

# **Program for working with vector analyzers**

## **VNA Mouse and NanoVNA V2**

User manual

version 2.0

UR5FFR, Odessa 2019-2021

## Getting started

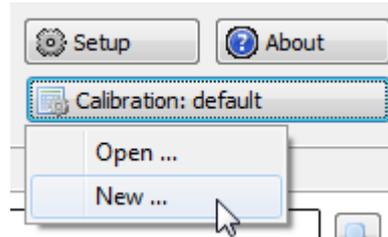
### Instrument connection and calibration

Run vna.exe. Connect the vector analyzer to your computer and select a COM port from the drop-down list. Click the "Open" button.

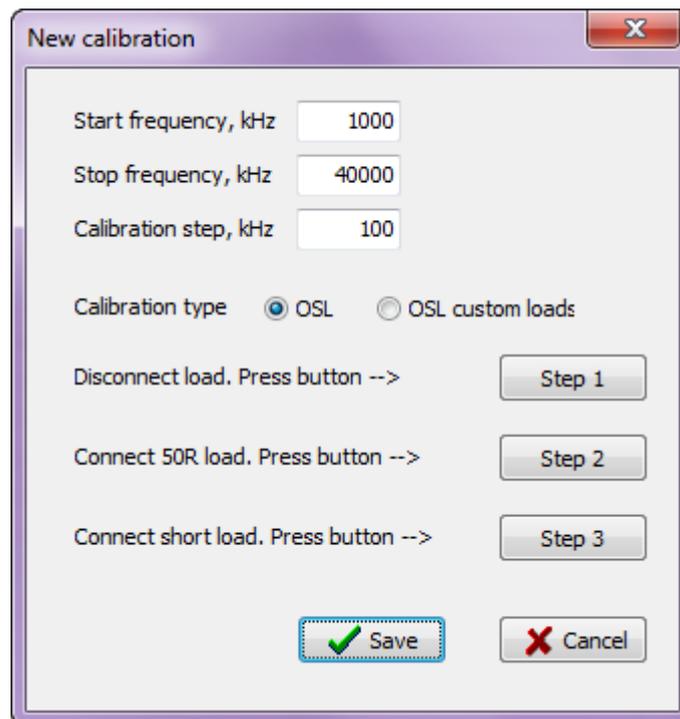


If communication with the device is established, then its version and name will be displayed in the window title.

Before starting measurements, it is necessary to calibrate the device. Calibration allows measurements to be made through a cable with arbitrary parameters. The program saves the calibration to a file on the computer and allows you to quickly switch between different calibrations. To create a new calibration, press the "Calibration" button and select "New"



The calibration window will open.



Each calibration is created for a certain frequency range in which, subsequently, measurements can be made with this calibration. In addition, the calibration is set on the frequency grid with a given step. The default is 100kHz steps. For accurate narrowband measurements, the step value can be reduced down to 1kHz.

For calibration, we need a set of reference loads. In the simplest case, calibration is carried out at 50 ohm load, short-circuit load and no load.

Select the required set of "Calibration type" loads. In the case of "OSL custom loads", you can specify the exact resistances of the loads:

New calibration

Start frequency, kHz

Stop frequency, kHz

Calibration step, kHz

Calibration type  OSL  OSL custom loads

Connect load  R. Press button -->

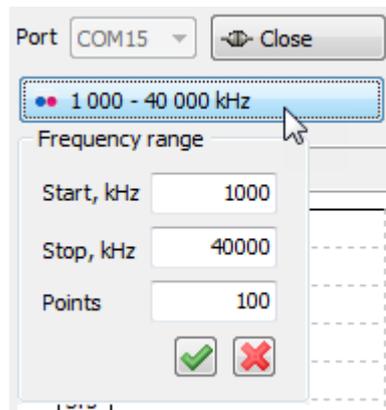
Connect load  R. Press button -->

Connect load  R. Press button -->

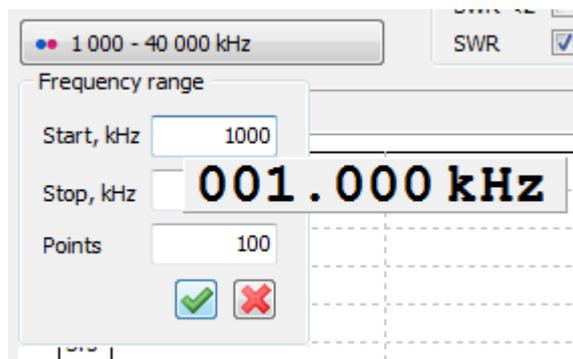
When sequentially connecting the loads, press the corresponding buttons. At the end of each calibration step, a green mark will appear on the corresponding load button. After calibrating on all three loads, click the «Save» button and specify a file name to save the calibration.

## Selection of the measuring range

Press the button for selecting the measurement range. A window opens



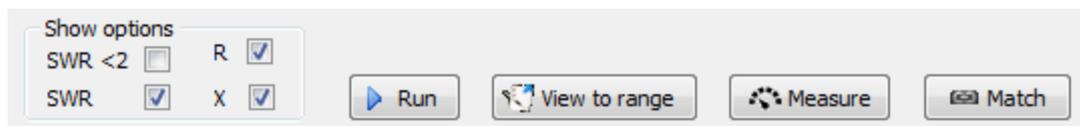
Enter into Start freq filed



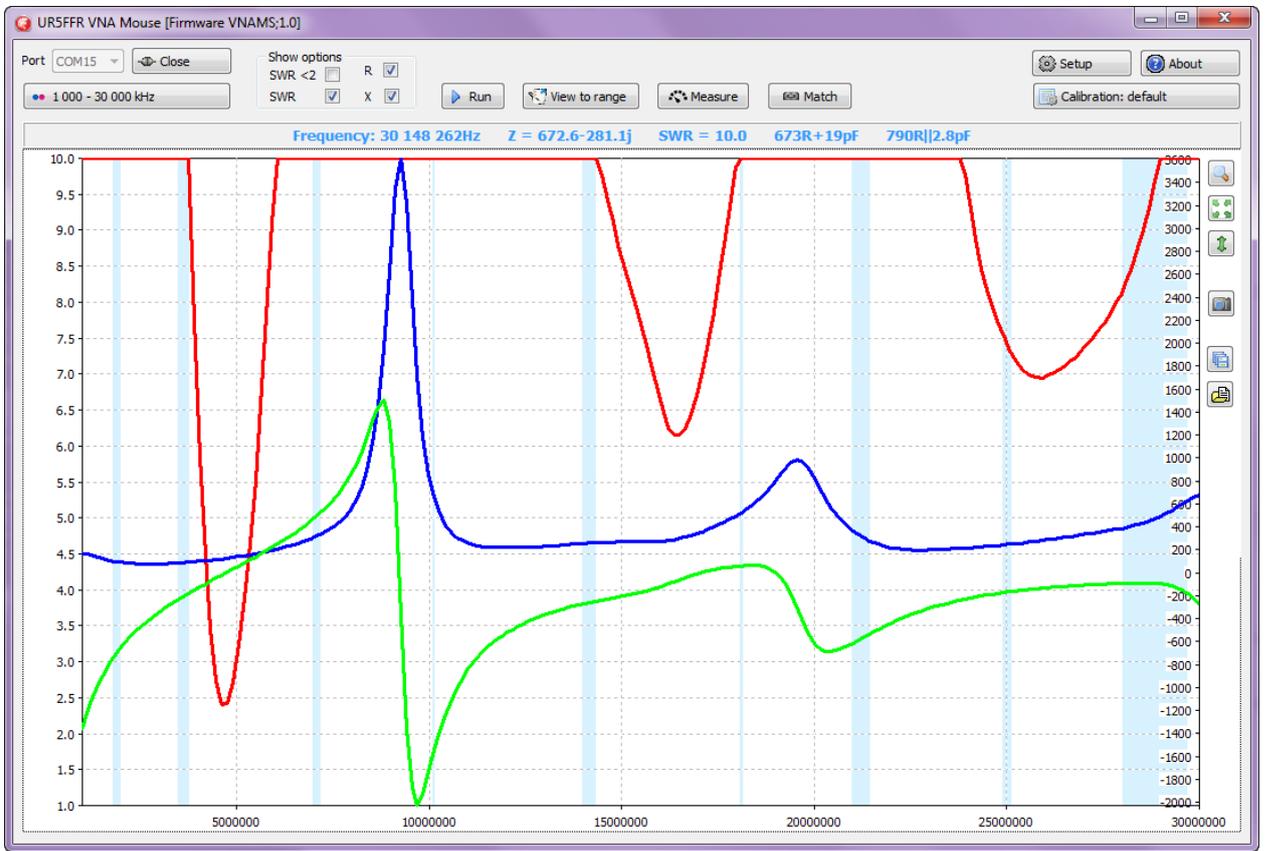
The frequency can be entered directly into the field using the keyboard or using the mouse scroll wheel on the large frequency digits. Double-clicking on a digit will clear the digits on the right.

The **Points** field defines the number of points at which the measurement will be carried out. Increase this parameter for smoother graphs.

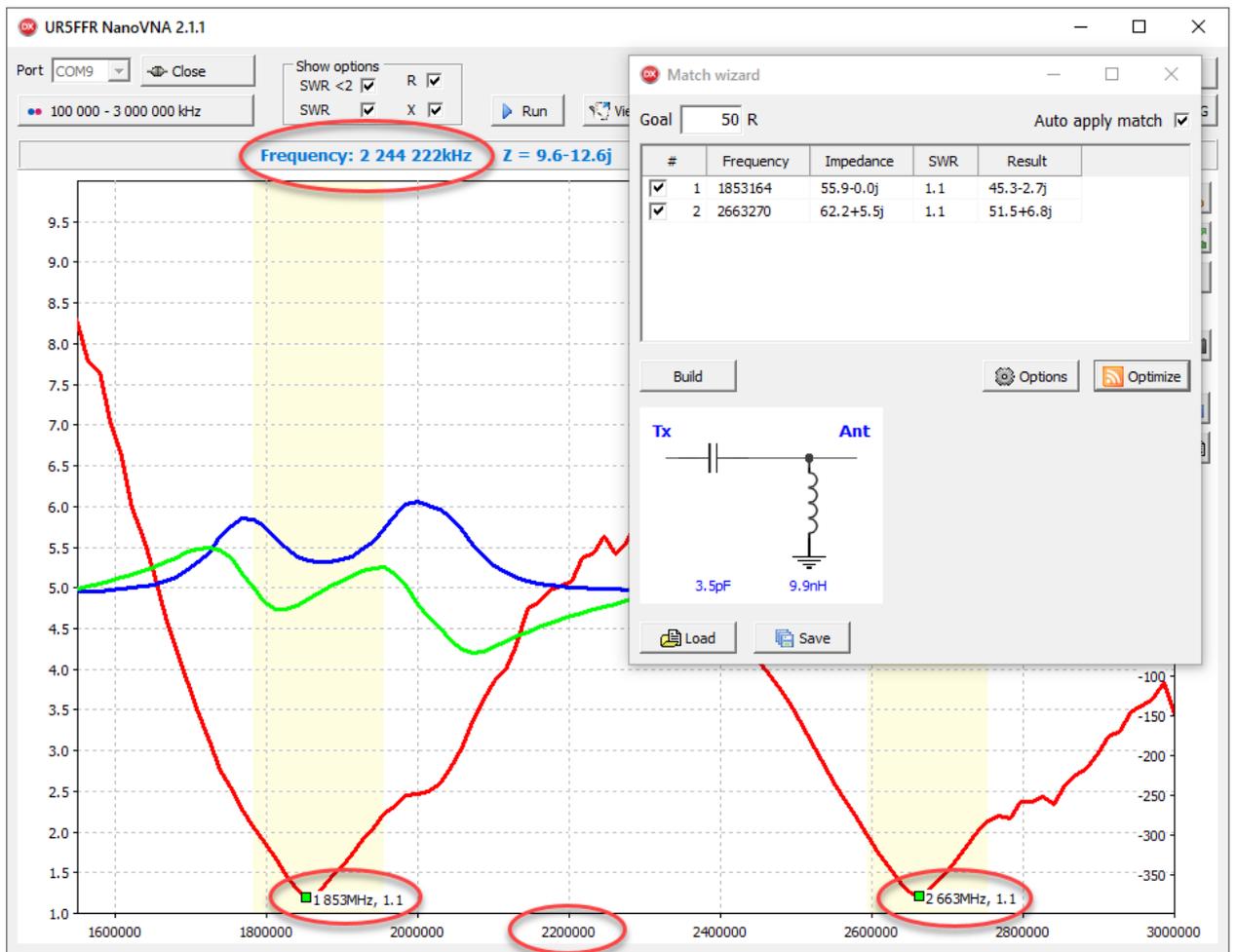
## Panoramic scan



After setting the required frequency range, press the "Run" button. The scan will start and the VSWR and impedance plot of the frequency range is displayed. By choosing different "Show options" you can control the display of graphs on the diagram.



If the scanning range lies above 100 MHz, then the frequency axis and markers are displayed in MHz.



## Working with charts

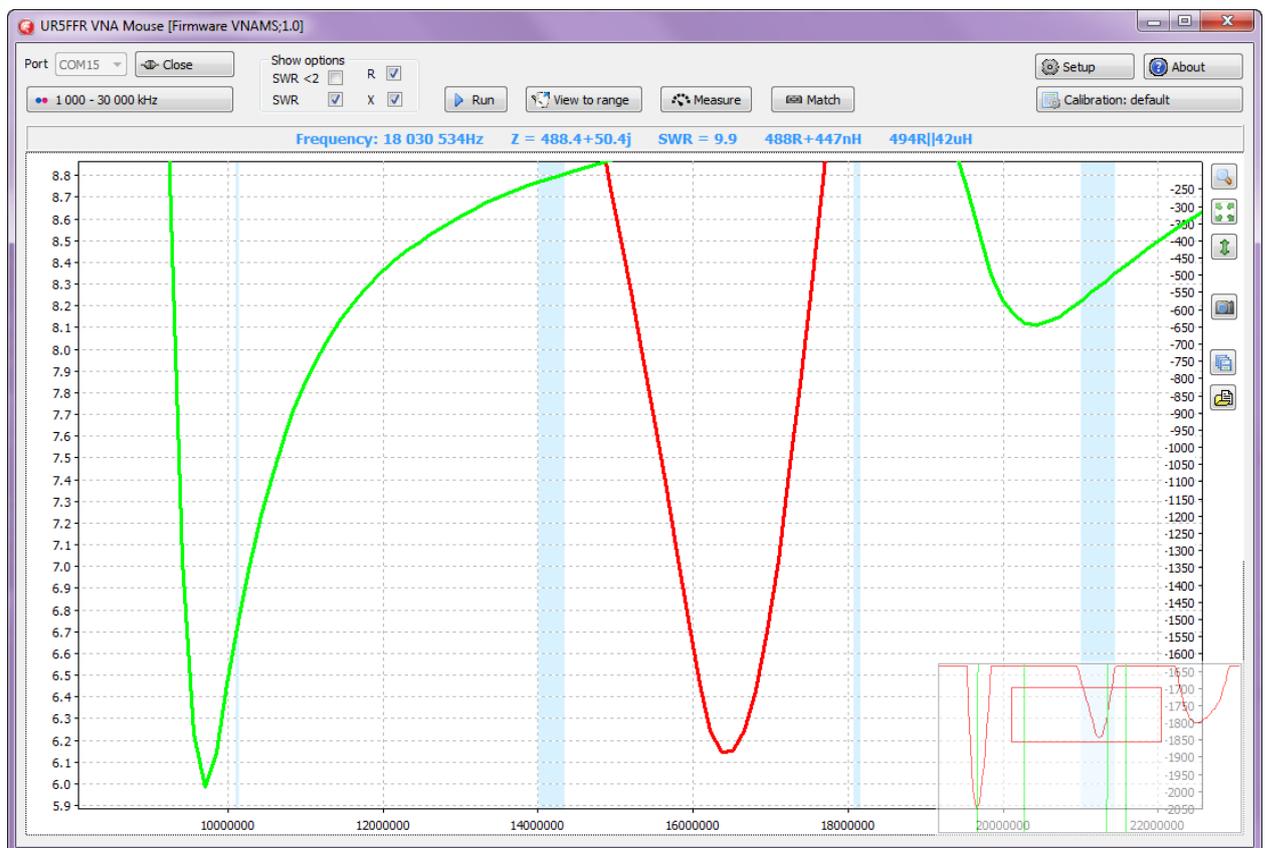
When working with charts, the following control combinations are used

1. Mouse scroll wheel allows you to scale the chart horizontally
2. The scroll wheel of the mouse with the pressed Shift key scales the graph vertically
3. Moving the mouse while holding down the right button - scrolling the chart
4. Moving the mouse with the left button pressed - measuring the range of levels/frequencies. At the same time, a dotted rectangle is drawn on the screen and its dimensions in the status bar
5. To restore the original chart scale, use the restore scale buttons on the right panel



6. To navigate the chart in zoom mode, you can use the navigator, which is called by the button on

the panel on the right



By clicking the mouse in the navigator window (bottom right), you can quickly position yourself on the desired part of the chart.

## Detailing

Pressing the "View to range" button will cause the measurement ranges to be changed to the currently displayed ones. For further measurement, press the Run/New button

## Chart management

Clicking on the right panel of the button



allows you to save the image of the graphs as a file in JPEG format.

Using the save



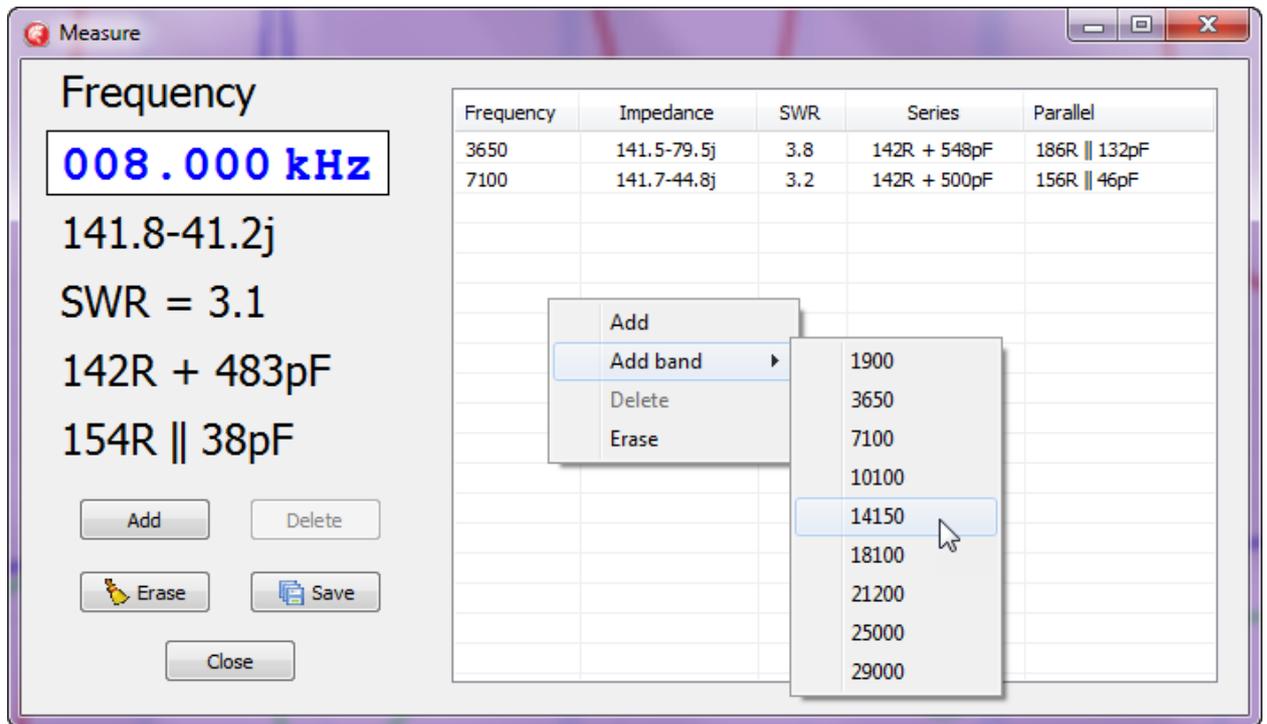
and load



buttons, you can save measurements to disk for further analysis.



On the measurement table, you can call the context menu by right-clicking. It duplicates the main actions, and it is also possible to select frequencies corresponding to the middle of the amateur bands.

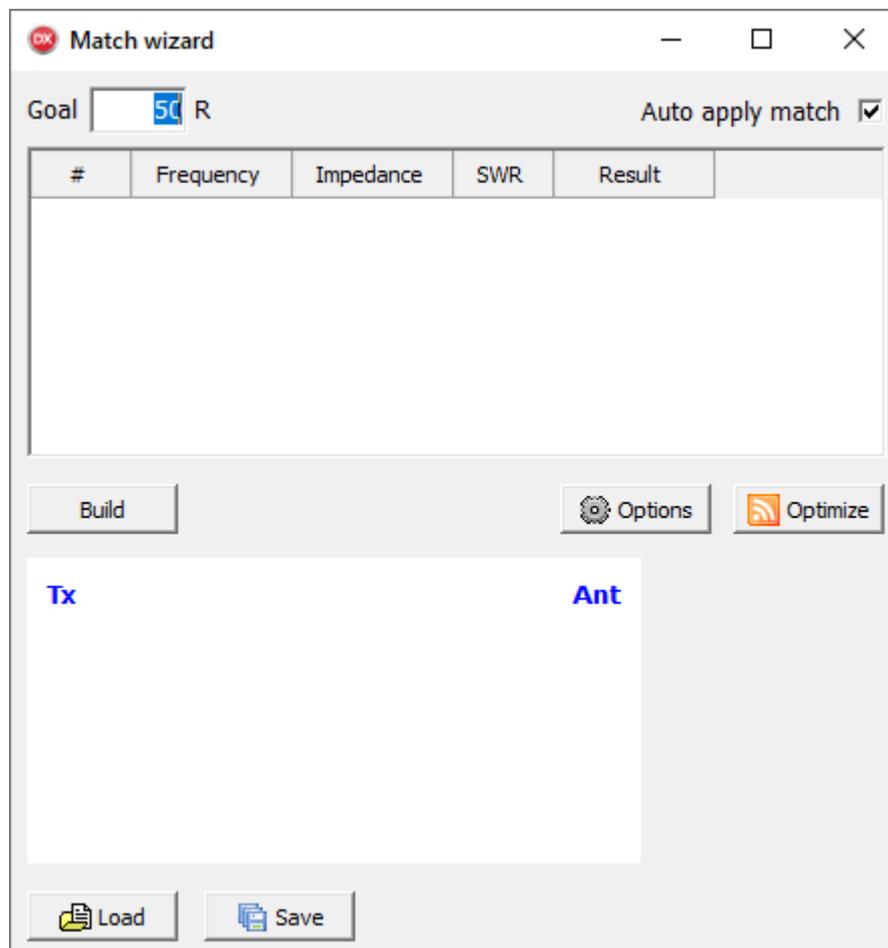


## Impedance matching

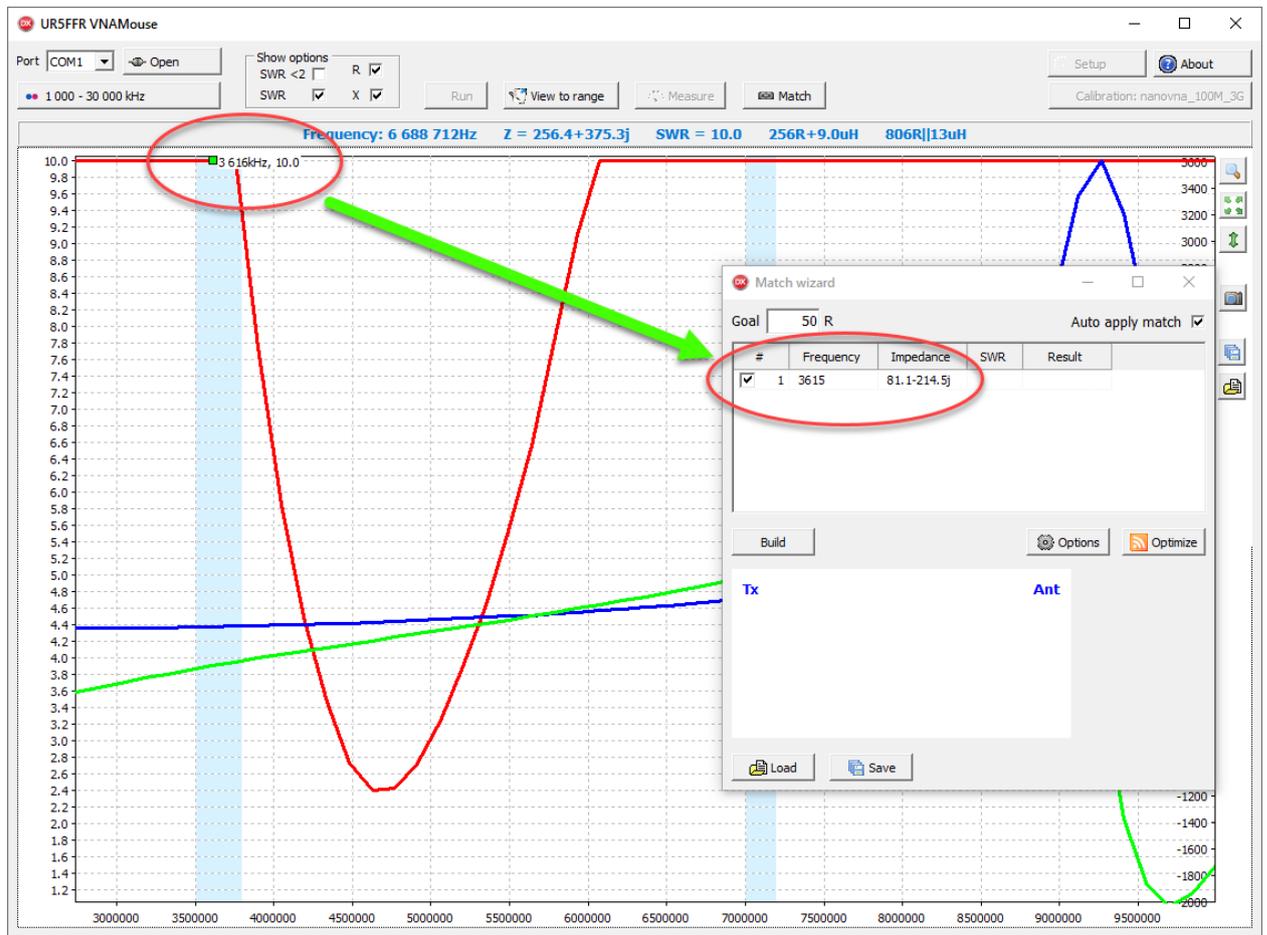
Press button "Match"



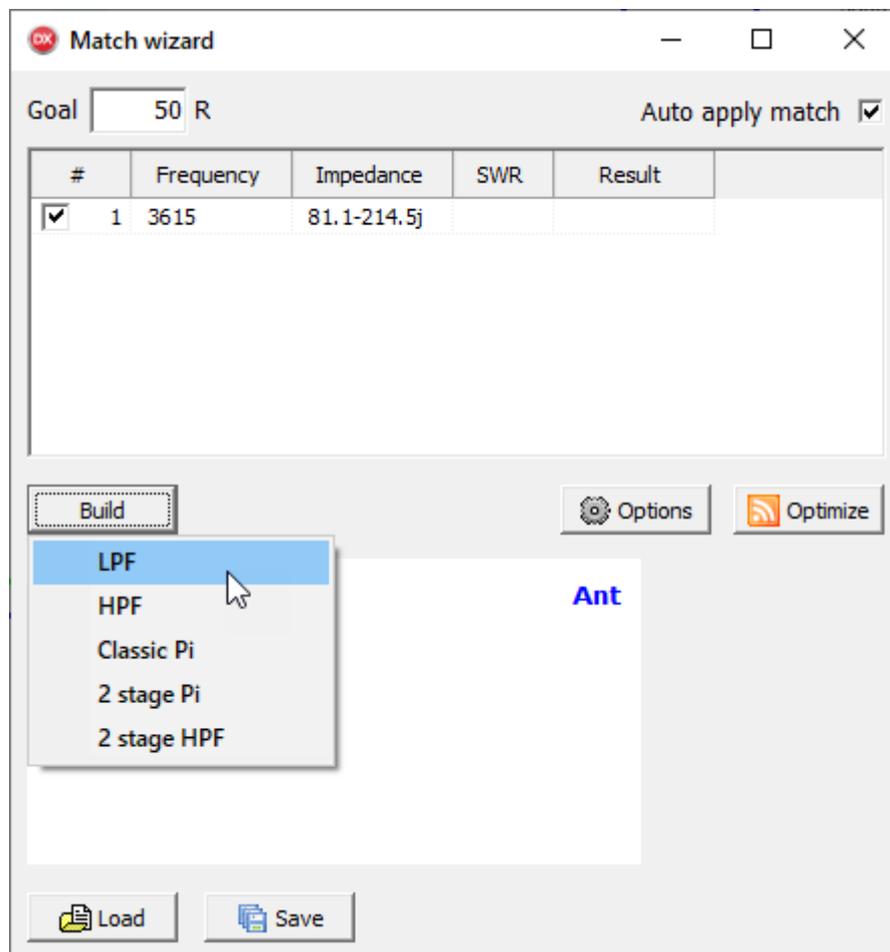
The window for calculating the complex impedance matching network will open.



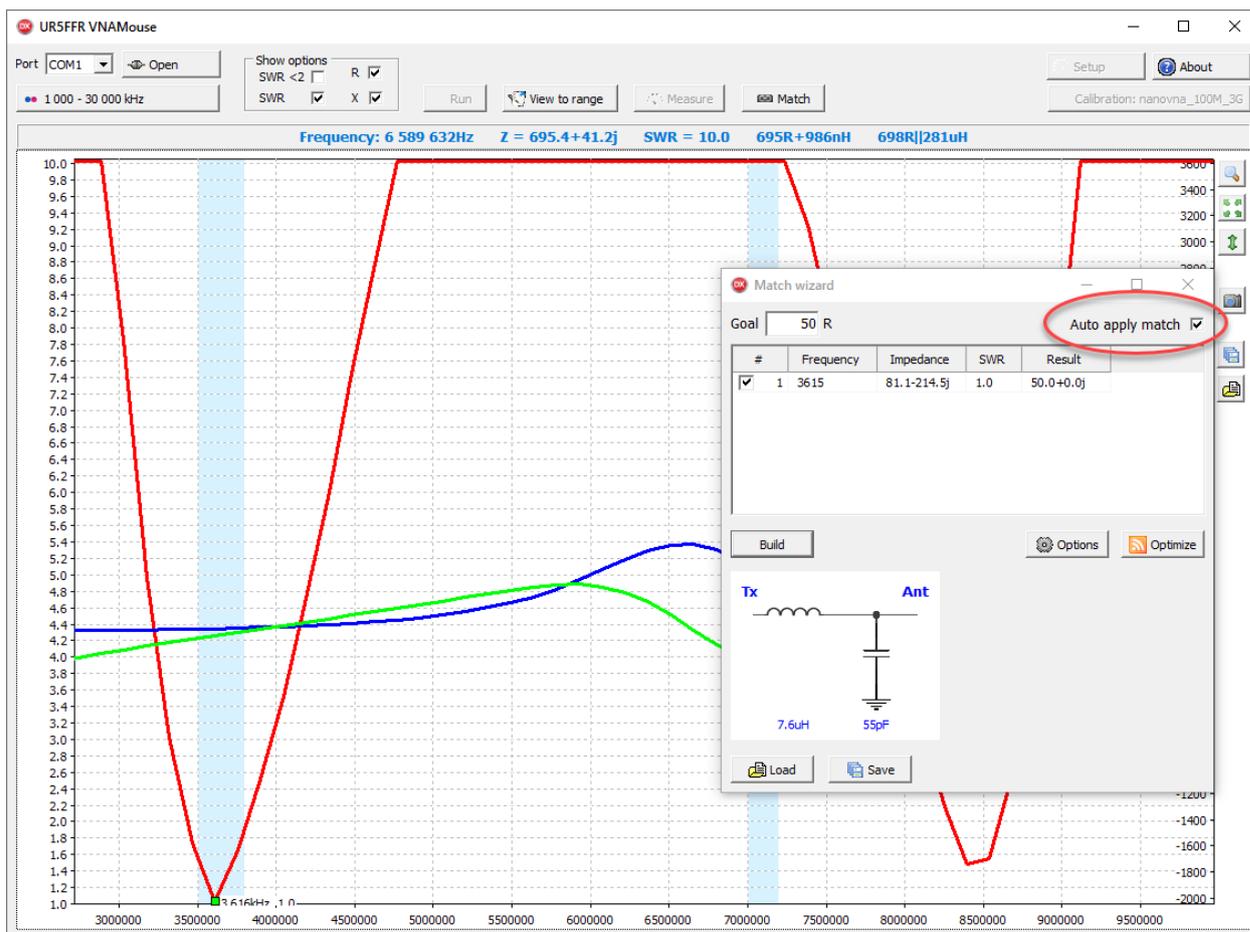
To set the frequency (one or several) at which it is necessary to calculate the matching network, put a marker on the measurement graph by double-clicking the left mouse button



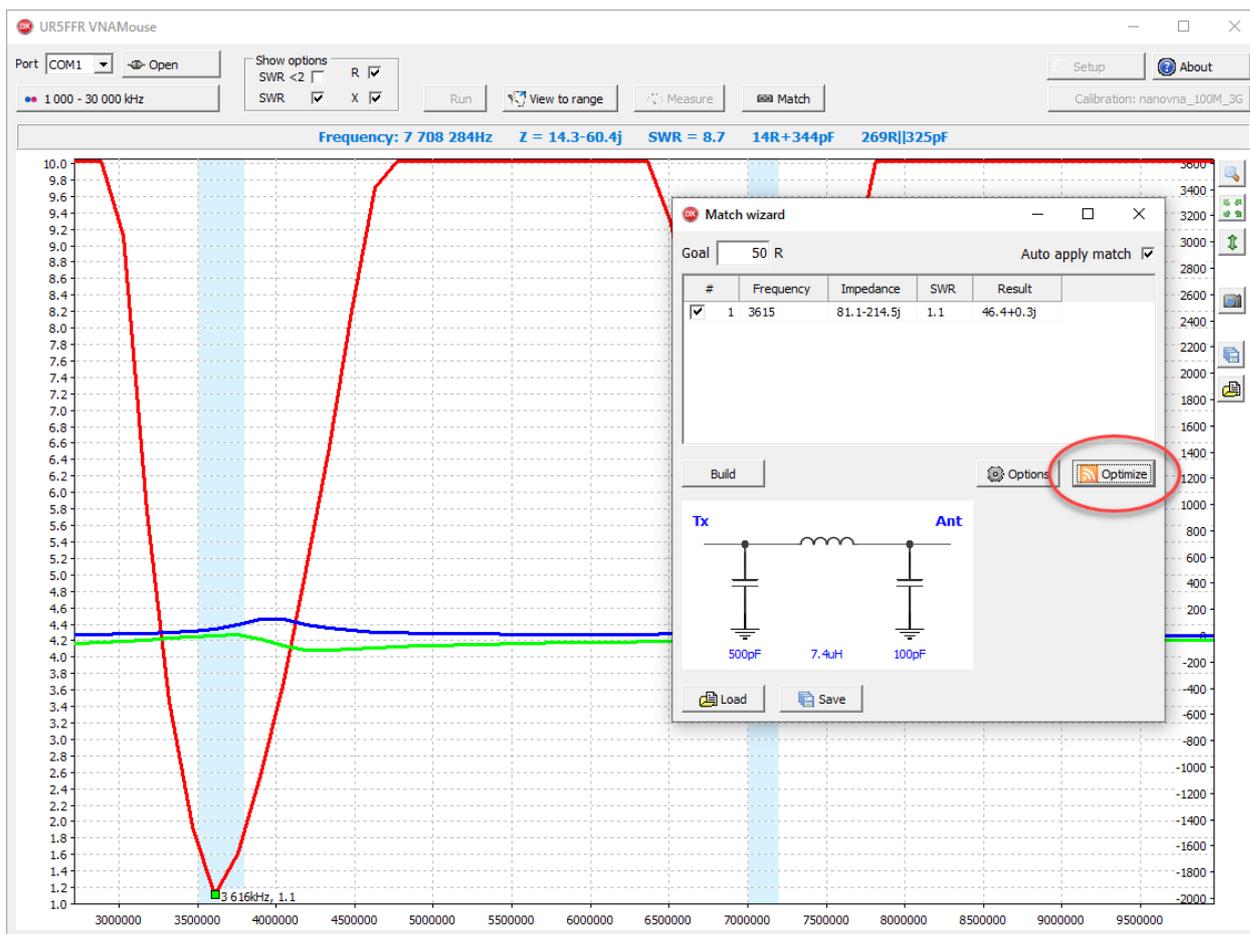
Then click the "Build" button and select the required matching network circuit



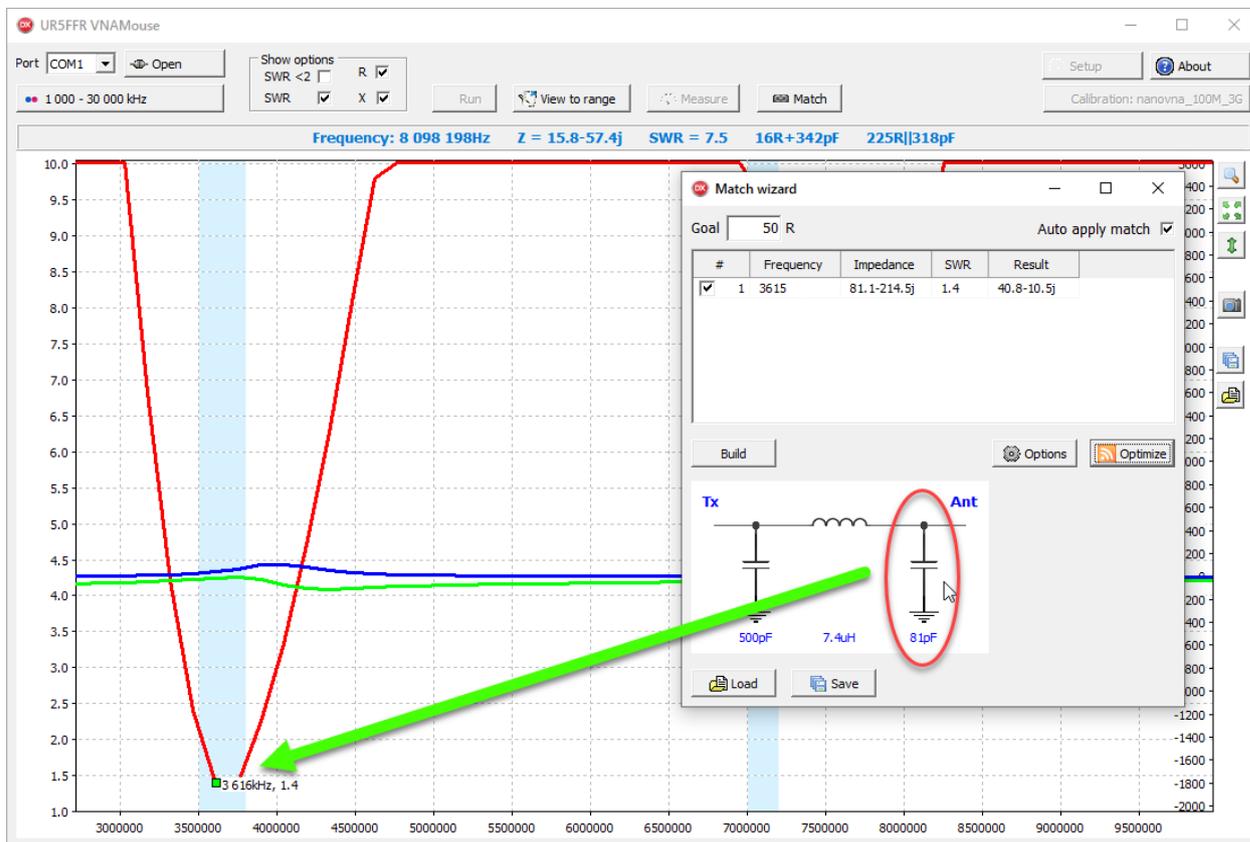
The matching network will be built and the results of its application will be displayed in the main window. To automatically display the results of changing the network chain in the panorama, "Auto apply match" must be enabled.



Automatic calculation of the network during its construction is performed only for simple network of the LPF / HPF type. For more complex circuits, it is necessary to press the "Optimize" button for the program to optimize the parameters of the matching circuit.

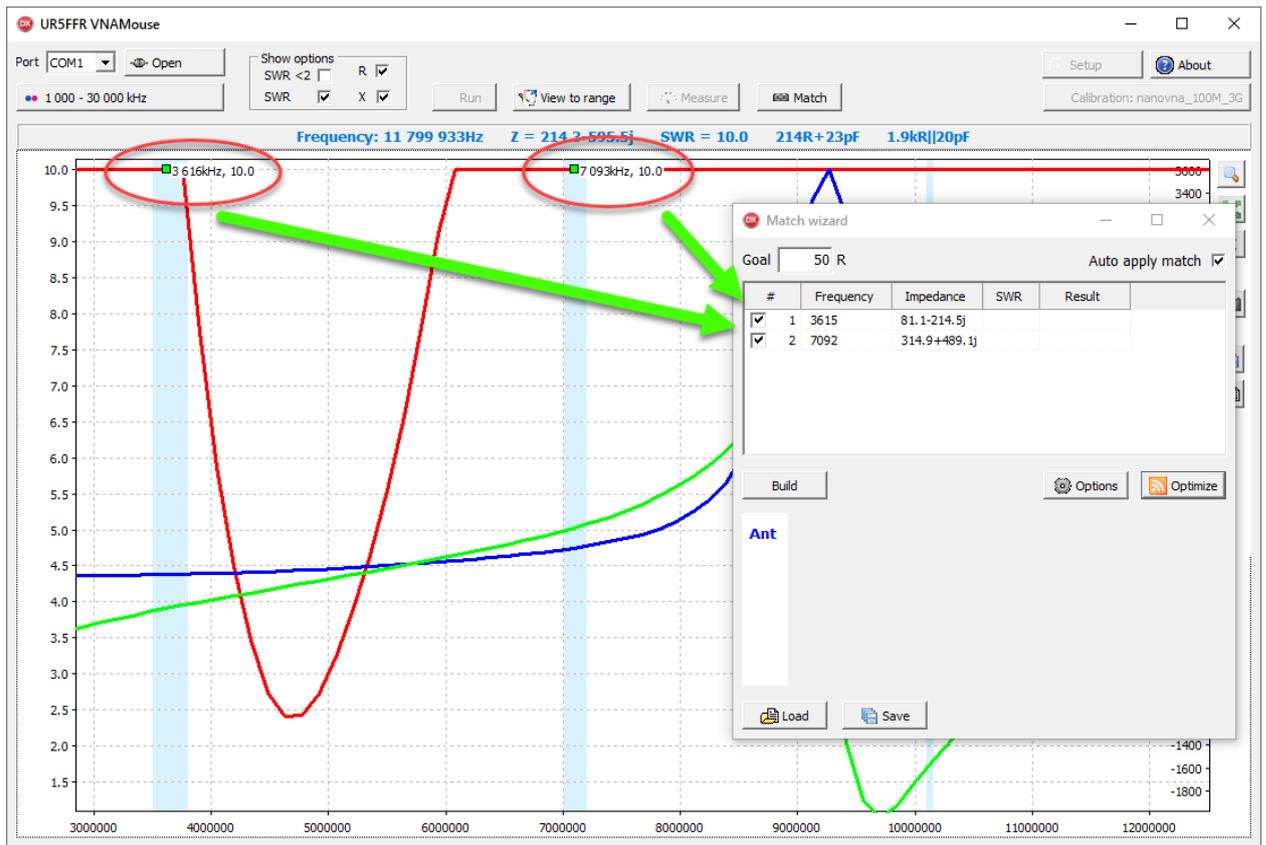


Using the mouse scroll wheel on the elements of the matching circuit, you can change their values and immediately watch how the matching will change in the panorama.

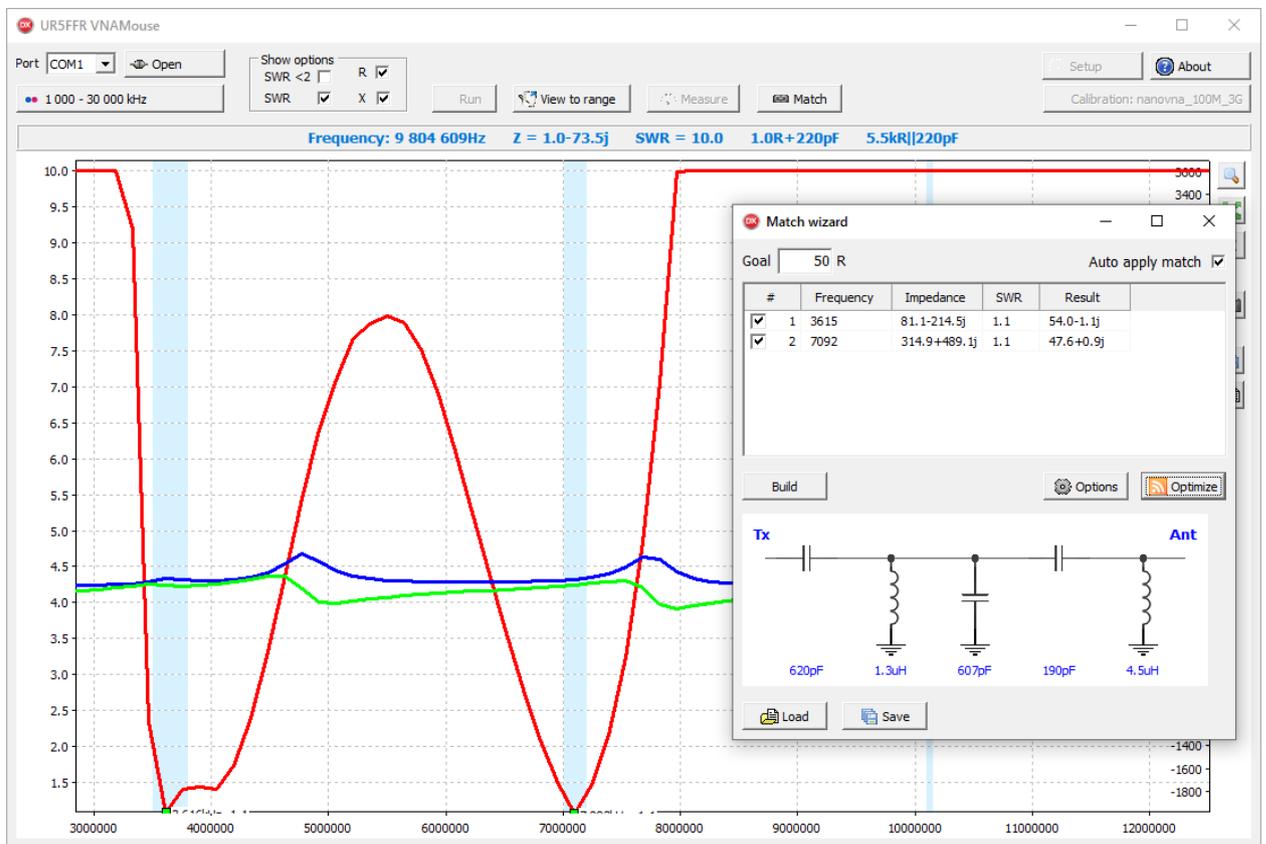


# Build impedance matching for multiple frequencies

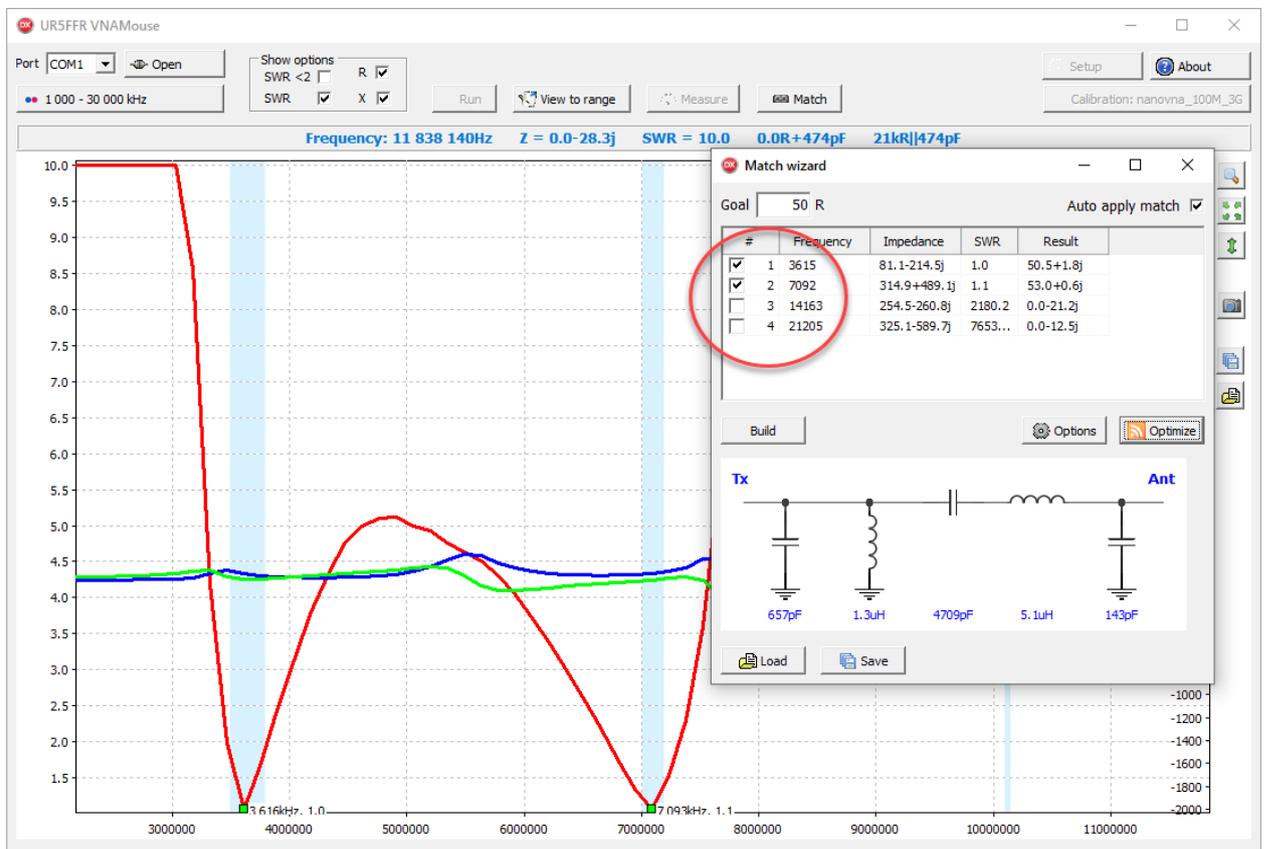
Using a double click of the mouse, place markers on the frequencies you are interested in - they will be added to the list of frequencies in the matching calculation window.



Click the "Build" button and select a complex network such as "2 stage Pi". Click the "Optimize" button for the program to optimize the matching network.



You can add many frequencies, but only calculate the matching network for the selected ones. For example, the calculation of matching for 20m and 15m.



## Settings

Press button "Options". A window will open with the adjustment optimization settings.

**Matching options**

Min capacitance:  pF

Max capacitance:  pF

Min inductance:  nH

Max inductance:  nH

Allow change series/parallel:

Allow change L/C:

Max count of inductance:

Inductor physical model

Inductor Q:

At frequency:  MHz

Capacitor physical mode

Capacitor Q:

At frequency:  MHz

OK Cancel

The min/max capacitance/inductance parameters define the limits within which the optimizer can vary the ratings of the matching network.

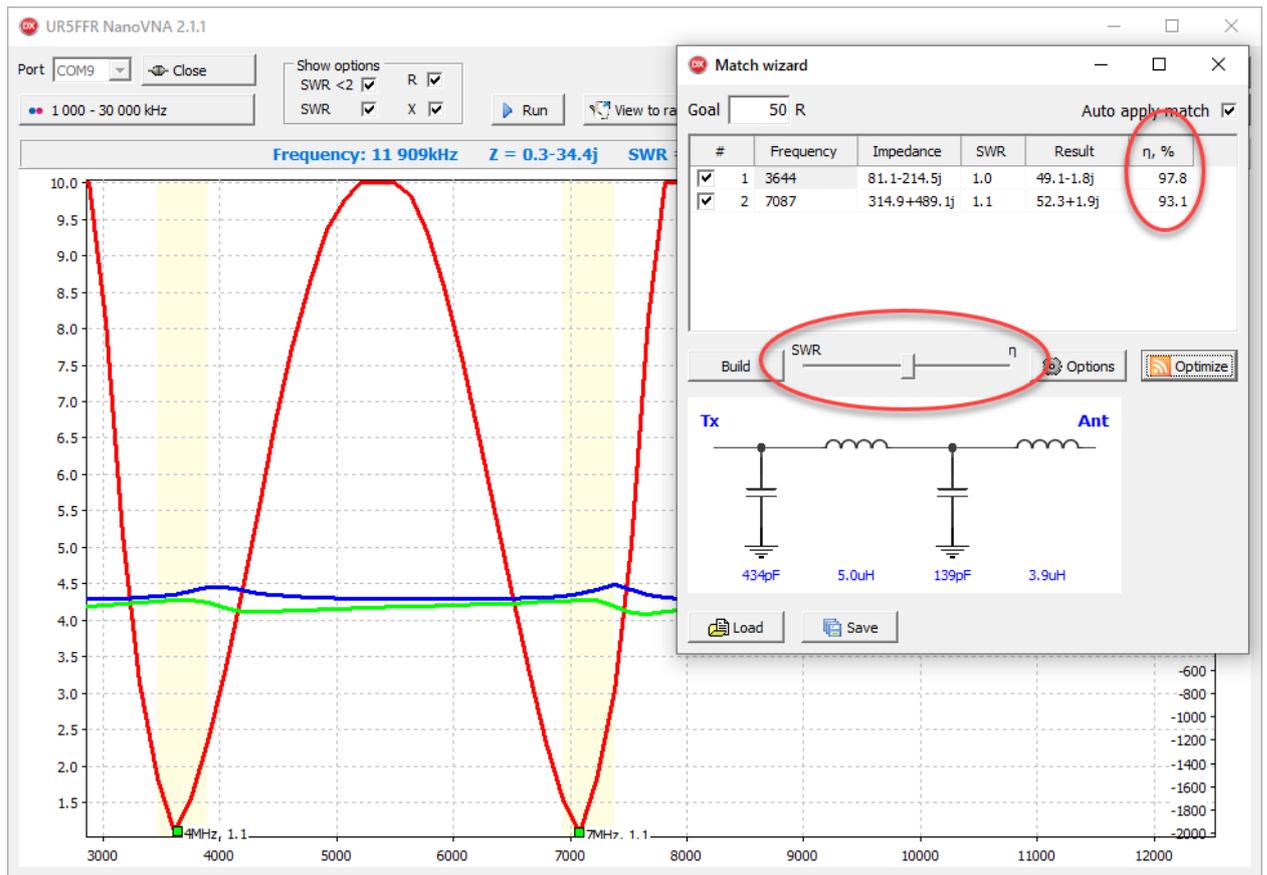
"Allow change series/parallel" allows the optimizer to change the topology of the circuit using parallel and serial connecting of elements.

"Allow change L/C" allows the optimizer to swap capacitors to inductors in the circuit and vice versa.

"Max count of inductance" sets the maximum number of inductors. This restriction makes sense if the optimizer is allowed to independently choose the types of network elements. A value of 0 indicates no restrictions.

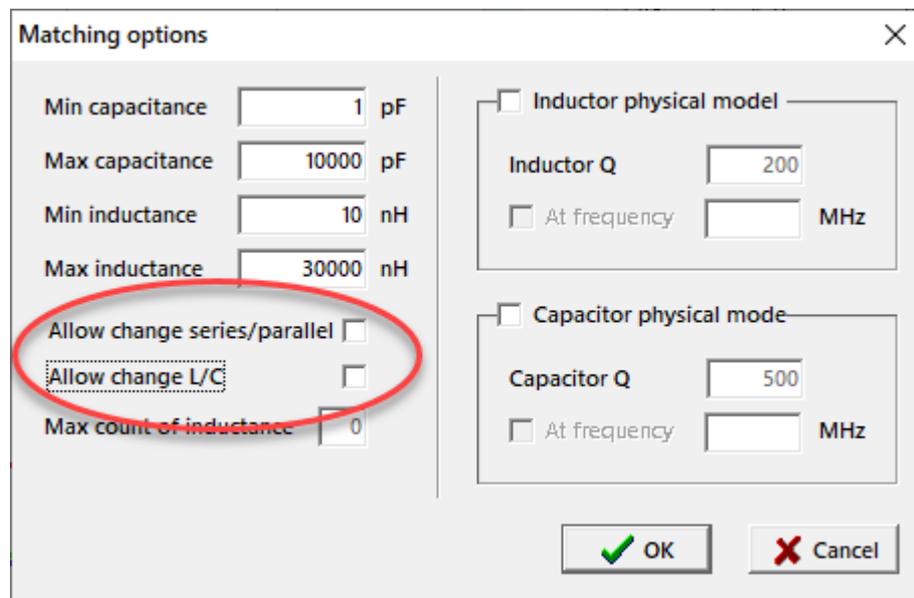
The program allows you to take into account the physical properties of the elements of the matching chain. For this, the quality factors of the elements are set.

When calculating taking into account physical properties, an additional column appears in the table, displaying the efficiency. In addition, a slider is displayed that allows you to set the balance between SWR and efficiency when optimizing the matching circuit.



## Build matching network with defined topology

If you need to calculate the matching chain of a fixed topology, you must prohibit the optimizer from changing it. We will indicate this in the options.



Press button "Build" and select "2 stage Pi". Press button «Optimize»

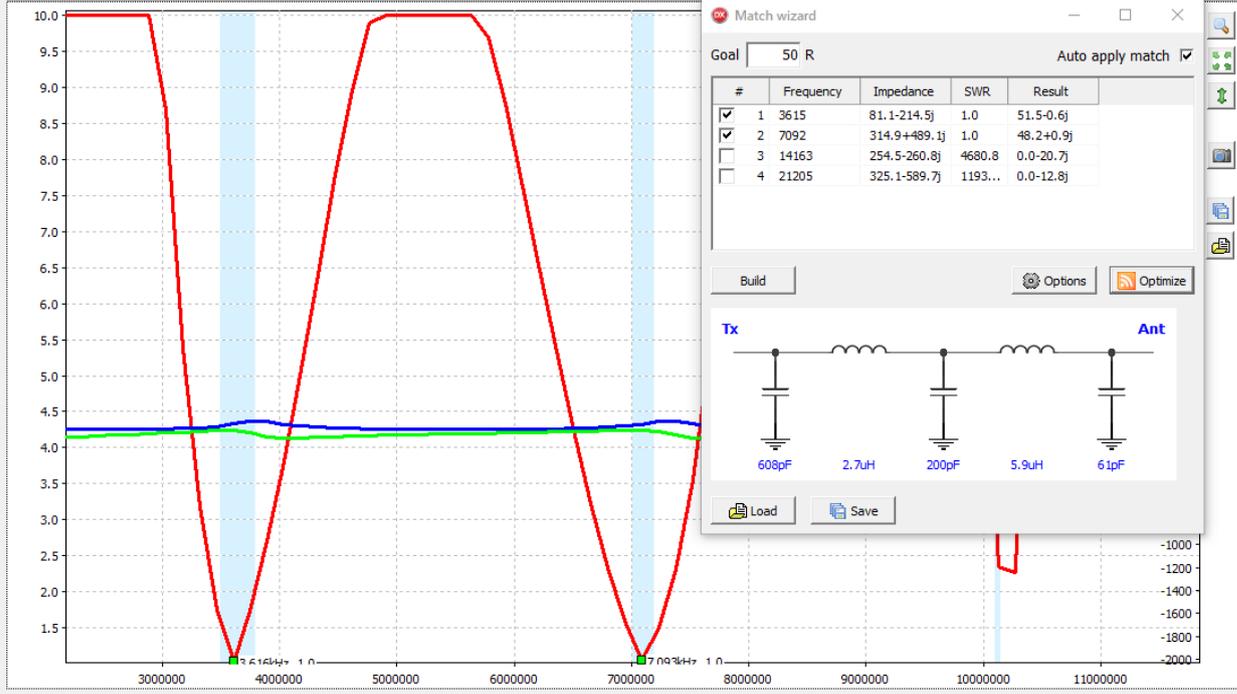
Port COM1 Open

Show options  
SWR < 2 R X  
SWR X X

Run View to range Measure Match

Setup About  
Calibration: nanovna\_100M\_3G

Frequency: 8 234 934Hz Z = 5.3-47.8j SWR = 10.0 5.3R+403pF 438R|[398pF



Match wizard

Goal 50 R Auto apply match

#	Frequency	Impedance	SWR	Result
<input checked="" type="checkbox"/>	1 3615	81.1-214.5j	1.0	51.5-0.6j
<input checked="" type="checkbox"/>	2 7092	314.9+489.1j	1.0	48.2+0.9j
<input type="checkbox"/>	3 14163	254.5-260.8j	4680.8	0.0-20.7j
<input type="checkbox"/>	4 21205	325.1-589.7j	1193...	0.0-12.8j

Build Options Optimize

Tx Ant

608pF 2.7uH 200pF 5.9uH 61pF

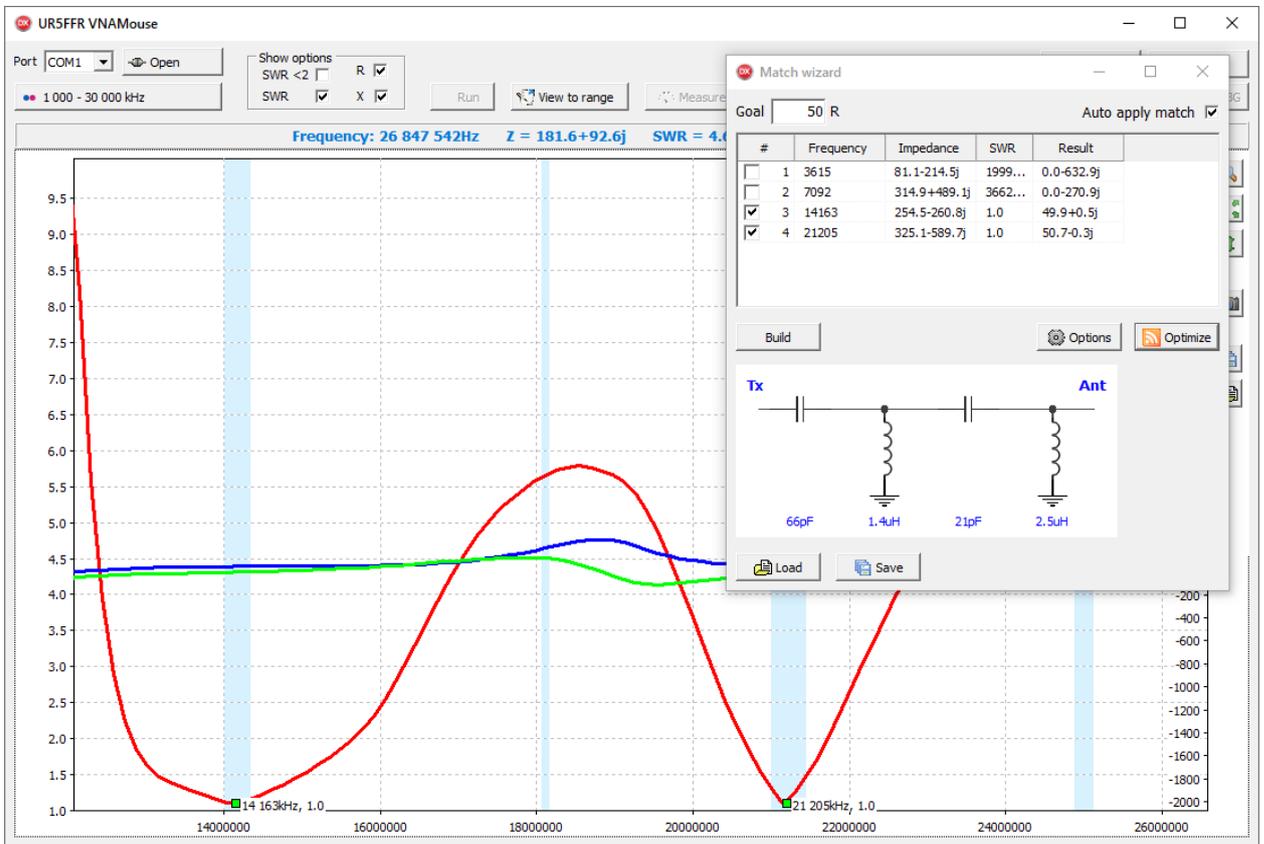
Load Save

## Build matching network with custom topology

Call the context menu by right-clicking on the matching circuit diagram.

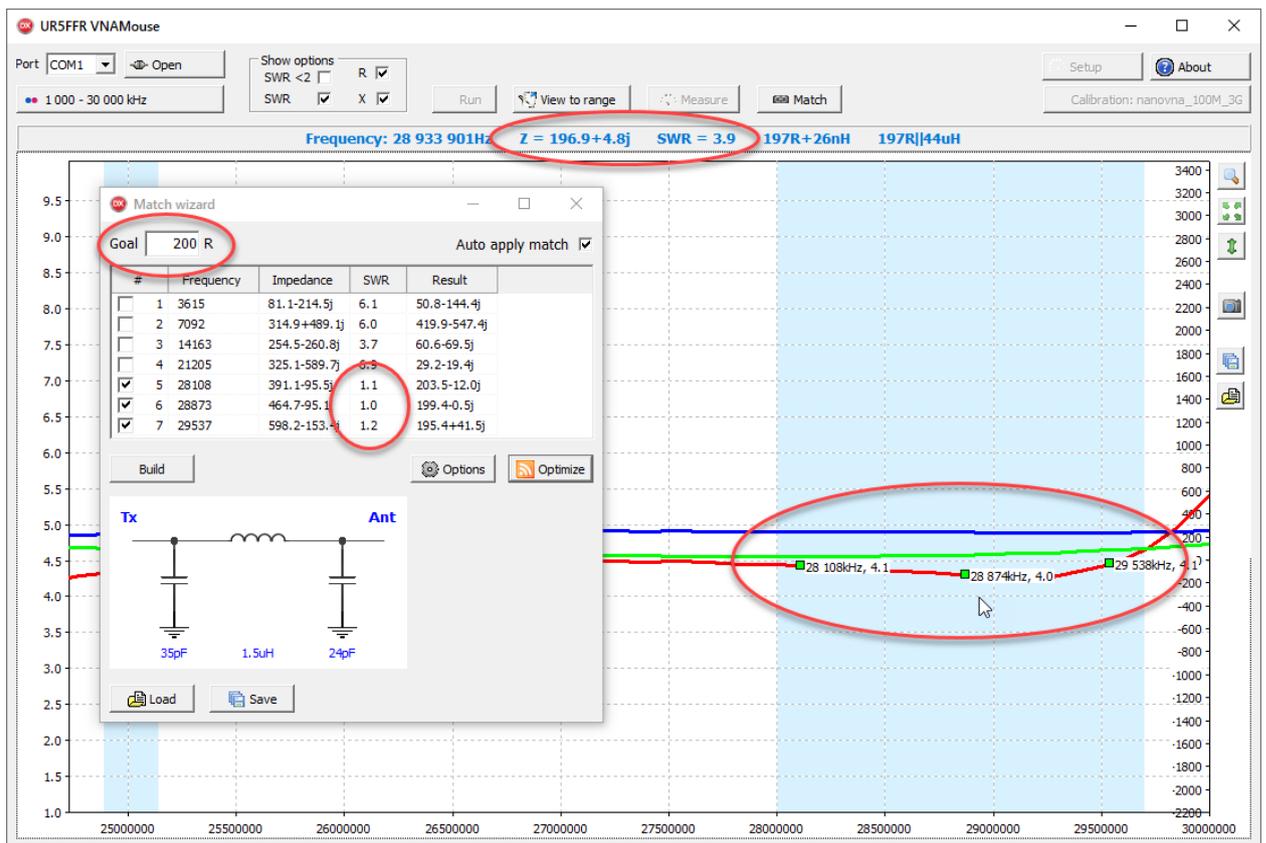
#	Frequency	Impedance	SWR	Result	
<input checked="" type="checkbox"/>	1	3615	81.1-214.5j	1.0	51.5-0.6j
<input checked="" type="checkbox"/>	2	7092	314.9+489.1j	1.0	48.2+0.9j
<input type="checkbox"/>	3	14163	254.5-260.8j	4680.8	0.0-20.7j
<input type="checkbox"/>	4	21205	325.1-589.7j	1193...	0.0-12.8j

It is possible to add/remove elements, change their type and include. By double-clicking on an element in the diagram, you can change its inclusion from parallel to serial and vice versa. After specifying the topology of the matching network, click the "Optimize" button.



The program stops searching for matching options if VSWR is not worse than 1.1 at all points, or if the search lasts more than 10 minutes. In some cases, the program cannot find the optimal value of the matching circuit parameters. This usually happens if the chain contains too few nodes and the number of matching points is large. To stop the search, press the "Abort" button in the optimizer window, increase the number of nodes in the circuit, or change its topology, or decrease the number of selected points (frequencies) to build the matching circuit.

Matching network can be calculated to obtain a net impedance other than 50 ohms. Enter the required impedance in the "Goal" field and click the "Optimize" button. Below is an example of calculating a matching network for a 10m range and a target impedance of 200 ohms.



The coordination chain can be saved or loaded from a file using the "Load" and "Save" buttons at the bottom of the window.

The screenshot shows the 'Match wizard' window with the following components:

- Goal:** 50 R
- Auto apply match:**
- Table:**

#	Frequency	Impedance	SWR	Result	$\eta$ , %
<input checked="" type="checkbox"/> 1	3644	81.1-214.5j	1.0	49.1-1.8j	97.8
<input checked="" type="checkbox"/> 2	7087	314.9+489.1j	1.1	52.3+1.9j	93.1
- Build:** A button to generate the circuit.
- SWR:** A slider control for the Standing Wave Ratio.
- $\eta$ :** A slider control for efficiency.
- Options:** A button to access settings.
- Optimize:** A button to optimize the circuit.
- Circuit Diagram:** A schematic showing a transmission line between 'Tx' and 'Ant'. It includes two shunt capacitors (434pF and 139pF) and two series inductors (5.0uH and 3.9uH).
- Buttons:** 'Load' and 'Save' buttons are circled in red at the bottom.