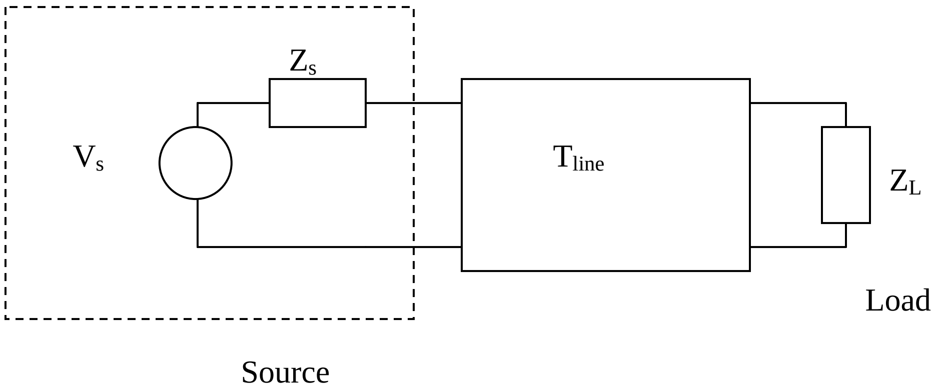
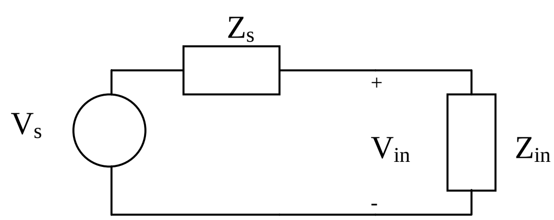
Some General Comments on Lossless Transmission Lines



For the transmission line, we need f, d, v, Z_o, β, ω, λ

For Steady-State Conditions (single frequency)

$$Z_{in} = Z_o \frac{Z_L + jZ_o \tan \beta d}{Z_o + jZ_L \tan \beta d}$$



Power in from the input voltage $V_{in} = V_s \frac{Z_{in}}{Z_s + Z_{in}}$

Power out equals power in for a lossless line

V_{out} can be found from the output power and the load impedance.

Special cases for loads include matched load, open circuit load, short circuit load.

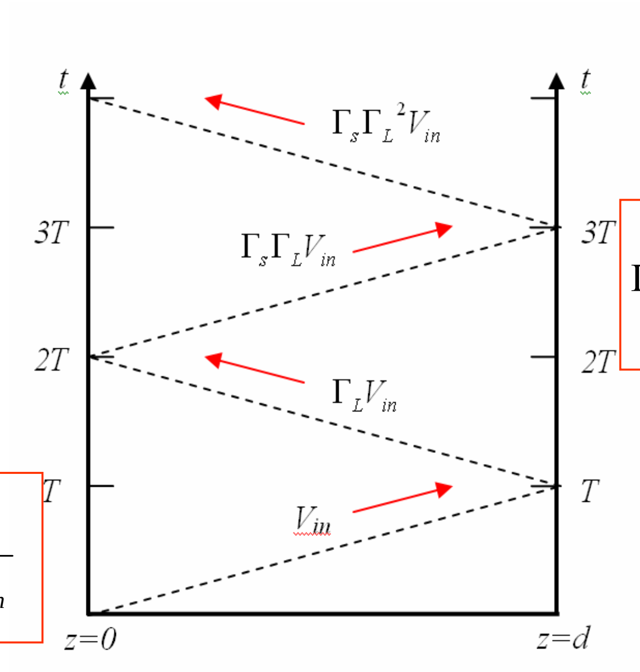
Special cases for line length include short line (much shorter than a wavelength), lengths that are odd multiples of a quarter wavelength, lengths that are multiples of a half wavelength.

The current for the positive traveling wave is found by dividing the voltage by Z_o. The current for the negative traveling wave is found by dividing the voltage by $-Z_o$.

The general forms of the voltage and current waves are:

$$v(z) = V^+ e^{-j\beta z} + \Gamma_L V^+ e^{+j\beta z} \qquad i(z) = \frac{V^+}{Z_o} e^{-j\beta z} - \frac{\Gamma_L V^+}{Z_o} e^{+j\beta z}$$

For pulses on lossless transmission lines, one uses the bounce or lattice diagram to fully characterize the response at either end or at some point in the middle of the line.



$$\Gamma_s = \frac{Z_s - Z_o}{Z_s + Z_o}$$

$$\Gamma_L = \frac{Z_L - Z_o}{Z_L + Z_o}$$

$$V_{in} = V_s \frac{Z_{in}}{Z_s + Z_{in}}$$

$$T = d/u$$

Special cases for loads again include matched, open circuit and short circuit. For this case, however, the same apply to the source end, since the source impedance is seen as a load for pulses going the negative z direction.

For line lengths, one can have a very short line (the output and input appear simultaneously), lines that have delay times much larger than the pulse length and lines that have delay times that are much less than the pulse length.

For positive traveling pulses, the current pulse is found by dividing by Z_o. For negative traveling pulses, the current is fund by dividing by -Z_o.

The power in a pulse is found from the product of the voltage times the current.

The general forms of the voltage and current pulses are:

$$V(z,t) = V^+\left(t - \frac{z}{u}\right) + V^-\left(t + \frac{z}{u}\right) \qquad I(z,t) = \frac{V^+}{Z_o}\left(t - \frac{z}{u}\right) - \frac{V^-}{Z_o}\left(t + \frac{z}{u}\right)$$