DEMONSTRATION

on

MICROWAVE AND OPTICAL COMMUNICATIONS LAB

By

Mr.D.Sivakumar, Associate Professor
DEPT. OF E.C.E, KEC KUPPAM

Topics to be discussed

- Vision, Mission, POs, PSOs & PEOs
- Syllabus & Course Outcomes (COs)
- Over view of Microwave
- Bench Setup
- Optical fiber Communication
- Major Equipment List
- Lab Physical View
- Dos & Don’t
- Safety Precautions

Syllabus & Course Outcomes (COs)

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

IV B.Tech. I-Sem (ECE)

(19A04701P) MICROWAVE & OPTICAL COMMUNICATIONS LAB

Course Outcomes (COs)

1. Inspect the mode characteristics of Reflex Klystron oscillator and Gunn Oscillator using Microwave Bench Setup.
2. Analyse the radiation characteristics to find the directivity and HPBW of a given antenna using Microwave Bench Setup
3. Design optical link between transmitter and receiver experimentally to find attenuation and signal strength of the received signal.

All the experiments shall be conducted and there is no choice

Microwave Engineering:

1. Study of Microwave Components And Instruments
2. Reflex Klystron Characteristics.
3. Determination of Guide Wavelength And Frequency Measurement
4. Gunn Diode Characteristics.
5. Scattering parameters of Magic Tee
6. VSWR Measurement.
7. Directional Coupler Characteristics
8. Radiation Pattern Measurement of Horn Antenna.
9. Optical Communication:
10. DC characteristics of LED and Photo diode
11. Measurement of Numerical Aperture and bending losses of a given optical fibe.
12. Establish an optical link between transmitter and receiver and determine the signal strength at the receiver. Give the comments about the experiment by transmitting (i)analog signal (ii) digital signal
13. Attenuation measurement in Fibers for various lengths.

ADVANCED EXPERIMENTS

1. V I Characteristics of LASER Diode
2. S-Parameters of Circulator

LIST OF EXPERIMENTS TO BE CONDUCTED

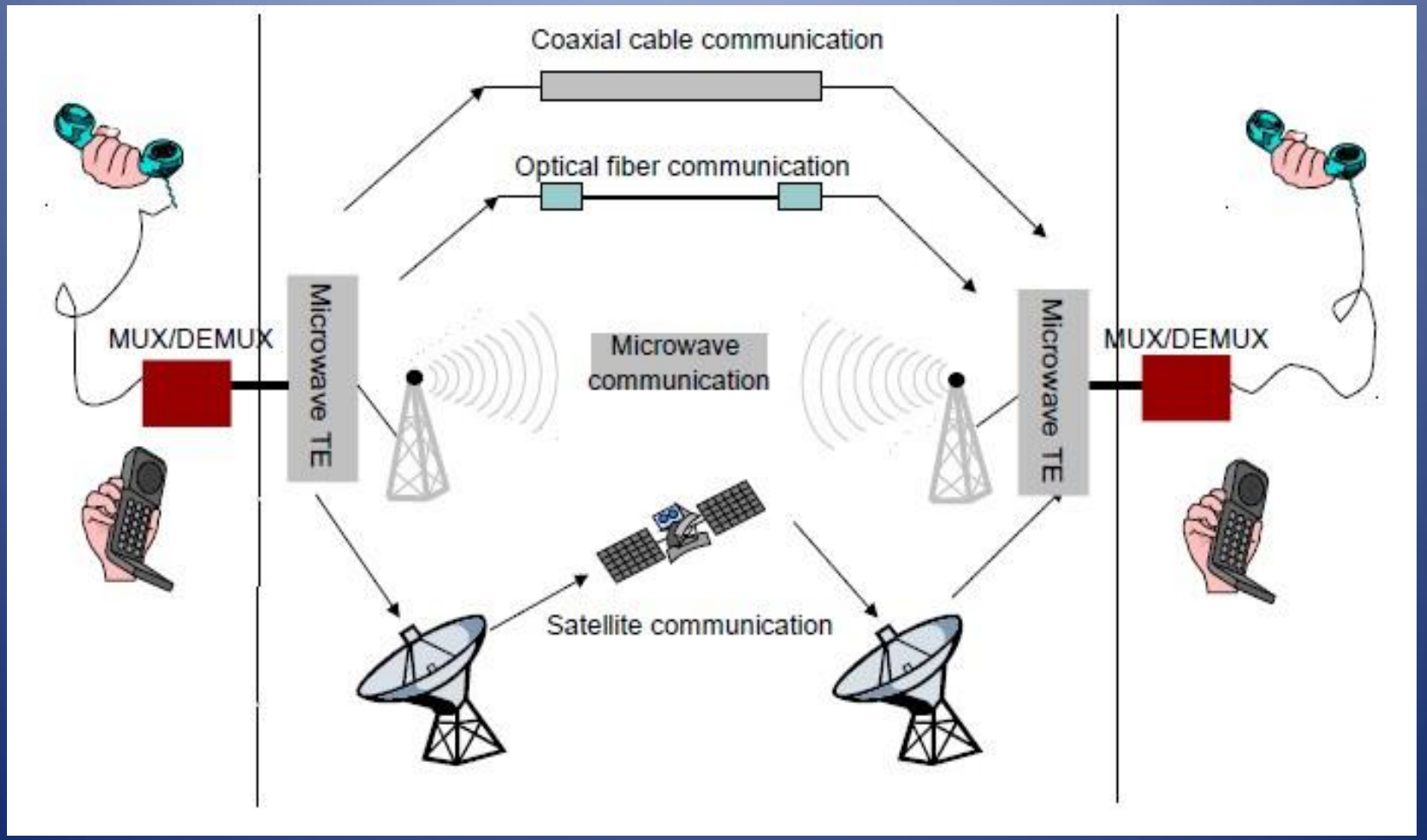
Microwave Engineering:

14. Study of Microwave Components And Instruments
15. Reflex Klystron Characteristics.
16. Determination of Guide Wavelength And Frequency Measurement
17. Gunn Diode Characteristics.
18. Scattering parameters of Magic Tee
19. VSWR Measurement.
20. Directional Coupler Characteristics
21. Radiation Pattern Measurement of Horn Antenna.
22. Optical Communication:
23. DC characteristics of LED and Photo diode
24. Measurement of Numerical Aperture and bending losses of a given optical fibe.
25. Establish an optical link between transmitter and receiver and determine the signal strength at the receiver. Give the comments about the experiment by transmitting (i)analog signal (ii) digital signal
26. Attenuation measurement in Fibers for various lengths.

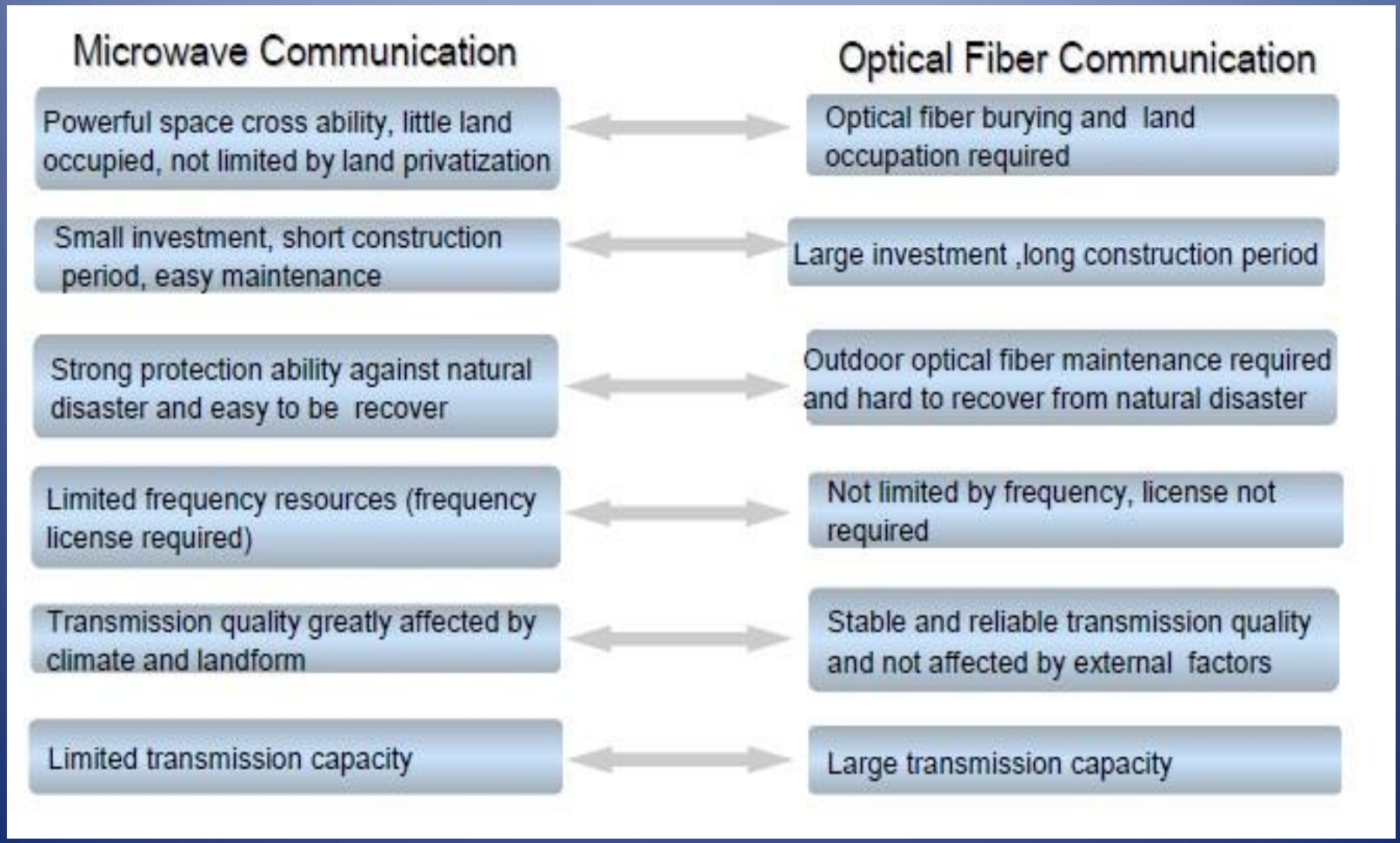
ADVANCED EXPERIMENTS

3. V I Characteristics of LASER Diode
4. S-Parameters of Circulator

Transmission Methods in Current Communications Networks



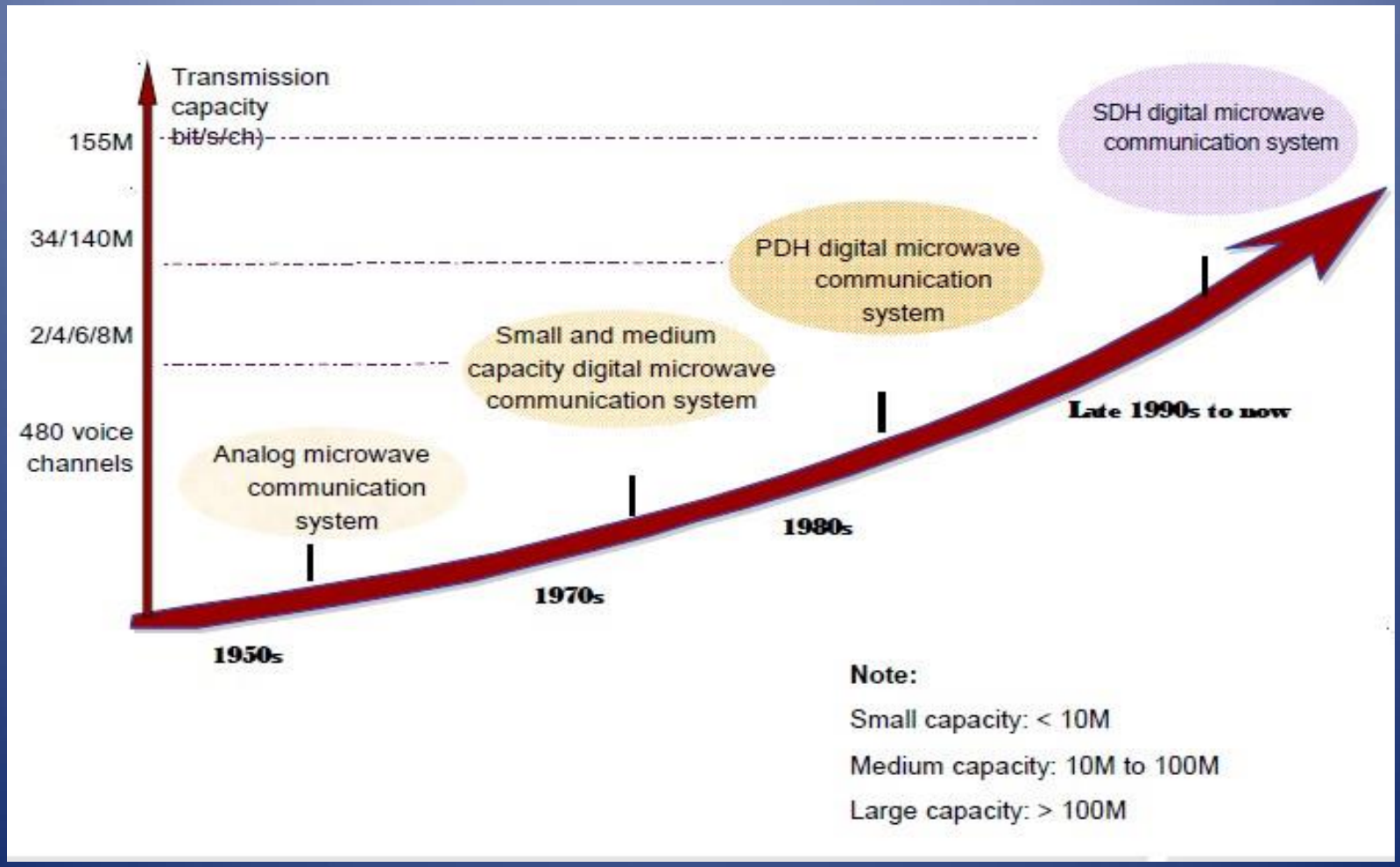
Microwave Communication vs. Optical Fiber Communication



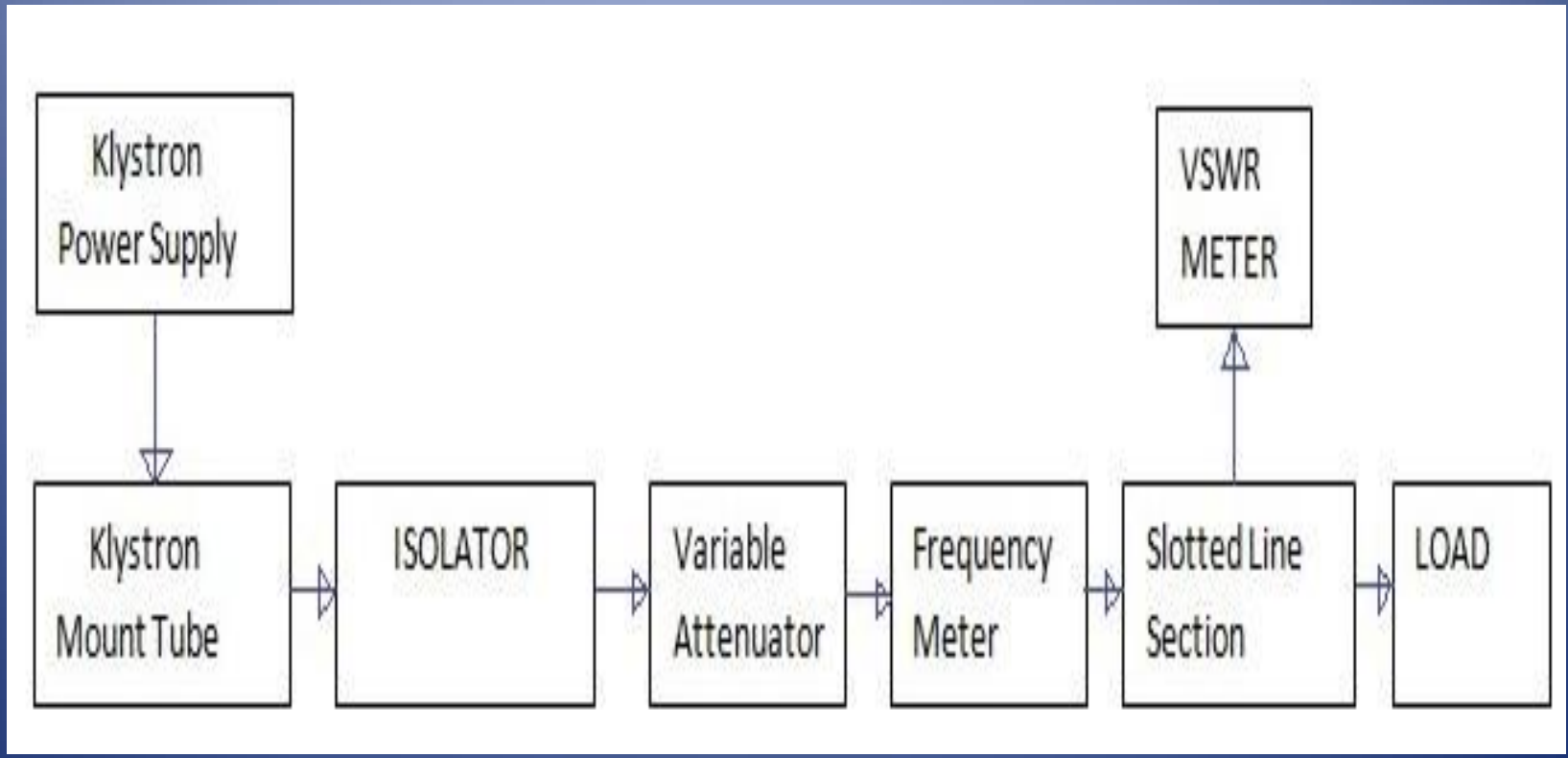
Definition of Microwave

- Microwave is a kind of electromagnetic wave. In a broad sense, the microwave frequency range is from 300 MHz to 300 GHz. But In microwave communication, the frequency range is generally from 3 GHz to 30 GHz.
- According to the characteristics of microwave propagation, microwave can be considered as plane wave.
- The plane wave has no electric field and magnetic field longitudinal components along the propagation direction. The electric field and magnetic field components are vertical to the propagation direction. Therefore, it is called transverse electromagnetic wave and TEM wave for short.

Development of Microwave Communication



Micro Wave Bench Setup



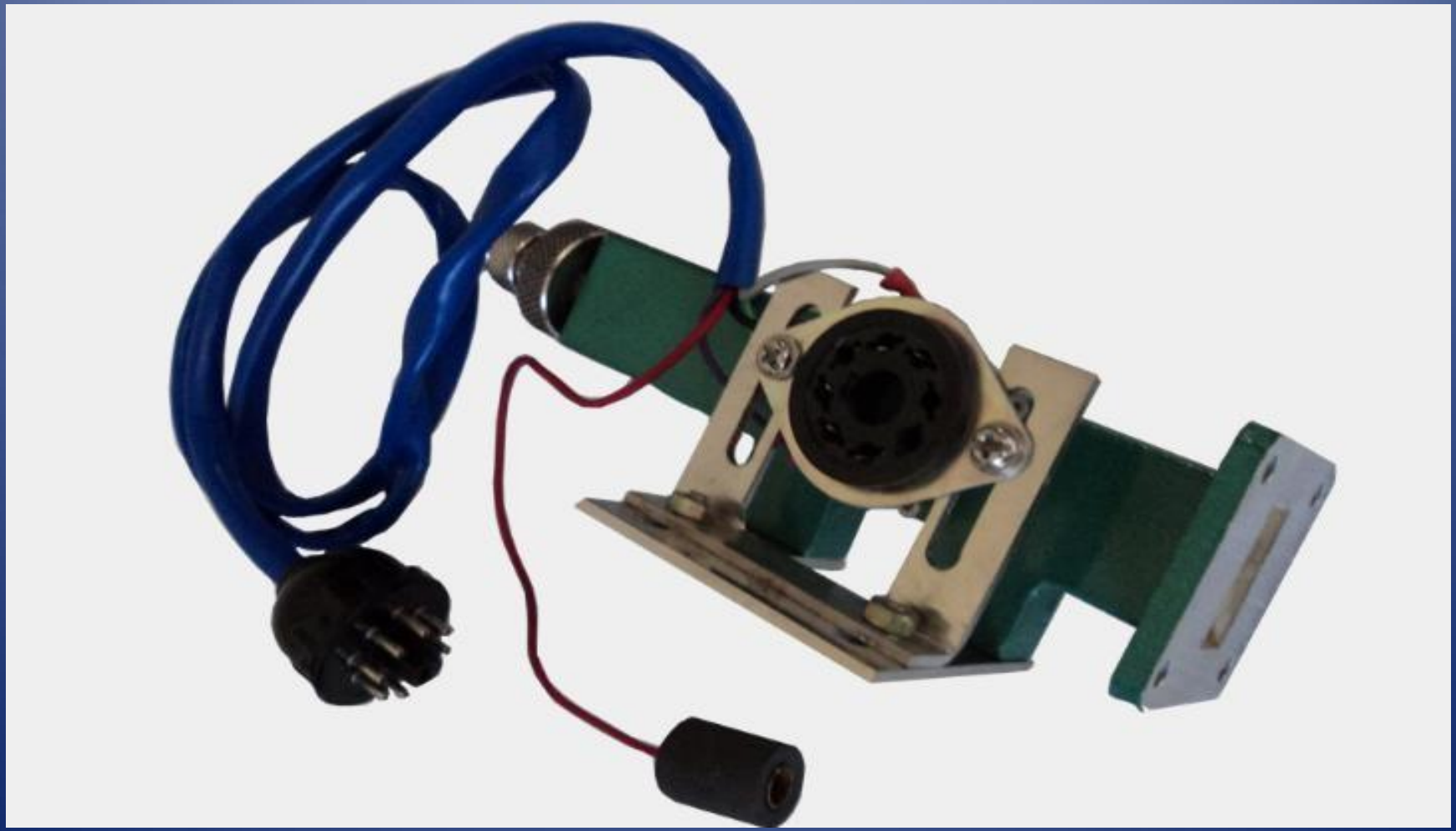
Klystron Power Supply

Klystron power supply, is a state-of-the-art solid-state, regulated **power supply** for operating low **power klystrons**.

Features

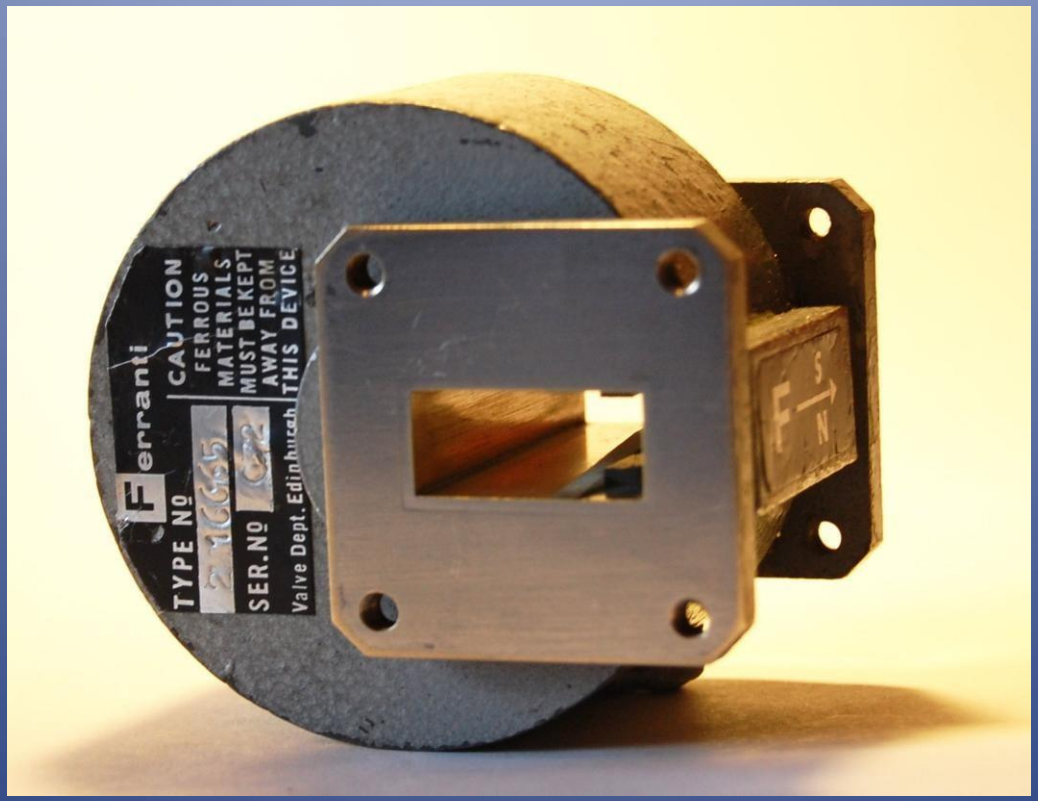
- Regulated Beam **Supply** and Repelled **Supply** voltages.
- LED Digital meter for Beam voltage, current and Repelled voltage.
- Compact and Reliable.
- Modular construction for easy maintenance.
- In addition to AM and FM modulation of beam current, a provision for external modulation is provided.

Klystron Mount Tube



- It is a waveguide of suitable length having octal base on the broad wall of the waveguide for mounting the klystron tube.
- It consists of movable short at one end of the waveguide to direct the microwave energy generated by the klystron tube.
- A small hole located exactly at the center of the broad wall of the waveguide is used to put the coupling pin of the tube as the electric field vector of EM energy is maximum at the center only.
- The maximum power transfer can be achieved by tuning of the movable plunger.

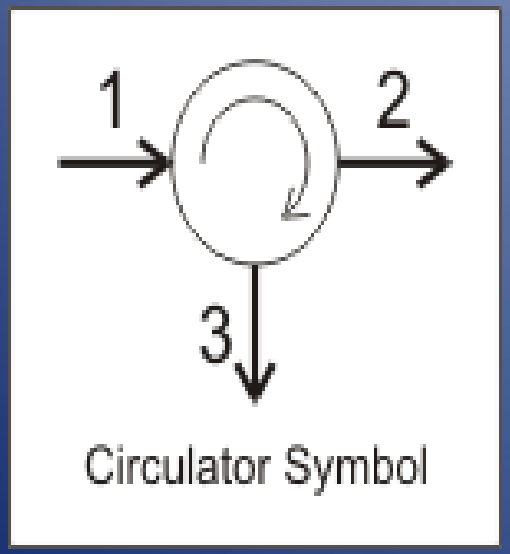
Isolator


Ferranti
TYPE Nº
SER.Nº
CAUTION
FERROUS
MATERIALS
MUST BE KEPT
AWAY FROM
THIS DEVICE
Valve Dept. Edinburgh

- An **isolator** is a two-port device that transmits microwave or radio frequency power in one direction only.
- It is used to shield equipment on its input side, from the effects of conditions on its output side.
- For example, to prevent a microwave source being detuned by a mismatched load.

Circulator

A microwave circulator is a three-port, passive RF or microwave device made of magnets and ferrite material which is used to control the direction of signal flow in a RF or microwave circuit.



Circulator Symbol

Attenuator

- The attenuators are basically passive devices which control power levels in microwave system by absorption of the signal.
- Attenuator which attenuates the RF signal in a waveguide system is referred as **waveguide attenuator**.
- There are two main types fixed and variable.
- They are achieved by insertion of resistive films.

Variable Attenuator

A variable attenuator is a circuit that decreases the strength of the input signal either continuously or step by step without appreciable signal distortion while substantially maintaining constant impedance match.

Fixed Attenuator

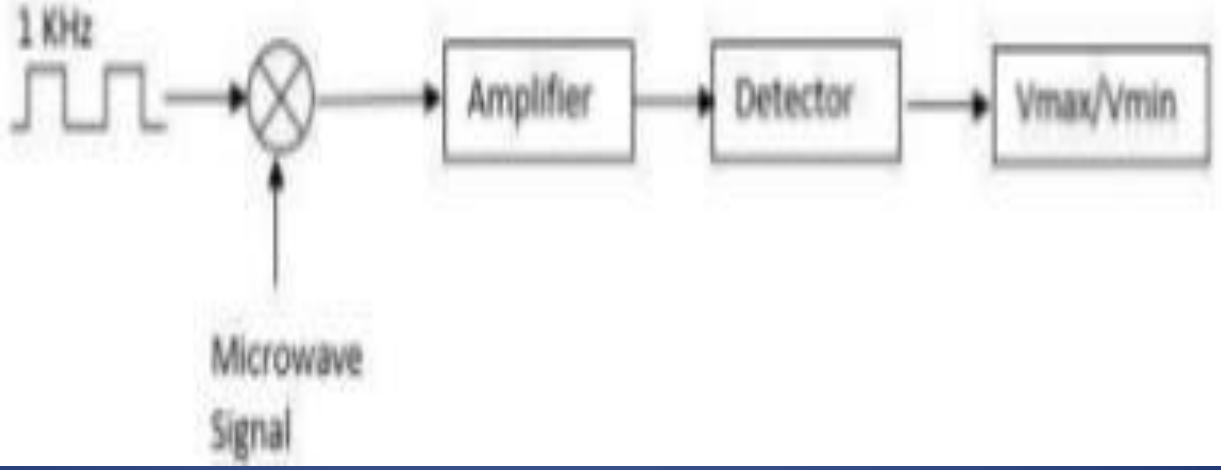
- Fixed Attenuator is used to reduce power levels of a signal by a **fixed** amount with little or no reflections. The output signal is attenuated relative to the input signal while the input and output impedance is maintained close to 50 ohms (or 75 ohms) over the specified bandwidth

Frequency Meter

- frequency meter measures frequencies from 3.7 to 12.5 GHz quickly and accurately.
- Its long scale length and numerous calibration marks provide high resolution.
- This is particularly useful when measuring frequency differences or small frequency changes.
- Frequency is read directly in GHz so interpolation or charts are not required.

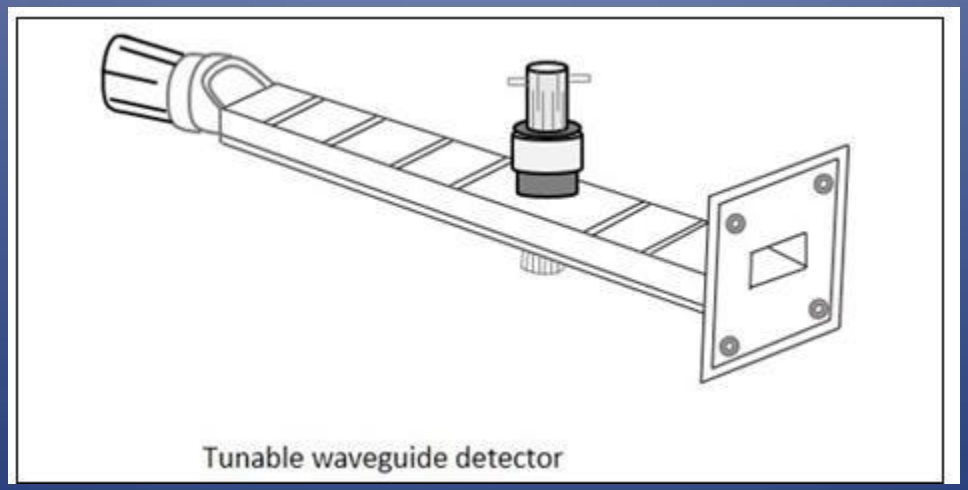
VSWR Meter

- VSWR meter is a highly sensitive, high gain, low noise voltage amplifier tuned normally at fixed frequency of 1KHZ square wave of which microwave signals modulated.
- The modulated signal is then amplified and detected which then measured with a calibrated voltmeter.
- This meter indicates calibrated VSWR reading for any loads.



Detector

- The tunable detector is a detector mount which is used to detect the low frequency square wave modulated microwave signals. The following figure gives an idea of a tunable detector mount.



Tunable waveguide detector

- The following image represents the practical application of detector. It is terminated at the end and has an opening at the other end

Gunn Diode

- **Gunn diodes** are used to build oscillators for generating **microwaves** with frequencies ranging from 10 GHz to THz.
- It is a Negative Differential Resistance device also called as transferred electron device **oscillator**
- electron device **oscillator** is a tuned circuit consisting of **Gunn diode** with DC bias voltage applied to it.

PIN Modulator

- PIN Diode modulators offer an ideal way for amplitude and the pulse modulation of microwave signal through wide range of frequencies. These modulators utilize PIN Diode which are mounted across the waveguide line a R.F. isolated DC bias lead passing to an external TNC (F) Connectors.

Directional Coupler

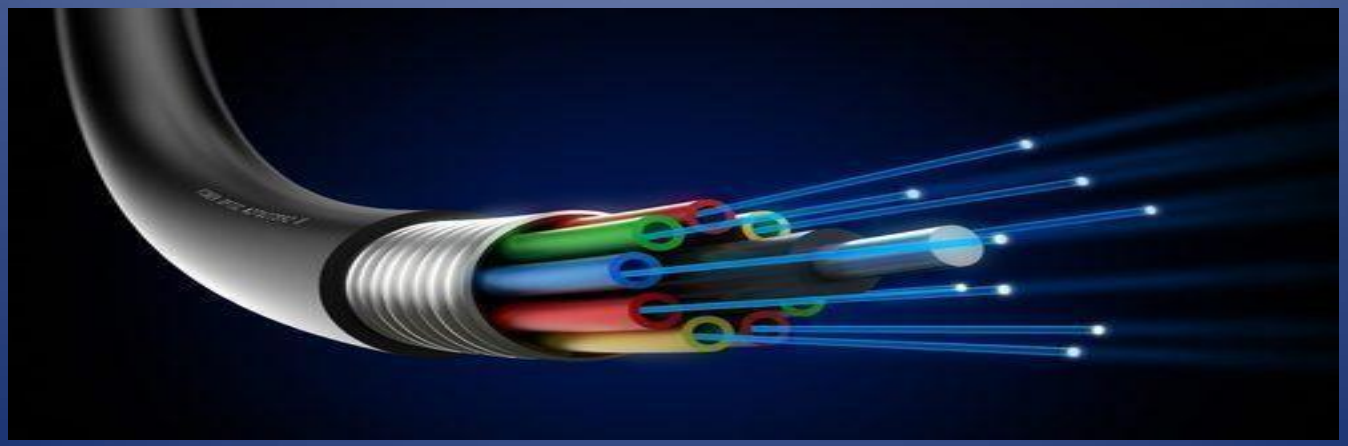
- A **Directional coupler** is a device that samples a small amount of **Microwave** power for measurement purposes.
- The power measurements include incident power, reflected power, VSWR values, etc.
- **Directional coupler** is used to couple the **Microwave** power which may be unidirectional or bi-**directional**.

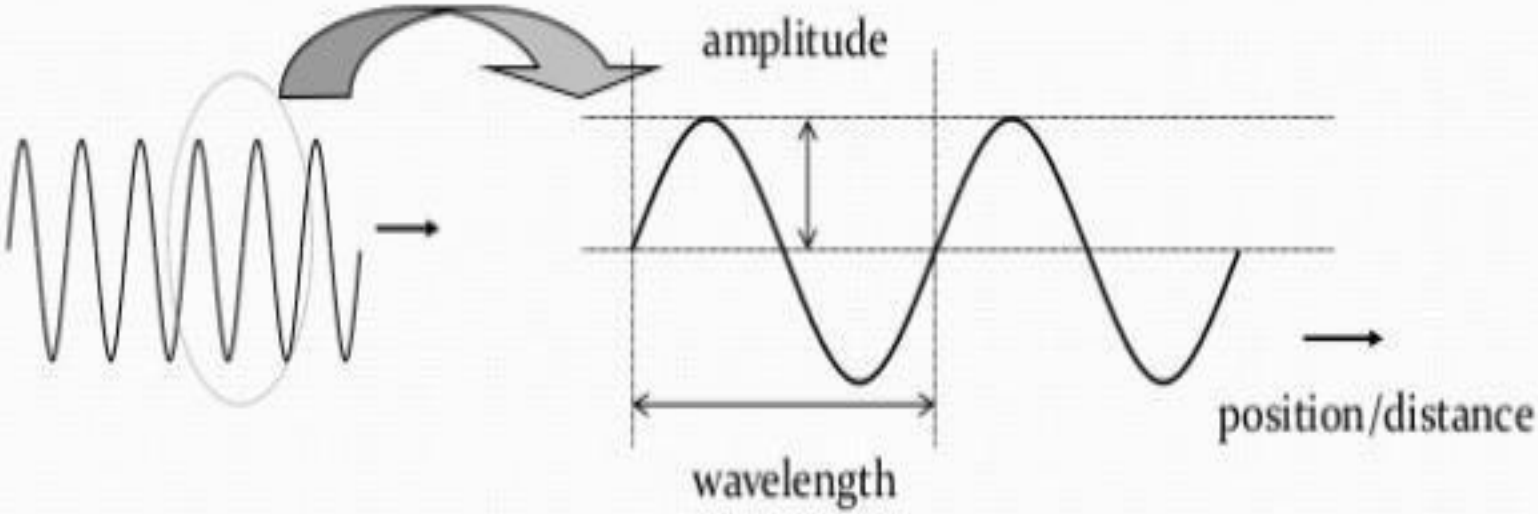
Magic Tee

- A **magic tee** (or **magic** T or hybrid **tee**) is a hybrid or 3 dB coupler used in **microwave** systems.
- It is an alternative to the rat-race coupler.
- This allows it to be used as a duplexer; for instance, it can be used to isolate the transmitter and receiver in a radar system while sharing the antenna.

Optical Communication

- Optical communication is any type of communication in which light is used to carry the signal to the remote end, instead of electrical current.
- Optical communication relies on optical fibers to carry signals to their destinations

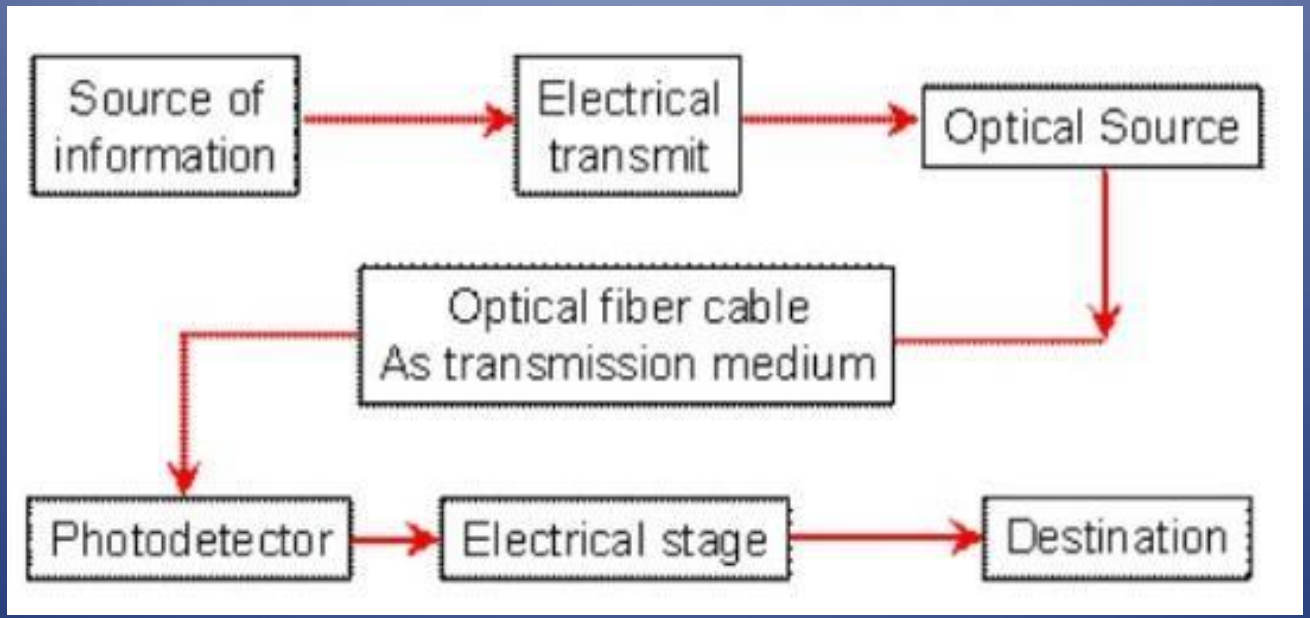


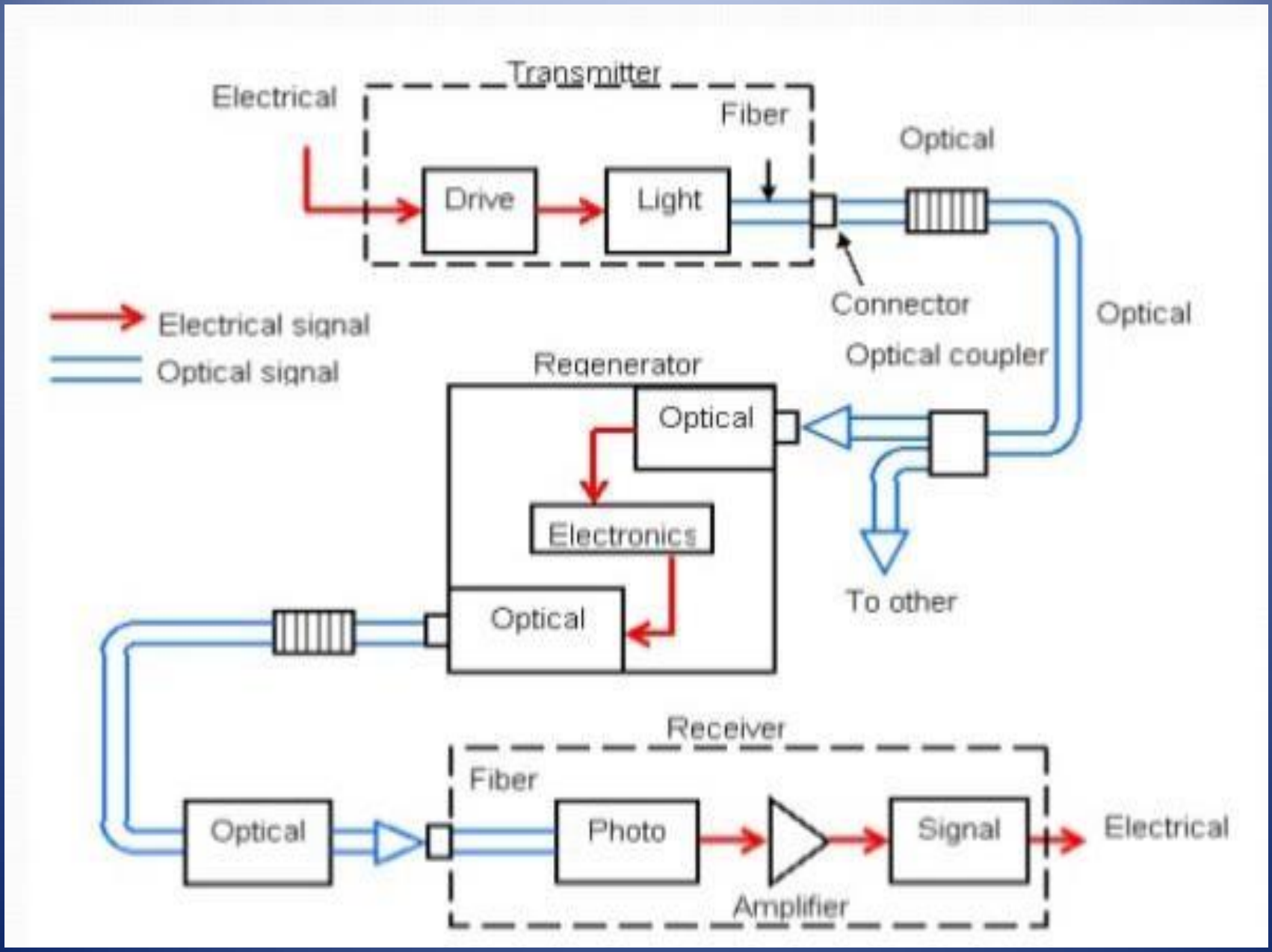


- electromagnetic wave
- carry energy from one point to another
- travel in straight line
- described in ***wavelength*** (usually in *mm* or *nm*)
- speed of light in vacuum = 3×10^{8} m/s

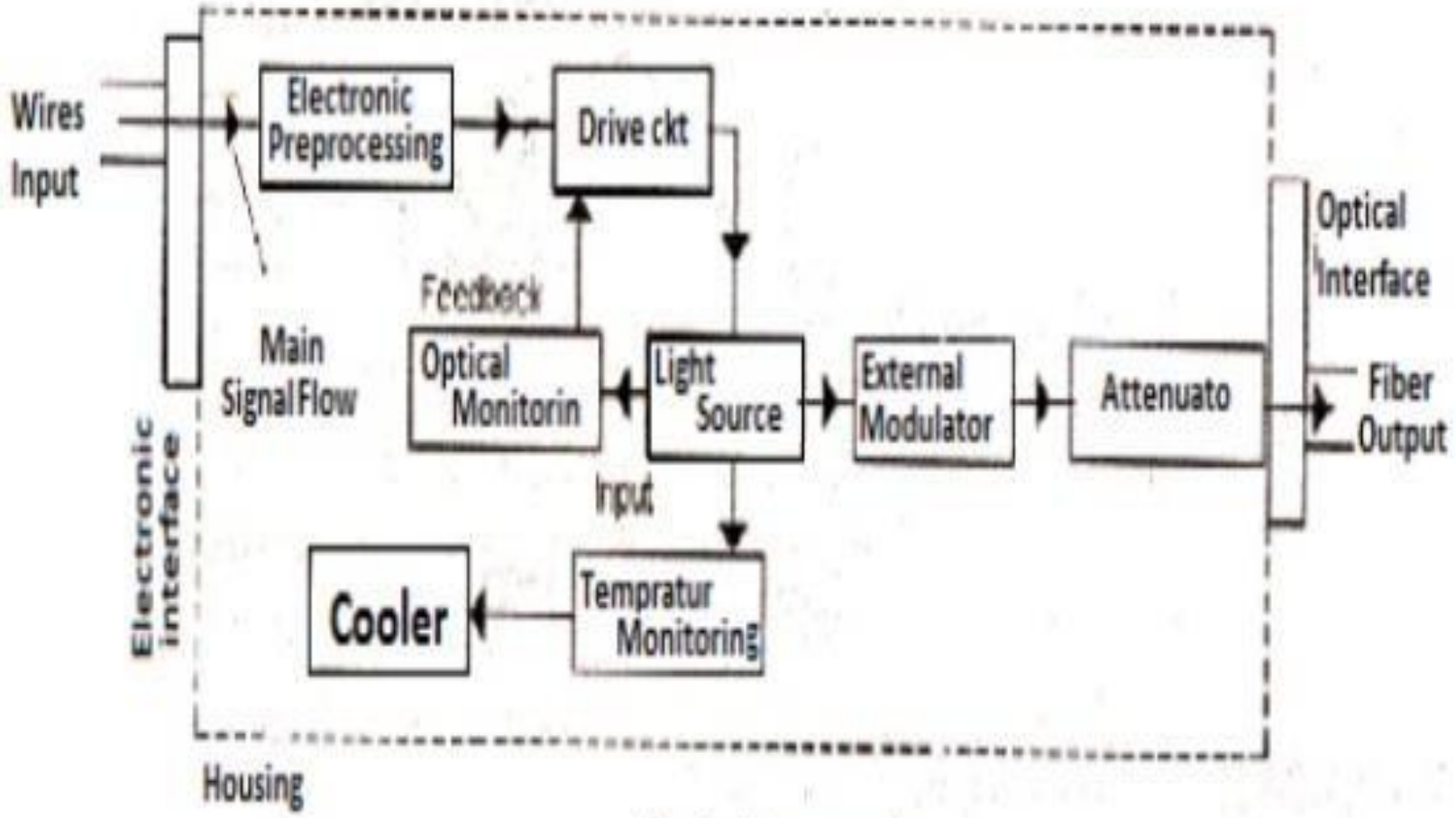
Block Diagram

A modulator/demodulator, a transmitter/receiver, a light signal and a transparent channel are the building blocks of the optical communications system



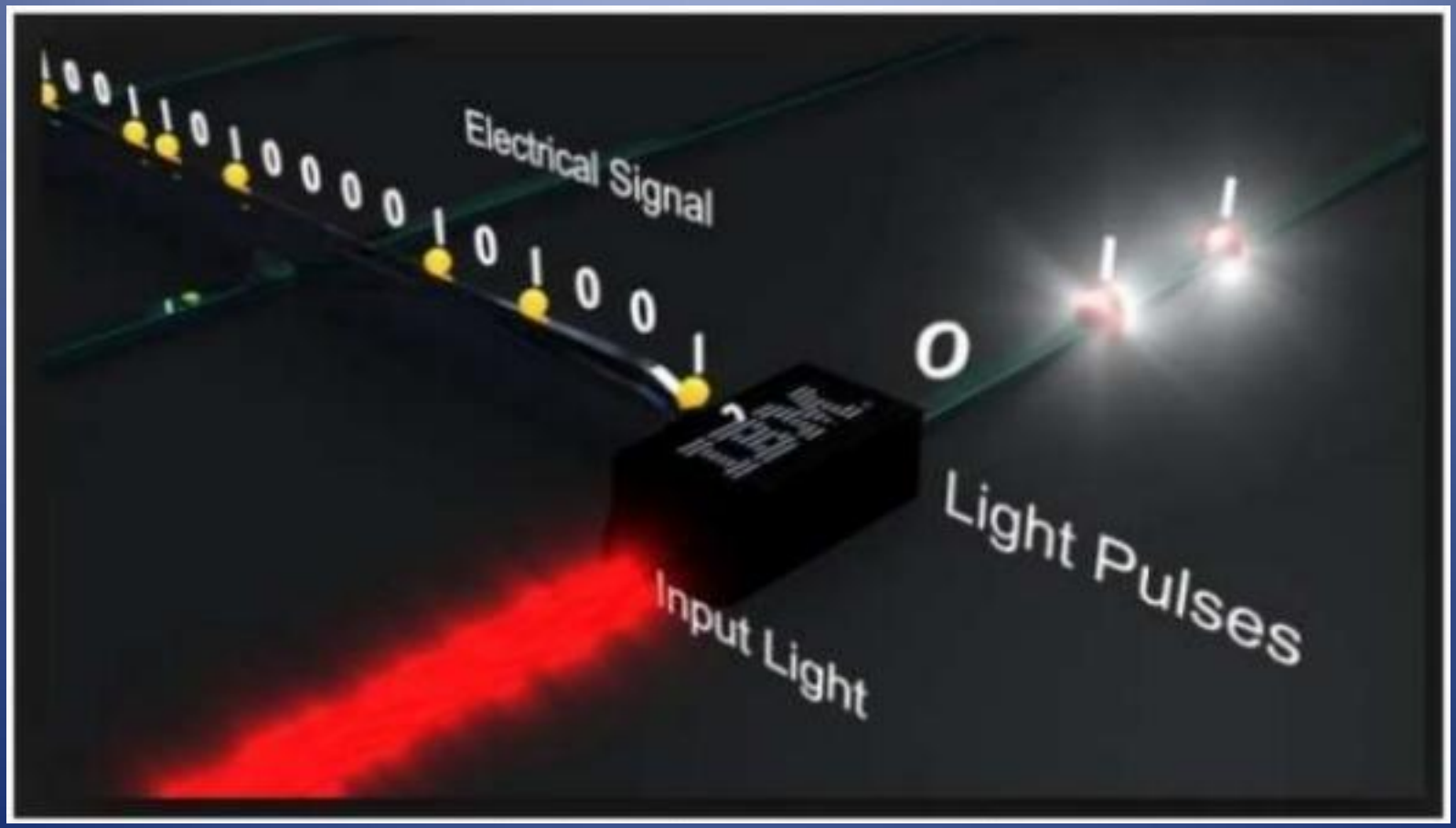

Transmitter
Electrical
Fiber
Optical
Drive
Light
Connector
Optical
Electrical signal
Optical signal
Optical coupler
Regenerator
Optical
Electronics
To other
Optical
Receiver
Fiber
Optical
Photo
Signal
Electrical
Amplifier

Optical Transmitter

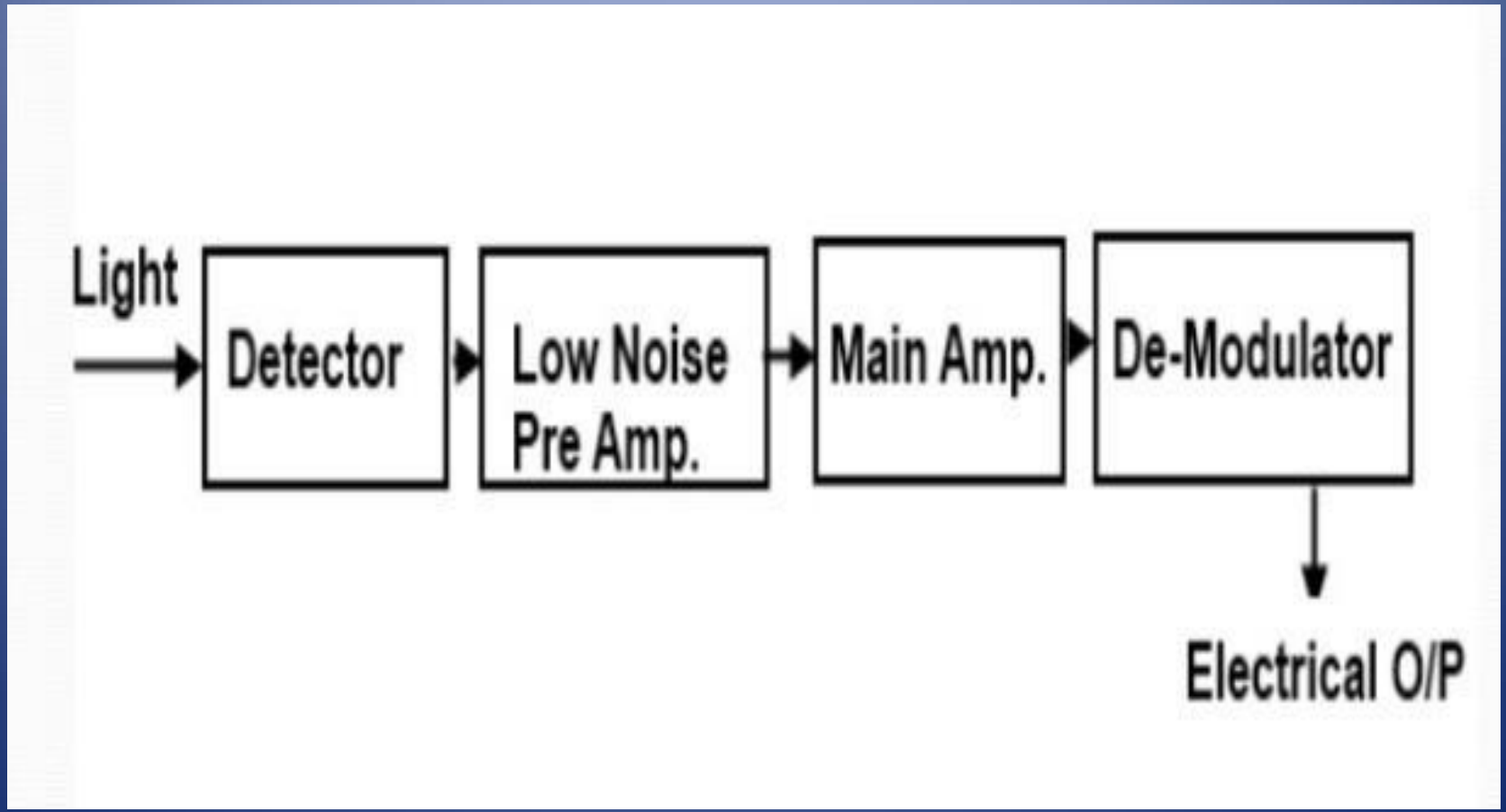


Optical transmitter

Optical Modulator



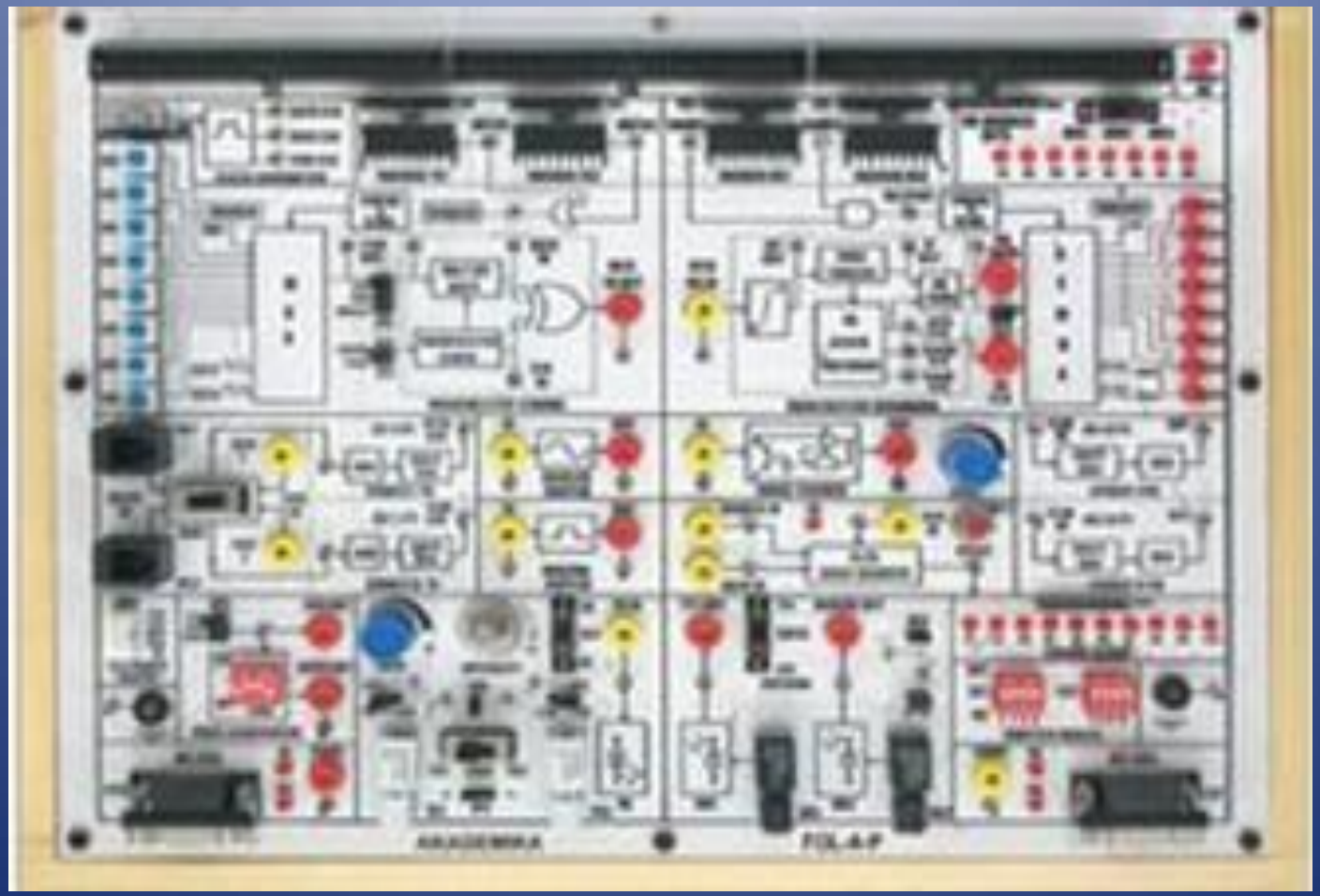
Optical Receiver



Advantages of optical fiber communication

- Increased Bandwidth and Channel Capacity
- Low Signal Attenuation
- Immune to Noise
- No Crosstalk
- Lower Bit Error Rates
- Signal Security
- Electrical Isolation
- Reduced Size and Weight of Cables
- Radiation Resistant and Environment Friendly
- Resistant to Temperature Variations etc.

Analog Optical Link



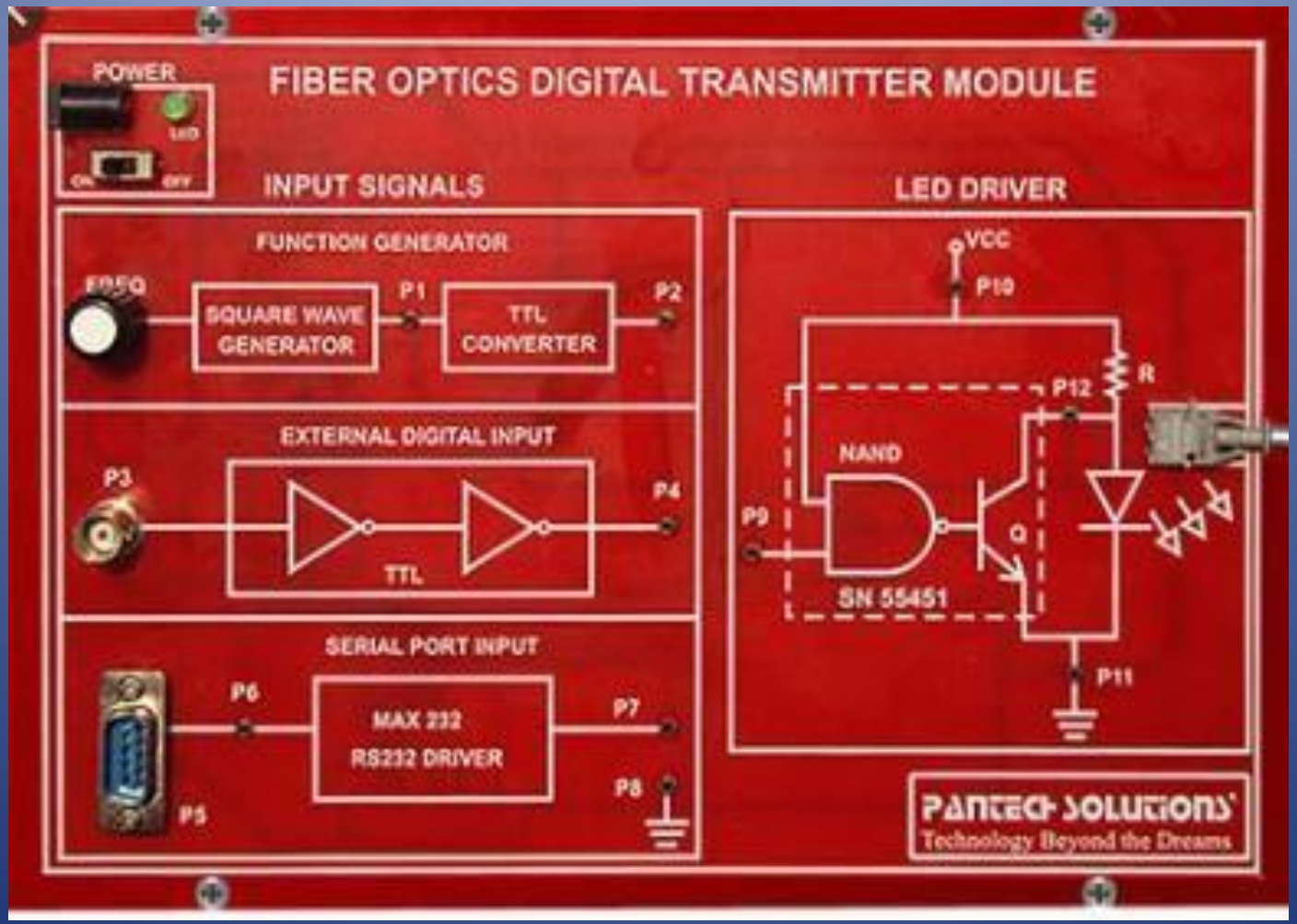
The **Fiber Optic Analog Link** consists of a transmitter which converts an electrical signal to a light signal, an optical fiber to guide the light and a receiver which detects the light signal and converts it to an electrical signal. Light sources are either **light emitting diodes** (**LED**'s) or **laser diodes** and detectors are phototransistors or Photodiodes

OFC Cable

OFC Cable

Fiber optic cable is a high-speed data transmission medium. It contains tiny glass or plastic filaments that carry light beams. Digital data is transmitted through the **cable** via rapid pulses of light. ... Because **fiber optic cables** transmit data via light waves, they can transfer information at the speed of light

Digital Optical Link



The best digital signal transmission on fiber optics is obtained with DC balanced data containing the same amount of low and high level bits on average, as it is implicitly the case with the clock. For the data line, this is achieved with a special four to five bit encoding and the NRZI (Non Return to Zero with Invert 1 on change) scheme. Basically, this scheme uses a line transition to represent a ``1'' and no transition to represent a ``0''. The idle symbol, which is sent when no other data are pending, is ``11111'', resulting in a square wave output of half the clock frequency.

MAJOR EQUIPMENT DETAILS

S.No	Name of the Equipment	Quantity	Amount (Rs.)
1.	Reflex Klystron Characteristics	1 Set	97,990/-
2.	Gunn Diode Characteristics	1 Set	73,680/-
3.	Attenuation Measurements	1 Set	1,00,480/-
4.	VSWR Measurements	1 Set	95,380/-
5.	Directional Coupler Characteristics	1 Set	1,18,580/-
6.	Wave Guide Parameter Measurements	1 Set	58,233/-
7.	LASER Diode Kit	01	35,000/-
8.	Fiber Optic Communication Trainer Kit	01	21,000/-
9.	Fiber Optic Glass and Plastic Trainer Kit	01	42,480/-
10.	Fiber Optic Analog Link & Digital Link Trainer Kits	02	20,081/-
11.	Wave Guide Stands	15	36,442/-
12.	Slotted Sections	03	
13.	Tunable Probes	03	
14.	Circulators	02	12,000/-
15.	Magic Tee	02	5,000/-
16.	Millimeters (Digital)	10	16,500/-
17.	Stabilizer (5 KVA)	01	12,564/-
		Total	7, 45,410/-

DOS & DON'TS

- Do not handle the equipment without reading the instructions/Instruction manuals.
- Read carefully the power ratings of the equipment before it is switched on. For Indian equipments, the power ratings are normally 230V/50Hz.If you have equipment with115V/60Hz ratings do not insert power plug, as our normal power supply is 230V/50Hz, Which will damage the equipment. Don't exceed klystron power supply voltage range above 300v.
- While entering the Laboratory, the students should follow the dress code (Wear shoes, White Apron & Female students should tie their hair back).
- The students should bring their observation note book, practical manual, record note book, calculator, necessary stationary items and graph sheets if any for the lab classes without which the students will not be allowed for doing the practical.
- All the equipments and components should be handled with at most care. Any breakage/damage will be charged.
- If any damage/breakage is noticed, it should be reported to the instructor immediately.
- If a student notices any short circuits, improper wiring and unusual smells immediately the same thing is to be brought to the notice of technician/lab in charge.
- Do not wander around the room, distract other students, startle other students or interfere with the laboratory experiments of others.
- Do not chew gum in the laboratory/class rooms.
- At the end of practical class the apparatus should be returned to the lab technician and take back the indent slip.
- Each experiment after completion should be written in the observation note book and should be corrected by the lab in charge on the same day of the practical class.
- Each experiment should be written in the record note book only after getting signature from the lab in charge in the observation note book.
- Record should be submitted in the successive lab session after completion of the experiment.
- 100% attendance should be maintained for the practical classes.

	
Fire Extinguishers	First Aid Box
	
Miniature Circuit Breaker's (MCB's).	CC Camera surveillance

Table 6.4.2 Safety Measures in the Laboratories

THANK YOU