RESONANT TRANSMISSION LINE

Objective: To observe the resonance of a transmission line with both a short and an open circuit termination.

List of Equipment:

1. Transmission Line Demonstrator (TLD)
2. Sine wave generator
3. Oscilloscope

Theory

When a line was terminated by any other impedance than the characteristics one, a signal on the line was reflected. In a real line, energy is associated with the reflected signal. Suppose that both ends of the line are terminated so that they absorb no energy and that energy losses in the line are small. Any signal on the line must then be totally reflected back and forth between the two ends. By terminating the line with an open and a short mismatching is obtained.

Line short-circuit both ends – In this arrangement a short is applied in both side of line after energizing it. For different lengths of line it shows series or parallel resonance. If RF of a slightly lower frequency is applied, the electrical length of the line decreases below a half wavelength and the input impedance is capacitive. If the frequency is increased, the input impedance is inductive. Thus the short circuited half wave line acts like a series resonant circuit. Similarly a quarter wave line can also be used in place of resonant LC circuit. The open circuited quarter wave line acts like a series LC circuit.

Line open-circuit both ends – In this arrangement an open is applied in both side of line after energizing it. If RF of a slightly lower frequency is applied, the electrical length of the line decreases below a half wavelength and the input impedance is inductive. If the frequency is increased, the input impedance is capacitive. Thus the short circuited half wave line acts like a series resonant circuit. Similarly a quarter wave line can also be used

in place of resonant LC circuit. The short circuited quarter wave line acts like a parallel LC circuit.

Procedure:

a) Line short-circuit both ends

1. Connect the generator to the A end of the TLD line through 50 ohm (Low impedance) resistor which is parallel to both lines as shown in figure1.
2. Put the link in there places and short the line.
3. Adjust attenuation to minimum.
4. Use Hold/run switch to 'run'.
5. Choose length for different wavelength operation.
6. Search for several different resonant frequencies and for each one note the frequency and sketch the shape of the wave on the line.

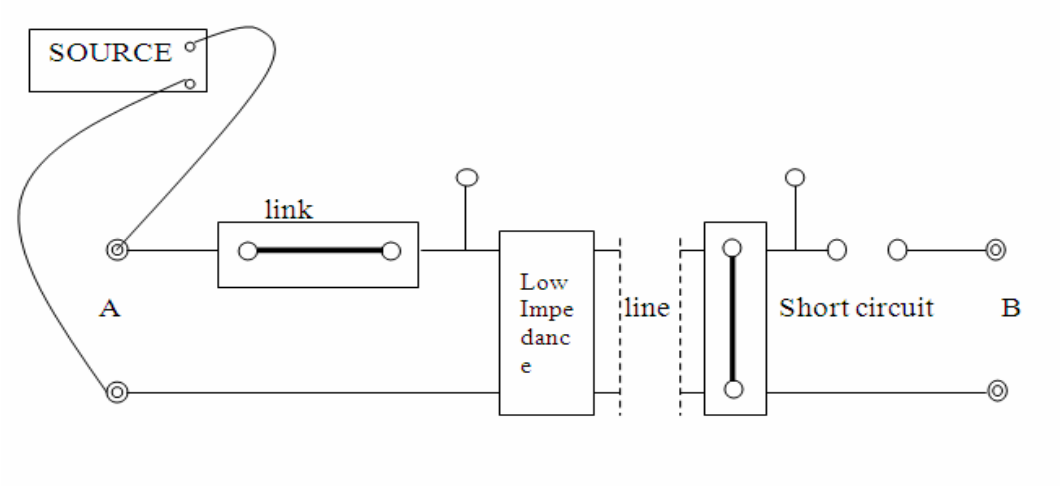

Figure 1. Experimental setup for the short circuited line

b) Line open-circuit both ends

1. Connect the generator to the A end of the TLD line through high impedance (10 kΩ resistance) as shown in fig 2. The 10 kΩ is high enough compared with the 600 Ω line to approximate to an open circuit.
2. Set the oscillator frequency t 1 Hz and its output to above 8 V peak to peak.
3. Use Hold/run switch to 'run' and choose line length to 'L'.

4. Adjust attenuation to minimum.
5. By continuously raising and adjusting the frequency as you approach to 2 Hz we will able to see the oscillating behavior.

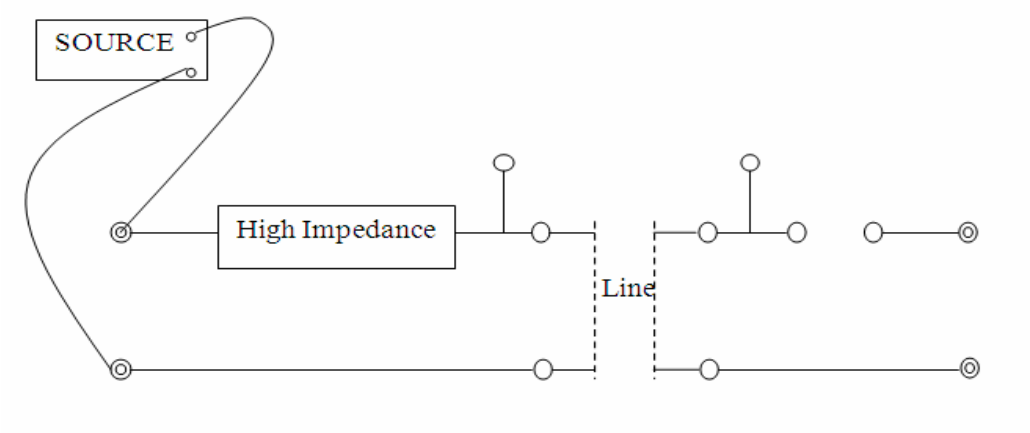

Figure 2. Experimental setup for the open circuited line

Discussions:

1. How do you come to know that the particular line is series or parallel resonant circuit?
2. What statement can you make about the shape of the voltage wave in case of line terminated in a short?
3. Where the voltage maximum is obtained in case of line with open circuit ends?

References:

1. E.C. Jordan and K.G.Balmain, 'Electromagnetic wave Radiating Systems' 1968.
2. A.W. Cross, 'Experimental Microwaves', 1977.
3. Mathew N. O. Sadiku, "Elements of Electromagnetics", Oxford University Press, 2001.