

# INTERNATIONAL STANDARD

**Fibre optic interconnecting devices and passive components performance  
standard –  
Part 081-2: Non-connectorized single-mode fibre optic middle-scale 1 × N DWDM  
devices for category C – Controlled environments**

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Part 081-2: Non-connectorized single-mode fibre optic middle-scale 1 × N DWDM devices for category C – Controlled environments**

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## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**FIBRE OPTIC INTERCONNECTING DEVICES AND  
PASSIVE COMPONENTS PERFORMANCE STANDARD –****Part 081-2: Non-connectorized single-mode fibre optic  
middle-scale 1 × N DWDM devices for category C –  
Controlled environments**

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International Standard IEC 61753-081-2 has been prepared by subcommittee 86B: Fibre optic interconnecting devices and passive components, of IEC technical committee 86: Fibre optics.

This standard cancels and replaces IEC/PAS 61753-081-2 published in 2005. This first edition constitutes a technical revision.

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

FDIS	Report on voting
86B/2863/FDIS	86B/2901/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.

A list of all parts of IEC 61753 series, under the general title *Fibre optic interconnecting devices and passive components performance standards*, can be found on the IEC website.

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

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# FIBRE OPTIC INTERCONNECTING DEVICES AND PASSIVE COMPONENTS PERFORMANCE STANDARD –

## Part 081-2: Non-connectorized single-mode fibre optic middle-scale $1 \times N$ DWDM devices for category C – Controlled environments

### 1 Scope

This part of IEC 61753 contains the minimum initial test and measurement requirements and severities which a fibre optic middle-scale  $1 \times N$  ( $16 \leq N \leq 64$ ) DWDM (Dense Wavelength Division Multiplexing) device with channel spacing of 50 GHz, 100 GHz and 200 GHz needs to satisfy in order to be categorized as meeting the requirements of category C-controlled environments. The requirements cover devices with single-mode non-connectorized pigtails and no circuit board. There is also a distinction between small-scale ( $N < 16$ ) and large-scale ( $N > 64$ )  $1 \times N$  DWDM devices for the purpose of this standard.

### 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 61300-2-1, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-1: Tests – Vibration (sinusoidal)*

IEC 61300-2-4, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-4: Tests – Fibre/cable retention*

IEC 61300-2-9, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-9: Tests – Shock*

IEC 61300-2-14, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-14: Tests – Optical power handling and damage threshold characterization*

IEC 61300-2-17, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-17: Tests – Cold*

IEC 61300-2-18, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-18: Tests – Dry heat – High temperature endurance*

IEC 61300-2-19, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-19: Tests – Damp heat (steady state)*

IEC 61300-2-22, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-22: Tests – Change of temperature*

IEC 61300-2-42, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-42: Tests – Static side load for connectors*

IEC 61300-3-2, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-2: Examinations and measurements – Polarization dependence of attenuation in a single-mode fibre optic device*

IEC 61300-3-6, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-6: Examinations and measurements – Return loss*

IEC 61300-3-20, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-20: Examinations and measurements – Directivity of fibre optic branching devices*

IEC 61300-3-29, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-29: Examinations and measurements – Measurement techniques for characterizing the amplitude of the spectral transfer function of DWDM components*

IEC 61300-3-32, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-32: Examinations and measurements – Polarization mode dispersion measurement for passive optical components*

IEC 61753-021-2, *Fibre optic interconnecting devices and passive components performance standard – Part 021-2 Fibre optic connectors terminated on single mode fibre for category C – Controlled environment*

IEC/PAS 62074-1, *Fibre optic WDM devices – Part 1: Generic specification*

ITU-T Supplement N.39:2003, *Optical system design and engineering considerations*

ITU-T Recommendation G.671:2005, *Transmission characteristics of optical components and subsystems*

ITU-T Recommendation G.692:1998, *Optical interfaces for multichannel systems with optical amplifiers*

ITU-T Recommendation G.694.1:2002, *Spectral grids for WDM applications: DWDM frequency grid*

### **3 Terms and definitions**

For the purposes of this document, the following terms and definitions, as well as those given in IEC/PAS 62074-1, apply.

#### **3.1**

##### **middle-scale 1 x N DWDM device**

wavelength-selective branching device which performs the function both of a wavelength multiplexer and demultiplexer with DWDM channel spacing of 50 GHz, 100 GHz and 200 GHz and a number of channels (N) equalling 16 ~ 64

### **4 Test conditions – General**

Unless otherwise specified, all test methods shall be in accordance with the IEC 61300 series. DWDM devices used for each test are intended to be previously unstressed new samples but may also be selected from previously used samples, if desired. All measurements shall be carried out at normal room temperature, unless otherwise stated. If the device is provided with an active temperature control, this shall be set at the set-point specified by the manufacturer.

The requirements apply to every combination of input and output port.

All tests are to be carried out to validate performance over the required operating wavelength range. As a result, single or multiple spectral bands may be chosen for the qualification and differing target specifications may be assigned to each spectral band.

The following Table 1 is intended to provide guidance on the wavelength ranges of the various spectral bands. It is not intended for specification. Values of operating wavelength used in performance verification shall be defined in the manufacturer's specification.

**Table 1 – Spectral bands for single-mode systems<sup>a</sup>**

Band	Descriptor	Range (nm)
O-band	Original	1260 to 1360
E-band	Extended	1360 to 1460
S-band	Short wavelength	1460 to 1530
C-band	Conventional	1530 to 1565
L-band	Long wavelength	1565 to 1625
U-band	Ultralong wavelength	1625 to 1675

<sup>a</sup> Taken from ITU-T Supplement G sup. 39: Optical system design and engineering considerations (12/2008).

## 5 Test report

Fully documented test reports and supporting evidence shall be prepared and be available for inspection as evidence that the tests have been carried out and complied with.

## 6 Reference components

The testing for these components does not require the use of reference components.

## 7 Performance requirements

### 7.1 Dimensions

Dimensions shall comply with either an appropriate IEC interface standard or with those given in appropriate manufacturers drawings, where the IEC interface standard does not exist or cannot be used.

### 7.2 Test details and requirements

The device is equipped with no circuit-board including a temperature controller. The requirements are given only for pigtailed DWDM devices. For connectorized components, the connector performances shall be in compliance with IEC 61753-021-2.

A minimum length of fibre or cable of 1,5 m per port shall be included in all climatic and environmental tests. The operating wavelengths, unless otherwise specified, shall be in accordance with ITU-T Recommendation G.692 and G.694.1. Where devices with wavelength spaced channels have to be considered, the conversion should refer to vacuum wavelength.

**Table 2 – Test and requirements for type A (Gaussian passband profile)**

No	Tests	Requirements	Details
1A	Number of channels: N	$16 \leq N \leq 64$	Design information (not test item)  Operating wavelength: ITU-T grid or custom design
2A	Channel frequency range	Channel central frequency $\pm 0,125 \times \Delta f$ where $\Delta f$ is the channel spacing	Information (not test item)  IEC 62074-1  Channel central frequency: ITU-T grid or custom design  ITU-T Recommendation G.694.1
3A	Insertion loss	Maximum allowable insertion loss over the channel frequency range:  4,8 dB	IEC 61300-3-29, IEC 62074-1  Condition: the insertion loss shall be determined as the worst case over all states of polarisation  Launch fibre length: $\geq 1,5$ m  The test conditions shall provide loss measurement results with accuracy of better than $\pm 0,05$ dB over the operating wavelength range
4A	Channel non-uniformity	Maximum allowable channel non-uniformity of insertion losses:  1,0 dB (Channel n. $\leq 24$ )  1,5 dB (Channel n. $> 24$ )	IEC 61300-3-29  Condition: the channel non-uniformity shall be determined as the worst case over all states of polarisation  Launch fibre length: $\geq 1,5$ m  The test conditions shall provide loss measurement results with accuracy of better than $\pm 0,05$ dB over the operating wavelength range
5A	1 dB passband width	Minimum allowable 1 dB passband width (centred at the channel frequency):  $0,25 \times \Delta f$ where $\Delta f$ is the channel spacing	IEC 61300-3-29, IEC 62074-1  Condition: the passband width shall be determined as the worst case over all states of polarisation  Launch fibre length: $\geq 1,5$ m
6A	3 dB passband width	Minimum allowable 3 dB passband width (centred at the channel frequency):  $0,5 \times \Delta f$ where $\Delta f$ is the channel spacing	Details: same as in test 5A

Table 2 (continued)

No	Tests	Requirements	Details
7A	Adjacent channel isolation	Minimum allowable adjacent channel isolation over the channel frequency range: 25 dB	<p>IEC 61300-3-29, IEC 62074-1</p> <p>The adjacent channel isolation is specified only for demultiplexer</p> <p>Condition: the adjacent channel isolation shall be determined as the worst case over all states of polarisation</p> <p>Launch fibre length: <math>\geq 1,5</math> m</p> <p>The test conditions shall provide isolation measurement results with accuracy of better than <math>\pm 0,1</math> dB over the operating wavelength range</p>
8A	Non-adjacent channel isolation	Minimum allowable non-adjacent channel isolation over the channel frequency range: 30 dB	<p>IEC 61300-3-29, IEC 62074-1</p> <p>The non-adjacent channel isolation is specified only for demultiplexer</p> <p>Condition: the non-adjacent channel isolation shall be determined as the worst case over all states of polarisation</p> <p>Launch fibre length: <math>\geq 1,5</math> m</p> <p>The test conditions shall provide isolation measurement results with accuracy of better than <math>\pm 0,1</math> dB over the operating wavelength range</p>
9A	Total channel isolation	<p>Minimum allowable total channel isolation value:</p> <p>22 dB (Channel <math>n \leq 40</math>)</p> <p>20 dB (Channel <math>n &gt; 40</math>)</p>	<p>IEC 61300-3-29, IEC 62074-1</p> <p>Condition: the minimum total channel isolation shall be determined as the worst case over all states of polarisation</p> <p>Launch fibre length: <math>\geq 1,5</math> m</p> <p>The test conditions shall provide isolation measurement results with accuracy of better than <math>\pm 0,1</math> dB over the operating wavelength range</p>
10A	Polarisation dependent loss (PDL)	Maximum allowable PDL over the channel frequency range: 0,4 dB	<p>IEC 61300-3-2, IEC 62074-1</p> <p>The allowable PDL combination applies to all combination of input and output ports</p> <p>Launch fibre length: <math>\geq 1,5</math> m</p>
11A	Polarisation mode dispersion (PMD)	Maximum allowable PMD over the channel frequency range: 0,5 ps	<p>IEC 61300-3-32, IEC 62074-1</p> <p>The allowable PMD combination applies to all combination of input and output ports</p>

**Table 2 (continued)**

No	Tests	Requirements	Details
12A	Chromatic dispersion	Maximum allowable chromatic dispersion over the channel frequency range (absolute value):  20 ps/nm for 100 GHz channel spacing  60 ps/nm for 50 GHz channel spacing	Method: A chromatic dispersion test method is under study in WG4  (Ex. Test method for fibre: IEC 60793-1-42)
13A	Return loss	Minimum allowable return loss: 40 dB	IEC 61300-3-6  Condition: All ports not under test shall be terminated to avoid unwanted reflections contributing to the measurement  Launch fibre length: $\geq 1,5$ m  The test conditions shall provide return loss measurement results with accuracy of better than $\pm 0,1$ dB over the operating wavelength range
14A	Directivity	Maximum allowable directivity: - 40 dB	IEC 61300-3-20  Condition: All ports not under test shall be terminated to avoid unwanted reflections contributing to the measurement  The directivity shall be measured between any pair of input or output ports  The test conditions shall provide directivity measurement results with accuracy of better than $\pm 0,1$ dB over the operating wavelength range
15A	Optical power handling and damage threshold characterization	+25 dBm	IEC 61300-2-14  Input port: single port

**Table 3 – Test and requirements for type B (Flat-top passband profile)**

No	Tests	Requirements	Details
1B	Number of channels	$16 \leq \text{Channel n.} \leq 64$	Operating wavelength: ITU-T grid or custom design
2B	Channel frequency range	Channel central frequency $\pm 0.125 \times \Delta f$ where $\Delta f$ is the channel spacing	IEC 62074-1 Channel central frequency: ITU-T grid or custom design ITU-T Recommendation G.694.1
3B	Insertion loss	Maximum allowable insertion loss over the channel frequency range:  6,0 dB	IEC 61300-3-29, IEC 62074-1 Condition: the insertion loss shall be determined as the worst case over all states of polarisation Launch fibre length: $\geq 1,5$ m The test conditions shall provide loss measurement results with accuracy of better than $\pm 0,05$ dB over the operating wavelength range
4B	Channel non-uniformity	Maximum allowable channel non-uniformity of insertion losses:  1,0 dB (Channel n. $\leq 24$ ) 1,5 dB (Channel n. $> 24$ )	IEC 61300-3-29 Condition: the channel non-uniformity shall be determined as the worst case over all states of polarisation Launch fibre length: $\geq 1,5$ m The test conditions shall provide loss measurement results with accuracy of better than $\pm 0,05$ dB over the operating wavelength range
5B	1 dB passband width	Minimum allowable 1 dB passband width (centred at the channel frequency):  $0,5 \times \Delta f$ where $\Delta f$ is the channel spacing	IEC 61300-3-29, IEC 62074-1 Condition: the passband width shall be determined as the worst case over all states of polarisation Launch fibre length: $\geq 1,5$ m
6B	3 dB passband width	Minimum allowable 3 dB passband width (centred at the channel frequency):  $0,5 \times \Delta f$ where $\Delta f$ is the channel spacing	Details: same as in test 5B

**Table 3 (continued)**

No	Tests	Requirements	Details
7B	Adjacent channel isolation	Minimum allowable adjacent channel isolation over the channel frequency range: 25 dB	<p>IEC 61300-3-29, IEC 62074-1</p> <p>The adjacent channel isolation is specified only for demultiplexer</p> <p>Condition: the adjacent channel isolation shall be determined as the worst case over all states of polarisation</p> <p>Launch fibre length: <math>\geq 1,5</math> m</p> <p>The test conditions shall provide isolation measurement results with accuracy of better than <math>\pm 0,1</math> dB over the operating wavelength range</p>
8B	Non-adjacent channel isolation	Minimum allowable non-adjacent channel isolation over the channel frequency range: 30 dB	<p>IEC 61300-3-29, IEC 62074-1</p> <p>The non-adjacent channel isolation is specified only for demultiplexer</p> <p>Condition: the non-adjacent channel isolation shall be determined as the worst case over all states of polarisation</p> <p>Launch fibre length: <math>\geq 1,5</math> m</p> <p>The test conditions shall provide isolation measurement results with accuracy of better than <math>\pm 0,1</math> dB over the operating wavelength range</p>
9B	Total channel isolation	<p>Minimum allowable total channel isolation value:</p> <p>22 dB (Channel n. <math>\leq 40</math>)</p> <p>20 dB (Channel n. <math>&gt; 40</math>)</p>	<p>IEC 61300-3-29, IEC 62074-1</p> <p>Condition: the minimum total channel isolation shall be determined as the worst case over all states of polarisation</p> <p>Launch fibre length: <math>\geq 1,5</math> m</p> <p>The test conditions shall provide isolation measurement results with accuracy of better than <math>\pm 0,1</math> dB over the operating wavelength range</p>
10B	Polarisation dependent loss (PDL)	Maximum allowable PDL over the channel frequency range: 0,4 dB	<p>IEC 61300-3-2, IEC 62074-1</p> <p>The allowable PDL combination applies to all combination of input and output ports</p> <p>Launch fibre length: <math>\geq 1,5</math> m</p>
11B	Polarisation mode dispersion (PMD)	Maximum allowable PMD over the channel frequency range: 0,5 ps	<p>IEC 61300-3-32, IEC 62074-1</p> <p>The allowable PMD combination applies to all combination of input and output ports</p>

Table 3 (continued)

No	Tests	Requirements	Details
12B	Chromatic dispersion	Maximum allowable chromatic dispersion over the channel frequency range (absolute value):  40 ps/nm for 100 GHz channel spacing  100 ps/nm for 50 GHz channel spacing	Method: A chromatic dispersion test method is under study in WG4  (Ex. Test method for fibre: IEC 60793-1-42)
13B	Return loss	Minimum allowable return loss: 40 dB	IEC 61300-3-6  Condition: All ports not under test shall be terminated to avoid unwanted reflections contributing to the measurement  Launch fibre length: $\geq 1,5$ m  The test conditions shall provide return loss measurement results with accuracy of better than $\pm 0,1$ dB over the operating wavelength range
14B	Directivity	Maximum allowable directivity: -40 dB	IEC 61300-3-20  Condition: All ports not under test shall be terminated to avoid unwanted reflections contributing to the measurement  The directivity shall be measured between any pair of input or output ports  The test conditions shall provide directivity measurement results with accuracy of better than $\pm 0,1$ dB over the operating wavelength range
15B	Optical power handling and damage threshold characterisation	+25 dBm	IEC 61300-2-14  Input port: single port

**Table 4 – Environmental test for all types**

No	Tests	Requirements	Details
16	Cold	<p>During and on completion of the test the requirement regarding the maximum allowable insertion loss shall be met</p> <p>During and on completion of the test, the insertion loss shall be within <math>\pm 0,5</math> dB with respect to the initial value</p>	<p>IEC 61300-2-17</p> <p>Temperature: <math>-10^{\circ}\text{C} \pm 2^{\circ}\text{C}</math></p> <p>Duration of exposure: 96 h</p> <p>Preconditioning procedure: Before test, specimens shall be maintained in room temperature condition for 2 h</p> <p>Specimen shall be optically functioning</p> <p>During the test the Insertion Loss value shall be measured at a maximum interval of 1 h</p> <p>Recovery procedure: After test, specimens shall be maintained in room temperature condition for 2 h</p>
17	High temperature endurance	<p>During and on completion of the test the requirement regarding the maximum allowable Insertion Loss shall be met</p> <p>During and on completion of the test, the Insertion Loss shall be within <math>\pm 0,5</math> dB with respect to the initial value</p>	<p>IEC 61300-2-18</p> <p>Temperature: <math>+60^{\circ}\text{C} \pm 2^{\circ}\text{C}</math></p> <p>Humidity is not controlled</p> <p>Duration of exposure: 96 h</p> <p>Preconditioning procedure: Before test, specimens shall be maintained in room temperature condition for 2 h</p> <p>Specimen shall be optically functioning</p> <p>During the test the insertion loss value shall be measured at maximum interval of 1 h during the first 16 h, and thereafter at a maximum interval of 24 h until completion of the test</p> <p>Recovery procedure: After test, specimens shall be maintained in room temperature condition for 2 h</p>
18	Damp heat (steady state)	<p>During and on completion of the test the requirement regarding the maximum allowable insertion loss shall be met</p> <p>During and on completion of the test, the insertion loss shall be within <math>\pm 0,5</math> dB with respect to the initial value</p>	<p>IEC 61300-2-19</p> <p>Temperature: <math>+40^{\circ}\text{C} \pm 2^{\circ}\text{C}</math></p> <p>Relative humidity: <math>93\% \pm 2\%</math></p> <p>Duration of exposure: 96 h</p> <p>Specimen shall be optically functioning</p> <p>During the test the Insertion Loss value shall be measured at a maximum interval of 1 h</p> <p>Preconditioning procedure: Before test, specimens shall be maintained in room temperature condition for 2 h</p> <p>Recovery procedure: After test, specimens shall be maintained in room temperature condition for 2 h</p>

Table 4 (continued)

No	Tests	Requirements	Details
19	Change of temperature	<p>During and on completion of the test the requirement regarding the maximum allowable insertion loss shall be met</p> <p>During and on completion of the test, the insertion loss shall be within <math>\pm 0,5</math> dB with respect to the initial value</p>	<p>IEC 61300-2-22</p> <p>High temperature:- <math>+60</math> °C <math>\pm 2</math> °C</p> <p>Low temperature: <math>-10</math> °C <math>\pm 2</math> °C</p> <p>Humidity is not controlled</p> <p>Duration at extreme temperatures: 1 h</p> <p>Temperature rate of change: <math>1</math> °C/min</p> <p>Number of cycles: 5</p> <p>Specimen shall be optically functioning</p> <p>During the test the insertion loss value shall be measured at a maximum interval of 30 min</p> <p>Preconditioning procedure: Before test, specimens shall be maintained in room temperature condition for 2 h</p> <p>Recovery procedure: After test, specimens shall be maintained in room temperature condition for 2 h</p>
20	Vibration (sinusoidal)	<p>During and on completion of the test the requirement regarding the insertion loss shall be met</p> <p>During and on completion of the test, the insertion loss shall be within <math>\pm 0,5</math> dB with respect to the initial value</p>	<p>IEC 61300-2-1</p> <p>Frequency range: 10 Hz-55 Hz</p> <p>Endurance duration per axis: 0,5 h</p> <p>Number of axes: Three orthogonal</p> <p>Number of sweeps: 15</p> <p>Vibration amplitude: 0,75 mm</p> <p>Method of mounting: The specimen shall be mounted rigidly to the mounting fixture</p>
21	Fibre/Cable retention	<p>During and on completion of the test the requirement regarding the insertion loss shall be met</p> <p>During and on completion of the test, the insertion loss shall be within <math>\pm 0,5</math> dB with respect to the initial value</p>	<p>IEC 61300-2-4</p> <p>Magnitude and rate of application of the tensile load:</p> <p>10 N + 1 N at a speed of 5 N/s for reinforced cables</p> <p>5 N + 0,5 N at a speed of 0,5 N/s for coated fibres</p> <p>Duration of application of tensile load: 60 s</p> <p>Point of application of tensile load: 0,3 m from the exit point of the fibre / cable from the specimen</p> <p>Method of mounting: The sample shall be rigidly mounted such that the load is only applied to the fibre/cable retention mechanism</p>