Fundamentals of Electric Theory and Circuits

by

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Applet Simulation of a Transmission Line

To view the interactive animation of the simulation of a transmission line

i) visit http://www.astrophysik.uni-kiel.de/~hhaertel/TL/TL-doc/index.htm and download the "User guide (video)" or view online

ii) Next, visit http://www.astrophysik.uni-kiel.de/~hhaertel/TL/TL-tutorial/TL-uk.pdf and download the file "Transmission Processes in Linear Systems.pdf'

iii) Then visit http://www.astrophysik.uni-kiel.de/~hhaertel/TL/TL.zip and download the WinRAR zip file "TL"(reproduced here with permission from Hermann Haertel, University Kiel, Germany). Then right click select Extract files choosing the option for the extracted file location. Run the extracted Java file program 'TL' executable Jar file. Java can be downloaded and installed from www.java.com.

The documentation file "Transmission Processes in Linear Systems", User-guide video "TL-uk", and the "TL" jar file are available in the "Transmission Line Simulation Program" folder in the CD.

iv) Read the descriptions of the progress of the pulses (Section 2.1.3 to 2.1.7) and follow the instructions to interactively set the Java applet (iii) to get a feel for the surface charge movements on a transmission line.

Screen shots of program runs with different settings of load parameters are shown in the Figs. 1 to 4.

When a transmission line is not terminated (open-circuit), the incident and returning waves of an applied sinusoidal voltage will produce *standing-waves*.
Standing waves shown in textbooks are usually static and hide the dynamics which is brought out richly in these animations.

Line Open Circuited
Fig. 1 shows a screen shot of a simulation run of the program with the line not terminated.
To view this, launch the TL program and click on the load resistor. In the load parameter dialog box check the open-circuit symbol.

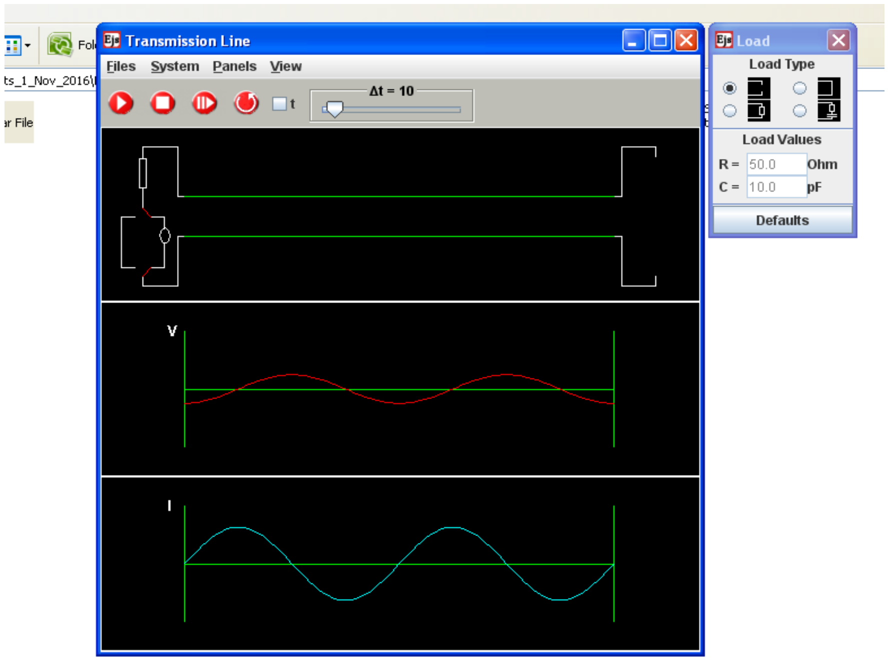

Fig. 1 Standing voltage and current waves in a transmission line

Note that the current is not uniform throughout the line as is observed in simple electric and electronic circuits of small dimensions as seen in the screen shot in Fig. 1.
Observe the *standing wave* set up along the line. Note that the current is zero at the beginning and the end of the line. The voltage is a maximum at points where the current is a minimum or zero, indicative of a purely reactive nature of the line when it is terminated by an open-circuit. Observe the difference in phase between the current and voltage waveforms. Answer the question "How much is the phase difference between V and I ?"

Short Circuited Line

Select the Load type to "short-circuit" (click the radio button of the short-circuit symbol). When the line is terminated by a short-circuit, a standing wave is set up along the line with the voltage zero at the beginning and the end of the line. The current is a maximum at points where the voltage is a minimum or zero, indicative of the purely reactive nature of the line when it is terminated by a short-circuit. Observe the difference in phase between the current and voltage waveforms. Answer the question "How much is the phase difference between V and I ?" Observe the dynamics of the standing wave.

The **default parameter** settings of the Source, Line and Load of the line are

Source: The source settings can be viewed in the interactive dialog by clicking the source resistor symbol once. Sinusoidal voltage, freq. = 300 MHz and Source resistance of 50 ohms.

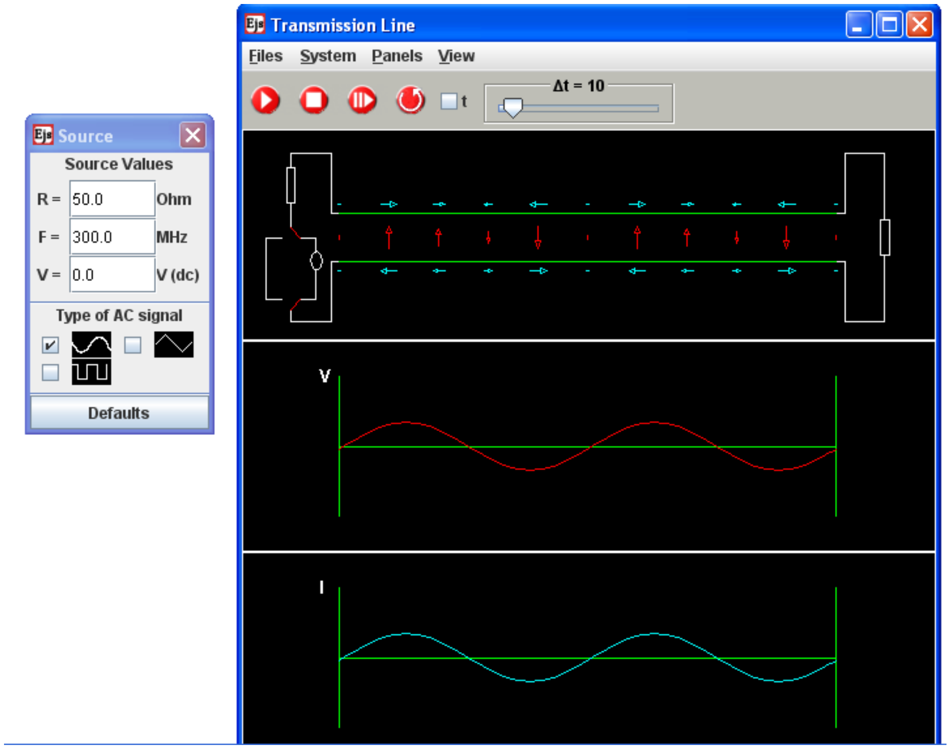

Fig. 2 Source settings - Line excited by a sinusoidal voltage generator

Line: The line settings can be viewed in the interactive dialog by clicking any one of the lines once. Uniform line with R = 0 ohms/m; R(p) (or G in Fig. 5.44 = 0); L = 166.7 nanohenries/m(nH/m); C=6.7picofarads/m; Z (or characteristic impedance) = 50 ohm.

Setting up the Line parameters

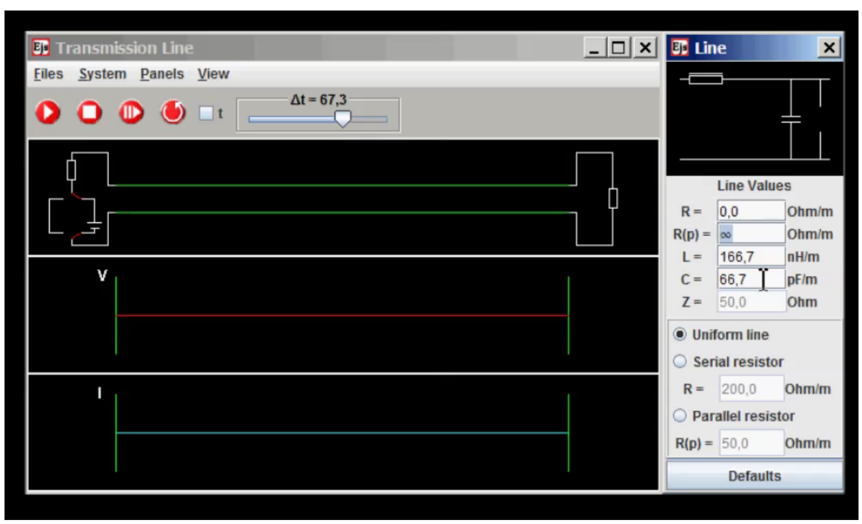

Fig. 3 Line parameter settings

Load: The load settings can be viewed in the interactive dialog by clicking the load impedance at the end of the lines once. Load type: Resistor; 50 ohms.

Incident and Reflected Wave components

To view the incident and reflected waves in the transmission line, click Panels in the menu bar and check the Incident and Reflected check boxes.

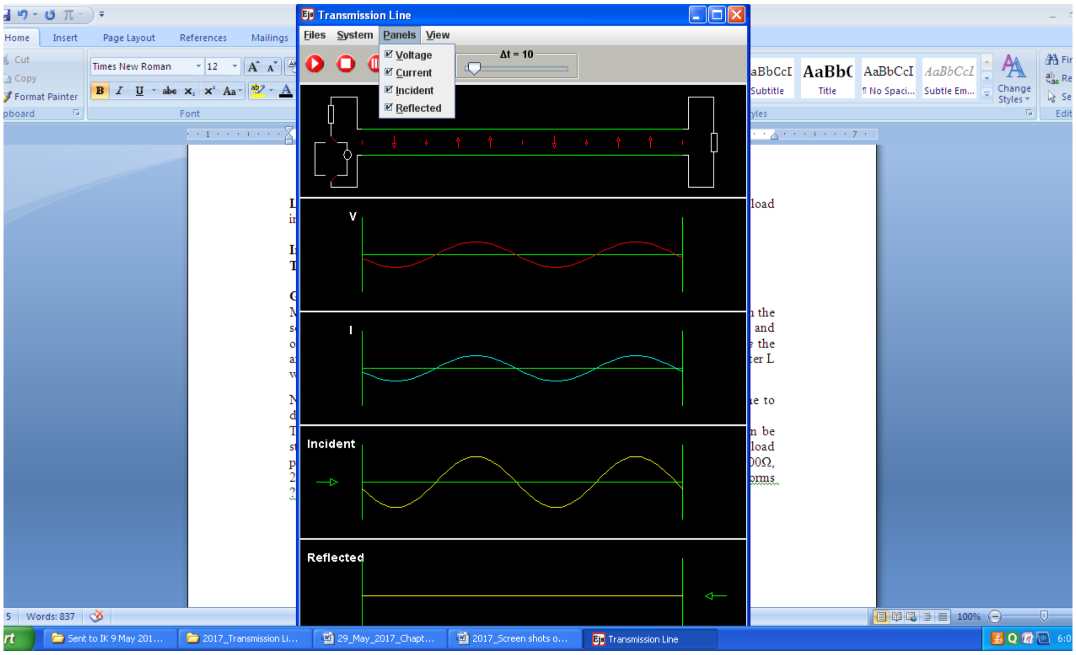

Fig. 4 Incident and Reflected Waves

Getting started

Make a note of the amplitude of the voltage and current amplitude of the sinewave on the screen. Now, click one of the lines and in the line parameters, set L = 166000.7 nH/m and observe the amplitude of the voltage wave and the current wave. Note how *large* the amplitude of the voltage wave is in comparison with the amplitude when the parameter L was 166.7 nH/m.

Next, click the "Defaults" button on the Line parameters dialog to restore the line to default values.

There are several more combinations of line parameters and loading types that can be studied in the applet of the webpage. For instance, click the source, line and load parameters to default and observe the voltage and current at each of the loads 100Ω, 200Ω, 300Ω, 400Ω, 500Ω and 600Ω. What did you observe happening to the waveforms ?