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Fibre optic (non-wavelength selective) branching devices

ITU-T Recommendation L.37

(Previously CCITT Recommendation)

ITU-T L-SERIES RECOMMENDATIONS

CONSTRUCTION, INSTALLATION AND PROTECTION OF CABLES AND OTHER ELEMENTS OF OUTSIDE PLANT

For further details, please refer to ITU-T List of Recommendations.

ITU-T RECOMMENDATION L.37

FIBRE OPTIC (NON-WAVELENGTH SELECTIVE) BRANCHING DEVICES

Summary

This Recommendation describes the main features of fibre optic branching devices, in terms of types, field of application, configurations, principles of operation and technical aspects.

Further, this Recommendation examines the optical, mechanical and environmental characteristics of fibre optic branching devices, advising on general requirements and test methods.

While taking into account Recommendation G.671, as far as the transmission parameters are concerned, this Recommendation is based on the most recent work carried out within IEC 86B Working Groups 4, 6 and 7, namely the future IEC 61753-2-3 and the IEC 61300-series.

Source

ITU-T Recommendation L.37 was prepared by ITU-T Study Group 6 (1997-2000) and was approved under the WTSC Resolution No. 1 procedure on the 9th of October 1998.

FOREWORD

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NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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Recommendation L.37

FIBRE OPTIC (NON-WAVELENGTH SELECTIVE) BRANCHING DEVICES

(Geneva, 1998)

1 Scope

This Recommendation applies to non-wavelength selective branching devices to be used in single mode optical transmission networks and systems.

This Recommendation:

- gives general information on fundamental types of fibre optic branching devices, their field of application and the main requirements about their characteristics in terms of optical, mechanical and environmental behaviour;
- makes a classification of these components in terms of functional configuration used into fibre optic plants;
- gives a general description of the basic principle of operation and of their fabrication technologies;
- describes all the most important optical parameters and gives general specifications on their optical, mechanical and environmental performances;
- describes the main test methods of fibre optic branching devices.

2 Abbreviations and definitions

2.1 Abbreviations

This Recommendation uses the following abbreviations:

A Attenuation

CVD Chemical Vapour Deposition

D Directivity

FBT Fused Biconic Taper

FHD Flame Hydrolysis Deposition

GRIN Graded Refractive Index

IEC International Electrotechnical Commission

ONT Optical Network Termination

ONU Optical Network Unit

ORL Optical Return Loss

OTDR Optical Time Domain Reflectometer

PDL Polarization Dependent Loss

WDM Wavelength Division Multiplexing

2.2 Definitions

This Recommendation defines the following terms.

2.2.1 fibre optic branching device: A passive optical component possessing three or more ports which shares optical power among its ports in a predetermined fashion, without any amplification, switching, or other active modulation. (IEC 875-1, 1.31).

2.2.2 balanced fibre optic branching device: A fibre optic branching device which shares the input optical power uniformly among the output ports.

3 General information

(Fibre optic) branching devices (or splitters) provide a method for splitting optical signals between M input and N output ports; branching devices are required when an optical signal has to be splitted onto two or more fibre lines or when several signals coming from different fibre lines have to be mixed in a single fibre line; in general branching devices are divider/combiner of transit signals.

Branching devices have applications in several distribution and interoffice transmission systems, in fibre optic monitoring systems, and they are also extensively used in fibre optic equipment and instrumentation.

In a point-to-multipoint distribution architecture, a splitter is used to connect the ONT located at the central office to several ONUs located in the outside plant or at the subscriber premises.

In point-to-point interoffice systems, bidirectional transmission using branching devices, requiring one fibre instead of two, may increase the capability of installed cables. In bidirectional transmission two optical signals propagate simultaneously, in opposite directions, along the same fibre.

Branching devices can also be used in remote monitoring systems to convey monitor wavelength, typically in the range of 1600-1650 nm, on the same fibres in service.

In optical equipments, branching devices provide feedback for stabilizing the light source output power, while in OTDRs they are used to launch light onto the fibre under measurement and guide the backscattered light along the optical detector.

4 Types and configurations

Branching devices can be classified as one or more of the following:

a) **star branching devices**: a branching device typically balanced; possessing more than four ports;

b) **tree branching devices**: a branching device having a single optical input distributed among several outputs or vice versa;

c) **taps**: a typical 2x2 or 1x2 branching devices where one of the output ports has a small fraction of the optical power collected by the input port.

Branching devices can be designed to operate at single wavelength (e.g. 1310 or 1550 nm), to be wavelength flat (e.g. insensitive to variations in wavelength within a single window) or to be not wavelength dependent (e.g. insensitive to variations in wavelength within both second and third windows, 1260-1360 nm and 1480-1580 nm).

5 Technological aspects

There are several methods used to manufacture branching components; they may be grouped into the following classes:

a) **Fusion technology**: this technology has proved to be simple, versatile and effective, allowing the industrial implementation of several kinds of branching devices for a lot of applications. In the Fused Biconic Taper (FBT) method, bare or etched fibres are brought into contact, stretched, possibly twisted, and fused so that the evanescent mode coupling takes place along the interaction length.

b) **Planar optics technology**: planar waveguide branching devices are made by photolithographic technology, using parallel processing techniques. To produce the refractive index profile, ions are diffused into a substrate such as glass, semiconductor (silicon), LiNbO3, polymer. Alternatively, doped silica glass is fabricated by Chemical Vapour Deposition (CVD) or by Flame Hydrolysis Deposition (FHD) and consolidation. The optical profile and the geometrical properties of the guiding structure are defined by photolithographic masking techniques followed by etching.

c) **Micro-optic technology**: this technology is based on the use, precise positioning and alignment of miniaturized traditional optical components such as Graded Refractive Index (GRIN) lenses, mirrors, gratings, beam splitters, etc. The branching devices are based on a rather simple concept, but they require a precise mechanical alignment and a careful assembly to assure long-term stability of the performances.

d) **Polishing technology**: in order to put the fibre cores close enough to allow the overlap of the evanescent fields (coupling conditions), the cladding of the fibres is removed to arrive within few microns of the core. This controlled removal of the cladding is obtained by mechanical abrasion (polishing).

6 Characterization parameters

6.1 Optical parameters and performances

Branching Devices are characterized by several parameters, the most important are the following:

– attenuation;

– return loss;

– directivity;

– polarization sensitivity.

These parameters are defined in Recommendation G.671.

6.2 Mechanical and environmental parameters

6.2.1 vibrations: Resistance of the component during the applications of sinusoidal oscillations along three orthogonal axis.

6.2.2 drop: Ability of the component to withstand the impact it could receive when dropped on to a hard surface.

6.2.3 mechanical resistance of the attachment of the fibre/cable to the component housing: It is the resistance of the attachment point of the fibre or cable to the component housing when it is subjected to mechanical stress as pulling and torsion.

6.2.4 operating temperature: It is the range of temperature in which the performances of the devices are guaranteed.

In order to asses the environmental performances, the following tests are recommended:

– cold;
– dry heat;
– damp heat;
– change of temperature.

7 Performance criteria and test methods

The confidence level of performance limit measurements is taken as 95%, unless otherwise mentioned.

The reference documents for all the requirements, the procedure and the test methods are:

– ITU Recommendation G.671 (1996), *Transmission characteristics of passive optical components*.
– IEC Publication 61753-2-3 Ed. 1.0 (work in progress), *Fibre optic interconnecting devices and passive components performance standard – Part 2-3: Non-connectorised single mode 1XN and 2XN non-wavelength selective branching devices for category U-Uncontrolled environment*.
– IEC Publication 61300-series, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures.*

7.1 Mechanical and environmental performances

The minimum mandatory specifications that are required to describe the environmental and mechanical performances of fibre optic branching components are the following.

During and after the mechanical and environmental tests the attenuation should be, depending on the number N of output ports, within $\pm$ 0.3 dB for $N \leq 4$, and within $\pm$ 0.5 dB for $N > 4$.

7.1.1 Vibration (IEC 61300-2-1)

The following details should be considered for the test:

– Frequency range: 10-55 Hz.
– Endurance duration per axis: 0.5 hour.
– Number of axis: three, orthogonal.
– Number of cycles (10-55-10): 15.
– Vibration amplitude: 1.5 mm (peak-to-peak).

7.1.2 Drop (IEC 61300-2-12, method A)

The following details should be considered for the test:

– Number of drops: 5.
– Drop height: 1.5 m.

7.1.3 Fibre/cable pulling (IEC 61300-2-4)

The following details should be considered for the test:

– Pulling force: 50 ± 5 N for reinforced cable; 5 ± 0.5 N for coated fibres (primary and secondary).

– Load rate: 5 N/s for reinforced cables; 0.5 N/s for coated fibres.

– Point of application of the tensile load: 0.3 m from the end of the device.

– Duration of the test: 120 s at 100 N and 60 s at 5 N (maintaining the load).

7.1.4 Torsion (IEC 61300-2-5)

The following details should be considered for the test:

– Tensile load: 15 N at a speed of 1 N/s for reinforced cable; 1 N at a speed of 0.1 N/s for secondary coated fibres.

– Point of application of the tensile load: 0.2 m from the end of the device.

– Duration of the test: 25 cycles (not to exceed cable specifications).

– Rotation: ± 180°.

7.1.5 Operating temperature

The recommended temperature range in which the performances should be guaranteed is from −25° C to +70° C.

7.1.6 Change of temperature (IEC 61300-2-22)

The following details should be considered for the test:

– High temperature: +70° C.

– Low temperature: –25° C.

– Duration at extreme temperature: 1 hour.

– Temperature rate of change: 1° C/min.

– Number of cycles: 12.

– Preconditioning and recovery: 2 hours in room temperature condition.

7.1.7 Cold (IEC 61300-2-17)

The following details should be considered for the test:

– Temperature: –25° C.

– Duration: 16 hours.

– Preconditioning and recovery: 2 hours in room temperature condition.

7.1.8 Dry heat (IEC 61300-2-18)

The following details should be considered for the test:

– Temperature: +70° C.

– Duration: 96 hours.

– Preconditioning and recovery: 2 hours in room temperature condition.

7.1.9 Damp heat (IEC 61300-2-19)

The following details should be considered for the test:

– Temperature: +40° C.

– Relative humidity: 93 ± 2%.

– Duration: 96 hours.

– Preconditioning and recovery: 2 hours in room temperature condition.

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