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EXPERIMENT - 7

AIM - To Study the change in characteristics impedance and reflection coefficients of the transmission line by changing the dielectric properties of materials embedded between two conductors.

THEORY

The transmission lines are used as wave-guiding structures for transferring power and information from one point to another. Transmission line is often schematically represented as a two wire line, since transmission lines always have at least two conductors.

Coaxial Transmission Lines :
This consists of an inner conductor and a coaxial outer conducting sheath separated by a dielectric medium. Characteristic Impedance, Z_0 can be given as:

$$Z_0 = (1/2\pi)*\sqrt{(\mu/\varepsilon)}\ln(D/d) = (138/\sqrt{\varepsilon_r})\log_{10}(D/d)$$

Advantages :

1. It supports TEM mode.
2. ability to minimize radiation losses as in a coaxial line no electric or magnetic fields extend outside of the outer conductor.

Disadvantages :

1. It is expensive to construct, and bulky in nature.
2. It must be kept dry to prevent excessive leakage between the two conductors.

Parallel Plate Transmission Lines:

This type of transmission line consists of two parallel conducting plates separated by a dielectric slab of a uniform thickness. Characteristic Impedance, Z_o of the parallel plate transmission line can be obtained from the relation:

$$Z_0 = (d/w)*\sqrt{(\mu/\varepsilon_r)} = (d/w)*\eta$$

Advantages :

1. Simple to construct.

Disadvantages :

1. High radiation losses by the changing fields created by the changing current in each conductor
2. Electrical noise.

Strip Lines:

This is a planar type of transmission line that lends itself well to microwave integrated circuitry and photolithographic fabrication.

The characteristic impedance is given by:

$$Z_o = \frac{30\pi}{\sqrt{\varepsilon_r}}\left(\frac{b}{w_e + 0.441b}\right)$$

Where w_e is the effective width of the center conductor given by:

$$\frac{W_e}{b} = \frac{W}{b} - 0 \qquad for\ {}^{W}/_{b} \geq 0.35$$

$$\frac{W}{b} - \left(0.35 - \frac{W}{b}\right)^2 \qquad for\ {}^{W}/_{b} \leq 0.35$$

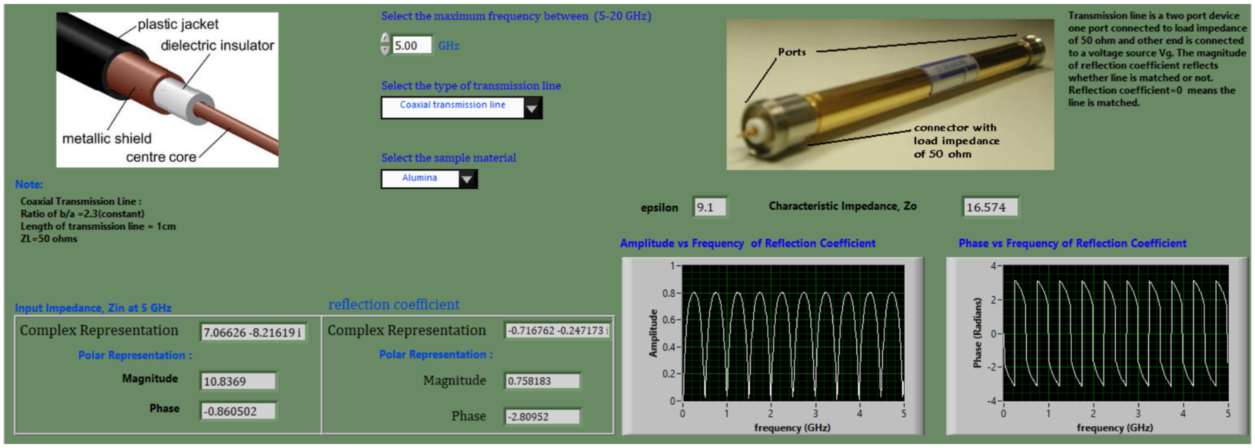
Microstrip Lines:

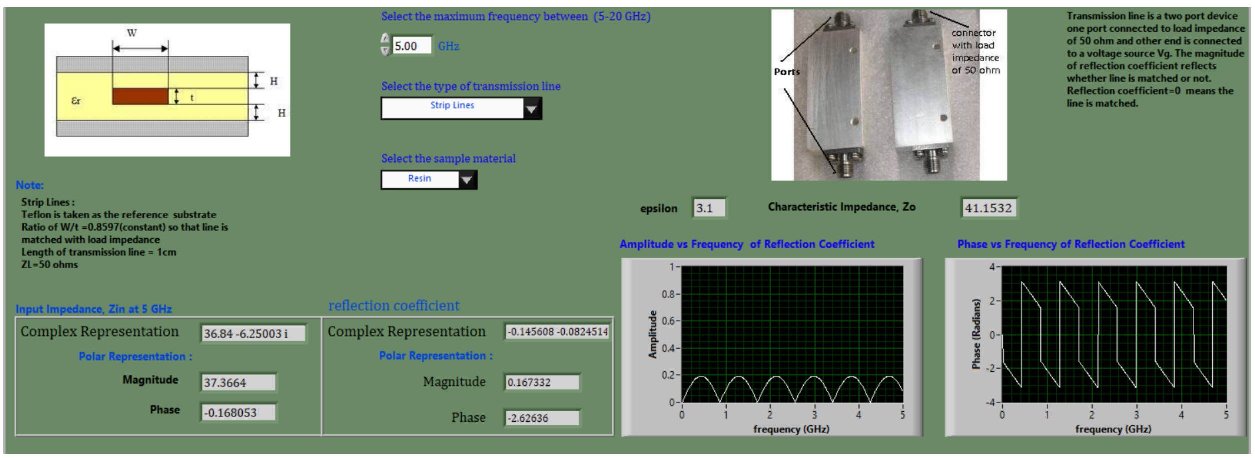
It can be fabricated by photolithographic processes and is easily integrated with other passive and active microwave devices. For given dimensions of the microstrip line, the characteristic impedance can be calculated as:

$$Z_o = \frac{60}{\sqrt{\varepsilon_e}} \ln\left(\frac{8h}{W} + \frac{W}{4h}\right) \qquad for\ \frac{W}{h} \leq 1$$

$$Z_o = \frac{120\pi}{\sqrt{\varepsilon_e}} \left[\frac{W}{h} + 1.393 + 0.667 \ln\left(\frac{W}{h} + 1.444\right)\right] \qquad for\ \frac{W}{h} \geq 1$$

RESULTS AND DISCUSSIONS





Parameters taken :-

Maximum Frequency - 5 GHz

Dielectric Material (epsilon)	Alumina (9.1)	Polyimide (3.5)	Resin (3.1)	Air (1)
Coaxial Transmission Line	16.574	26.7247	28.3966	49.9974
Parallel Plate Transmission Line	16.5712	26.7202	28.3918	49.9889
Strip Lines	24.0195	38.7303	41.1532	72.4577
Micro Strip Lines	25.6872	40.1751	42.426	67.4849

OBSERVATIONS

a) On increasing the value of epsilon of a dielectric medium, the characteristic impedance decreases for all types of transmission lines.
b) As we move from coaxial to microstrip lines, the characteristic impedance of transmission lines in a particular dielectric medium increases.
c) There is very small difference in characteristic impedance of coaxial and parallel plate transmission lines.
d) Similarly, strip and microstrip have almost the same characteristic impedance for greater values of epsilon dielectric.
e) Microstip is easily miniaturized and integrated with microwave devices.
f) All the devices have the highest characteristic impedance in Air having dielectric constant as 1.

CONCLUSIONS

The experiment shows the change in dielectric properties of a material embedded between the two conductors change the characteristic impedance and reflection coefficients.
This experiment provides a better understanding of geometry of transmission lines. Here one can observe the reflection coefficient magnitude and phase variation with frequency.

END