Investigations on Receiver sensitivity of SOA based optical communication system using RZ super Gaussian pulse

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Abstract

In this paper, investigations are made on performance improvement of the optimized SOA preamplifier [9] based system. The effects of order and pulse width RZ super Gaussian pulse are analyzed in terms of receiver sensitivity of optimized preamplifier. It was found that the system is more sensitive when 95ps (Full width at half maximum) FWHM, RZ super Gaussian pulse is used as compared to NRZ pulse.

1. Introduction

Preamplification is an important part of optical communication system. The transmission distance increases as well as receivers with optical preamplifiers are more sensitive as compared to coherent and APD receivers [1]. A high receiver sensitivity of -37.2 dBm and -38.8 dBm was achieved using single EDFA (Erbium doped fiber amplifier) and two cascaded EDFAs [2],[3] at 10 Gbps. Avalanche photodiodes (APDs) are also used as low cost and high sensitive receivers in metropolitan areas. A high receiver sensitivity of -29.5 dBm was achieved at 10 Gbps using an APD based receiver [4], [16]. However, low gain bandwidth product of APDs prohibits their use at 40 Gbps. Semiconductor optical amplifiers (SOA) being compact in size and integerable on chip makes them prime candidates for their use as optical preamplifiers. But high inherent noise figure, strict requirements on anti reflection coatings and fiber alignments on both sides are some of disadvantages of SOAs. T. Yamatoya et al. demonstrated an optical amplifier based on optical modulation of Amplified spontaneous emissions (ASE), in saturation region by the optical signal ,the output of such an amplifier is amplified but inverted, they showed its operation on 10 Gbps bit rate and also fabricated it [5],[6],[7]. The preamplifier based system achieved a BER of 10^{-9} for a received power of -22.7 dBm [8]. Gain fluctuations, which causes cross talk is a function of carrier density, length of active region, confinement factor, power of signals carrier lifetime, bias current [9]. Surinder Singh [9], optimized SOA parameters to minimize the gain fluctuations. He evaluated the performance of the preamplifier system on single and multichannel with 20 channels and 100 GHz spacing. It was found that 0.25ns is the optimum value of carrier lifetime to be used. Different data formats are important in communication. It has been found that at 40 Gbps TDM-systems, the performance of RZ modulation format with a duty cycle of 0.5 is better as compared to NRZ data format [10] to [14]. Super Gaussian pulse format is another important pulse shape. It has been found that super Gaussian format is more immune to the destructive influence of the initial linear chirp than Gaussian pulse and Gaussian shape is less sensitive to initial chirp as compared to hyperbolic secant shape [15]. In this paper, we have analyzed the effect of order and pulse width of super Gaussian pulse shape on BER of the SOA based single channel optical communication system.

2. SOA structure parameters

The parameters taken for the SOA are approximately same as in [9], which are as follows: length is 900 µm, the width of active layer is 2 µm, its thickness is 0.2 µm and confinement factor is 0.3.The transparency carrier density in the SOA is taken to be 1.08×10^{18} cm^{-3}. The spontaneous carrier lifetime is taken 0.25 ns and injection current is 400 mA. The input and output coupling losses are taken 3 dB. In order to operate the preamplifier with least crosstalk and ASE, the gain fluctuations have been minimized in [9].

3. System description

The proposed SOA based single channel communication system is shown in figure 1. The SOA pre amplifier parameters were same as stated in section 2. A 10 Gbps logical data source and an NRZ or RZ-super gaussian driver was used to generate random data for the channel. The power launched in the fiber from the transmitter in each channel was varied by varying laser power. The total length of the fiber link was 350 Km made of five spans. Each span was made of one

Standard single mode fiber (SSMF) of length 60 Km and one Dispersion compensating fiber (DCF) of 10 Km and an inline SOA having the same parameters as given in section 2. The fiber loss parameter was set 0.2dB/Km for SSMF and 0.55 dB/Km for DCF at 1550 nm while dispersion at this frequency was selected 16 ps/nm/km for SSMF and -80ps/nm/km for DCF. The fiber non linear effects were considered and Raman cross talk was turned off. The receiver consists of a raised cosine optical band pass filter, PIN photodiode and an electrical low pass filter. The optical filter has a raised cosine function exponent 1, roll-off factor 0.5, 3 dB two sided bandwidth is 0.17 nm. The quantum efficiency, responsivity (at reference frequency), dark current of the PIN diode is set as 0.7, 0.8751 A/W, 0.1 nA respectively. Quantum noise was not considered.

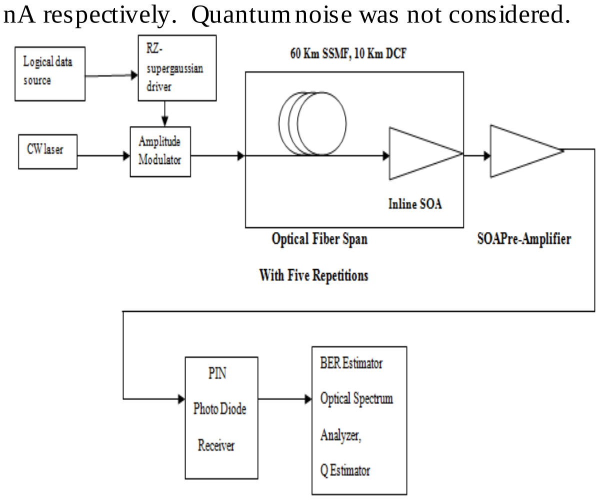

Figure 1: Simulation setup for single channel using RZ-super gaussian driver

4. Results and discussion:

4.1 NRZ pulse:

The plot of BER vs received power in the channel and corresponding details are given in figure 2 and table 1. The BER for a minimum launched power of -20 dBm (received power -35.55 dBm) is $0.17\text{x}10^{-16}$. With further increase in launched power the BER starts to decrease until it reaches a minimum of $0.35\text{x}10^{-38}$ (Q-factor of 13.21) for a launched power of -2.5 dBm (received power -18.11 dBm). With further increase in launched power the BER started to increase. The results obtained here show a huge improvement of the order of 10^{29} times smaller in terms of BER as compared to the results reported in [8], but the power required to achieve such low BER is nearly 4.5 dBm higher

Table 1: BER Performance of NRZ pulse

L.P(dBm)	NRZ	
	R.P(dBm)	B.E.R
-20	-35.55	$0.17\text{x}10^{-16}$
-17.5	-33.05	$0.84\text{x}10^{-22}$
-15	-30.56	$0.29\text{x}10^{-26}$
-12.5	-28.06	$0.42\text{x}10^{-31}$
-10	-25.56	$0.25\text{x}10^{-33}$
-7.5	-23.07	$0.71\text{x}10^{-36}$
-5	-20.57	$0.16\text{x}10^{-35}$
-2.5	-18.11	$0.35\text{x}10^{-38}$
0	-15.64	$0.50\text{x}10^{-37}$
2.5	-13.21	$0.64\text{x}10^{-34}$
5	-10.79	$0.33\text{x}10^{-32}$
7.5	-8.45	$0.5\text{x}10^{-27}$
10	-6.21	$0.28\text{x}10^{-19}$
12.5	-4.15	$0.22\text{x}10^{-13}$

**L.P launched power, R.P Received power

4.2 RZ-super Gaussian pulse, order 1:

The plot of BER vs received power in the channel and corresponding details are given in figure 2 and table 2 and 3. The minimum BER for a lowest received power was obtained for RZ super Gaussian pulse, order 1 with a FWHM of 95 ps (picoseconds). It is $0.99\text{x}10^{-40}$ (Q-factor 13.31) for a launched power of -10 dBm and received power of -26.39 dBm. The performance of 90 ps FWHM was nearly similar to 95 ps pulse. These results are far better than using NRZ pulse both in terms of received power and lowest BER. Also, the performance is hugely improved as compared to ASE modulation based SOA preamplifier reported in [8]. With further decrease in pulse width (FWHM),the performance of the system degraded ; as an example, to reach the same lowest BER the 80 ps pulse required a launched power of 0 dBm (received power of -16.8 dBm). The BER performance of pulse shapes up to 80 ps FWHM is better as compared to NRZ pulse format.

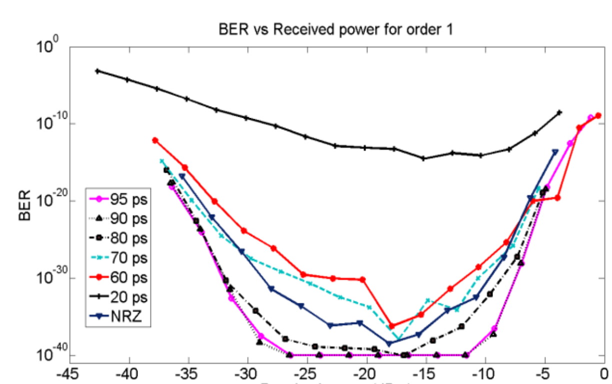

Figure 2: BER vs received power for order 1

Table 2: BER Performance of order 1,RZ super Gaussian.

L.P(dBm)	95 ps, FWHM		90 ps, FWHM		80 ps, FWHM	
	R.P(dBm)	B.E.R	R.P(dBm)	B.E.R	R.P(dBm)	B.E.R
-20	-36.389	0.71x10^{-18}	-36.509	0.209x10^{-17}	-36.815	0.11x10^{-15}
-17.5	-33.891	0.87x10^{-24}	-34.01	0.225x10^{-23}	-34.316	0.24x10^{-22}
-15	-31.391	0.24x10^{-32}	-31.51	0.318x10^{-31}	-31.817	.047x10^{-29}
-12.5	-28.892	0.33x10^{-37}	-29.01	0.464x10^{-38}	-29.318	0.55x10^{-34}
-10	-26.395	0.99x10^{-40}	-26.514	0.99x10^{-40}	-26.82	0.12x10^{-37}
-7.5	-23.899	0.99x10^{-40}	-24.018	0.99x10^{-40}	-24.324	0.13x10^{-38}
-5	-21.407	0.99x10^{-40}	-21.526	0.99x10^{-40}	-21.832	0.86x10^{-39}
-2.5	-18.937	0.99x10^{-40}	-19.055	0.99x10^{-40}	-19.345	0.62x10^{-39}
0	-16.462	0.99x10^{-40}	-16.579	0.99x10^{-40}	-16.882	0.99x10^{-40}
2.5	-14.02	0.99x10^{-40}	-14.136	0.99x10^{-40}	-14.435	0.84x10^{-38}
5	-11.582	0.99x10^{-40}	-11.697	0.99x10^{-40}	-11.991	0.52x10^{-36}
7.5	-9.237	0.28x10^{-36}	-9.347	0.479x10^{-37}	-9.636	0.81x10^{-32}
10	-6.956	0.78x10^{-28}	-7.056	0.771x10^{-28}	-7.321	0.55x10^{-27}
12.5	-4.826	0.63x10^{-18}	-4.923	0.346x10^{-18}	-5.18	0.11x10^{-18}
15	-2.867	0.28x10^{-12}	-2.91	0.43x10^{-11}	-3.08	0.6x10^{-11}
17.5	-1.166	0.608x10^{-9}	-1.22	0.2128x10^{-9}	-2.3	0.55x10^{-9}

**L.P launched power, R.P Received power

Table 3: BER Performance of order 1,RZ super Gaussian pulse.

L.P(dBm)	70 ps, FWHM		60 ps, FWHM		20 ps, FWHM	
	R.P(dBm)	B.E.R	R.P(dBm)	B.E.R	R.P(dBm)	B.E.R
-20	-37.24	0.15x10^{-14}	-37.82	0.71x10^{-12}	-42.63	0.64x10^{-3}
-17.5	-34.74	0.13x10^{-19}	-35.32	0.23x10^{-15}	-40.13	0.5x10^{-4}
-15	-32.24	0.32x10^{-24}	-32.82	0.94x10^{-20}	-37.63	0.37x10^{-5}
-12.5	-29.74	0.35x10^{-27}	-30.33	0.14x10^{-23}	-35.13	0.16x10^{-6}
-10	-27.24	0.73x10^{-29}	-27.83	0.74x10^{-26}	-32.63	0.65x10^{-8}
-7.5	-24.75	0.20x10^{-30}	-25.33	0.29x10^{-29}	-30.13	0.60x10^{-9}
-5	-22.25	0.33x10^{-32}	-22.84	0.92x10^{-30}	-27.64	0.51x10^{-10}
-2.5	-19.76	0.16x10^{-33}	-20.35	0.65x10^{-30}	-25.14	0.21x10^{-11}
0	-17.30	0.12x10^{-37}	-17.88	0.61x10^{-36}	-22.65	0.14x10^{-12}
2.5	-14.84	0.13x10^{-32}	-15.41	0.19x10^{-34}	-20.16	0.83x10^{-13}
5	-12.40	0.77x10^{-34}	-12.96	0.44x10^{-31}	-17.68	0.56x10^{-13}
7.5	-10.63	0.10x10^{-29}	-10.57	0.27x10^{-28}	-15.21	0.32x10^{-14}
10	-7.70	0.17x10^{-25}	-8.23	0.44x10^{-25}	-12.77	0.16x10^{-13}
12.5	-5.53	0.48x10^{-18}	-6.01	0.10x10^{-19}	-10.38	0.80x10^{-14}
15	-3.27	0.83x10^{-13}	-3.94	0.28x10^{-19}	-8.01	0.51x10^{-13}

**L.P launched power, R.P Received power

4.3 RZ-super Gaussian pulse, order 2:

The plot of BER vs received power and the corresponding details are given in figure 3 and table 4, 5 respectively. The minimum BER of 0.99x10^{-40} (Q-factor 13.31) was obtained at a launched power of -10 dBm (received power -26.11 dBm) for RZ super Gaussian pulse with 95 ps FWHM. The performance of 90 ps FWHM is nearly similar to 95 ps pulse. With further decrease in the FWHM, the BER performance of the system deteriorated, as it can be seen that for 80 ps FWHM, the lowest BER obtained was 0.10x10^{-35}

10^{31} times smaller than [8] and requires around 3.6 dBm lesser received power. When the FWHM is 80 ps, the BER performance degrades as compared to that using NRZ pulse format. With further decrease in

(Q-factor of 12.60)for a launched power of 0 dBm (received power of -16.75 dBm). This BER is 10^{5} times higher than 95 ps pulse and requires nearly 10 dBm more received power. The results obtained using 95 and 90 ps FWHM pulse are far better than using NRZ pulse. The BER using the former is somewhat around 10^{2} times smaller than using NRZ pulse and requires nearly 8.2 dBm lesser received power. Also the system is much more sensitive than the ASE modulation based receiver reported in [8]. The system based on 95 ps FWHM has a lowest BER of around FWHM, the BER performance deteriorates as compared to NRZ pulse format.

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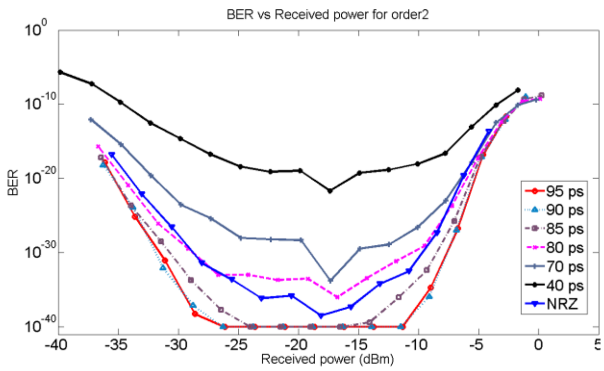

Figure 3: BER vs received power for order 2

Table 4: BER Performance of order 2, RZ super Gaussian.

L.P(dBm)	95 ps, FWHM		90 ps, FWHM		80 ps, FWHM	
	R.P(dBm)	B.E.R	R.P(dBm)	B.E.R	R.P(dBm)	B.E.R
-20	-36.11	$0.15x10^{-17}$	-36.26	$0.66x10^{-18}$	-36.68	$0.21x10^{-15}$
-17.5	-33.61	$0.72x10^{-25}$	-33.76	$0.12x10^{-23}$	-34.18	$0.12x10^{-20}$
-15	-31.11	$0.88x10^{-31}$	-31.26	$0.88x10^{-32}$	-31.68	$0.86x10^{-26}$
-12.5	-28.61	$0.57x10^{-38}$	-28.76	$0.76x10^{-37}$	-29.18	$0.37x10^{-29}$
-10	-26.11	$0.99x10^{-40}$	-26.26	$0.99x10^{-40}$	-26.68	$0.11x10^{-32}$
-7.5	-23.62	$0.99x10^{-40}$	-23.77	$0.99x10^{-40}$	-24.19	$0.11x10^{-32}$
-5	-21.12	$0.99x10^{-40}$	-21.28	$0.99x10^{-40}$	-21.70	$0.22x10^{-33}$
-2.5	-18.65	$0.99x10^{-40}$	-18.80	$0.99x10^{-40}$	-19.21	$0.31x10^{-33}$
0	-16.18	$0.99x10^{-40}$	-16.33	$0.99x10^{-40}$	-16.75	$0.10x10^{-35}$
2.5	-13.74	$0.99x10^{-40}$	-13.89	$0.99x10^{-40}$	-14.30	$0.37x10^{-33}$
5	-11.32	$0.99x10^{-40}$	-11.46	$0.99x10^{-40}$	-11.86	$0.70x10^{-31}$
7.5	-8.97	$0.21x10^{-34}$	-9.11	$0.11x10^{-35}$	-9.51	$0.83x10^{-29}$
10	-6.7	$0.19x10^{-26}$	-6.84	$0.105x10^{-26}$	-7.21	$0.21x10^{-23}$
12.5	-4.6	$0.16x10^{-16}$	-4.72	$0.809x10^{-17}$	-5.06	$0.49x10^{-17}$
15	-2.68	$0.25x10^{-11}$	-2.77	$0.89x10^{-12}$	-3.07	$0.45x10^{-12}$

Table 5: BER Performance of order 2, RZ super Gaussian.

L.P(dBm)	70 ps, FWHM		60 ps, FWHM		40 ps, FWHM	
	R.P(dBm)	B.E.R	R.P(dBm)	B.E.R	R.P(dBm)	B.E.R
-20	-36.95	$0.29x10^{-14}$	-37.975	$0.26x10^{-9}$	-39.82	$0.21x10^{-5}$
-17.5	-34.45	$0.16x10^{-18}$	-35.47	$0.57x10^{-12}$	-37.21	$0.57x10^{-7}$
-15	-31.96	$0.67x10^{-22}$	-32.97	$0.33x10^{-14}$	-34.82	$0.19x10^{-9}$
-12.5	-29.46	$0.13x10^{-23}$	-30.47	$0.47x10^{-17}$	-32.32	$0.31x10^{-12}$
-10	-26.96	$0.11x10^{-27}$	-27.97	$0.92x10^{-18}$	-29.82	$0.24x10^{-14}$
-7.5	-24.46	$0.91x10^{-29}$	-25.48	$0.29x10^{-19}$	-27.32	$0.19x10^{-16}$
-5	-21.97	$0.36x10^{-30}$	-22.98	$0.53x10^{-20}$	-24.82	$0.42x10^{-18}$
-2.5	-19.48	$0.40x10^{-31}$	-20.49	$0.45x10^{-20}$	-22.33	$0.83x10^{-19}$
0	-17.02	$0.19x10^{-35}$	-18.02	$0.22x10^{-21}$	-19.84	$0.11x10^{-18}$
2.5	-14.56	$0.10x10^{-30}$	-15.55	$0.52x10^{-21}$	-17.37	$0.22x10^{-21}$
5	-12.12	$0.26x10^{-31}$	-13.12	$0.26x10^{-19}$	-14.90	$0.56x10^{19}$
7.5	-9.76	$0.85x10^{-28}$	-10.7	$0.77x10^{-20}$	-12.47	$0.15x10^{-18}$
10	-7.44	$0.41x10^{-23}$	-8.36	$0.16x10^{-17}$	-10.08	$0.90x10^{-18}$
12.5	-5.29	$0.55x10^{-17}$	-6.13	$0.40x10^{-16}$	-7.76	$0.26x10^{-16}$
15	-3.27	$0.57x10^{-12}$	-4.05	$0.85x10^{-13}$	-5.57	$0.87x10^{-13}$
17.5	-1.51	$0.13x10^{-9}$	-2.18	$0.16x10^{-9}$	-3.52	$0.83x10^{-10}$

** L.P launched power, R.P Received power

Table 6: BER Performance of order 3, RZ super Gaussian.

L.P(dBm)	95 ps, FWHM		90ps, FWHM		85ps, FWHM	
	R.P(dBm)	B.E.R	R.P(dBm)	B.E.R	R.P(dBm)	B.E.R
-20	-36.00	$0.35x10^{-17}$	-36.18	$0.77x10^{-18}$	-36.41	$0.12x10^{-16}$
-17.5	-33.50	$0.46x10^{-25}$	-33.68	$0.99x10^{-24}$	-33.91	$0.52x10^{-23}$
-15	-31.00	$0.11x10^{-30}$	-31.18	$0.16x10^{-31}$	-31.41	$0.90x10^{-28}$
-12.5	-28.50	$0.22x10^{-38}$	-28.68	$0.26x10^{-36}$	-28.91	$0.26x10^{-32}$
-10	-26.01	$0.99x10^{-40}$	-26.18	$0.99x10^{-40}$	-26.41	$0.92x10^{-37}$
-7.5	23.51	$0.99x10^{-40}$	-23.69	$0.99x10^{-40}$	-23.92	$0.17x10^{-36}$
-5	-21.02	$0.99x10^{-40}$	-21.20	$0.99x10^{-40}$	-21.43	$0.28x10^{-37}$
-2.5	-18.55	$0.99x10^{-40}$	-18.73	$0.99x10^{-40}$	-18.96	$0.99x10^{-40}$
0	-16.08	$0.99x10^{-40}$	-16.25	$0.99x10^{-40}$	-16.48	$0.99x10^{-40}$
2.5	-13.64	$0.99x10^{-40}$	-13.81	$0.99x10^{-40}$	-14.04	$0.32x10^{-36}$
5	-11.21	$0.99x10^{-40}$	-11.39	$0.99x10^{-40}$	-11.60	$0.37x10^{-34}$
7.5	-8.87	$0.57x10^{-34}$	-9.04	$0.53x10^{-35}$	-9.25	$0.12x10^{-30}$
10	-6.61	$0.12x10^{-25}$	-6.77	$0.56x10^{-26}$	-6.97	$0.55x10^{-24}$
12.5	-4.51	$0.35x10^{-16}$	-4.65	$0.23x10^{-16}$	-4.84	$0.13x10^{-16}$
15	-2.59	$0.53x10^{-11}$	-2.71	$0.17x10^{-11}$	-2.88	$0.12x10^{-11}$
17.5	-0.93	$0.64x10^{-8}$	-1.03	$0.17x10^{-8}$	-1.17	$0.63x10^{-9}$

Table 7: BER Performance of order 3, RZ super Gaussian.

L.P(dBm)	80 ps, FWHM		75ps, FWHM		70ps, FWHM	
	R.P(dBm)	B.E.R	R.P(dBm)	B.E.R	R.P(dBm)	B.E.R
-20	-36.68	$0.42x10^{-15}$	-36.99	$0.93x10^{-13}$	-37.31	$0.49x10^{-11}$
-17.5	-34.18	$0.28x10^{-19}$	-34.49	$0.79x10^{-16}$	-34.81	$0.23x10^{-14}$
-15	-31.68	$0.18x10^{-23}$	-31.99	$0.48x10^{-19}$	-32.31	$0.50x10^{-18}$
-12.5	-29.19	$0.31x10^{-27}$	-29.49	$0.29x10^{-23}$	-29.81	$0.13x10^{-20}$
-10	-26.69	$0.11x10^{-27}$	-26.99	$0.98x10^{-26}$	-27.31	$0.53x10^{-22}$
-7.5	-24.19	$0.17x10^{-29}$	-24.49	$0.18x10^{-27}$	-24.81	$0.69x10^{-24}$
-5	-21.70	$0.18x10^{-29}$	-22.00	$0.14x10^{-27}$	-22.32	$0.37x10^{-25}$
-2.5	-19.21	$0.25x10^{-30}$	-19.51	$0.26x10^{-28}$	-19.83	$0.14x10^{-25}$
0	-16.75	$0.87x10^{-35}$	-17.05	$0.24x10^{-33}$	-17.36	$0.13x10^{-27}$
2.5	-14.30	$0.32x10^{30}$	-14.59	$0.63x10^{-29}$	-14.90	$0.24x10^{-25}$
5	-11.86	$0.34x10^{-30}$	-12.15	$0.87x10^{-29}$	-12.46	$0.27x10^{-24}$
7.5	-9.51	$0.24x10^{-27}$	-9.79	$0.34x10^{-26}$	-10.08	$0.21x10^{-23}$
10	-7.21	$0.29x10^{-22}$	-7.47	$0.59x10^{-22}$	-7.76	$0.30x10^{-20}$
12.5	-5.06	$0.12x10^{-16}$	-5.31	$0.22x10^{-16}$	-5.58	$0.21x10^{-16}$
15	-3.07	$0.13x10^{-11}$	-3.29	$0.2x10^{-11}$	-3.54	$0.65x10^{-12}$
17.5	-1.34	$0.22x10^{-9}$	-1.52	$0.16x10^{-9}$	-1.73	$0.17x10^{-9}$

**L.P launched power, R.P Received power

4.4 RZ-super Gaussian pulse, order 3:

The corresponding details are given table 6, 7 respectively and the plot of BER vs received power is shown in figure 4. The minimum BER of $0.99x10^{-40}$ (Q-factor 13.31) was obtained at a launched power of -10 dBm (received power -26.01 dBm) for RZ super Gaussian pulse with 95 ps FWHM. The performance of 90 ps FWHM is nearly similar to 95 ps pulse. The BER performance of the system based on third order RZ super Gaussian pulse is better up to 85 ps as compared to the system based on NRZ pulse format. With further decrease in FWHM of the pulse the performance degraded and the pulse format with 80 ps FWHM and less; has inferior BER performance as compared to the NRZ pulse based system. As an example RZ super Gaussian pulse with 70 ps FWHM has lowest BER of $0.13x10^{-27}$ which is of the order of 10^{11} times larger as compared to the lowest BER obtained using NRZ pulse format. The RZ super Gaussian pulse based system is again far better as compared to the system reported to in [8]. The BER performance at 95 ps FWHM is around 10^{31} times smaller as compared to system reported in [8] at nearly 3.31 dBm lesser received power.

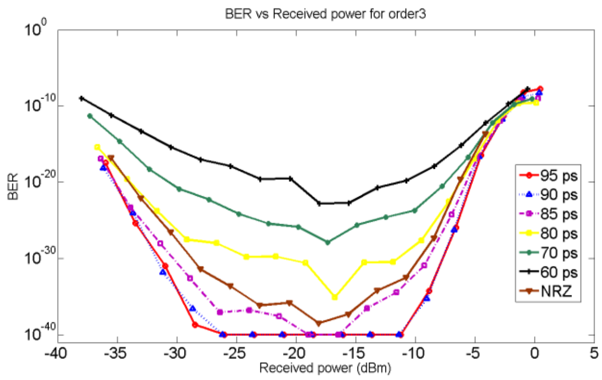

Figure 4: BER vs received power for order 3

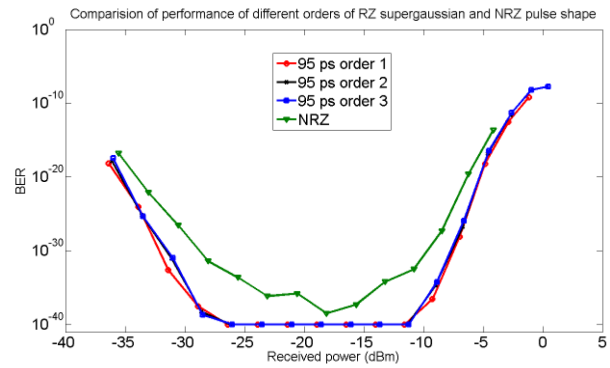

Figure 5: Comparison of different orders of RZ super Gaussian pulse with NRZ pulse format

4.5 Comparison of different orders of RZ super Gaussian:

To compare the performance of different orders of RZ super Gaussian pulse, we have plotted 95 ps FWHM pulse for all three orders and compared it with NRZ pulse format. It can be seen from figure 5 that the curves corresponding to different orders of pulse at 95 ps are overlapped, thus the BER performance of different orders of pulse is nearly same. In the initial part of the curves for low received power, the first order 95 pulse has slightly low BERs for same launched powers.

5. Conclusion:

It was analyzed that SOA as a preamplifier based optical receiver is more sensitive using RZ super Gaussian pulse as compared to the one using NRZ. For orders 1, 2, 3 of RZ super gaussian pulse; the 95 ps FWHM pulse produced a BER of $0.99x10^{-40}$ which is nearly 10^2 times smaller than the lowest BER produced by the NRZ pulse. While the received power required to get the same performance is nearly 8.2 dBm lesser (launched power 7.5 dBm lesser) for the RZ super Gaussian. The performance of the SOA preamplifier optical system using RZ super Gaussian pulse is far better as compared to the ASE modulation based preamplifier reported in [8]. With further decrease in FWHM of the RZ super Gaussian pulse, the BER performance degraded and eventually became poorer as compared to NRZ pulse at 70, 80, 80 ps FWHM respectively for the three orders. Finally, it is concluded that FWHM pulse width is the main characteristic in achieving the higher sensitivity in our optimized preamplifier system and order of the pulse has very less effect on it.

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