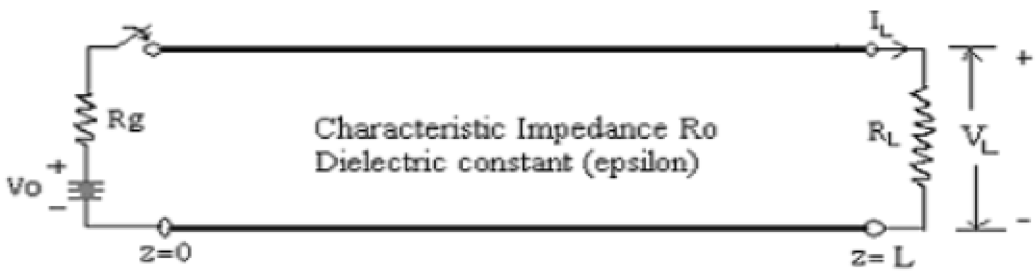
Name : ADITYA SINGH Date : 10/09/21
Roll No : 2K19/EP/005

EXPERIMENT - 3

AIM - Observe the transient phenomenon of terminated coaxial transmission lines in order to study their time domain behavior.

THEORY

It is a device designed to guide the electrical energy from one point to another. It is used, for example, to transfer the RF energy from source to antenna. For efficient point-to-point transmission of power and information the source energy must be directed or guided. Transmission line that consists of two or more conductors may support transverse electromagnetic (TEM) waves, characterized by the lack of longitudinal field components.



A dc source applied to a terminated lossless line

Lossless, when R = 0 and G = 0.
Characteristics Impedance is given by :-

$$\mathbf{Z}_0 = \frac{1}{\mathbf{Y}_0} = \sqrt{\frac{\mathbf{Z}}{\mathbf{Y}}} = \sqrt{\frac{R + j\omega L}{G + j\omega C}} = R_0 \pm jX_0$$

Reflection Coefficient

a) at Load End
$$\Gamma_L = \frac{Z_L - Z_o}{Z_L + Z_o}$$

b) at generator end
$$\Gamma_g = \frac{Z_g - Z_o}{Z_g + Z_o}$$

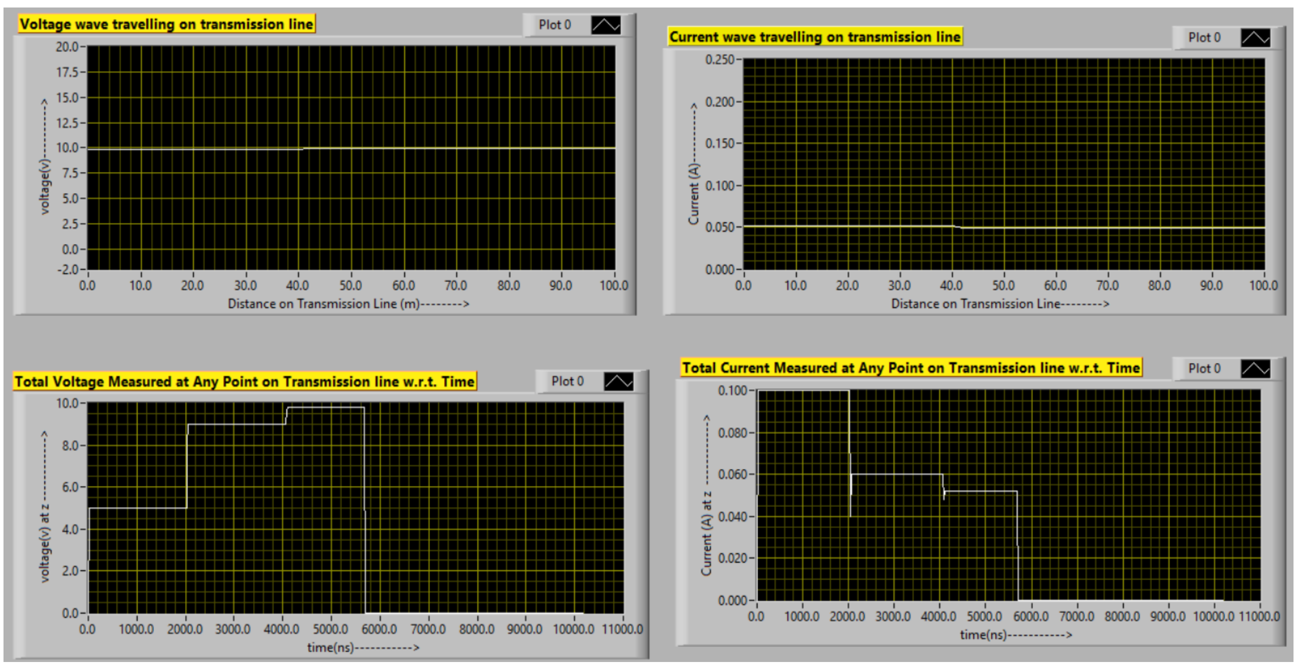
RESULTS AND DISCUSSIONS

1. **When (R_o != R_g != R_L)**

   Parameters taken :-

   R_g = 100 ohm, R_o = 50 ohm , R_L = 200 ohm
   Source Voltage V_0 = 12 V
   No. of Cycles = 10
   Location of point at which voltage has to be measured = 0
   Length of Transmission Line = 100 m
   Relative Dielectric constant = 9

$$\Gamma_G = \frac{100-50}{100+50} = 0.33 \quad \text{and} \quad \Gamma_L = \frac{200-50}{200+50} = 0.6$$



Observations :

a) There will be reflection at the load end i.e z = 1 since $R_0 \neq R_L$. The first reflective wave at the load end is given by $V_1^- = \Gamma_L V_1^+$.

b) At each reflection, the amplitude is multiplied by the reflection coefficient corresponding to that end.

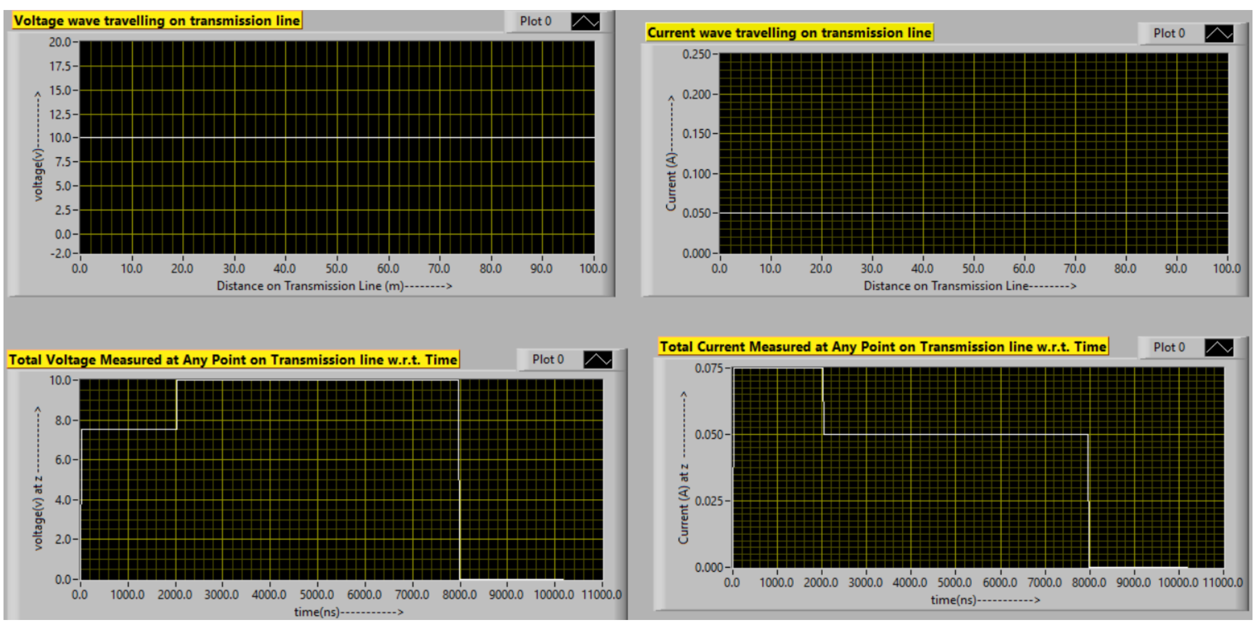
c) With every successive reflection, the amplitude decreases as the coefficient lies between 0 and 1. Moreover, the decrease at the generator end will be higher as compared to the decrease at the load end.

2. **When (R_o = R_g != R_L)**

Parameters taken :-

R_g = 100, R_o = 100, R_L = 200
Source Voltage V_0 = 12 V
No. of Cycles = 10
Location of point at which voltage has to be measured = 0
Length of Transmission Line = 100 m
Relative Dielectric constant = 9

$\Gamma_G = \frac{100-100}{100+100}$ = 0 and $\Gamma_L = \frac{200-100}{200+100}$ = 0.33



Observations :

1. The transient behaviour of the transmission line has been observed when (R_g=R_0). In this case only V^+_1 and V^-_1 exist along the line.
2. Because of impedance mismatch at the load end, reflection occurs whenever the wave reaches the load end.

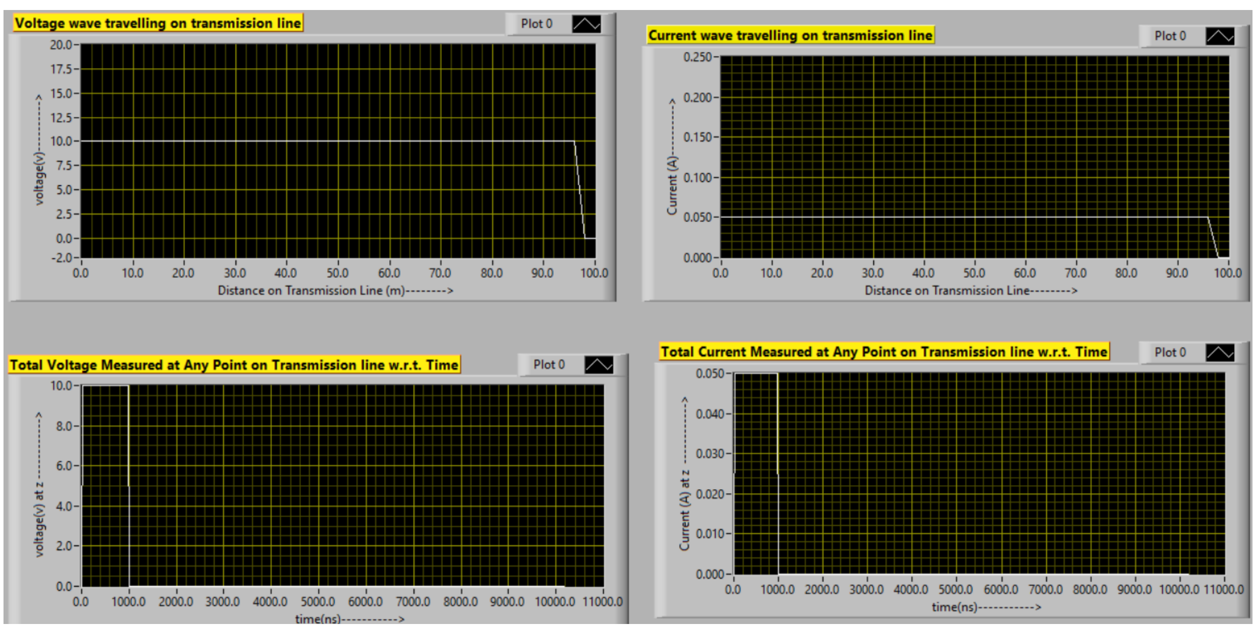
3. Hence the wave reflects once at the positive end and then moves along the negative z-direction without reflecting at the generator end.
4. At reflection, the amplitude is multiplied by the reflection coefficient at load end, the amplitude decreases because the value of load coefficient lies between 0 and 1.

3. When ($R_o = R_L \neq R_g$)

Parameters taken :-

$R_g = 100$, $R_o = 200$, $R_L = 200$
Source Voltage $V_0 = 12$ V
No. of Cycles = 10
Location of point at which voltage has to be measured = 0
Length of Transmission Line = 100 m
Relative Dielectric constant = 9

$\Gamma_G = \frac{100-200}{100+200} = -0.33$ and $\Gamma_L = \frac{200-200}{200+200} = 0$



Observations :

1. The transient behaviour of the transmission line has been observed when ($R_g=R_L$). In this case only V^+_1 exists along the line.

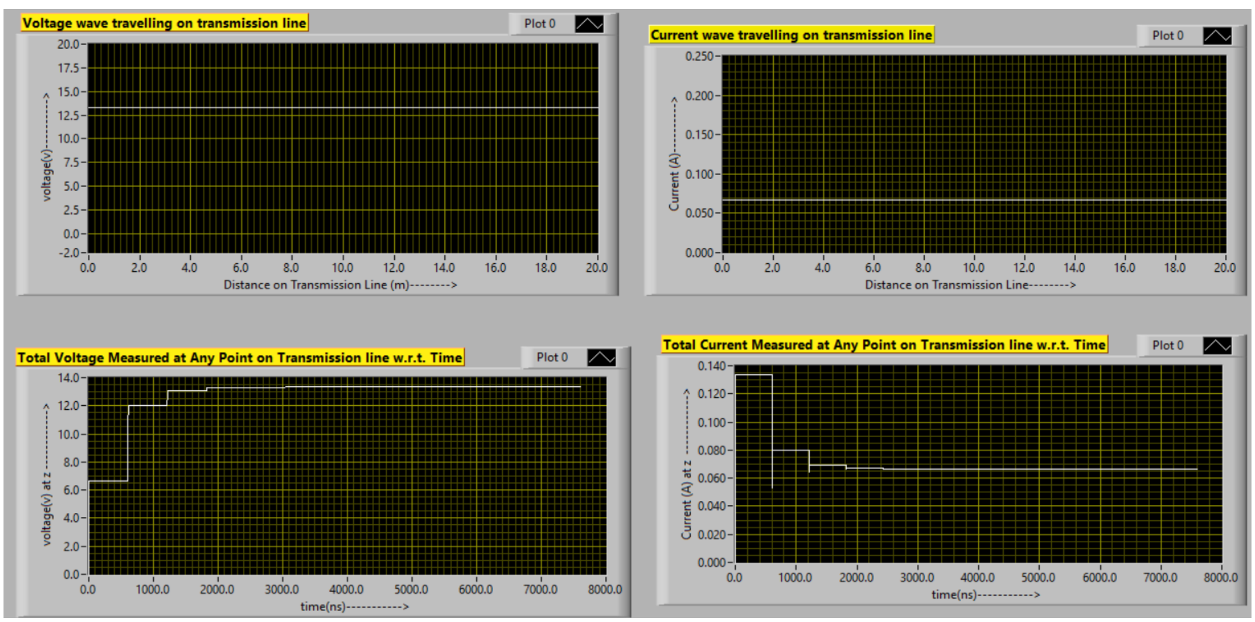
2. Because of impedance mismatch at the generator end, reflection occurs whenever the wave reaches the generator end.
3. Hence the wave reflects once at the positive end.
4. But the wave first hits the load end, and since the coefficient of load end is zero, no reflection occurs at the load end. Hence the wave never reflects.

4. When (R_o != R_L != R_g) and changing different parameters

Parameters taken :-

R_g = 50 ohm, R_o = 300 ohm, R_L = 70 ohm
Source Voltage V_0 = 12 V
No. of Cycles = 15
Location of point at which voltage has to be measured = 20 m
Length of Transmission Line = 60 m
Relative Dielectric constant = 15

$\Gamma_G = \frac{50-300}{50+300}$ = -0.714 and $\Gamma_L = \frac{70-300}{70+300}$ = -0.622



Observations :

1. Here, R_0 R_G and R_L, all three have different values. Hence both the reflection coefficients have non-zero values and reflection occurs at both the generator end and the load end.
2. The magnitude of the amplitude decreases at each reflection because the values of the reflection coefficients lie between 0 and 1. This can also be observed from the graph obtained.
3. As the value of the transmission line is decreased, the time between successive reflections also decreases.
4. As the value of the relative dielectric constant increases, the time between successive reflections also increases.

CONCLUSIONS

Wave reflection occurs due to impedance mismatch.

- When all three of R_o, R_G, and R_L are unequal, impedance mismatch occurs whenever the wave hits either the generator or load end, and reflection occurs.
- When $R_g = R_O$, but $R_L \neq R_O$, one reflection occurs at the load end. When the wave hits the generator end again, no reflection occurs due to no impedance mismatch. Amplitude becomes zero and no successive reflections occur.
- When $R_L = R_O$, but $R_g \neq R_O$, no reflection occurs. This is because when the wave hits the load end the first time, no reflection occurs due to no impedance mismatch. Amplitude becomes zero and no successive reflections occur.

Voltage Expressions :-

a) When $Z_L = Z_o$, reflection coefficient at load end becomes zero. Therefore only V_1^+, the first voltage expression, exists.
b) When $Z_g = Z_o$, reflection coefficient at the generator end becomes zero. Therefore the first two voltage expressions will exist, V_1^+ and V_1^-.

Changing Parameters :-

- On changing the length of the transmission line, it is observed that time taken between subsequent reflections increases or decreases with increase or decrease in length. The change is directly proportional.
- On increasing the relative dielectric constant of the transmission line, the time taken between subsequent reflections increases. The change is directly proportional since the velocity factor of the wave is dependent on the square root of the relativistic permittivity.

A negative reflection coefficient indicated a phase inversion of 180 degree.

The voltage will become steady after a few cycles.

The entire phenomenon is a convergent process as the amplitude of each successive reflected wave decreases by a factor of the corresponding reflection coefficient.

END