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Simulation Investigation of Impact of SRS Effect on WDM System

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ABSTRACT: For single channel, SRS has little impact on the performance of the system, but for DWDM fiber optic communication system, it is showing a major non linear effect. In this paper, simulation is being done on the WDM system for different number of channels and different power levels so as to observe system performance effected by the induced non linear effect SRS which stands for stimulated Raman scattering. Here, the SRS effect is observed for 16, 32, 64, 96 channels WDM system and the respective channels are observed for different input power levels like 1 mw, 5 mw and 10 mw using optsim software. Power tilt is evaluated for WDM using RZ and NRZ driver in transmitter section and their output power level is compared. Power tilt comes out to be 2.80, 7.23, 15.66, 16.53 in dBm for 16, 32, 64, 96 channels respectively for 10 mw input power to each channel using NRZ driver. Q factor and BER values are also evaluated for different channels for both RZ and NRZ driver.

KEYWORDS: WDM, BER, Optsim, SRS, Q Factor.

I. INTRODUCTION

WDM has achieved wide attention in wireless communication and the broadband optical network so as to utilize the huge bandwidth accessible with optical fiber. On the other hand, when large number of optical signals is multiplexed, it gives rise to cross talking and coupling among the signals which are multiplexed, due to different non linear effects which takes place in fiber. Different non linear effects have different effect on system; in case of scattering it causes disproportionate attenuation, especially at higher optical power level [1]. This phenomenon limits the ultimate performance of WDM network [2]. These non linear effects put constraints on factors like adjacent channel spacing and they also limit the maximum power for each channel, bit rate and also effects system performance [3]. When SRS effects come in to picture, Optical waveguide does not behave completely as linear channel, where output power is directly proportionate to input power. Major effect of SRS on system is that it causes transfer of power from channels having lower wavelength to channels having higher wavelength [4]. This unwanted tilt in power is due to higher power level and also due to higher number of channels and also channel spacing also becomes a problem due to this, so we need to set an optimum power level to compensate for SRS effect [4].

II. METHODOLOGY

To investigate SRS effect, WDM link is designed using efficient optical communication software, Optsim. WDM system is here designed for different number of channels. Laser source will be operated at centre wavelength 1552.5, 1560.5, 1565.2 and 1533 nm for 16, 32, 64, 96 channels WDM system respectively. Spacing between successive channels will be kept uniform which is 1 nm for 16 and 32channels WDM system, while for 64 and 96 channels; spacing will be 0.8 and 0.4 nm respectively. To observe the effect of input power on SRS effect, each channel will be operated for different input powers like 1, 5 and 10 mw. With input power, one more input parameter will be Raman constant. There will be two values of Raman constant 0.3 and 0.7, which will be analyzing SRS effect for each value of input power for each respective WDM system. So, impact of SRS effect on WDM system will be analyzed, first for

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NRZ modulator driver. Then the same set of input will be given to RZ modulator driver in transmitter section and SRS effect will be observed by simulation.

III. EXPERIMENTAL SETUP

To demonstrate the effect of SRS on different power levels and large number of channels in WDM, we are using optsim software. Whenever optical power of high intensity is transmitted in single mode fiber, the SRS effect will take place. Due to which there will be limitation on the minimum power that could be send through fiber. So, if input power is decreased, SRS effect will be reduced. WDM has been simulated for 16, 32, 64, 96 channels and the outputs are compared for different power levels and Raman constant.
Fig.1 is the basic block diagram for SRS configuration; it is divided in to 3 sections:

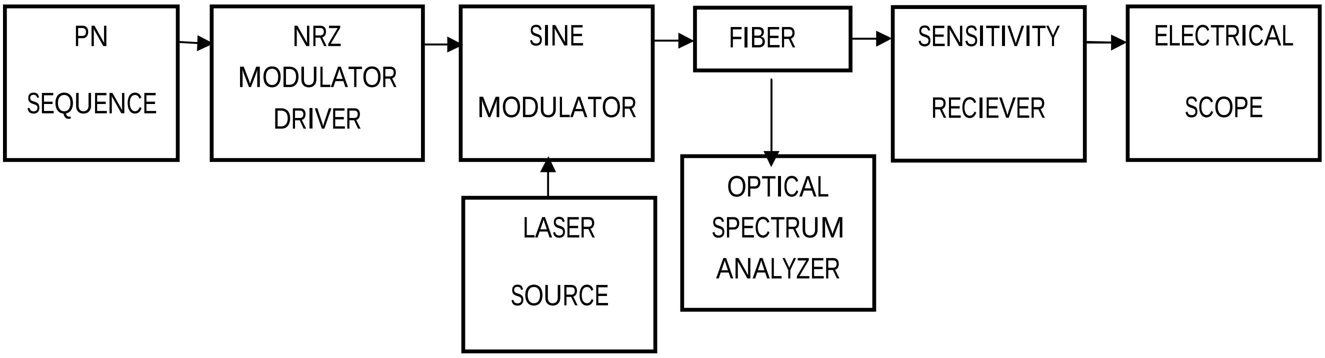

Fig.1 Block diagram for single channel.

Transmitter section contains PN sequence as data source, modulator driver to convert binary sequence in to pulses and laser source as light carrier. Fiber is acting as transmitting medium to transmit light from transmitter to receiver. Receiver section contains raised cosine filter, avalanche photodiode and electrical Bessel filter which are tuned to a specific wavelength to receive. Two kind of modulating schemes are used here for modulator driver are NRZ and RZ format. For n channel WDM, we have to replicate transmitter section n times and then with the help of optical combiner all optical inputs are connected to optical fiber. Experimental setup for 16 channels WDM system is shown in Fig.2.

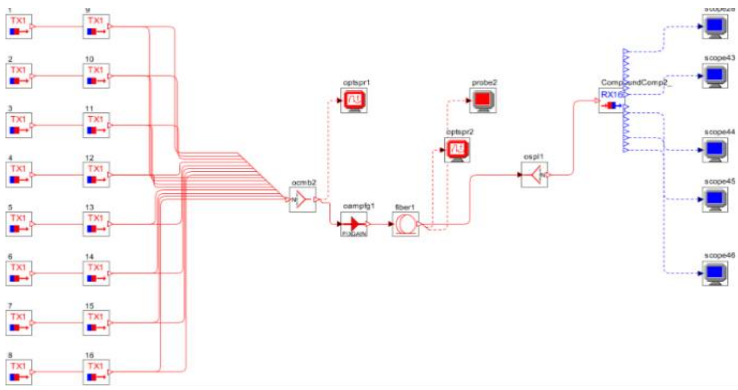

Fig.2 Experimental set up for 16 channels

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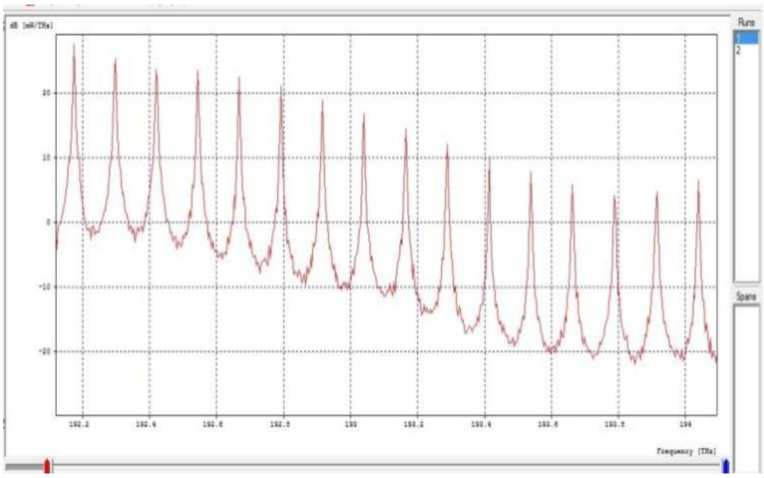
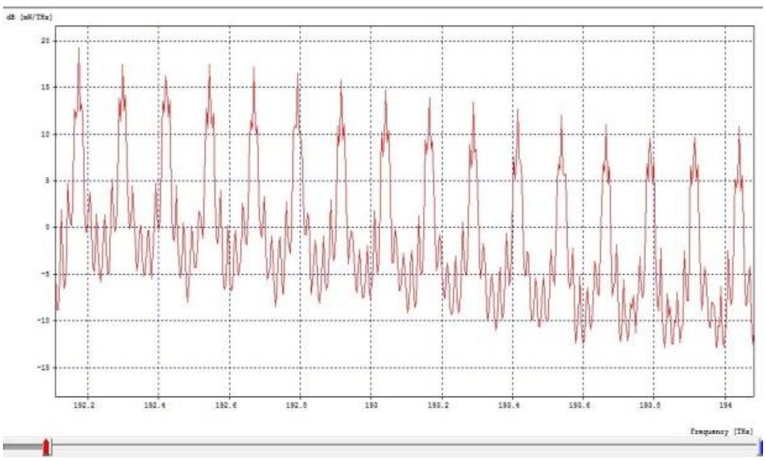
IV. RESULTS AND DISCUSSION

16 CHANNELS WDM SYSTEM:

Here, WDM system has been designed for 16 channels. Each channel is provided with equal input power of 10 mw and also equal channel spacing of 1nm with centre wavelength set equal to 1552.5 nm. The output of multiplexer is given to fiber where Raman crosstalk is kept ''ON''. Output optical spectrum for 16 channels WDM is shown in Fig.3. Optical output power is measured with the help optical power meter. For Raman constant equal to 0.7, Power tilt came out to be 4.60 dBm for NRZ and 2.80 dBm for RZ driver. For Raman constant equal to 0.3, power tilt is 1.79 dBm for NRZ and 1.69 dBm for RZ. For lower Raman constant power tilt is lesser for both 16 channel NRZ and RZ driver, where for RZ power tilt has reduced almost to half as compared to NRZ.



(a)



(b)

Fig.3 Output spectrum for 16 channels WDM system (a) NRZ format (b) RZ format

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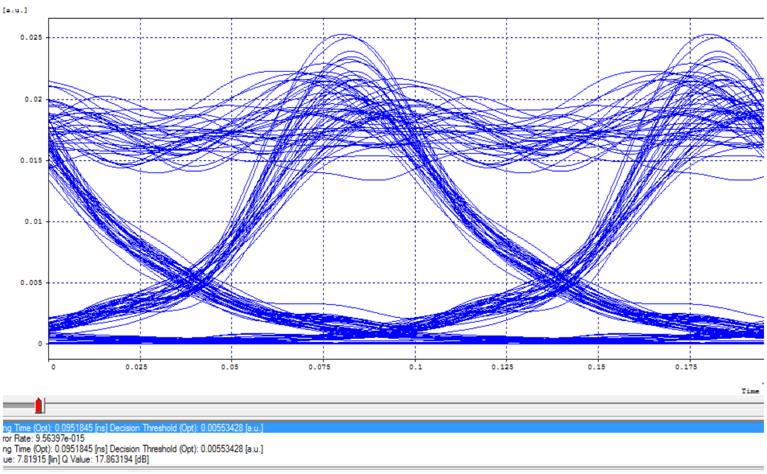
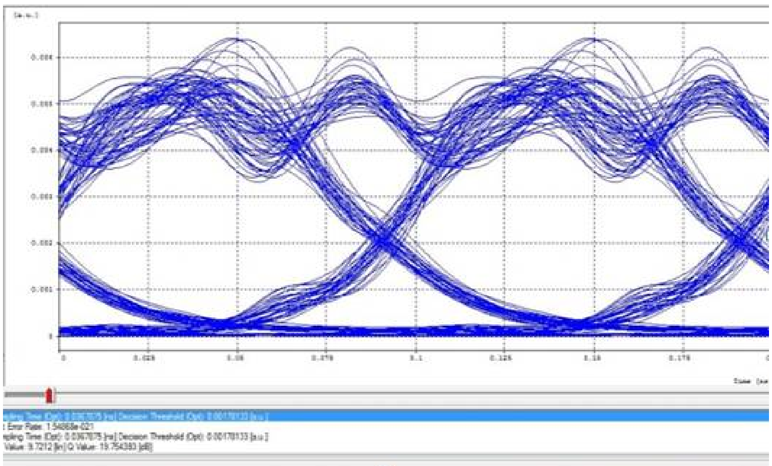
Eye diagrams for 16 channel WDM system are shown in Fig.4. Q factor value for 16 channels NRZ driver is 17.864 dB and for RZ driver 19.75 dB. Bit error rate (BER) for NRZ driver is 9.56E-15 and for RZ its va1ue is 5.48E-21. Q factor value for RZ driver is 2 dB more than NRZ driver. BER has improved by E-6 factor for RZ. 16 channels WDM with RZ driver system is showing lesser impact of SRS effect as compared to NRZ driver.



(a)



(b)

Fig.4 Eye diagram for 16 channels WDM system (a) NRZ format (b) RZ format

64 CHANNELS WDM SYSTEM:

Here, WDM system is being designed for 64 channels where each channel is provided with equal channel spacing of 0.8 nm and equal power of 5 mw. Centre wavelength is set equal to 1565.2 nm. Power tilt value is calculated from output spectrum shown in Fig.5. For Raman constant equal to 0.7, it is 9.33 dBm for NRZ and for RZ it is 3.17 dBm. For 0.3 Raman constant, power tilt is 4.125 dBm and 1.314 dBm for NRZ and RZ respectively. Here again, we can see that 64 channel RZ driver is having power tilt value reduced almost to half as compared to NRZ driver.

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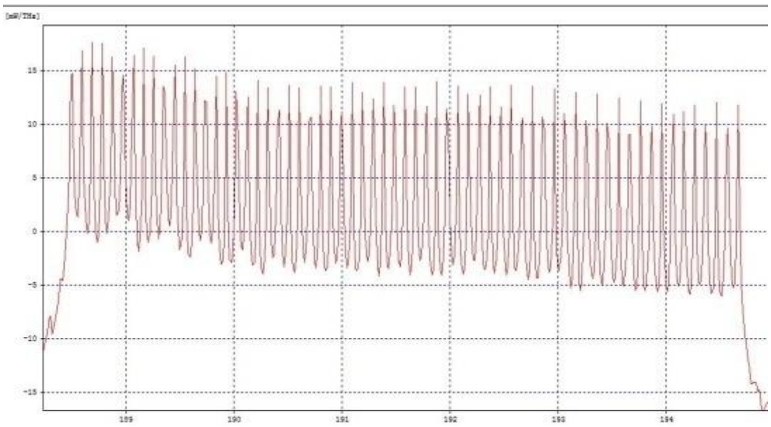
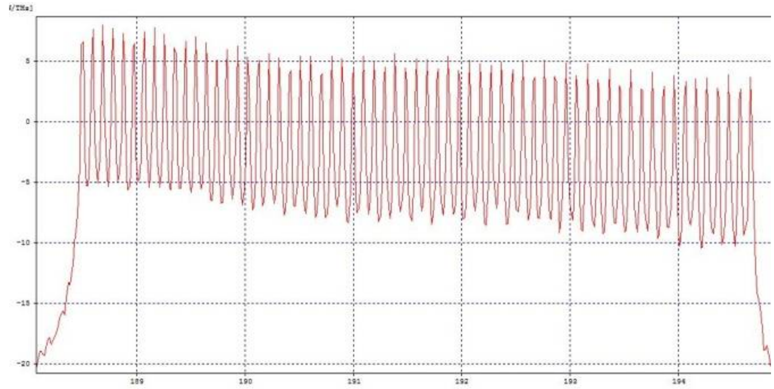


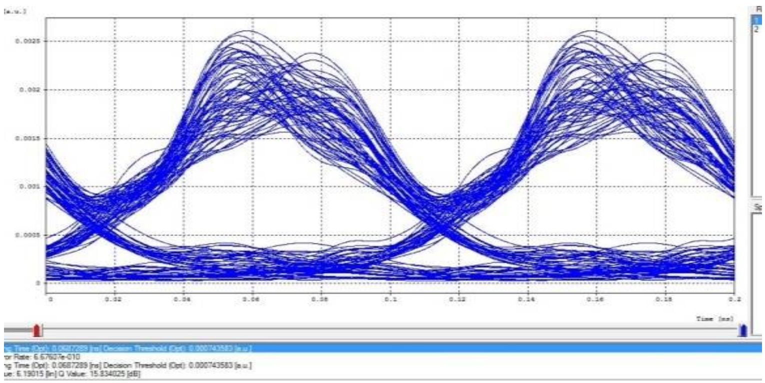
(a)



(b)

Fig.5 output Spectrum for 64 channels WDM system (a) NRZ format (b) RZ format

Eye diagram for 64 channels WDM system is shown in Fig.6.Q factor is 16.83 dB and BER value is 6.68E-11. For RZ, Q factor is 17.99 dB and BER value is 2.36E-15. Q factor is 1dB larger for RZ and BER is increased by a factor of E-4 as compared to NRZ driver. It can be seen that 64 channels WDM system with RZ driver is showing lesser impact of SRS effect as compared to NRZ.



(a)

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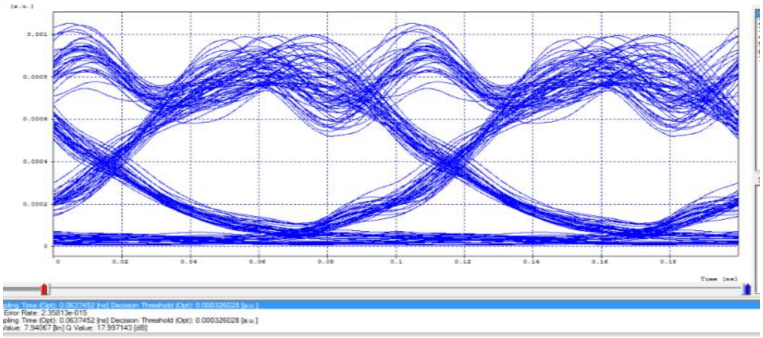

(b)

Fig.6 Eye diagram for 64 channels WDM system (a) NRZ format (b) RZ format

TABLE 1: Power tilt for Raman constant 0.7

Table 1.1 shows the results for power tilt for different channels 16,32,64,96 WDM systems for different input power of 1, 5 and 10 mw using NRZ driver format keeping Raman constant equal to 0.7.and table 1.2 shows the results for power tilt using RZ driver format.

Table 1.1 for NRZ format

Input power (mw)	Number of channels	Power tilt (dBm)
1	16	0.24
	32	1.02
	64	1.89
	96	3.46
5	16	1.97
	32	4.76
	64	9.33
	96	13.62
10	16	2.80
	32	7.23
	64	15.66
	96	16.53

Table 1.2 for RZ format

Input power (mw)	Number of channels	Power tilt (dBm)
1	16	0.45
	32	1.35
	64	0.62
	96	1.09
5	16	0.56
	32	2.49
	64	3.17
	96	5.47
10	16	4.06
	32	4.84
	64	6.29
	96	10.95

Table 2 shows power tilt values for 16, 32, 64 and 96 and for different input power 1, 5, 10 mw using NRZ format keeping Raman constant value equal to 0.3. Table 3 contains values of Q factor and BER value for different channels and different input powers.

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Table 2: for Raman constant 0.3

Input power (mw)	Number of channels	Power tilt (dBm)
1	16	0.223
	32	1
	64	0.784
	96	1.48
5	16	0.849
	32	4.757
	64	4.125
	96	7.222
10	16	1.691
	32	4.103
	64	7.993
	96	12.664

Table 3: Q factor and BER

Input power (mw)	Number of channels	Q Factor (dB)	BER
1	16 NRZ	17.619	3.263E-14
	16 RZ	17.153	3.679E-13
	32 NRZ	17.439	1.944E-13
	32 RZ	18.500	4.802E-17
5	16 NRZ	16.637	1.869E-11
	16 RZ	18.028	2.162E-15
	32 NRZ	17.567	1.081E-13
	32 RZ	19.521	3.544E-19
10	16 NRZ	17.080	1.316E-9
	16 RZ	18.172	2.879E-16
	32 NRZ	16.708	5.826E-10
	32 RZ	18.849	2.602E-18

V. CONCLUSION

Here WDM system has been designed for 16, 32, 64, 96 channels and SRS effect has been studied for these channels. For NRZ driver, power tilt value is more than RZ driver, most of the time it is nearly equal to half of the NRZ power tilt. Power tilt value lies in the range of 0.24-16.527 dBm for Raman constant 0.7. For 0.3, it varies from 0.223-12.664 dBm. For RZ, Raman constant equal to 0.7, range lies from 0.448-10.496. For 0.3 it is from 0.224-4.796 dBm. So this unwanted tilt in power can be reduced by setting minimum power. Though Q factor and BER value is not showing a uniform effect, still we can see that BER is better for RZ where minimum value is E-13 and goes up to E-19 compared to NRZ where maximum value is E-14. So, effect of SRS for WDM systems can be compensated by giving optimum input power and also using RZ modulator driver.

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