

Fibre optic interconnecting devices and passive components — Basic test and measurement procedures —

**Part 3-43: Examinations and
measurements — Mode transfer
function measurement for fibre optic
sources**

ICS 33.180.20

National foreword

This Draft for Development is the UK implementation of IEC/PAS 61300-3-43:2006.

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It is being issued in the Draft for Development series of publications and is of a provisional nature. It should be applied on this provisional basis, so that information and experience of its practical application can be obtained.

A PAS is a Technical Specification not fulfilling the requirements for a standard, but made available to the public and established in an organization operating under a given procedure.

A review of this Draft for Development will be carried out not later than 3 years after its publication.

Notification of the start of the review period, with a request for the submission of comments from users of this Draft for Development, will be made in an announcement in the appropriate issue of *Update Standards*. According to the replies received, the responsible BSI Committee will judge whether the validity of the PAS should be extended for a further 3 years or what other action should be taken and pass their comments on to the relevant international committee.

Observations which it is felt should receive attention before the official call for comments will be welcomed. These should be sent to the Secretary of the responsible BSI Technical Committee at British Standards House, 389 Chiswick High Road, London W4 4AL.

The UK participation in its preparation was entrusted by Technical Committee GEL/86, Fibre optics, to Subcommittee GEL/86/2, Fibre optic interconnecting devices and passive components.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

This Draft for Development was published under the authority of the Standards Policy and Strategy Committee on 30 November 2007

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ISBN 978 0 580 56659 2

Amendments issued since publication

Amd. No.	Date	Comments

PUBLICLY
AVAILABLE
SPECIFICATION

IEC
PAS 61300-3-43

Pre-Standard

First edition
2006-02

**Fibre optic interconnecting devices
and passive components –
Basic test and measurement procedures –**

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Examinations and measurements –
Mode transfer function measurement
for fibre optic sources**



Reference number
IEC/PAS 61300-3-43:2006(E)

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FIBRE OPTIC INTERCONNECTING DEVICES AND PASSIVE COMPONENTS – BASIC TEST AND MEASUREMENT PROCEDURES –

Part 3-43: Examinations and measurements – Mode transfer function measurement for fibre optic sources

1 Scope

This part of IEC 61300 describes the method for measuring the mode transfer function (MTF) to be used in characterizing the launch conditions for measurements of attenuation and or return loss of multimode passive components, according to IEC 61300-1 and IEC 61300-3-4. The MTF may be measured at the operational wavelengths.

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.

IEC 61300-1, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 1: General and guidance*

IEC 61300-3-4, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-4: Examination and measurements – Attenuation*

3 General description

The modal distribution launched into multimode fibre can vary widely with different light sources. This variation in launched modal distribution can result in significant differences in measured attenuation in the same component. The MTF test method gives information about the launched modal distribution (LMD) condition in a measured component. The MTF test method is based on a measurement of the near-field intensity distribution in the fibre [1], [2]¹.

4 Theory

For a fibre with a power-law index profile $n(r)$, given by

$$n(r) = n_1 \left[1 - 2\Delta \left(\frac{r}{a} \right)^\alpha \right]^{0,5} \quad \left(\frac{r}{a} \right) \leq 1 \quad (1)$$

where

a is the fibre core radius;

α is the profile factor ($\alpha = 2$ for a parabolic profile);

Δ is the relative index difference, given by

¹ Figures in square brackets refer to the Bibliography.

$$\Delta = \frac{n_1^2 - n_2^2}{2n_1^2} \quad (2)$$

where

n_1 is the index at the fibre centre;

n_2 is the cladding index.

The near-field intensity profile in the fibre $I(r)$ may be determined from an integration of the mode transfer function MTF, δ , in the fibre, as follows (ignoring constants):

$$I(r) = \int_{\Delta(r/a)^\alpha}^{\Delta} \text{MTF}(\delta) \cdot d\delta \quad (3)$$

where

δ is the normalized propagation constant;

r/a is the normalized radial position.

Differentiating both sides gives the MTF as follows (ignoring constants):

$$\text{MTF}(\delta) = \left[\frac{dI(r)}{dr} \cdot \frac{1}{r^{\alpha-1}} \right]_{\delta=\Delta(r/a)^\alpha} \quad (4)$$

The MTF is usually plotted in terms of the principal mode number, m , divided by the maximum principal mode number, M , where

$$\frac{m}{M} = \left[\frac{\delta}{\Delta} \right]^{(2+\alpha)/2\alpha} = \left[\frac{r}{a} \right]^{(2+\alpha)/2} \quad (5)$$

The term, m/M , is usually referred to as the relative mode number, or the normalized mode number.

The maximum principle mode number, M , is given by

$$M = \sqrt{\frac{\alpha}{\alpha+2}} \left(\frac{n_1 2\pi a}{\lambda} \right) \sqrt{\Delta} \quad (6)$$

A typical normalized MTF plot is shown in Figure 1, where it can be seen, in this example, that normalized mode numbers up to about 0,6 are equally filled and higher order modes are progressively less well-filled.