TESCA™

Tesca Technologies Pvt. Ltd.

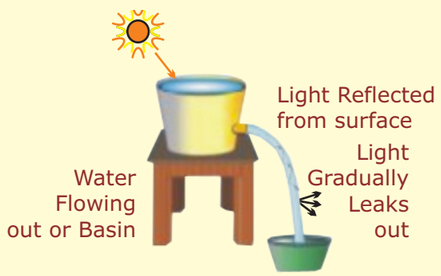
Understanding Fiber Optics

History

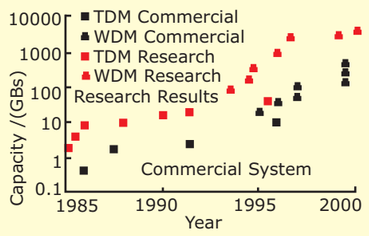
In 1870, John Tyndall, demonstrated that light used internal reflection to follow a specific path.
Alexander Graham Bell, in 1880, patented a method of light transfer called "piping light"
William Wheeling developed an optical voice transmission system he called the photophone.

Light wave Volution

1975 : Coax, 274 Mb/s at 1km repeater spacing
1980 : 0.8 um GaAs lasers, MMF, 45 Mb/s @ 10km
1987 : 1.3 u, In GaAsP lasers, SMF, 1.7 Gb/s @ 50kM
1990s : 1.55 um In GaAsP DFB lasers, SMF, 2.5-10 Gb.s @ 40km
1990s : WDM, 1.55 um InGaAsP DFB lasers, EDFA, SMF, 2.5-10 Gb.s @ 300-10,000km repeater spacing
2002 : 64 WDM chx 10Gbps over 250,000 km span

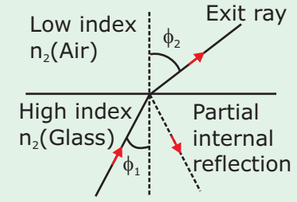


The Arrival of Optical Revolution



Total Internal Reflection

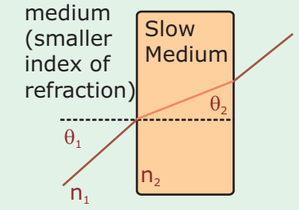
The angle of incidence ϕ_1 and refraction ϕ_2 are related to each other and to refractive indices of dielectrics by Shell's Law of Refraction which states that:



Snell's Law

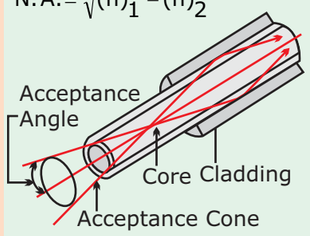
$$\frac{n_1}{n_2} = \frac{\sin\theta_2}{\sin\theta_1}$$

Fast medium (smaller index of refraction)



Numerical Aperture & Acceptance Angle

$$N.A. = \sqrt{(n)_1^2 - (n)_2^2}$$



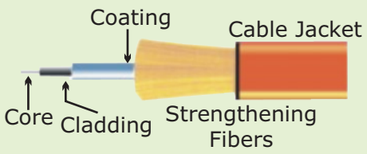
Advantages of F.O.

- Greatly increased bendwidth and capacity
- Low signal attenuation (loss)
- Immunity of Electrical Noise
- Immune to noise
- (Electromagnetic interference) [EMI] and radio frequency interference [RF]
- No crosstalk
- Lower bit error rates
- Signal Security
- Difficult to tap
- Non-counductive (does not radiate signals Electrical Isolation)
- No common ground required
- Freedom from short circuit and sparks.
- Size and Weight
- Environmental Protection
- Resistant to radiation and corrosion
- Resistant to Temperature variations.
- Improved ruggedness and flexibility.
- Less restrictive in harsh environments
- Overall System Economy
- Low per-channel cost
- Lower installation cost.

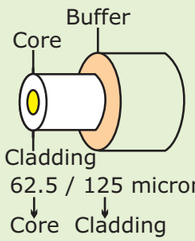
Disadvantage of E.O.

- Fiber optic components are expensive
- The lack of standardization
- More difficult and expensive to splice than wires.

F.O. Cable Construction

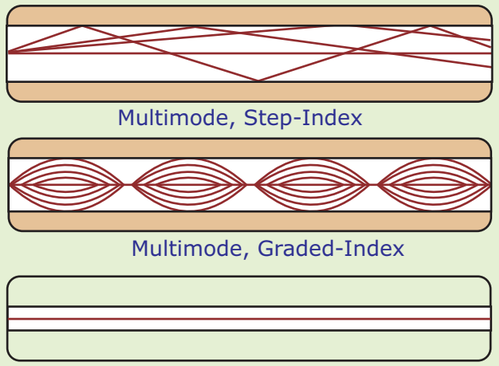


The simplest fiber optic cable concentric of two concentric layers of transparent materials. The inner portion (the core) transports the light; the outer covering (the cladding) must have a lower refractive index than the core so the two are made of different materials. To provide mechanical protection of the cladding an additional plastic layer; the Primary Buffer is added. Some constructions of optic fiber have additional layers of buffer, which are then referred to as Secondary Buffer. It is vary important of note that the whole fiber Core, Cladding & Primary Buffer is solid and the light is confined to the core by the Total Internal Reflection due to the difference in the refractive index of the core compared to that of cladding.



Cables

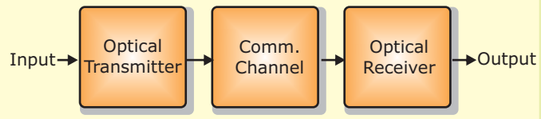
Multimode | Single mode



Refractive Indexing Material

Vacuum	1.00000	Glass	1.5
Air at STP	1.00029	Sodium Chloride	1.54
Ice	1.31	Flint glasses	1.57-1.75
Water 20°C	1.33	Extra dense Flint	
Acetone	1.36	EDF-	1.7200
Ethyl alcohol	1.36	Diamond	2.417
Glycerine	1.473	Sapphire	2.417
Sugar (80%)	1.49		

F.O. Communication System



Transmitter
Produces and encodes the light signals
- Format
- Bandwidth
- Protocol
- Modulation
- Characteristics
- Power

Optical Fiber
Conducts the light signals over a distance
- Loss
- Dispersion
- 4-Wave Mixing
- Boise
- Crosstalks
- Distortion

Optical Regenerator
May be necessary to boost the light signal (for long distance)
- Bandwidth
- Responsivity
- Sensitivity
- Noise
- Wavelength

Fiber is deployed at a rate of 200 miles every hour.

Losses in F.O.

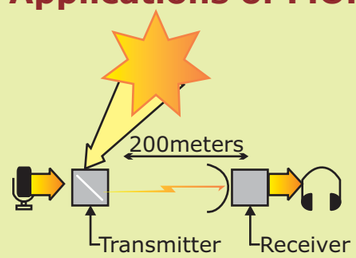
1. Attenuation
2. Material Absorption Losses
3. Linear Scattering Losses
   a. Ray Leigh Scatter b. Mie Scattering
4. Non Linear Scattering
5. Micro Bending and Macro Bending
6. Dispersion
   a. Inter modal Dispersion b. Intra modal Dispersion

F.O. Components

Transmitter ! LEDs, Laser Diode
Receiver

- Cables
- Connectors
- Splices
- Amplifiers
- Hardware (Installation hardware, patch panels, splice closures, conduit

Applications of F.O.



Applications-Networks

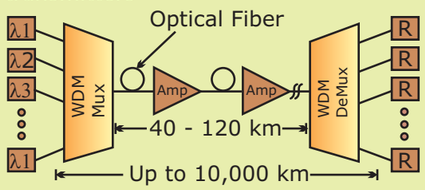
- Telecom, SONET, ATM, DWDM,
- Fiber Amps, CATV
- AM vs FM vs Digital HFC, LANs, Ethernet
- Token Ring, FDDI, SANs, ESCON, Fiber

Applications-Links

- Video, Security, Broadcast TV, Industrial links
- RS-232, RS-422, Wireless Antennas
- Utility gnd management, Sensors

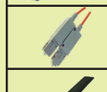
VDM Optical System

Frequency-registered transmitters



Δλ = 25-100GHz
(0.4 or 0.8mm @ 1500nm)

Fiber Optics Connectors

Connector	Insertion Loss	Repeatability	Fiber Type	Applications
	0.50 -1.00dB	0.20 dB	SM, MM	Datacom Telecommuni-cations
	0.20 -0.70dB	0.20dB	SM, MM	Fiber Otic Network
	0.15 db(SM) 0.10dB (MM)	0.2dB	SM, MM	High Density Interconnection
	0.30 -1.00dB	0.25dB	SM, MM	High Density Interconnection
	0.20-0, 45dB	0.10dB	SM, MM	Datacom
	0.20-0, 45dB	0.10dB	SM, MM	Datacom
	Typ, 0.40dB (SM) Typ. 0.50 dB (MM)	Typ, 0.40dB (SM) Typ. 0.20 dB (MM)	SM, MM	Inter/Intra Building, Security, Navy


28505
Fibre-Optic trainer


28507
Laser Fibre Optic Trainer


28508
Physics of Fiber Optics Trainer


28512
Multiplexer / Demultiplexer


28520-21
Fiber Optic Connectorization Kit


28522
Fiber Optic Connectors Kit


28524
Optical Power Meter


28526
Fibre Optics Communication Trainer

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