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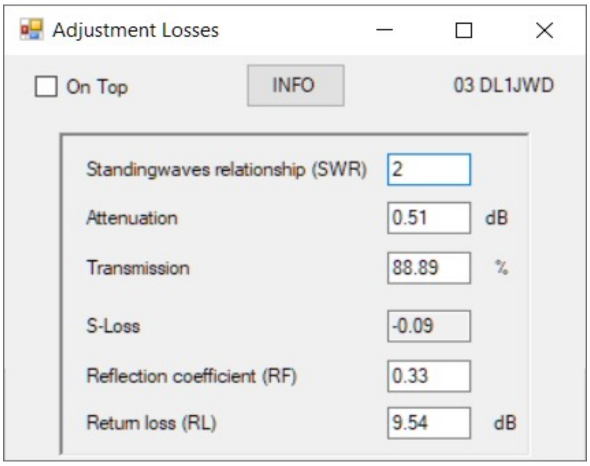
Adjustment losses

Standing wave ratio (SWR), **Reflection factor** (RF) and **Return loss** (RL) describe three variants to quantify the reflection at an impedance jump, for example when a load impedance mismatches a generator.

Example 1:
Common automatic antenna tuners do not end their tuning process at a SWR close to 1, but much earlier.
What adjustment losses occur with a 100W PA with a SWR = 2.0 ?

The transmission loss is approx. 0.5dB, i.e. 88.9% of the maximum available PA power is delivered (approx. 90 watts). This means a loss of only about 0.1 S-steps, which is hardly detectable in practice.

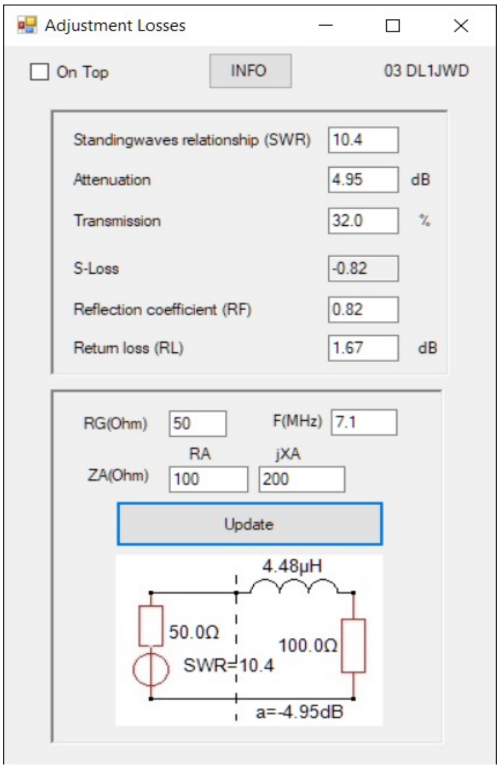


It does not matter in which of the five input fields you enter something, the remaining fields are automatically updated immediately.

Example 2:
With an antenna analyzer you measured an impedance ZA(Ω) = 100 + j200 at 7.1MHz at the input of the supply cable. What adjustment losses occur?

Enlarge the window by dragging the mouse at the bottom of the window.
Enter the values for **System Impedance** RG (typically 50 Ω), **Frequency** F, and **Load Impedance** ZA.

After you have clicked on "Adjustment losses", you can read the quantities you are looking for directly at the bottom of the replacement circuit diagram or in the upper half of the window.



Theory

The **Complex Reflection factor** $\boldsymbol{\Gamma}$ is calculated from the real internal resistance of the generator R_G and the complex load impedance Z_A to:

$$\boldsymbol{\Gamma}=\frac{R_G-\boldsymbol{Z}_A}{R_G+\boldsymbol{Z}_A} \quad \text{with} \quad \boldsymbol{Z}_A=R_A+jX_A$$

We simplify $R_1=R_G-R_A$ and $R_2=R_G+R_A$ and obtain:

$$\boldsymbol{\Gamma}=\frac{R_1 R_2-X_A^2}{R_2^2+X_A^2}-j\frac{X_A(R_1+R_2)}{R_2^2+X_A^2}$$

The **Standing wave ratio** SWR results from the amount of the reflection factor to:

$$SWR=\frac{1+|\Gamma|}{1-|\Gamma|}$$

The **Return loss** RL is directly related to the standing wave ratio:

$$RL(dB)=-20\log\left(\frac{SWR-1}{SWR+1}\right)$$

The **Transmission attenuation** (the adjustment losses) is determined by the ratio of the power converted at the load resistor RA to the maximum available generator power and can be determined directly from the standing wave ratio:

$$a(dB)= -10\log\left[1-\left(\frac{SWR-1}{SWR+1}\right)^2\right]$$