Influence of Optical Signal Self-Phase Modulation on a Channels Quality of DWDM System

Olga Reshetnikova

Abstract - **The problem of optical signal's self-phase modulation influence estimation on the optical channels quality in the system with a spectral channeling is considered. The simulation model of one DWDM system channel is constructed in the MatLab environment taking into account the amplified spontaneous emission noise of optical amplifiers as well as linear and nonlinear distortions in optical fibre. Comparison of the obtained results with the similar researches in this domain of science is performed.**

Keywords – **DWDM, Fiber Optic Transmission system (FOTS), SPM, SSFM, Q-factor.**

I. Introduction

Application of DWDM systems allows to raise efficiency of optical fibres (OF) use and to reduce the cost price of a telecommunication service. It is necessary to raise signal's power in the transmitter output in order to increase the signal's immunity at the input of a decision-making scheme in the receiving path. Increasing of the nonlinear distortions power leads to an intersymbol and interchannel interference. Therefore the problem of taking into account the OF nonlinear distortions within the calculation of quality parameters for optical channels is actual. In the majority of publications only the four-wave mixing [1] and the optical amplifier noise [2] is considered during the calculation of optical channel (OC) error probability. However it is necessary to consider also the self-phase modulation (SPM), leading to form distortion of the output signal impulses and OC quality parameters degradation, in calculations. Therefore purpose of the given work is the evaluation of optical signal SPM influence on the OC quality parameters of DWDM system.

II. THE SIMULATION MODEL

The simulation model of the one DWDM FOTS channel is constructed in the MatLab environment for the task solution including the OC transmitter and receiver, and also N identical optical sections. The known Shredinger nonlinear equation [4] is used in a basis of fibres models

$$j\frac{\partial A}{\partial z} = -\frac{j\alpha}{2}A + \frac{\beta_2}{2}\frac{\partial^2 A}{\partial t^2} - \gamma|A|^2 A\,, \qquad (1)$$

where A (z, t) – intensity of optical signal electric field at distance z from the transmitter at the moment of time t; α and β_2 – attenuation factor and the second derivative of distribution factor $\beta(\omega)$ for fibres at emission wavelength; γ – nonlinearity factor of OF.

Method of the Shredinger equation solution is the known Split Step Fourier Method [3]. Its essence consists in OF with a length L splitting on N conditional pieces of identical length. In each of them dispersion and nonlinear effects modeling is performed in three stages. The main criterion of DWDM system OC quality is the error probability which is connected with the Q-factor. Dependence of the Q-factor on transmitter signal's peak power that allows of draw a conclusion on existence of input power optimum value at which maximum Q is obtained. At low power of a transmitter signal the signal/noise relation on a photodetector input is insignificant because of small signal immunity from amplifiers spontaneous emission noise. When increase of input signal level the noise immunity of amplifiers raises, however also the phase shift simultaneously increases. There is an intersymbol interference of a signal that leads to reduction of the Q-factor for input signals with the big power as a result of linear signal spectrum expansion and its following limitation in the demultiplexer channel filter. The increase in optical sections quantity leads to the phase shift accumulation in the accepted signal and Q reduction.

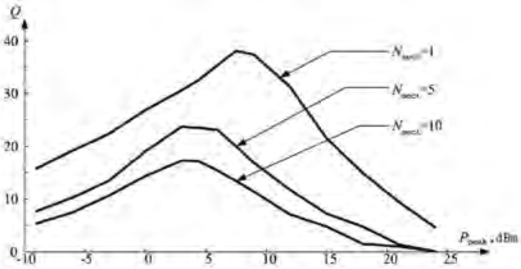

Fig. 5 The Q-factor dependence on the transmitter signal's power ($er=10$ dB $A_1=0{,}2$; $A_2=0{,}2$; $t_{fr}=35$ ps; $N_{simb}=1000$)

III. Conclusion

Simulation modeling has shown that for the 50 – 500 km optical line 3 – 6 dBm input signal level is optimum. It provides much more smaller error probability, in comparison with acceptable for FOTS values 10^{-12} – 10^{-15}. The simulation model constructed in the MatLab environment considers OF linear and nonlinear distortions, and also the optical amplifier spontaneous emission noise. It can be used for an estimation of DWDM systems parameters at a stage of their designing.

References

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Olga Reshetnikova – Odessa National Academy of Telecommunications named after O.S.Popov, Kuznechnaya Str., 1, Odessa, 65029, UKRAINE, E-mail: o.s.reshetnikova@mail.ru

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