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Pre-Standard

First edition
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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**



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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 × N DWDM devices for category C – Controlled environments

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This PAS was approved for publication by the P-members of the committee concerned as indicated in the following document

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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 specification 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 shall satisfy in order to be categorized as meeting the IEC standard 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 standards.

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 60793-1-42:2001, *Optical fibres – Part 1-42: Measurement methods and test procedures – Chromatic dispersion*

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 – Maximum input power*

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 61300-2-22, *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 61753-2-1, *Fibre optic interconnecting devices and passive components performance standard – Part 2-1: Fibre optic connectors terminated on single-mode fibre for category U – Uncontrolled environment*

IEC 62074-1, *Fibre optic WDM devices – Part 1: Generic specification for fibre optic WDM devices*

ITU-T Recommendation G.692, *Optical interfaces for intra-office systems*

ITU-T Recommendation G.694-1, *Spectral grids for WDM applications – DWDM frequency grid*

3 Definitions

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

3.1

Middle-scale 1 x N DWDM device

wavelength-selective branching device which performs functions both of a wavelength multiplexer and demultiplexer with DWDM channel spacing and a number of channel (N) of 16 ~ 64. The device is equipped with no circuit-board including a temperature controller

4 Tests

Unless otherwise specified, all test methods are in accordance with IEC 61300-x. Each test defines the number of samples to be evaluated. 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 conditions, unless otherwise stated. If the device is provided with an active temperature control, this shall be set at the setpoint specified by the manufacturer.

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

All tests shall 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.

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 specified between the customer and supplier or shall be as defined in the manufacturer's specification.

Table 1 – Spectral bands for single-mode systems

Band	Descriptor	Range nm
O-band	Original	1 260 to 1 360
E-band	Extended	1 360 to 1 460
S-band	Short wavelength	1 460 to 1 530
C-band	Conventional	1 530 to 1 565
L-band	Long wavelength	1 565 to 1 625
U-band	Ultralong wavelength	1 625 to 1 675

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

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 the appropriate manufacturer's drawings, where the IEC interface standard does not exist or cannot be used.

7.2 Test details and requirements

The requirements are given only for pigtailed DWDM devices. For connectorized components, the connector performances shall be in compliance with IEC 61753-2-1.

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 Recommendations G.692 and G.694.1. Where devices with wavelength spaced channels are to be considered, the conversion should refer to vacuum wavelength.

7.3 Sample size

The sample size to be used for the tests shall be as defined in Annex A.

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

No	Tests	Requirements	Details
1A	Number of channel: N	$16 \leq N \leq 64$	Operating wavelength: ITU-T grid or custom design
2A	Channel frequency range	Channel central frequency $\pm 0,125 \cdot \Delta f$ where Δf is the channel spacing	IEC 62074-1 Channel central frequency: ITU-T grid or custom design
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 polarization
4A	Channel non-uniformity	Maximum allowable channel non-uniformity of insertion losses: 1,0 dB (Channel n. ≤ 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 polarization
5A	1 dB passband width	Minimum allowable 1 dB passband width (centred at the channel frequency): $0,25 \cdot \Delta f$ where Δf 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 polarization
6A	3 dB passband width	Minimum allowable 3 dB passband width (centred at the channel frequency): $0,5 \cdot \Delta f$ where Δf 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 polarization
7A	Adjacent channel isolation	Minimum allowable adjacent channel isolation over the channel frequency range: 25 dB	IEC 61300-3-29, IEC 62074-1 The adjacent channel isolation is specified only for demultiplexer Condition: the adjacent channel isolation shall be determined as the worst case over all states of polarization
8A	Non-adjacent channel isolation	Minimum allowable non-adjacent channel isolation over the channel frequency range: 30 dB	IEC 61300-3-29, IEC 62074-1 The non-adjacent channel isolation is specified only for demultiplexer Condition: the non-adjacent channel isolation shall be determined as the worst case over all states of polarization
9A	Total channel isolation	Minimum allowable total channel isolation value: 22 dB (Channel n. ≤ 40) 20 dB (Channel n. > 40)	IEC 61300-3-29, IEC 62074-1 Condition: the minimum total channel isolation shall be determined as the worst case over all states of polarization
10A	Polarization Dependent Loss (PDL)	Maximum allowable PDL over the channel frequency range: 0,4 dB	IEC 61300-3-2, IEC 62074-1 The allowable PDL combination applies to all combination of input and output ports

11A	Polarization Mode Dispersion (PMD)	Maximum allowable PMD over the channel frequency range: 0,5 ps	IEC 61300-3-32, IEC 62074-1 The allowable PMD combination applies to all combination of input and output ports
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 (For example, 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
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
15A	Optical power handling and damage threshold characterization	+25 dBm	IEC 61300-2-14

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

No	Tests	Requirements	Details
1B	Number of channel	$16 \leq (\text{channel n.} \leq 64)$	Operating wavelength: ITU-T grid or custom design
2B	Channel frequency range	Channel central frequency $\pm 0,125 \cdot \Delta f$ where Δf is the channel spacing	IEC 62074-1 Channel central frequency: ITU-T grid or custom design
3B	Insertion loss	Maximum allowable insertion loss over the channel frequency range: 7,0 dB	IEC 61300-3-29, IEC 62074-1 Condition: the insertion loss shall be determined as the worst case over all states of polarization
4B	Channel non-uniformity	Maximum allowable channel non-uniformity of insertion losses: 1,0 dB (Channel n. ≤ 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 polarization
5B	1 dB passband width	Minimum allowable 1 dB passband width (centred at the channel frequency): $0,5 \cdot \Delta f$ where Δf 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 polarization

6B	3 dB passband width	Minimum allowable 3 dB passband width (centred at the channel frequency): $0,5 \cdot \Delta f$ where Δf 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 polarization
7B	Adjacent channel isolation	Minimum allowable adjacent channel isolation over the channel frequency range: 25 dB	IEC 61300-3-29, IEC 62074-1 The adjacent channel isolation is specified only for demultiplexer Condition: the adjacent channel isolation shall be determined as the worst case over all states of polarization
8B	Non-adjacent channel isolation	Minimum allowable non-adjacent channel isolation over the channel frequency range: 30 dB	IEC 61300-3-29, IEC 62074-1 The non-adjacent channel isolation is specified only for demultiplexer Condition: the non-adjacent channel isolation shall be determined as the worst case over all states of polarization
9B	Total channel isolation	Minimum allowable total channel isolation value: 22 dB (Channel n. ≤ 40) 20 dB (Channel n. > 40)	IEC 61300-3-29, IEC 62074-1 Condition: the minimum total channel isolation shall be determined as the worst case over all states of polarization
10B	Polarization Dependent Loss (PDL)	Maximum allowable PDL over the channel frequency range: 0,4 dB	IEC 61300-3-2, IEC 62074-1 The allowable PDL combination applies to all combinations of input and output ports
11B	Polarization mode dispersion (PMD)	Maximum allowable PMD over the channel frequency range: 0,5 ps	IEC 61300-3-2, IEC 62074-1 The allowable PMD combination applies to all combinations of input and output ports
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 (For example, 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
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
15B	Optical power handling and damage threshold characterization	+25 dBm	IEC 61300-2-14

Table 4 – Environmental test for all types

No	Tests	Requirements	Details
16	Cold	During and on completion of the test the requirement regarding the maximum allowable insertion loss shall be met During and on completion of the test, the insertion loss shall be within $\pm 0,3$ dB with respect to the initial value During and on completion of the test, the limits of test 11 shall be met	IEC 61300-2-17 Temperature: $-10\text{ °C} \pm 2\text{ °C}$ Duration of exposure: 96 h Preconditioning procedure: Before test, specimens shall be maintained in room temperature condition for 2 h Specimen shall be optically functioning Sampling rate: tbd Recovery procedure: After test, specimens shall be maintained in room temperature condition for 2 h
17	High-temperature endurance	During and on completion of the test, the requirement regarding the maximum allowable insertion loss shall be met During and on completion of the test, the insertion loss shall be within $\pm 0,3$ dB with respect to the initial value During and on completion of the test, the limits of test 11 shall be met	IEC 61300-2-18 Temperature: $+60\text{ °C} \pm 2\text{ °C}$ Duration of exposure: 96 h Preconditioning procedure: Before test, specimens shall be maintained in room temperature condition for 2 h Specimen shall be optically functioning. Sampling rate: tbd Recovery procedure: After test, specimens shall be maintained in room temperature condition for 2 h
18	Damp heat (steady state)	During and on completion of the test the requirement regarding the maximum allowable insertion loss shall be met During and on completion of the test, the insertion loss shall be within $\pm 0,3$ dB with respect to the initial value During and on completion of the test, the limits of test 11 shall be met	IEC 61300-2-19 Temperature: $+40\text{ °C} \pm 2\text{ °C}$ Relative humidity: $93 \pm 2\%$ Duration of exposure: 96 h Specimen shall be optically functioning Sampling rate: tbd Preconditioning procedure: Before test, specimens shall be maintained in room temperature condition for 2 h. Recovery procedure: After test, specimens shall be maintained in room temperature condition for 2 h

19	Change of temperature	During and on completion of the test, the requirement regarding the maximum allowable insertion loss shall be met During and on completion of the test, the insertion loss shall be within $\pm 0,3$ dB with respect to the initial value During and on completion of the test, the limits of test 11 shall be met	IEC 61300-2-22 High temperature: $+60\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ Low temperature: $-10\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ Duration at extreme temperatures: 1 h Temperature rate of change: $1\text{ }^{\circ}\text{C/min}$ Number of cycles: 5 Specimen shall be optically functioning Sampling rate: tbd Preconditioning procedure: Before test, specimens shall be maintained in room temperature condition for 2 h Recovery procedure: After test, specimens shall be maintained in room temperature condition for 2 h
20	Vibration (sinusoidal)	On completion of the test, the requirement regarding the insertion loss shall be met On completion of the test, the insertion loss shall be within $\pm 0,5$ dB with respect to the initial value During and on completion of the test, the limits of test 11 shall be met	IEC 61300-2-1 Frequency range: 10-55 Hz Endurance duration per axis: 0,5 h Number of axes: Three orthogonal Number of sweeps: 15 Vibration amplitude: 0,75 mm Method of mounting: The specimen shall be mounted rigidly to the mounting fixture.
21	Fibre/cable retention	On completion of the test, the requirement regarding the insertion loss shall be met On completion of the test, the insertion loss shall be within $\pm 0,5$ dB with respect to the initial value During and on completion of the test, the limits of test 11 shall be met	IEC 61300-2-4 Magnitude and rate of application of the tensile load: 10 + 1N at a speed of 5 N/s for reinforced cables 5 + 0,5N at a speed of 0,5 N/s for coated fibres Duration of application of tensile load: 60 s Point of application of tensile load: 0,3 m from the exit point of the fibre/cable from the specimen Method of mounting: The sample shall be rigidly mounted in such a way that the load is only applied to the fibre/cable retention mechanism

22	Shock	On completion of the test, the requirement regarding the insertion loss shall be met On completion of the test, the insertion loss shall be within $\pm 0,5$ dB with respect to the initial value During and on completion of the test, the limits of test 11 shall be met	IEC 61300-2-9 Shock: 500 G Number of axis: 6 Number of shock: 2 per axis Duration: 1 ms duration Pulse: half-sine
23	Static side load	On completion of the test the requirement regarding the insertion loss shall be met. On completion of the test, the insertion loss shall be within $\pm 0,5$ dB with respect to the initial value During and on completion of the test, the limits of test 11 shall be met	IEC 61300-2-42 1 N for 1 h for reinforced cable 0,2 N for 5 min for buffered fibres Two mutually perpendicular directions

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