American Journal of Engineering Research (AJER)
e-ISSN: 2320-0847 p-ISSN : 2320-0936
Volume-10, Issue-11, pp-10-17
www.ajer.org
Research Paper Open Access

Effect of Light Pulses Generator as a Narrow Bandwidth in Communication System Application by using Gaussian optical pulse

Asst.Prof.Dr. Ahmed Abd Al Kader[1], Muthana. Y. Aldouri[2], Maki mahdi[3]
[1]*Hatay Mustafa Kemal University- Hassa MYO/Hatay-Turkey*
[2,3]*Al-Nisour University College/Department of Computer, Technical engineering/Baghdad-Iraq.*

Abstract: *light pulse generator like soliton waves working in Fiber optic communication to offer higher frequency transmission of signals with greater bit rate and larger data carrying capacity over a long distance with lower loss and interference as compared to copper wire electrical communication. This paper describes how can use soliton pulse wave characteristics to send information for long distances by designing a new system with the help of software simulation optisystem version 7. It is found the minimum and maximum fiber length can achieved from 30 to100Km distance and can amplified by Semiconductor Optical Amplifier(SOA) . the system have one loop controlling amplifier.*

Keynote: *optical sech pulse generator, SOA, loop control, pseudo code.*

Date of Submission: 26-10-2021 Date of acceptance: 10-11-2021

I. INTRODUCTION;

Fiber Optic communication uses pulses of light to transmit information through a fiber optic. Fiber Optic communication offers higher frequency transmission of signals with greater bit rate and larger data carrying capacity over a long distance. This means of data transmission is with a lower loss and interference if compared to the normal copper wire used in the electrical telecommunication systems. Optical fiber is widely used in the application of internet communication technology in developing countries largely due to its feasibility to transmit data over a longer distance. However, the good performance of optical fiber transmission is compromised by factors such as group velocity dispersion (GVD), fiber loss and also self-phase modulation (SPM).

The GVD phenomenon or Chromatic dispersion is due to the refractive index *n* of the fiber, which is a frequency dependent parameter; and dispersion parameter
D (ps/(km.nm)) is related to GVD, parameter, β_2 as follows [1].

$$D = d\beta_1 / d\lambda = 2\pi C / \lambda^2 \quad (1)$$

1.1Soliton waves:

When both the dispersive and the nonlinear term were added in equation, the two effects can neutralize each other. If the water wave have a special shape of the effects are exactly counterbalanced and the wave rolls along undistorted. The soliton shape can be found by direct integration of the KdV equation.

$$U(x,t) = a\, sech^2[b(x-vt)] \quad (2)$$

With $b = (a/12)^{1/2}$ and $v = 3a$.

The constant (a) is the only free parameter in the solution. It defines the amplitude and the width in such a way that a large (tall) soliton will be narrow, while a low soliton will be broad. The constant *v* defines the velocity of the soliton. Since $v=3a$ a tall soliton will move faster than a low one. [2]

A soliton is a self-reinforcing solitary wave packet that maintains its shape while it propagates at a constant velocity. Solitons are caused by a cancellation of nonlinear and dispersive effects in the medium. (The term "dispersive effects" refers to a property of certain systems where the speed of the waves varies according to frequency.) Solitons are the solutions of a widespread class of weakly nonlinear dispersive partial differential equations describing physical systems.

A single, consensus definition of a soliton is difficult to find. Ascribe three properties to solitons:

1. They are of permanent form;
2. They are localized within a region;
3. They can interact with other solitons, and emerge from the collision unchanged, except for a phase shift.

More formal definitions exist, but they require substantial mathematics. Moreover, some scientists use the term *soliton* for phenomena that do not quite have these three properties (for instance, the 'light bullets' of nonlinear optics are often called solitons despite losing energy during interaction).

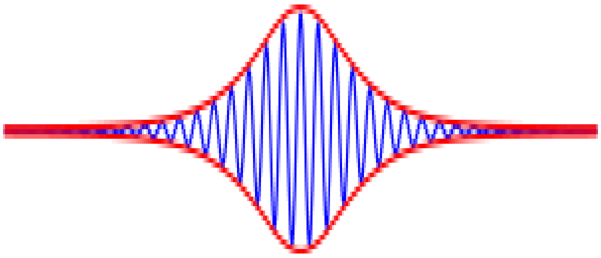


Fig 1. Hyperbolic secant (sech) envelope soliton for water waves

A hyperbolic secant (sech) envelope soliton for water waves. The blue line is the carrier signal, while the red line is the envelope soliton.

1-2 Solitons in fiber optics:

More experimentation has been done using solitons in fiber optics applications. Solitons in a fiber optic system are described by the Manakov equations. Solitons' inherent stability makes long-distance transmission possible without the use of repeaters, and could potentially double transmission capacity as well.

1-3 Wavelength Division Multiplexing (WDM) Technique:

Wavelength Division Multiplexing (WDM) is a technique in which simultaneous transmission of signals occurs at different optical wavelength. In some applications of this technique, more than a few optical signals combine, transmit in concert, and will be separated again based on different arrival times. To touch this technique, optical signals from separating lasers can be joint together with a broadband optical signal from for example a light emitting diode spectrally be sliced into smaller pulses. The use of multiple channels allows increased overall data transmission capacities without increasing the data rates of the single channels, where the time slot per bit must be reduced. still if the bandwidth of the data modulator is limited, that can be done by using a train of ultra-short pulses (rather than a continuous optical wave) as the input of the modulator [3].

1-4 Nonlinear Effect as Self-Phase Modulation (SPM):

In a Kerr effect medium such as fiber optics, high intensity of light causes a phase delay having the similar temporal shape with the intensity. This nonlinear phenomenon occurs for a beam is called self phase modulation (SPM) which is generated by its intensity.

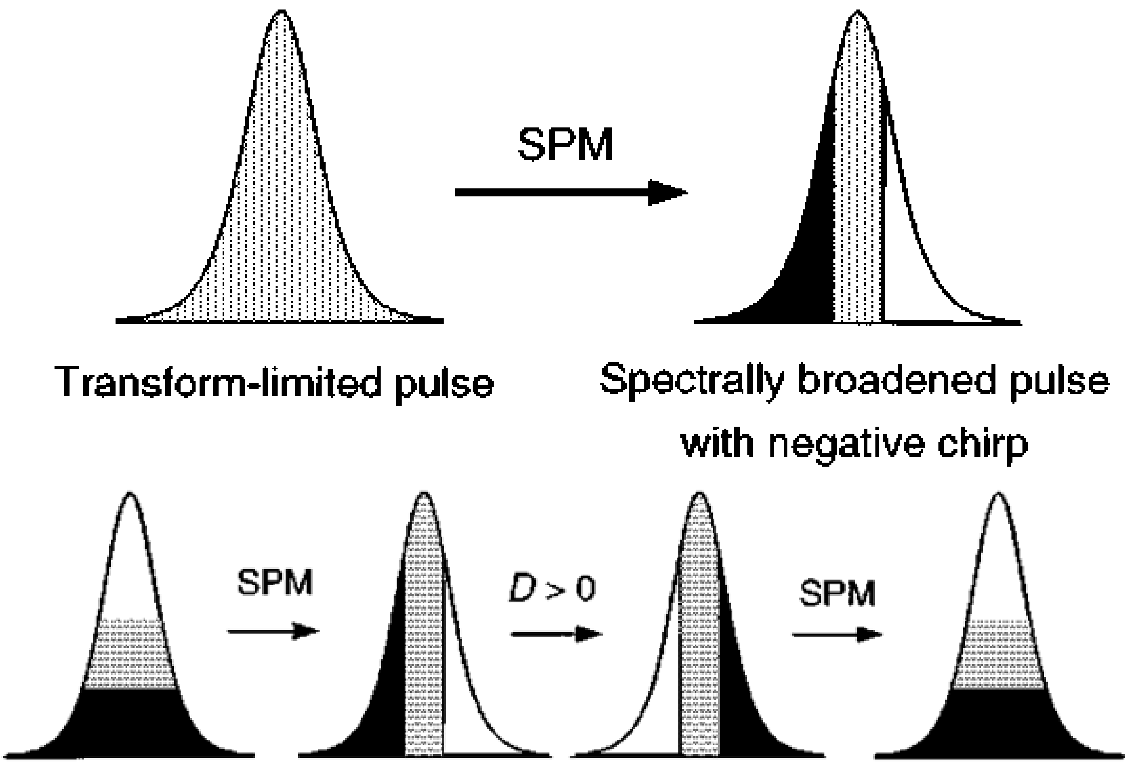


Fig 2. Soliton shape

This effect refers to nonlinear changes of the refractive index given by

$$\Delta n = n^2 I \qquad (3)$$

Where, *n*2 is the nonlinear index and the optical intensity is shown by *I*. Therefore, This phase shift is a temporal dependence effect, whereas the transverse dependence leads to the effect of self-focusing.

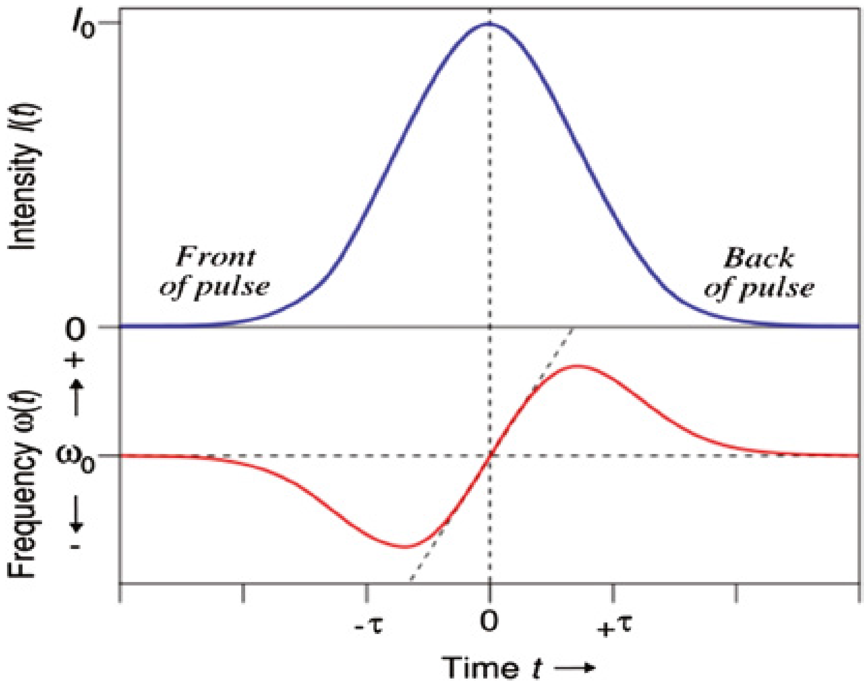


Fig.3 Spectral broadening of a pulse due to SPM [3]

Unlike the way that SPM affects the phase of the propagating pulse such phase changes in semiconductor lasers do not follow the temporal intensity profile. Therefore, this effect is declared for the pulse of picoseconds to a few nanoseconds. SPM is very efficient in mode-locked femto second lasers with the Kerr nonlinearity effect medium. In materials with negligible or zero dispersion effects, the nonlinear phase shift is unstable, thus soliton pulse mode is employed which is a result of balancing SPM and dispersion [4, 5]. The intensity of a Gaussian ultra short pulse at a time (t) can be expressed by

$$I(t) = I_o e^{(-t2/\tau 2)} \quad (4)$$

Where I_0 and τ are the peak intensity and pulse duration. In a Kerr type medium,
The refractive index is given by:

$$n(I) = n_o + n_2 I \quad (5)$$

Where, $n0$ and $n2$ are the linear and nonlinear refractive indices.

An optical pulse is a flash of light. Lasers and related devices have been found to have an amazing potential for generating light pulses with very special properties:
There is a wide range of techniques for generating pulses with durations of nanoseconds, picoseconds, or even femto seconds with lasers. Such short durations make light pulses very interesting for many applications, such as telecommunications or ultra precise measurements of various kinds [6].

1-5 Semiconductors Optical Amplifiers (SOA)

An SOA is based on the same technology as a Fabry-Perot diode laser. Such a laser consists of an amplifying medium located inside a resonant (Fabry-Perot type) cavity. The amplification function is achieved by externally pumping the energy levels of the material. In order to get only the amplification function, it is necessary to protect the device against self-oscillations generating the laser effect. This is accomplished by blocking cavity reflections using both an antireflection (AR) coating and the technique of angle cleaving the chip facets. Unlike erbium-doped fiber amplifiers (EDFAs), which are optically pumped, SOAs are electrically pumped by injected current.

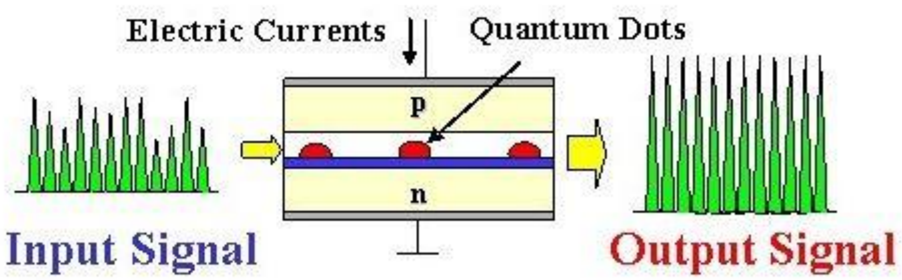


Fig 4. Structure of SOA

II. SIMULATION SETUP:

The simulation has been carried out by using opt system software version 7.
In this occupation we used optical sech pulse generator as a source to transmit data over 300 km length through one loop control and a traveling wave SOA (0.15 an injection current). The systems build as figure 7. This figure shows the system design of soliton wave effect in optical fiber.

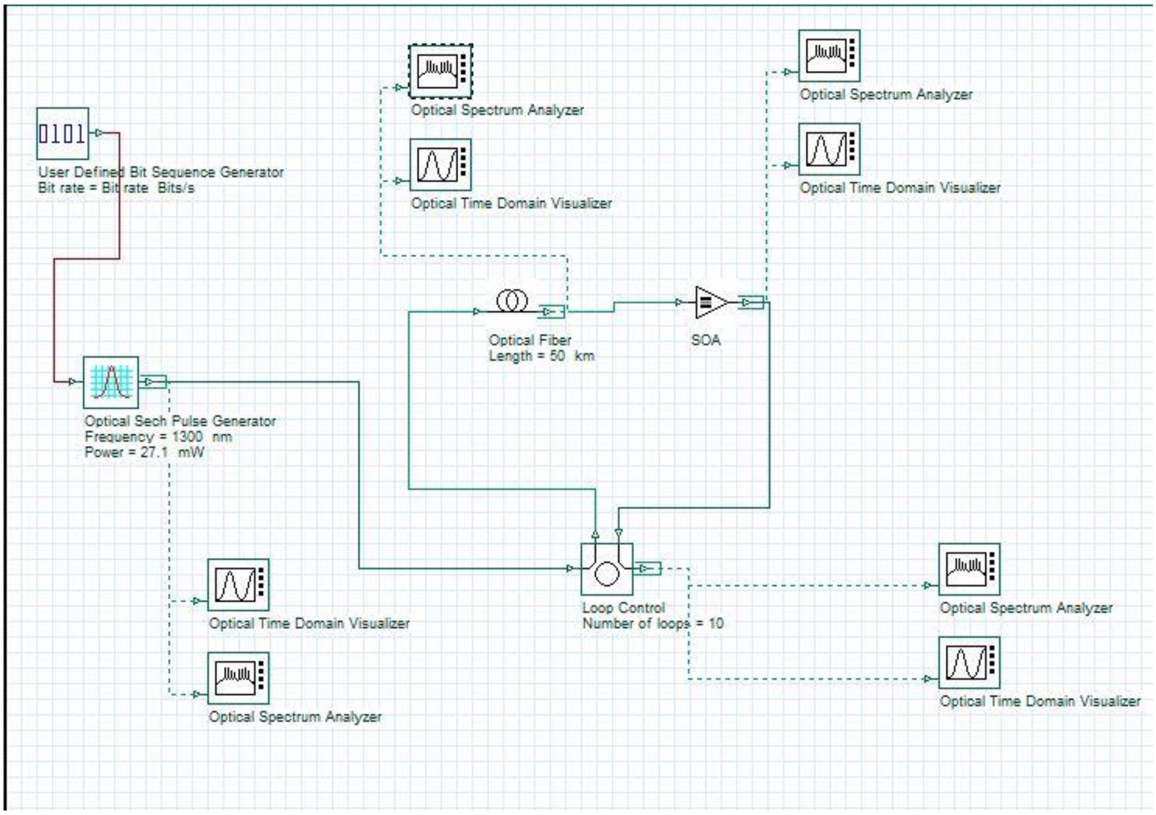


Fig 5**.** Opt system Set up.

In optical systems with optical amplifier, like SOA is used in this system, the signal gets amplified without resetting the effects due to nonlinearity from previous span. In a link of length L with amplifiers spaced ι distance apart, the effective length is approximately given by:

$$L_{eff} = (1-\exp(-\alpha z)) / \alpha \, . \; L/i \qquad (6)$$

As above formula it used to see that the effects of nonlinearities can be reduced by reducing the amplifier spacing, where α is the attenuation constant, L is the fiber length

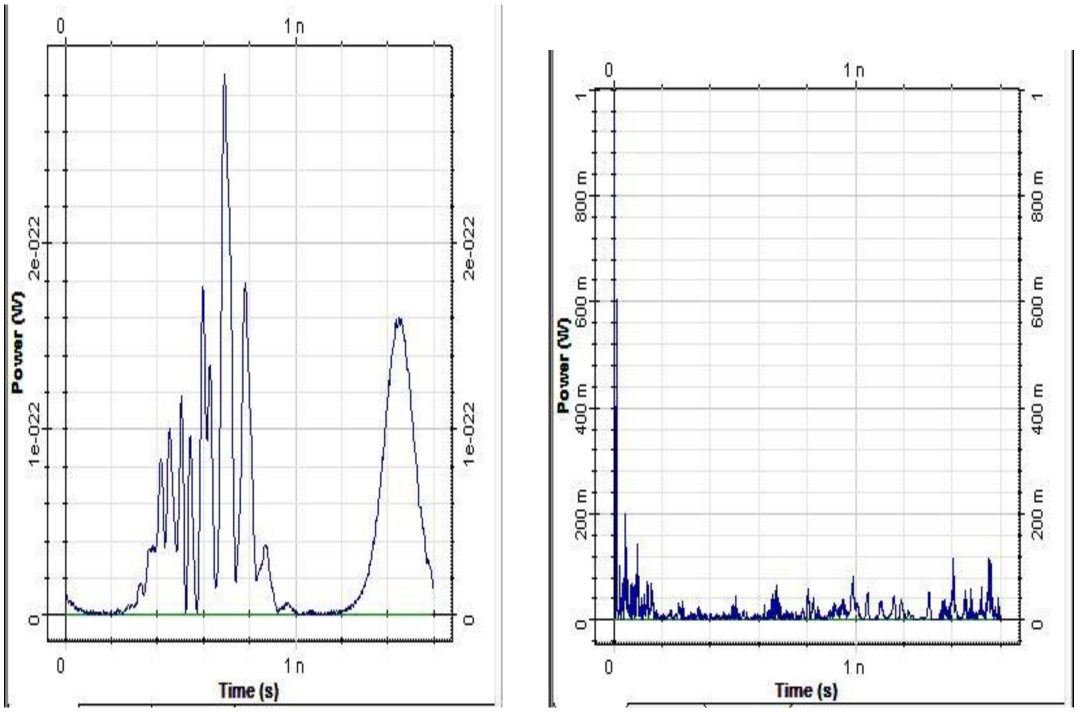
Table **1.** Parameters used in simulation system designed

Parameter	Component	symbol	value	Unit
Bit rate	Layout	B	10	Gb/s
Sequence length	Layout	-	16	Bit
Bit sequence	Bit sequence generator	-	00001000	-
Frequency	Optical Sech Pulse Generator	f	193.1	THz
Peak power	Optical Sech Pulse Generator	$P0$	0.30208	W
Width	Optical Sech Pulse Generator		0.5	Bit
Wavelength	Optical fiber	λ	1330	Nm
Length	Optical fiber	L	100	Km
Attenuation	Optical fiber	α	0.4	dB/km
GVD	Optical fiber	$\beta 2$	-20	$ps2/km$
effective area	Optical fiber	A_{eff}	80	Um^2
nonlinear index of refraction	Optical fiber	N_2	2.6×10^{-26}	M^2 /w
Nonlinear coefficient	Optical fiber	γ	1.317	W^{-1} /Km
Birefringence type	Optical fiber	-	Deterministic	-
Differential group delay	Optical fiber	-	0	Ps /Km
Pulse Width parameter	-	$T0$	7.0902	Ps
Dispersion length	-	L_D	2.5135	Km
Nonlinearity length	-	L_{NL}	2.5135	Km
Soliton period	-	Z_O	3.9482	Km

For this system the parameters was setting as;

- Multiplexing channel from the transmitter is 1556nm, 1550nm, for the two users.

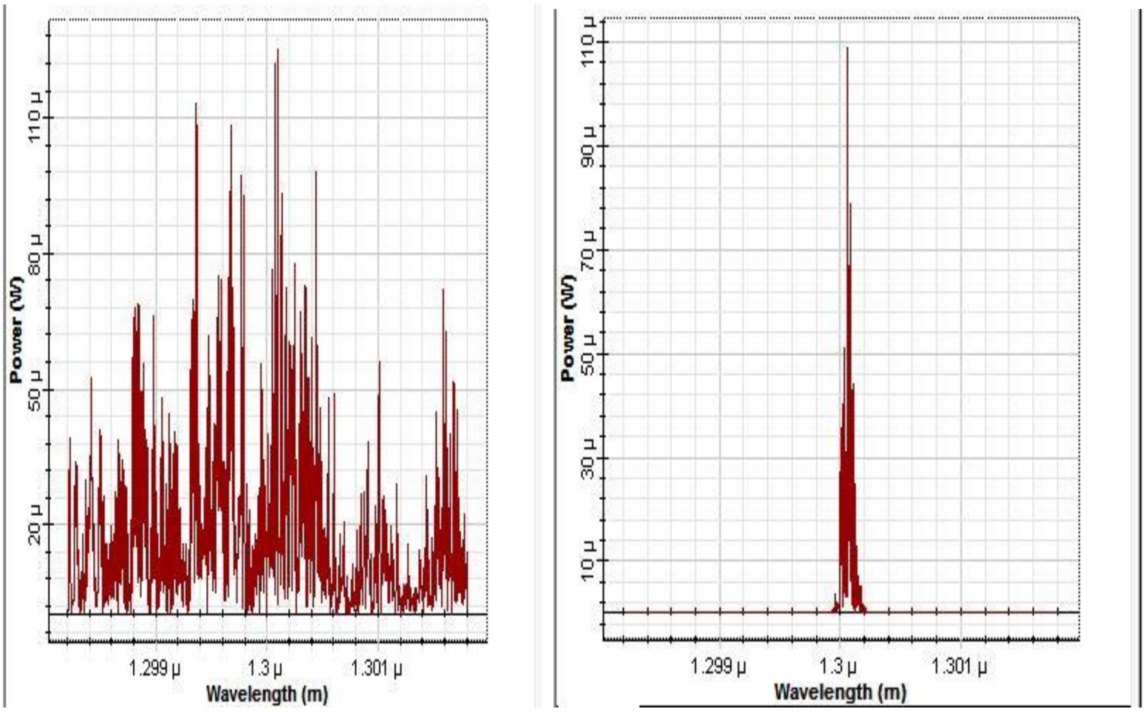
- FSO channel is setting at 1556nm.
- Demultiplexing channel at the receiver is 1556, 1550, for the two users.
- Coupling coefficient = o.5. [7].



a) At 100Km fiber length b) at 30Km fiber length

*fig 6.*Time domain OF fiber length

the comparison between time domain of fiber length at minimum distances 30(b) Km and maximum distance 1ooKm(a),power equal to almost 600mW and 3.0623x10^{-22} respectively. also the same difference we can illustrated between them but in frequency domain at 30 Km(b) power equal to 0.1315mw and at 100Km(a) power equal to 3.288x10^{-24} w. as referring to the figure 8.



a) Wavelength at 100 Km fiber length b) wavelength at 50Km fiber length

fig 7. Frequency domain power comparison at maximum and minimum distance fiber length.

As figure 7.the shape wavelength showing clearly the difference in 5oKm (b) and at 100Km (a) at the same center frequency at 1330nm.

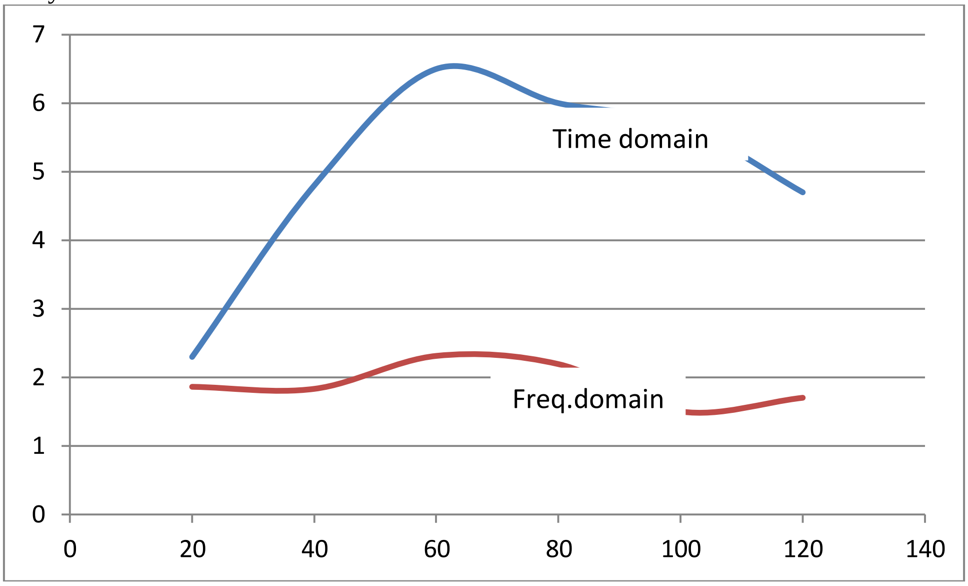


Fig 8.number of loop amplifiers effect in fiber length distance at 30Km

In this paper the number of loops is very effective as we can see in the comparison illustrated in figure 8, between number of loops and power in time domain and power in frequency domain for 30 Km minimum distance, while the results taken at 100Km fiber length distance as illustrated in figure 9.the desiccation always between time and frequency domain in order to find the relations in fiber optics lengths.

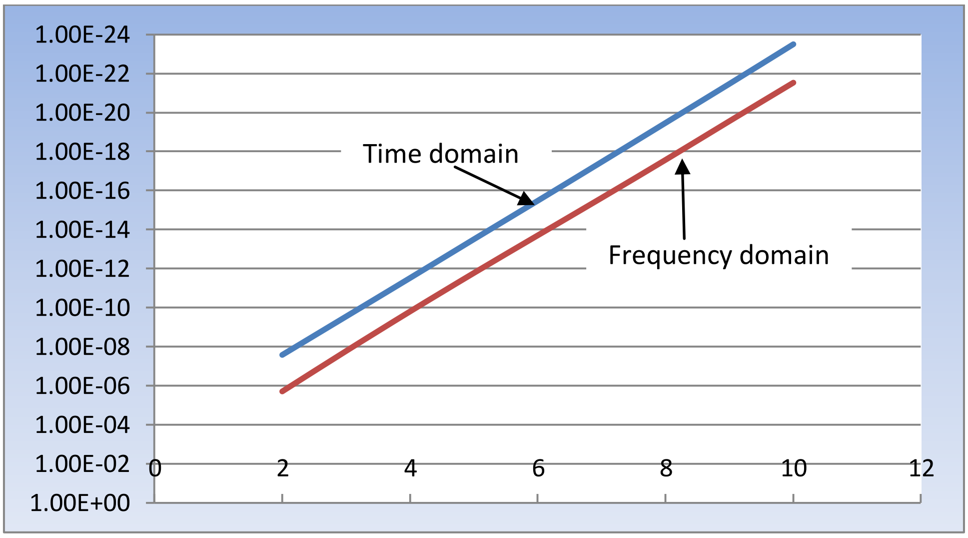


Fig9.Effect of time domain & frequency domain in number of amplifiers loop at 100Km

III. CONCLUTION:

By this paper can clearly study the definition of the effective length of fiber optics by the results obtained in time and frequency domain .As we have discussed that to transfer data (voice, sound and data) through two buildings, we can use a modified leaser with high data rate up to 2 Gbps using soliton system in fiber optic with the use of Gaussian optical pulse generators. The narrow width of the signal to more than 3ps increasing the data rate to be transferred.

Meanwhile, the (sech) optical pulse generator which is equal to the square root of Gaussian. is the perfect solution in Application which has a great potential to become one of the optical communication suitable system for OCDMA implemented in FTTH application.

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Asst.Prof.Dr. Ahmed Abd Al Kader, et. al. "Effect of Light Pulses Generator as a Narrow Bandwidth in Communication System Application by using Gaussian optical pulse."*American Journal of Engineering Research (AJER)*, vol. 10(11), 2021, pp. 10-17.