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SIMULATION AND ANALYSIS OF SIGNAL TRANSMISSION THROUGH SMF AND DCF FOR WIRELESS COMMUNICATION

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ABSTRACT

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Now-a-days optical fiber becomes a popular medium in the field of wireless communication. Optical fiber provides a wide range of bandwidth and coverage for wireless communication. For these purpose various type of modulation technique are used. One of them Orthogonal Frequency Division Multiplexing (OFDM) is significant. Here, Single Mode Fiber (SMF) has been used for OFDM simulation but there was dispersion at the signals after passing through SMF. So it went through further analysis and concluded that Dispersion Compensation Fiber (DCF) can be used for dispersion less transmission. To investigate this, this paper investigates the feasibility of signal transmission through SMF for OFDM and it is also concerned with the study on OFDM to design a simulation model using MATLAB/SIMULINK for OFDM over fiber to show and analyze the Eye Diagram & Spectrum Scope Pass-band analysis for SMF and DCF.

Key words: *optical fiber, ofdm, smf, dcf, matlab/simulink, eye diagram, spectrum scope, pass band*

INTRODUCTION

In future generation wireless and mobile communication system must be increase with high quality bandwidth service for inaccessible area. In this case, optical fiber communication system has attracted more attention in the recent year, due to some outstanding advantages of optical fibers. As optical fiber provides enormous bandwidth, it plays a vital role in the development of high quality and high-speed telecommunication systems. Usually optical fiber communication system uses a very high carrier frequency, around 200 THz, whereas the coaxial cables have a bandwidth up to approximately 500 MHz. In the optical systems, the carrier frequency is usually expressed as a wavelength, 1.55 um (Afroozeh *et al.* 2011).

The OFDM has very high spectrum data efficiency. It designs to improve the system capability and it transmitted distance over optical fiber and RF. It is consider being promising technology for high-speed optical and wireless transmission. OFDM is a multicarrier transmission technology that transmits a high-speed data stream by splitting it into multiple parallel low-speed data channels. OFDM is a special class of the multi-carrier modulation (MCM) scheme that referred to as subcarriers. The sub-carriers are modulated by using Phase shift Keying (PSK) or Quadrature Amplitude Modulation (QAM). This is similar to conventional Frequency Division Multiplexing (FDM) or Sub-carrier Multiplexing. Coded OFDM offers very robust communications with the frequency diversity that result from channel coding and interleaving (Mousa 2012).

A single-mode optical fiber (SMF) is an optical fiber designed to carry light only directly down the fiber-the transverse mode. These modes define the way the wave travels through space. Waves can have the same mode but have different frequencies. Single-mode fibers can have a higher bandwidth. Equipment for single mode fiber is more expensive than equipment for multi-mode optical fiber, but the single mode fiber itself is usually cheaper in bulk. *Single mode fiber* is optical fiber that is designed for the transmission of a single ray or mode of light as a carrier. The core diameter of single mode optical fiber is about 8 and 10.5 µm and a cladding diameter of 125 µm. Single-mode optical has different type of classification to give special properties, such as dispersion-shifted fiber and nonzero dispersion-shifted fiber (Elo 2011).

In double-clad fiber for dispersion compensation, the inner cladding layer has lower refractive index than the outer layer. This type of fiber is also called depressed-inner-cladding fiber and W-profile fiber. This type of double-clad fiber has the advantage of very low micro bending losses. It also has two zero-dispersion points, and low dispersion over a much wider wavelength range than standard singly clad fiber. Mainly, when the signals pass through SMF some dispersion induced in the signal. To obtain dispersion less signal it went through further analysis and Dispersion Compensation Fiber (DCF) can be used for dispersion less transmission (Wong *et al*. 2012; Karthikeyan and Prakasam, 2014).

METHODOLOGY

To observe OFDM technique over optical fiber with the MATLAB/SIMULINK, a simulation model was chosen. The first step to carry out this experiment was the understanding the property of SMF and DCF over fiber technology and the second was the study on the observation of eye diagram and Spectrum Scope Pass-band analysis for the transmitted and received signal (Sultana and Islam, 2012). The eye diagram and the Spectrum Scope Pass-band analysis diagram are analyzed before and after passing through the SMF and DCF. The software used for the simulation is MATLAB 7.6/SIMULINK software.

SYSTEM MODEL

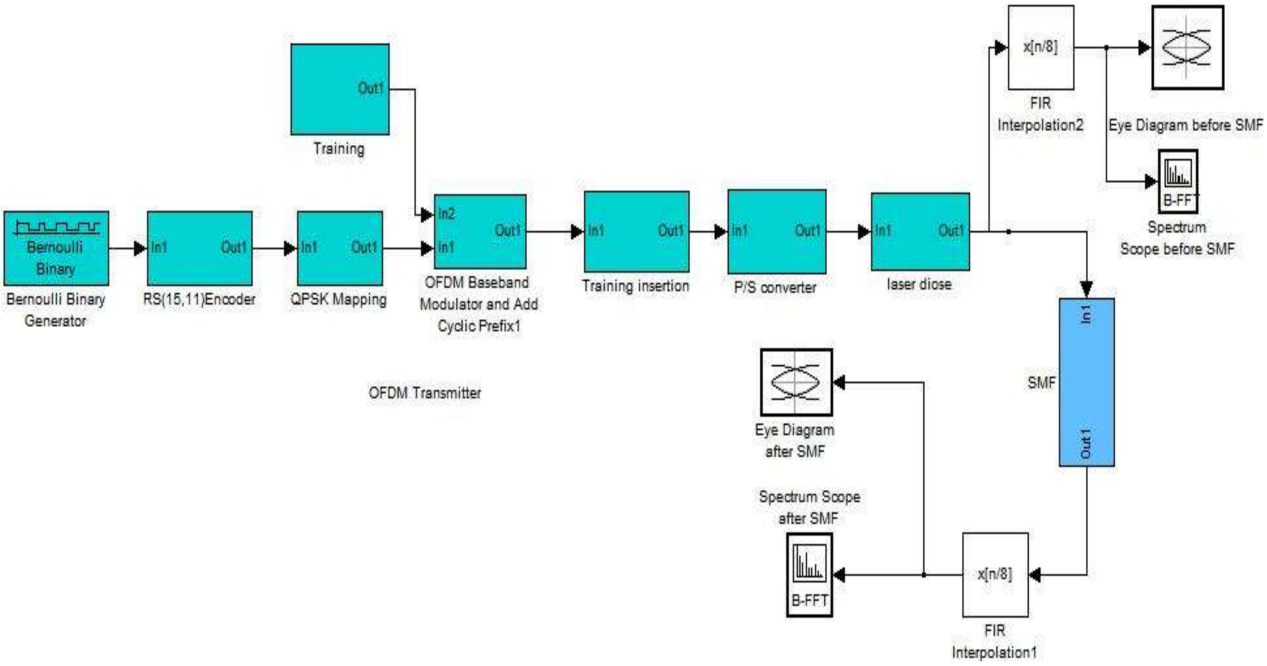

Fig. 1. Transmission analysis for SMF

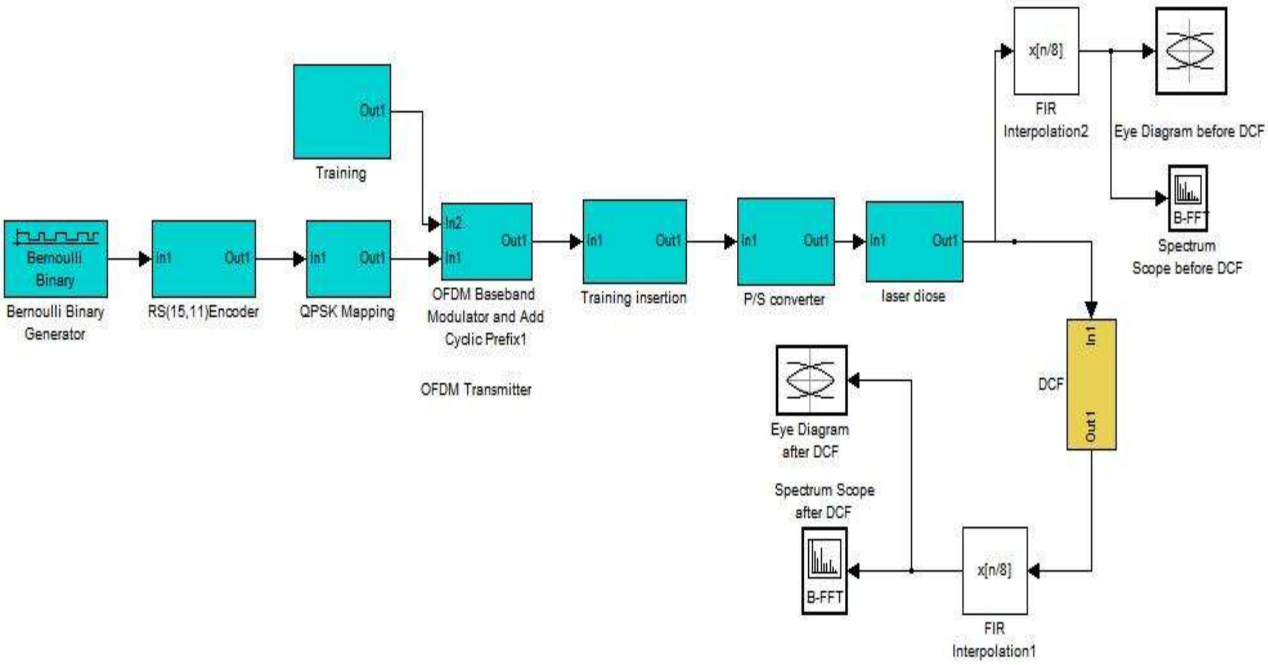

Fig. 2. Transmission analysis for DCF

The transmitter converted the input data from a serial stream to parallel sets. The transmitter contains a Bernoulli binary generator block which generates the base band signal. The parallel to serial block converted this parallel data into a serial stream. Reed Solomon (RS) double error correcting (15, 11) code had been used as FEC code for base band signal to be sent to next stage.

Coherent QPSK modulation and training (pseudo noise sequence generation) blocks were used to provide input to OFDM symbol generation (IFFT add cyclic prefix block). An inverse Fourier transform converted the frequency domain data set into samples of the corresponding time domain representation of this data. IFFT generated samples of a waveform with frequency components satisfying orthogonal conditions, for these reason IFFT is useful to OFDM.

Then cyclic prefix is added to the signal. Cyclic prefix mainly insert guard time between consecutive OFDM symbols which helped to combat against ISI. Training insertion block placed training pattern at predefined position in OFDM symbol to facilitate training process. Then, the parallel to serial block converted this parallel data into a serial stream and created the OFDM signal by sequentially outputting the time domain samples. A Laser diode is also used to convert the signal from electrical to optical signal. The optical signal then carried over single mode optical fiber link. The receiver just performed the inverse of the transmitter to recover the baseband signal and transmitted to the corresponding wireless user. At the receiver, the photodiode had converted the signal from optical to electrical signal.

In this experiment OFDM transmitter output signals were launched onto a Single Mode Fiber as shown in Figure 1 and Dispersion Compensation Fiber as shown in Figure 2 and then the simulated results were analyzed. The benefit of this scheme was the compensation of dispersion.

RESULTS AND DISCUSSION

We observed the required properties via MATLAB/SIMULINK software version 7.0. The following figures will show the QPSK-OFDM transmitted and received signal Eye Diagram and Spectrum Scope pass band before and after the transmission over SMF and DCF.

A. Eye diagram of OFDM for Single Mode Fiber (SMF)

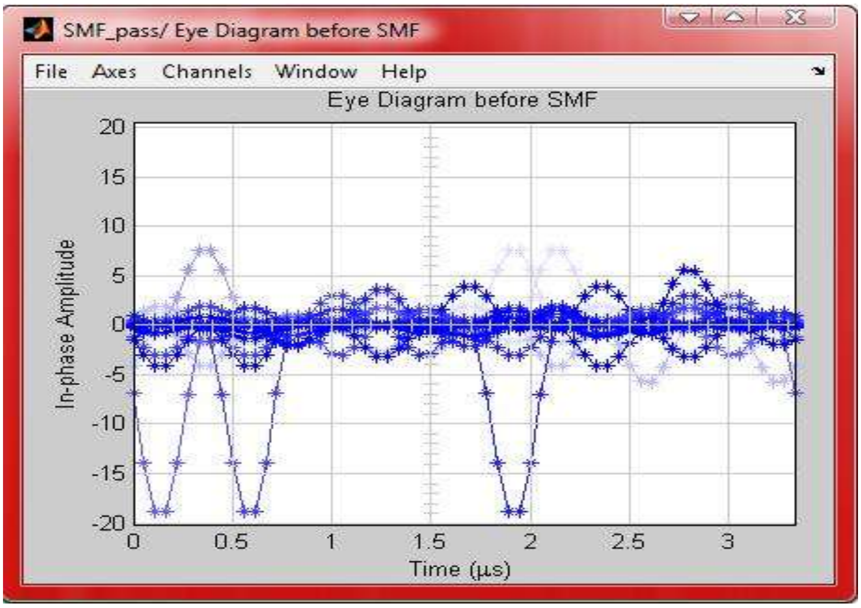

Fig. 3. Eye diagram before Fiber (SMF)

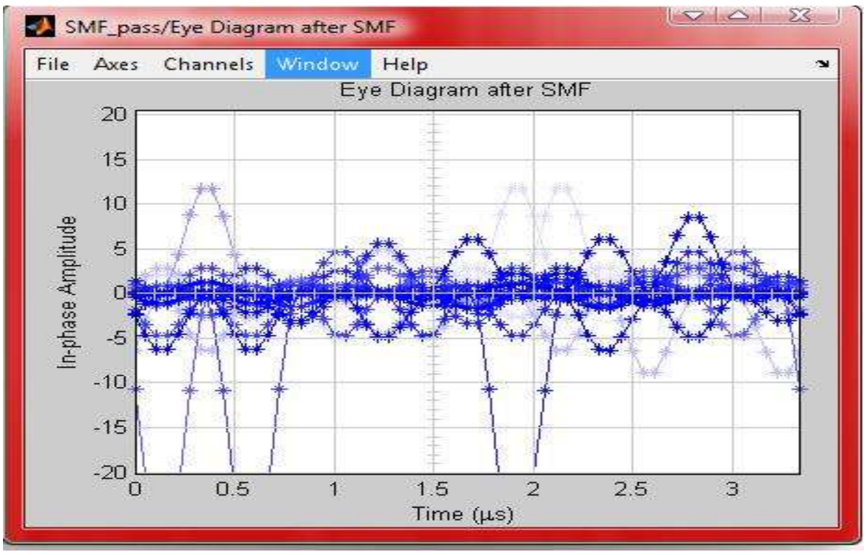

Fig. 4. Eye diagram after Fiber (SMF)

Multiple OFDM carriers have been passed through the SMF and as a result, an amplitude variation occurred after passing through the fiber which means that the dispersion occurred in SMF. Figure 3 and Figure 4 shows that the Eye diagram before SMF and the Eye diagram after SMF were not same. By comparing the above two figures we can understand that a variation in amplitude is present and the amplitudes of signals after passing through SMF are high. So, dispersion occurs in Single Mode Fiber (SMF) for OFDM.

We can summarize that, for OFDM communication a group of signal pulses are transmitted and for the dispersion effect, the pulses overlap and causes the following problems:

- Lose the shape and create difficulties to detect by receivers at the end of a fiber span, thus causes bit error rates (BER).
- Spreading of the pulse limits the information capacity of the fiber.
- Results in Inter Symbol Interference (ISI) and hence power penalty.
- Induces coherent cross-talk between channels in multiplexed transmission systems.
- Causes pulse spreading and distortion and thus can lead to system penalties.

B. Spectrum scope pass band of OFDM for Single Mode Fiber (SMF)

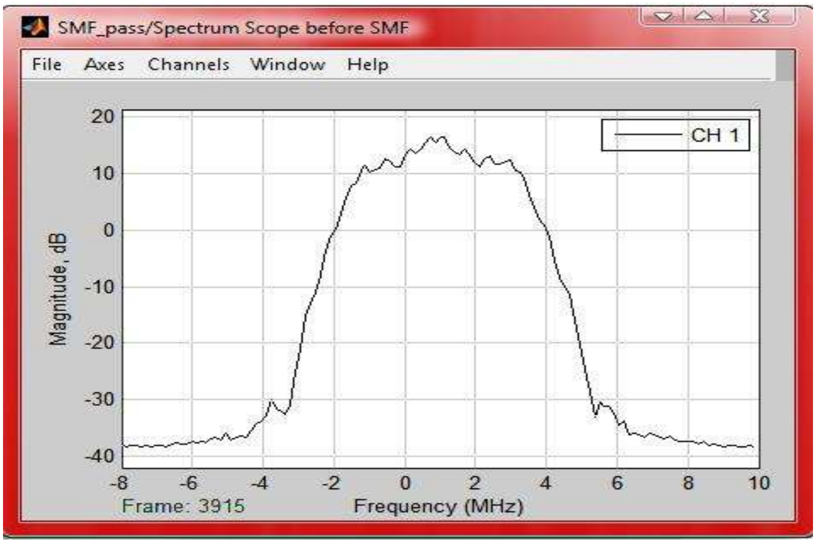

Fig. 5. Spectrum scope pass band (before SMF)

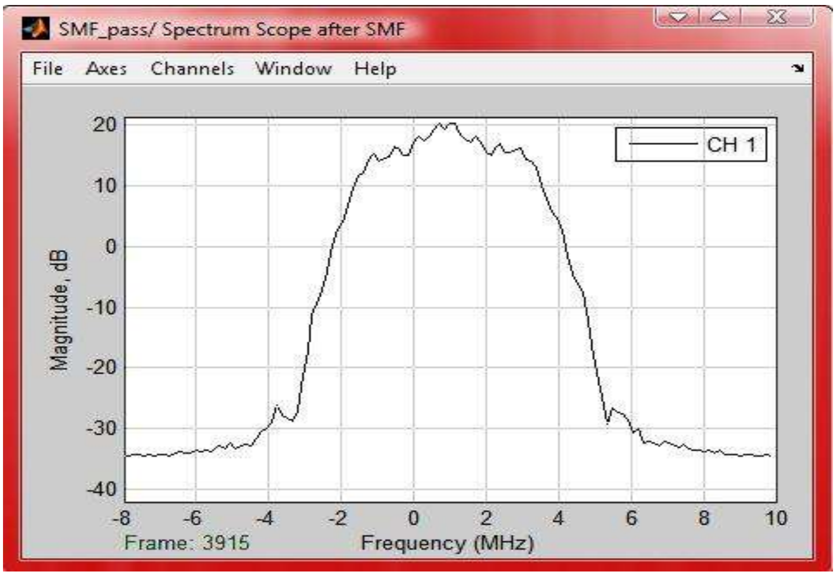

Fig. 6. Spectrum scope pass band (after SMF)

Comparing Figure 5 and Figure 6, it can be observed that, at pass band, the carrier is assumed to be an artificial value.

C. Eye diagram of OFDM for Dispersion Compensation Fiber (DCF)

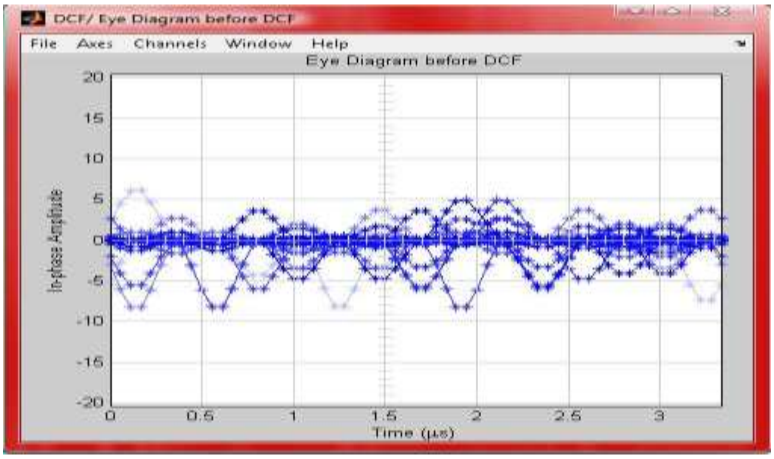

Fig. 7. Eye diagram before DCF

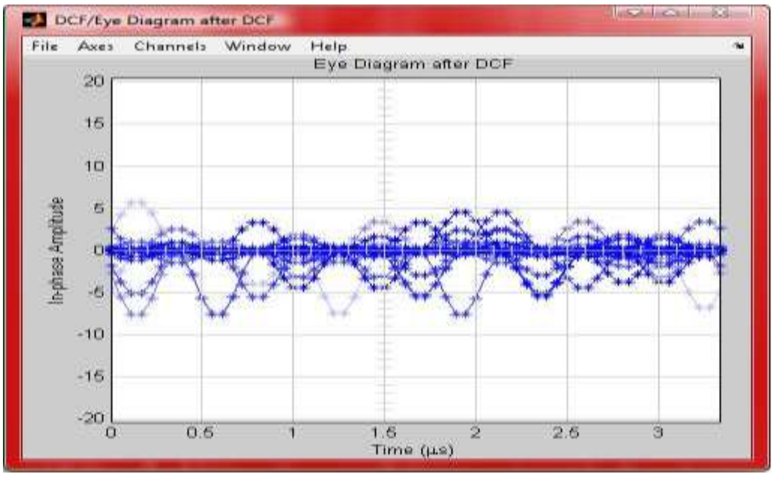

Fig. 8. Eye diagram after DCF

Again, when Multiple OFDM carriers have been passed through the DCF, then no amplitude variation occurred after passing through the fiber which means that no dispersion occurred in DCF. Figure 7 and Figure 8 shows that the Eye diagram before DCF and the Eye diagram after DCF were same. By comparing the above two figures we can understand that a variation in amplitude is not present and the amplitudes of signals after passing through DCF are same. So, dispersion does not occur in Dispersion Compensation Fiber (DCF) for OFDM.

D. Spectrum scope pass band of OFDM for Dispersion Compensation Fiber (DCF)

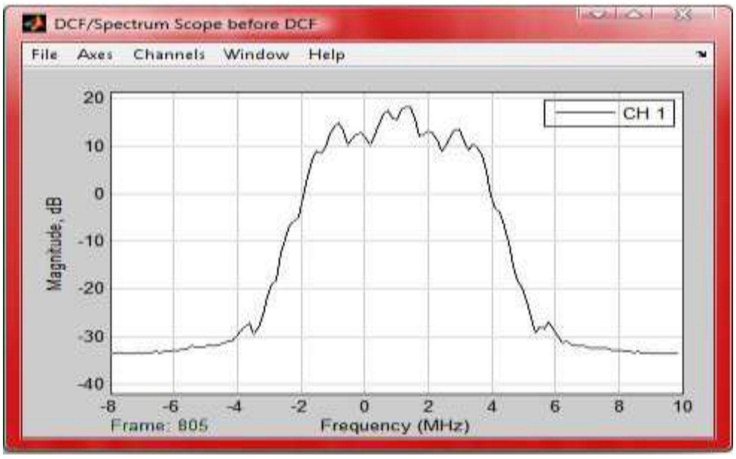

Fig. 9. Spectrum scope pass band (before DCF)

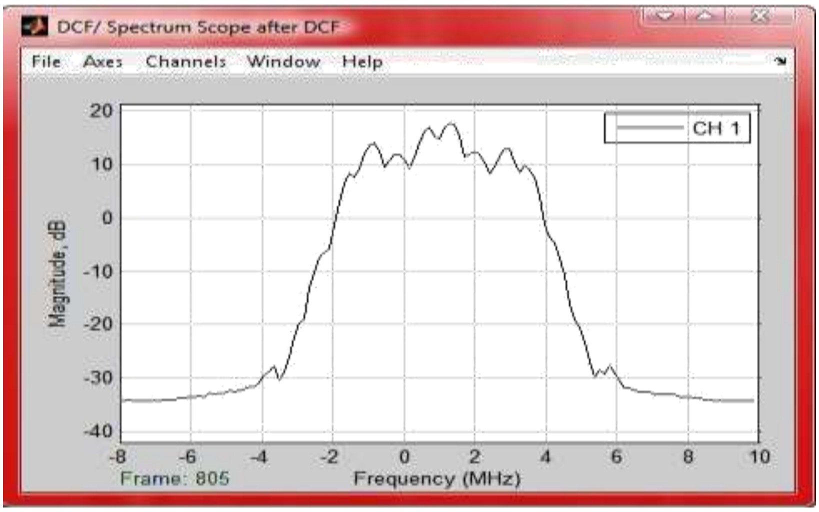

Fig. 10. Spectrum scope pass band (after DCF)

CONCLUSION

The principle of this paper was to demonstrate the SIMULINK model for OFDM system over fiber for wireless communication. This paper was concerned with the study on OFDM signal transmission and to analysis its Eye diagram and Spectrum scope pass band characteristics before and after the transmission over SMF and DCF. The basic structure of the system was that, OFDM baseband signals were passed through a SMF link but there was dispersion in the signals after passing through SMF. So, OFDM transmitted signals were passed through a DCF link and no dispersion occurred there. Thus dispersion less transmission can be achieved by OFDM transmission through DCF link.

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