

### Fibre Optics is the transmission of data through glass or plastic fibre using light.

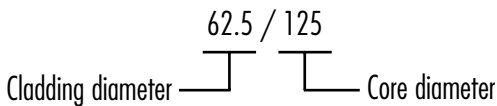
This happens by the light travelling in continuous strings called photons that travel in waves along the fibre. Electrical signals are converted into light via a laser or light emitting diode (LED), this light is then fed down the fibre. A detector collects the light which then reconverts the signal back to electricity. Optical Fibres have many advantages over electrical cables, advantages such as:

- Lower losses
- Longer distances
- Smaller size & lighter weight
- Increased bandwidth
- No electromagnetic interference

An optical fibre is a thin strand of glass, (about the thickness of a human hair)- that is made up of layers of glass / silica of different refractive indices.

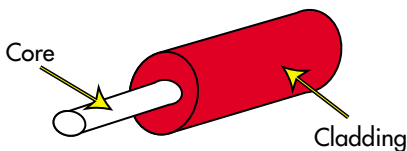
Fibres consist of concentric elements of either plastic or glass and have two essential components - core and cladding

An example of a typical fibre description is:

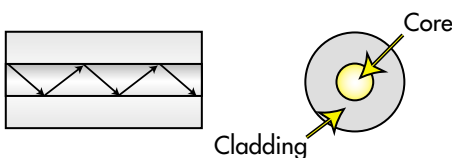


**Core** is the central cylinder of the fibre and has a higher refractive index than the cladding. The core is usually doped with germanium dioxide (GeO<sub>2</sub>) to achieve this. Core diameters are typically 9µm, 50µm, 62.5µm or 100µm.

**Cladding** is the layer of quartz (SiO<sub>2</sub>) surrounding the core.

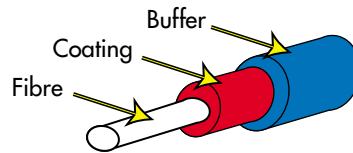


The light is guided through the fibre by total internal reflection at the interface between the core and the cladding, where the core has a slightly higher index of refraction.



Total Internal Reflection in an optical fibre

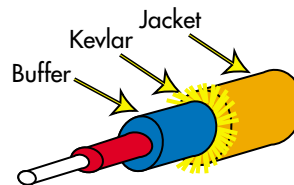
To protect the fibre, there are additional layers of materials: **Coating** the fibre cladding protects it from being damaged, this coating is often 250µm in diameter. This coating may be used to strip out any rays of light travelling in the cladding.



**Buffer** is an extra layer of material either 500µm or 900µm in diameter that may then be added to give further protection.

### Cable

For a buffered fibre to be used in an outdoor or harsh environment it needs to be cabled. Cable can be singleway or multiway and tight jacket or loose tube construction.



### Tight Jacket

The buffered fibre is normally surrounded by Kevlar and then jacketed to diameters ranging from 1.8 to 3.0mm.

### Loose Tube

The fibres are contained inside a plastic tube that in turn is jacketed for harsh environments. Fibre counts for this type of cable range from 2 to 24 fibres.

### Fibres are normally described as two types:

**Multimode** fibre allows the propagation of many modes down the one fibre.

There are two types of multimode fibre, step index and graded index.

**Singlemode** fibre only allows one mode (the fundamental mode) to travel down the fibre.

In principle, the small size of the core 5µm - 10µm only allows one mode that travels in a straight line.

A **Mode** is equivalent to a ray of light that exists inside the fibre.

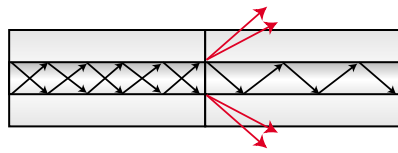


### Measurement terms:

The Decibel (dB) is the unit used for measuring the attenuation of optical power.

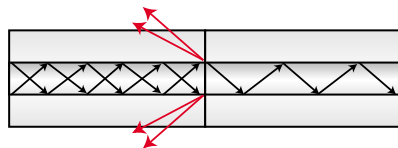
**Attenuation** is the measure of the amount of light loss that occurs in a fibre or fibre optic system, (normally measured in dBs).

**Insertion Loss** is the increase in attenuation caused by inserting a connector pair (or passive component) in to a fibre optic link. A certain amount of signal will be lost at each joint.



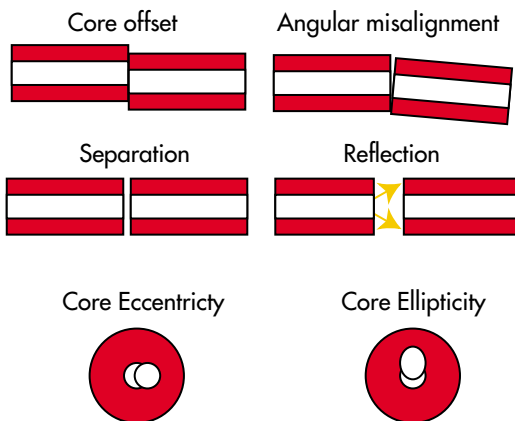
Insertion loss at fibre joint

**Return Loss** is the ratio of the forward optical power to the reflected optical power. This reflected light is dependent on the form of the fibre end.



Return Loss at fibre joint

### What Causes Losses in Fibre Optic Connections?



Separation and offset are the most common contributors to loss in fibre connections

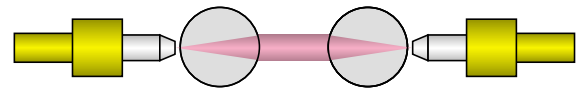
### Wavelength

The wavelength of light is the distance between two waves  
Common transmission wavelengths are:

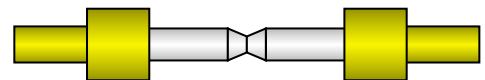
- Multimode 850nm and 1310nm.
- Singlemode 1310nm, 1550nm and 1625nm.

### Connectors

Many different fibre optic connector styles are available on the market. Connectors come in two basic types: expanded beam and butt joint, but within each of these there are a number of different variants or styles depending upon which environment it is to be used with.



Expanded beam connectors are where a lens is placed in front of the fibre to expand the emitting beam of light. The expanded beam is then refocused back into the fibre of the mating half. The distance between mating halves is variable.



Butt Joint connectors are where the fibres are normally mounted in a cylindrical ferrule. This ferrule end is then specially polished allowing two ferrules to be mated together. This provides a fibre joint that is aligned using high precision components.

### Typical Optical Fibre Applications

- Telecommunications
- Data Communication
- Petro-Chemical
- Military
- Aerospace
- Broadcast
- Industrial



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