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Adjusting complex loads

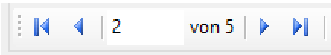
This tool, presented in detail in /1/ as "Ham-Tuning-Stick", calculates important fitting circuits for antennas or other complex load resistors:

- Optimal settings for hand-tuned MFJ antenna tuners
- L/C-Elements of a Collins filter
- Elements of simple L/C adjustments
- Adjustment by means of transformation and stub line, taking into account cable losses

Input values are, for example, the impedances measured with an antenna analyzer (e.g. AA-54 or miniVNA).

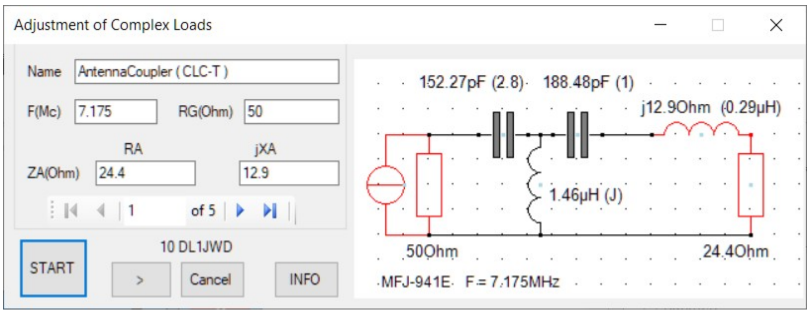
Note: Your antenna analyzer should not only be able to measure the SWR,
but also the **real and sign correct** imaginary part of the input impedance!

With the small blue arrow keys of the **navigator** you scroll between five different pages:



MFJ Antenna Coupler

On **page 1**, a CLC-T element is used for tuning (MFJ-941E):



On the left you enter frequency, RG (output resistance of the PA), and real part RA and imaginary part XA of the impedance measured at the input of the antenna cable.

The basic units of measurement used in the program are MHz, Ohm, µH and pF!

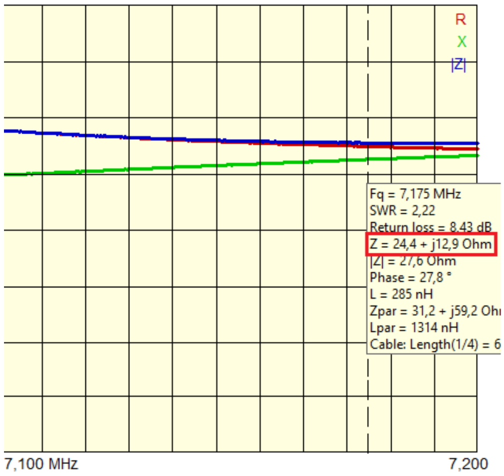
Click "START" and the first of several possible settings of the antenna coupler will be displayed.
The values in brackets refer to the positions of the knobs (0...10) of the two capacitances or to the position of the inductance rotary switch (A... L).

After clicking ">" on more possible combinations appear, but the adjustment then becomes narrower (operating quality QB and losses increase).
Depending on whether XA is positive or negative, an inductance or capacitance is automatically drawn in the red equivalent circuit diagram of the load.

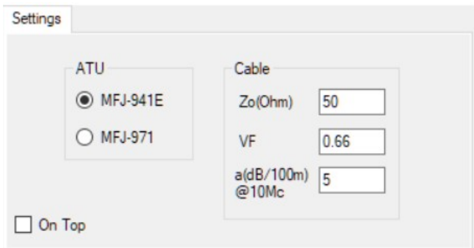
For our example (see figure above), the SWR is brought to a value close to 1 with the following settings of the MFJ-941:

TRANSMITTER-Drehko: approx. 2.8 scale parts (152pF)
INDUCTOR switch: position J (1.46µH)
ANTENNA-Drehko: approx. 1 scale part (188pF)

The input values Za = 24.4 + j12.9Ohm in the figure above are in our example the result of a measurement with the antenna analyzer AA-54 at 7.175MHz (displayed with the software AntScope):



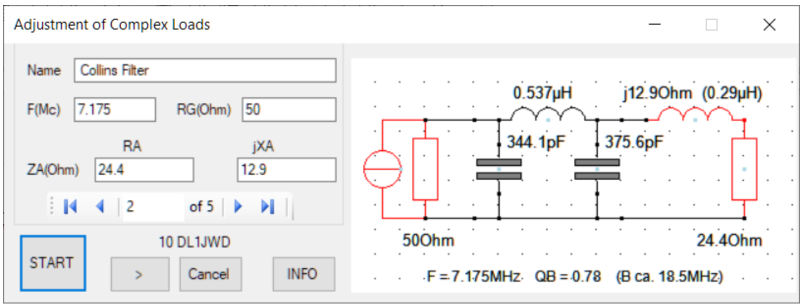
You can choose another antenna coupler by scrolling to page 5 with the navigator and clicking on the **Settings** tab (currently only two types are available):

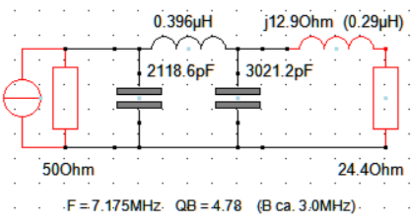


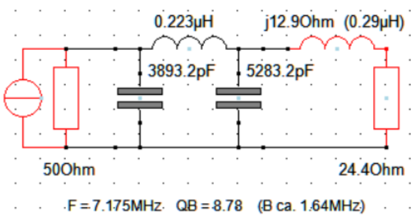
Here you also enter the parameters for coax or symmetric cables, as they are the starting point for the calculation of transformation and stub lines.

CLC low-pass (Collins filter)

If you scroll to **page 2**, you will receive several dimensioning suggestions for Collins filters (sorted by ascending operating quality). Again, click "START" , then click ">" to get other variants with ever higher operating quality QB and ever lower bandwidth B.





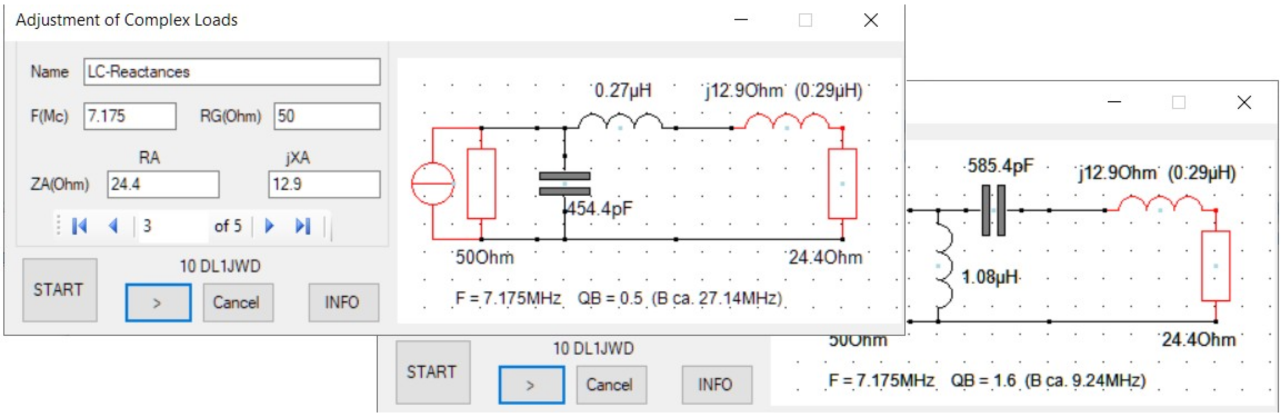


Here, too, the lower the operating quality QB, the more broadband and low-loss the adjustment.

However, the fact that harmonic suppression is also worse is unlikely to be seen as a disadvantage today, since modern power amplifiers are inherently equipped with high-quality low-pass systems.

Adjustment with two reactant resistors

Page 3 offers a maximum of four options for adaptors with two reactant resistors.
Again, click on "START" , then on " >" for further variants.



Note:

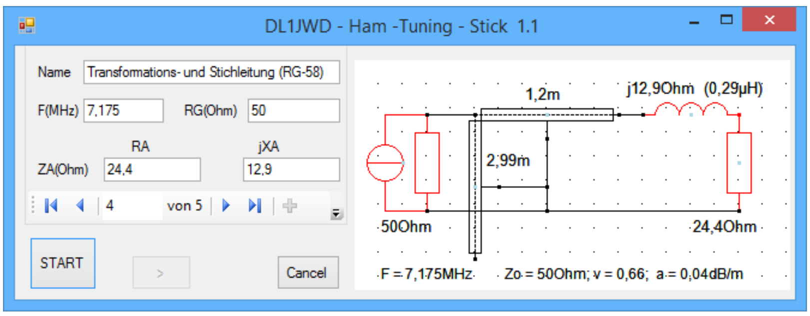
- Due to its lower operating quality QB, which is synonymous with the lowest losses and flat resonance curve, you should use the first circuit in this example if possible!
- If a circuit diagram cannot be realized, the values of the capacitances or inductors are marked with "NaNpF" or "NaNµH".

Adjustment with transformation and stub line

On **page 4**, the adjustment is calculated by means of lossy transformation and stub lines based on the cable parameters specified on the Settings tab (see above).

The program specifies the required lengths and automatically draws the required shorted or open stub.

The parameters in the example refer to RG-58 coax line (according to catalog 5dB/100m at 10MHz).
According to the display, the cable has a basic attenuation of 0.04dB/m on 7.175MHz.



Attention:
Depending on the fitting situation, more or less large SWV-related additional losses can occur, so that the total attenuation of the fitting circuit can exceed the basic attenuation of the cable several times over.

Remarks

- If you do not have a suitable measuring device for determining RA+jXA (e.g. NanoVNA), you can also obtain these values at least approximately via an antenna simulation program such as EZNEC or MMANA-GAL or also by means of the *Dipole GP-*, or the *Double-zepp* calculator (JWD-Tools).
- To convert a Collins filter into a T-member (and vice versa), the Pi- vs T-Coupler tool can be used.
- The data obtained for operating quality QB and 3 dB bandwidth B are only rough approximations, since the load impedance ZA applies only to the operating frequency F.
- For the detailed analysis of antenna adjustments (practically usable bandwidth, SWR, losses...) the *SpecialNetworkAnalyser* SNWA is recommended, as it can also calculate the frequency-dependent input impedance of a dipole or groundplane instead of a constant ZA.

Reference

/1/ Doberenz,W., DL1JWD: Schaltungen zur Antennenanpassung rechnergestützt entwerfen (1).
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