

INTERNATIONAL STANDARD

**Fibre optic interconnecting devices and passive components performance
standard –**

**Part 031-6: Non-connectorized single-mode 1×N and 2×N non-wavelength-
selective branching devices (NWBD) for Category O – Uncontrolled environment**

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**FIBRE OPTIC INTERCONNECTING DEVICES AND PASSIVE
COMPONENTS PERFORMANCE STANDARD –****Part 031-6: Non-connectorized single-mode 1×N and 2×N
non-wavelength-selective branching devices (NWBD) for Category O –
Uncontrolled environment**

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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 the parts in the IEC 61753 series, under the general title *Fibre optic interconnecting devices and passive components performance standard*, can be found on the IEC website.

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INTRODUCTION

This International Standard takes into account two technologies present on the market: the Fused Biconical Taper (FBT) and the Planar Lightwave Circuit (PLC). The requirements cover balanced bidirectional non-connectorized single-mode $1\times N$ and $2\times N$ non-wavelength-selective branching devices for use in an IEC Category O environment (N is the number of output ports), especially but not exclusively used for PON network application. The specifications of unbalanced branching devices are limited to 1×2 and 2×2 devices because they are the most commonly used.

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FIBRE OPTIC INTERCONNECTING DEVICES AND PASSIVE COMPONENTS PERFORMANCE STANDARD –

Part 031-6: Non-connectorized single-mode 1×N and 2×N non-wavelength-selective branching devices (NWBD) for Category O – Uncontrolled environment

1 Scope

This part of IEC 61753 contains the minimum initial tests and measurement requirements and severities which a non-wavelength selective branching device (NWBD) should satisfy in order to be categorized as meeting the requirements of Category 0 (uncontrolled environment) as defined in Annex A of IEC 61753-1.

2 Normative references

The following normative 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 60793-2, *Optical fibres – Part 2: Product specifications – General*

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 61300-2-5, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-5: Tests – Torsion/Twist*

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 61300-2-19, *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 2-19: Tests – Change of temperature*

IEC 61300-2-42, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-19: Tests – Static side load for connectors*

IEC 61300-2-44, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-19: Tests – Flexing of the strain relief of fibre optic devices*

IEC 61300-2-48, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-19: Tests – Temperature-humidity cycling*

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 61300-3-3, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-3: Examinations and measurements – Active monitoring of changes in attenuation and return loss*

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 61300-3-7, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-7: Examinations and measurements – Wavelength dependence of attenuation and 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 61753-021-6, *Fibre optic interconnecting devices and passive components – Performance standard – Part 021-6: Grade B/2 single-mode fibre optic connectors for category O – Uncontrolled environment*

3 Test

All test methods are selected within the IEC 61300 series of standards.

The samples for tests shall be terminated onto single-mode fibres according to Type B1.1 of IEC 60793-2 in either coated fibres (primary and secondary) or reinforced cable format.

All tests shall be carried out to validate performance over the full wavelength range of the optical fibre, namely 1 260 nm to 1 650 nm. However, from an application and laser wavelength point of view, more limited bands can be considered in the test, such as:

1. Spectral bands I:
 - 1 260 nm to 1 360 nm
 - 1 480 nm to 1 500 nm
 - 1 550 nm to 1 560 nm
2. Spectral bands II:
 - 1 615 nm to 1 635 nm (1 625 nm OTDR band)
 - 1 640 nm to 1 660 nm (1 650 nm OTDR band).

Other wavelength ranges may be agreed upon between the customer and the supplier.

4 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.

5 Performance requirements

5.1 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.

5.2 Sample size, sequencing and grouping

Sample sizes for the tests are defined in Annex B and test groups and sequences shall be in sequential order, as shown in Annex B.

5.3 Test details and requirements

Attenuation and return loss performances are given only for non-connectorized branching devices. For connectorized components the connector performances shall be in compliance with IEC 61753-021-6.

During the environmental tests where monitoring of the branching device is needed, all ports of the device shall be controlled.

Table 1 – Test details and requirements

No.	Tests	Requirements					Details
		1xN	2xN	PLC	FBT	PLC	
1	Attenuation (A) IEC 61300-3-7	Configuration					Launch patchcord length: $\geq 2\text{m}$
		Technology					Light source: unpolarized.
		Balanced NWBD					Launch conditions: The wavelength of the source shall be longer than cut-off wavelength of the fibre.
		Spectral Band I	$A [\text{dB}] \leq 0,1 + 3,8 \log_2 N$	$A [\text{dB}] \leq 1,2 + 3,3 \log_2 N$	$A [\text{dB}] \leq 0,4 + 3,6 \log_2 N$	$A [\text{dB}] \leq 1,5 + 3,3 \log_2 N$	Uncertainty: $\pm 0,05 \text{ dB}$ or lower
		Spectral Band I & II	$A [\text{dB}] \leq 4 \log_2 N$	$A [\text{dB}] \leq 1,5 + 3,4 \log_2 N$	$A [\text{dB}] \leq 0,3 + 4 \log_2 N$	$A [\text{dB}] \leq 1,5 + 3,5 \log_2 N$	The measurement should be performed with any combination of input/output and output/input ports. The results should meet the requirements.
		Unbalanced NWBD					See Tables A.1 and A.2 for examples
		Spectral Band I Spectral Band I & II	$A [\text{dB}] \leq 22 - 10,8 \log_{10} P$ where P is the nominal percentage of power associated with one port				Same as above.
2	Uniformity (U) IEC 61300-3-7	Configuration		1xN	2xN		See Table A.3 for example
		Technology					
		Balanced NWBD					
		Spectral Band I	$U [\text{dB}] \leq 0,1 + 0,55 \log_2 N$	$U [\text{dB}] \leq 0,3 \log_2 N$	$U [\text{dB}] \leq 0,4 + 0,55 \log_2 N$	$U [\text{dB}] \leq 0,1 + 0,65 \log_2 N$	
		Spectral Band I & II	$U [\text{dB}] \leq 0,3 + 0,9 \log_2 N$	$U [\text{dB}] \leq 0,65 + 0,2 \log_2 N$	$U [\text{dB}] \leq 0,6 + 0,9 \log_2 N$	$U [\text{dB}] \leq 0,7 + 0,6 \log_2 N$	
		Unbalanced NWBD					
		Spectral Band I Spectral Band I & II	$A [\text{dB}] \leq 22 - 10,8 \log_{10} P$ where P is the nominal percentage of power associated with one port				

Table 1 (continued)

No.	Tests	Requirements	Details
3	Directivity IEC 61300-3-20	≥ 55 dB	Same as in test No. 1 Source type : LD Uncertainty: ± 1 dB or lower. All ports not under test shall be terminated to avoid unwanted reflections contributing to the measurement. The measurement should be made between any pair of input /output ports. NOTE Because of the high cost of this test, the buyer and manufacturer may agree to discard it. However, the potential negative effect of this parameter on system performance must not be neglected.
4	Return loss IEC 61300-3-6	≥ 50 dB Grade U	Same as in Test No. 1 Source type : LD Uncertainty of ± 1 dB or lower All ports not under test shall be terminated to avoid unwanted reflections contributing to the measurement. NOTE Because of the high cost of this test, the buyer and manufacturer may agree to discard it. However, the potential negative effect of this parameter on system performance must not be neglected.
5	Polarization dependent loss IEC 61300-3-2	For balanced branching devices: $\leq 0,2$ dB for $N < 4$ and $\leq 0,3$ dB for $N = 4$ and $\leq 0,4$ dB for $N > 4$ For unbalanced 1x2 and 2x2 branching devices and for both output ports: $\leq 0,7 - 0,25 \log_{10} P$ where P is the nominal percentage of the power associated with one port	Launch patchcord length: ≥ 2 m Source type : LD Uncertainty: $\pm 0,05$ dB or lower The test should be performed for all combinations of input and output ports.
6	Active monitoring of changes in attenuation and return loss IEC 61300-3-3	<u>Requirement 1</u> During the test the attenuation limits of test no. 1 shall be met During and on completion of the test the attenuation of the device shall be within $\pm 0,5$ dB with respect to the initial value Return loss shall satisfy the requirements for the specified class <u>Requirement 2</u> On completion of the test the attenuation limits of test No. 1 shall be met, and the attenuation shall be within $\pm 0,5$ dB of the original value at ambient conditions Return loss shall satisfy the requirements for the specified class	Uncertainty: $\pm 0,05$ dB or lower for attenuation. Uncertainty: ± 1 dB or lower for return loss. Other details: same as in tests No. 1 and 4.

Table 1 (continued)

No.	Tests	Requirements	Details
7	Optical power handling and damage threshold characterization IEC 61300-2-14	P_{max}= 500 mW (+27 dBm) per port only one at the time. Other applications than PON may require lower values of P_{max} to be decided between the customer and the supplier. During the test the attenuation limits of test No. 1 shall be met. Moreover, during and on completion of the test, the attenuation shall be within +/-0,3dB of original value under ambient conditions. After the test the return loss limits of test No. 4 shall be met	Same as test no.1 Test wavelengths: 1 310 nm ± 20 nm, 1 550 nm ± 20 nm, 1 625 nm ± 20 nm. Power increments: 3 dB. Duration of the optical power exposure at the each level: 30 min. Attenuation test: Uncertainty = ± 0,05 dB or lower. Return loss test: Uncertainty = ± 1 dB or lower
8	Damp heat (steady state) IEC 61300-2-19	See requirements 1 on test No. 6	Temperature: +75 °C ± 2 °C. Relative humidity: 90 % ± 5 %. Duration of exposure: 168 h. Length of the cable on each side of the device: >1,5 m. Specimens shall be optically functioning: attenuation and return loss shall be measured before the test, during the test at a maximum interval of 1 h and after the test by means of the monitoring set-ups defined in test No. 6. Preconditioning procedure: Before test, specimens shall be maintained at room temperature for 2 h. Recovery procedure: After test, specimens shall be maintained at room temperature for 2 h.
9	Vibration (sinusoidal) IEC 61300-2-1	See requirements 2 on test No. 6	Frequency range: 10-55 Hz Duration per axis: 2 h Number of axis: 3 orthogonal Number of sweeps (10-55-10 Hz): 12 per axis Rate of change: 1 octave/min Vibration amplitude: 1,52 mm Specimens shall be optically functioning: attenuation and return loss shall be measured before and after the test by means of the monitoring set-ups defined in test No. 6. Method of mounting: the device shall be mounted rigidly to the mounting fixture together with the assembling tray or organizer.

Table 1 (continued)

No.	Tests	Requirements	Details
10	Shock (only in case the device is normally mounted in a shock resistance mounting) IEC 61300-2-9	See requirements 2 on test No. 6	Acceleration forces: 500 g _n 0,125 kg ≤ module mass ≤ 0,225 kg: 200g _n 0,225 kg ≤ module mass ≤ 1kg: 50g _n Nominal 1ms duration, half sine pulse 3 axes in 2 directions, 2 shocks per axis, 12 shocks total Specimens shall be optically functioning: attenuation and return loss shall be measured before and after the test by means of the monitoring set-ups defined in test No. 6.
11	Change of Temperature IEC 61300-2-22	See requirements 1 on test No. 6	High temperature: +75 ± 2 °C Low temperature: -40 ± 2 °C Duration at extreme temperatures: 1 h Temperature rate of change: ≥ 1 °C/min Number of cycles: 10 Specimens shall be optically functioning: attenuation and return loss shall be measured before the test, during the test at a maximum interval of 10 min and after the test by means of the monitoring set-ups defined in test No. 6. Preconditioning procedure: Before test, specimens shall be maintained at room temperature for 2 h Recovery procedure: After test, specimens shall be maintained at room temperature for 2 h
12	Temperature humidity cycling IEC 61300-2-48	See requirements 1 on test No. 6	(Method A) High temperature: +85 ± 2 °C Low temperature: -40 ± 2 °C Relative humidity: 85 % ± 5 % Duration at extreme temperatures: 1 h Temperature rate of change: ≥ 1 °C/min Number of cycles: 42 Specimens shall be optically functioning: attenuation and return loss shall be measured before the test, during the test at a maximum interval of 10 min and after the test by means of the monitoring set-ups defined in test No. 6. Preconditioning procedure: Before test, specimens shall be maintained at room temperature for 2 h. Recovery procedure: After test, specimens shall be maintained at room temperature for 2 h

Table 1 (continued)

No.	Tests	Requirements	Details
13	Flexing of strain relief of fibre optic devices ¹ IEC 61300-2-44	See requirements 2 on test No. 6	5 N for reinforced cable 2 N for secondary and primary coated fibres 30 cycles $\pm 90^\circ$. Specimens shall be optically functioning: attenuation and return loss shall be measured before and after the test by means of the monitoring set-ups defined in test No. 6
14	Torsion/twist ¹ IEC 61300-2-5	See requirements 2 on test No. 6	Magnification and rate of application of the tensile load: 5 N at a speed of 0,1 N/s for reinforced cables. 2 N at a speed of 0,1 N/s for secondary and primary coated fibres. Point of application of the load: 0,2 m from the end of the device. Duration of the test: 10 cycles $\pm 180^\circ$ Specimens shall be optically functioning: attenuation and return loss shall be measured before and after the test by means of the monitoring set-ups defined in test No. 6
15	Static side load ¹ IEC 61300-2-42	See requirements 1 on test No. 6	Magnitude and duration of the tensile load: 5 N for 5 s minimum for reinforced cable. 2,3 N for 5 s minimum for buffered fibre. Point of application of tensile load: 0,3 m from the end of the device and two mutually perpendicular directions as permitted by the product design. Specimens shall be optically functioning: attenuation shall be measured before, during, and after the test while return loss shall be measured before and after the test, by means of the monitoring set-ups defined in test No. 6.

Table 1 (continued)

No.	Tests	Requirements	Details
16	Fibre/cable retention ¹ IEC 61300-2-4	See requirements 1 on test No. 6	Magnitude and rate of application of the tensile load: 10 ± 1 N at a speed of 0,5 N/s for reinforced cable. 5 N ± 0,5 N at a speed of 0,5 N/s for primary and secondary coated fibres. Point of application of tensile load: 0,3 m from the exit point of the fibre/cable from the specimen. Duration of the test (maintaining the load): 120 s at 10 N or 60 s at 5 N. Sampling rate: Losses shall be measured at least once after the load has reached its maximum level and been maintained for a minimum period of 30 s. Method of mounting: The sample shall be rigidly mounted such that the load is only applied to the fibre/cable retention mechanism. Specimens shall be optically functioning: attenuation shall be measured before, during, and after the test; while return loss shall be measured before and after the test, by means of the monitoring set-ups defined in test No. 6
¹ These tests shall be applicable to branching devices that incorporate fibre or fibre cable pigtails in their product design.			

Annex A (informative)

Examples of attenuation requirements of 1 × N and 2 × N branching devices

Table A.1 – Attenuation and uniformity requirements of balanced bidirectional branching devices having the most common port configurations for Class FBT

N	1 × N				2 × N			
	Spectral band I		Spectral band I & II		Spectral band I		Spectral band I & II	
	Amax (dB)	Umax (dB)	Amax (dB)	Umax (dB)	Amax (dB)	Umax (dB)	Amax (dB)	Umax (dB)
2	3,7	0,7	4,0	1,2	4,0	1,0	4,3	1,5
3	5,8	1,0	6,3	1,7	6,1	1,3	6,6	2,0
4	7,3	1,2	8,0	2,1	7,6	1,5	8,3	2,4
6	9,4	1,5	10,3	2,6	9,7	1,8	10,6	2,9
8	10,9	1,8	12,0	3,0	11,2	2,1	12,3	3,3
12	13,0	2,1	14,3	3,5	13,3	2,4	14,6	3,8
16	14,5	2,3	16,0	3,9	14,8	2,6	16,3	4,2
24	16,6	2,6	18,3	4,4	16,9	2,9	18,6	4,7
32	18,1	2,9	20,0	4,8	18,4	3,2	20,3	5,1

Table A.2 – Attenuation and uniformity requirements of balanced bidirectional branching devices having the most common port configurations for Class PLC

N	1 × N				2 × N			
	Spectral band I		Spectral band I & II		Spectral band I		Spectral band I & II	
	Amax (dB)	Umax (dB)	Amax (dB)	Umax (dB)	Amax (dB)	Umax (dB)	Amax (dB)	Umax (dB)
2	4,5	0,3	4,9	0,85	4,8	0,75	5,0	1,3
3	6,4	0,5	6,9	1,1	6,7	1,1	7,0	1,7
4	7,8	0,6	8,3	1,3	8,1	1,4	8,5	1,9
6	9,7	0,8	10,3	1,4	10,0	1,8	10,5	2,3
8	11,1	0,9	11,7	1,6	11,4	2,1	12,0	2,5
12	13,0	1,1	13,7	1,7	13,3	2,4	14,0	2,9
16	14,4	1,2	15,1	1,9	14,7	2,7	15,5	3,1
24	16,3	1,4	17,1	2,0	16,6	3,1	17,5	3,5
32	17,7	1,5	18,5	2,2	18,0	3,4	19,0	3,7