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Enhanced Performance Analysis of Polarization Interleaved Advanced Modulation Scheme Based 128 User Is-OWC DWDM System

Harjasleen Kaur
Student, ECE Department
GNDU R.C.
Jalandhar, India

Harmandar Kaur
Assistant Professor, ECE Department
GNDU R.C.
Jalandhar, India

Abstract: In this paper, the improvement in 128 channel DQPSK-DWDM system after incorporation of polarization interleaving using Optisystem has been presented. Polarization interleaving helps to overcome non-linear inter-channel effects. Improvement in system performance is observed in terms of system performance parameters Q, BER and SNR.

Keywords: Differential Quadrature Phase Shift Keying, Dense Wavelength Division Multiplexing, Polarization interleaving, State of polarization, Is-OWC.

I. INTRODUCTION

With improvement of Lasers and their increased utilization in communication technologies, a method to connect satellites with one another through lasers and wireless medium came into existence. In this work, 128 channel DWDM system incorporating DQPSK modulation is merged with polarization interleaving scheme. Polarization interleaving is utilized for reducing non-linear inter-channel effects. This scheme divides total number of channels into even and odd channels separately and multiplexed together orthogonally [1]. In this work state of polarization is ˚0 and 90˚ for odd and even channels respectively.

In [1], an 8 channel DWDM system utilizing AMI system is merged with polarization interleaving scheme for transmission of 160 Gbps over a link of 1000 Km. Space turbulences are considered in this work. SNR obtained for channel 1 is 49.43 dB and channel 8 is 51.34 dB for 1 µrad, 16.21 dB for channel 1 and 17.95 dB for channel 8 at 5 µrad values of pointing errors. Similarly, Q for channel 1 is 23.32 and 23.78 for channel 8 at 1 µrad, and 0 dB for both channel 1 and 8 at 5 µrad. It was observed that maximum tolerable value of pointing error is 4 µrad beyond this system performance become worse. A 6-channel WDM system including polarization interleaving scheme has been analyzed for 6 x 20 Gbps data rate and link length of 1000 km. The role of turbulences was also considered for the proposed system. It was concluded that proposed WDM-PI scheme is beneficial for designing inter-satellite communication system by considering transmitting and receiving pointing errors [2]. In [3] 12.48Gbps data rate is transmitted over 8 channels having capacity of 1.54 Gbps through FSO upto 15 km under clear weather conditions. The FSO link for the proposed system prolonged to 15 km with accepted SNR and total power when the beam divergence was set to 1 µrad and when beam divergence was changed to 3 µrad the proposed link reduced to 6 Km only with acceptable SNR and total power. A four and eight channel DWDM system was investigated to evaluate Q, electrical power and average eye opening for a span of 100 Km in the presence of Four-wave-mixing under the effect of unequal channel spacing varied from 0.24-0.27 mm at 100 KHz,10 MHz and 100 MHz laser line-width. It was observed that FWM effect system least at minimal laser linewidth and also the effect of FWM is more at intermediate channels than at boundary channels [4]. A 2.50 Gbps OWC system using PPM modulation schemes with various parameters was studied and from results it was observed that as we move to higher wavelengths, optical and electrical SNR with transmission range start decreasing. A BER of 10^{-6} was achieved from HAP-to-satellite link [5]. In [6], impact of polarization interleaving on WDM-FSO system was studied by taking 16 independent channels. The capacity of whole system was 128 Gbps over a link length of 25 Km link, the Q factor obtained was 6.80072 for the proposed system. A polarization interleaved WDM system with two orthogonal pump optical parametric amplifiers was realized and it was observed that sensitivity improved by about 2 dB as compared to its counterpart in which all channels were co-polarized with same signal gain which itself dramatically improved over conventional two-parallel pump OPA [7].

II. SYSTEM DESCRIPTION

In proposed DQPSK-DWDM-Polarization Interleaved system, 128 channels are multiplexed on different polarizations. Every consecutive channel is working on different state of polarizations. All even channels under consideration works with state of polarization kept at 90˚In the same way, all odd channels are kept at state of polarization 0˚; thus all consecutive channels have different state of polarization that is orthogonal to each other.

At the transmitter side; odd and even channels are separated and multiplexed together at different polarization. All these channels now works on different frequencies as well as different polarization which leads to removal of interference, cross-talk etc.

The schematic diagram for the DQPSK-DWDM-Polarization interleaved system is as shown below in figure 1. Phase modulation DQPSK is utilized for the simulation at 193.1 THz frequency and channel spacing of 25 GHz between adjacent channels of DWDM system.

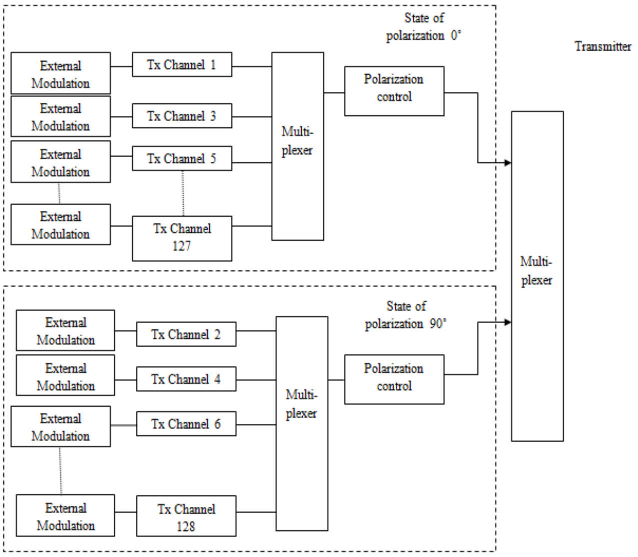

Figure 1. Transmitter end of proposed DQPSK-DWDM-Polarization system

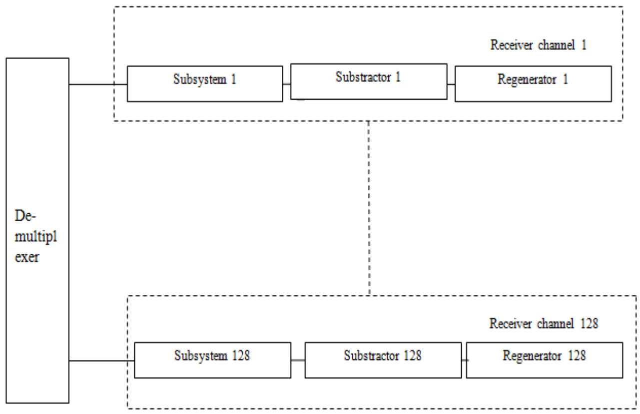

Figure 3. Receiver Section for proposed system

Link distance between transmitting and receiving transponder is varied from 250 km to 1250 km and input power given to the system is 30 dBm at the transmitting end.

Transmission media here is OWC channel with amplifiers in pre and post configuration. The distance of OWC channel is kept at 250 Km and whole system covers a link distance of 1250 Km. The transmission channel set up is as shown in figure 2.

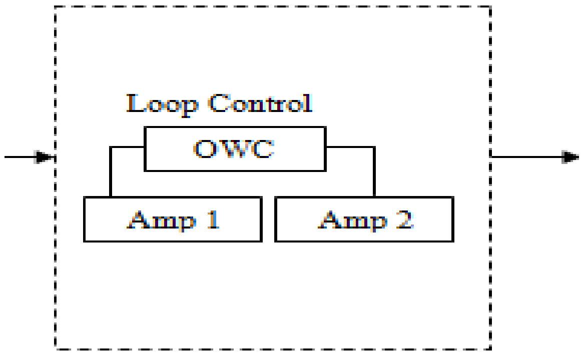

Figure 2. Model of transmission Channel for proposed system

At the receiver end, all channels are separated at their respective frequencies as well as corresponding states-of-polarization. The receiver set up is given in figure 3. Each receiver channel comprises a subsystem used designed for demodulating DQPSK signals followed by a substractor and a regenerator used to obtain original data and visualizers to analyze the proposed system in terms of system performance parameters.

III. RESULT DISCUSSION

The proposed system is simulated for two configurations. One is with polarization interleaving and other is without polarization interleaving. For a system without polarization interleaving; when even channels and odd channels are separately multiplexed the system performance in terms of Q, BER and SNR comes out to be as shown in table I.

Table I. System performance in terms of Q, BER and SNR without polarization interleaving

Distance (Km)	*Q*	*BER*	*SNR*
250	1.46	$7.1*10^{-2}$	46.60
500	1.46	$7.1*10^{-2}$	40.35
750	1.46	$7.1*10^{-2}$	35.20
1000	1.45	$7.2*10^{-2}$	30.41
1250	0	1	0

Above results are however not competent as value of Q is very low also BER is very high and performance deteriorate as the distance is increased from 250 to 1250 km. As shown in table 1 the system is highly unstable due to unacceptable values of Q and BER which depicts that there is presence of noise and co-channel interference or more precisely called as cross-talk. This leads to poor reception and regeneration of original data which is here depicted by poor SNR results which varies from 46.60 to 0 as the distance is increased from 250 to 1250 km.

Above analysis leads to adoption of polarization interleaving scheme in order to remove the noise and crosstalk present in proposed system. On designing a DQPSK-DWDM-

Polarization Interleaved system; the system started working better as shown in table π

Table π. System performance in terms of Q, BER and SNR with polarization interleaving

Distance (Km)	*Q*	*BER*	*SNR*
250	22.39	$2.30*10^{-111}$	29.86
500	21.72	$5.96*10^{-105}$	23.82
750	19.48	$7.61*10^{-85}$	18.60
1000	15.16	$3.07*10^{-52}$	13.56
1250	10.64	$9.64*10^{-27}$	8.55

The improvement in system after setting state of polarization of adjacent channels orthogonal to each other is clear from above results. The improved values of SNR with respect to increasing distance from 250 to 1250 Km as compared to variation in the system without polarization interleaving clearly depict reduction of noise in the system and also good quality reception of optical signal and regeneration of original data. After introducing Polarization interleaving in the system; the value of Q and BER also improves and system become acceptable. The comparison of both layouts is done in figure 4, figure 5 and figure 6.

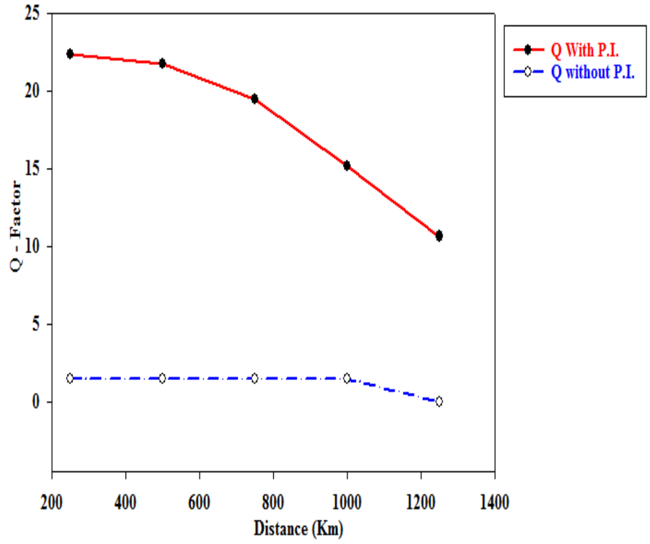

Figure 4. Comparison of system with and without Polarization Interleaving in terms of Q

It is clearly indicated from the above figure that polarization interleaving reinforced the DQPSK DWDM system. The Q factor varies from 22.39 to 10.64 and 1.46 to 0 for system with and without polarization interleaving layout respectively.

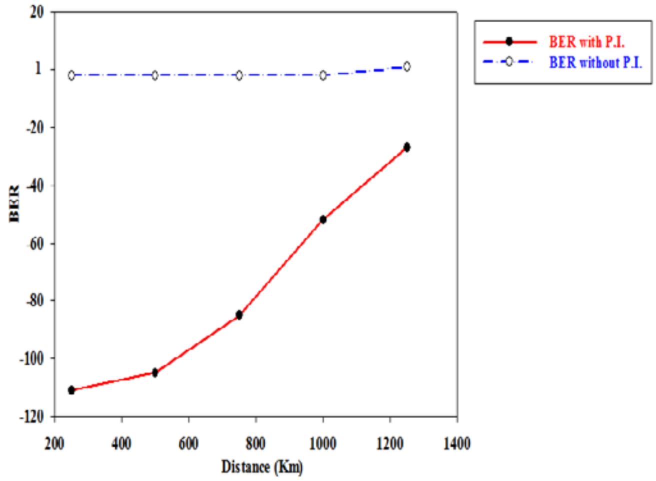

Figure 5. Comparison of system with and without Polarization Interleaving in terms of BER

BER for proposed DQPSK-DWDM-Polarization interleaved system changes from $2.307*10^{-111}$ to $9.64*10^{-27}$ when distance changes form 250 km to 1250 km. It is clear from above figure that BER starts decreasing as soon as distance in increased. Without utilizing polarization interleaving; BER comes out to be $7.1*10^{-2}$ at 250 km and 1 at 1250 km which is unacceptable for any system.

Similarly, variation in SNR has been observed in order to investigate the effect of polarization interleaving on noise introduced due to interference of signals as the medium they are travelling through is wireless, so the system is more prone to such effects.

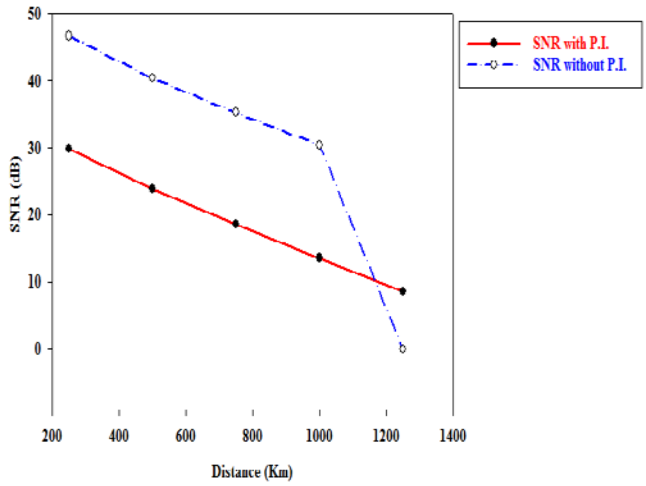

Figure 6. Comparison of system with and without Polarization Interleaving in terms of SNR

Figure 6 depicts the SNR at the receiver of both systems. The system in which polarization interleaving is incorporated has higher value of SNR as compared to the system working without it at 1250 Km. However, at least distance of 250 Km the value of SNR is more in the sytem without polarization interleaving. With increase in distance the effects of interleaving and changed state of polarization are clearly distinguishable. At maximum distance of 1250 Km for the proposed system; SNR with interleaving is 8.55 dB and without interleaving is 0 dB which is a significant improvement in system due to polarization interleaving.

IV. CONCLUSION

From the above study; it can be concluded that for the proposed polarization interleaved 128 channels DWDM Is-OWC system there is a significant improvement in system performance in terms of performance parameters such as quality factor (Q), BER and SNR. A significant improvement in Q at 1250 km in proposed interleaving scheme with a value of 10.64 is observed as compared to a system without interleaving. Similarly BER improves from 1 to -27 and SNR from 0 dB to 8.55 dB with proposed scheme.

V. REFERENCES

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