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A Fabrication Study on DCF Compensated SMF using Optsim Simulation Software

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Abstract: This Paper deals with the analysis of the performance limitation of SMF (single mode fiber) due to nonlinear effect. With the help of optsim simulation software a combination of SMF and DCF (dispersion compensation fiber) has been simulated with a proper variation in length to tackle the effects in the transmission system. Better performance was shown when a combination of SMF length 90Km and DCF length 10km was chosen. The Q-value and BER technique has been used for show the system performance.

Keywords: Chromatic dispersion, DCF, Nonlinear effect, SMF, FWM.

I. INTRODUCTION

The attractiveness of optical communication is the capability of silica-optical fibers to carry huge amounts of information over a long span.

Nonlinear effects in optical fibers have become a most recent area of academic research in the optical fiber based WDM system. The optical communication has taken its first commercial development in 1980, scaling in bit rate from very low Mbps to very high GBPS today [1]. In WDM system operating at a very high rates (beyond 10 Gbps), non-linearity such as SPM could play a significant role. This nonlinear effect can be counteracting through proper system design [2]. In non-linearity (NL), spreading occur in frequency domain and in chromatic dispersion (CD) spreading occur in time domain and It is very difficult to manage chromatic dispersion and nonlinear effects in optical fiber separately.

It is better to compensate CD with NL as frequency and time inversely related to each other and both dispersion and optical Kerr's effects [3-7] together Known as dispersion management technique. At very high bit rate transmission over SMF at 1550 nm suffer severely from combined effect of CD and NL.

These optical non-linear effects can lead to excess attenuation, distortion, interference of the optical signals, resulting in system degradation. The WDM system needs to achieve an expected optical signal to noise ratio so each channel operating relatively at high power level.

II. RELATED WORK

In a dispersion compensated link the input pulses first propagate through the SMF has positive dispersion coefficient (negative chirp in nature) and DCF having negative dispersion coefficient (positive chirp in nature). Due to SPM effect frequency chirp is positive irrespective of the sign of the dispersion coefficient parameter and broaden its spectrum .The pulse broadening rate increases during propagation in the fiber with negative dispersion coefficient parameter and the pulse broadening rate decreases during propagation in the fiber with positive dispersion coefficient parameter, as the two chirp contribution cancels each other [8].

According to dispersion management technique, the condition for perfect dispersion compensation is

$$D_{SMF}\,L_{SMF} + D_{DCF}\,L_{DCF} = 0 \qquad (1)$$

$$L_{DCF} = -\,(D_{SMF}/\,D_{DCF})\,L_{SMF} \qquad (2)$$

D_{SMF}, D_{DCF} are the fiber dispersion of SMF and DCF respectively.

L_{SMF}, L_{DCF} are the fiber length of SMF and DCF respectively.

For practical reasons, LDCF should be as small as possible. This is possible only if the DCF has large negative value of D_{DCF} (fiber dispersion).

III. SIMULATION MODEL

Typical setup is shown in figure 1.

For exact physical realization of the system, optsim simulation software has been used. The simulation model consists of three major section transmitter, channel (optical fiber), and receiver.

A. Transmitter

The transmitter consists of a pseudo random bit sequence, Non return to zero (NRZ) coder, continuous wave laser, Mach-zender modulator.

B. Optical fiber (Channel)

The optical signal generated by transmitter is carried by the fiber. The 100 km fiber span consists of the two segment SMF of length 85 Km and DCF of length 15 Km.

C. Receiver

A photodiode converts the light signal into an electrical signal. For measurement optsim provide a visualization tool called scope which is an electrical oscilloscope with numerous data processing options, BER estimation and Q value features.

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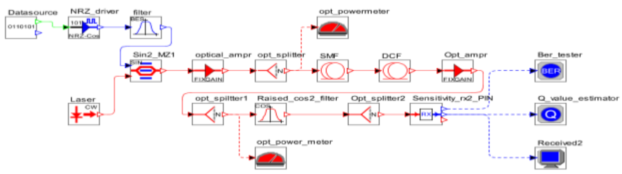

Fig.1 Simulation setup optical communication transmission system

III. SIMULATION RESULT

TABLE I SMF and two different DCF parameter.

Parameter	SMF	DCF_1	DCF_2
Fiber length(Km)	100-70	0-30	0-30
Fiber dispersion D (ps .(nm.Km)$^{-1}$)	17	-95	-170
Effective core area A_{eff} (micro-m^2)	80	20	20
Dispersion slope (ps(nm^2.Km)$^{-1}$)	0.08	-0.1	0.086
Nonlinear refractive index n_2(*10^{-20}).	2.5	2.5	2.5
Nonlinear coefficient Y(1.(W.Km)$^{-1}$	1.26	5.05	5.05
Attenuation (dB.Km^{-1})	0.25	0.55	0.50

TABLE II Comparison of Q value with two different types

SMF length in Km(L_{SMF})	DCF length in Km(L_{DCF})	Q value$_1$(dB) for DCF_1	Q value$_2$(dB) for DCF_2
100	0	16.4545	16.4545
95	5	20.3151	22.9953
90	10	24.7225	31.4566
`85	15	33.4132	16.0005
80	20	23.1211	8.3441
75	25	15.9809	6.0206
70	30	10.7480	6.0206

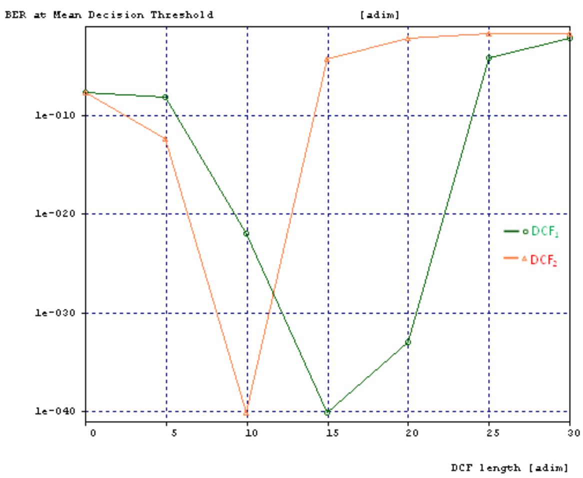

Fig.2. Comparison of BER vs DCF length.

TABLE III Comparison of BER with two different type DCF

SMF length in Km (length (L_{SMF}))	DCF length in Km (length (L_{DCF}))	BER_1 for SMF-DCF_1(DCF_1 – Conventional Dispersion compensated fiber)	BER_2 for SMF DCF_2 (DCF_2 – compensated fiber)
100	0	0.2234E-07	0.2234E-07
95	5	0.7611E-08	0.4801E-12
90	10	0.1330E-21	0.9999E-40
85	15	0.9999E-40	0.5786E-04
80	20	0.1312E-32	0.7025E-02
75	25	0.6978E-04	0.2275E-01
70	30	0.8450E-02	0.2275E-01

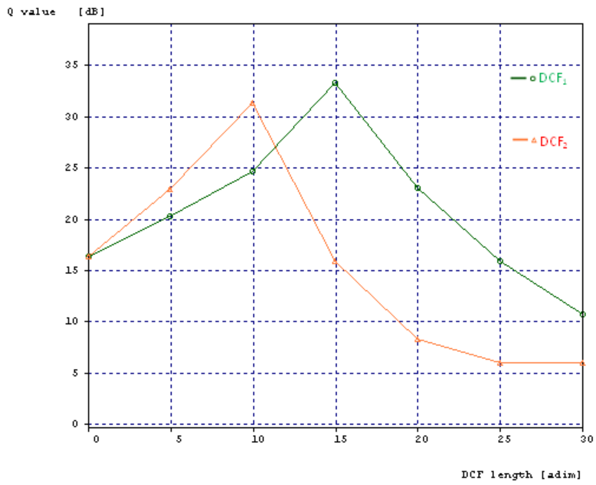

Fig.3. Comparison of Q value vs DCF

IV. CONCLUSION

The comparison of two different type of DCF is to analyse the SPM effects on optical transmission system in terms of Eye diagrams, BER and Q value. In this Model transmission link consisting of SMF of length L_{SMF} and DCF of length L_{DCF} (L_{DCF1} and L_{DCF2}) and maintain link at 10 dBm to investigate the Nonlinear effect. From Table I, only one parameter that differ with the other DCF is Fiber dispersion [D (ps.(nm.Km)$^{-1}$)].

The first combination contains DCF_1 length L_{DCF1} varied from 0 to 30 km and other combination contains DCF_2 length L_{DCF2} varied from 0 to 30 km. The lower value of BER and higher Q Value for the L_{SMF} = 85 km, L_{DCF1} = 15 km and L_{SMF} = 90 km, L_{DCF2} = 10 km indicates second combination result gives better system performance at less L_{DCF2} length. Fig. 2 and

Fig 3 provides minimum bit error rate and maximum Q value occurred at 10 Km length of DCF_2 as compare to the length DCF_1. In the analysis, the length of DCF_2 is less as compare to DCF_1 which is very significant result in terms of cost because DCF is costly as compare to SMF.

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BIOGRAPHY

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