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The new Transmission Line Calculator TLC 2.4

This tool you can not only use as an "all-purpose weapon" when it comes to input and output impedance of a lossy transmission line (TL), but it also makes it easier to decide in advance whether a certain antenna can be operated meaningfully despite an ideal transmitter-side SWR=1.0.

In the new version 2.4 the input of the TL attenuation has been simplified and the loss analysis has been extended so that two extreme cases can now be analyzed, between which one moves in practice:

- Ideal adaptation PA to TL (lossless tuner)
- PA is directly connected to TL (no tuner)

Another small addition is that below the input and output impedances of the transmission line, the values of the equivalent parallel circuits are also displayed (not editable). This sometimes may facilitates the calculation of fitting circuits.

However, it is important to note that the values of the equivalent parallel connection (Rp, Lp or Cp) only applies to the current frequency!

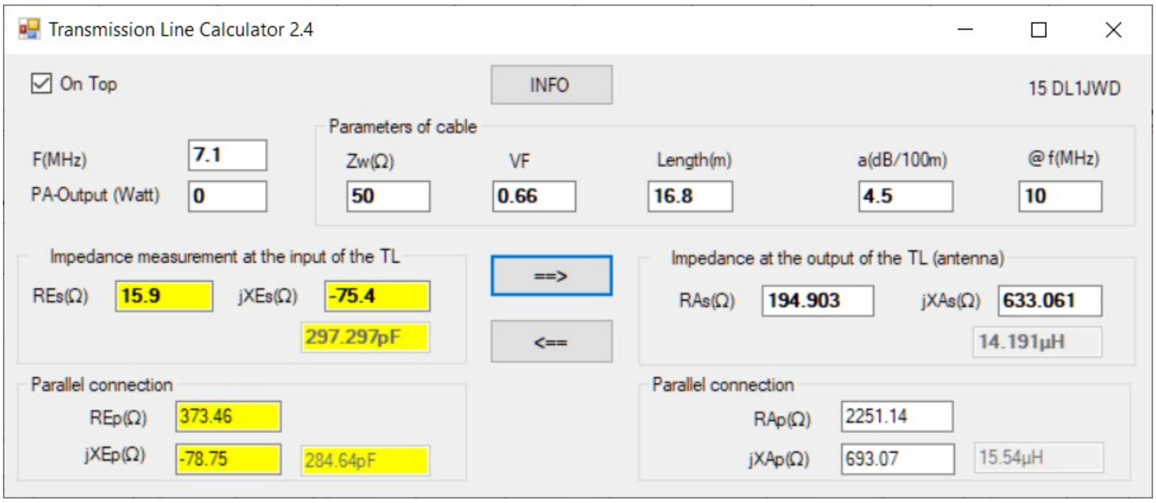
Example 1: Determination of antenna impedance

With your NanoVNA you measure an impedance of 15.9 - j75.4Ohm at the input of a 16.8m long RG 58 supply cable at 7.1 MHz.

What is the input impedance of the dipole?

First, enter the frequency and cable data. Since the attenuation at 7.1MHz is not known, you take the attenuation for the nearest frequency from the catalog (here 10MHz), the program then interpolates the desired value according to the known dependence from the root of the frequency ratio.

On the left, in the two upper yellow fields, enter the measured values of your NanoVNA and click the button "=>".
On the right you can now see the input impedance of the dipole ZA(Ohm) = 194.9 + j633.

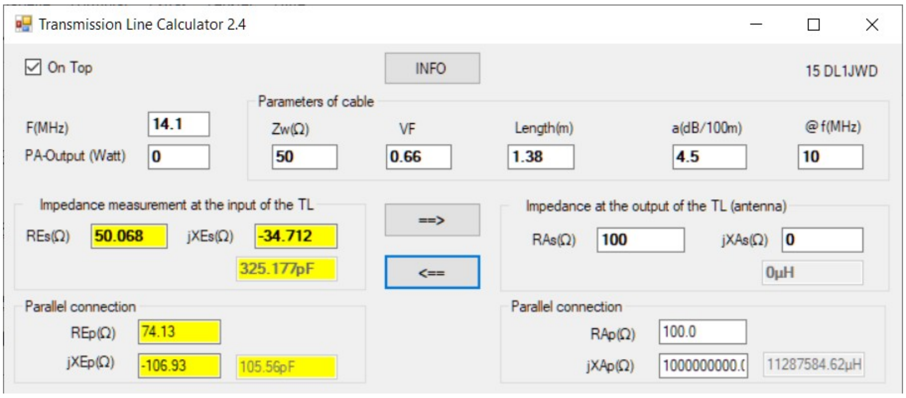


Example 2: Iterative calculation of an antenna adjustment
with transformation- and compensation line

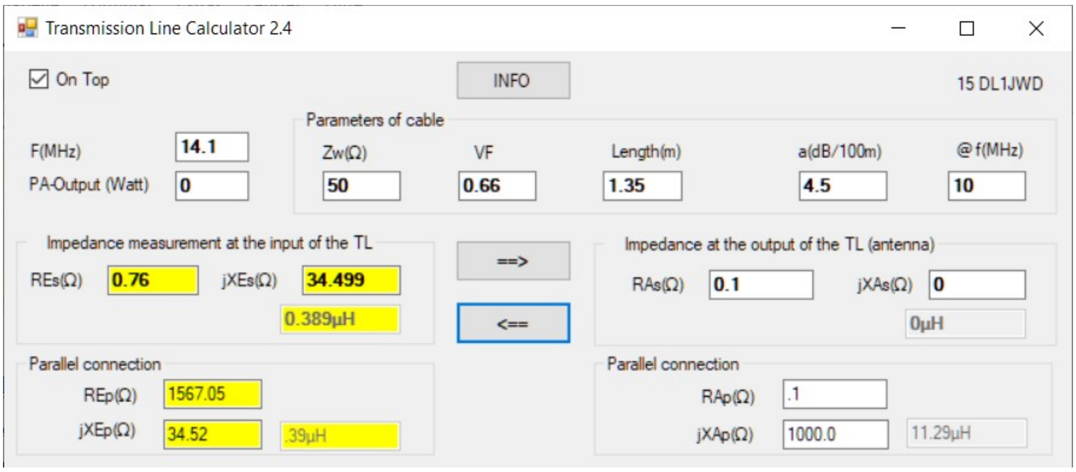
The input impedance of a resonant Lambda/2 vertical radiator is about 100Ohm near the ground.

How do I calculate the adjustment with transformation line and stub at 14MHz using RG 58 cable?

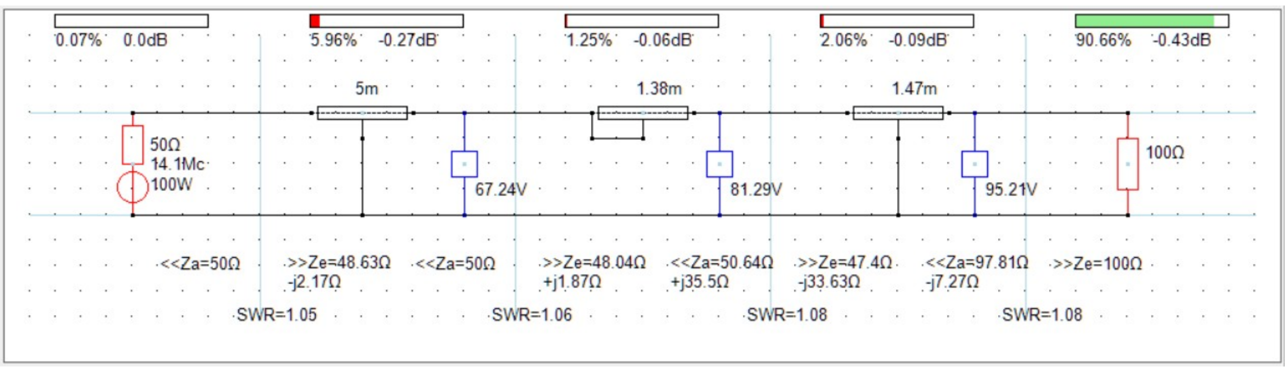
After entering the data, I change the length in small steps until the real part RE of the input impedance is about 50 ohms. This is approximately the case with a cable length of 1.38m:



I compensate for the remaining reactive component XE = -34.7 Ohm with a cable piece shorted at the output (RA must be very small).
To do this, I gradually change the length until the input impedance corresponds approximately to the value XE = +34.7 Ohm (1.35m):



The series connection of both cable pieces leads to perfect success, as the simulation with the *Special NetworkAnalyser* proves:



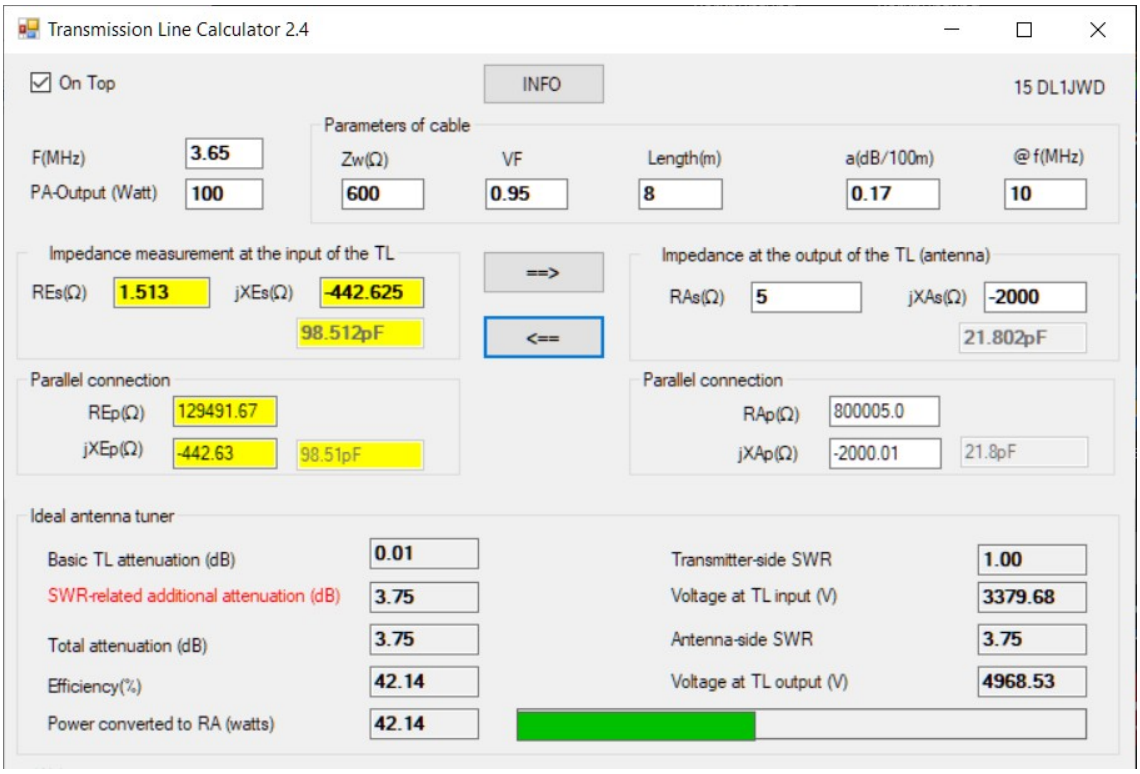
Example 3: Maximum possible efficiency of a double zepp

A sufficiently well-known from the relevant literature 2x6.5m double zepp is feeded over a 8m long ladder line (Zw=600Ω; VF=0.95) adapted to the unbalanced 50Ω output of the PA by means of a very low-loss balanced tuner.
The basic attenuation of the good ladder line is about 0.17dB/100m based on 10MHz.
As can be determined according to example 1 (or with the DZR or also with EZNEC), the input impedance of the dipole at 3.65MHz is about ZA(Ohm) 5 - j2000.

What efficiency can I achieve with this antenna system at 3.65MHz?

After entering all data, transform the output impedance back to the input impedance of the transmission line by clicking on the "<=" button.
Now also enter a value for the PA power (100W), as voltages are also calculated.

The results of the loss analysis become visible when you touch and drag the window with the mouse at the bottom.



The deflection of the green bar at only about 42% gives no cause for euphoria and means that at best only about 42% of the maximum available PA power can be converted into the radiation resistance of the antenna (RA).

Note that this efficiency requires an absolutely lossless antenna tuner, so it is only theoretical.
In reality, despite its perfect transmitter-side SWR = 1.0, this antenna system will only achieve an efficiency below 20%!

The paradox is that the majority of the transmission power gets stuck in the high-quality and relatively short ladder line, although according to the data sheet it has a practically negligible attenuation of only 0.01dB!

Unfortunately, these 0.01dB only refer to the basic attenuation of a standing wave-free ladder line with 600 ohms on both sides!

The actual cause of the high losses is the extreme SWR-related additional attenuation of 3.75dB.
A bitter realization for all SWR believers, who have always been convinced to work with a great antenna and have been confirmed in this view by alleged super reports.

To a certain extent as an "addition", the TLC also determines the antenna-side SWR as well as the voltages at the input and output of the feeder, of course the PA power (top left) must be entered beforehand.
At 100W input there are almost 5kV at the base of the dipole - that's quite a lot!

Result:
This antenna is for the 80m band completly unsuitable, even if it has been adapted to the transmission output with SWR=1.0!

Nevertheless, the myth of the "King SWR" still persists in amateur radio circles.
Nowhere else in amateur radio literature are so many fanciful untruths to be found as on this topic!

In the previous examples we have learned that even with an ideal transmitter-side SWR = 1.0 and with a high quality ladder line considerable additional losses can occur in the cable, which are caused by heat and dielectric losses due to higher currents and voltages.

If you think you can significantly improve your antenna with a much less lossy feed cable, you can be wrong in many cases.

Example 4: **Exploring the ZS6BKW**

In contrast to the previous examples the ZS6BKW double zepp actually deserves the title "miracle antenna", this can easily be proven with the *MultiResonanceFinder* (MRF).

With a radiator length of 27.8m and a feeder length of 12.5m with semi-open wireman band line, this antenna comes with resonances on 5 bands (40m, 20m, 12m, 10m, 6m) on a transmitter-side SWR of less than 2.0, and that without using an antenna tuner!

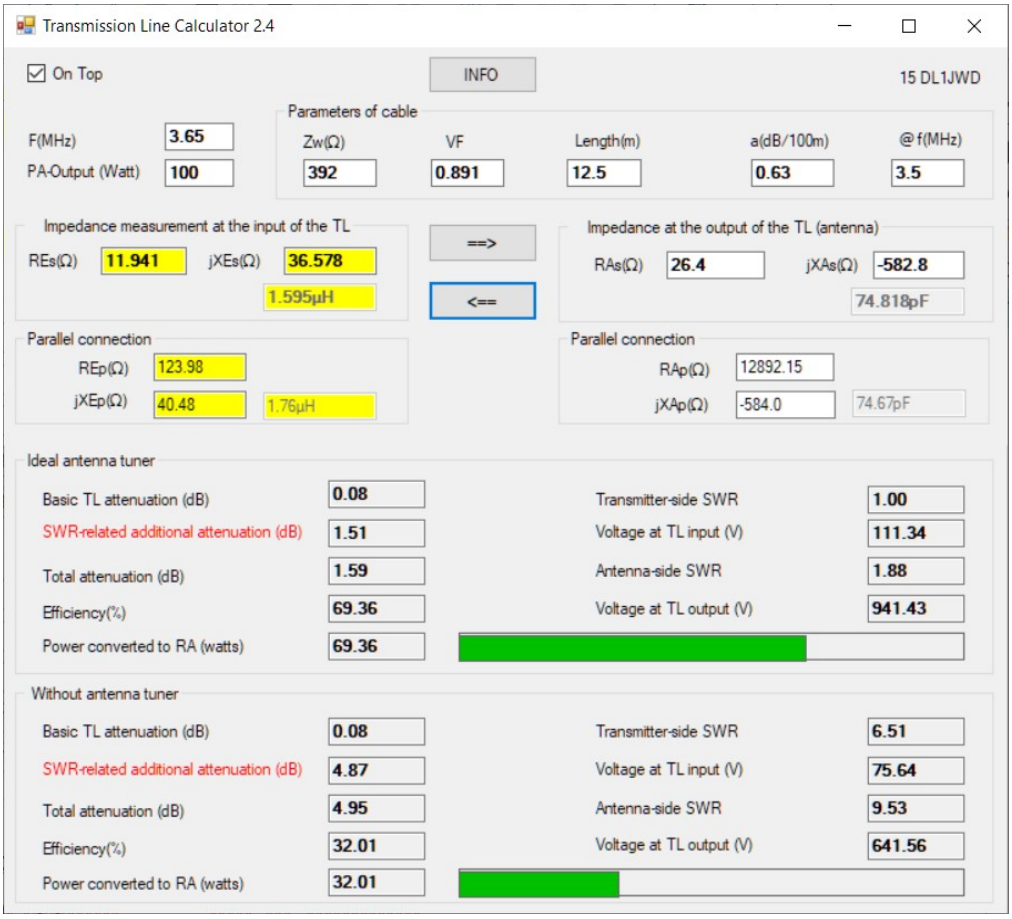
The 80m band can only be used with a good antenna tuner, but the 15m and 30m bands do not work at all.

What is the maximum efficiency that can be achieved with the ZS6BKW on the 80m band?

To answer this question first we have to know the base impedance of the dipole at 3.65MHz.
Let's say we measured **ZA (ohms) = 26.4 – j582.8** (see Example 1).
You can do it also with the *OCF dipole calculator*, with *EZNEC* and so on.

After clicking "<=" the TLC now shows an efficiency of approx. 70%, but that is with an absolutely loss-free antenna coupler.

Without an ATU this antenna doesn't work at all (see lower part).



The simulation with the *Double zepp calculator* shows that in practice with the ATU MFJ-993 an efficiency of only approx. 66% can be achieved: