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# Optics and photonics — Preparation of drawings for optical elements and systems —

Part 17: Laser irradiation damage  
threshold

ICS 01.100.20; 31.260; 37.020





## National foreword

This British Standard reproduces verbatim ISO 10110-17:2004 and implements it as the UK national standard.

The UK participation in its preparation was entrusted to Technical Committee CPW/172, Optics and optical instruments, which has the responsibility to:

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- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

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### Summary of pages

This document comprises a front cover, an inside front cover, the ISO title page, pages ii and iii, a blank page, pages 1 to 4, an inside back cover and a back cover.

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This British Standard was published under the authority of the Standards Policy and Strategy Committee on 1 June 2004

### Amendments issued since publication

Amd. No.	Date	Comments

© BSI 1 June 2004

ISBN 0 580 43828 7

INTERNATIONAL  
STANDARD

**ISO**  
**10110-17**

First edition  
2004-03-01

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**Optics and photonics — Preparation of  
drawings for optical elements and  
systems —**

Part 17:

**Laser irradiation damage threshold**

*Optique et photonique — Préparation des dessins pour éléments et  
systèmes optiques —*

*Partie 17: Seuil de dommage au rayonnement laser*



Reference number  
ISO 10110-17:2004(E)

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## Foreword

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ISO 10110-17 was prepared by Technical Committee ISO/TC 172, *Optics and photonics*, Subcommittee SC 1, *Fundamental standards*.

ISO 10110 consists of the following parts, under the general title *Optics and photonics — Preparation of drawings for optical elements and systems*:

*Part 1: General*

*Part 2: Material imperfections — Stress birefringence*

*Part 3: Material imperfections — Bubbles and inclusions*

*Part 4: Material imperfections — Inhomogeneity and striae*

*Part 5: Surface form tolerances*

*Part 6: Centring tolerances*

*Part 7: Surface imperfection tolerances*

*Part 8: Surface texture*

*Part 9: Surface treatment and coating*

*Part 10: Table representing data of optical elements and cemented assemblies*

*Part 11: Non-toleranced data*

*Part 12: Aspheric surfaces*

*Part 14: Wavefront deformation tolerance*

*Part 17: Laser irradiation damage threshold*



# Optics and photonics — Preparation of drawings for optical elements and systems —

Part 17:

## Laser irradiation damage threshold

### 1 Scope

ISO 10110 specifies the presentation of design and functional requirements for optical elements in technical drawings used for manufacturing and inspection.

This part of ISO 10110 specifies rules for the indication of the damage threshold from laser irradiation up to which optical surfaces shall not exhibit any damage as defined in ISO 11254-1.

### 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 10110-5, *Optics and optical instruments — Preparation of drawings for optical elements and systems — Part 5: Surface form tolerances*

ISO 10110-6, *Optics and optical instruments — Preparation of drawings for optical elements and systems — Part 6: Centring tolerances*

ISO 10110-7, *Optics and optical instruments — Preparation of drawings for optical elements and systems — Part 7: Surface imperfection tolerances*

ISO 10110-10:2003, *Optics and photonics — Preparation of drawings for optical elements and systems — Part 10: Table representing data of optical elements and cemented assemblies*

ISO 11145, *Optics and optical instruments — Lasers and laser-related equipment — Vocabulary and symbols*

ISO 11254-1:2000, *Lasers and laser-related equipment — Determination of laser-induced damage threshold of optical surfaces — Part 1: 1-on-1 test*

ISO 11254-2, *Lasers and laser-related equipment — Determination of laser-induced damage threshold of optical surfaces — Part 2: S-on-1 test*

### 3 Terms and definitions

For the purposes of this document the terms and definitions given in ISO 11145, ISO 11254-1 and the following apply.



### 3.1

#### wavelength

$\lambda$

wavelength of the laser radiation

### 3.2

#### threshold

highest quantity of laser radiation incident upon the optical surface for which the extrapolated probability of damage is zero

NOTE The quantity of laser radiation may be expressed in energy density  $H_{\max}$  or power density  $E_{\max}$ .

[ISO 11254-1:2000]

### 3.3

#### effective pulse duration

$T_{\text{eff}}$

⟨laser pulse⟩ ratio of the total pulse energy to maximum pulse power

[ISO 11254-1:2000]

### 3.4

#### threshold energy density

$H_{\text{th}}$

⟨pulsed laser irradiation⟩ energy density threshold, expressed in joules per square centimetre, above which damage may occur

### 3.5

#### threshold power density

$E_{\text{th}}$

⟨pulsed laser irradiation⟩ power density threshold, expressed in watts per square centimetre, above which damage may occur

### 3.6

#### threshold linear power density

$F_{\text{th}}$

⟨continuous wave and long pulse laser irradiation⟩ linear power density threshold, expressed in watts per centimetre, above which damage may occur

NOTE For laser damage considerations a long pulse is when the thermal transit distance,  $(2 D \tau_{\text{eff}})^{1/2}$ , where  $D$  is the thermal diffusivity, is in the order of the size of the test spot  $d_{T,\text{eff}}$ .

## 4 Other test parameters

Any other test parameters shall be in accordance with the relevant parts of ISO 11254. For certain optical elements it may be necessary to specify the state and plane of polarization as well as the angle of incidence.

## 5 Specifications

### 5.1 General

Specifications of laser irradiation damage threshold apply to the finished surfaces, particularly surface treatments and coatings.



## 5.2 Damage threshold for pulsed laser irradiation

The specification of a laser irradiation damage threshold,  $H_{th}$  or  $E_{th}$ , for an optical surface shall include the laser wavelength,  $\lambda$ , and the effective pulse duration,  $\tau_{eff}$ .

## 5.3 Damage threshold for long pulse and continuous wave (cw) laser irradiation

The specification of a laser irradiation damage threshold,  $F_{th}$ , for an optical surface shall include the laser wavelength,  $\lambda$ , and the effective pulse duration,  $\tau_{eff}$ . In case of cw-irradiation specify the irradiation time.

NOTE In case of cw-lasers (i.e. irradiation time longer than 0,25 s according to ISO 11145) the effective pulse duration is not defined and the term "irradiation time" is used.

## 6 Indication

The laser irradiation damage threshold shall be indicated on the technical drawing by a code number and the parameters specified in Clause 5. Additional requirements shall be covered by notes.

The code number for the laser radiation threshold is **6**.

The indication shall have the following form:

a) for pulsed laser irradiation:

$$\mathbf{6}/H_{th}; \lambda; \tau_{eff} \text{ or } \mathbf{6}/E_{th}; \lambda; \tau_{eff}$$

b) for long pulse and cw laser irradiation:

$$\mathbf{6}/F_{th}; \lambda; \tau_{eff}.$$

The units of  $H_{th}$ ,  $E_{th}$ ,  $F_{th}$ ,  $\lambda$  and  $\tau_{eff}$  shall be given in the indication.

## 7 Location

The indication on the technical drawing shall be shown in connection with a leader line to the surface to which it relates and will be associated with other surface codes (3/, 4/, 5/) as specified in ISO 10110-5, ISO 10110-6 and ISO 10110-7. An example of such an indication is shown in Figure A.1 of ISO 10110-1:1996.

Alternatively, the indication may be listed in a table according to Figure 3 of ISO 10110-10:2003.

## 8 Examples of indication

EXAMPLE 1:  $\mathbf{6}/25 \text{ J}\cdot\text{cm}^{-2}; 1\,064 \text{ nm}; 20 \text{ ns}$

This means that the damage threshold is above an energy density of  $25 \text{ J}\cdot\text{cm}^{-2}$ , for a laser wavelength of 1 064 nm (Nd:YAG) and an effective pulse duration of 20 ns.

EXAMPLE 2:  $\mathbf{6}/10 \text{ kW}\cdot\text{cm}^{-1}; 10,6 \mu\text{m}; 1 \text{ s}$

This means that the damage threshold is above a linear power density of  $10 \text{ kW}\cdot\text{cm}^{-1}$  for a cw laser emitting at 10,6  $\mu\text{m}$  wavelength ( $\text{CO}_2$ ) and an irradiation time of 1 s.

## Bibliography

- [1] ISO 10110-1:1996, *Optics and optical instruments — Preparation of drawings for optical elements and systems — Part 1: General*



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