Types of Transmission Lines

Transmission Line - Definition

A conductor or conductors designed to carry electricity or an electrical signal over large distances with minimum losses and distortion.

The electrical lines which are used to transmit the electrical waves along them are called transmission lines.

Types

(i) open wire line

→ These lines are parallel conductors

→ open to air

→ The conductors are seperated by air dielectric and mounted on poles or towers.

Ex : The telephone lines, Power transmission lines.

Advantages

→ low cost

→ simplest form of transmission line.

Disadvantages

→ Installation cost is somewhat higher.

→ It's maintenance is sometimes difficult due to the change in atmospheric conditions.

ii) cables

→ These are underground lines
→ consists of hundreds of individually paper insulated conductors twisted in pairs and placed inside a protective lead or plastic sheath.

Ex: Telephone cable, Electrical transmission cable

Advantages

→ Reduced range of electromagnetic field emission into the surrounding area.
→ They pose no hazard to low flying aircraft or to wildlife

(iii) COAXIAL LINES

→ These lines are formed when a conducting wire is coaxially inserted inside another hollow conductor.
→ The dielectric may be solid or gaseous.
→ These are widely used in applications where high voltage levels are needed.

Advantages

→ Lower error rates
→ coaxial cable shielding reduces noise

Disadvantages

→ Expensive when compared to twisted pair cable.

iv) OPTICAL FIBERS

→ Method of transmitting information from one place to another by sending pulses of Infrared light.

→ It is an assembly similar to an electrical cable but containing one or more optical fibers that are used to carry light.

→ can transmit voice, video and telemetry through local area networks, computer networks or across long distances.

Advantages

→ Greater bandwidth
→ Low power loss
→ High level of security
→ Low cost

Disadvantages

→ Expensive to install
→ Requires more protection

v) WAVE GUIDES

→ Used for signal transmission at microwave frequencies.

→ These are basically hollow conducting tubes as they somewhat resemble like coaxial cable line but do not have center conductor as present in coaxial cables.

→ The energy is transmitted from inner walls of the tube by the phonomenon total internal reflection.

Advantages

→ Higher power handling capability
→ Simple structure
→ Lower attenuation
→ Good amount of immunity against RF interference from outside.

Disadvantages

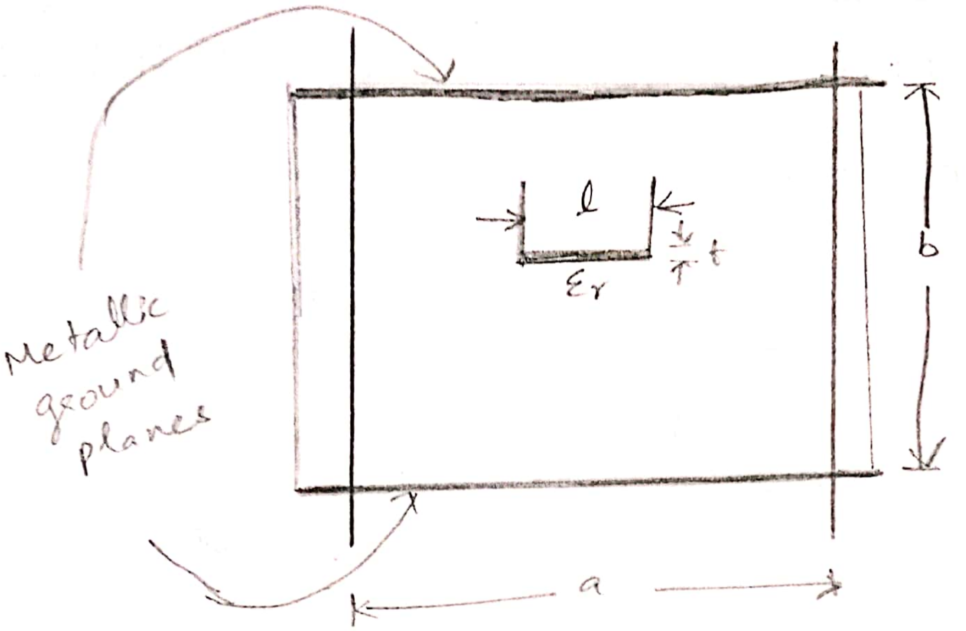
→ Not suitable for low frequency applications
→ Bulky in size and weight.
→ TEM mode propagation is not possible.

vi) STRIP-TYPE TRANSMISSION LINES

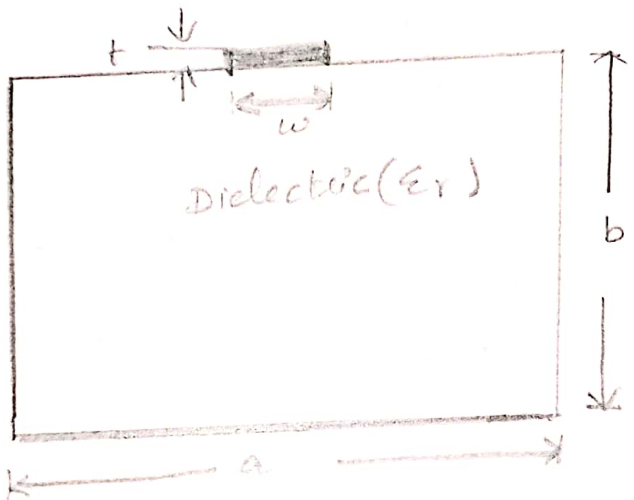
→ Used as microwave circuits / components in conjuction with microwave semiconductor devices.
→ configuration is either symmetrical or as asymmetrical.
→ developed as an alternative conductive medium to waveguides.
→ used in microwave applications in which miniaturization has been found very advantageous.
→ Also used in receiver front ends low-power stages of microwave transmitters and patch antennas in cell phones.

vii) Microstrip Lines

→ Asymmetric strip transmission
→ Consists of a thin metallic strip of width w and ground plane seperated by a low loss dielectric with relative permittivity ε_r.



(Fig) Strip transmission Line



(Fig) Microstrip Line

LINE PARAMETERS (PRIMARY CONSTANTS OF THE LINE)

Transmission Line parameters are

* Resistance (R)
* Capacitance (C)
* Inductance (L)
* Conductance (G)

RESISTANCE

* This parameter of any transmission line rely on the cross sectional area of the conducting material.

* It is represented by R and its unit is ohms per unit length of the line.

* This parameter is uniformly distributed along the entire length.

Resistance 'R' is given by,

$$R = \rho \frac{l}{a}$$

where

ρ – conductivity of the conducting material

l – The length of the transmission line

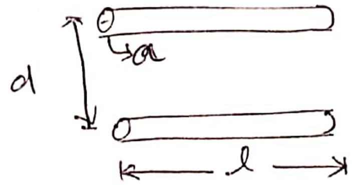
a – cross sectional area of the line.

CAPACITANCE (C)

* A transmission line is composed of two Parallel conducting wire seperated by a dielectric material.

* So it behaves as a parallel plate capacitor. Thus it has some capacitance which is also distributed uniformly over its length.

* It is measured in farads per unit length of the transmission line.



INDUCTANCE (L)

* when current flows through a conductor it generates a magnetic field perpendicular to the direction of the electric field.

* As the magnetic field varies, electromagnetic flux generated in the line.

* So this emf now flows in opposite direction with the current flowing through the device, which is known as inductance.

* It's value depends on the current flowing through the conductor.

* Represented by 'L' & it's unit is Henry per unit length of the conductor.

CONDUCTANCE (G)

* If the dielectric between the parallel conductors is not perfect, leakage current flows through the dielectric.

* This leakage current is responsible for leakage conductance through the transmission line.

* It is present between the conducting wires and is represented by G,

* It's unit is mho per unit length of the conductor.

Relation to other parameters

$$Z = R + j\omega L$$

$$Y = G + j\omega C$$

Relation to secondary constants.

characteristic impedance $Z_0 = \sqrt{Z/Y}$

Propagation constant $\gamma = \sqrt{ZY}$

$Z_0, \gamma \rightarrow$ secondary constants of the line

$\gamma Z_0 = \sqrt{ZY} \times \sqrt{Z/Y}$	$\gamma / Z_0 = \sqrt{ZY} / \sqrt{Z/Y}$
$= Z$	$= Y$
$= R + j\omega L$	$= G + j\omega C$