INTERNATIONAL STANDARD

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Identification cards — Optical memory cards — Holographic recording method —

Part 3: Optical properties and characteristics

Cartes d'identification — Cartes à mémoire optique — Méthode d'enregistrement holographique —

Partie 3: Propriétés et caractéristiques optiques

Reference number
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Contents

Page

Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of the joint technical committee is to prepare International Standards. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

ISO/IEC 11695-3 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 17, *Cards and personal identification*.

ISO/IEC 11695 consists of the following parts, under the general title *Identification cards — Optical memory cards — Holographic recording method*:

— *Part 1: Physical characteristics*

— *Part 2: Dimensions and location of accessible optical area*

— *Part 3: Optical properties and characteristics*

Introduction

ISO/IEC 11695 is one of a series of International Standards defining the parameters for optical memory cards and the use of such cards for the storage and interchange of digital data.

These International Standards recognize the existence of different methods for recording and reading information on optical memory cards, the characteristics of which are specific to the recording method employed. In general, these different recording methods will not be compatible with each other. Therefore, these International Standards are structured to accommodate the inclusion of existing and future recording methods in a consistent manner.

ISO/IEC 11695 is specific to optical memory cards using the holographic recording method. Characteristics which apply to other specific recording methods are found in separate International Standards.

This part of ISO/IEC 11695 defines the optical properties and characteristics and the extent of compliance with, addition to, and/or deviation from the relevant base document, ISO/IEC 11693.

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Identification cards — Optical memory cards — Holographic recording method —

Part 3:
Optical properties and characteristics

1 Scope

This part of ISO/IEC 11695 specifies the optical properties and characteristics of optical memory cards using the holographic recording method.

2 Normative references

The following referenced documents are indispensable for the application 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.

ISO/IEC 11695-1, *Identification cards — Optical memory cards — Holographic recording method — Part 1: Physical characteristics*

ISO/IEC 11695-2, *Identification cards — Optical memory cards — Holographic recording method — Part 2: Dimensions and location of accessible optical area*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 11695-1, ISO/IEC 11695-2 and the following apply.

3.1
reflectivity
ratio of reflected light to the light incident at a specified wavelength measured at a normal incidence on the holographic memory card

NOTE Reflectivity is generally expressed as a percentage.

3.2
scattering
deviation of reflected radiation from the angle predicted by the law of reflection

NOTE Reflections that undergo scattering are called diffuse reflections. Diffuse reflections are measured by means of an integration sphere, while properly averaging over all angles of illumination and observation.

3.3
spatial resolution
ability of the storage material to distinguish and/or record physical details by electromagnetic means

NOTE The (spatial) resolution is typically expressed in line pairs per millimetre.

3.4
contrast transfer function
CTF
mathematical function that expresses the ability of an optical device to transfer signals faithfully as a function of the spatial or temporal frequency of the signal

NOTE The CTF is the ratio of percentage modulation of a square wave signal leaving to that entering the device over the range of frequencies of interest. The CTF is usually presented as a graph of CTF versus log (frequency).

3.5
diffraction
interference effects occurring when light is incident on a hologram

NOTE The light is reflected or transmitted in discrete directions, called diffraction orders.

3.6
diffraction efficiency
relation of the power of the diffracted light beam (P_{diff}) to the incident power of the read-out beam (P_{inc}):

$$\eta = \frac{P_{diff}}{P_{inc}}$$

NOTE The diffraction efficiency is dependent upon the holographic storage medium. It varies between 0 and 1.

3.7
diffraction grating
device having periodical variations of absorption index and/or refractive index and/or optical path length

3.8
read power
laser power used to read out holograms from the accessible optical area

NOTE Read power is usually expressed in milliwatts.

3.9
write power
laser power required to write information to the accessible optical area at a specified wavelength and beam size

NOTE Write power is usually expressed in milliwatts.

4 Optical properties and characteristics

4.1 Surface roughness/scattering

The substrate shall provide a flat and smooth surface as the carrier for the reflective and optical storage layers. The surface roughness (Ra) shall be less than 100 nm: higher values can cause substantial scattering of the read-out beam. Scattered light shall be less than 10 % for wavelengths between 500 nm and 1 000 nm.

4.2 Reflectivity of blank accessible optical area

The reflective layer enables reading of holographic memory cards in reflection mode. The reflectivity of the blank accessible optical area (not containing holograms) shall be greater than 90 % for wavelengths between 500 nm and 1 000 nm.

4.3 Spatial resolution

The limiting resolution of the holographic memory card is measured by determining the smallest group of bars, both vertically and horizontally, for which the correct number of bars can be recorded and/or seen. By calculating the contrast between the black and white areas at several different frequencies, points of the contrast transfer function (CTF) can be determined with the contrast equation.

$$Contrast = \frac{C_{\mathrm{max}} - C_{\mathrm{min}}}{C_{\mathrm{max}} + C_{\mathrm{min}}}$$

where

C_{max} is the normalized value of the maximum (for example, the voltage or grey value of the white area);

C_{min} is the normalized value of the minimum (for example, the voltage or grey value of the black area).

When the system can no longer resolve the bars, the black and white areas have the same value, so $Contrast = 0$. At very low spatial frequencies, $C_{\mathrm{max}} = 1$ and $C_{\mathrm{min}} = 0$ so $Contrast = 1$.

For the holographic memory card the minimum $Contrast$ shall be 1, up to a density of 1 000 line pairs per millimetre.

Annex A
(normative)

Reading/writing test conditions

In order to verify the optical properties and characteristics of the optical memory card – holographic recording method the characteristics of the illumination sources are detailed below.

NOTE 1 It is intended that the reading / writing test conditions will become part of ISO 10373, describing the conditions for optical memory cards – holographic recording method.

NOTE 2 These test conditions apply to all tests unless otherwise specified.

A.1 Illumination source

The illumination source shall be a semiconductor laser diode having a wavelength between 630 nm and 680 nm. The beam shall be collimated. The beam shall have a circularly symmetric Gaussian intensity profile. Depending on the material used as storage layer, the light can be polarized.

A.2 Illumination beam diameter

The collimated beam at the surface of the accessible optical layer shall be measured at the $1/e^2$ point. The beam diameter shall be 110–150 % of the period of the diffraction grating.

A.3 Read power

The read power at the surface of the accessible optical layer shall be less than 0,50 mW.

A.4 Default test environment and conditioning

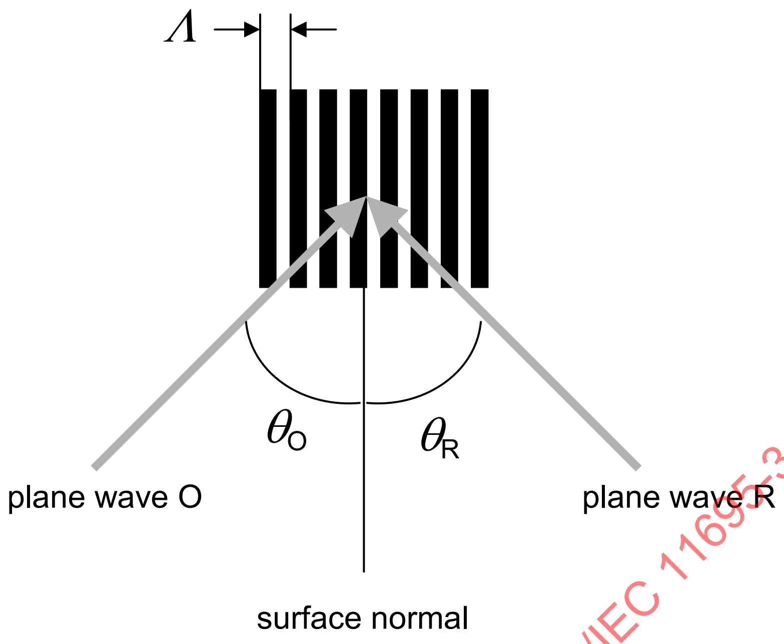
For testing the holographic memory card, diffraction gratings shall be recorded in the storage layer. The diffraction gratings shall be read out with a read-out beam and the intensity of the diffracted beams shall be measured by means of a light-sensitive sensor (camera, photodiode).

The gratings shall be produced by means of interference of two coherent plane waves O and R, with wavelength λ, intensity I_O and I_R at angles of incidence θ_O and θ_R.

The period of the grating Λ is related to the angles of incidence (Figure A.1).

$$\Lambda = \frac{\lambda}{\sin\theta_O - \sin\theta_R}$$

The resulting profile of the single rulings forming the grating is sinusoidal.



NOTE θ_R < 0 in the case of Figure A.1.

Figure A.1 — Recording of a diffraction grating in the storage layer by interference of two plane waves

For the test a grating period of 2 µm shall be used, meaning 500 line pairs per millimetre are recorded in the storage layer. The size of the grating shall be between 1 mm x 1 mm and 2 mm x 2 mm.

The conditions for recording the diffraction gratings in the holographic memory card (write power, etc.) are dependent upon the material used as the storage layer.

When a beam is incident on a grating with an angle α (measured from the normal of the grating), it is diffracted into several beams. The beam that corresponds to direct transmission (or specular reflection in the case of a reflection grating) is called the zero order, and is denoted i = 0. The other orders correspond to diffraction angles which are represented by non-zero integers i. For a groove period d and an incident wavelength λ, the grating equation gives the value of the diffracted angle $b_i(\lambda)$ in the order i (Figure A.2).

$$d(\sin\beta_i(\lambda) + \sin\alpha) = m\lambda$$

NOTE i can be positive or negative, resulting in diffracted orders on both sides of the zero order beam. The angles of the diffracted orders depend only on the pitch of the rulings, and not on their shape.