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## **Abstract**

In this thesis, various modulation formats with the polarization interleaving scheme are investigated and compared to improve the spectral efficiency of the high capacity Wavelength Division Multiplexing (WDM) systems.

The system is first simulated with a single channel at a bit rate of 40 Gb/s to analyze the performance with no Stimulated Raman Scattering (SRS), Cross Phase Modulation (XPM) and Four Wave Mixing (FWM) effects. Then the system of 8×40 Gb/s is simulated at 100 GHz (0.8 nm) and 50 GHz (0.4 nm) channel spacing.

In order to evaluate the modulation formats performance, Q factor verses launched power curves and the eye diagrams are presented. A reference Q factor to evaluate the performance of the formats is taken as 17 dB, which corresponds to a BER of  $1 \times 10^{-12}$ . The communication system is simulated by the (Optisystem v 7.0) simulation package.

The eye diagrams that are presented in the thesis, show clearly the effectiveness of using the polarization interleaving in decreasing the nonlinear effects and the crosstalk arising among the adjacent channels.

Return to Zero (RZ) modulation formats in general are found to give a better performance than Non-Return to Zero (NRZ) formats indicating their tolerance to the various linear and nonlinear effects of the optical fiber but with a reduced spectral efficiency.

Among the compared modulation formats, Return to Zero Alternate Mark Inversion (RZ-AMI) and the Return to Zero Differential Quadrature Phase Shift Keying (RZ-DQPSK) are the only formats that are found to be the optimal performance for high capacity WDM networks. RZ-AMI has an SE of 0.5 b/s/Hz with a Q factor of 19.4 dB at a power range from 7.6 dBm to 14.4 dBm at 100 GHz. At 50 GHz channel spacing, it gives a Q factor of 17.6 dB with a power range from 9.6 dBm to 12.4 dBm. 33% RZ-DQPSK has an SE of 0.5 b/s/Hz with a Q factor of 20.7 dB at a power range from 8.2 dBm to 17 dBm at 100 GHz. At 50 GHz channel spacing, it gives a Q factor of 20.4 dB with a power range from 7.8 dBm to 16.4 dBm. 67% RZ-DQPSK on the other hand gives a high value of the SE with 0.8 b/s/Hz and gives a Q factor of 18.9 dB with a power range from 9 dBm to 17 dBm at 100 GHz. At 50 GHz channel spacing, it gives a Q factor of 18.2 dB with a power range from 8.8 dBm to 14.4 dBm.

Keywords : Spectral Efficiency , Polarization Interleaving , Modulation Formats.