INTERNATIONAL TELECOMMUNICATION UNION

ITU-T

G.654

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

(03/93)

TRANSMISSION MEDIA CHARACTERISTICS

CHARACTERISTICS OF A 1550 nm WAVELENGTH LOSS-MINIMIZED SINGLE-MODE OPTICAL FIBRE CABLE

ITU-T Recommendation G.654

(Previously "CCITT Recommendation")

FOREWORD

The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of the International Telecommunication Union. The ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Conference (WTSC), which meets every four years, established the topics for study by the ITU-T Study Groups which, in their turn, produce Recommendations on these topics.

ITU-T Recommendation G.654 was revised by the ITU-T Study Group XV (1988-1993) and was approved by the WTSC (Helsinki, March 1-12, 1993).

NOTES

1 As a consequence of a reform process within the International Telecommunication Union (ITU), the CCITT ceased to exist as of 28 February 1993. In its place, the ITU Telecommunication Standardization Sector (ITU-T) was created as of 1 March 1993. Similarly, in this reform process, the CCIR and the IFRB have been replaced by the Radiocommunication Sector.

In order not to delay publication of this Recommendation, no change has been made in the text to references containing the acronyms "CCITT, CCIR or IFRB" or their associated entities such as Plenary Assembly, Secretariat, etc. Future editions of this Recommendation will contain the proper terminology related to the new ITU structure.

2 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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CHARACTERISTICS OF A 1550 nm WAVELENGTH LOSS-MINIMIZED SINGLE-MODE OPTICAL FIBRE CABLE

(Melbourne, 1988; amended at Helsinki, 1993)

The CCITT,

considering

(a) that very low loss fibres are required in some telecommunication network applications;

(b) that the foreseen potential applications may require several kinds of single-mode fibres differing in:

- geometrical characteristics;
- operation wavelength;
- attenuation, dispersion and other optical characteristics;

(c) that Recommendations on different kinds of single-mode fibres can be prepared when practical use studies have sufficiently progressed,

recommends

a single-mode fibre which has the zero dispersion wavelength in the 1310 nm wavelength region which is loss minimized at a wavelength around 1550 nm and which is designed for use in this region.

The geometrical, optical, transmission and mechanical characteristics of this fibre are described below.

- The meaning of the terms used in this Recommendation and the guidelines to be followed in the measurements to verify the various characteristics are given in Recommendation G.650. The characteristics of this fibre, including the definitions of the relevant parameters, their test methods and relevant values, will be refined as studies and experience progress.
- The definitions contained in 1/G.650 are in principle applicable also to loss-minimized fibre.
- The present experience on loss-minimized single-mode fibres is rather limited, therefore, further study is needed on some definitions and references, and alternative test methods for this type of fibre. Nevertheless, most of the test methods described in 2/G.650 are in principle applicable also to loss-minimized fibres; the specifics of each test procedure need further study. It should be noted that the working wavelength for G.654 fibres is in the 1550 nm region.

NOTE – The characteristics of this fibre and the relevant values will be verified as studies and experience progress.

1 Fibre characteristics

1.1 Mode field diameter

The nominal value of the mode field diameter at 1550 nm shall be 10.5 µm[1]. The mode field diameter deviation should not exceed the limits of ±10% of the nominal value.

1.2 Cladding diameter

The recommended nominal value of the cladding diameter is 125 µm. The cladding deviation should not exceed the limits of ±2 µm.

1.3 Mode field concentricity error

The recommended mode field concentricity error at 1550 nm should not exceed 1 µm.

1.4 Non-circularity

1.4.1 Mode field non-circulatory

In practice, the mode field non-circularity of fibres having nominally circular mode fields is found to be sufficiently low that propagation and jointing are not affected. It is therefore not considered necessary to recommend a particular value for the mode field non-circularity. It is not normally necessary to measure the mode field non-circularity for acceptance purposes.

1.4.2 Cladding non-circularity

The cladding non-circularity should be less than 2%. For some particular jointing techniques and joint loss requirements, other tolerances may be appropriate.

1.5 Cut-off wavelength

The cut-off wavelength values shall be between 1350 nm[1] and 1600 nm[1] for λ_c, and smaller than 1530 nm for λ_{cc}.

1.6 1550 nm bend loss performance

Under study.

NOTE – The performance of this fibre should not be worse than fibre designed to meet Recommendation G.652.

1.7 Material properties of the fibre

This is given in 1.7/G.652.

1.8 Longitudinal uniformity

Under study.

2 Factory length specifications

2.1 Attenuation coefficient

Optical fibre cables covered by this Recommendation shall have an attenuation coefficient in the 1550 nm region below 0.22 dB/km.

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[1] Under study.

NOTE – The lowest values depend on fabrication process, fibre composition and design, and cable design. Values of 0.15 to 0.19 dB/km in the 1550 nm region have been achieved.

2.2 Chromatic dispersion coefficient

The maximum chromatic dispersion coefficient and the maximum dispersion-slope at 1550 nm in single-mode fibres covered in this Recommendation shall be 20 ps/(nm•km) and 0.06 ps/(nm^2•km), respectively.

3 Elementary cable sections

An elementary cable section usually includes a number of spliced factory lengths. The requirements for factory lengths are given in 2. The transmission parameters for elementary cable sections must take into account not only the performance of the individual cable lengths, but also, amongst other factors, such things as splice losses and connector losses (if applicable).

In addition, the transmission characteristics of the factory length fibres as well as such items as splices and connectors, etc. will all have a certain probability distribution which often needs to be taken into account if the most economic designs are to be obtained. The following sub-paragraphs in this section should be read with this statistical nature of the various parameters in mind.

3.1 Attenuation

The attenuation A of an elementary cable section is given by:

$$A = \sum_{n=1}^{m} \alpha_n \cdot L_n + \alpha_s \cdot \chi + \alpha_c \cdot y$$

where

α_n is the attenuation coefficient of nth fibre in elementary cable section;

L_n is the length of nth fibre;

m is the total number of concatenated fibres in elementary cable section;

α_s is the mean splice loss;

χ is the number of splices in elementary cable section;

α_c is the mean loss of line connectors;

y is the number of line connectors in elementary cable section (if provided).

A suitable allowance should be allocated for a suitable cable margin for future modifications of cable configurations (additional splices, extra cable lengths, ageing effects, temperature variations, etc.).

The above expression does not include the loss of equipment connectors.

The mean loss is used for the loss of splices and connectors. The attenuation budget used in designing an actual system should account for the statistical variations in these parameters.

3.2 Chromatic dispersion

The chromatic dispersion in ps can be calculated from the chromatic dispersion coefficients of the factory lengths, assuming a linear dependence on length, and with due regard for the signs of the coefficients and system source characteristics (see 2.2).