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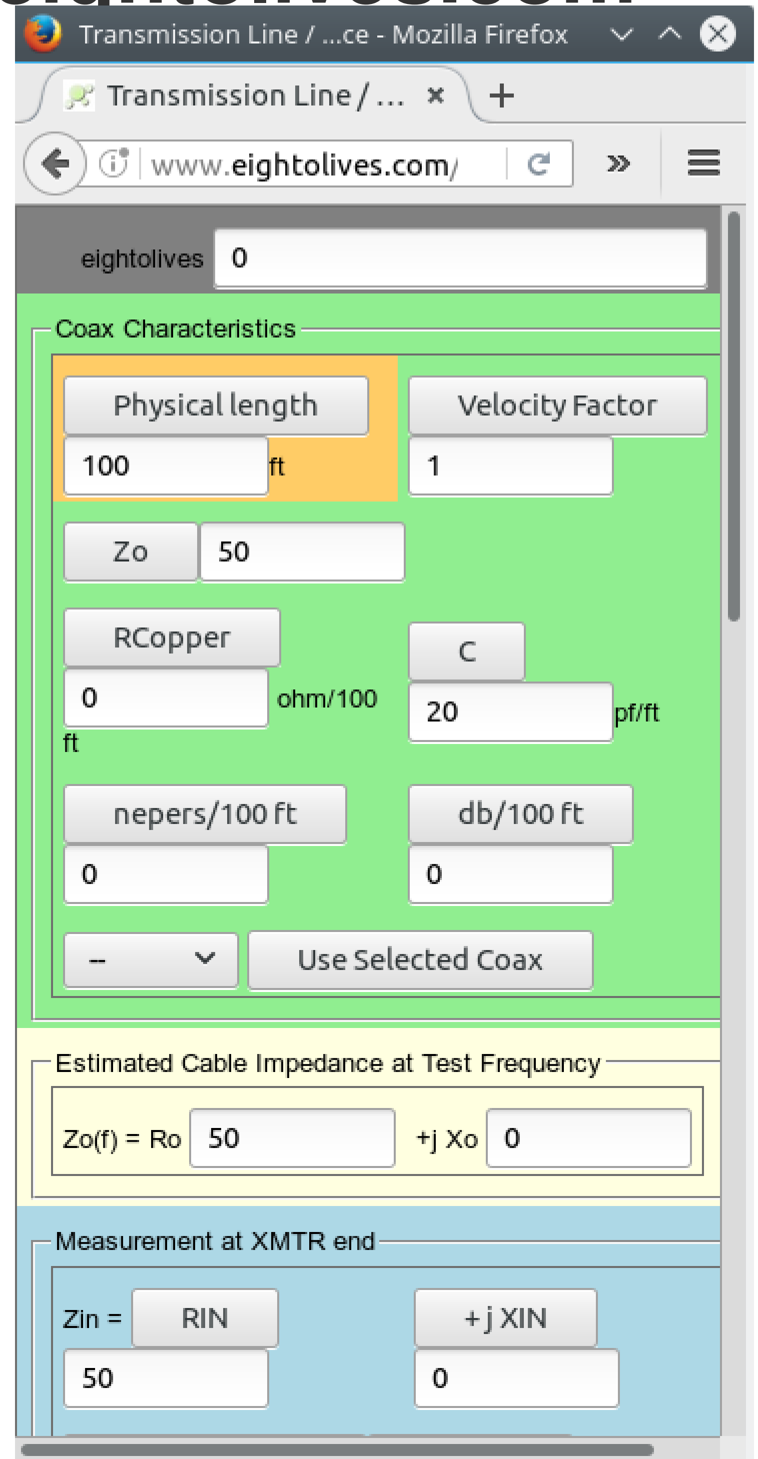


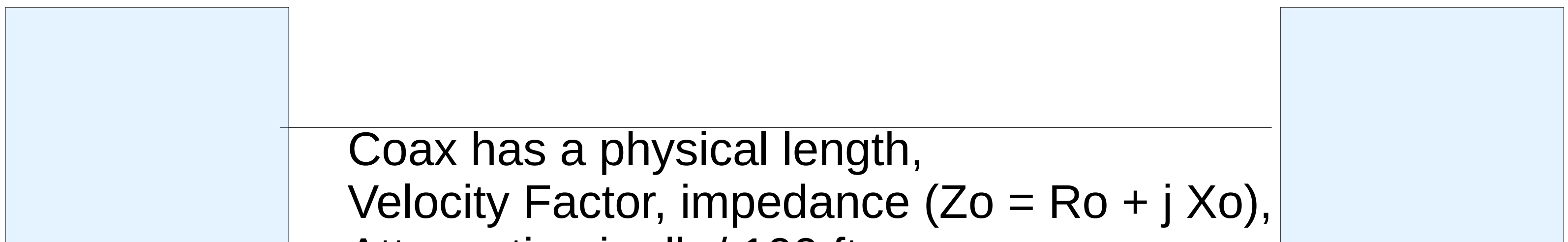
Transmission Line Equation and Antenna Impedance Quick App Tool

William_Kaupinis@eightolives.com
Jan 18, 2017

What is it?

- The eightolives Transmission Line / Antenna Impedance QuickApp is a web-based calculator tool.
- The tool implements the Transmission Line equation used to relate the impedance at the source end (transmitter) of a (coax) transmission line to the impedance at the load (antenna)

http://www.eightolives.com/docs/Mobile/js_tools/antimp.htm



Coax has a physical length,
Velocity Factor, impedance (Zo = Ro + j Xo),
Attenuation in db / 100 ft

Source end,
Transmitter or
Measuring device

Test Frequency

Impedance Zin = Rin + j Xin

Load end,
Antenna

Impedance ZL = RL + j XL

Typical use is to compute Load Impedance after measuring Zin.

Alternatively, for a known load, estimate the impedance at the source.

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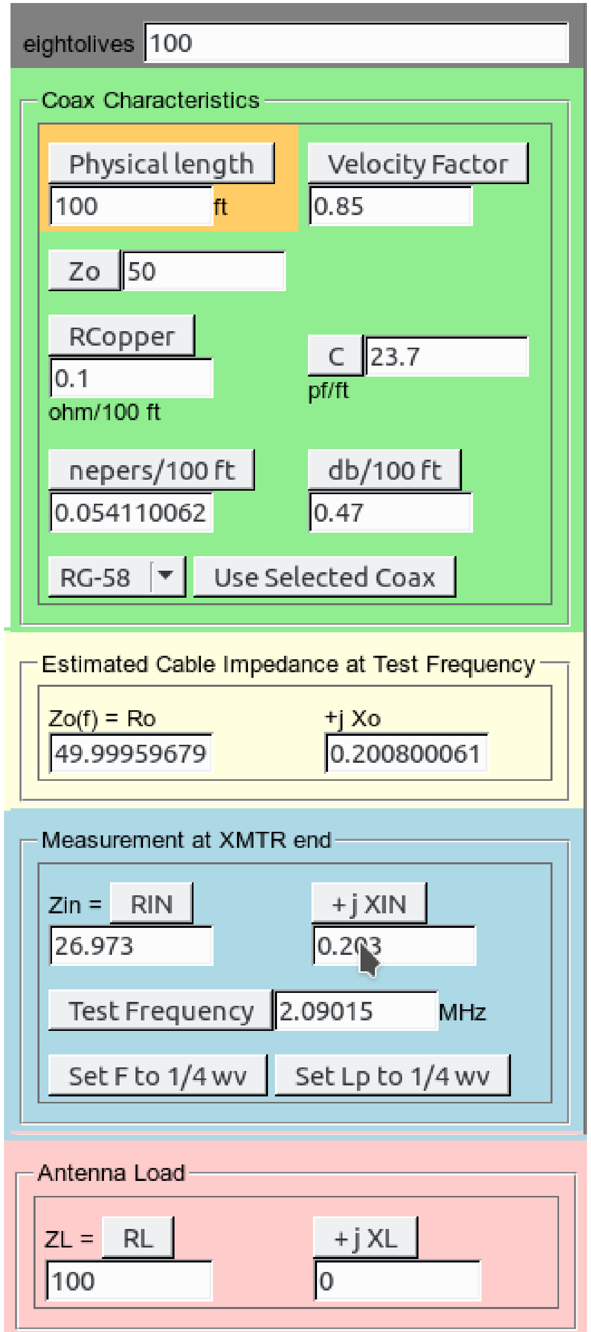

The tool has four interactive sections:

The Coax Characteristics include physical length, velocity factor, impedance, copper resistance, capacitance and attenuation expressed as db/100 feet or in nepers / 100 feet. When coax "--" is selected, you can manually enter these parameters. You can also select a common coax type for typical values for that type.

An estimate of the cable impedance at the specified Test Frequency is calculated.

At the source or measurement end you can specify Test Frequency and complex impedance. Special buttons are provided to either set the Test Frequency to be ¼ wavelength for the given physical length or set the physical length to be ¼ wavelength for the given frequency.

The Antenna Load impedance is displayed. If you set the impedance values, then source impedance Zin is updated.

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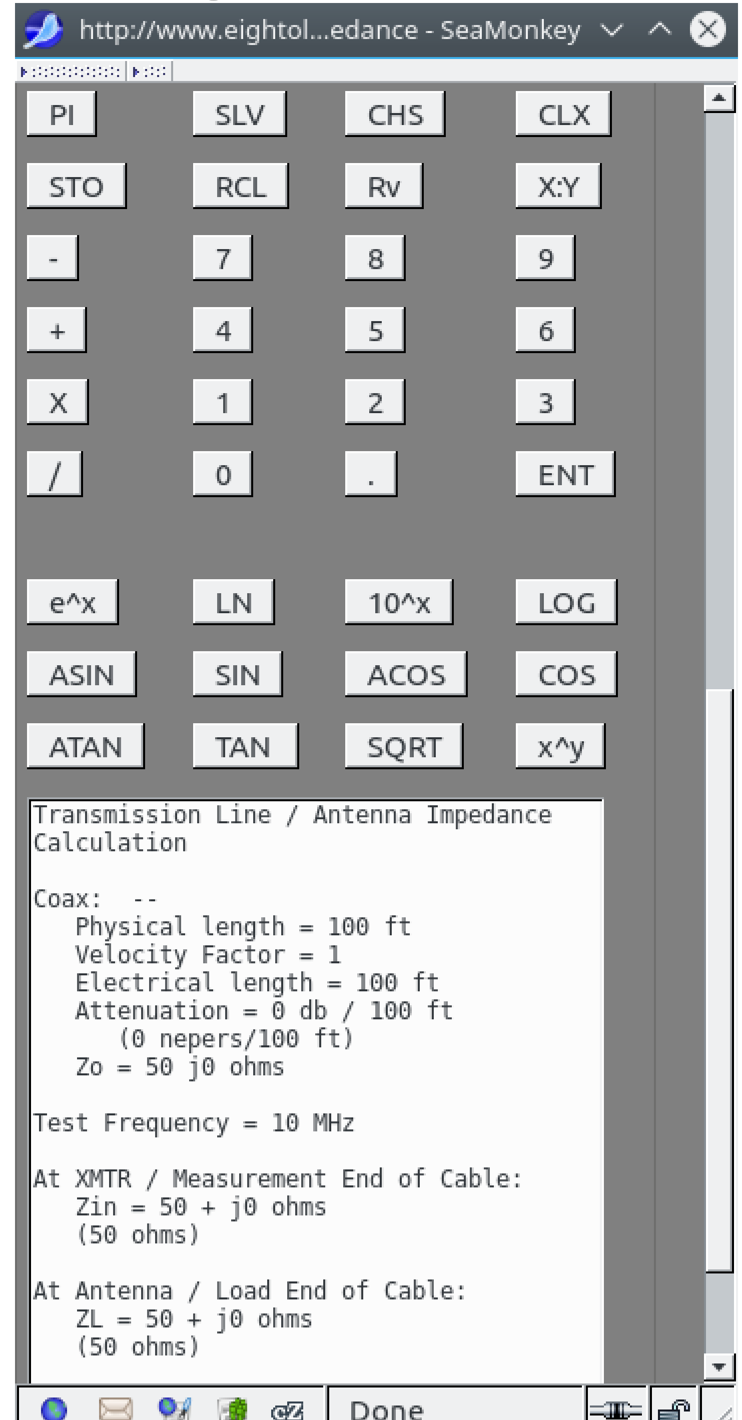
Scrolling down from the entry areas, you find the calculator keys and a Report area which summarizes the last computation.

Like other QuickApp tools, the calculator uses Reverse Polish Notation.

Data in the entry text boxes can be entered by either selecting the text box and editing he value or by entering the value from the calculator keys and clicking the button associated with the text box.



Transmission Line Equation

$$Zin / Zo = \frac{(ZL \cosh(G) + Zo \sinh(G))}{(ZL \sinh(G) + Zo \cosh(G))}$$

where

- G = L (a + j b)
- L = physical length in feet
- a = matched loss attenuation in nepers / unit length

  1 neper = 8.686 db
- b = phase constant = 2 π / (VF * 983.6 / F)
- VF = velocity factor
- F = Test frequency in MHz

Source: ARRL Antenna Book (22nd edition)

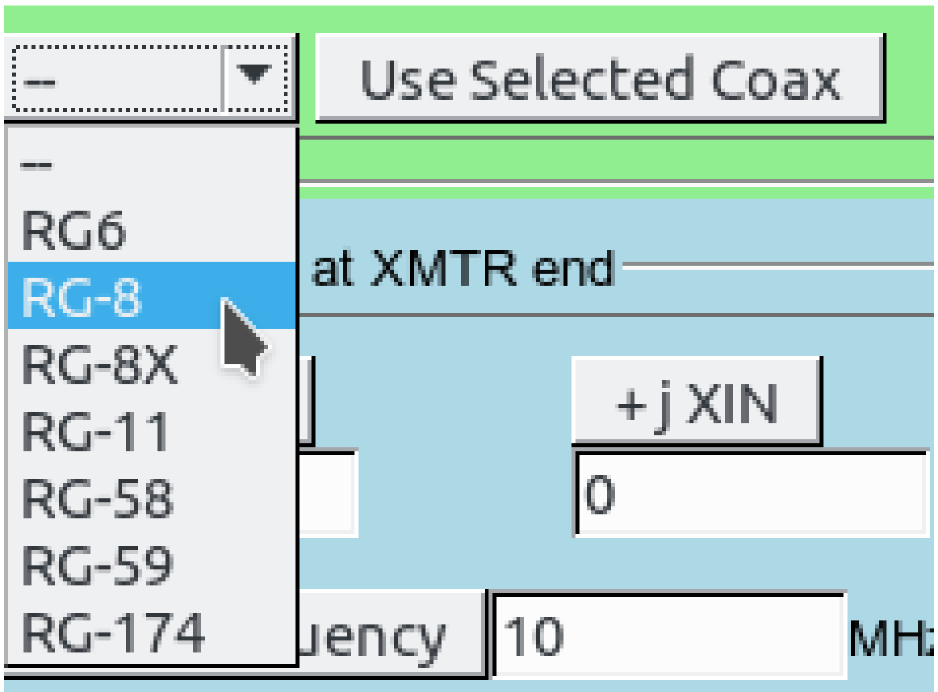
Coax Characteristics

- Coax data sheets normally specify
  - Characteristic impedance Zo at high frequency
  - Attenuation in db/100 ft at specified frequencies
  - Velocity Factor VF
  - Wire resistance ohms / 100 ft
  - Capacitance pf / ft
- Values can vary between manufacturers and between manufacturing lots.

Estimating Coax Impedance At Frequency

- Z(f) = Math.sqrt(Zo^2 -j (Rdc / 2 π f C))
  - At high frequencies, Z(f) = Zo
  - At low frequencies, Z(f) = Math.sqrt(-j Rdc / 2 π f C)
- The general equation is:
  - Z(f) = Math.sqrt((R + j 2 π f L) / (G + j 2 π f C))
  - The shunt conductance, G, is assumed to be 0
- Skin effects in the 10 – 100 kHz range are not considered in this estimate

Notes



- If you select a coax type, the values set are "typical". Check the manufacturers data sheet for your particular cable.
- Attenuation values for a selected "typical" coax are interpolated for the test frequency used.
- To specify all values, select the default "--" coax.

Example 1 – ¼ wave Line

- The ¼ Wavelength Line has special impedance transform property such that

  Zin = Zo **2 / ZL

- An open circuit at the load appears as a short at the input
  - You can set RL to 1000000 ohms to represent “open”
- A short at the load appears as an open circuit at the input

Example 2

- A 50 foot coax with velocity factor of .66 has an impedance of 50 -j 0.45 at 7.15 MHz and a matched line loss of 0.54 db / 100 ft at that frequency.
- If an attached dipole antenna is assumed to have an impedance of 43 +j 30 ohms, the input impedance will be 65.8 +j 32 ohms

Source: ARRL Antenna Book 22nd Edition

Ways to measure cable length

- Use a tape measure to measure physical length.
- If you can’t do that, leave the load end open and determine the lowest frequency where the impedance at the source (Zin) appears to be 0.
  - This would be ¼ wavelength (electrical length)
  - Physical length = Electrical length * VF
- Alternatively, short the load end and parallel a 50 ohm resistor at the source. Then determine the lowest frequency where the impedance Zin = 50 ohms
  - This would be ¼ wavelength (electrical length)

For more information

- Visit http://www.eightolives.com