OPTICAL FIBER COMMUNICATION

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MODULATION:

Communication by optical fiber includes optical transmitter, optical receiver and optical fiber cable as transmission medium. The data is first encoded and then modulated over the optical carrier.

In analog direct modulation amplitude modulation, frequency modulation and Phase modulation are used and ASK, FSK, PSK, DPSK, etc. modulation techniques are used in digital communication.

The speech signal and audio signal are analog signals which can be directly modulated using amplitude, frequency and Phase modulation using optical source. Both LED and Laser have linear region which are used for modulation

DIRECT INTENSITY MODULATION:

In direct modulation technique the modulation of laser source is done directly by analog signal whereas in indirect method the conversion of analog signal into digital signal is done by costly A to D converters, encoding it using pulse code modulation and then modulating it using ASK / FSK / PSK / DPSK technique.

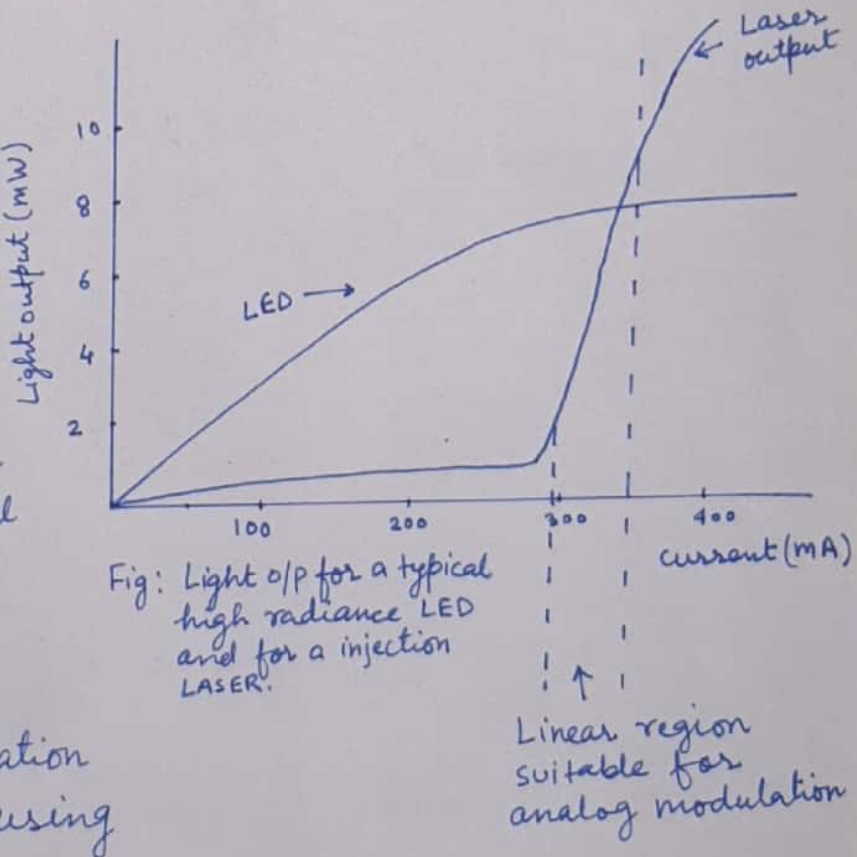

Fig: Light o/p for a typical high radiance LED and for a injection LASER.

In cable TV (CATV) application or in optical analog signal transmission, direct analog signal are used for modulation of laser source. This means, laser source provides high signal to noise ratio (means high laser output), high end to end linearity to avoid any direct operation in phase and amplitude and crosstalk between multichannel signal transmission

As optical fiber provides high bandwidth and are lower in cost than coaxial cables, these fibers are replacing coaxial cable in cable TV when hight quality online video and internet services are needed

Signal to Noise Ratio (S/N):

S/N ratio of an optical fiber is:

$$\frac{S}{N} = \frac{\eta P_0}{2h\nu B}$$

where:

η = quantum efficiency.
P_0 = incident Power
$h\nu$ = photon energy
B = Post detection bandwith.

This can be written as:

$$\left(\frac{S}{N}\right)_{f_0} = \frac{\eta P_i \exp(-\sigma_N)}{2h\nu B} \quad ; P_0 = P_i \exp(\sigma_N).$$

In direct modulation technique, the optical o/p from the source is modulated by changing the current flow in the device by using a suitable bias below laser threshold. Hence, the intensity modulated signal is transmitted directly in the baseband.

DIRECT OPTICAL MODULATION:

In direct optical modulation, the drive current applied to optical source is modulated directly by analog signal and hence no additional circuits in transmitter and receiver are needed. So it is easy to install and less expensive.

Let us consider a sinusoidal modulating signal, we may write modulating signal as

$$S = A_m \cos \omega_0 t$$

where,

A_m = modulating index
ω_0 = angular frequency of the modulating signal

The transmitted optical power with respect to time is given by:

$$P_{op}(t) = P_i(1 + A_m \cos \omega_0 t) \text{ and}$$

$$I_p = \left(\frac{\eta e}{h\nu}\right) P_0 \text{ is Primary Photocurrent.}$$