UDC 621.37/39(075.8)

REFLECTOMETER WITH SPECTRAL SEPARATION OF SIGNALS

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The characteristics of a reflectometer with spectral separation of the signal are studied. The measurements and parameters of the optical fiber in the operating wavelength range of 1550 nm are analyzed. The perspective of the use of the study results in telecommunication systems for servicing fiber optic communication lines is considered.

The relevance of the study is explained by the need to improve the quality of fiber optic transmission systems in response to the increased data transmission traffic and lack of optical fibers in the fiber optic backbone network.

When measured with a spectrometric reflectometer, the main parameters of the optical fibers that affect the signal transmission are evaluated:

1. Attenuation of the optical fiber.

The attenuation coefficient is a = aa + ad + aat + ac + ai, where

aa и ad are attenuation coefficients, caused by losses in the absorption and dissipation of light energy;

aat is attenuation coefficient, caused by impurities in the optical fiber;

ac is additional (cable) losses, caused by twisting, deformation and bending of the optical fiber;

ai is loss of infrared absorption.

Losses in optical fiber occur due to the two processes of absorption and scattering. Absorption is determined by the properties of quartz, which is the main material for the manufacture of high-quality optical fibers. Scattering is highly dependent on the wavelength as well as manufacturing technology and composition of optical fiber.

In measurements, a reflectometer with spectral separation is easily defined by macro-bends (fiber bends with a radius less than the minimum allowable radius). In this case, additional losses occur, significantly affecting the total attenuation of the optical line.

With a change in the operating wavelength, attenuation in the cable in dB/km changes (table 1), which causes a change in the reflectogram angle.

When comparing losses at three wavelengths of 1310 nm, 1490 nm, and 1550 nm, macro-bends give greater attenuation at a longer wavelength. 1550 nm macro-bends are best defined.

The difference is particularly noticeable for multimode fibers.

Table 1. – Attenuation measurement

Wavelength	Requirements G.652.D, type A	Requirements G.652.D, type B	Requirements G.652.D, type C
1310 нм	≤ 0.34	≤ 0.33	≤ 0.35
1550 нм	≤ 0.21	≤ 0.19	≤ 0.21
1625 нм	≤ 0.24	≤ 0.22	≤ 0.23

2. Dispersion and bandwidth of the optical fiber.

The dispersion results both in limiting the transmission bandwidth over the cable and in reducing the length of the regeneration section.

When light travels through an optical fiber there are significant limitations. The signal at the receiving end is blurred and distorted, and the longer the line, the more distorted the transmitted signal is.

The parameters of frequency band ΔF and transmission distance L are interdependent.

The ratio between them for short lines is

$$\Delta F / \Delta F_x = L_x / L$$

where values with index x are required, without it are specified.

In long lines, in which the process has already been established the following quadratic law of the ratio applies:

$$\Delta F / \Delta Fx = \sqrt{Lx} / L$$

3. The propagation coefficient, the transmission speed of optical fiber, and wave resistance depend on the fiber length. The greater the length of the fiber, the worse the signal is to noise ratio. The ratio of the average optical radiation power of the signal to the average optical radiation power of the noise in the frequency band of the optical channel is expressed in dB.

Optical signal to optical noise ratio is one of the most important characteristics of fiber optic communication lines, determining the quality of information transmission, maximum transmission distance, the stability of the signal.

It has been found that the reflectometer signal level is more than 29 dB; the spectra of adjacent channels expand to a critical level of more than 0.8 nm. When the power is less than 29 dBm the traffic quality does not deteriorate, and the power of the backscattered radiation meets the specified value.

Studies have shown that the reflectometry method with frequency division by wavelength provides measurement accuracy of more than 99%, allows to quickly determine the location of fiber damage, performs quality control during emergency operations, monitors unauthorized access to the fiber optical highway.

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