Enhancement of Light Fidelity System According to Multi-Users Utilizing OCDMA Technology under Weather Conditions

Satea H.Alnajjar [*], Baker Kalid ALfaris [**]

[*] Department of Network Engineering, College of Engineering, Al-Iraqia University, Iraq
[**] Department of Computer Engineering, College of Engineering, Al-Iraqia University, Iraq

Abstract

Due to the significant need for modern technologies to meet the growing requirements of wide bandwidths, high levels of security, and high speeds. Considered Light fidelity is a future technology optical WC system that employs VL to transport data in open space. The end-user has employed VLC based on (LEDs). This technique provides a high data transfer rate, higher security, and less interference with other radio frequencies. This study investigates Li-Fi System Performance based on OCDMA/FOS under Effective Weather conditions on L-band frequency. LI-FI technology faces many challenges in maintaining system performance owing to the rise in user numbers and the different weather conditions. This causes the system performance to decrease in BER, Q-factor, power, etc. and maintains good security at the lowest possible costs and the best results. Proposed system, in addition to measuring the frequency filtering amount used in the proposed system, The results showed a significant improvement using the proposed technique, where the system achieved the error bit rate in clear weather from $3.93 * 10^{-28}$ to $2.5 * 10^{-24}$, and also in dusty weather, it achieved from $1.7 * 10^{-28}$ to $8 * 10^{-23}$ in addition to that The amount of frequencies filtering in UFBG This means that the minimum amount to use the filter feature is1.2nm. Suggested design has proven its ability to maintain acceptable performance in end-user in light of the increase in the number of users.

Keywords:- light fidelity, visible-light communication, Optical Code division multiple access, Light-Emitting Diodes, Free space optical.

1_ Introduction

Significant growth in mobile data transmission is expected within a few years since wireless internet has evolved necessary products equivalent to electricity [1]. Free space optical (FSO) communication technology has become the future technology since this duality offers several benefits, such as data security, transmission speed, a free spectrum license, and high bandwidth. However, this approach is impacted by weather turbulence like dust, rain, snow, and fog [2]. Therefore, FSO is still not prevalent in many nations, despite possessing several qualities mentioned earlier. In addition, FSO devices are mobile and may be deployed rapidly [3]. Optical wireless communication Using white LEDs, VLC may be used for illumination and data transfers in future applications (indoor and outdoor), resulting in significant energy savings worldwide [4]. Therefore, the need for telecommunications services with a huge Frequency range, high data rates, and Service quality has increased steadily during the last two decades.

Due to the rising diversity of needs and the need for quicker and more secure communication systems, there is a continuing demand for these services. Multiple solutions have been adopted in various access networks to fulfill the increased need for user data exchange[5, 6]. Physical restriction of dispatch networks and the techniques chosen to distribute resources among users are intimately connected to transmission throughput and bandwidth sharing. Therefore, Developed multiple access systems permit multiple users to share the same canal Frequency range [7]. Optical _CDMA (Code Division Multi-Access) is a fascinating multi-access method in Optical telecommunications. This multiplexing method is founded on spectrum spreading, which enables strength band and confers to the spreading over a wide frequency transmitted signal [8]. This approach also concurrently utilizes all available bandwidth, allowing more efficient use of resources that can be used. In addition, the orthogonally of the code series decreases interference from users that degrade the efficiency of an Optical _CDMA system while providing an exceptionally high level of security [9]. FBGs are presented as very cramped -band reflecting filters that enable the selection of very particular wavelengths [10]. One of FBG's applications is compensation for dispersion in optical fiber linkage, which is also characterized by a minimal input loss. These properties boost the system's capacity, hence enhancing the overall system's efficiency [11].

The challenges that Li-Fi technology faces to maintain system performance with the rise in user numbers and this causes the system's BER and Q-factor performance will decline, power, etc. The main objective is to investigate and guarantee the LI-FI performance over hybrid FSO/Fiber Optic communication and, therefore, the end-user getting reliable internet. The primary goal in writing this paper was to find a way to scale up the number of end users without negatively impacting the system's overall performance, challenging ones, and controlling the input frequencies. In addition, this feature can increase the system's security and not interfere between frequencies and loss of information even if the network name or security code is discovered.

The remainder of the paper it's laid out like this. This document has four parts: Research Elaborations is discussed in section II, Finding in section III, and Conclusions in section IV.

2_ Research Elaborations

As shown in Fig. 1, the suggested system was formed using the Optisystem tool V19 FSO channel, and 2-Gbps data rate is supported. The design is made up of four VLS system connected with four rooms each with eight end users.

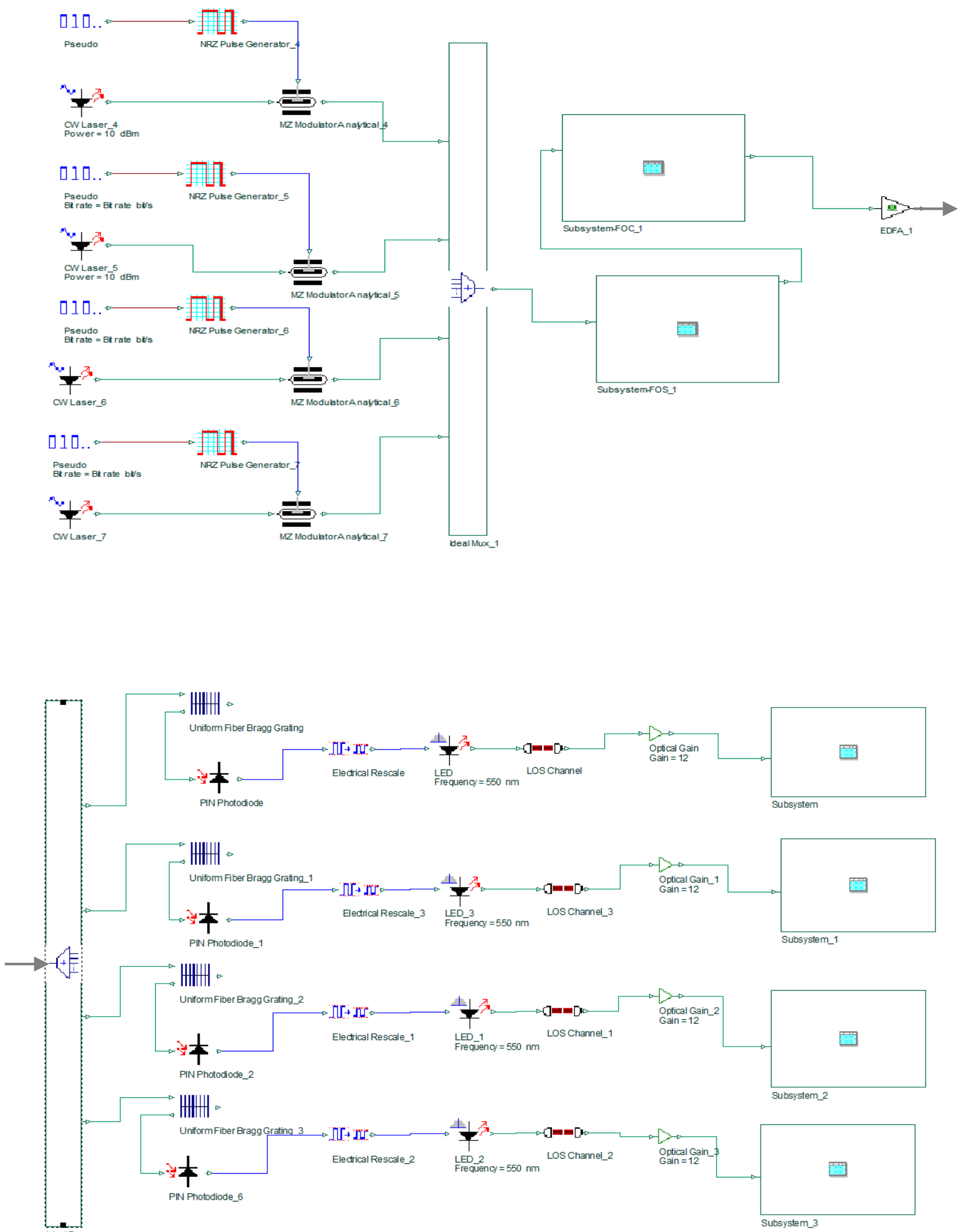

Fig1. The Suggested system design.

2.1 free space optic

A (FOS) communication system is a wireless communication system technology that utilizes air to convey optical information [12]. FSO is a line of sight point-to-point technique that requires a clear path between the sender and the receiver. At the same time, the infrared or visible beam is sent after modulation over the air [13]. Therefore, it is more appropriate when the physical connection fails and there is a need to transport a large amount of data [13]. Fig 2 shows The FSO system is a design and Table (1) FSO elements.

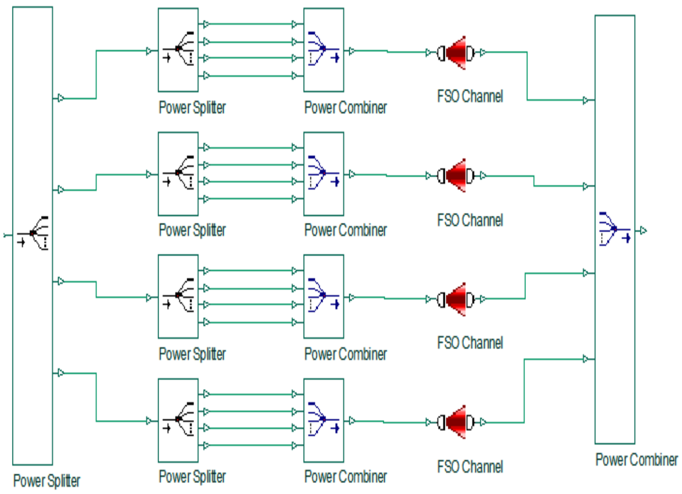

Fig 2. The Free space optical system design.

Table (1) FSO elements.

FSO elements	Value
range	5_12 km, 500-850 m
Attenuation	0.4 , 34 dB/m
Beam divergence	1mred
Aperture's diameter of the transmitter	2.5cm
Aperture's diameter of the receiver	25cm

2.2 light-emitting diodes

The (LED) serves as the transmitter. First, the electrical signal is converted to the proper voltage for driving the LED source directly, then modulates the lights. Table (2) elements of the LED.

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LED elements	Value
wavelength	550nm
Electron carrier lifetime	1×10^{-12} s
RC time constant	1×10^{-12} s
Quantum efficiency	0.65

The strength of the (LEDs) given by [14] is as follows: $\rho=\eta.h.f\frac{i(t)}{q}$ (1)

2.3 line-of-sight

The modulated signal is sent from the LED to the receiver (PD) through a line-of-sight (LOS) beam. The simulator's default elements are shown in Table (3).

Table (3). LOS channel elements

LOS elements	Value
range	3m
Transmitter half-angle	60deg
Irradiance half-angle	20deg
Incidence	20deg

The style is as follows when the emission density has a Lambertian [15]: $R_{\emptyset} = \begin{cases} \frac{m+1}{2\pi}\cos^{m}\emptyset, \text{for } \emptyset \in \left[-\frac{\pi}{2}, \frac{\pi}{2}\right] \\ 0, \text{otherwise} \end{cases}$ (2)

The radiation angle and *m* is the Lambertian order, both of which are coupled by the transmitter's semi-angle

$$m = \frac{-\log 2}{\log[\cos(TransmitterHalfAngle)]} \quad (3)$$

The following connection exists between the optical transmitter power and radiant intensity when taking into account the transmitter's axially symmetric radiation pattern (measured in W/sr): $P_t . R_0(\emptyset)$ (4)

This is the effective collection area:

$$A_{eff}(\varphi) = \begin{cases} A_{det}\, T_s(\varphi) \cos\varphi \text{ if } 0 \le \varphi \le \varphi_c \\ 0 \text{ if } \varphi > \varphi_c \end{cases} \quad (5)$$

2.4 fiber Bragg grating

The barriers of glass fibers alter the refractive index, resulting in the transmission of specific wavelengths and the reflection of others. Therefore, FBG may be regarded as an optical filter and can be utilized for this purpose and for remote monitoring after being positioned as a laser filter diode. The dispersion may be expressed using the following equation[16, 17].

$$Dg = \frac{2\,n}{c\,(\Delta\lambda)} \quad (6)$$

$$n \sin(\theta 2) = n\, sin(\theta 1) + m\frac{\lambda}{\Lambda}" \quad (7)$$

Where θ2the angle of the diffracted wave and the integer m determine the diffraction order.

3. Finding

n dusty weather circumstances, the suggested design got extremely excellent results compared to similar designs at the BER level, achieving from $1.7*10^{-28}$ to $8*10^{-23}$ at a range from 500 m to 850 m as shown in figure 3.

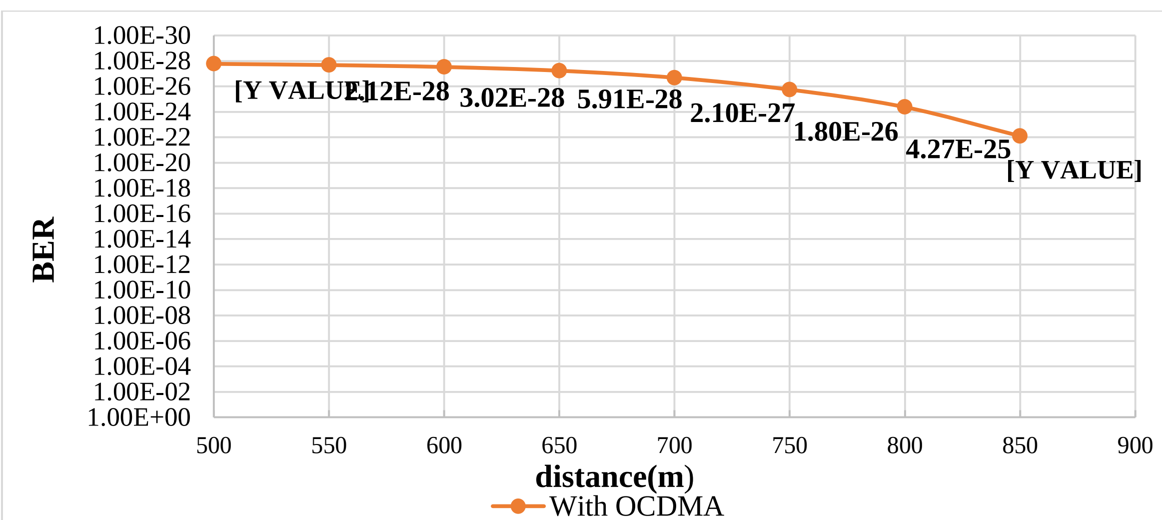

Fig3. BER in dusty weather using OCDMA technology.

In a clear atmosphere, this design achieved promising results in BER as it starts from $3.93 * 10^{-28}$ to $2.5 * 10^{-24}$ at a distance ranging from 5km to 12 km, as shown in fig 4.

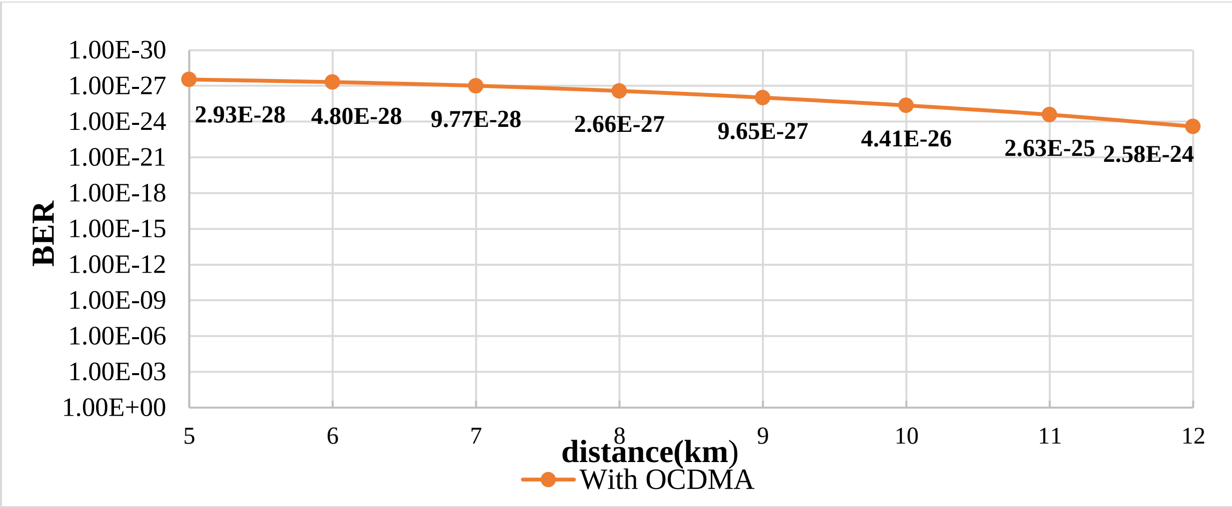

Fig. BER in clear weather with the use of technology OCDMA.

Figure 5 shows power was measured in each room from the first user at varying angles in a clear atmosphere at 6 km, where the measurement ranges from 0 to 60 degrees.

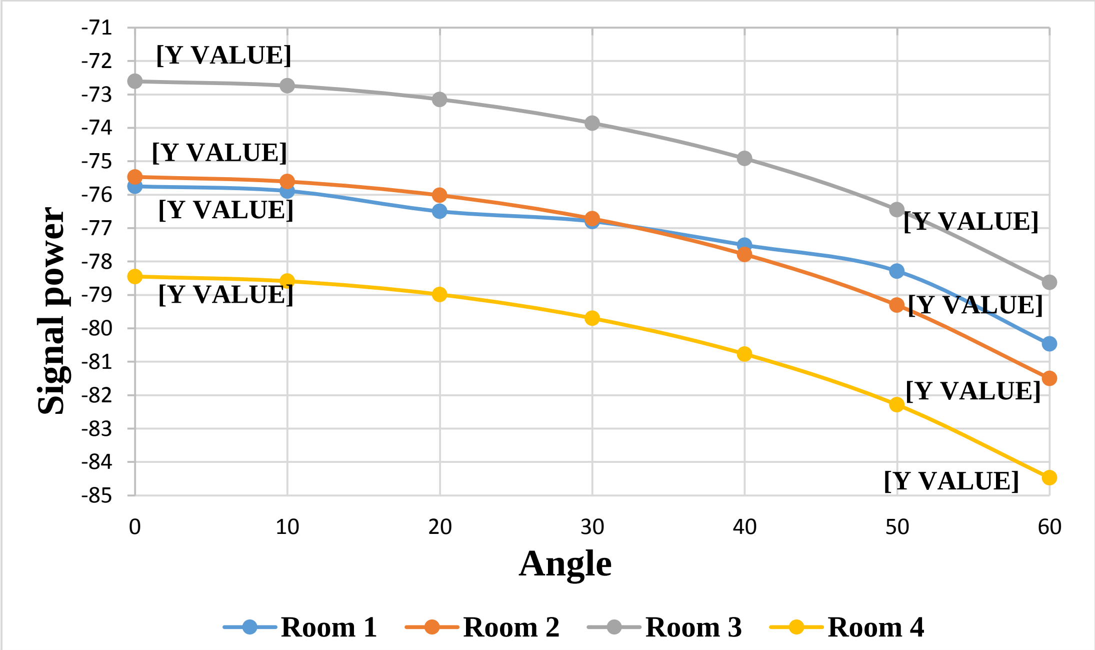

Fig5. Total power in all rooms with first users in clear weather conditions at 6km.

The second suggested system examined the particular UFBG filter amount for the frequencies entering the CW laser, where we performed frequency testing. Programmed distinct frequencies into four CW lasers as follows:
CW Laser 1= 1570 nm
CW Laser 2= 1575 nm
CW Laser 3= 1580 nm
CW Laser 4= 1585 nm

On the other hand, we entered the following frequencies in UFBG
UFBG Frequency 1= 1570 nm
UFBG Frequency 2= 1571.2 nm
UFBG Frequency 3= 1580 nm
UFBG Frequency 4= 1581.2 nm
As demonstrated in Figures 6 and 7 Frequency filtering amount in UFBG and our suggested system is around 1.2 nm at the First user in all the rooms. This means that the minimum amount to use the filter feature is1.2nm.

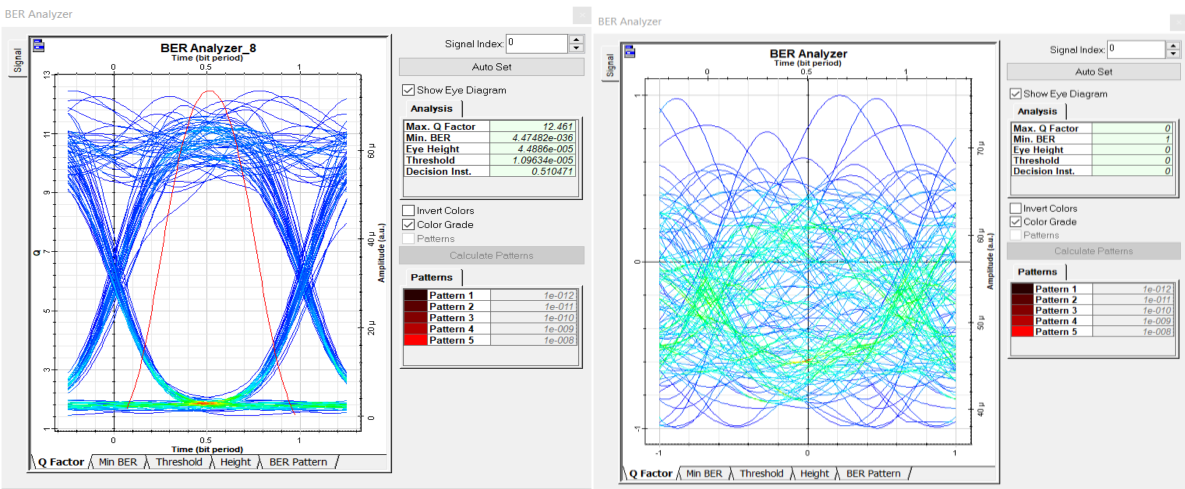

Fig 6. Frequency filtering amount in UFBG using Li.Fi technology at 1571.2nm and 1570 nm.

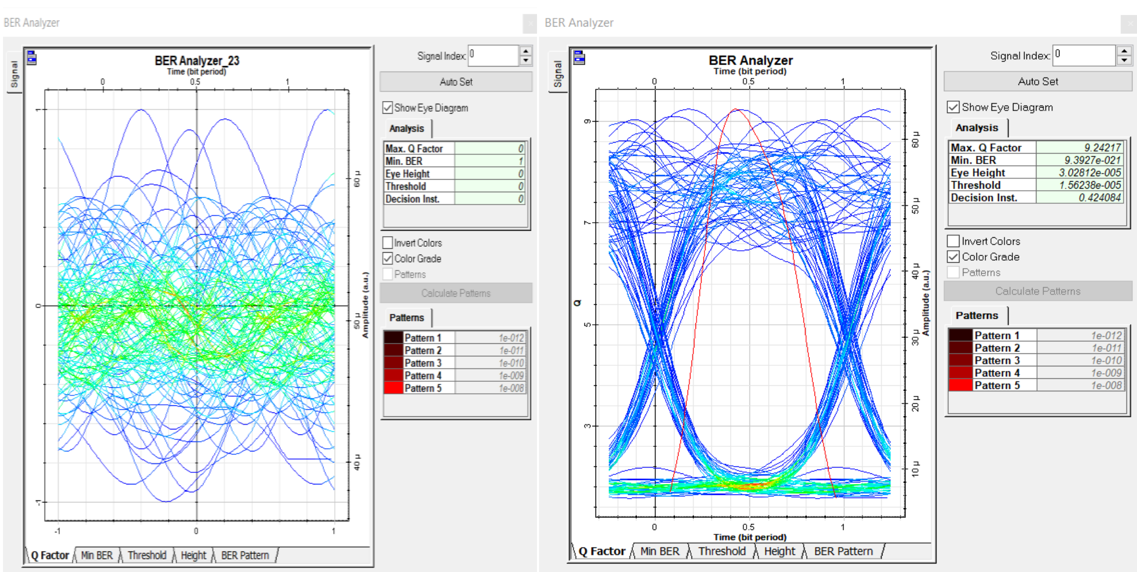

Fig7. Frequency filtering amount in UFBG using Li.Fi technology at 1581.2nm and 1580 nm

5. Conclusions

This study investigated the influence of weather conditions on L-band frequencies on Li-Fi system performance based on OCDMA/FOS when the system was tested in clear and dust weather conditions. The proposed system achieved very promising results, as it achieved a percentage of error bits in the clear air approximately from $3.93 * 10^{-28}$ to $2.5 * 10^{-24}$, and in dusty weather, it achieved approximately from $1.7 * 10^{-28}$ to $8 * 10^{-23}$, in addition to you, we conducted Tests to find out the frequency filtering amount in UFBG/ OCDMA using Li-Fi technology The results showed that the amount of filtration in UFBG/ OCDMA is approximately 1.2 nm This amount is excellent compared to the input frequencies as well as inverters and other filters This means that the minimum amount to use the filter feature is1.2nm. The total power was measured in each first user in the four existing rooms, each room has eight users. Suggested design has proven its ability to maintain acceptable performance in end-user in light of the increase in the number of users.

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Authors

First Author – Satea H.Alnajjar, Department of Network Engineering Al-iraqia University Baghdad, Iraq ,sateaahn@gmail.com.
Second Author – Baker Kalid ALfaris, Department of Computer Engineering, Al-iraqia University Baghdad, Iraq, bakerkahlid96@gmail.com.