Implementation of CATV network using different Dispersion compensating Techniques

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Abstract : *The main objective of the paper is to implementation of 16-QAM CATV (Community Antenna TV) system. To achieve this task, various dispersion compensation techniques that are more suitable for CATV system in the near future, are determine. It is necessary to use dispersion compensation devices .Dispersion compensation techniques have many advantages as a smooth dispersion profile (i.e. no dispersion ripples or group delay ripples), are tunable, and potentially provide a high channel-to-channel variation in the dispersion. It describes the affect of different dispersion compensation techniques on the eye opening, eye closure, bit-error rate (BER), Q-factor without the use of an optical amplifier, with the use of optical amplifier.This paper uses OPTSIM V3.6 and MATLAB software to simulate various dispersion compensation techniques. To extend the transmission distance is the goal of the fiber optical CATV transport systems.*

Keywords - *Dispersion compensation fiber ,Fiber Bragg gratings (fbg),Optical phase conjugation method, Reverse dispersion fiber, Negative dispersion fiber*

1. Introduction

The original purpose for cable television was to deliver broadcast signals in areas where they were not received in an acceptable manner with an antenna. These systems were called Community Antenna Television, or CATV. In 1948, Oregon, built the first CATV system consisting of twin-lead transmission wire strung from housetop to housetop. In 1950, Bob Tarlton built a system in Lansford, Pennsylvania, using coaxial cable on utility poles under a franchise from the city.

Martin Malarkey is a pioneer who organized and developed the National Community Television Association, NCTA, which later was, renamed the National Cable Television Association and more recently renamed again as the National Cable Telecommunications Association [1]

• DISPERSION COMPENSATION TECHNIQUES

The distance over which a signal can be transmitted from a transmitter to a receiver (or repeater) can be limited by either attenuation, a limitation which can be removed by optical amplifiers, or by dispersion. Chromatic dispersion in an optical fiber is a phenomenon caused by the wavelength dependence of its group velocity.

(DCF) is the predominant technology for dispersion compensation. It consists of an optical fiber that has a special design such as providing a large negative dispersion coefficient while the dispersion of the transport fiber is positive.When light propagates through periodically alternating regions of higher and lower refractive index, it is partially reflected at each interface between those regions. If the spacing between those regions is such that all the partial reflections add up in phase—when the round trip of the light between two reflections is an integral number of wavelengths—the total reflection can grow to nearly 100%, even if the individual reflections are very small. Of course, that condition will only hold for specific wavelengths. For all other wavelengths, the out-of-phase reflections end up canceling each other, resulting in high transmission [2].Optical phase conjugation (OPC) is used as a generic term for a multitude of nonlinear optical processes. The common feature is that all these processes are capable of reversing both the direction of propagation and the phase factor for each plane wave component of an arbitrary incoming beam of light. This means that a phase conjugator can be considered as a kind of mirror with very unusual reflection properties. Unlike a conventional mirror, where a ray is redirected according to the ordinary law of reflection, a phase conjugate mirror (PCM) retro-reflects all incoming rays back to their origin. Thus, any optical beam that is reflected by a PCM will retrace its original path. [3].Reverse dispersion fiber (RDF) has several advantages compared with the conventional dispersion compensation fiber (DCF), including lower loss, lower nonlinearity, and lower polarization mode dispersion (PMD.Negative dispersion fiber (NDF) has been used as the transmission medium in digital light wave transport systems. Chung et al [4] had used negative dispersion fiber for transmitting a directly modulated 10 Gbps signal. The transmission distance attained was found to be over 320 Km. NDF, which has negative dispersion, is expected to compensate positive laser chirp and improve the dispersion tolerance in a directly modulated CATV transport system.

2. IMPLEMENTATION OF VARIOUS TECHNIQUES

I. Without using optical fiber

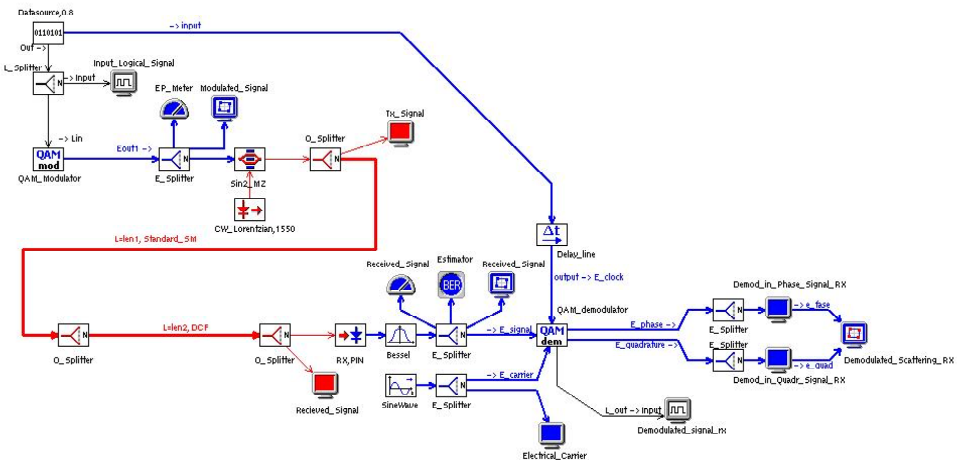

Figure 1 a(DCF)

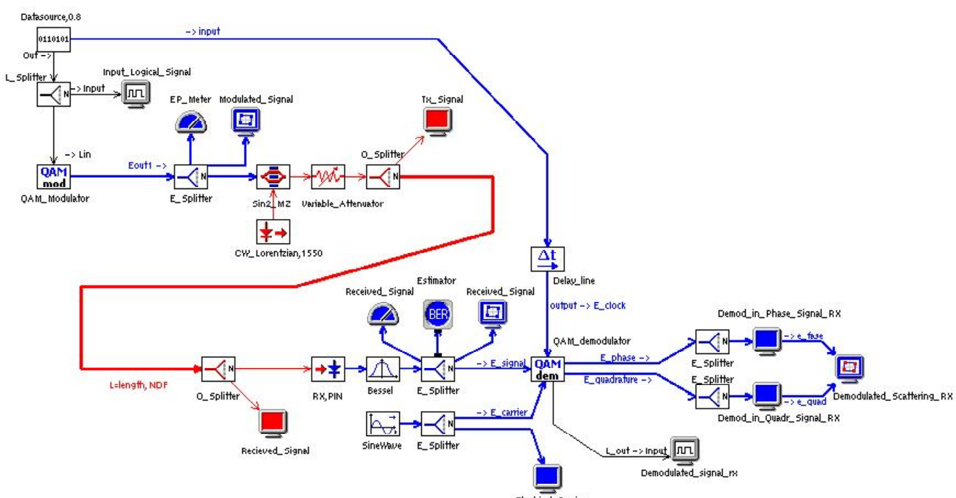

Figure 1 b(NDF)

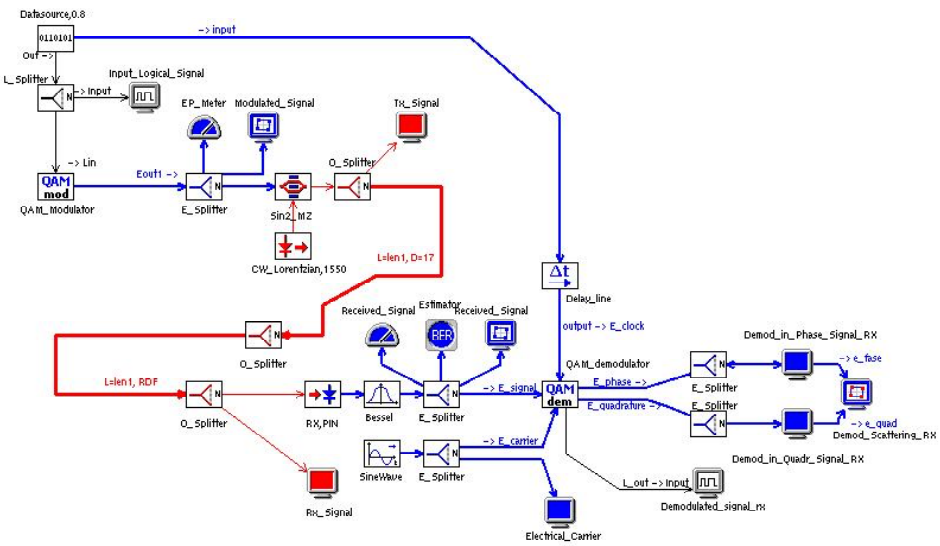

Figure 1c (RDF)

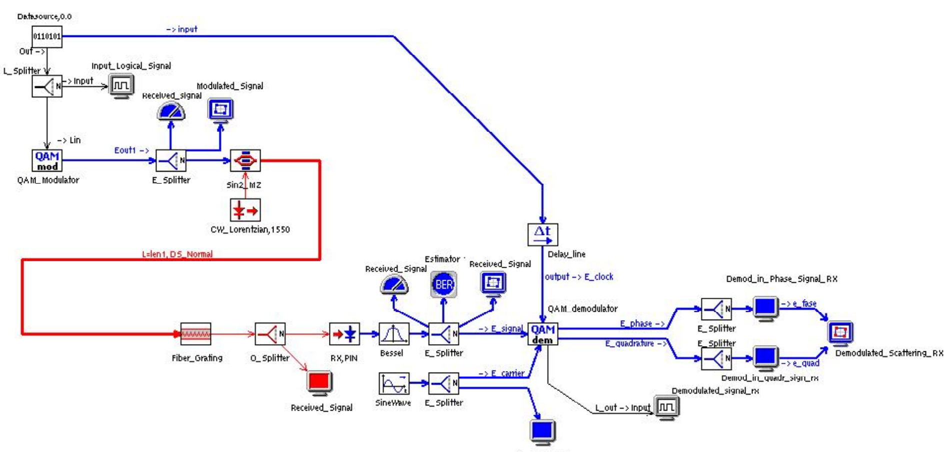

Figure 1 d(FBG)

Here optosim 3.6 version software is used. Simulation setup of various dispersion compensation techniques are implemented by using optsim 3.6 version.After implementation of various techniques individually in CATV network, various results are determined.

II. With optical fiber[using Erbium doped fiber amplifier (EDFA)]

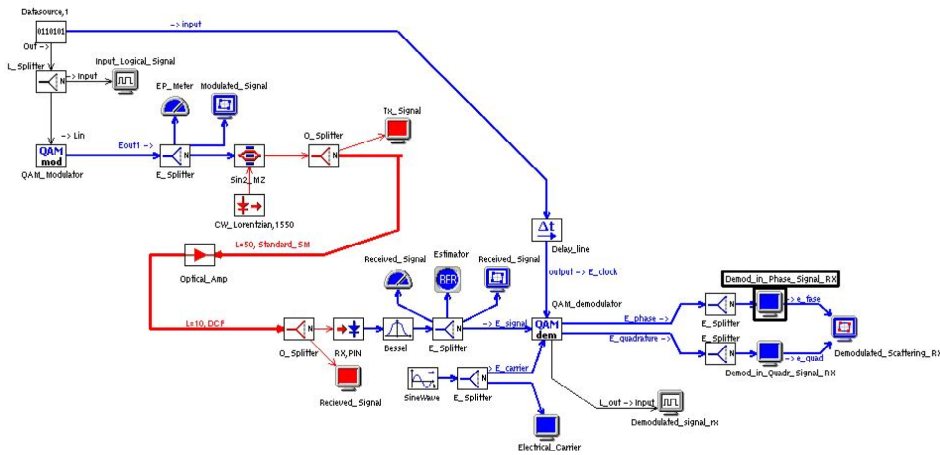

Figure 2.a(DCF)

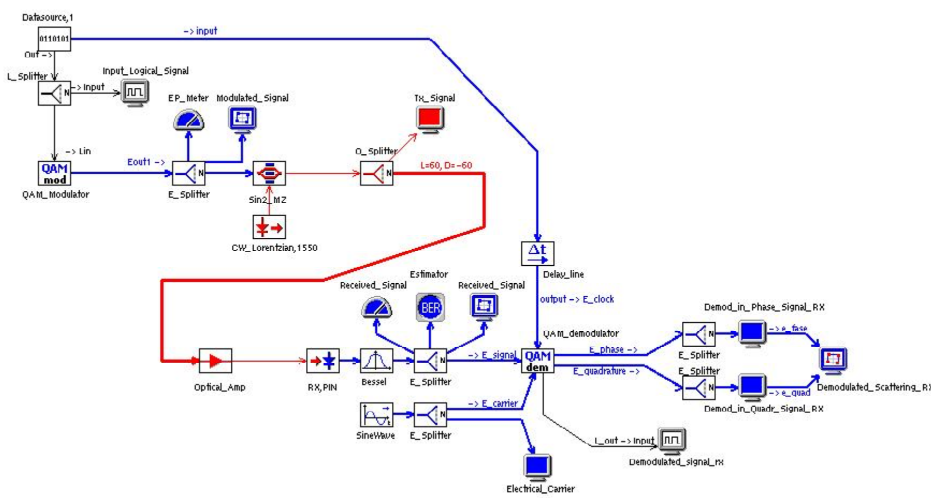

Figure 2.b(NDF)

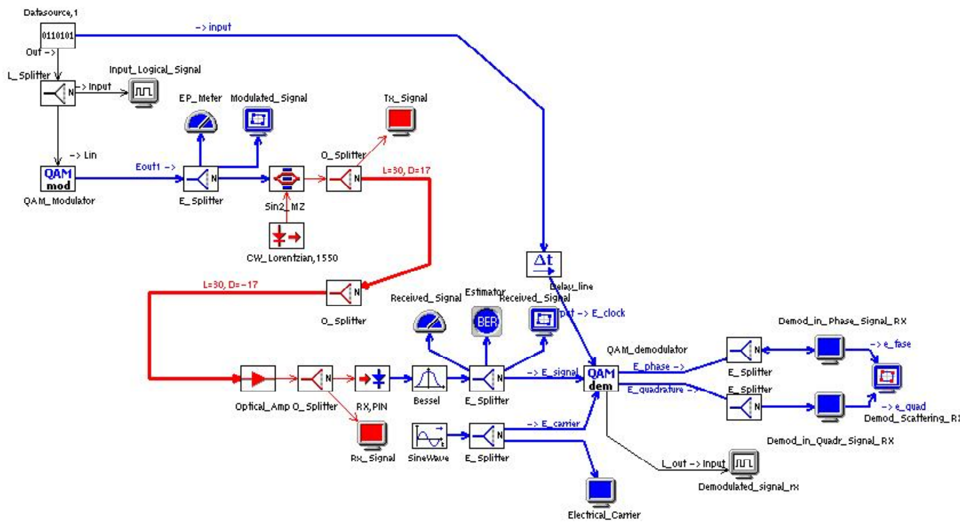

Figure 2.c(RDF)

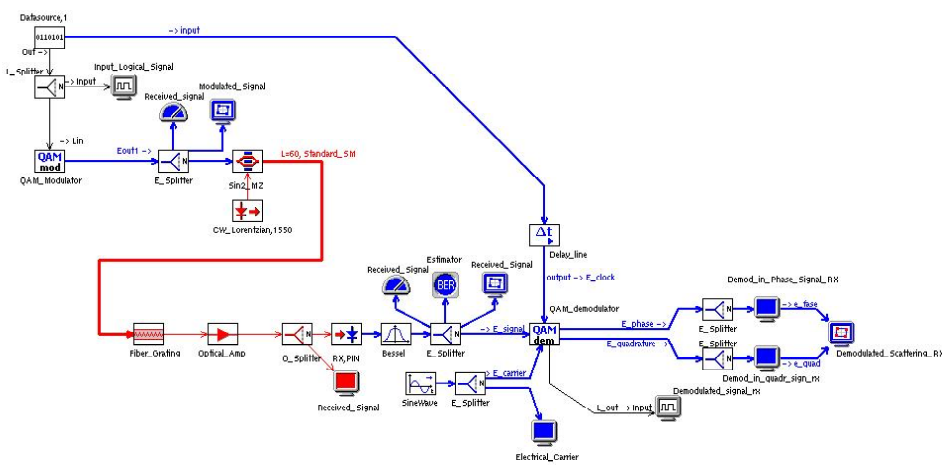

Figure 2.d(FBG)

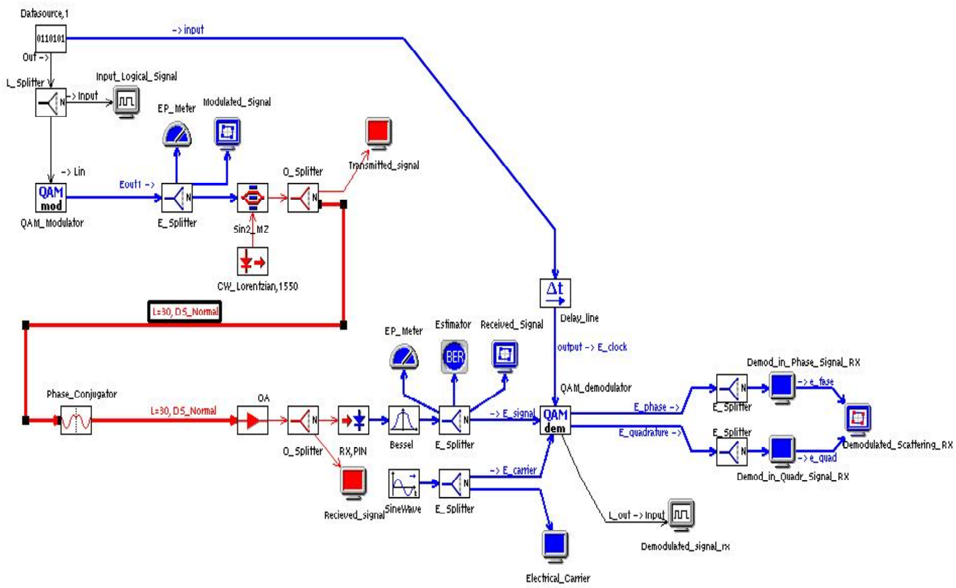

Figure 2.e(OPC)

3. Result and Discussion

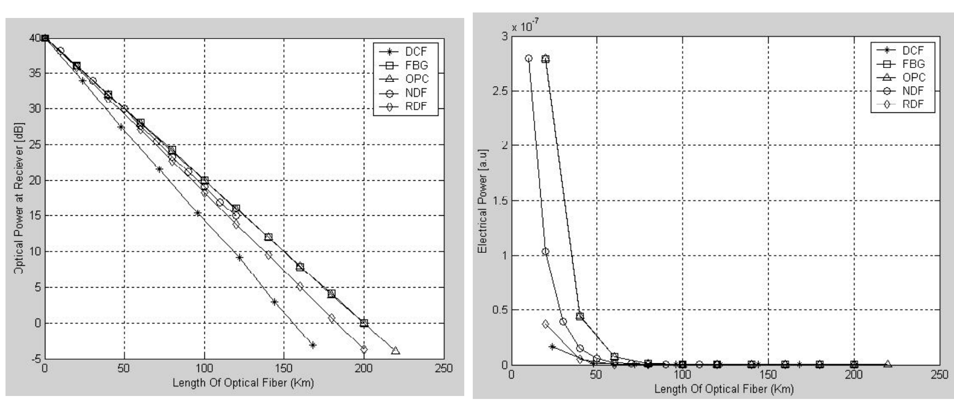

Figure 3 a(Optical power and electrical power received for various DCT)

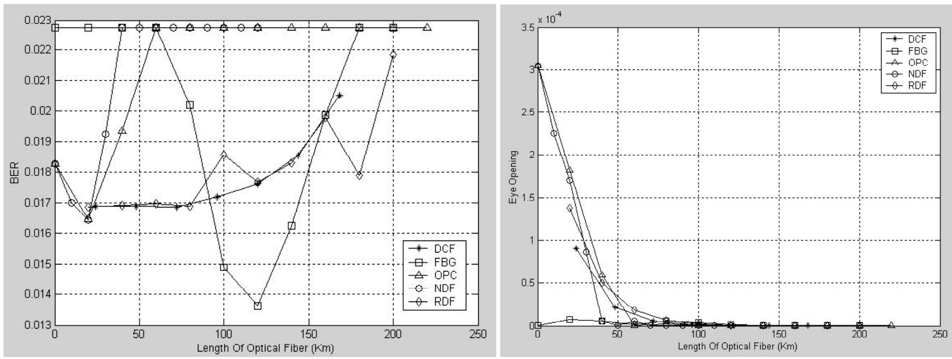

Figure 3.b(BER and eye opening for various dispersion compensation techniques)

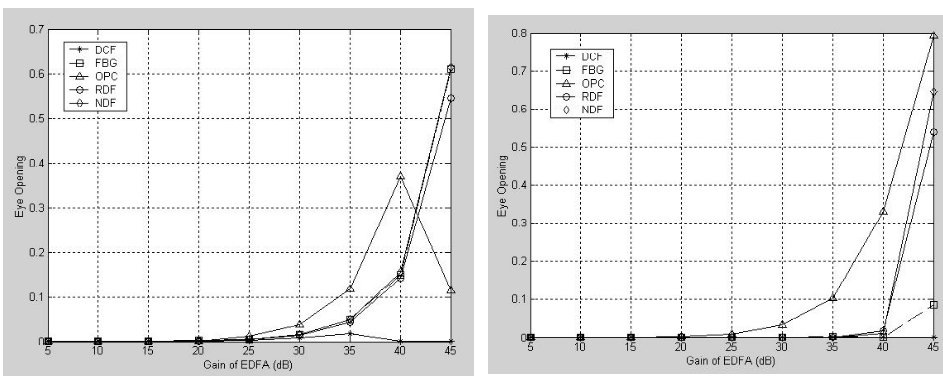

Figure 3.c(Comparison of eye opening at different values of amplifier gain for different dispersion compensation techniques at 0.8 Gbps and 1.0 Gbps)

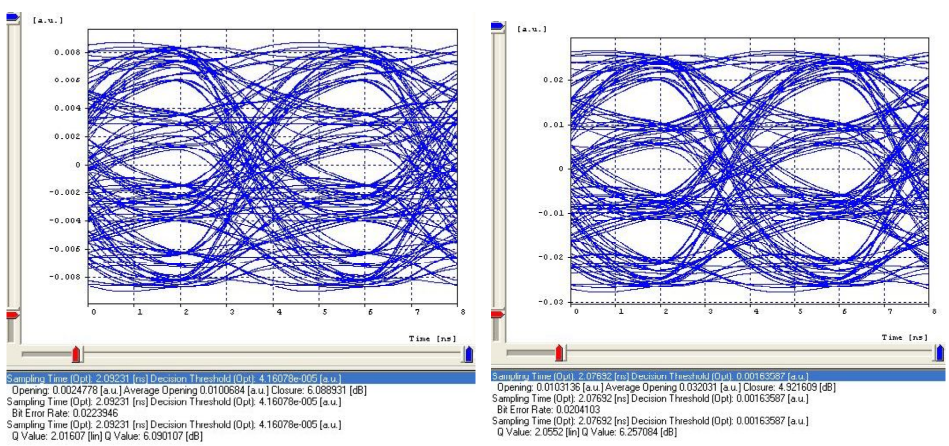

Figure 3. d(OPC technique at 20 dB and 25 dB gain & 1.0 Gbps)

4. Conclusions

Therefore we can conclude that the technique using fiber Bragg grating (FBG) is more attractive technique for dispersion compensation in CATV networks without using any optical amplifier in the range of 100 to 140 Km. The next better technique is by using optical phase conjugator (OPC) as a dispersion compensation device. The transmission length obtainable is around 210 Km without any optical amplification. RDF technique is more effective for long distances of about 200 Km again without any amplification.

Table 1: compare results of various techniques (at 0.8Gb/s)

Dispersion compensating Techniques	Gigabit/s	Eye opening	Eye closure	BER	Q-Fector
DCF	0.8	optimum value	best	optimum	next best
OPC	0.8	high	optimum	optimum	optimum
FBG	0.8	best	optimum	next best	next best
RDF	0.8	best	best	best	next best
NDF	0.8	best	best	best	best

Table 2: compare results of various techniques (at 1.0Gb/s)

DCT	Gigabit/s	Eye opening	Eye closure	BER	Q-Fector
DCF	1.0	optimum value	best	next best	best
OPC	1.0	very best	poor	optimum	very best
FBG	1.0	best	next best	next best	next best
RDF	1.0	best	best	next best	best
NDF	1.0	best	best	best	next best

Table3: compare results of various techniques (at 1.2Gb/s)

Dispersion compensating Technique	Gigabit/s	Eye opening	Eye closure	BER	Q-Fector
DCF	1.2	optimum value	best	optimum	best
OPC	1.2	very best	poor	optimum	optimum
FBG	1.2	optimum	worst	next best	best
RDF	1.2	best	best	best	very best
NDF	1.2	best	best	very best	very best

In the previous topics we have discussed the results of simulation for the comparison of various dispersion compensation techniques. The results of simulation were confined to 1.2 Gigabit per second bit rate. A lot of research work has been done to increase the data rates. By using CSRZ bit rate 20 Gigabit per second was simulated.

From eye opening, eye closure, bit error rate (BER) and Q-factor characteristics it is clear that, the dispersion compensation techniques using fiber Bragg grating (FBG) and optical phase conjugator (OPC) as dispersion compensating devices may be interchangeably used at 10 Gigabit per second and 15 Gigabit per second bit rates. At higher bit rates of 20 Gigabit per second, the dispersion compensation technique using a combination of standard single mode fiber (SSMF) and reverse dispersion fiber (RDF) for dispersion compensation is attractive for longer transmission distances at higher bit rate.

5. References

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