DISCIPLINE OF ASTRONOMY, ASTROPHYSICS & SPACE ENGINEERING, IIT INDORE

# RF Lab

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## 1 OBJECTIVES

To observe the transient phenomenon of terminated coaxial transmission lines in order to study their frequency domain behavior. To observe the voltage waves and modified voltage waves along the lossless (R=0 and G=0) transmission line if the load resistance is zero or infinity or in between to give a finite Voltage Standing Wave Ratio(VSWR).

## 2 OBSERVATIONS

Waves along the transmission line is observed when the $R_L$ and the source resistance $R_0$ are matched.
Here $R_0 = R_L = 100\Omega$ Frequency of the incident AC voltage is $0.03GHz$ ,amplitude= 15 V,length of transmission line is 40 meters.
The VSWR is 1 in this case is:

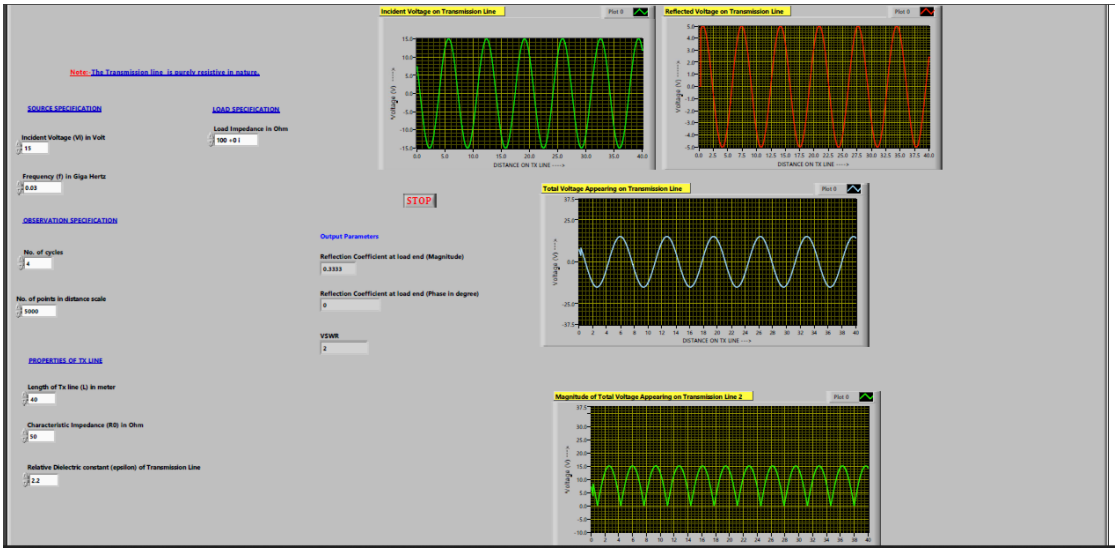


Figure 2.1: Incident,reflected and total voltage appearing on transmission line for matched impedances

Now the $R_0$ and $R_L$ are mismatched with $R_L = 80\Omega$ and $R_0 = 100\Omega$.Other parameters are same as above.
The VSWR for this case comes out to be 1.25. Now the waves are observed for short circuited transmission line i.e $R_L = 0\Omega$ and the other parameters are same as the previous one.

The VSWR in this case is infinity and reflection coefficient for amplitude is 1.

For open circuited transmission line $R_L$=infinity and the other parameters are kept same' The VSWR is undefined in this case.

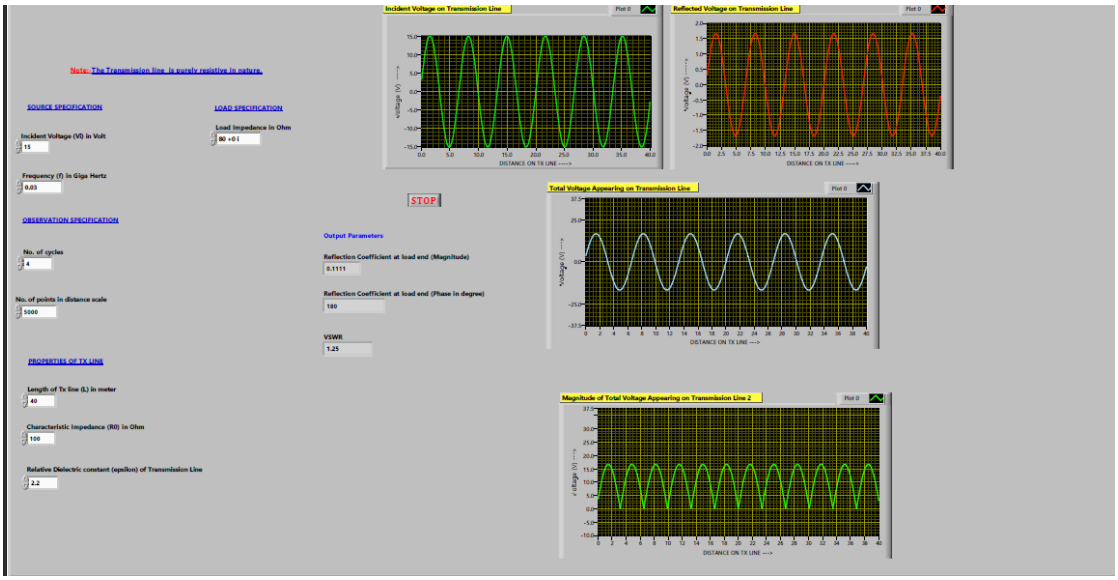


Figure 2.2: Incident,reflected and total voltage appearing on transmission line for matched impedances

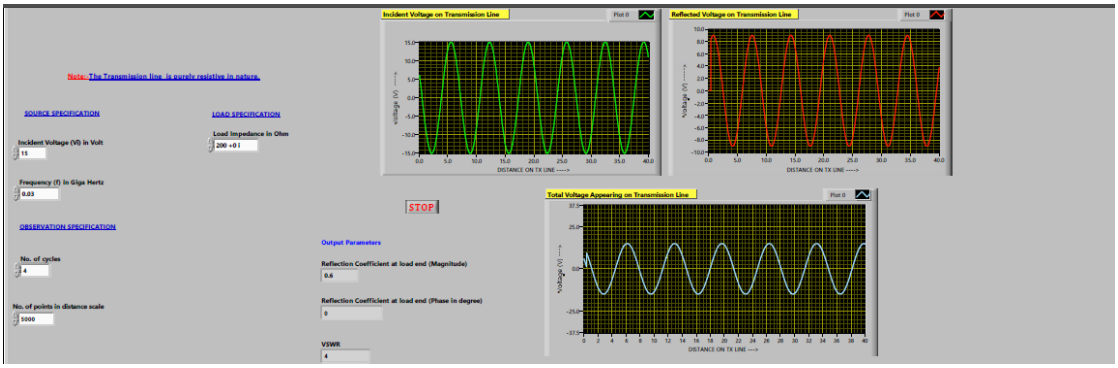


Figure 2.3: Incident,reflected and total voltage appearing on transmission line for matched impedances

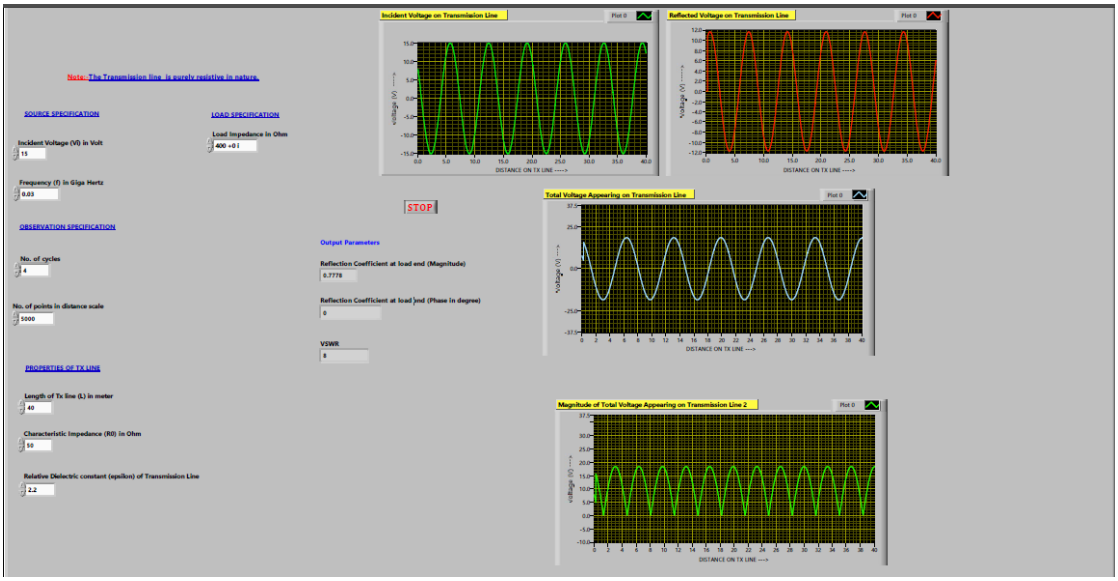


Figure 2.4: Incident,reflected and total voltage appearing on transmission line for matched impedances

Now setting $R_0 = 50\Omega$ and $R_L = 100\Omega$ ,we find VSWR=2.For same other parameter the reflected voltage and incident voltage are recorded in the following table and plotted.

| $V_I$(in V) | $V_R$(in V) |
|---|---|
| 5.0 | 1.7 |
| 10.0 | 3.4 |
| 15.0 | 5.0 |
| 20.0 | 6.5 |
| 25.0 | 8.5 |
| 30.0 | 10.0 |
| 35.0 | 11.5 |
| 40.0 | 12.6 |
| 45.0 | 15.0 |
| 50.0 | 17.0 |

Table 2.1: Incident voltage and reflected voltage

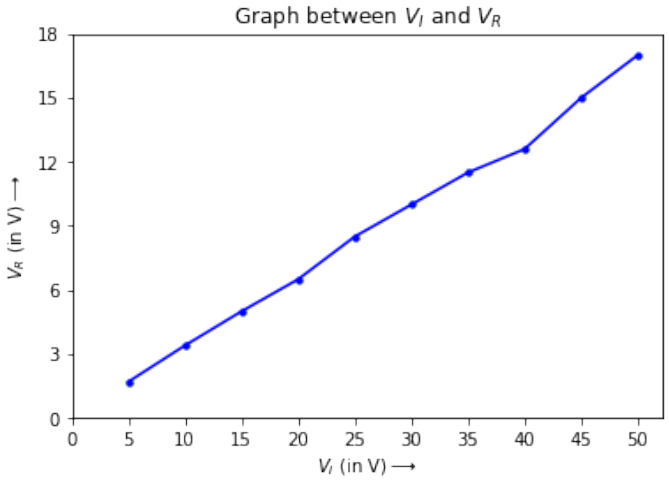


Figure 2.5: Reflected vs incident voltage wave amplitude for VSWR=2.

Now setting $R_L = 200$ and same other parameters we find VSWR=4.

| $V_I$(in V) | $V_R$(in V) |
|---|---|
| 5.0 | 3.0 |
| 10.0 | 6.0 |
| 15.0 | 9.0 |
| 20.0 | 12.0 |
| 25.0 | 15.0 |
| 30.0 | 18.0 |
| 35.0 | 21.0 |
| 40.0 | 24.0 |
| 45.0 | 27.0 |
| 50.0 | 30.0 |

Table 2.2: Incident voltage and reflected voltage

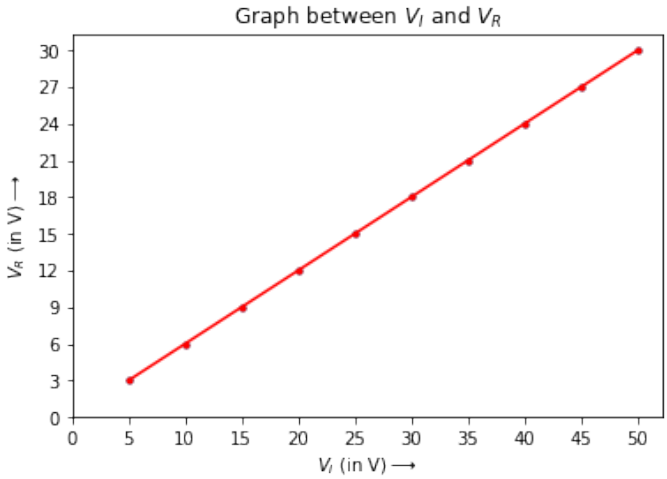


Figure 2.6: Reflected vs incident voltage wave amplitude for VSWR=4.

| $V_I$(in V) | $V_R$(in V) |
|---|---|
| 5.0 | 3.9 |
| 10.0 | 7.8 |
| 15.0 | 11.7 |
| 20.0 | 15.6 |
| 25.0 | 19.4 |
| 30.0 | 23.3 |
| 35.0 | 27.2 |
| 40.0 | 31.0 |
| 45.0 | 35.0 |
| 50.0 | 38.9 |

Table 2.3: Incident voltage and reflected voltage

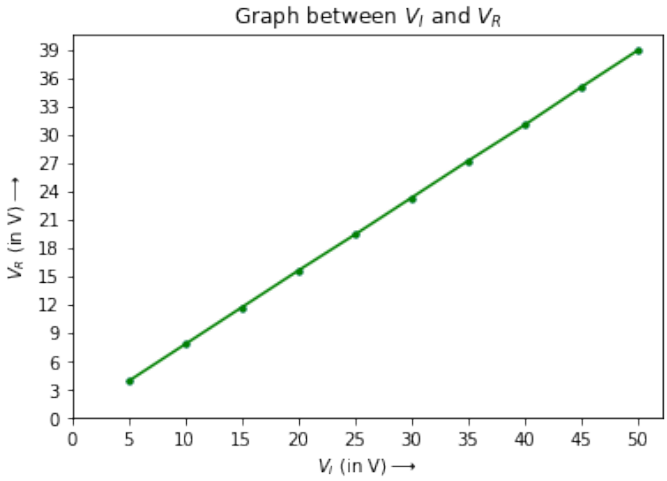


Figure 2.7: Reflected vs incident voltage wave amplitude for VSWR=8.

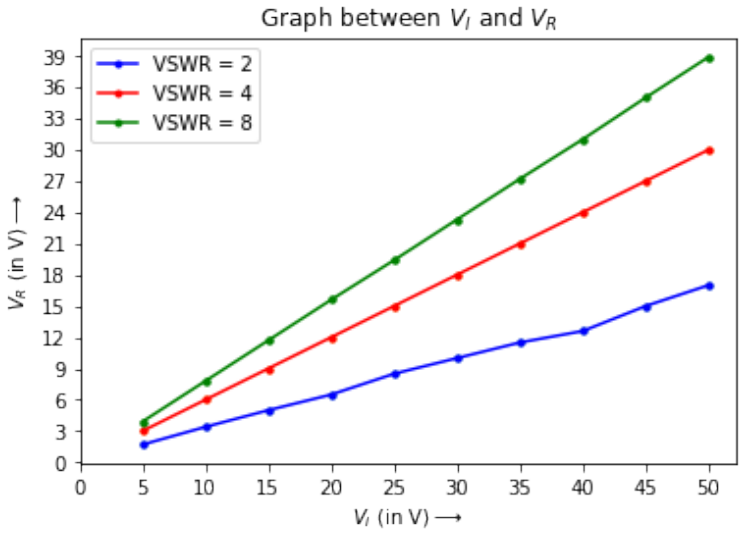


Figure 2.8: Reflected vs incident voltage wave amplitude for all values of VSWR

## 3 Conclusions

1.For matched impedance i.e $R_L = R_0$ no reflection occurs at the load end and all the energy gets dissipated in the load itself.
2.For short-circuited transmission line i.e.$R_L = 0$,all of the wave gets reflected back from load end.
3.For open circuit transmission line no reflected or total voltage is expected due to connection break.
4.All the plots of reflected vs incident wave follow a linear trend due to constant reflection coefficient at the pure resistive load end.

## 4 Acknowledgement

The experiment, theory, procedure and simulations are taken from the Virtual Labs – IIT Kanpur `http://www.iitk.ac.in/mimt_lab/vlab/`.