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Software simulation for the study of the fiber optic properties and its impact on the output power

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ABSTRACT

The planning fiber optic properties are one of the important fields in fiber optic communication systems. In this article a software simulation proposed to study the main properties of single mode fiber and impact on the output power. This is because fiber optics has many advantages, including a small transmission loss, so it is used for high-speed data transmission. Dispersion is the main factor limiting performance. By simulating an optical communication device model and using the system's most suitable settings that include power inputs (dB), the length of the optical cable (km) and attenuation coefficient (dB /km) which belongs to the fiber optics, different parameters were calculated in this project, including the recipient's decibel energy. From the monitors at the end of transmission link like as (OTDV, OSA, and WDM Analyzer) the overall system behaviors show good results.

Keywords: SSMF, Attenuation, Dispersion, Numerical Opening, OptiSystem

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1. Introduction

Optical fibers as transporter of energy and information have intrigued intensive interest worldwide due to its scientific and technological significance in various practical fields. For example, in optical communications, fibers have received tremendous interest from both theoretical and experimental aspects not only on the sort of fiber materials yet additionally on different communicating techniques [1]. It plays a significant role in modern telecom networks. Optical fiber networking as a modern technology is unique in the history of communications in recent years, its rapid growth and the wide variety of applications [2]. Optical fibers consist of a cylindrical core also, an encompassing cladding, both made of silica [3], is a medium for carrying information from one point to another in the form of light [4]. These systems also involve multiple signal channels, different topology structures, nonlinear devices and non-Gaussian noise sources, making their design and analysis very complex and requiring work of high intensity. OptiSystem will enable the expeditious and efficient planning and review of these systems [2]. In the optical fiber communication network, there are several limiting factors associated with the information rate and cap. There may be linear or non-linear limiting factors. We can recompense the linear impact, for example, scattering and constriction by utilizing beat having right shape by using simulation OptiSystem7.0 [5]. The article falls into many sections the literature review in section II, the fiber optic and its properties section III, in section IV the methodology will be introduced, in section V the results and discussion, and finally section VI contains the conclusion.

2. Literature review

Many researchers in previous studies introduce many projects related to the SSMF and its properties here, we demonstrate some of them, Rameez, and et. al. [6]. Fourier method up to 3.6dB related eye-opening (EO)-improvement managed at 6dBm signal launch capacity by optimizing and changing the Digital Backward Propagation (DBP) algorithm parameters is used in computationally efficient study. R. Sonee, and et. al. [7], this paper deals used a simple Brillouin-Raman multichannel fiber laser with Rayleigh support scattering. The degradation of OSNR between Stokes lines is due to the impact of tumultuous waves LEAF to achieve the widest fiber laser bandwidth with high OSNR in BRFL wavelength. Alla, and et. al. [8], this system has accomplished the primary job of the innovation of parallel adjustment, which dazzles information on the optical bearer utilizing the program OptiSystem. Shehab, and et. al. [9], the specialists examined configuration studies and investigation of the model reproduction of the advanced fiber correspondence framework just as front-end parts and units used to actualize them. Utilizing a laser transmitter with (1310 and 1550nm) wavelength as vitality inputs (dBm), fiber optics with both (SMF and MMF), three distinct parameters were explored to be specific power yield (dBm), commotion figure (decibel), and penetrability of two sorts of fiber. Aditya Goel and Gaurav Pandey [10], in this paper a proficient plan calculation utilizing quadratic FEM is talked about for planning of NZDSF and DCF utilizing LP01 mode. Records show that Perfect plan DCF can decrease the current conventional scattering Single-mode fiber (CSMF) from (17.56 to 2.13) ps/nm/km Over the wavelength. Marcionilo, and et. al. [11], this paper manages how to adjust the hypothetical model of nonlinear dispersion in optical filaments. It was discovered that when the composite associations of unadulterated silica main element and NZDSF in the two cases demonstrated that the framework works better when the optical sign is spread through the convergence of NZDSF. Zihan, and et. al. [12], this examination manages improved sign to-clamor proportion (OSNR) innovation within the sight of mutilations brought about by non-direct optical filaments at 224 Mbps. The OSNR innovation has accomplished much preferable execution over MOSMB and EVM-ACF OSNR checking strategies.

3. Fiber optic and it's properties

According to the transmission modes, optical fibers can be separated into single-mode fibers and multimode fibers. SMFs show magnificent capacity in optical correspondences, and furthermore the lightweight vitality transmitted by SMFs presents to be Gauss circulations, which proposes the extra incorporated vitality will be acquired [1], Single mode fiber features a abundant smaller core solely concerning nine microns, so the sunshine travels in barely one ray. Single mode fiber shows lower lessening [13]. The exhibition of single mode is in this manner reasonable that it's the sole sort of fiber utilized for long separation joins [14]. Multimode strands have center distances across of 50μm or more [15], this fiber has a generally enormous numerical gap, making it appropriate for gathering the light from a mixed-up light source, for example, a light-transmitting diode [16]. Multimode strands likewise have a few hindrances. As the quantity of modes builds, the impact of modular scattering increments. Modular scattering implies that modes land at the fiber end at marginally various occasions. This time contrast makes the light heartbeat spread. Modular scattering influences framework data transfer capacity. Fiber producers change the center measurement, numerical opening (NA) as show in Equation 1, and record profile properties of multimode filaments to augment framework transmission capacity [13].

$$NA = n\sin(\theta) \qquad (1)$$

It can also be expressed as a factor of the refractive indices of the fiber.

$$NA = \sqrt{\left(N_1^2 - N_2^2\right)} = N_1\sin(\theta_2) \qquad (2)$$

The fiber optic has many important properties in the following subsection we introduce some of them:

3.1. Attenuation

Attenuation is because, as lightweight, the losing of optical power falls on the cable. In fiber this setback or narrowing depends on the wavelength of the light that is multiplying among it. There square measure 3 essential information measure 'windows' of excitement inside the reducing scope of fiber. The chief window is at 800nm to 900nm, here is a certifiable supply of Simplicity fundamentally dependent sources and markers. The next window is at 1260nm to 1360nm, here is low fiber constriction, not to mention zero scattering of materials. The third intrigue window is at 1430nm to 1580nm whichever position fiber has its least lessening. normally the media communications exchange use wavelengths inside the third window that corresponds with the increase data proportion of fiber intensifiers [17]. Signal lessening is sketched out in light of the fact that the optical input power (Pi) link size to the optical power (Po) function. Optical input control is that the power from accomplice degree of optical supply is blended into the cable. Optical power regulation is that the fiber finish or optical marker provided the power. The resulting condition defines signals weakening as length units:

$$Att. = \frac{10}{L}\ log_{10}\left(\frac{P_i}{P_\circ}\right) \quad (3)$$

Where (L) is that the length of fiber communicated in metric linear unit, and furthermore the constriction is estimated in dB/km. Weakening is brought about by retention, dispersing, and twisting misfortunes, each system of misfortune is affected by characteristics of fiber materials and arrangement of fibers. Be that as it may, misfortune is moreover blessing at fiber connections [18].

3.2. Dispersion

Light from an ordinary optical inventory can includes restricted range. Very surprising the various wavelength components during this gamut can opened up at different velocities on a fiber in the long run perpetrating the pulse to unfurl. When the beats unfurl to the point that any place, they clash with its causing recognition issues at the beneficiary prompting blunders in transmission. This can be known as entomb image Interference (ISI) or chromatic dispersion could be a limiting think about fiber information measure, since the shorter the pulses a lot of inclined they're to Directorate for Inter-Services Intelligence, [19]. Dispersion diffuses the optical pulse as it transmits on the fiber. That spread of the sign heartbeat lessens the framework data measure or the data conveying ability of the fiber. Dispersion restricts how energetically knowledge is moved. A Bumble happens once the beneficiary can't separate between input beats brought about by the spreading of each pulse [11].

4. System setup

The System transmits data from transmitter to collector through optical fiber using optical bearer wave. The data signal consists of electrical data labeled by 0's and 1's was rendered with non-return-zero (NRZ) pseudo-Random Bit Sequence Generator. Until then, the information signal is made to do with the semiconductor laser, which is tended through the Mach-Zehnder modulator to the Continuous Wave (CW) Laser. The fiber utilized for optical application is SMF. The format of the system is given as the accompanying Figure (1):

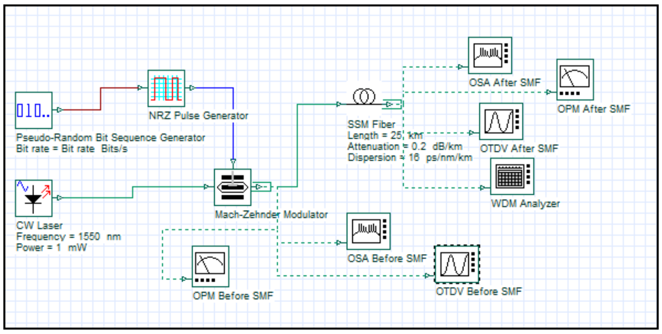

Figure 1. The designed model of simulated system with OptiSystem software

The main layout of software simulation for the SSMF demonstrate in Figure 1, the system consist of many components (active/passive), (the continuous wave laser produce an optical power with wavelength of (1550nm) and its power is (1mW), the Mach Zehnder to modulate the optical signal and electrical signal, the pseudo bit sequence random generator to produce random seeds of bits, and the electrical signal generator like none return to zero (NRZ), the SSMF with its properties (attenuation (0.2-0.4 dB/km), dispersion (16-30ps/nm/km), and fiber length (25-100km), and the bandwidth of our optimization is 10Gbps.

5. Results and disscusion

After run series of iterations the output signal showing in Figures (2-5), at the end of fiber optical the optical spectrum analyzer (OSA) display the wavelength on x-axis versus power on y-axis it show the stability of signal because the attenuation and dispersion at the standard values, the output signals at iterations (1-6) seems are very good in shape without filtering refer to precise fiber characteristics, on the other hand, the output signals for iterations (7-10) are not good in shape due to appear nonlinearity problems in fiber optic.

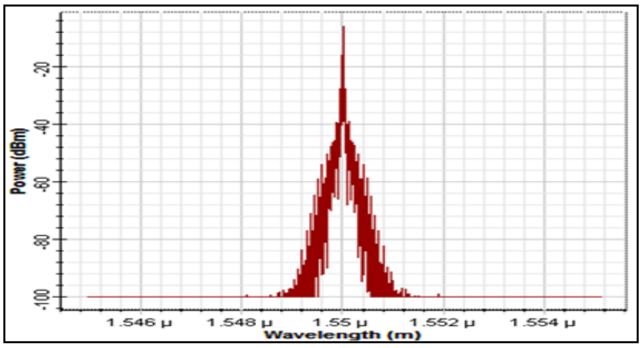

Figure 2. Power versus wavelength signal before lunched to the link when attenuation=0.2dB/km, dispersion=16ps/nm/km, length=25km, power=1mW

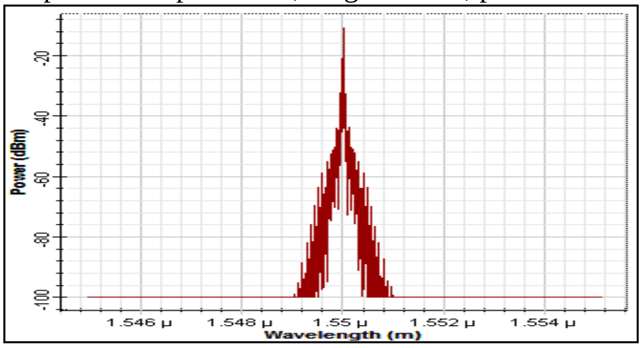

Figure 3. Power versus wavelength signal after journey from the link when attenuation=0.2dB/km, dispersion=16ps/nm/km, length=25km, power=1mW

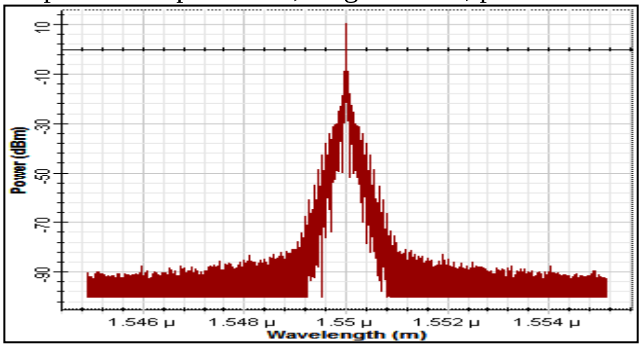

Figure 4. Power versus wavelength signal before lunched to the link when attenuation=0.4dB/km, dispersion=30ps/nm/km, length=100km, power=40mW

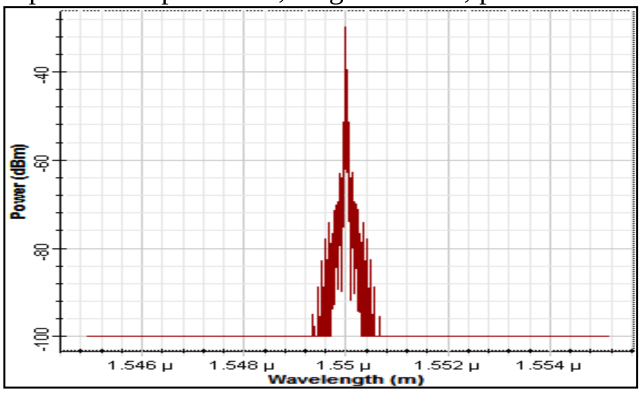

Figure 5. Power versus wavelength signal after journey from the link when attenuation=0.4dB/km, dispersion=30ps/nm/km, length=100km, power=40mW

Figures (6-9) illustrate the input and output signal concluded by the optical time domain visualizer (OTDV), the x-axis show the signal time, and the y-axis show the power signal, the output signal for iterations (1-6) seems are good because the fiber characteristics are stable and selected perfectly, but the output signals for iterations (7-10) are showing not good i.e., there is no output due to the bad fiber optic characteristics.

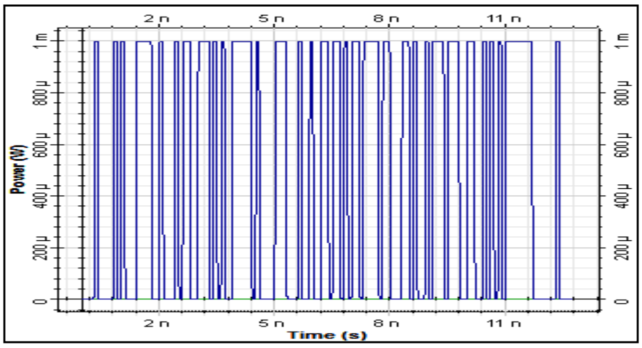

Figure 6. Power versus time signal before lunched to the link when attenuation=0.2dB/km, dispersion=16ps/nm/km, length=25km, power=1mW

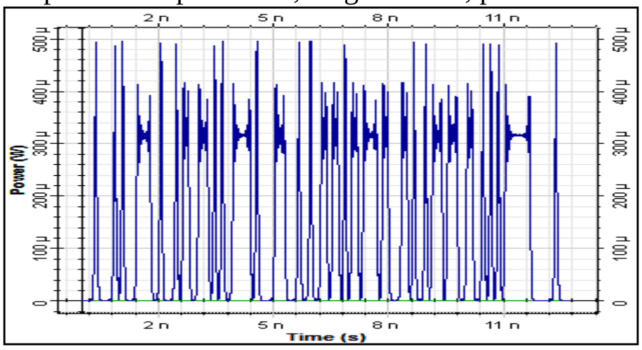

Figure 7. Power versus time signal after journey from the link when attenuation=0.2dB/km, dispersion=16ps/nm/km, length=25km, power=1mW

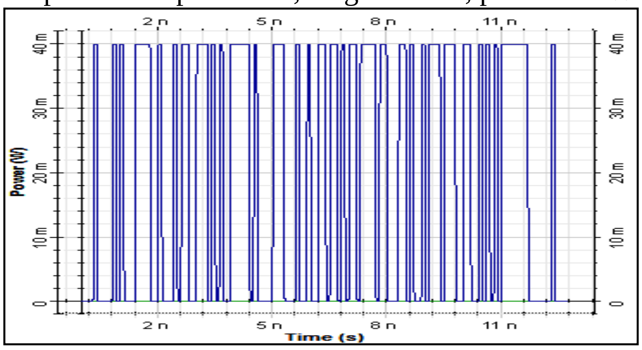

Figure 8. Power versus time signal before lunched to the link when attenuation=0.4dB/km, dispersion=30ps/nm/km, length=100km, power=40mW

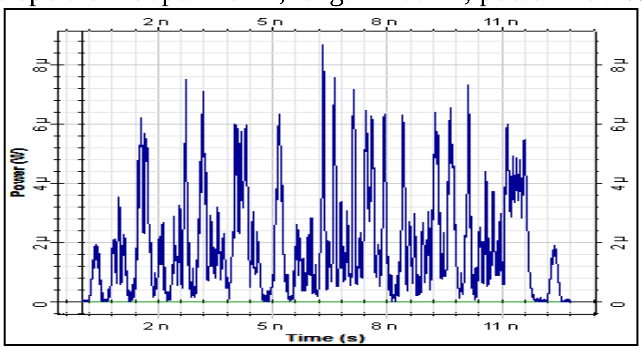

Figure 9. Power versus time signal after journey from the link when attenuation=0.4dB/km, dispersion=30ps/nm/km, length=100km, power=40mW

From the optical time domain visualizer (OTDV) and optical power meter we getting these results after signal journey in optical fiber, the average amplitude for all ten iterations is (-56.291dBm), the average output power is (-10.0814dB), the output signal power for all iterations is (-10.25dBm), the output noise power is (-

60.15dBm), and the OSNR is (49.9dB), the fiber length for distance over 50km are best, the results compare with the power before lunched to the fiber are good.

6. Conclusions

The optical transmission framework has been demonstrated by utilizing Optisystem7.0 test system so as to explore various parameters of the framework. From the reenactment result, it can presume that the fiber length and the information control are legitimately corresponding to the signal power. While the output power is decreased although the attenuation coefficient and dispersion increased. The affecting of fiber properties are important parameters in fiber optic system architecture due to the overcome the nonlinearities problems, increasing the attenuation, and dispersion will be unfavorable effects on the output power. This can be overcome by using amplifiers or compensators.

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