Understanding Transmission Line Effects

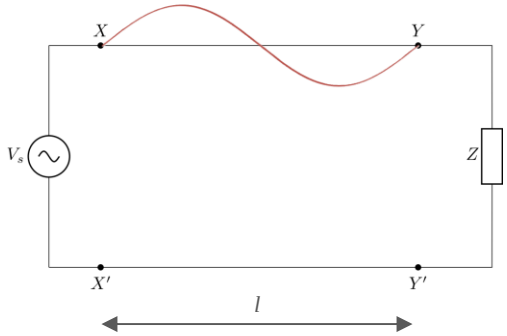

Fig: A Generic Circuit Diagram

Source Voltage: $V_s(t) = V_0 \cos(\omega t)$

Voltage at XX': $V_{XX'} = V_0 \cos(\omega t)$

Voltage at YY': $V_{YY'} = V_0 \cos\left[\omega\left(t - \frac{\ell}{c}\right)\right]$

Consider a Time Reference $t = 0$

$$V_{XX'} = V_0, \quad V_{YY'} = V_0 \cos\left(\frac{\omega \ell}{c}\right)$$

For l = 1 m and V_0 = 1 V

$$V_{YY'} = V_0 \cos\left(\frac{2\pi f \ell}{c}\right)$$

Understanding Transmission Line Effects

Evaluating at Different Frequencies:

Frequency	Vyy′ (V)	Wavelength λ (m)
10 kHz	0.999999802	10,000
1 MHz	0.998026728	100
5 MHz	0.951056	20
10 MHz	0.809	10
20 MHz	0.309	5
25 MHz	0	4
30 MHz	-0.309	3.33
50 MHz	-1	2
100 MHz	+1	1

Evaluating at Different Frequencies:

$$\frac{\omega \ell}{v} = \frac{2\pi f \ell}{v} = 2\pi \frac{\ell}{\lambda}$$

Case 1:

$$\frac{\ell}{\lambda} \ll 1$$

No Transmission Line Effects

Case 2:

$$\frac{\ell}{\lambda} \geq 0.01$$

Transmission Line Domain