

Fibre optic communication system design guides —

Part 1: Single-mode digital and analogue systems

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Summary of pages

This document comprises a front cover, an inside front cover, the IEC title page, pages 2 to 32, an inside back cover and a back cover.

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de communications à fibres optiques –**

**Partie 1:
Systèmes numériques et analogiques
à fibres unimodales**

**Fibre optic communication system
design guides –**

**Part 1:
Single-mode digital and analogue systems**



Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

FIBRE OPTIC COMMUNICATION SYSTEM DESIGN GUIDES –

Part 1: Single-mode digital and analogue systems

FOREWORD

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IEC 61282-1, which is a technical report, has been prepared by subcommittee 86C: Fibre optic systems and active devices, of IEC technical committee 86: Fibre optics.

The text of this technical report is based on the following documents:

Enquiry draft=	Report on voting
86C/163/CDV=	86C/212/RVC

Full information on the voting for the approval of this technical report can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 3.

This document which is purely informative is not to be regarded as an International Standard.

INTRODUCTION

This technical report describes a methodology for engineering a single-mode fibre optic transmission system. The methods address the types of transmitters, fibres and receivers used in a system, as well as the performance characteristics of any passive components. The system design may be an iterative process in which various trade-offs among system components are evaluated. For each system design, several solutions may be technically viable. The designer must choose which of the viable solutions is best suited to the particular application.

FIBRE OPTIC COMMUNICATION SYSTEM DESIGN GUIDES –

Part 1: Single-mode digital and analogue systems

1 General

1.1 Scope

This technical report provides system design methodology guidance to users and suppliers of fibre optic transmission systems for telecommunications and broadband video distribution applications. The function of the fibre optic systems considered in this technical report is to interconnect signals between defined digital and analogue interfaces via a fibre optic link. In general, fibre optic systems are built-up from basic fibre optic systems (BFOS). As a result, it is necessary to consider only the BFOS, which transmits a single electrical signal between two points without intermediate regeneration. Thus, these guidelines are applicable to almost all design cases.

As an initial step, only laser systems using direct detecting technologies in the 1 310 and/or 1 550 nm regions over B1 and B2 types of unshifted and dispersion shifted single-mode fibres are considered. For systems using longitudinal multi-mode lasers above approximately 0,5 Gb/s, the calculated dispersion limited lengths may be conservatively low. Bidirectional systems, in which both directions of transmission use a common fibre, and unidirectional systems are covered in this technical report.

In the clauses which follow, the transmission design parameters are specified by their worst-case values. It is the option of the user to require that suppliers guarantee the worst-case values over the lifetime of their respective system components. Some users or system designers may desire to perform analysis and design calculations via a statistical approach and to request statistical values of the parameters. The statistical approach is covered in annex A. The determination of the worst-case dispersion coefficient is covered in annex B.

Some examples are presented to clarify concepts and to illustrate order of magnitude. The numbers presented in these examples are illustrative only and should not be considered as requirements for system design or performance.

1.2 Fibre optic systems performance considerations

In order to ensure meeting overall end-to-end performance criteria, impairments (deviations from perfect transmission) are allocated to the fibre optic system. This allocation is done considering the range of system applications, performance objectives and specifications in effect prior to the advent of fibre optic communications systems. The criteria are subject to future change for reasons such as advances in technology, changing economic conditions and the need to provide new services.

2 Reference documents

IEC 60050(731):1991, *International Electrotechnical Vocabulary (IEV) – Chapter 731: Optical fibre communication*

IEC 60793-1 (all sections), *Optical fibres – Part 1: Generic specification*

IEC 60793-2:1998, *Optical fibres – Part 2: Product specifications*

IEC 60794-1-1:1999, *Optical fibre cables – Part 1-1: Generic specification – General*

IEC 60794-1-2:1999, *Optical fibre cables – Part 1-2: Generic specification – Basic optical cable test procedures*

IEC 60794-2:1989, *Optical fibre cables – Part 2: Product specifications*

IEC 60825-1:1993, *Safety of laser products – Part 1: Equipment classification, requirements and user's guide*

IEC 60825-2:1993, *Safety of laser products – Part 2: Safety of optical fibre communication systems*

IEC 60869-1:1999, *Fibre optic attenuators – Part 1: Generic specification*

IEC 60874-1:1999, *Connectors for optical fibres and cables – Part 1: Generic specification*

IEC 60875-1:1996, *Fibre optic branching devices – Part 1: Generic specification*

IEC 60876-1:1994, *Fibre optic switches – Part 1: Generic specification*

IEC 61073-1:1999, *Splices for optical fibres and cables – Part 1: Generic specification – Hardware and accessories*

IEC 61280 (all parts), *Fibre optic communication subsystem basic test procedures*

IEC 61280-4-2:1999, *Fibre optic communication system basic test procedures – Part 4-2: Fibre optic cable plant – Single-mode fibre optic cable plant attenuation measurement*

IEC 61281-1:1999, *Fibre optic communication subsystems – Part 1: Generic specification*

IEC 61291-1:1998, *Optical fibre amplifiers – Part 1: Generic specification*

IEC 61931:1998, *Fibre optic – Terminology*

ITU-T G.911:1997, *Parameters and calculation methodologies for reliability and availability of fibre optic systems*

ITU-T G.912: —, *Methodologies for deriving fibre optic reliability objectives* ¹⁾

ITU-T G.957:1999, *Optical interfaces for equipments and systems relating to the synchronous digital hierarchy*

ITU-T G.958:1994, *Digital line systems based on the synchronous digital hierarchy for use on optical fibre cables*

NCITS: —, *Fibre channel; Physical level (FC-O), REV 0.6* ¹⁾

EIA/TIA-559:1989, *Single-Mode Fibre Optic System Transmission Design*

¹⁾ To be published.

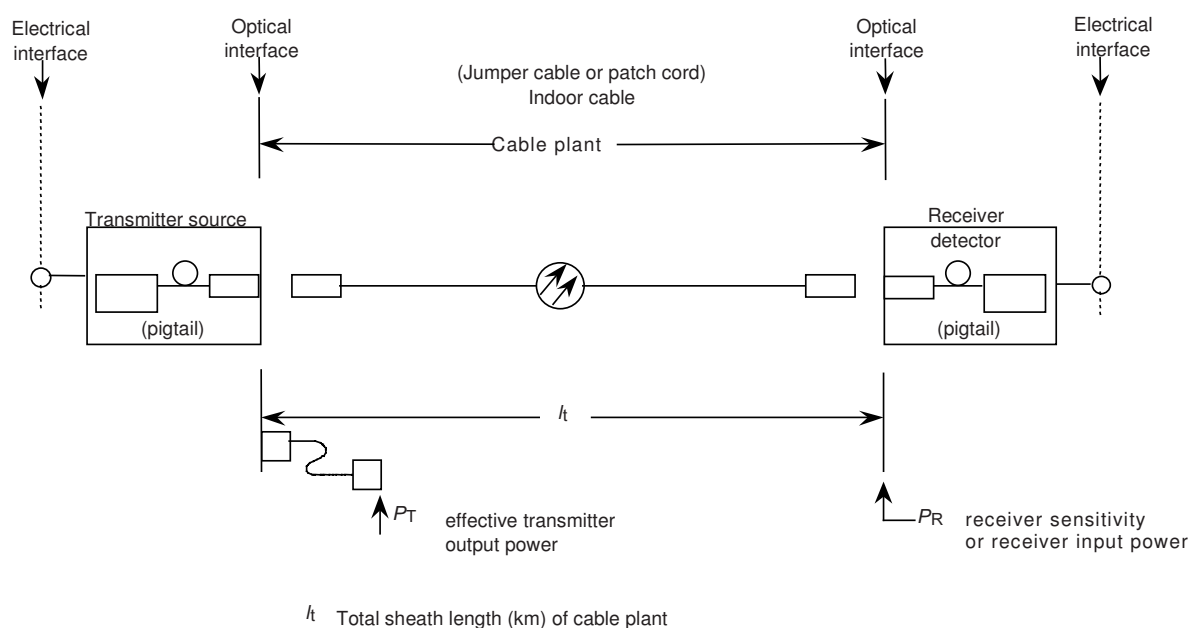
3 Basic fibre optic system (BFOS)

Whatever the complexity of the optical network, it is possible to define a set of BFOSs (as defined in IEC 61281-1), each of them linking only a point to another point without intermediate regeneration. Examples are given in figures 1, 2, 3, 4 and 5. All these have common components which depend on the topology of the network.

Therefore, the first item will be to define this set of BFOSs. In addition, every BFOS will be characterized at minimum by:

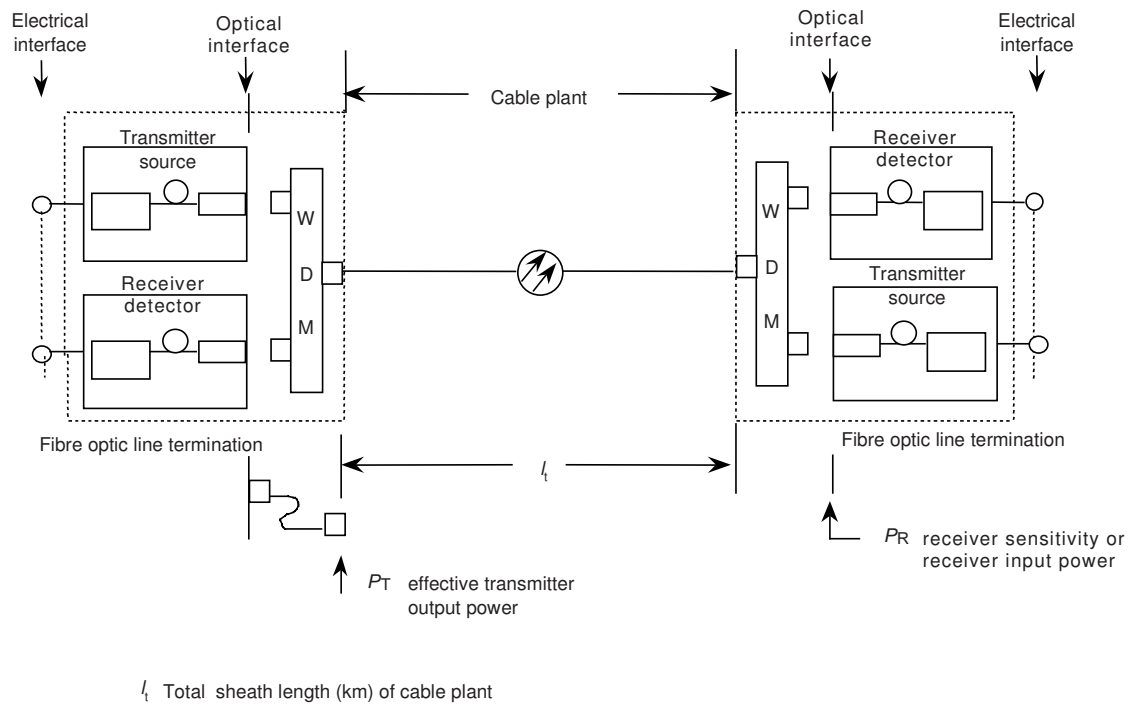
- the electrical signal to the transmitter (form, bit-rate, frequency, etc.);
- the electrical signal from the receiver (bit error rate, carrier to noise ratio, etc.);
- the distance;
- the environment.

Every BFOS is composed of functional elements with accessible input and output interfaces (see figures 1, 2, 3, 4 and 5), defined in specified conditions (see IEC 61281-1).



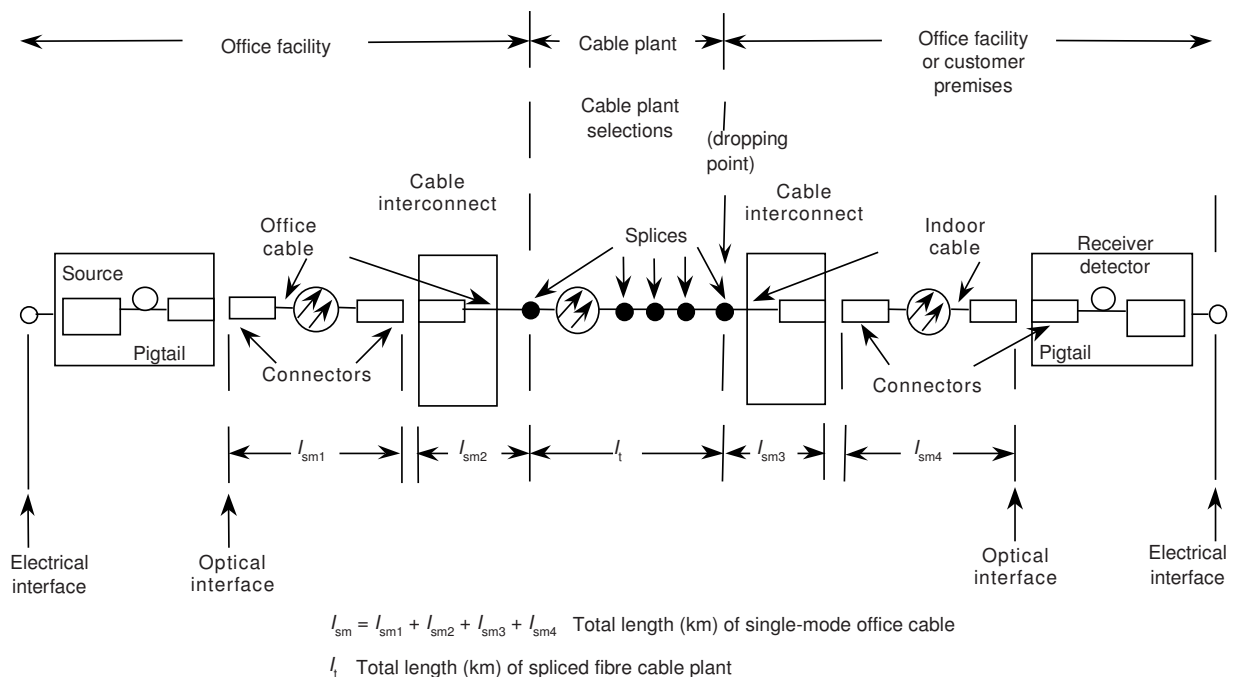
IEC 1772/99

Figure 1 – Example of basic fibre optic system (BFOS)



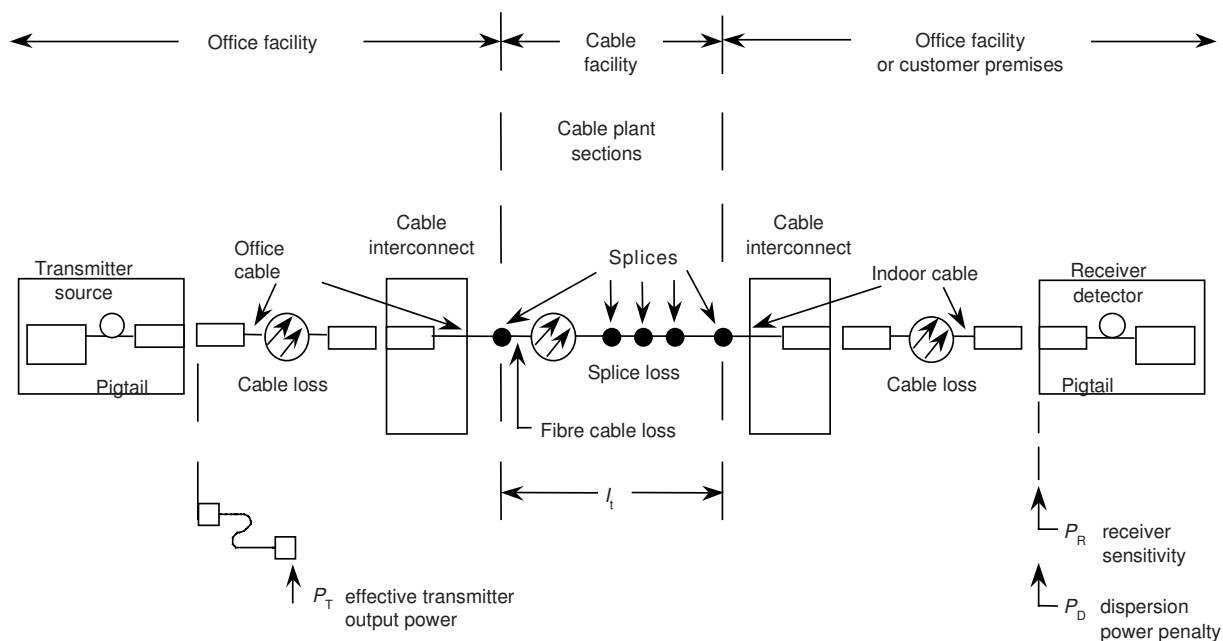
IEC 1773/99

Figure 2 – Example of basic fibre optic WDM system



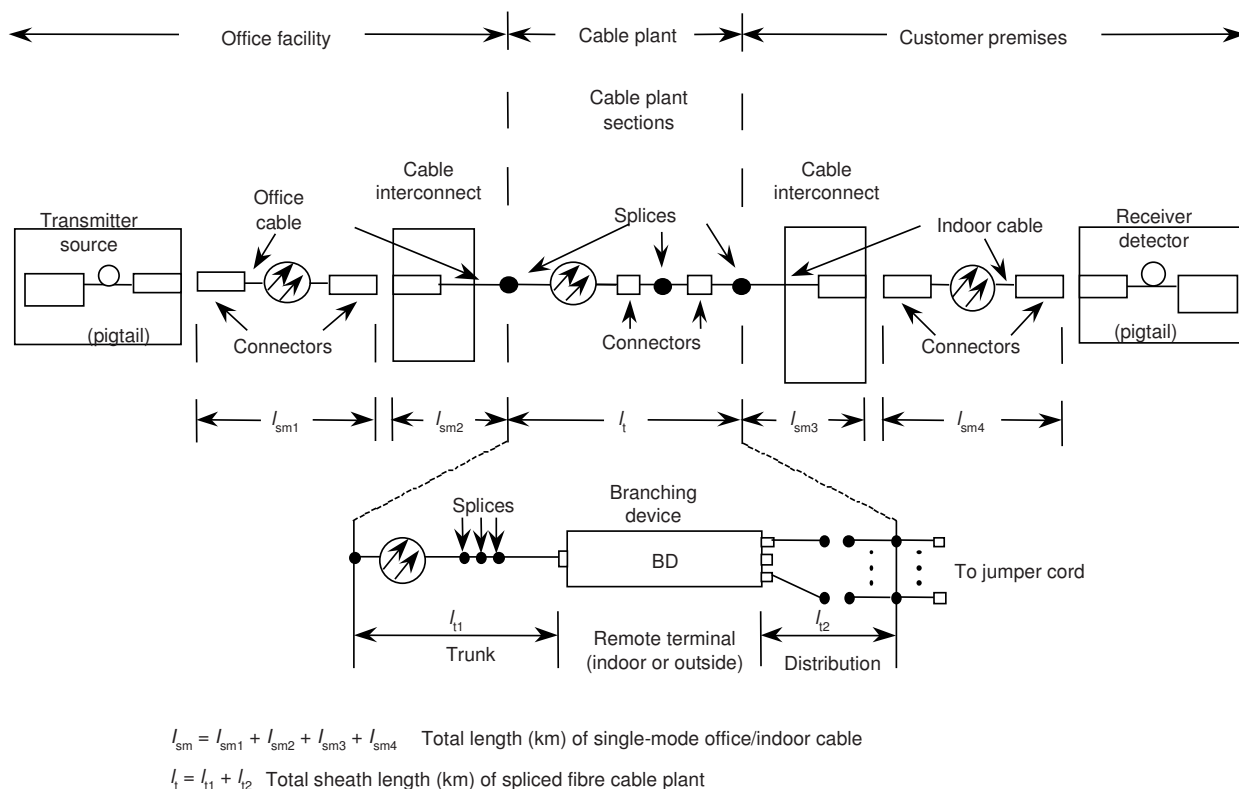
IEC 1774/99

Figure 3 – Example of fibre optic communication system



IEC 1775/99

Figure 4 – Example of office/cable plant sources of loss



IEC 1776/99

Figure 5 – Example of fibre optic subscriber access network