IEC 61978-1

Edition 3.0 2014-05

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

IEC 61978-1:2014-05(en-fr)

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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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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 bilingual version (2016-01) corresponds to the English version, published in 2014-05.

This third edition cancels and replaces the second edition, published in 2009, and constitutes a technical revision.

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

a) introduction of new terms and definitions;
b) revision of classifications;
c) addition of Annex E.

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

CDV	Report on voting
86B/3639/CDV	86B/3710/RVC

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

The French version of this standard has not been voted upon.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

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 publication will remain unchanged until the stability 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- withdrawn,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 documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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 TR 61930, *Fibre optic graphical symbology*

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

ISO 129-1, *Technical drawings – Indication 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*

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 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)

3.2 Component terms

3.2.1
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.

3.2.2
dispersion compensating fibre
DCF
speciality fibre to compensate for the chromatic dispersion of an optical path

3.2.3
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

3.2.4
fibre Bragg grating
FBG
fibre type optical device which has modulated refractive index profile in the core

3.2.5
passive FBG based dispersion compensator
PCDC which constitutes a FBG; PCDC is realised by a chirped FBG which has gradually changing refractive index along the fibre axis

3.2.6
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.

3.2.7
passive VIPA based dispersion compensator
PCDC which 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.

3.2.8
etalon
optical cavity which consists of a pair of parallel reflective mirrors

3.2.9
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.

3.2.10
passive GT etalon based dispersion compensator
PCDC which comprises a GT etalon

3.3 Performance parameter

3.3.1
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

3.3.2
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.

3.3.3
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 units of ps/GHz are not commonly used; however, it is suitable for the evaluation of transmission system influence.

3.3.4
dispersion slope
derivative of chromatic dispersion with respect to wavelength or frequency

Note 1 to entry: A typical unit is ps/nm2 or ps/GHz2.The unit of ps/GHz2 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

3.3.5
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.

3.3.6
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.

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

3.3.8
passband
wavelength range within which a passive optical component is required to operate with optical attenuation less than or equal to a specified optical attenuation value

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

3.3.9
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.

3.3.10
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

3.3.11
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.

3.3.12
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.

3.3.13
return loss
fraction of input power that is returned from a 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 a port;

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

3.3.14
reflectance
ratio of the optical power returning back from a port to input power expressed in %

3.3.15
polarization dependent loss
PDL
maximum variation of insertion loss due to a variation of the state of polarization (SOP) over all the SOPs

3.3.16
wavelength dependent loss
WDL
maximum variation of the insertion loss over operating wavelength range

3.3.17
polarization mode dispersion
PMD
average delay of the travelling time between the two principal states of polarization (PSP), when an optical signal passes through an passive optical component

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

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.			

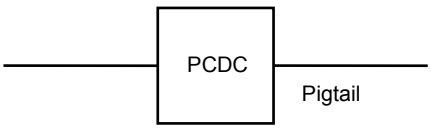
4.2.3 Style

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

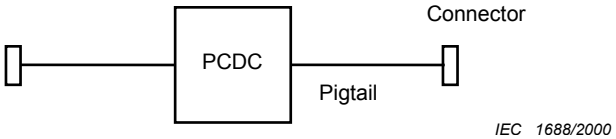
A device containing integral fibre optic pigtails, without connectors.



IEC 1687/2000

4.2.3.3 Configuration B

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



4.2.3.4 Configuration C

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

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, 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 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 the IEC 60027 series, IEC 60617 and IEC TR 61930.

4.3.2 Specification system

4.3.2.1 General

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.

Table 2 – Three-level IEC specification structure

Specification level	Examples of information to be included	Applicable to
Basic	Inspection rules Optical measuring methods Environmental test methods Sampling plans Identification rule Marking standards Dimensional standards Terminology standards Symbol standards Preferred number series SI units	Two or more component families or subfamilies
Generic	Specific terminology Specific symbols Specific units Preferred values Marking Selection of tests	Component family
Blank detail	Quality conformance test schedule Inspection requirements Information common to a number of types	Groups of types having a common test schedule
Detail	Individual values Specific information Completed quality conformance test schedules	Individual type