ATTENUATION LOSS

Objective: To measure propagation or attenuation loss in optical fiber.

List of Equipment:

1. Optical fiber kit
2. Function generator
3. Optical fiber of different length

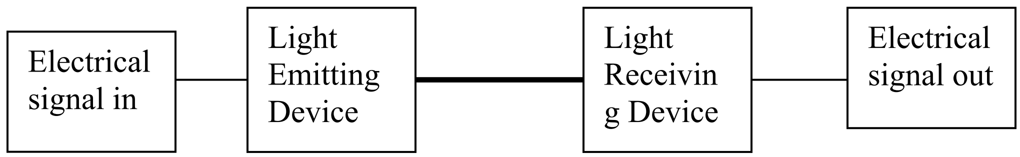
Theory:

Attenuation is loss of power. During transit light pulse lose some of their photons thus reducing their amplitude. Attenuation for a fiber is usually specified in decibels per kilometer. For commercially available fibers, attenuation ranges from 1db/km for premium small core glass fibers to over 2000 dB/km for a large core plastic fiber. Loss is by definition negative decibels. In common usage, discussions of loss omit the negative sign. The basic measurement for loss in a fiber is made by taking the logarithmic ratio of the input power (P_i) to the output power (P_o).

$$\alpha\ (\mathrm{dB}) = 10 \log_{10} \frac{P_i}{P_o}$$

where α is Loss in dB/meter.

Another impairment to the signal, besides attenuation is called dispersion. This effect limits the highest frequency that can transmitted through a certain length of fiber, and one of its causes (called 'mode' dispersion) results from the fact that there are different path lengths for each ray – those rays with larger values of angle of incidence travel less distance than those with smaller angle of incidence. Since the light in a fiber contains rays with all angels up to the critical angle, the time of arrival at the receiver of a short transmitted pulse will be spread over a time that is determined by the path lengths over which the individual rays travel, as the speed over a time that is determined by the path lengths over which the individual rays travel, as the speed of the light is the same in all directions. If the two short pulses are transmitted one after the other in quick succession, then the spreading of each pulse may cause the two to overlap at the receiver. Thus dispersion limits the frequency at which pulses can be detected, since the received could not be easily identified as having been generated from two separate pulses.



Procedure:

1. Connect power supply to board
2. Make the following connections (as shown in fig)
    a) Function generator 1 KHz sinewave output to input 1 socket of emitter 1 circuit via 4 mm lead.
    b) Connect 0.5 m optic fiber between emitter 1 output and detector 1's input.
    c) Connect detector 1 output to amplifier 1 input socket via 4 mm lead.
3. Switch ON the power supply.
4. Set the oscilloscope channel 1 to 0.5V/Div and adjust 4-6 div amplitude by using X 1 probe with the help of variable pot in function generator block at input 1 of emitter1.
5. Adjust the amplitude of the received signal as those of transmitted one with the help of gain adjust pot in AC amplifier block. Note this amplitude and name it V_1.
6. Now replace the previous F.O. cable with 1 m cable without disturbing any previous setting.
7. Measure the amplitude at the receiver side again at output of amplifier and name it V_2. Calculate the propagation (attenuation) loss with the help of following formula.

$$\left(\frac{V_1}{V_2}\right)^2 = e^{-\alpha(L_1+L_2)}$$

Where α is loss in nepers/meter

1 neper = 8.686 dB

L_1 = length of shorter cable (1m)

L_2 = length of longer cable (2m)

Discussions:

1. What are the causes of attenuation?
2. Explain with suitable diagrams the different mechanisms that contribute to attenuation in optical fibers.
3. How many types of dispersion are there in optical fiber?
4. Mention the two causes of intramodal dispersion.
5. Distinguish dispersion shifted and dispersion flattened fiber.

References:

1. Gerd Keiser, Optical Fiber Communications, Tata McGraw Hill, 2008.