ANNOTATION

Thesis work by Yusupova Gulbakhar Madreimovna on the topic:
"Development of Bragg fiber grids for use in telecommunication systems", presented for the Ph.D. in PhD degree in specialty
6D071900 - "Radio engineering, electronics and telecommunications"

Relevance of the topic. In modern conditions it is necessary to ensure reliable and high-quality functioning of a complex of interconnected information, computer and telecommunication technologies. The modern main medium of data transmission at medium and long distances of telecommunications has become optical fiber. Due to its unique transmission properties, immunity to interference and security, and relatively affordable price, in exchange for strength and resistance to aging, it has been used in many areas of life. On the way to fast and without loss of data exchange over optical fiber, there are a number of difficulties. These include: attenuation, absorption, linear and nonlinear scattering, and the basic limit for increasing the fiber bandwidth, which relate to the dispersion

Bragg fiber gratings are currently one of the basic elements in various fiber optics devices. In particular, they are widely used in fiber-optic communication systems, as well as in fiber lasers, sensor systems. Their demand is due to unique optical (narrow spectrum of reflection) and operational (small optical losses, dimensions and weight) characteristics.

Fiber Bragg gratings have unique properties and simple filtering elements of fiber communication links, so they have found many applications and are becoming more common in transmission technology. Studies that have been done in recent years have made it possible to effectively apply the Bragg fiber grating in the telecommunications industry to compensate for variance.

Taking into account the above, the topic of this paper, devoted to improving and increasing the possibility of transmission and switching by controlling the optical signal, taking into account the principle of operation and properties of the transmission medium based on Bragg fiber grids, is topical

The aim of the thesis is to increase the operational characteristics of fiber-optic telecommunication systems based on research and optimization of design properties and modes of transmission of Bragg fiber grids.

- To achieve this goal, it was necessary to solve the following tasks:
- Present and analyze the emergence of the phenomenon of modal dispersion, chromatic dispersion and polarization in fiber-optic networks;
- to compare the methods of compensation, alignment of chromatic dispersion with the help of a special fiber design based on modern, proven methods of growing chromatic dispersion compensation using the Bragg grating;

The object o f the study The object of the study are Bragg fiber-optic gratings.

develop a mathematical model of Bragg fiber grids and calculate the optimal properties of Bragg grids using the constructed model;

- to improve the method of increasing the switching speed of fiber Bragg gratings based on thermal control.

The subject of the study are the performance characteristics associated with the structural properties of Bragg grids

The scientific novelty of the work is as follows:

A method for modeling Bragg gratings based on the appropriate choice of grid parameters that provide dispersion compensation is proposed;

- the influence of the apodization parameters of the fiber Bragg gratings on the characteristics of the dispersion compensator based on fiber Bragg gratings is revealed;

- the use of the combination of regimes for quantitative information on diffraction efficiency and its influence on the spectral characteristics of Bragg gratings is scientifically justified, on the basis of which their optimal regimes for maximum values of reflectivity and dispersion were obtained.

- the possibility of improving the method for increasing the switching speed of fiber Bragg gratings based on thermal control is proved, and the required values for the nanosecond range are obtained.

Methods of research. During the research, classical and special methods of the theory of signals were applied. Verification and modeling of the transmission of light signals in fiber-optic communication lines. The experiments and mathematical processing of the experimental data, the theoretical results obtained during the work, were carried out in the Matlab environment

Approbation of work. On the topic of the thesis 16 publications were published, including 5 articles in scientific publications recommended by the Committee for Control in Education and Science of the Ministry of Education and Science of the Republic of Kazakhstan; 4 articles - in the log, included in the Scopus database, 7 papers - in the materials of international conferences, 4 of which are included in the Scopus database

Structure and scope of the dissertation. The thesis consists of an introduction, four chapters, a conclusion, an appendix, a bibliographic list of used literature.

In the introduction, the relevance is revealed, the problems associated with the topic under study are specified. The idea of work, the purpose and objectives of the research, the scientific novelty and practical value of the work, the methods of research are given.

In the first chapter, the design features and principles of the transmission of optical fibers, which are the basis of fiber-optic communication lines and used in modern telecommunication systems, are considered. A formula is given for calculating the NA NA fiber, which is the main indicator describing data transmission by an optical fiber. It is shown that the variable speed of propagation modes is the main obstacle to the transmission of information of this type of medium. Attempts to

eliminate different propagation time modes may distort the transmitted light pulses by which the information is encoded. As a result, this can lead to a superposition of pulses, which will lead to a change in the logic of the transmitted signal, i. E. To the effect in an optical fiber is called modal dispersion. Based on the analysis carried out, the goal of the dissertation research and tasks

The second chapter is devoted to the analysis of the chosen methods of dispersion compensation. The distortions and difficulties in signal transmission in fiber-optic lines have been investigated in more detail and the main way to eliminate the effect of chromatic dispersion is the use of a special design with modified fiber dispersion characteristics and filter frequency, called Bragg gratings. The principle of operation and properties of Bragg fiber-optic gratings with an analytical description of the reflectivity of a grid in the form of a function of the length and a grid of wavelengths is considered. In the section given, also the rationale and description of the matrix transition method of the theory of coupled modes with the introduction of two mesh counters, for the propagation of a wave in the core of an optical fiber for modeling the Bragg fiber-optic gratings. Using the transition matrix (TMM) method, the dependence of the spectral reflectivity of the Bragg gratings on the lattice length and on the local changes in the refractive index of the fiber core is shown. The purpose of the dissertation research and tasks was formulated

In the third chapter, the technique of combining regimes for obtaining quantitative information on diffraction efficiency and its effect on the spectral characteristics of Bragg gratings is applied. The results of the mathematical analysis of the propagation of light in the structure of the Bragg grating fiber clearly indicate the possibility of expanding the control values of the time pulses. The results show that it is possible to accurately control the dispersion shells in the fiber optic line by appropriately selecting the apodization parameters of the fiber Bragg gratings. Calculations and MATLAB model networks were used to analyze methods for compensating chromatic dispersion using Bragg gratings. It was shown that under certain conditions for creating Bragg gratings, it is possible to control the time of pulse expansion after passing through the optical fiber on which the network is located. It is also shown that the best settings for the grating and the optimal settings for the profile apodization parameter improve the compensation properties of the Bragg diffraction grating apodized by the sine profile, rather than the Gaussian profile.

The fourth chapter is devoted to a special fiber design with the ability to electrically control the light propagating in the lightguide. The Bragg gratings recorded in such fibers are an excellent tool to monitor the development of refraction in a crystal that is tested by light during polarization in parallel and perpendicular to the direction of the crystal aperture. In this chapter, two lengths of 4-cm Hemming-apodized FBGs, recorded in fibers with additional apertures with internal electrodes, are described, nanosecond high current pulses are called, which cause matrices of quasi-instantaneous expansion of the matrix of metal electrodes. An increase in the

birefringence of the fiber and full on-off, and switching-off switching on the tested gratings with a response time of -29 ns is shown. Numerical simulation is performed, which confirms the experimental results. A temperature dependence of the characteristics of the crystal lattice without electrical excitation pulses of the crystal was also obtained.

In conclusion, the main results and conclusions of the dissertation work are reflected.

18 publications were published on the topic of the thesis:

1. Yusupova G.M. "Connection of optical fibers to the cable transmission path" magazine KUPS "Industrial Transport", Almaty, 2014. №2, page 70.
2. Yusupova G.M. "The quality and range of telecommunications systems for computer networks on fiber-optic communication lines" magazine KUPS "Industrial Transport", Almaty, 2014, No. 1, page 71.
3. Yusupova G.M "Switching the railroad" owu Rail, Almaty, 2014 ж.
4. Yusupova G.M. "Subscriber access in multiservice networks" textbook, Almaty 2014 ж.
5. Yusupova G M., Kemelbekov B.Zh., Turebekova A.Zh. "Processing of the results of OTDR reflectometric measurements on a personal computer" magazine KUPS "Industrial Transport of Kazakhstan" Almaty, 2015, No. 2
6. Yusupova GM, Kemelbekov B.Zh., Turebekova A.Zh. "Experimental research and mathematical modeling of scattering and reflection effects in an optical cable" magazine KUPS "Industrial Transport of Kazakhstan" Almaty, 2015, No.
7. Yusupova G.M., Kemelbekov B.Zh., Tileu A. "Experimental Investigations of the Effect of Deformations on the Transmission of a Fiber and a Fiber Splitter" magazine KUPS "Industrial Transport of Kazakhstan" Almaty, 2016 No. 1№1, p. 107 -111.
8. Yusupova G.M., Balgabekova L.O., Sadikova G.S. "Analysis of Probabilistic Characteristics of Network Traffic", an article of the International Scientific and Practical Conference dedicated to the 80th anniversary of Doctor of Technical Sciences, Professor, Academician of the Engineering Academy of the Republic of Kazakhstan, International Transport Academy, International Academy of Informatization AM Muratova. "Industrial and Innovative Development of the Transport and Communication Complex" Almaty, 2014.
9. Yusupova G.M., Kasimov A.O., Kusambaeva N.Sh. "Analysis of Probabilistic Characteristics of Network Traffic", an article of the International Scientific and Practical Conference dedicated to the 80th anniversary of Doctor of Technical Sciences, Professor, Academician of the Enginee ring Academy of the Republic of Kazakhstan, International Transport Academy, International Academy of Informatization AM Muratova. "Industrial and Innovative Development of the Transport and Communication Complex" Almaty, 2014.
10. Yusupova G.M., Utepbergenov I.T., Kasimov A.O., Kusambaeva N.Sh. "The influence on the of stretching phanthers during the operation of the FOC.".

Scientific and reliability Technical Conference "Satpayev Readings" Almaty KazNTU named after. K.Satpayev, 201531.

11. Piotr Kisala, Waldemar Wojcik., Yussupova G. "Tworzenie chirpu stefowego w FBR jako sposob na uzyskanie z funkcyjnosci czujnika". International scientific and technical conference dedicated to the 75th birthday of the professor, academician Amangeldy Dzhumagalievich Omarov. Almaty, 2016, 133-136 pages.

12. Yusupova G.M, Daraev A.M, Nautieva Zh.I. "Optimization of transient processes of electric drive of solar photovoltaic station". International scientific and technical conference dedicated to the 75th birthday of the professor, academician Amangeldy Dzhumagalievich Omarov. Almaty, 2016, p.125-127.

13. Waldemar Wojcik, Piotr Kisala, Nazym Kussambayeva, Gulzhan Kashaganova, Damian Harasim, Yussupova G. Analysis of the Possibilities for Using a Uniform Bragg Grating in a Tunable Dispersion Compensator. (Scopus) Intl journal of electronics and telecommunications, 2015, Vol. 61, No. 4, pp. 381-387. Manuscript received October 15, 2015 revised December, 2015. Doi: 10.2478/eletel-2015-50.

14. Ronald Rovira, Marcia M. Bayas, Sergii V.Pavlov, Tatiana I. Kozlovskaya, Piotr Kisala, Ryszard S. Romaniuk. Yussupova G. Application of a modified evolutionary algorithm for the optimization of data acquisition to improve the accuracy of a video-polarimetric system. (Scopus) Proceeding of spie – the international society for optical engineering, 2015 Vol. 9816, optical fibers and their applications 2015, 981619 (22-25 September 2015); doi: 10.1117/12.2229087.

15. Andres J. Utreras, Hennadii L. Licenko, Piotr Kisala, Ryszard S. Romaniuk. Yussupova G. Optical switching technologies: problems and proposed solution Proceeding of spie – the international society for optical engineering, 2015Vol. 9816., optical fibers and their applications 2015, 98161D.

16. Oleg V. Bisikalo, Slawomir Cieszczyk., Yussupova G Solving problems on base of concepts formalization of language image and figurative meaning of the natural-language constructs. Proceeding of spie – the international society for optical engineering, 2015Vol. 9816, optical fibers and their applications 2015, 98161U.

17. Domian Harasim., Yussupova G. Improvement of FBG peak wavelength demodulation using digital signal processing algorithms. From Conference Volume 9662 Photonics Applications in Astronomy, Communications, Industry, and High-Energy Physics Experiments 2015Wilga, Poland | May 25, 2015

18. Toigozhinova A.,Yussupova G. Mathematical modeling of processes in the zone of corona discharge ionization. Lubelskie Dni Nauki i Biznesu. Pod patronatem honorowym. Polskiego stowarzyszenia tomografii procesowej I Komitetu elektrotechniki polskiej akademii nauk. Warsztaty doktoranckie. WD2016. Science conference. Lublin. 11 – 13 Czerwca 2016. p.219-220.