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ANALYSIS OF ACOUSTIC-OPTIC-FIBRE CHANNEL LEAKAGE IN FIBRE-OPTIC COMMUNICATION LINES

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The paper considers the model of fibre-optic communication lines. The experiment has shown the greatest influence of acoustic signal on the optical signal in the optical fibre passes. Physical principles of formation of leakage channels in fibre cable are described. Modulation types peculiar to the optical signal under the influence of an external acoustic source are listed.

Introduction. Currently, the protection of speech information during the confidential negotiations is an urgent problem. Fibre-optic lines are widely used in information communication systems, as they have a number of advantages over cable lines: data transmission speed, anti-leakage electromagnetic field, etc. Thus, the fibre-optic cable laid in the room can be subjected to acoustic impact, which leads to information leakage channels. The principle of functioning of a leakage channel is described by L.Glushchenko [1], which explains that the light beam is modulated by the fibre under the action of bending vibrations generated by an external acoustic field, i.e., voice information carrier.

If a fibre-optic cable can create a channel of information leakage, then analyzing its characteristics can help to choose ways to protect the link from the removal of confidential information. And determining which of the optical signal transmission parameters are the most informative, you can find the right kind of fibre protection.

Description of experimental models. It is known that fibre-optic communication line is a type of communication in which information is transmitted through the optical fibre. The optical fibre is a thin glass strand (about 125 mm diameter) made of quartz. Therefore, to construct a working model of fibre-optic communication lines, you need an optical fibre, the receiver and the transmitter radiation, and an acoustic system. Figure 1 shows a model of fibre optic data transmission.

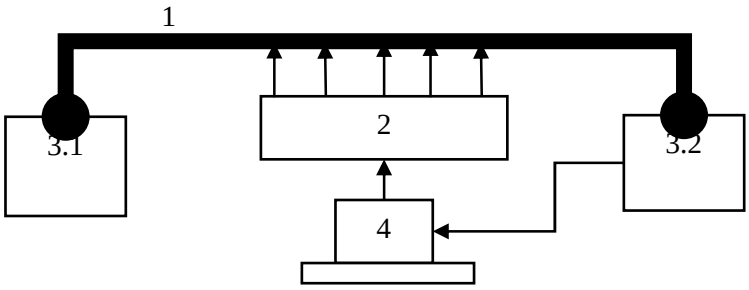

Fig. 1. Model of fibre optic data transmission:
1 - optical fiber; 2 - speaker system; 3.1 - multi tester optical emitter;
3.2 - multi tester optical receiver; 4 - PC.

The experiment was carried out with the help of G652 single-mode model of fibre optic data transmission, two optical multi testers capable of changing the luminous flux of the radiation wavelength and frequency modulation. Also, for the simulation of the acoustic signal as the source of confidential information, the computer has a sound generator that plays a constant level of the acoustic signal through the speaker system. Sound generator can adjust the frequency and type of signal as well as audio output. Since selecting an external signal and its influence analysis were not the goal of the experiment, the acoustic signal frequency and power were constant: f_{SS} = 1072 Hz, P_{SS} = 1 W.

We used two types of external influence: sinusoidal and noise acoustic signal, so it was monitored whether the output signal depends on the type of bearing information, and whether it can be overlapped by the noise component. All output data are recorded on the computer via the USB-connection and a special application connected to multi tester.

Results. The basic physical principles of leakage channels formation can be divided into the following types [2]:

1. Violation of the total internal reflection;

2. Registration of the scattered radiation at the wavelengths of the main flow of information, and the combination frequencies;

3. Parametric methods for recording the transmitted radiation.

Analysis of fibre-optic communication cable flexing showed similarity with the characteristics of the window glass under the influence of micro vibrations. The article [3] shows that the glass is exposed to three types of modulation (amplitude, frequency and phase), so an optical signal flowing in the fibre is subjected to the same modulation. However, there are a pulse modulation and polarization characteristic of fibre under certain physical principles, such as photo elasticity, acoustic-optical, magneto-optical, electro-optical, piezoelectric effects, and the modulation of absorption [4].

Since it is recommended to use wavelength equal to 1550 nm in single-mode fibre, this kind of fibre was used in the experiment. The results, shown in the graph (Fig. 2), were obtained when checking some well-known physical principles affecting acoustic-fibre channel leakage.

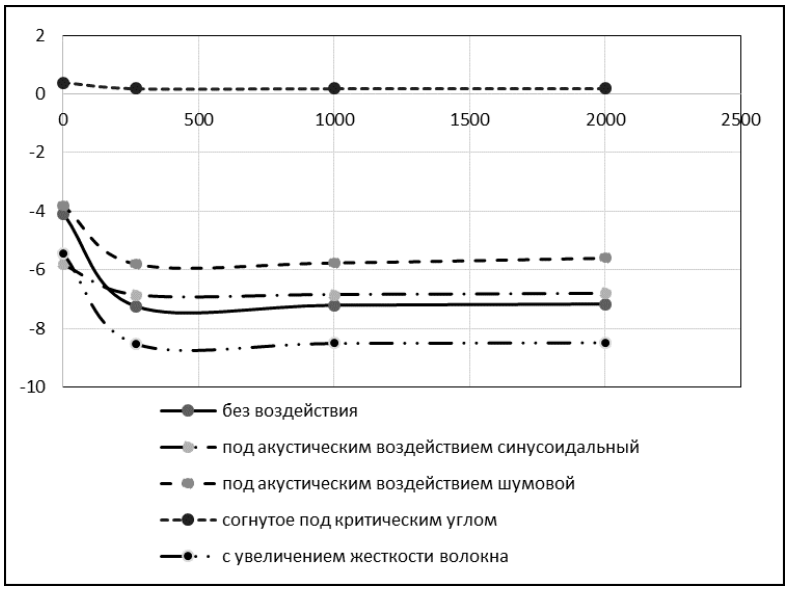

Fig.2. Graph of ratio of output power from the modulated frequency

The graph shows that the fibre is sensitive to an external acoustic field, especially in the state of the transmission line folded to a critical angle. Increasing the stiffness curve is more similar to the original, but the deformation bend is greater, so confidential information leakage is possible from a fiber optic cable stretched in the room. Types of acoustic signal show clearly that the noise acoustic signal is stronger than sinusoidal signal. This suggests that it is possible to conceal confidential negotiations acoustic noise near the laid fibre, but this option is not very convenient to use, therefore, it is necessary to protect it from optical fiber bending vibrations, rather than the acoustic source.

Conclusion. Having analysed the acoustic-optical fibre channel of information leakage it can be stated that fibre defence is a difficult task, since it is exposed to different types of acoustic signals and receives all micro fluctuations, however, not all equipment can catch them. Total internal reflection at the bend of the fibre influences confidential information leakage sufficiently. Thus, the analysis showed that the main purpose is to protect the fibre with increased rigidity because it carries the most informative signal by an external acoustic field.

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