RESEARCH OF CHROMATIC DISPERSION MANAGEMENT STRATEGIES APPLIED FOR FIBER-OPTIC TRANSMISSION SYSTEMS WITH WAVELENGTH DIVISION MULTIPLEXING

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In large scale and large capacity backbone optical networks which are based on wavelength division multiplexing (WDM), applied dispersion management strategy should be carefully selected and then optimized for corresponding optical signal format and transmission rate (i.e., per channel bitrate). Selected management strategy could reduce nonlinear optical effects such as cross-phase modulation (XPM) and increase transparent optical reach [1, 2]. This is even more important for systems with high frequency band utilization [3, 4].

In this paper authors give an overview of chromatic dispersion compensation methods such as dispersion compensating fiber (DCF), fiber Bragg grating (FBG) and optical phase conjugation (OPC) and investigate dispersion compensation module (DCM) placement strategies for a dense WDM system (DWDM) that complies with the following criteria: 1) 40 Gbit/s per channel bitrate; 2) non-return to zero encoded differential phase-shift keying (NRZ-DPSK) is used for an optical signal manipulation; 3) 200 GHz channel spacing according to ITU-T Recommendation G.694.1 is used to define the central frequencies of each system's channel; 4) standard single-mode fiber (SSMF, according to ITU-T Rec. G.652 D) is used as a transmission fiber.

Using such WDM systems configuration, firstly, the maximum transmission distance without any CD compensation was detected. As appears, optical signals on the other fiber's end can be detected with bit-error-rate below 10^{-16} if distance is less than 4.5 kilometers. Secondly, if it is required to transmit optical signals over 40 km of SSMF with previous BER threshold then such DCM modules must be used: 1) based on DCF which length could be changed in range of 7.3 – 9.0 km (see Fig. 1 (a)); 2) based on FBG which compensation levels could be changed in range of 550 – 700 ps/nm (see Fig. 1 (b)). In addition, compensation levels could be chosen regardless to DCM placements (i.e., dispersion pre- and post-compensation performs equally well for such transmission conditions). In turns, if OPC is used for the CD compensation then DCM must be placed not further

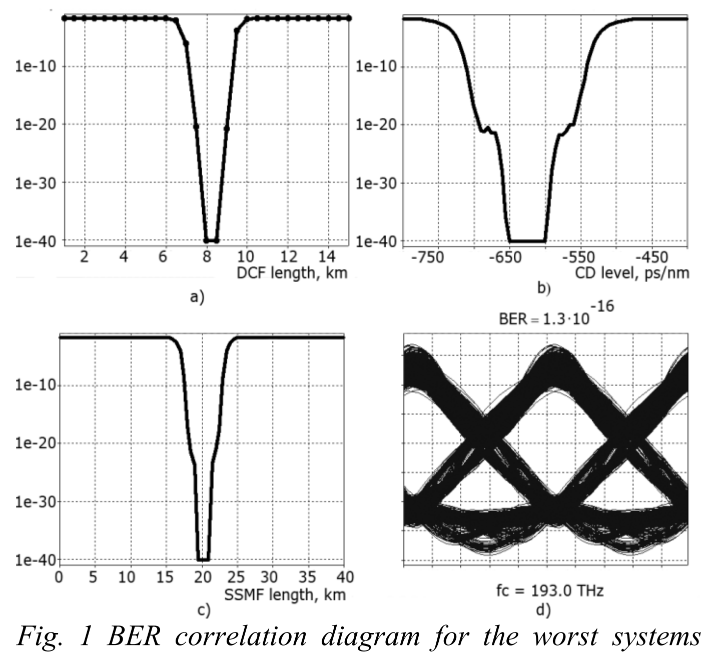

Fig. 1 BER correlation diagram for the worst systems channels which represent BER as a function of: a) DCF length; b) CD level compensated by FBG; c) OPC placement distance, and d) worst channels eye diagram after signal transmission over five iteration loops.

than 3 km from the SSMF mid-length. Otherwise, signal detection with previous BER threshold is complicated (see Fig. 1 (c)). Additionally, authors have studied the mixed CD compensation methods such as DCF-FBG, DCF-OPC, FBG-OPC and OPC-FBG regarding to items and their placements in DCM pre- and post-compensation modules. As the result, it is revealed that implementation of mixed CD compensation methods for WDM systems with one span of transmission fiber do not secure significant improvement of detected signal quality and detailed analyze for multi-span systems is required. And finally, maximum transmission distance for studied system was detected using the number of iteration loops consisted of an inline optical erbium doped fiber amplifier (EDFA), DCM based on FBG which compensates all accumulated CD, and 40 km of SSMF. Results showed that after transmission over five such loops the worst system's channels BER is still around 10^{-16} (see Fig. 1 (d)) but further increase of the distance unavoidable leads to more significant signal distortions and signals quality drops below detectable threshold.

In this paper authors studied CD compensation strategies applicable for WDM systems based of 40 Gbit/s NRZ-DPSK channels. It is revealed the dispersion levels that are required to compensate to gain BER below the required threshold regarding compensation method and DCM placement strategies. Additionally, maximum transmission distance for selected CD compensation plan was detected using the principle of iteration loops.

References

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