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# Optical Double sideband signal with different electrical pulses

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**Abstract**
In this paper, we have analyzed the optical double sideband signal with different electrical pulses. The ODSB signal has been generated using Mach-Zehnder modulator. The Mach-Zehnder modulator uses the electrical signal for this purpose. We have used four elctrial pulses in the simulation.

## 1. Introduction

The ODSB signal is the signal with carrier signal and two sidebands[1]. These sidebands carries the information that is transmitted and extracted from the carrier signal. The generation of optical double sideband carrier is as shown in figure 2. Different components are used with the Mach-Zehnder modulator. The role of the optical transmitter is to convert the electrical signal into optical form, and launch the resulting optical signal into the optical fiber. The optical transmitter consists of the optical source, electrical pulse generator and optical modulator. There are two fundamental noise mechanisms in a photodetector i.e, shot noise and thermal noise. PRBSG generates a Pseudo Random Binary Sequence (PRBS) according to different operation modes. The bit sequence is designed to approximate the characteristics of random data. As shown in figure, it sends the bit sequence to the NRZ Pulse Generator. The pulses modulate the Laser Measured. The Photodetector PIN receives the optical signal.

In the optical fibber communication different tpes of perforamnce degrading factors are present. Such degrading factors are chromatic dispersion, polarization mode dispersion(at higher bit rates)[2], different non-linear effects such as four wave mixing. Many other degrading factors are involved in WDM systems. Many mitigation techniques have been used to mitigate these problems.

The optical fiber component simulates the propagation of an optical field in a single-mode fiber with the dispersive and nonlinear effects taken into account by a direct numerical integration of the modified nonlinear Schrödinger (NLS) equation (when the scalar case is considered) and a system of two, coupled NLS equations when the polarization state of the signal is arbitrary. The optical sampled signals reside in a single frequency band, hence the name total field. The parameterized signals and noise bins are only attenuated. Optical Spectrum Analyzer displays the modulated optical signal in the frequency domain.

Different electrical pulses used at the Mach-Zehnder modulator have different response . We have demonstrated the effect of these pulses on the system. The minimum BER of system using these pulses are shown in fig. These electrical pulses effects the performance of the system. The electrical pulses used here are non return to zero(NRZ), Gaussian pulse, return to zero(RZ), sine pulse. Diffrent modulation foemats are availables for enhacing the performance of the optical systems. Many advances modulation formats have been developed[5]. Optical soliton transmission systems are important candidate for future ultrahigh-speed long-distance optical communication[3]. Soliton transmission is the beneficial thing for the optical communication system and also have robustness to the PMD[4].

## 2. Experimental setup and results

The figure 2 shows the experimental set up using Mach-Zehnder modulator with different electrical pulses for the input of modulator we are using pseudo-random bit sequence generator with different electrical pulses. Electrical Pulse Generator generates a Return to Zero (RZ) coded signal, an electrical Gaussian-pulsed signal, a sine-pulsed signal and Non Return to Zero (NRZ) coded signal. We are using continous wave laser Generates a continuous wave (CW) optical signal at frequency 193.1Thz and power 1 mW. the system simulates the transmission of a sequence of pulses for a 10 Gb/s bit rate and optical fiber used is of length 40 km attenuation=0.2 db/km and dispersion is of 16.75 ps/nm/km.

At receiver side photodetector used is PIN photodiode with low pass Bessel filter . Filter with a Bessel frequency transfer function. Figure 3 shows the carrier and sidebands observed at the output of modulator. The BER Analyzer measures the performance of the system based on the signal before and after the propagation. Mach-Zehnder modulator simulates a Mach-Zehnder modulator using an analytical model. The Mach-Zehnder modulator is an intensity modulator based on an interferometric principle. It consists of two 3 dB couplers which are connected by two waveguides of equal length as shown in figure 1. By means of an electro-optic effect, an externally applied voltage can be used to vary the refractive indices in the waveguide branches. The different paths can lead to constructive and destructive interference at the output, depending on the applied voltage. Then the output intensity can be modulated according to the voltage.

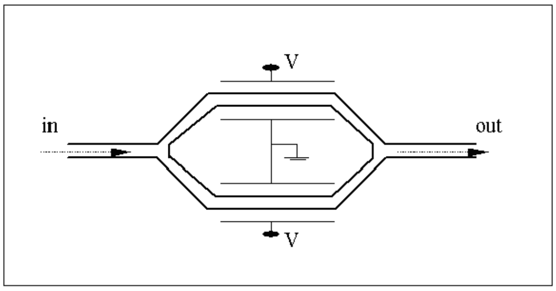


Fig. 1 Mach-Zehnder modulator

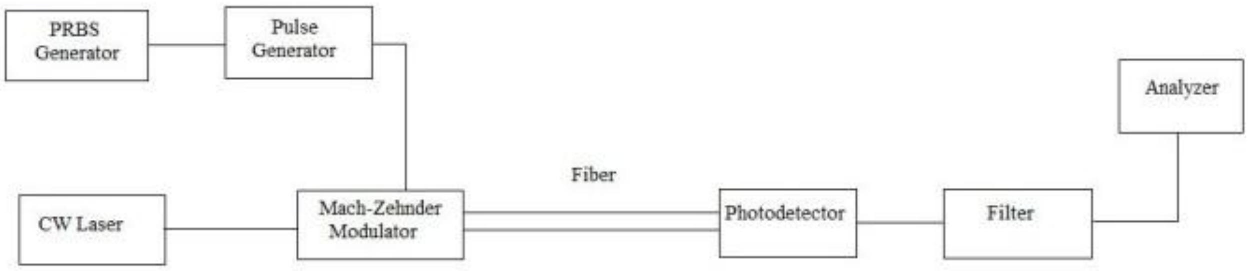


Fig. 2 Experimental set up for double sideband signal with Mach-Zehnder modulator

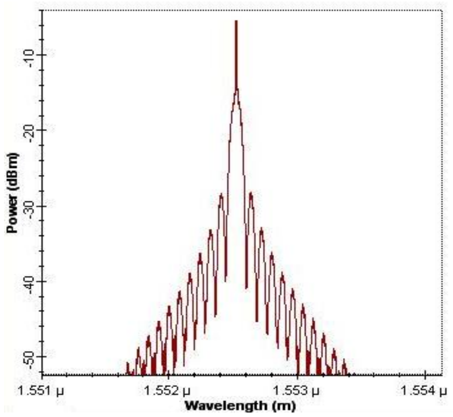


Fig. 3 Double sideband spectrum at Mach-Zehnder modulator

These electrical inputs for the Mach-Zehnder modulator has been compared according to their Min. BER and Q-factor perfromance at different dispersion values as shown in table 1 and 2.

Table 1. At dispersion 8ps/nm-km

| Electrical pulse | Min BER | Q-factor |
|---|---|---|
| Gaussian pulse | 0 | 38.52 |
| NRZ | 1.49e-073 | 18.10 |
| RZ | 1.15e-144 | 25.58 |
| Sine pulse | 0 | 39.21 |

Table 2. At dispersion 16.75ps/nm-km

| Electrical pulse | Min BER | Q-factor |
|---|---|---|
| Gaussian pulse | 4.85e-065 | 16.98 |
| NRZ | 1.07e-024 | 10.18 |
| RZ | 3.18e-039 | 13.04 |
| Sine | 2.58e-055 | 15.62 |

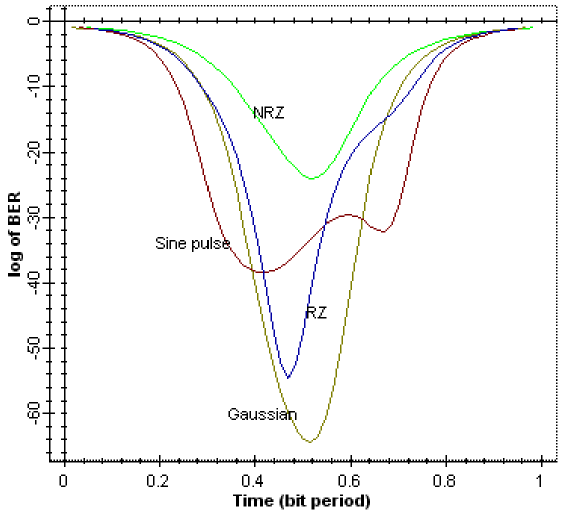


Fig 4 Min BER of different electrical pulses used at modulator

As shown in the figure 4 the response of the gaussian pulse is best as compared to the other electrical pulses. The Min. BER response of the gaussian pulse is also better at dispersion values.

**3. Conclusion**

In this paper, we have analyzed the optical double sideband signal with different electrical pulses. It is noted that the gaussian pulse as a electrical pulse input for the Mach-Zehnder modulator is best response. We have analyzed four electrical pulses for the Mach-Zehnder modulator. The Min BER and Q–Factor performance of the gaussian pulse is also better than the other elctrical pulses. Its repsonse is better at both dispersion values(8 and 16.75ps/nm-km).

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