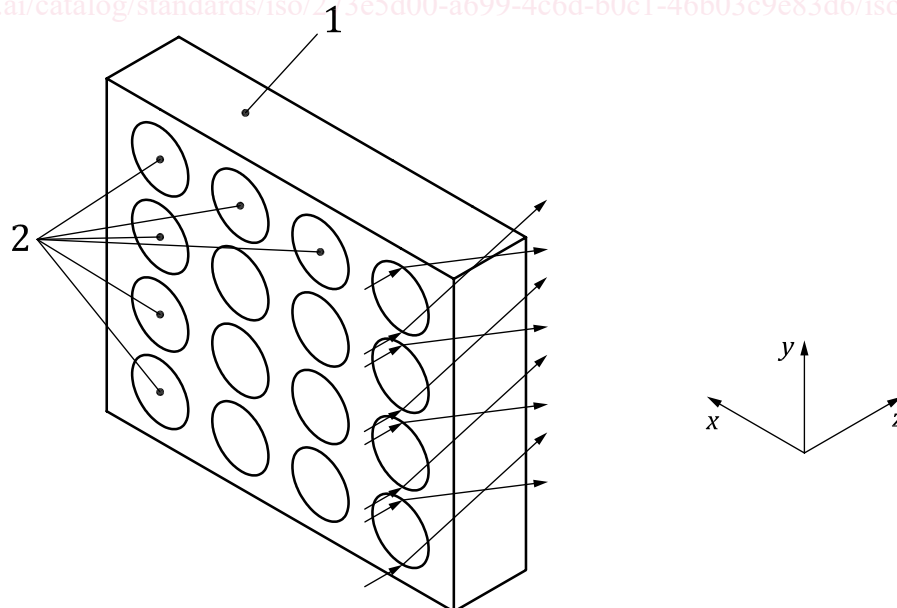
For the purposes of this document, the following terms and definitions apply.

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

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

NOTE 1 The coordinate system used for the description of the microlenses can be found in [Figure 1](#). The description of the coordinate system and its application can be found in [Clause 4](#).

<https://standards.iteh.ai/catalog/standards/iso/273e5d00-a699-4c6d-b0c1-46b03c9e83d6/iso-14880-1-2019>



Key

- 1 substrate
- 2 microlenses

Figure 1 — Microlens array with Cartesian coordinate system

NOTE 2 Five common types of microlenses are illustrated in [Figure 5](#), and described in [Clause 5](#).

NOTE 3 For common microlens array applications, see [Annexes A](#) to [F](#).

3.1 Symbols and units of measure

[Table 1](#) lists symbols and units which are used in this document.

Table 1 — Symbols and units of measure

Symbol	Unit	Term
A_d	mm ²	diffraction-limited optical aperture
A_g	mm ²	geometric aperture
a_1, a_2	mm	lens radius
$2a_1, 2a_2$	mm	lens width
D_n	mm ⁻²	lens density
h	mm	surface modulation depth
L_1, L_2	mm	edge lengths of substrate
NA	none	numerical aperture
NA_d	none	diffraction-limited numerical aperture
NA_g	none	geometric numerical aperture
$n(x, y, z)$	none	refractive index
n_0	none	refractive index at the centre of the lens
P_x, P_y	mm	pitch
$f_{E,b}$	mm	effective back focal length
$f_{E,f}$	mm	effective front focal length
R_c	mm	radius of curvature
S_x, S_y, S_z	mm	coordinates of focal spot position
$\Delta S_x, \Delta S_y, \Delta S_z$	mm	focal spot position shift
T	mm	thickness of substrate
T_c	mm	physical thickness
w_x, w_y	µm	focal spot size
x, y, z	mm	coordinates of lens aperture centre position
θ	degree	acceptance angle
Φ_{rms}	parts of wavelength	wavefront aberration
λ	nm	wavelength
v_{eff}	none	effective Abbe-number

3.2 Basic definitions of microlens and microlens array

3.2.1

microlens

lens in an array with an aperture of less than a few millimetres including lenses which work by refraction at the surface, refraction in the bulk of the substrate, diffraction or a combination of these

Note 1 to entry: The microlens can have a variety of aperture shapes: circular, hexagonal or rectangular for example. The surface of the lens can be flat, convex or concave.

3.2.2**microlens array**

regular arrangement of microlenses on/in a single substrate

Note 1 to entry: Irregular or structured arrays are sometimes used, for example, in beam shaping, diffusion, and homogenization.

3.3 General terms and definitions**3.3.1****effective front focal length**
 $f_{E,f}$

distance from the vertex of the microlens to the position of the focus given by finding the maximum of the power density distribution when collimated radiation is incident from the back of the substrate

Note 1 to entry: The effective front focal length can differ from the paraxial front focal length in the case of aberrated lenses.

Note 2 to entry: The effective front focal length is different from the classical effective focal length since it is measured from the lens vertex.

3.3.2**effective back focal length**
 $f_{E,b}$

distance from the back surface of the substrate or the vertex of the microlens to the position of the focal point, when collimated radiation is incident from the lens side of the substrate

Note 1 to entry: The effective back focal length can differ from the paraxial back focal length in the case of aberrated lenses.

Note 2 to entry: In case the microlens or microlenses are formed on both sides of the substrate, "effective back focal length" is defined from the vertex of the microlens to the position of the focal point.

3.3.3**radius of curvature**
 R_c

distance from the vertex of the microlens to the centre of curvature of the lens surface

Note 1 to entry: The radius of curvature is expressed in millimetres.

3.3.4**wavefront aberration**
 Φ_{rms}

root mean square of deviation of the wavefront from an ideal spherical or other wavefront

Note 1 to entry: The wavefront aberration is expressed in parts of the wavelength, λ .

3.3.5.1**chromatic aberration**

change of the focal length with wavelength

Note 1 to entry: Chromatic aberration is characterized by the effective Abbe-number, which is given by:

$$v_{\text{eff}} = \frac{1}{\frac{1}{f(\lambda_2)} - \frac{1}{f(\lambda_3)}}$$

where the values of λ_1 , λ_2 and λ_3 are specified in order to correspond to current practice in optical lens design. The effective Abbe-number is dimensionless.

Note 2 to entry: At optical wavelengths the C line (656,3 nm) as λ_3 , d line (587,56 nm) as λ_2 , F line (486,1 nm) as λ_1 are generally used. However, other wavelengths such as the infrared spectrum can be used where appropriate, provided that $\lambda_1 < \lambda_2 < \lambda_3$.

3.3.5.2

achromatic microlens array

microlens array designed to limit the effects of chromatic aberration

Note 1 to entry: Achromatic microlens arrays are generally corrected to bring radiation of two wavelengths into focus in the same plane, for example, red and blue light or infrared wavelengths where appropriate.

3.3.6.1

aperture shape

shape which is specified as square, circular, hexagonal, circular sector or other geometric shape

Note 1 to entry: For non-regular shapes, the vertices of the microlens aperture are to be defined by coordinates, X_{ajk}, Y_{ajk} , where j is the microlens number index and k is the vertex number index.

3.3.6.2

geometric aperture

A_g
area in which the optical radiation passing through it is deviated towards the focused image and contributes to it

Note 1 to entry: For graded index microlenses where no obvious boundary exists, the edge is the locus of points at which the change of index is 10 % of the maximum value.

Note 2 to entry: The geometric aperture is expressed in square millimetres.

3.3.6.3

lens width

$2a_1, 2a_2$

width of the microlens on the substrate defined by the geometric aperture of the microlens

Note 1 to entry: The widths are determined by measuring the longest distance ($2a_1$) and the shortest distance ($2a_2$) between the lens edges as shown in [Figure 2](#). If the lens is circular symmetric, then the term diameter can be used.

Note 2 to entry: Lens widths are expressed in millimetres.

Note 3 to entry: The geometric aperture of the microlens can be given by a variety of shapes such as circular, rectangular, elliptical and so on.

3.3.6.4

diffraction-limited optical aperture

A_d
area within which the peak-to-valley wavefront aberrations are less than one quarter of the wavelength of the radiation with which it is tested

Note 1 to entry: The diffraction-limited optical aperture is expressed in square millimetres.

3.3.6.5

geometrical numerical aperture

NA_g

sine of half the angle subtended by the aperture of the lens at the focal point

3.3.6.6

diffraction-limited numerical aperture

NA_d

sine of half the angle subtended by the diffraction limited optical aperture of the lens at the focal point