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INTERNATIONAL STANDARD

colour inside

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

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

Part 1: Generic specification

FOREWORD

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This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition IEC 61978-1:2014. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

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

This fourth edition cancels and replaces the third edition published in 2014. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) harmonization of terms and definitions with IEC TS 62627-09;

b) change of Clause 4 regarding requirements.

The text of this International Standard is based on the following documents:

Draft	Report on voting
86B/4866/FDIS	86B/4901/RVD

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

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC 61978 series, published under the general title *Fibre optic interconnecting devices and passive components – Fibre optic passive chromatic dispersion compensators*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

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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~~ can be polarization sensitive.

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

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 – 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 60793-2-50:2012, *Optical fibres – Part 2-50: Product specifications – Sectional specification for class B single-mode fibres*~~

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

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

~~IEC 61300-3-38, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-38: Examinations and measurements – Group delay, chromatic dispersion and phase ripple*~~

IEC 61753 (all parts), *Fibre optic interconnecting devices and passive components performance standard*

IEC TR 61930, *Fibre optic graphical symbology*

IEC 62005 (all parts), *Reliability of fibre optic interconnecting devices and passive components*

IEC TS 62627-09, *Fibre optic interconnecting devices and passive components – Vocabulary for passive optical devices*

~~IEC Guide 102, *Electronic components – Specification structures for quality assessment (Qualification approval and capability approval)*~~

ISO 129-1, *Technical ~~drawings~~ product documentation (TPD) – ~~Indication~~ Presentation of dimensions and tolerances – Part 1: General principles*

~~ISO 286-1, *Geometrical product specifications (GPS) – ISO coding system for tolerances of linear sizes – Part 1: Bases of tolerances 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*~~

ISO 8601-1, *Date and time – Representations for information interchange – Part 1: Basic rules*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-731 and IEC TS 62627-09 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

~~**3.1 Basic terms**~~

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

3.1 Component terms

3.1.1
passive chromatic dispersion compensator
PCDC
two-port in-line passive device used to perform chromatic dispersion compensation

Note 1 to entry: PCDCs are commonly used to compensate the chromatic dispersion of an optical path by adding the opposite sign chromatic dispersion.

Note 2 to entry: The typical optical paths comprise single-mode fibre, dispersion shifted fibre and/or non-zero dispersion shifted fibre. PCDCs have either negative or positive chromatic dispersion values depending on the chromatic dispersion sign of the optical path.

[SOURCE: IEC TS 62627-09:2016, 3.3.17]

3.1.2
dispersion compensating fibre
DCF
speciality fibre to compensate for the chromatic dispersion of an optical path

3.1.3
passive DCF based dispersion compensator
PCDC which constitutes DCF; realised by having chromatic dispersion characteristics of opposite sign to that of the optical path which are controlled the refractive index profile of the fibre

3.1.4
fibre Bragg grating
FBG
fibre type optical device which has periodically modulated refractive index profile in the core along the fibre axis

3.1.5
passive FBG based dispersion compensator
PCDC which constitutes an FBG; PCDC is realised by a chirped FBG which has gradual change in either modulation period or refractive index, or both, along the fibre axis

3.1.6
virtually imaged phased array
VIPA
optical device having a glass plate with a highly reflective mirror

Note 1 to entry: A VIPA has the same functions as a grating.

3.1.7
passive VIPA based dispersion compensator
PCDC consisting of a VIPA, focusing lens and 3-dimensional mirror

Note 1 to entry: PCDC produces both positive and negative chromatic dispersion by the movement of the 3-dimensional mirror to compensate for the chromatic dispersion of an optical path.

3.1.8
etalon
optical cavity which consists of a pair of parallel reflective mirrors

3.1.9
Gires-Tournois etalon
GT etalon
etalon having a highly reflective mirror and a half mirror

Note 1 to entry: The GT etalon is sometimes called a GT interferometer.

3.1.10
passive GT etalon based dispersion compensator
PCDC which comprises a GT etalon

3.2 Performance ~~parameter~~ terms

3.2.1
chromatic dispersion compensation
process by which a specific amount of chromatic dispersion is removed in order to mitigate the system impairment caused by unwanted dispersion

3.2.2
group delay
time by which a pulse is delayed by an optical device

Note 1 to entry: The group delay generally varies with the operating wavelength.

3.2.3
chromatic dispersion
derivative of group delay with respect to wavelength or frequency

Note 1 to entry: A typical unit is ps/nm or ps/GHz. The chromatic dispersion generally varies with the operating wavelength.

Note 2 to entry: The unit of ps/GHz are not commonly used; however, it is suitable for the evaluation of transmission system influence.

3.2.4
dispersion slope
derivative of chromatic dispersion with respect to wavelength or frequency

Note 1 to entry: A typical unit is ps/nm^2 or ps/GHz^2.The unit of ps/GHz^2 is not commonly used; however, it is suitable for the evaluation of transmission system influence.

Note 2 to entry: The dispersion slope generally varies with the operating wavelength.

3.2.5
operating wavelength
nominal wavelength λ at which a passive device operates with the specified performance

Note 1 to entry: Operating wavelength includes the wavelength to be nominally transmitted, attenuated and isolated.

3.2.6
operating wavelength range
specified range of wavelengths including all operating wavelengths

Note 1 to entry: Operating wavelength range shall include all passbands when two or more the passbands are exist.

3.2.7
figure of merit
FoM
ratio of the dispersion to the insertion loss of a PCDC at a particular operating wavelength

3.2.8
passband
wavelength range within which a passive optical ~~component~~ device is required to operate with optical attenuation less than or equal to a specified optical attenuation value

Note 1 to entry: There ~~may~~ can be one or more passbands for a PCDC.

3.2.9
passband ripple
maximum peak-to-peak variation of insertion loss in the passband

Note 1 to entry: The passband ripple of a PCDC is defined as the maximum passband ripple for all passbands.

3.2.10
group delay ripple
GDR
maximum peak-to-peak variation of the group delay approximated by a desired function of wavelength (or frequency), typically a linear fit, within a channel wavelength (or frequency) range

3.2.11
phase ripple
maximum peak-to-peak variation in measured phase spectrum when compared to a quadratic fit within a channel wavelength (or frequency) range

Note 1 to entry: Phase ripple (unit: radian) is calculated as the product of a peak-to-peak group delay ripple (unit: s) and a period of group delay ripple (unit: Hz). Refer to IEC 61300-3-38.

3.2.12
insertion loss
reduction in optical power between an input and output port of a passive ~~component~~ device

Note 1 to entry: expressed in decibels (dB).

Note 2 to entry: insertion loss is expressed as follows:

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

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

where

P_0 is the optical power launched into the input port;

P_a is the optical power received from the output port.

3.2.13
return loss
fraction of input power that is returned from a port of a passive ~~component~~ device expressed in decibels

Note 1 to entry: The return loss is defined as follows:

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

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

where

P_0 is the optical power launched into a port;

P_r is the optical power received back from the same port.

3.2.14
reflectance
ratio of the optical power returning back from a port to input power expressed in %

3.2.15
polarization dependent loss
PDL
maximum variation of insertion loss (attenuation) due to a variation of the state of polarization (SOP) over all the SOPs

3.2.16
wavelength dependent loss
WDL
maximum variation of the insertion loss (attenuation) over operating wavelength range

3.2.17
polarization mode dispersion
PMD
average delay of the travelling time between the two principal states of polarization (PSP), when an optical signal passes through a passive optical ~~component~~ device

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.~~

4.1 Classification

~~4.2.1 General~~

~~PCDCs shall be classified as follows:~~

~~– type;~~
~~– style;~~
~~– variant;~~
~~– normative reference extensions.~~

~~4.2.2 Type~~

~~PCDCs can be categorized into different types, as follows:~~

~~– by operating technologies (DCF, FBG, VIPA, GT etalon and so on);~~
~~– by dispersion compensating performance (for example, wavelength dispersion compensating, dispersion slope compensating);~~
~~– by operating wavelength range (for example, O-band, C-band, L-band);~~
~~– by categories of transmission fibre which PCDCs are applied (for example, IEC 60793-2-50:2012, B1, B2, B4).~~

~~The application of PCDCs and the suitable operating mechanisms are summarized in Table 1.~~

~~Table 1 – Types of passive chromatic dispersion compensators~~

~~Applications~~	~~Channel number~~	~~Passbands~~	~~Technologies~~
~~TDM (Time division multiplexing)~~	~~Single channel~~	~~Narrow~~	~~Dispersion compensating fibre (DCF)~~ ~~Fibre Bragg grating (FBG)~~ ~~GT etalon~~
~~WDM (Wavelength division multiplexing)~~	~~Single channel~~	~~Narrow~~	~~FBG~~
	~~Multi-channel [a]~~	~~Narrow~~	~~FBG~~ ~~GT etalon~~ ~~Virtually imaged phased array (VIPA)~~
		~~Wide~~	~~DCF~~
~~[a] Multi-channel PCDCs can be used for a single channel use.~~			

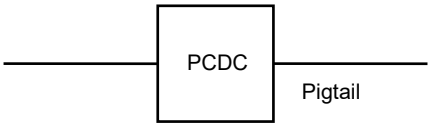
4.2.3 Style

4.2.3.1 General

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.

4.2.3.2 Configuration A

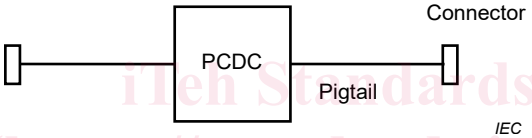
A device containing integral fibre optic pigtails, without connectors.



IEC 1687/2000

4.2.3.3 Configuration B

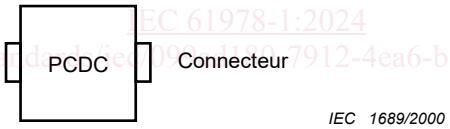
A device containing integral fibre optic pigtails, with a connector on each pigtail.



IEC 1688/2000

4.2.3.4 Configuration C

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



IEC 1689/2000

4.2.3.5 Configuration D

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

4.2.4 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.

4.2.5 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,