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INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Fibre optic interconnecting devices and passive components – Fibre optic passive chromatic dispersion compensators – Part 1: Generic specification

Dispositifs d'interconnexion et composants passifs à fibres optiques – Compensateurs de dispersion chromatique passifs à fibres optiques – Partie 1: Spécification générique

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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International Standard IEC 61978-1 has been prepared by subcommittee 86B: Fibre optic interconnecting devices and passive components, of IEC technical committee 86: Fibre optics.

This second edition cancels and replaces the first edition published in 2000. It constitutes a technical revision. Changes from the previous edition of this standard are to reconsider the requirements.

The text of this standard is based on the following documents:

FDIS	Report on voting
86B/2908/FDIS	86B/2946/RVD

Full information on the voting for the approval of this standard 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 2.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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FIBRE OPTIC INTERCONNECTING DEVICES AND PASSIVE COMPONENTS – FIBRE OPTIC PASSIVE CHROMATIC DISPERSION COMPENSATORS –

Part 1: Generic specification

1 Scope

This part of IEC 61978 applies to fibre optic passive chromatic dispersion compensators, all exhibiting the following features:

– they are optically passive;
– they have an optical input and an optical output for transmitting optical power;
– the ports are optical fibres or optical fibre connectors;
– they are wavelength sensitive;
– they may be polarization sensitive.

This standard establishes uniform requirements for the passive chromatic dispersion compensator.

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 60027 (all parts), *Letter symbols to be used in electrical technology*

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

IEC 60617 (all parts), *Graphical symbols for diagrams*

IEC 60695-11-5, *Fire hazard testing – Part 11-5: Test flames – Needle-flame test method – Apparatus, confirmatory test arrangement and guidance*

IEC 60793-2-50, *Optical fibres – Part 2-50: Product specifications – Sectional specification for class B single-mode fibres*

IEC 60825 (all parts), *Safety of laser products*

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

IEC 60874 (all parts), *Connectors for optical fibres and cables*

IEC 60974 (all parts), *Arc welding equipment*

IEC 61073-1, *Fibre optic interconnecting devices and passive components – Mechanical splices and fusion splice protectors for optical fibres and cables – Part 1: Generic specification*

IEC 61300 (all parts), *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures*

IEC 61754-4, *Fibre optic connector interfaces – Part 4: Type SC connector family*

IEC 61754-13, *Fibre optic connector interfaces – Part 13: Type FC-PC connector*

IEC 61754-15, *Fibre optic connector interfaces – Part 15: Type LSH connector family*

IEC/TR 61930, *Fibre optic graphical symbology*

IEC Guide 102, *Electronic components — Specification structures for quality Assessment (Qualification approval and capability approval)*

IECQ 01, IEC *Quality Assessment System for Electronic Components (IECQ System) Basic Rules*

IECQ QC 001002-3, *IEC Quality Assessment System for Electronic Components (IECQ) – Rules of Procedure – Part 3: Approval procedures*

ISO 129-1, *Technical drawings – Indication of dimensions and tolerances – Part 1: General principles*

ISO 286-1, *ISO system of limits and fits – Part 1: Bases of tolerances, deviations and fits*

ISO 1101, *Geometrical Product Specifications (GPS) – Geometrical tolerancing -- Tolerances of form, orientation, location and run-out*

ISO 8601, *Data elements and interchange formats – Information interchange – Representation of dates and times*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050(731), as well as the following definitions apply.

3.1 Basic term

3.1.1
port
optical fibre or optical fibre connector attached to a passive component for the entry and/or exit of the optical power (input and/or output port)

3.2 Component

3.2.1
passive chromatic dispersion compensator
PCDC
two-port in-line passive device used to perform chromatic dispersion compensation. PCDCs are commonly used to compensate the chromatic dispersion of an optical path by adding the opposite sign chromatic dispersion. The typical optical paths are single-mode fibre, dispersion shifted fibre and non-zero dispersion shifted fibre. PCDCs have either negative or positive chromatic dispersion values depending on the chromatic dispersion sign of the optical path

3.2.2
dispersion compensating fibre
DCF
DCF is a speciality fibre to compensate chromatic dispersion of an optical path. By the control of the refractive index profile of the fibre, DCF realises opposite sign chromatic dispersion characteristics to that of the optical path

3.2.3
fibre Bragg grating
FBG
FBG is a fibre type optical device which has modulated refractive index profile in the core. PCDC is realised by a chirped FBG which has gradually changed refractive index along the fibre axis

3.2.4
virtually imaged phased array
VIPA
VIPA is an optical device which consists of coated glass plate, focusing lens and 3-dimensional mirror. VIPA produces both positive and negative chromatic dispersion by the move of the 3-dimensional mirror, in order to compensate the chromatic dispersion of an optical path

3.2.5
etalon
etalon is an optical cavity which consists of a pair of parallel reflective mirror. PCDC is realised by the etalon application called Gires-Tournois interferometer

3.3 Performance parameter

3.3.1
chromatic dispersion compensation
process by which a certain amount of chromatic dispersion is removed in order to mitigate the system impairment caused by this excessive unwanted amount

3.3.2
group delay
time by which a pulse is delayed by an optical device. The group delay generally varies with the operating wavelength

3.3.3
chromatic dispersion
derivative of group delay with respect to wavelength or frequency. A typical unit is ps/nm or ps/GHz [1)]. The chromatic dispersion generally varies with the operating wavelength

3.3.4
dispersion slope
derivative of chromatic dispersion with respect to wavelength or frequency. A typical unit is ps/nm^2 or ps/GHz [1)]. The dispersion slope generally varies with the operating wavelength

3.3.5
operating wavelength
nominal wavelength λ at which a passive device operates with the specified performance

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1 Units of ps/GHz are generally considered as better definition, even though it is not widely used.

3.3.6
operating wavelength range
specified range of wavelengths from λ_{min} to λ_{max} about an operating wavelength λ, within which a passive component operates with the specified performance

3.3.7
figure of merit
FoM
ratio of the dispersion to the insertion loss of a PCDC at a particular operating wavelength

3.3.8
passband ripple
maximum peak-to-peak variation of insertion loss in the passband

3.3.9
group delay ripple
maximum peak-to-peak variation of group delay in the operating wavelength range

3.3.10
phase ripple
maximum peak-to-peak variation of optical phase in the operating wavelength range

3.3.11
insertion loss
reduction in optical power between an input and output port of a passive component expressed in decibels. It is defined as follows:

$$a = -10 \log \frac{P_a}{P_0}$$

where

P_0 is the optical power launched into the input port;

P_a is the optical power received from the output port

3.3.12
return loss
fraction of input power that is returned from the input port of a passive component expressed in decibels. It is defined as follows:

$$RL = -10 \log \frac{P_r}{P_0}$$

where

P_0 is the optical power launched into the input port;

P_r is the optical power received back from the same port

3.3.13
reflectance
negative of the return loss

3.3.14
polarization dependent loss
PDL
maximum variation of insertion loss due to a variation of the state of polarization (SOP) over all the SOPs

3.3.15
wavelength dependent loss
WDL
maximum variation of the insertion loss over operating wavelength range

3.3.16
polarization mode dispersion
PMD
when an optical signal passes through an optical fibre, component or subsystem, the change in the shape and width of the pulse due to the average delay of the travelling time between the two principal states of polarization (PSP), differential group delay (DGD), and/or to the waveform distortion for each PSP, is called PMD

NOTE PMD, together with polarization dependent loss (PDL) and polarization dependent gain (PDG), when applicable, may introduce waveform distortion leading to unacceptable bit error rate increase.

4 Requirements

4.1 General

The requirements for PCDCs covered by this clause are intended to aid in classifying this device in a relevant specification. Additional or more severe requirements may be imposed by the relevant blank detail specification and by the detail specification.

4.2 Classification

PCDCs shall be classified as follows:

– type;
– style;
– variant;
– assessment level;
– normative reference extensions.

4.2.1 Type

PCDCs are divided into types by their main characteristics as follows.

PCDCs for WDM applications are divided into single channel type and multi-channel type. Operating wavelength range of multi-channel type PCDCs covers at least two channels of WDM systems. Multi-channel type PCDCs are divided into narrow band type and wide band type according to its spectral characteristics:

– for TDM or for WDM;
– single channel or multi-channel;
– narrow or wide;
– any combination of the above.

Table 1 – Types of passive chromatic dispersion compensators

Applications	Channel number	Operating wavelength range	Technologies
TDM	Single channel	Narrow	Dispersion compensating fibre (DCF) Fibre Bragg grating (FBG) Etalon
WDM	Single channel	Narrow	FBG
	Multi-channel	Narrow [a)]	FBG Etalon Virtually imaged phased array (VIPA)
		Wide	DCF
[a] Can be used as fixed, although it has tuneable function.			

Each type shall be applied to the following optical paths with negative or positive chromatic dispersion:

– for single-mode fibre or for dispersion shifted fibre or for non-zero dispersion shifted fibre;

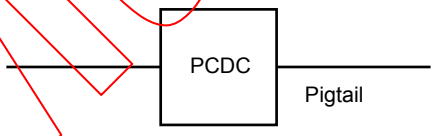
– to add negative chromatic dispersion to compensate the positive chromatic dispersion of an optical path or to add positive chromatic dispersion to compensate the negative chromatic dispersion of an optical path.

4.2.2 Style

PCDC may be classified into styles based on the fibre type(s), the connector type(s), cable type(s), housing shape, temperature control and the configuration. Style is not intended to define material or design. The configurations of PCDC ports are classified as follows.

4.2.2.1 Configuration A

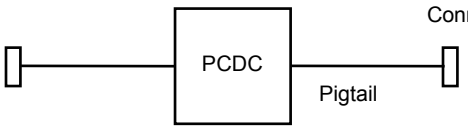
A device containing integral fibre optic pigtails, without connectors.



IEC 1687/2000

4.2.2.2 Configuration B

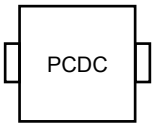
A device containing integral fibre optic pigtails, with a connector on each pigtail.



IEC 1688/2000

4.2.2.3 Configuration C

A device containing fibre optic connectors as an integral part of the device housing.



IEC 1689/2000

4.2.2.4 Configuration D

A device containing some combination of the interfacing features of the preceding configurations.

4.2.3 Variant

The PCDC variant identifies those common features which encompass structurally similar components.

Examples of features which define a variant include, but are not limited to, the following:

– fibre type;
– connector type.

4.2.4 Assessment level

Detail specifications shall specify one or more assessment levels, each of which shall be designated by a capital letter. The assessment level defines the relationship between the inspection levels of groups A and B and the periodicity of inspection of groups C and D.

The following are the preferred levels.

Assessment level A:

– group A inspection: inspection level II, AQL = 4 %;
– group B inspection: inspection level II, AQL = 4 %;
– group C inspection: 24-month periods;
– group D inspection: 48-month periods.

Assessment level B:

– group A inspection: inspection level II, AQL = 1 %;
– group B inspection: inspection level II, AQL = 1 %;
– group C inspection: 18-month periods;
– group D inspection: 36-month periods.

Assessment level C:

– group A inspection: inspection level II, AQL = 0,4 %;
– group B inspection: inspection level II, AQL = 0,4 %;
– group C inspection: 12-month periods;
– group D inspection: 24-month periods.

NOTE 1 AQL stands for acceptable quality level.

One additional assessment level (other than those specified above) can be given in the detail specification. When this is done, the capital letter X shall be used.

NOTE 2 Groups A and B are subject to lot-by-lot inspection. Groups C and D are subject to periodic inspection.

4.2.5 Normative reference extensions

Normative reference extensions are used to identify integrated independent standards, specifications or other reference documents into blank detail specifications.

Unless a specified exception is noted, additional requirements imposed by an extension are mandatory. Usage is primarily intended to merge associated components to form hybrid devices, or integrated functional application requirements that are dependent on technical expertise other than fibre optics.

Published reference documents produced by ITU consistent with the scope statements of the relevant IEC specification series may be used as an extension. Published documents produced by other regional standardization bodies such as TIA, ETSI, JIS, etc., may be referenced in a bibliography attached to the generic specification.

Some optical fibre splice configurations require special qualification provisions that shall not be imposed universally. This accommodates individual component design configurations, specialized field tooling, or specific application processes. In this case, requirements are necessary to assure repeatable performance or adequate safety, and provide additional guidance for complete product specification. These extensions are mandatory whenever used to prepare, assemble or install an optical fibre splice either for field application usage or preparation of qualification test specimens. The relevant specification shall clarify all stipulations. However, design- and style-dependent extensions shall not be imposed universally.

In the event of conflicting requirements, precedence shall be given, in descending order, as follows: generic over mandatory extension, over blank detail, over detail, over application specific extension.

Examples of optical connector extensions are given as follows.

- Using IEC 61754-4 and IEC 61754-15 to partially define a future specification of the IEC 60874 series for a duplex type "SC/LSH" hybrid connector adapter.
- Using IEC 61754-13 and IEC 60869-1 to partially define a future specification of the IEC 60874 series for an integrated type "FC" preset attenuated optical connector.
- Using IEC 61754-15 and IEC 61073-1 to partially define a future specification of the IEC 60974 series for a duplex "LSH" receptacle incorporating integral mechanical splices.

Other examples of requirements for normative extensions are as follows:

a) some commercial or residential building applications may require direct reference to specific safety codes and regulations or incorporate other specific material flammability or toxicity requirements for specialized locations;

b) specialized field tooling may require an extension to implement specific ocular safety, electrical shock or burn hazard avoidance requirements, or require isolation procedures to prevent potential ignition of combustible gases.

4.3 Documentation

4.3.1 Symbols

Graphical and letter symbols shall, whenever possible, be taken from IEC 60027 series, IEC 60617 and IEC/TR 61930.

4.3.2 Specification system

This specification is part of a three-level IEC specification system. Subsidiary specifications shall consist of blank detail specifications and detail specifications. This system is shown in Table 2. There are no sectional specifications for passive dispersion compensators.