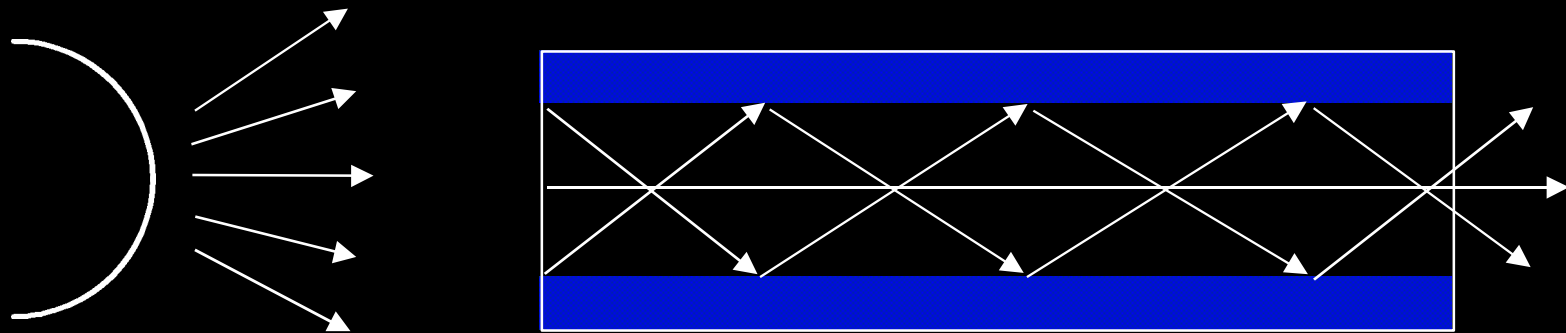


What is Fiber Optics?

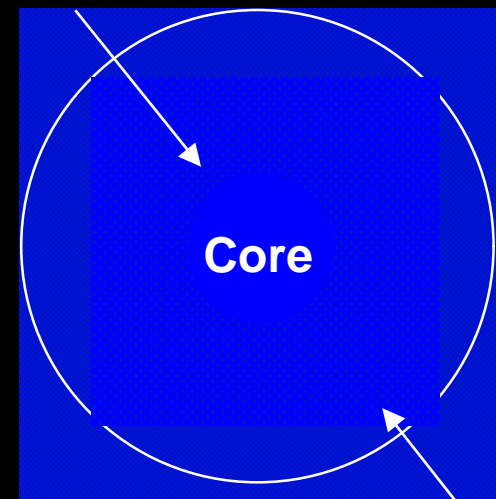
Use rays of light to send large quantities of information over hair thin fiber at very high speeds



The Optical Fiber

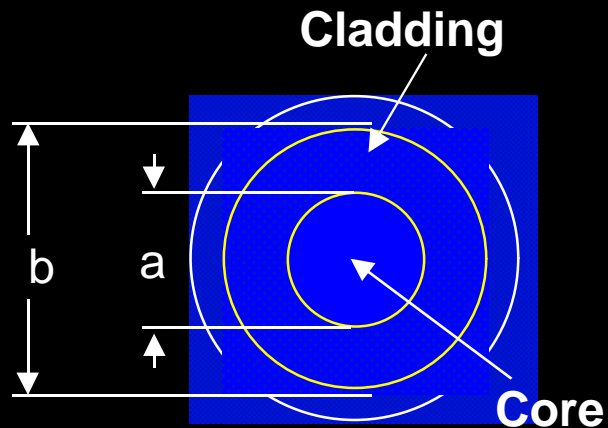
- Core
 - usually glass
 - carries the light signal
- Cladding
 - keeps the light within the core
- Buffer
 - protective coating

Cladding



Buffer

Fiber Size



- Measured in microns (1 millionth of a meter)
- Human hair = 85 μm

Fiber Size

- Most common industrial sizes

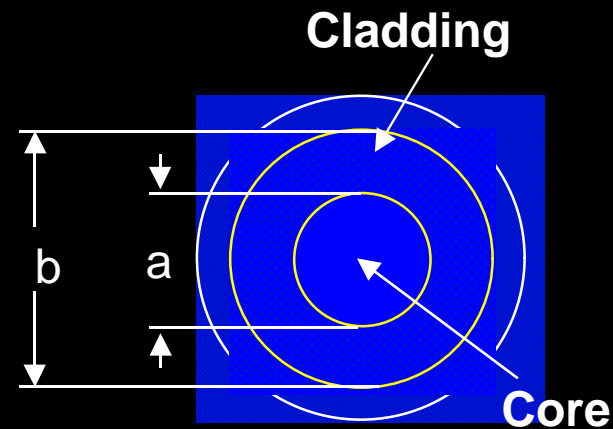
9/125 μm

50/125 μm

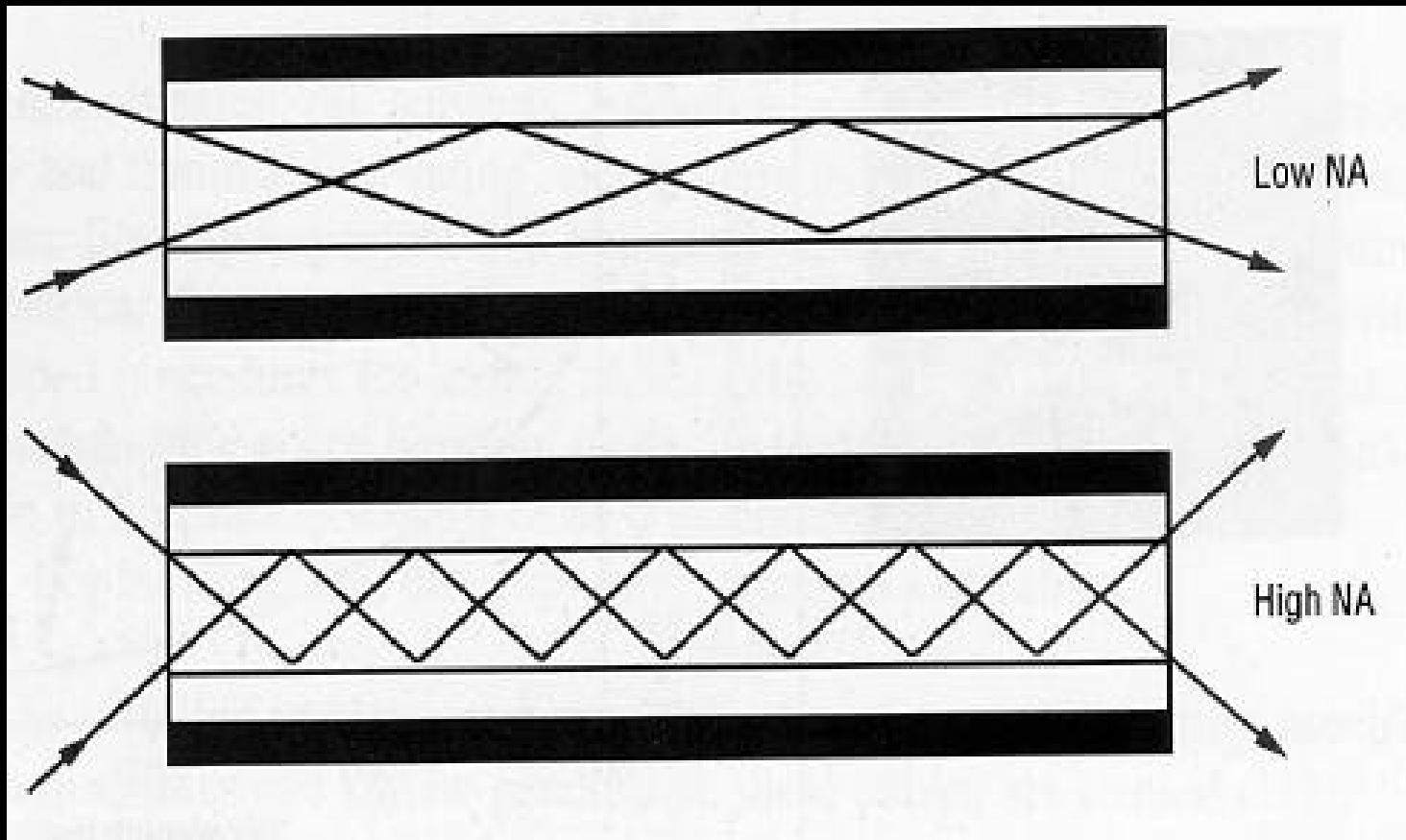
62.5/125 μm

100/140 μm

200/230 μm

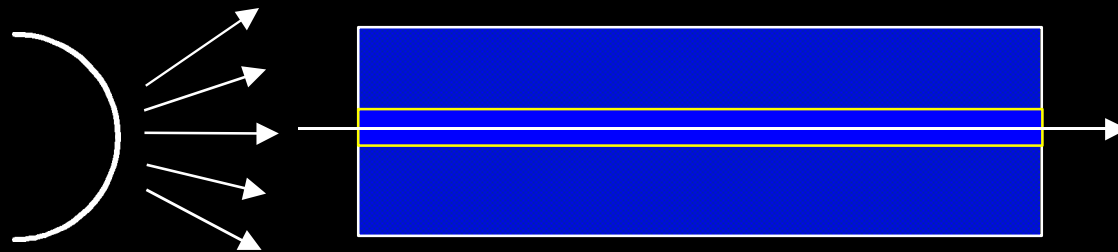


Numerical Aperture

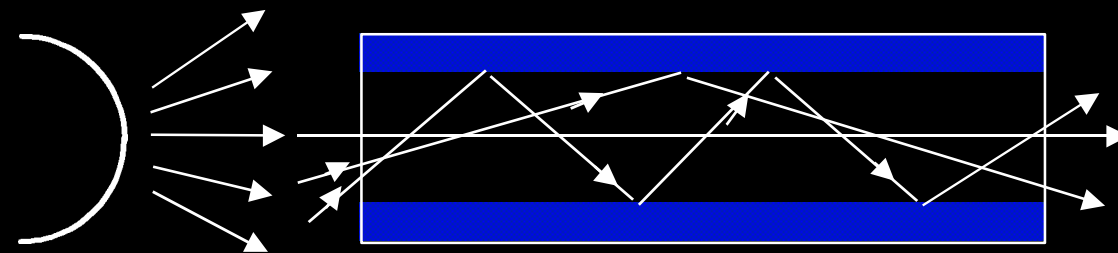


Structure

- The structure of the fiber determines how light travels through it - modes



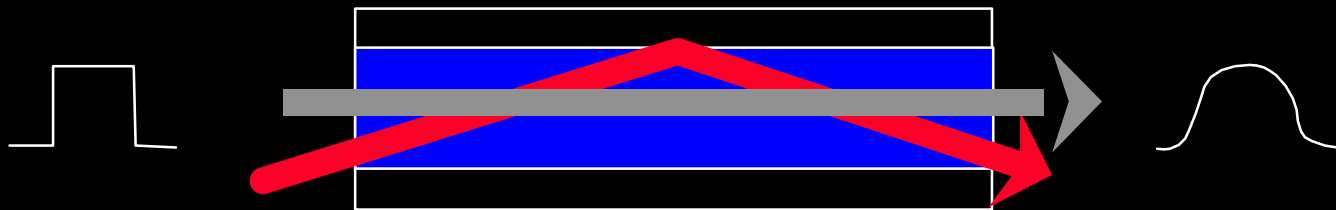
Single-mode Fiber:
A single path
through the fiber.



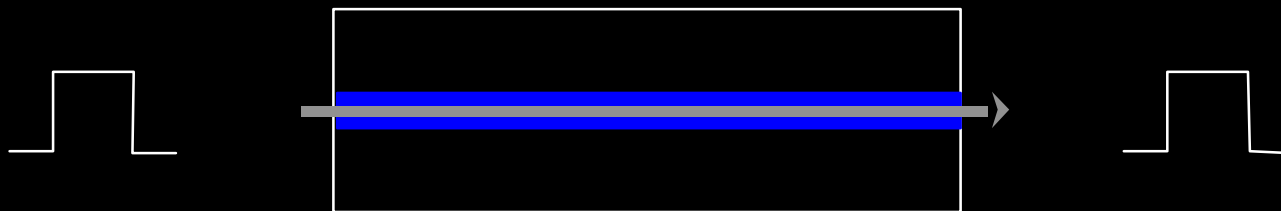
Multimode Fiber:
Multiple paths
through the fiber.

Multi vs Single Mode

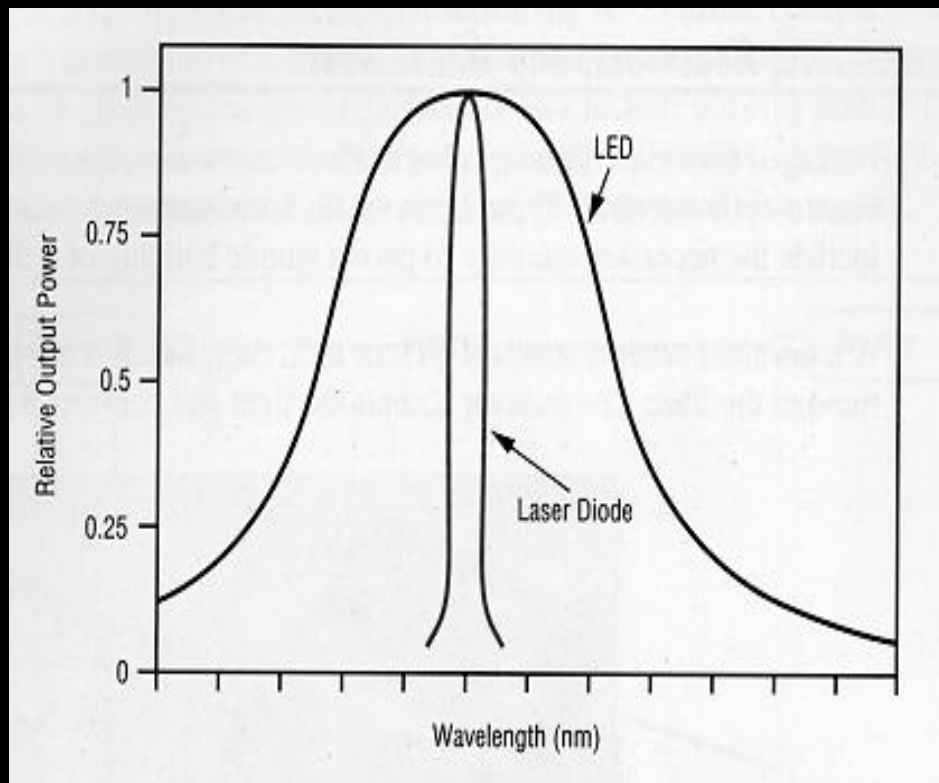
MULTIMODE



SINGLE-MODE



Equipment Factors (cont)



- Spectral width
 - all light sources emit a range of wavelengths around a center wavelength
 - for LED this is about 50 nm in the 1300 nm window (100 for 850 nm)
 - for a laser it is less than 5 nm

Dispersion

- Modal dispersion (mode = pathway)
 - Various modes follow different paths, resulting in pulse broadening
- Chromatic dispersion
- Material dispersion

Typical Attenuation Values

- Cable
 - singlemode - 9um
 - » 0.5 dB/km @ 1300 nm
 - multimode - 62.5um
 - » 3.5 dB/km @ 850 nm
 - » 1.5 dB/km @ 1300 nm
 - large core - 200um
 - » 6-8 dB/km @ 850 nm
- Connectors
 - adhesive/polish
 - 62.5um
 - 0.5 - 0.75 dB
 - crimp & cleave
 - 200um
 - 1.5 - 2dB

Bandwidth

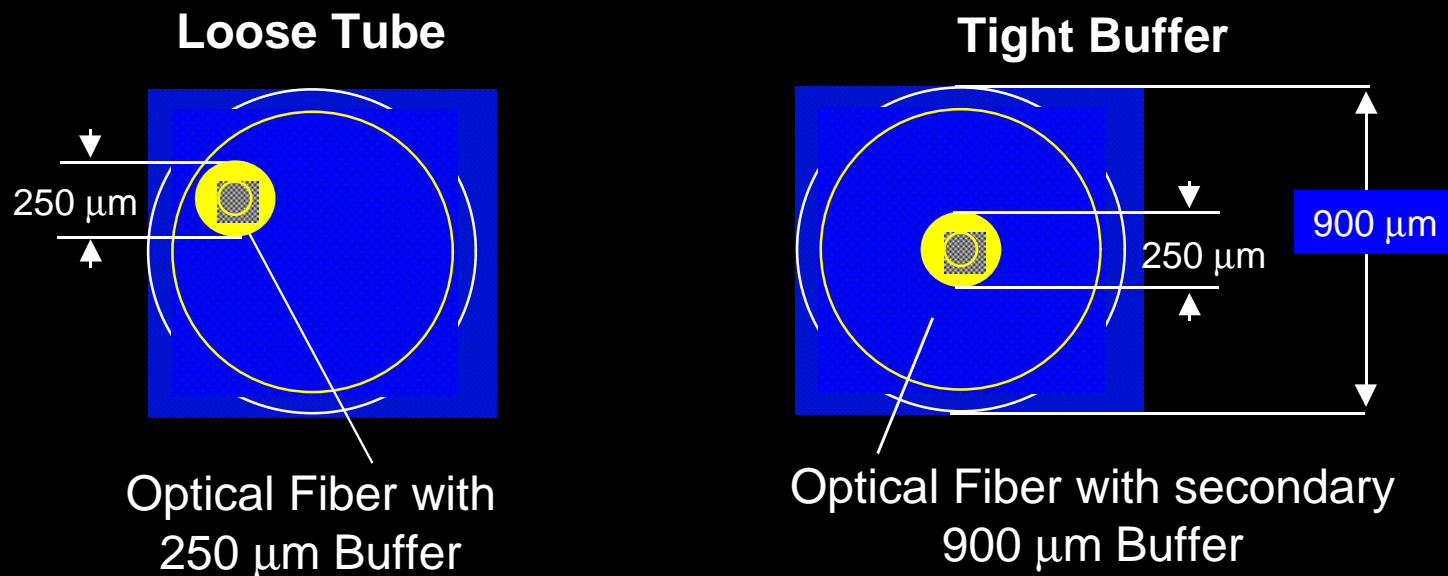
- Bandwidth is the amount of information that a fiber can carry
- Specified in MHz / km
- Industrial fiber = 20 MHz / km
Datacom fiber = 500 MHz / km
Telecom fiber = >2 GHz

Fiber Comparison

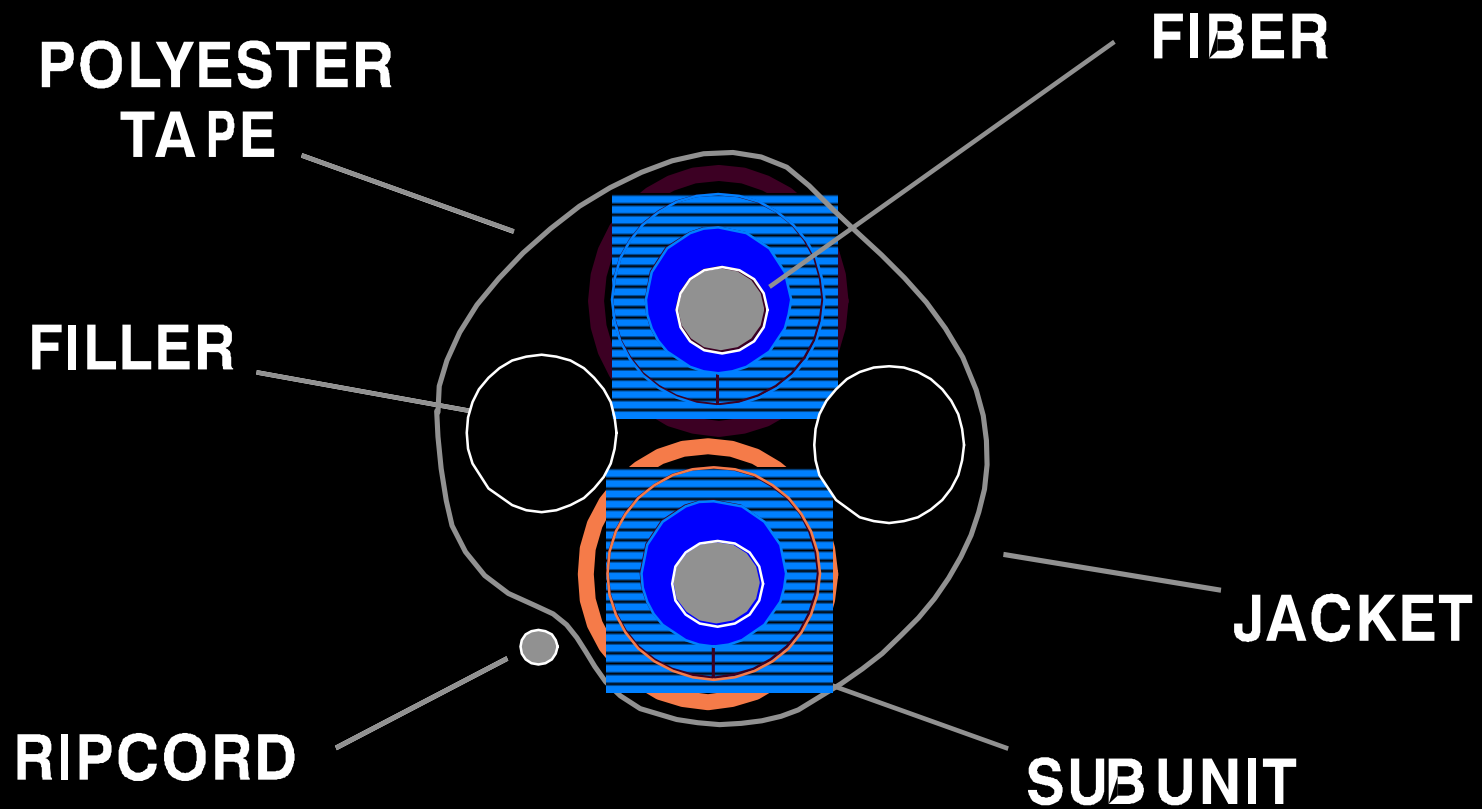
| | Size μm | Source | λ nm | Attenuation dB/km | Bandwidth Mhz/km |
|-------------------|--------------------|--------|--------------|----------------------|---------------------|
| Singlemode | 9/125 | Laser | 1300 - 1500 | .3 - .6 | >GhZ |
| Multimode | 62.5/125 | LED | 850 - 1310 | 1.5 - 3.5 | 100 - 500 |
| Large Core | 200/230 | LED | 850 | 6 - 8 | 20 |
| Plastic | 980/1000 | LED | 660 | 220 | 5 |

Cable Construction

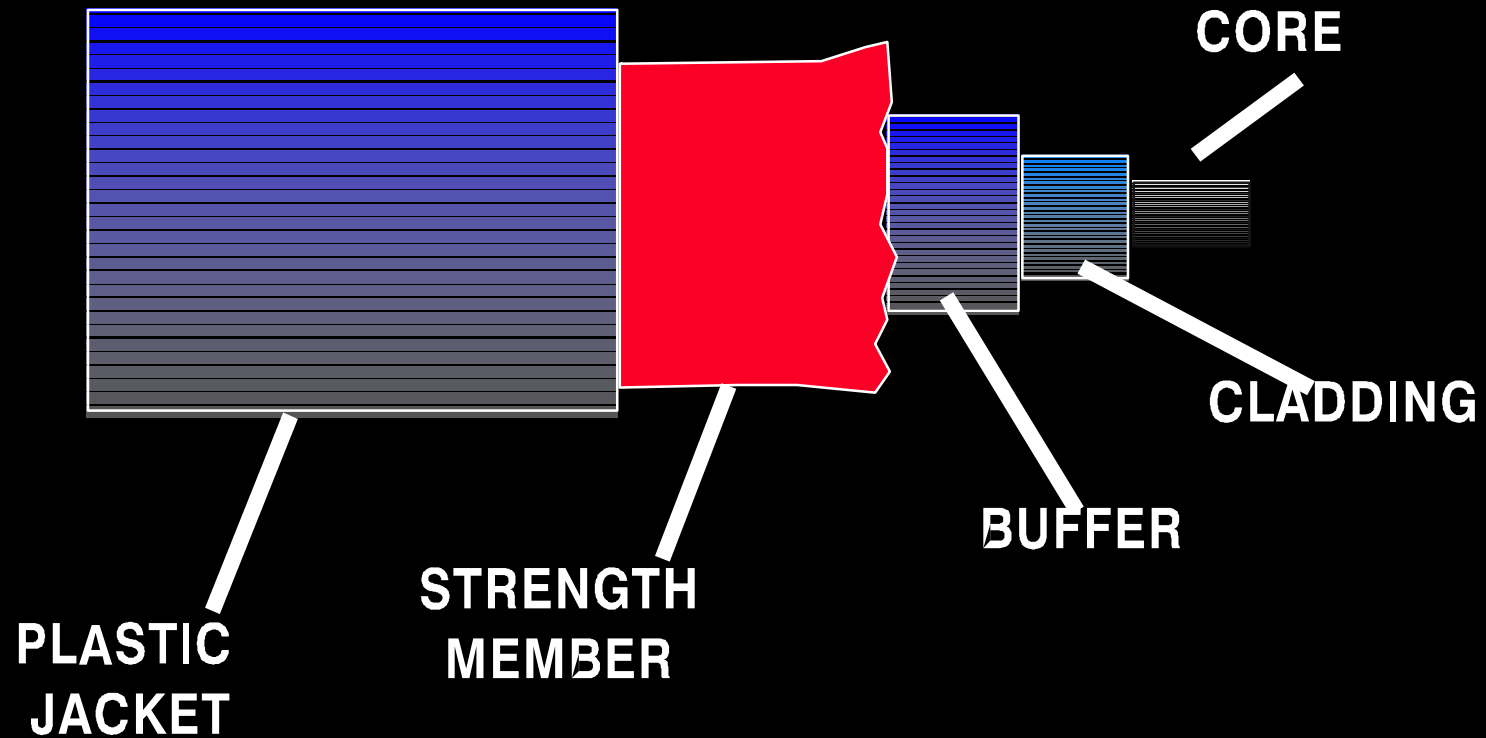
- Two Basic Types:
 - Loose Tube (Outdoors)
 - Tight Buffer (Indoors)



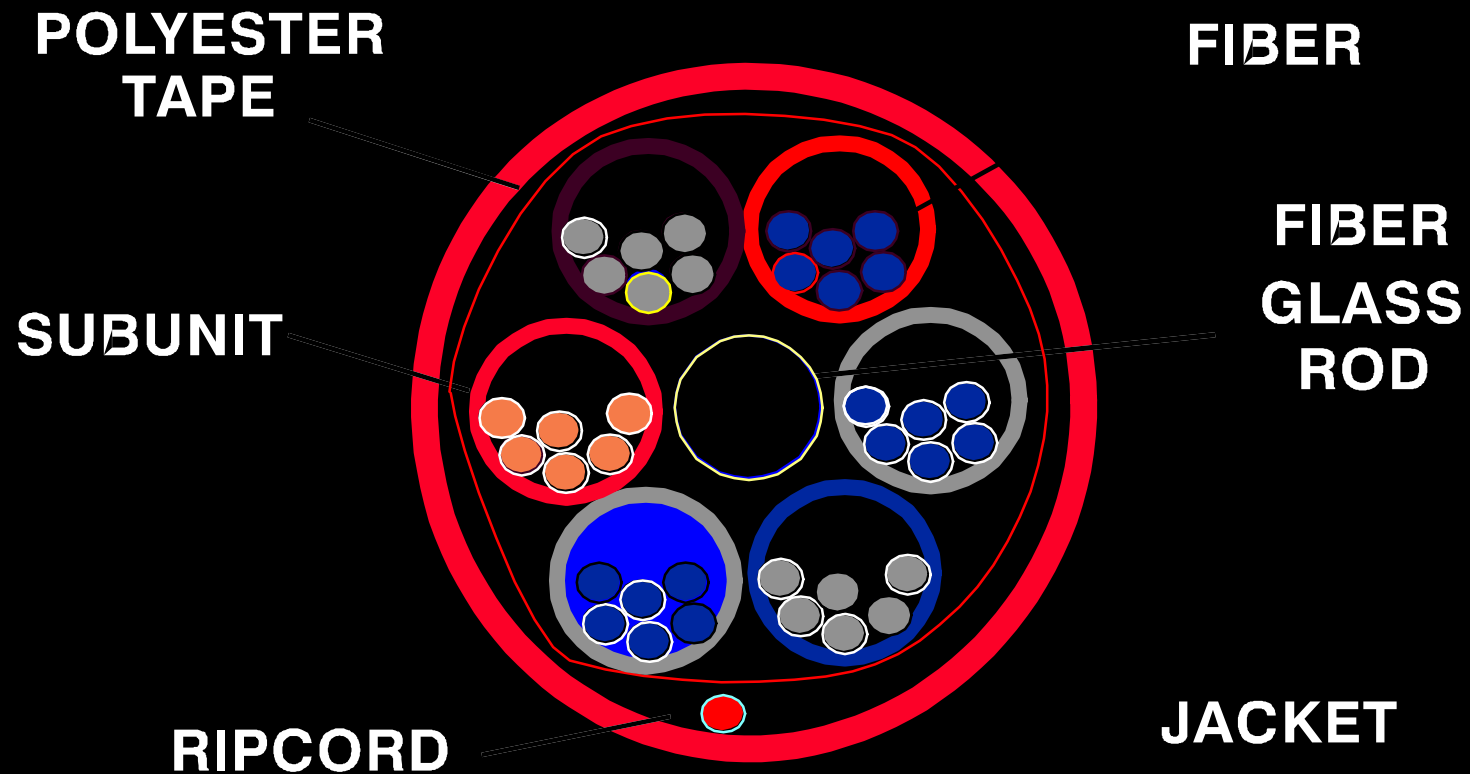
Tight Buffered



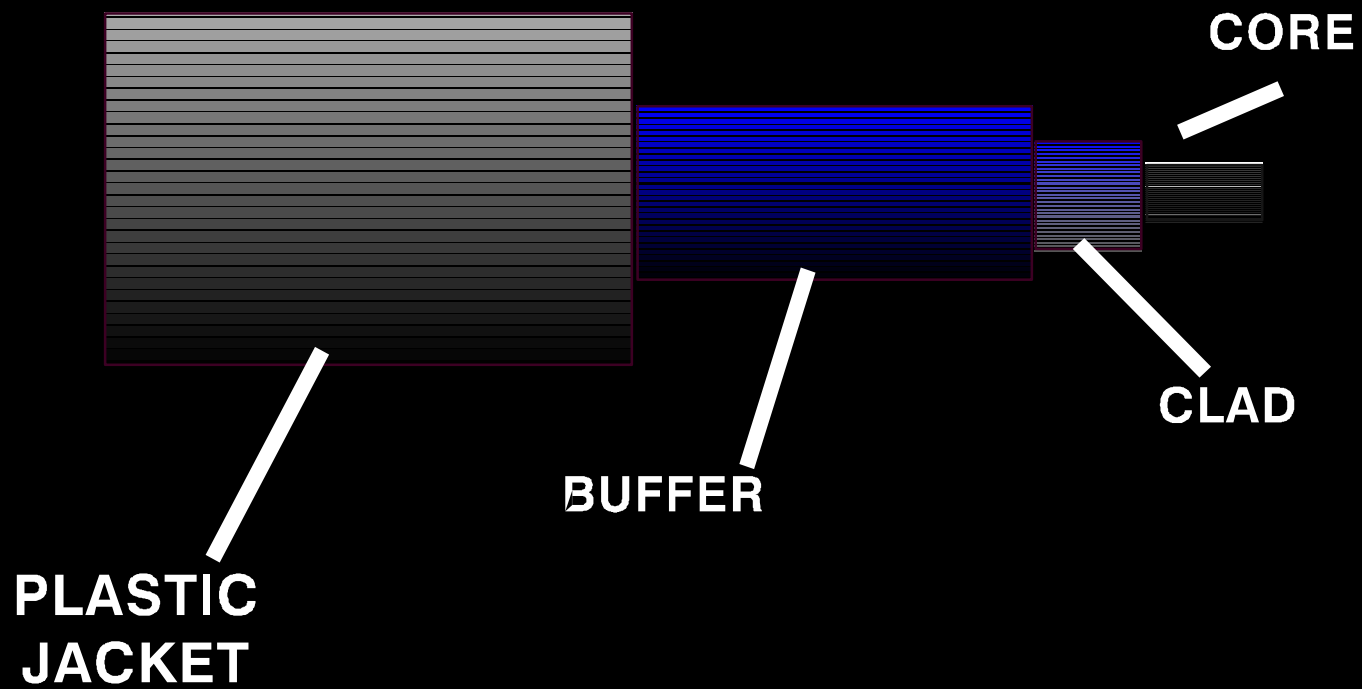
Tight Buffered



Loose Tube Cable



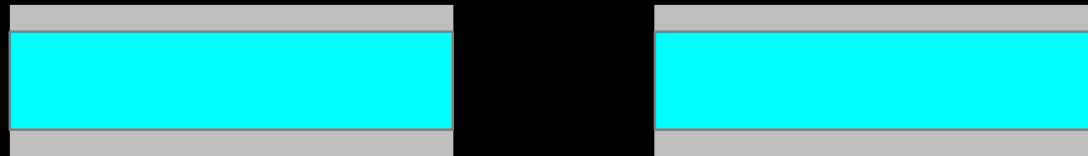
Loose Tube Cable



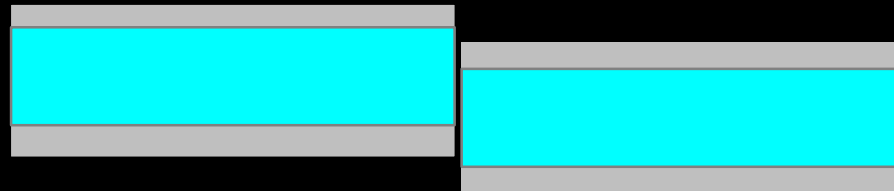
Connector - ST

Connector - SMA

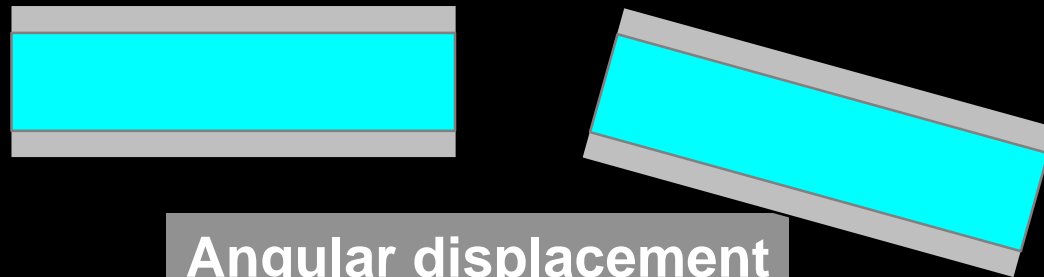
Misalignment



Linear displacement

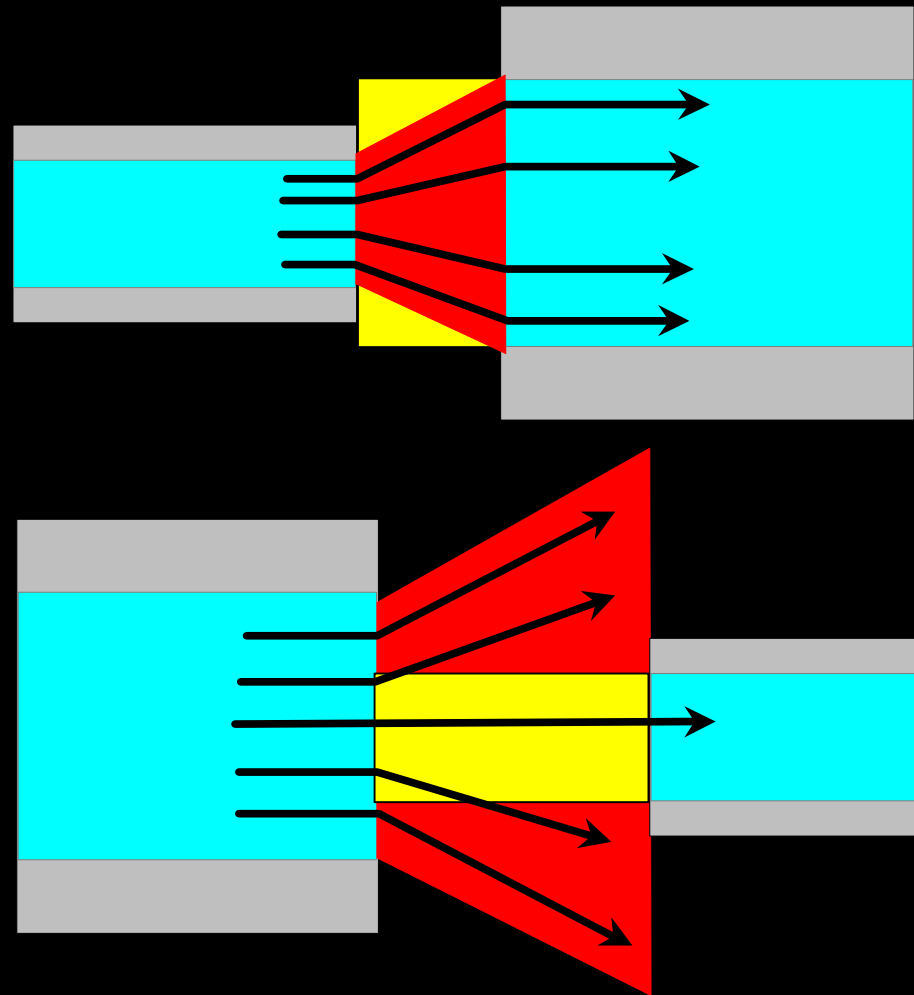


Lateral displacement

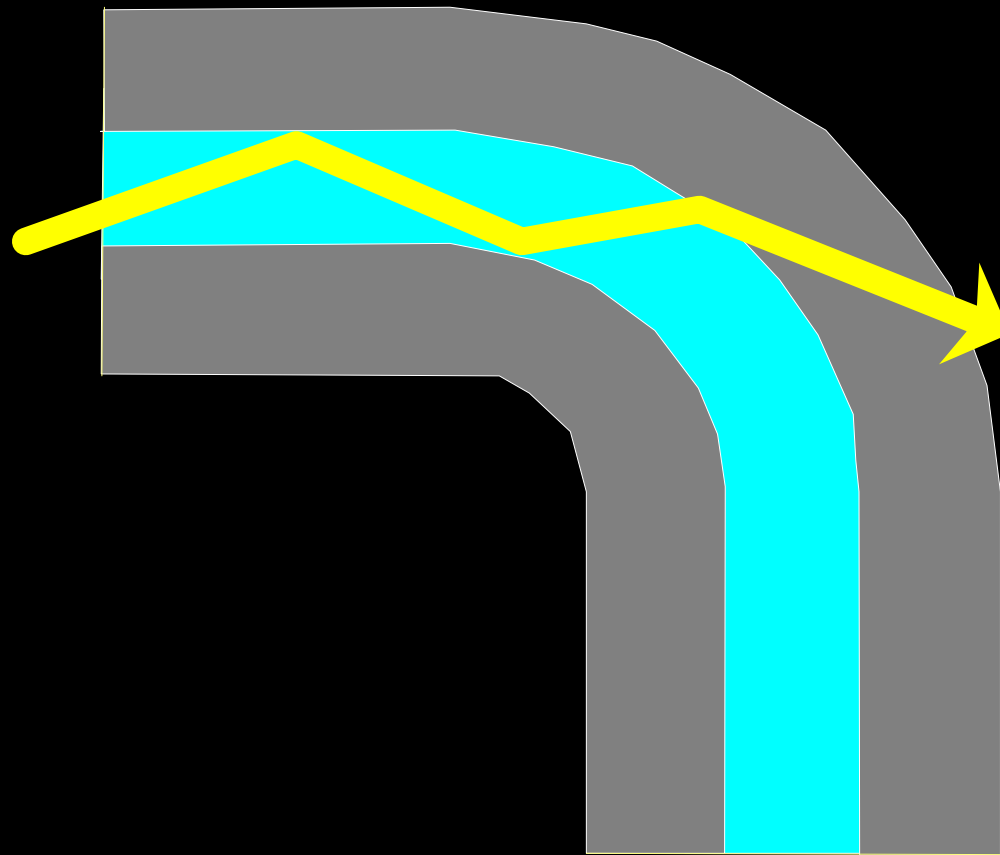


Angular displacement

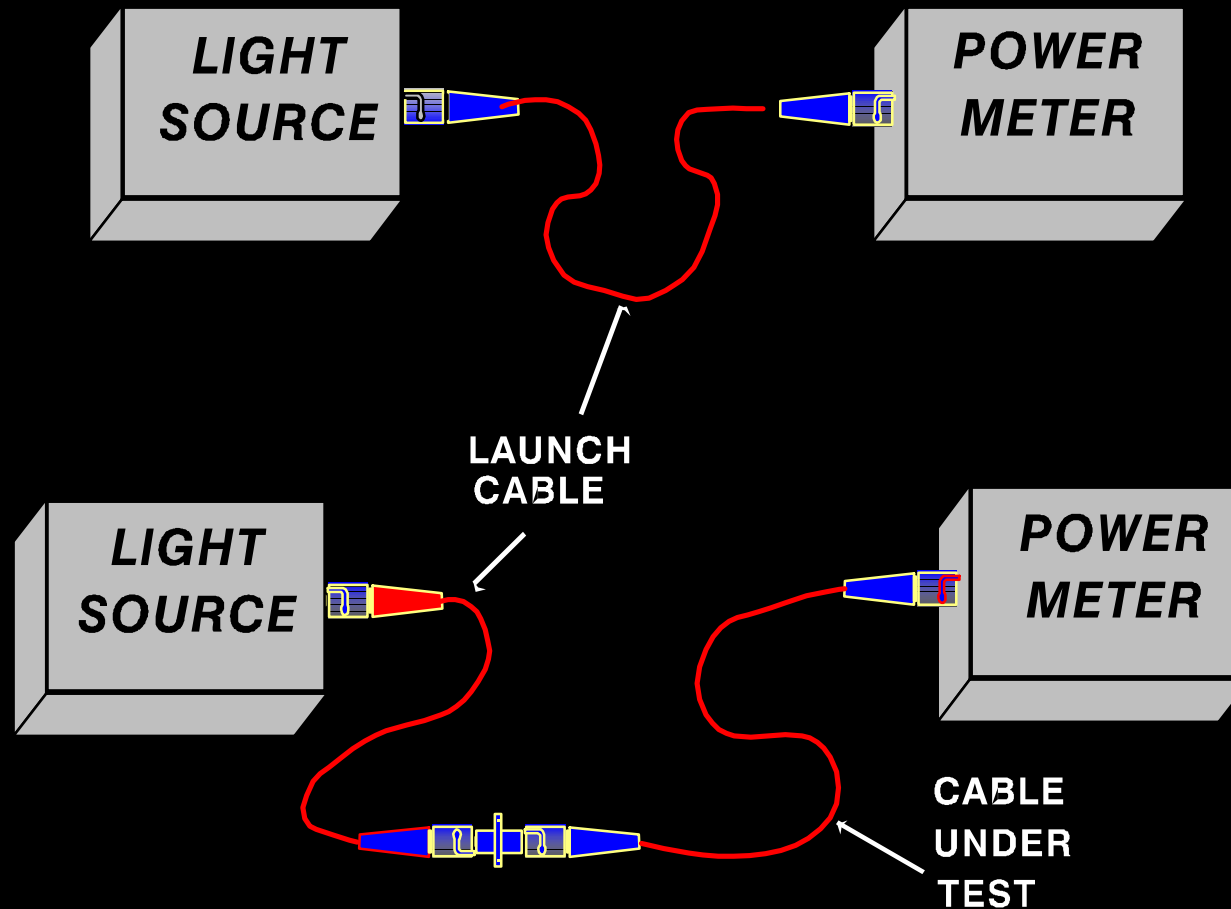
Fiber to Fiber



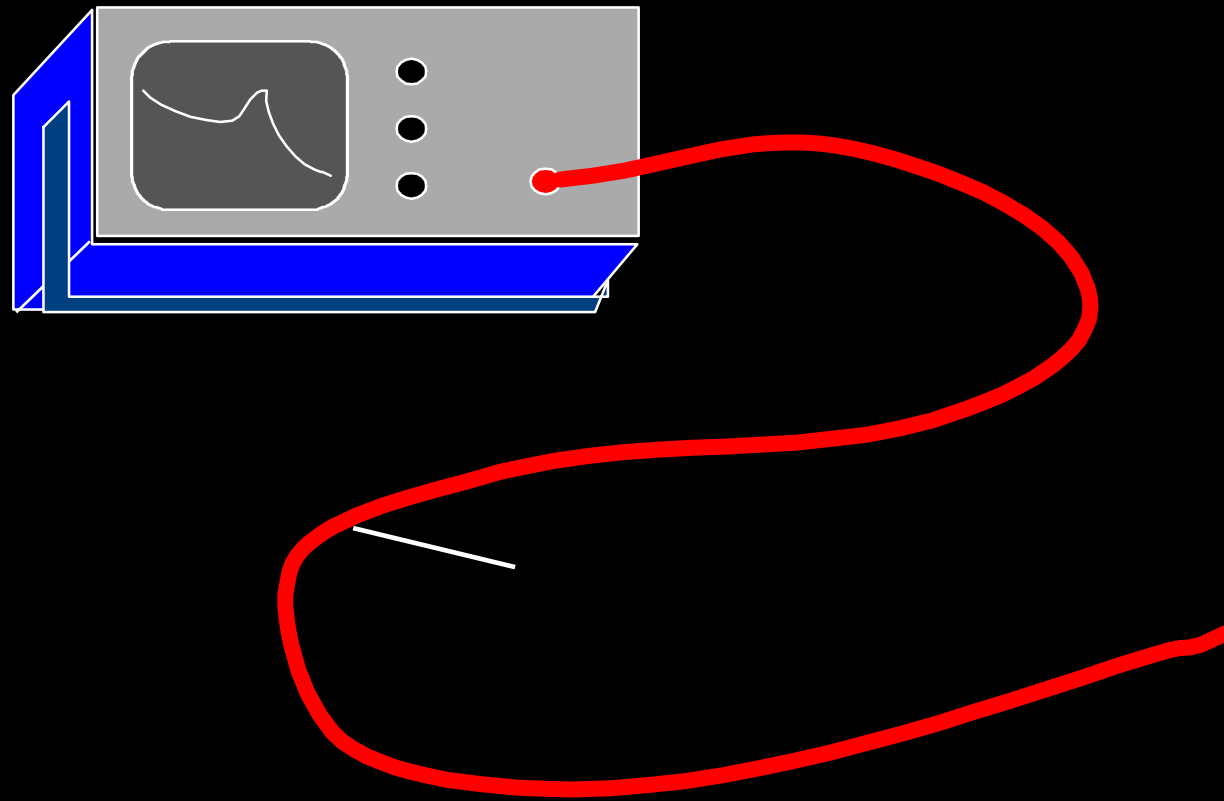
Bend Radius



Power Meter



Optical Time Domain Reflectometer



Applications

- Factory communications
- Factory automation
- Control systems
- High lightning areas
- High EMI/RFI areas
- Secured communications
- Transportation systems/traffic control

Markets Served

- Petrochemical
- Power generation
- Water & wastewater
- Mining
- Pipeline
- Pulp & paper
- Pharmaceutical
- Food & Beverage
- Oil & gas
- Automotive
- Transportation
- Chemical
- Any industry that uses PLC's

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