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CHARACTERISTICS OF FIBER-OPTIC COMMUNICATION SYSTEM RECEIVERS

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This article discusses fiber-optic receivers used in fiber-optic communication systems. Their characteristics are considered. The reasons for errors are analyzed.

The main task of the optical receiver is to convert the modulated light stream coming from the optical fiber into a copy of the original electrical signal sent to the transmitter. As a detector, the receiver usually uses a PIN or avalanche photodiode, which is mounted on an optical connector (similar to that used for light sources). Photodiodes usually have a fairly large sensor element (a few micrometers in diameter), so the requirements for positioning the optical fiber are not as strict as for transmitters. The intensity of the radiation coming out of the optical fiber is quite small, and high-gain internal amplifiers are installed in the optical receivers. Therefore, it is important to use receivers only with the fiber size for which they are intended, otherwise there may be an overload of the amplifier [1].

Recently, various new modulation formats have been intensively studied in scientific laboratories. Receivers for such systems have a more complex structure, but they are part of the receivers of binary amplitude-modulated signals.

The most important performance characteristic of the current information transmission system that determines the communication quality is the error rate. The error coefficient is determined by the formula:

$$K_{er} = N_{er}/N, \quad (1)$$

where N is the total number of characters transmitted over the measurement interval; N_{er} – the number of characters received incorrectly over the measurement interval.

The reason for errors is the presence of noise. Indeed, in real communication systems, the photocurrent values corresponding to both 1 and 0 fluctuate over time due to the presence of noise. Such temporary current fluctuations can lead to erroneous interpretation of the information symbol.

The nature of errors in binary digital communication systems with amplitude modulation is explained in Fig. 1.

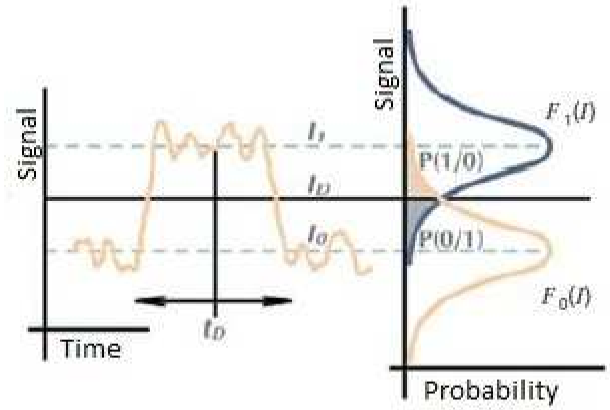

Figure 1. – Electrical information signal with noise at the input of the comparison circuit, zero level I_0, unit level I_1, comparison level I_D, clock duration t_D (left) and probability distributions of the measured signal current values for 1 and 0 (right). The shaded areas show error probabilities: P (1/0) – the probability of interpreting 0 as 1; P (0/1) – the probability of interpreting 1 as 0

Due to the presence of noise, the measured current value differs from its exact value. The spread of measured current values when transferring logical 1 and 0 is described by the corresponding functions F1(I) and F0(I) of the probability distribution. On the right (Fig.1) the graphs of functions F1(I) and F0(I) are shown as upper and lower curves, respectively. As you can see from the figure, the graphs of these functions intersect the line corresponding to the I_D comparison voltage level. This means that there is some probability of an incorrect interpretation of the received signal. Such probability is usually very small, but different from 0. The probability P (1/0) of an erroneous interpretation of 0 as 1 is determined by the area under the part of the distribution function F0(I) cut off by the I_D comparison level. Similarly, the probability P (0/1) of an erroneous interpretation of 1 as 0 is determined by the area under the part of the distribution function F1(I) that is cut off by the I_D comparison level.

If the transmission probability is equal to 0 and 1, the error coefficient is determined by a simple expression:

$$K_{er} = 1 / 2 (P (1/0) + P (0/1)), \quad (2)$$

Under the assumption of a Gaussian noise distribution with zero average intensity values and standard deviations σ1, σ2 for 1 and 0, respectively, the error coefficient is determined by the expression:

$$K_{er}(Q) = \frac{1}{\sqrt{2\pi}} \int_{Q}^{\infty} dx \exp(-\frac{x^2}{2}) = \frac{1}{2} erfc(\frac{Q}{\sqrt{2}}), \quad (3)$$

Where $Q = \frac{I1 - I2}{\sigma 1 + \sigma 2}$ is an indicator of the quality of the received signal [2].

REFERENCES

1. Оптоволоконные линии связи [Electronic resource]. – Электронные данные. – Mode of access: https://www.avclub.pro. – Date of access: 13.01.2020.
2. Убайдуллаев Р.Р. Протяженные ВОЛС на основе EDFA. Lightwave Russian Edition, № 1, 2003, с. 22–28.