

Design And Implementation A System Communication Of Optical Fiber By Using Interval Wavelength (532nm-820nm) Of Diode Laser

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Abstract: The optical fiber communication system has different designs and implementations. In this work, two light sources were used in the optical system , a diode laser of a wavelength (532nm) and a light emitting diode of a wavelength 820nm . Multimode optical fiber is used as a channel and PIN photodiode is used as an optical detector . For each light source, the power budget for the optical design and the power-current curve have been measured by using the experimental results.

Keywords: Opticalfiber, Communcation System, PIN,DiodeLaser,LED

I. INTRODUCTION

An optical communication system consists of a *transmitter*, which encodes a *message* into an optical *signal*, a *channel*, which carries the signal to its destination, and a *receiver*, which reproduces the message from the received optical signal.[1]

One of the most important types of optical communication system is optical Fiber communication which is based on using an optical fiber as the channel which carries the signal. A block diagram of the fiber optics communication system is shown in figure (1).[2]

Optical fiber is the most common type of channel for optical communications, however, other types of optical waveguides are used within communications gear, and have even formed the channel of very short distance (e.g. chip-to-chip, intra-chip) links in laboratory trials. The transmitters in optical fiber links are generally light-emitting diodes (LEDs) or laser diodes. Infrared light, rather than visible light is used more commonly, because optical fibers transmit infrared wavelengths with less attenuation and dispersion. The signal encoding is typically simple intensity modulation, although historically optical phase and frequency modulation have been demonstrated in the lab. The need for periodic signal regeneration was largely superseded by the introduction of the erbium-doped fiber amplifier, which extended link distances at significantly lower cost.[2]

II. LIGTH SOURCES

The light sources used in optical fiber communication system must have some desirable characteristics which are required for light source to function properly. The requirement which must be satisfied are [3].

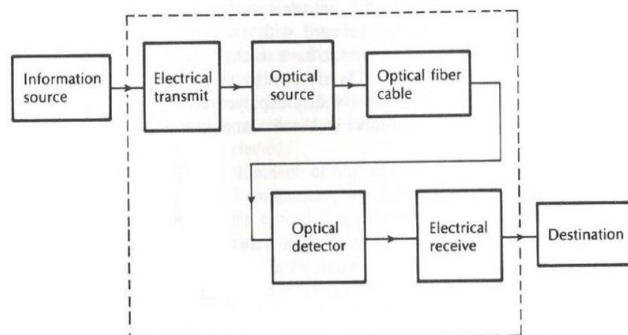


Figure (1):A block Diagram of an Optical Fiber Communication System

- Output wavelength: must coincide with the loss minima of the fiber.
- Output power: must be high, using lowest possible current and less heat.
- High output directionality: narrow spectral width.
- Wide bandwidth.
- Low distortion.

These requirement made the LEDs and LDs the preferable light sources for optical communication system.

Table (1): Comparison of Light Sources[4]

LED	LD
Low efficiency	High efficiency
Broad output spectrum	Narrow output spectrum
Incoherent beam	Coherent output beam
Low launch power	High launch power
Higher distortion level at the output	Less distortion
Suitable for shorter transmission distances.	Suitable for longer transmission distances
Simple construction	Construction is complicated
Longer life time	Smaller Life time
Lower modulation bandwidth	Higher modulation bandwidth

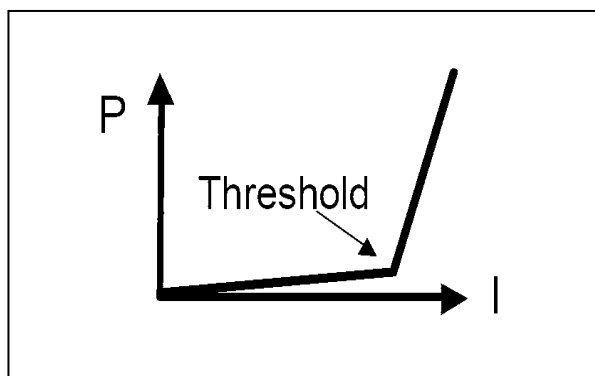


Figure (2): The radiant output power versus the injected current

III. OPTICAL POWER AND OPTICAL POWER LINK BUDGET.

The output optical power is increased as the injection current increase but a low output power achieved below the threshold point until the current reached to the threshold where the laser action start and above the threshold a great change in the output optical power with a small change in injection current is obtained [2].

The relationship between optical output power and diode drive current is presented in figure (2) [4] .

The purpose of the optical power link budget is to ensure that enough power will reach the receiver to maintain reliable performance during the entire system lifetime , The minimum average power required by the receiver is the receiver sensitivity P_{sens} . The average launch power P_i is generally known for any transmitter. The power budget takes an especially simple form in decibel units with optical powers expressed in dBm [5]. More specifically,

$$P_i = P_{sens} + C_L + M_a \dots\dots\dots (1)$$

Where C_L is the total channel loss and M_a is the safety margin. If α_f is the fiber loss in decibels per kilometer, α_s is the splice loss in decibels per kilometer, and α_c is the connector loss in decibels then C_L can be written as:

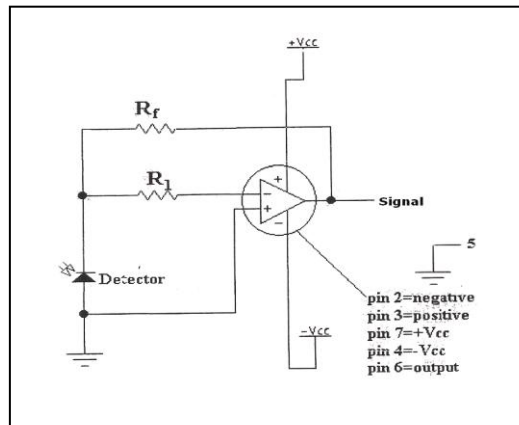
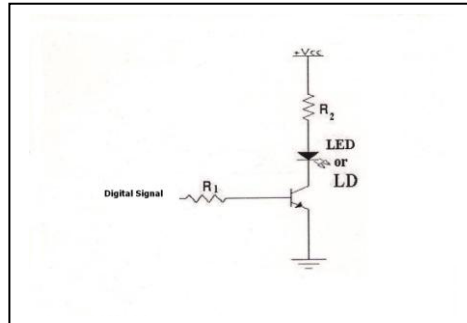
$$C_L = (\alpha_f + \alpha_s)L + \alpha_c \dots\dots\dots (2)$$

Where L: is the length of the fiber in kilometers.

IV. EXPERIMENTAL SETUP OF OPTICAL FIBER COMMUNICATION SYSTEM.

A brief description of each of the parts of the optical fiber communication system is presented as follow:

The optical transmitter: the optical transmitter is HFBR 1402, which contains an optical source is a LED with a wavelength of 820 nm, and LD with wavelength of (532) nm which is modulated using direct intensity modulation as shown in figure (3). The optical receiver: the optical receiver is HFBR 2402, which contains a PIN detector and a DC amplifier as shown in figure (4). The optical fiber is (20) m long with a core to cladding diameter ratio of 50/125 μm



We connected the circuit as shown in figure (3). The function generator was used by passing 5 volt to the input of the transmitter circuit by using pulse waveform. In addition, the photo-diode converted the photo energy into an electric.

V. EXPERIMENTAL RESULTS AND DISCUSSION:

5.1 The power versus current curve for the laser diode operation:

The power-current curve was drawn depending on the values of the laser output power, which was measured using a power-meter, and the driving current, which was measured on R_2 , indicated in figure (5). Figure (5) shows the P-I curve for the measured values of the power and the current for the laser diode.

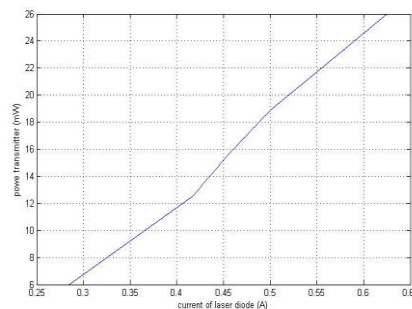


Figure (5): The power-current curve for the laser diode

Table (2): The measured values of the power and the current for Laser

Current (A)	Power transmitter (mW)
0.2846	6
0.4167	12.5
0.4545	15.6
0.5000	18.9
0.5556	22
0.6250	26

5.2 The power versus current curve for the light emitting diode operation:

The power-current curve was drawn depending on the values of the LED output power, which was measured using a power-meter, and the driving current, which was measured on R₂.

Figure (6) shows the P-I curve for the measured values of the power and the current for the laser diode.

Table (3) shows the measured values of the power and the current.

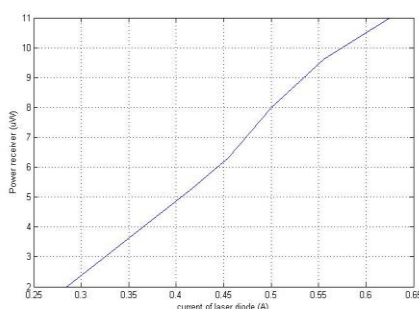


Figure (6): The power-current curve for the LED

Table (3): The measured values of the power and the current for LED

Current (A)	Power receiver (μW)
0.2846	2
0.4167	5.3
0.4545	6.3
0.5000	8
0.5556	9.6
0.6250	11

5.2 POWER LINK BUDGET:

The required receiver power and available transmission power, the upper limit of the allowable power loss form transmission is called the power budget specifically, if the transmission power is (p_{in})and the minimum required receiving power is(P_{min}) the power budget.

$$\text{Power budget(dB)}=P_{in} [\text{dB}]-P_{min}[\text{dB}] \dots\dots\dots (3)$$

$$\alpha=(1/L)\log(p_o/p_{in}) \dots\dots\dots(4)$$

where α is Fiber attenuation(in dB/Km) and L is a fiber length.

table (4) shows the power budget calculation of two sources LED and LD which are calculated from equations (1),(2) , (3) and (4).

Table (4) the power budget calculations.

The properties	LED	LD
The optical power launched into the fiber (in dB)	-24.55 dBm	-15.85 dBm
The minimum required received power(in dB)	-39.15 dBm	-39.15 dBm
The total power margin (in dB)	14.6 dB	23.30 dB
Fiber attenuation(in dB/Km)	3 dB	-0.186 dB
The connector loss (2*1.5dB)	3 dB	3 dB
Safety margin (in dB)	6dB	8dB

VI. CONCLUSION

Due to the use of the optical fiber as a transmission medium, the maximum distance is increased largely as compared to the distance obtained with the twisted pair cable. Because of the optical power launched into the fiber for the LD is larger than LED Then the power link budget for LD is larger than LED. The output power from the LD increases slowly with the drive current, until the threshold point, where it will increase rapidly.

The attenuation factor is increased (in case of transferring data through the air or fiber) when the distance between the transmitter and the receiver is increased with the decreasing of the received power.

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