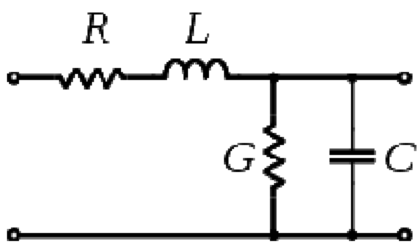
Wikipedia entry for **Telegrapher's equations**

Main article: Telegrapher's equations

See also: Reflections on copper lines

The **Telegrapher's Equations** (or just **Telegraph Equations**) are a pair of linear differential equations which describe the voltage and current on an electrical transmission line with distance and time. They were developed by Oliver Heaviside who created the *transmission line model*, and are based on Maxwell's Equations.



Schematic representation of the elementary component of a transmission line.

The transmission line model represents the transmission line as an infinite series of two-port elementary components, each representing an infinitesimally short segment of the transmission line:

- The distributed resistance R of the conductors is represented by a series resistor (expressed in ohms per unit length).
- The distributed inductance L (due to the magnetic field around the wires, self-inductance, etc.) is represented by a series inductor (henries per unit length).
- The capacitance C between the two conductors is represented by a shunt capacitor C (farads per unit length).
- The conductance G of the dielectric material separating the two conductors is represented by a shunt resistor between the signal wire and the return wire (siemens per unit length).

The model consists of an *infinite series* of the elements shown in the figure, and that the values of the components are specified *per unit length* so the picture of the component can be misleading. R, L, C, and G may also be functions of frequency. An alternative notation is to use R', L', C' and G' to emphasize that the values are derivatives with respect to length. These quantities can also be known as the primary line constants to distinguish from the secondary line constants derived from them, these being the propagation constant, attenuation constant and phase constant.

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Malcolm Davidson

http://www.ivorcatt.co.uk/2_2.htm

The L-C Model for the transmission line.

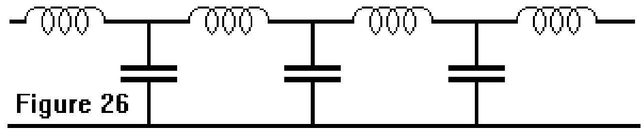

Figure 26

It is common for textbooks to represent a transmission line as shown in Figure 26. It is possible, on the basis of this model and making use of the Laplace transform to derive the equations of step propagation. However, this method has little to recommend it, especially since it appears to lead to a high frequency cutoff which is quite spurious. There is of course no high frequency cutoff inherent in any transmission line geometry. The only factor which can lead to high frequency cutoff is frequency-dependent behaviour in the dielectric. If the dielectric is a vacuum there is no high frequency cutoff.

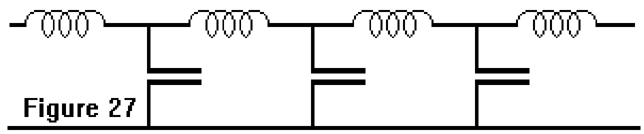

Figure 27

Malcolm Davidson has pointed out that since a capacitor is a transmission line (Ref.16), the model models a transmission line in terms of itself, which is absurd[3], see Figure 27.