International Standard

ISO 11421

Optics and photonics — Uncertainty of optical transfer function (OTF) measurement

Optique et photonique — Incertitude de mesurage de la fonction de transfert optique (OTF)

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Foreword

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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 document 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).

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This document was prepared by Technical Committee ISO/TC 172, *Optics and photonics*, Subcommittee SC 1, *Fundamental standards*.

This second edition cancels and replaces the first edition (ISO 11421:1997), which has been technically revised.

The main changes are as follows:

— sagittal and tangential OTF were defined;

— symbols, formulae and nomenclature have been revised

— off-axis magnification errors due to image distortion using grating objects has been newly added;

— the document has been revised to be in agreement with the terms and definitions of ISO/IEC Guide 98 (GUM) and ISO/IEC Guide 99 (VIM) regarding the expression of measurement uncertainties;

— Explanations for the calculation of measurement uncertainties have been added;

— Annex C was revised.

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 optical transfer function (OTF) is one of the main criteria used for objectively evaluating the image-forming capability of optical, electro-optical and photographic systems.

The terms used in the measurement of OTF are defined in ISO 9334, whilst ISO 9335 covers the actual principles and procedures of measurement. A further International Standard, ISO 9336 (all parts), deals with specific applications in various optical and electro-optical fields and is in several parts, each dealing with a particular application.

Although ISO 9335 lists the main factors which influence the uncertainty of OTF measurement and describes procedures which are aimed at achieving accurate and repeatable results, it does not cover in detail the techniques and procedures for evaluating the uncertainty of OTF measuring equipment and for estimating the uncertainty in measurements made on specific imaging systems.

The present document lists the main sources of uncertainty in OTF measuring equipment and provides guidance on how these can be assessed and how the results of these assessments can be used in estimating the uncertainty in any measurement of OTF. One of the aims in preparing this document is to encourage the setting of more realistic uncertainty levels for the results of OTF measurements. Another is to encourage the use of methods of expressing the uncertainty of OTF test equipment which recognize the fact that the uncertainty of a particular measurement is a function of both the equipment and the test piece.

Optics and photonics — Uncertainty of optical transfer function (OTF) measurement

1 Scope

This document gives general guidance on evaluating the sources of error in optical transfer function (OTF) equipment and in using this information to estimate errors in a measurement of OTF. It also gives guidance on assessing and specifying a general uncertainty for a specific measuring equipment, as well as recommending methods of routine assessment.

The main body of this document deals exclusively with the modulation transfer function (MTF) part of the OTF. The phase transfer function (PTF) is dealt with relatively briefly in Annex A.

2 Normative references

There are no normative references in this document.

3 Terms, definitions and symbols

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:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1 Terms and definitions

3.1.1
standard lens
single- or multi-element lens which has been constructed with a level of uncertainty which is sufficient to ensure that for precisely specified conditions of measurement the MTF is equal to that predicted from theoretical calculations to an uncertainty of better than 0,05 (MTF units)

Note 1 to entry: In order to achieve this uncertainty, standard lenses are usually of simple construction and therefore of limited performance. An example of a widely used lens is the 50 mm focal length piano-convex lens described in Reference [3]. This and several other standard test lenses (including afocal systems and lenses operating in the infrared wavelength bands) are available commercially.

3.1.2
audit lens
single- or multi-element lens of stable construction whose uncertainty of construction is not sufficient to enable the MTF to be predicted by calculation from design data (usually as a result of the complexity of the lens), but whose "accepted" values for the MTF under precisely defined measuring conditions have been obtained by measurements done by a reputable authority (preferably a national standards laboratory, if such a service is available)