KROKS

SCIENTIFIC AND PRODUCTION COMPANY

THE 1-PORT VECTOR NETWORK ANALYZER
(REFLECTOMETER)

ARINST VR 1-6200
ARINST VR 23-6200

MANUAL

CONTENT

1. PURPOSE

1.1. Portable 1-port vector network analyzer **ARINST VR 1-6200** (Vector Reflectometer 1-6200 MHz) and **ARINST VR 23-6200** (Vector Reflectometer 23-6200 MHz) (hereafter the reflectometer, the device) are designed to measure the matching characteristics of passive and active radio devices[1] (antennas, cables, filters, attenuators, amplifiers, etc.). The device allows you to measure the parameters of the complex reflection coefficient, standing wave ratio (VSWR), impedance, admittance, magnitude, phase, loss and distance to fault in the cable.

1.2. The device is intended for amateur radio use, as it is not a professional measuring instrument. The presence of a built-in battery allows you to measure in laboratory and outside conditions.

1.3. The device is designed to work in the range of ambient temperatures from 0 to +40°C and relative air humidity not more than 75%.

1.4. Reflectometer is not intended:

- for work on the open areas during a snowfall or a rain;
- in places with a corrosive or explosive environment (dust, steam, gas);
- for use by people (including children) who have physical, nervous or psychological abnormalities or lack of experience and knowledge that prevent the safe operation of the device without supervision or training;
- use by children for games.

2. COMPLETENESS

2.1. The set of delivery of the device is given in Table 1 and Figure 2.1.

Table 1

Name	**Quantity**	
	ARINST VR 1-6200	ARINST VR 23-6200
Vector reflectometer	1 pc.	1 pc.
Connecting cable USB 2.0 type A – USB 2.0 type B	1 pc.	1 pc.
Manual (Passport of product)	1 pc.	1 pc.
Package	1 pc.	1 pc.

Figure 2.1 - Set of delivery

[1] Test devices must allow for the possibility of filing on the test port of the stimulating signal from the reflectometer. The manufacturer of the reflectometer is not responsible for the failure of devices that do not allow the supply of a stimulating signal to the test port.

3. SPECIFICATIONS

3.1. Technical characteristics of the device are shown in Table 2.

Table 2

Parameter name		Value	
		ARINST VR 1-6200	ARINST VR 23-6200
Operating frequency range		1-6200 MHz	23-6200 MHz
Frequency resolution, for frequencies 1-99,9999 MHz		100 Hz	10 kHz
Frequency resolution, for frequencies 100-6200 MHz		10 kHz	10 kHz
Maximum number of scan points		1000	
Scanning rate		1000 points/s	
The direction of the bridge, uncorrected throughout the range		> 12 dB	
Directivity effective [2] (after full single-port calibration)		> 50 dB	
Standing wave ratio at the input		< 2	
Phase measurement precision[2]		> 1,5°	
Magnitude measurement precision[2]		> 0,25 dB	
Resolution determining the distance to fault [3]		$(C \times VF)/2S$ m	
The maximum length of the measured cable [4], at VF=1		3000 m	
Compensation of electrical cable length, at VF=1		±3 m	-
Maximum DC input voltage		25 V	
Displayed plots	■ the Smith chart; ■ polar chart; ■ the phase of the reflection coefficient; ■ magnitude; ■ logarithmic magnitude; ■VSWR; ■ distance-to-fault; ■ cable loss		
Number of user settings to save		30	8
Number of traces to save		12	-
Operating temperature range		0 … +40°C	
Screen diagonal		3,2”	
Screen type		touch, resistive	
Screen resolution		320×240	
Maximum current consumption, not more than	when charging the battery	300 mA	
	when working on battery power	1000 mA	
	when working from USB with battery charging [5]	800 mA	
Battery capacity		2500 mAh	
Continuous battery life [6]		2 h	
Battery charge time		~6 h	
Overall dimensions (L×W×H)		155×81×27 mm	
Weight		0,4 kg	

In connection with the constant improvement of the design and software, the manufacturer reserves the right to make changes to the scheme, technical characteristics and completeness of this device.

[2] The measurement is performed after warming up the device for at least five minutes with a full (short, open, load) single-port calibration. The change in ambient temperature from the time of calibration to the time of measurement shall not exceed ±3°C.

[3] Where C is the speed of light m/s; VF is the speed factor (the ratio of the speed of propagation of the electromagnetic wave in the cable to the speed of propagation of the electromagnetic wave in vacuum), takes a value depending on the cable from 0.1 to 1; S is the scanning frequency range in the frequency plan (Hz).

[4] Depends on the amount of attenuation in the cable and is the limit of the display.

[5] If your PC has a limit on the maximum current supplied to the USB port, charge the device before taking measurements, not turning on the device during charging.

[6] At ambient temperature plus 20±5°C after full charge.

4. SAFETY RULES WHEN WORKING WITH THE DEVICE

4.1. General safety requirements

4.1.1. To work with the device allowed persons familiar with the present "Manual" and been briefed on rules for safe work with electrical devices.

4.1.2. The possibility of injury is possible when you connect or disconnect the charger into the electrical network. Use serviceable outlets and chargers.

4.1.3. To avoid damage to the wires and connectors of the device, do not hang anything on the wires, paint and seal the wires and connectors, disconnect the wires pulling the cord.

4.1.4. Persons using the device are strictly prohibited: to transfer the device to outsiders, to disassemble and make any repair of the device not agreed with the manufacturer, to use the device with a damaged body.

4.1.5. If a fault is detected, stop operation immediately and turn off the device.

4.1.6. If you need to leave the workplace, disconnect the device and other devices. Do not leave the device running unattended!

4.1.7. Do not use the device in hospitals. Use of the device near medical equipment is allowed only with the consent of the medical staff.

4.2. Additional safety requirements

4.2.1. Use the device only for its intended purpose. Familiarize yourself with the purpose, device and technical characteristics of the device.

4.2.2. Keep the balance and steady posture while working with the device. Move slowly, do not run.

4.2.3. Avoid working in open spaces during snow or rain. Increased humidity and all types of liquid, once inside the device, can damage it.

4.2.4. Do not expose the device to very low or very high temperatures; exposure to extreme temperatures may damage the internal battery.

4.2.5. Do not use the device in areas with corrosive and explosive environments. Pairs of aggressive substances can destroy the insulation, which can lead to the failure of the device.

4.2.6. Do not carry the device by the cables and wires connected to it, do not unplug the connectors by pulling the cable or cord.

4.2.7. Do not apply excessive force to the control buttons and the device screen.

4.2.8. Avoid bumps and drops. If dropped, the device may be damaged.

4.2.9. Do not disassemble or modify the device without the approval of the manufacturer or outside the steps described in this manual. Incorrect self-intervention in the device will lead to loss of warranty.

4.2.10. Do not allow children to play with the device, as they could hurt or injure others, or disable the device.

4.2.11. Use chargers, cords, adapters and other accessories recommended by the manufacturer.

4.2.12. When connecting to the device other devices, carefully read their purpose, technical characteristics and safety rules in their manuals. Do not connect incompatible devices.

4.2.13. Maintenance and repair of the device should be performed only by the manufacturer or an authorized service center.

5. COMPOSITION OF THE DEVICE

5.1. The composition of the device is shown in Figure 5.1.

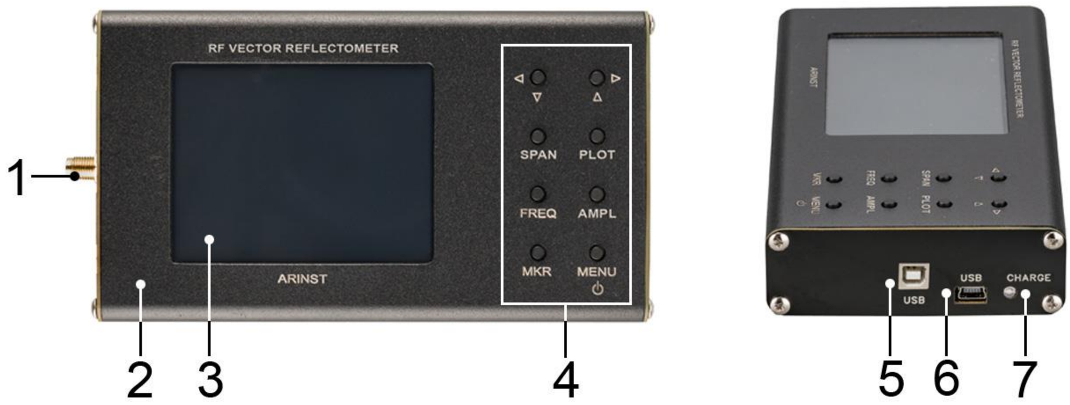


Figure 5.1 – External view of the device

1. Port for connection of test devices and load **TEST PORT**
2. Housing
3. Colour resistive screen of 3.2”
4. Control buttons block
5. Connector for transferring data and charging the battery of the device **USB type B**
6. Connector for data transfer and charging device battery **mini-USB**
7. Battery charge indicator **CHARGE**

5.2. The block of buttons for controlling the device is shown in Figure 5.2.

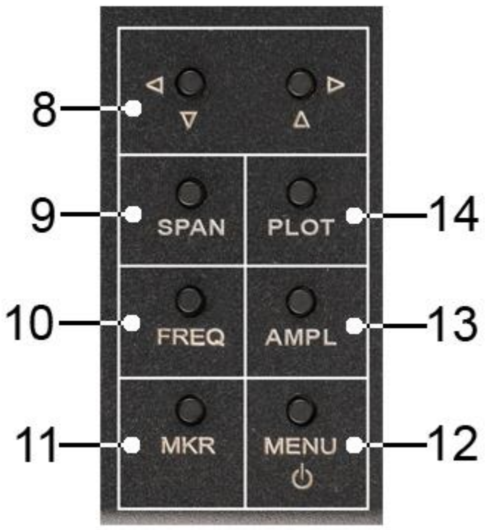


Figure 5.2 – Control buttons unit

8. Buttons for moving markers, moving in frequency and amplitude, changing the scanning range.
9. **«SPAN»** - switching buttons (8) to the mode for changing the scan range at a constant center frequency (widening and narrowing of the range).
10. **«FREQ»** - switching buttons (8) to the center frequency change mode without changing the scan range (left / right shift of the range).
11. **«MKR» -** switch the marker number and set the button mode (8) to move the marker in frequency.
12. **«MENU»** - exit to the main menu. Turning the device on and off when pressed and held for more than 2 seconds.
13. **«AMPL»** - switches the buttons (8) to the reference level change mode when some plots are displayed.
14. **«PLOT»** - switches the buttons (8) to the mode of switching the displayed plots. Quick exit from any menu item to display the plot.

<u>Note</u> – The operating mode (Span, Freq, Plot, Mkr) in which the navigation buttons (8) are now located is displayed in the lower left corner of the screen, next to the battery status indicator.

6. DESCRIPTION AND PRINCIPLE OF OPERATION OF THE DEVICE

Vector reflectometers **ARINST VR 1-6200** and **ARINST VR 23-6200** are a technically sophisticated measuring device consisting of: directional coupler, synthesizer, local oscillator, processor, LCD screen and Li-Ion battery.

The device sweeps the synthesizer according to the frequency set by the user. The signal from the synthesizer (incident wave) is fed to the port for the test devices (TEST PORT) to which the device or load is connected. Depending on the reflection coefficient of the test device or the load, a reflected wave is formed, which is extracted using a directional coupler. The frequency of the local oscillator is shifted relative to the frequency of the synthesizer at an intermediate frequency (IF). The IF signal contains information about the amplitude and phase of the direct and reflected signals, and, due to the relatively low frequency, it can be digitized with a fast ADC. At each frequency, a direct and reflected wave IF signal is sampled with further calculation of the amplitude and phase of each signal using the maximum likelihood method.

The obtained values allow us to calculate the reflection coefficient (RC), which is a complex number carrying information, both on the phases and on the amplitudes of the reflected and incident waves.

$$RC = \frac{U_{rwa}}{U_{iwa}} \times \exp\left[j\left(\varphi_{rwp} - \varphi_{iwp}\right)\right]$$

where U_{rwa} – Reflected wave amplitude;

U_{iwa} – Incident wave amplitude;

φ_{rwp} – Reflected wave phase;

φ_{iwp} – Incident wave phase;

j - √-1 – Imaginary unit.

After calculating the RC, the control processor displays the result of the scan by the frequency assignment in the form of plots and charts selected by the user: the Volpert-Smith chart, the phase / magnitude plot RC, the VSWR plot, and others.

7. TURNING ON

Attention! Use of the device in open spaces during snowfall or rain is prohibited. If the device is brought from a cold room in the winter, or from the street into a warm room, do not turn it on for a time sufficient to evaporate condensate from the device.

Attention! Match the voltage applied to the port for the test devices (TEST PORT) with the maximum technical characteristics of the device specified in Table 1.

7.1. Turning on the device

7.1.1. Make sure that the device is not damaged externally and that the battery is charged. Charge the battery before using the device. To charge the battery, it is recommended to use a stabilized power supply with an output voltage of 5V and a current of at least 500 mA. It is recommended to use a stabilized power supply with an output voltage of 5V and a current of at least 800 mA to charge the battery during operation of the device.

Simultaneous use of two USB ports of the device is strictly prohibited! Violation of this requirement may result in device failure.

7.1.2. Press and hold the **«MENU»** button (12) for 2 seconds. The screen (3) will display the results of the device self-test. Then, the device switches to normal operation.

Note – When the device is first turned on, it is necessary to configure the frequency plan, the type of plots displayed on the screen (3) and perform calibration. User settings will be saved in the device's memory, and on subsequent power-ups will be set automatically.

7.2. Turning off the device

7.2.1. To turn off the device, press and hold the button (12) **«MENU»** for 2 seconds. The screen (3) of the device goes out, the device turns off.

Note – Each time the device is turned off, the basic user settings are recorded in the non-volatile memory, which allows to avoid setting up the device during the next power up.

8. DEVICE SCREEN

The device displays the results of scanning the specified frequencies in the form of user-defined plots and charts. The current settings of the device, the scanning range, the type of displayed plot or chart and other important information for the user are located on the bottom line of the screen. Consider this information line from left to right.

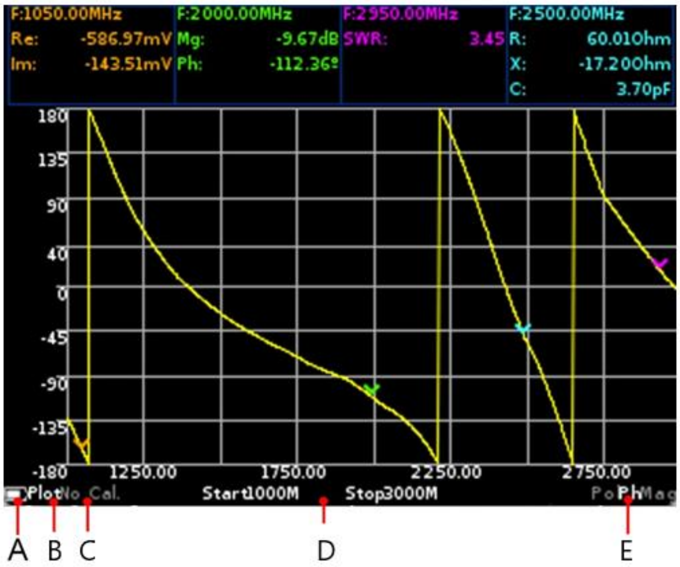


Figure 8.1 – Screen of the device

8.1. In Figure 8.1, in the lower left corner of the screen is placed the indicator (A) of the status of the internal battery, which, depending on the state of the battery, can be displayed as:

- indicator in the form of a spark (lightning) - battery is charging;
- the indicator symbol in the form of a battery is completely filled with white - the battery is fully charged;
- indicator symbol in the form of a white battery circuit - the battery is discharged, it is necessary to charge it;
- the device has displayed a message on the critical power level - the battery is completely discharged, the device will automatically turn off.

8.2. To the right, from the battery status indicator, the mode (B) is displayed, Figure 8.1, in which the navigation buttons (8) are located:

- **Plot** - a mode in which the buttons (8) switch charts and plots on the device screen;
- **Span** - using the buttons (8), the user can change the viewing range at a constant center frequency;
- **Freq** - use the buttons (8) to change the initial and final frequencies without changing the width of the frequency plan (shifting the frequency plan);
- **Mkr 1 ... Mkr 4** - an active marker that can be moved with the buttons (8). Switching between markers is done by pressing the button (11) **"MKR";**
- **Amp** - mode in which the buttons (8) change the reference level when outputting such plots as magnitude, logarithmic magnitude and VSWR.

8.3. Designation of the type of calibration (C) figure 8.1:

- **No Cal** - factory calibration;
- **Cal** - calibration corresponding to the frequency plan, displayed in green;
- **Cal. Int** - calibration interpolation, displayed in orange;
- **Cal. Ext** - extrapolation of calibration, displayed in red.

8.4. In the center of the bottom line, the frequency plan is displayed (D) Figure 8.1:

- **Start** - the initial frequency of the frequency plan;
- **Stop** - the final frequency of the frequency plan.

8.5. In the lower right corner of the screen, the type of the plot is displayed on the device screen (E) (Figure 8.1):

- **Smh** - Volpert-Smith chart allowing to display the complex reflection coefficient, relative to an impedance of 50 Ohms;
- **Pol** - polar chart for displaying the complex reflection coefficient;
- **Ph** - plot showing the phase of the reflection coefficient, reduced to degrees in the range from -180 to 180;
- **Mag** - plot showing the modulus of the reflection coefficient in a linear scale;
- **LMag** - plot representing the modulus of the reflection coefficient in a logarithmic scale (in dB);
- **SWR** - plot showing the standing wave voltage ratio;
- **DTF** - plot showing the distance to fault or discontinuity in the cable;
- **Loss** - plot showing cable loss.

Note – To the left and to the right of the designation displayed on the plot, the designations of the previous and next plot are displayed.

Note – Due to the characteristics of **Smh** and **Pol** charts on the device screen, the frequency plan is displayed in the lower right corner. For the **DTF** plot, the distance or time is displayed instead of the frequency setting, depending on the user settings.

8.6. Clicking on the screen with the displayed plot during the measurements puts the device in the pause mode (Figure 8.2). In this mode, the user can take a closer look at the plot. Device status information is displayed by a flashing **PAUSE** symbol next to the battery symbol.

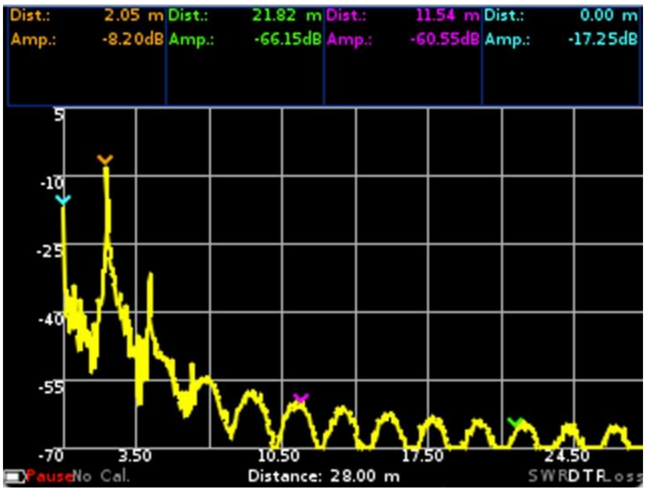


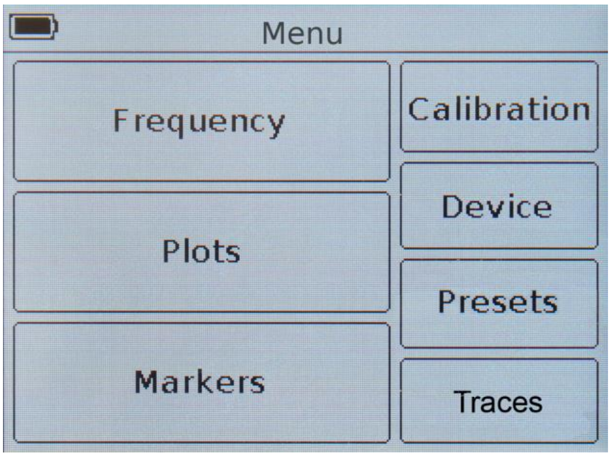
Figure 8.2 – Pause mode

8.7. To exit the pause mode, press the device screen again or press any of the buttons of the control unit.

9. DEVICE MENU

9.1. Main menu

9.1.1. Turn on the device in accordance with section 7 of this Manual. After switching on the device, press the **"MENU"** button (12). The device will display the main menu as in Figure 9.1.



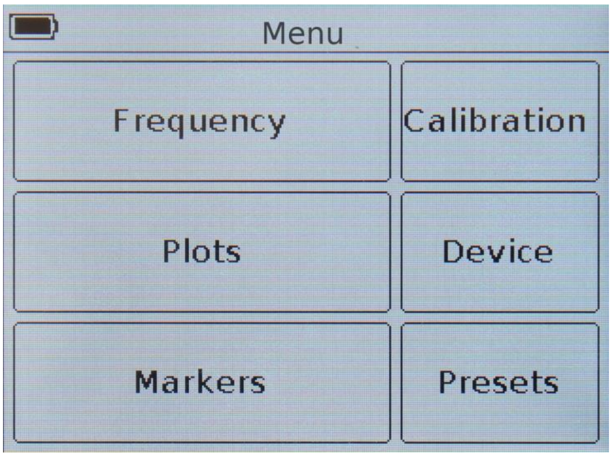


Figure 9.1 – Main menu of ARINST VR 1-6200 and ARINST VR 23-6200

9.1.2. Each section of the main menu has its own purpose:

Frequency – menu section where the user sets the frequencies at which devices or loads are tested.

Plots – the section of the main menu where you can select and configure the parameters of the charts and plots displayed on the screen.

Markers – section for setting visual markers and setting parameters for their display during measurements.

Calibration – menu for calibration of the device.

Device – this section specifies the electrical cable length compensation (ARINST VR 1-6200 only), the device serial number and the software version.

Presets – section to save user settings.

Traces – section to save the results of the current measurements (traces) with the subsequent possibility of loading and comparing them.

9.1.3. To exit the main menu, press the **"MENU"** button (12). To quickly exit from any menu to the displayed plots, press the **"PLOT"** button (14).

9.2. Frequency setting menu

The frequency plan consists of the parameters by which the synthesizer sweeps and sets the measurement mode (frequency range, number of measurement points, digital filter bandwidth)

9.2.1. To set the frequency plan enter the main menu of the device (Figure 9.1) by pressing the **"MENU"** button (12). Enter the **Frequency** section. A menu will appear on the screen, as in Figure 9.2.

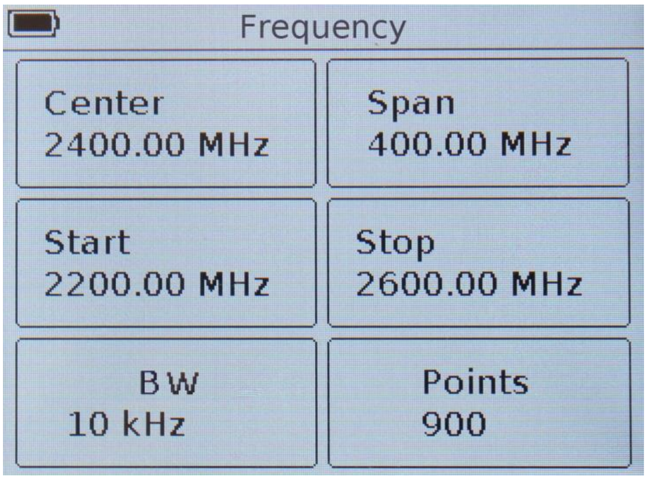


Figure 9.2 – Menu for setting scan parameters

9.2.2. Each of the options in the **Frequency** menu has its own purpose:

Center – setting the center frequency of the scan range.

Span – scanning band (range) of frequencies.

Start – setting the initial frequency of the scanned frequency range.

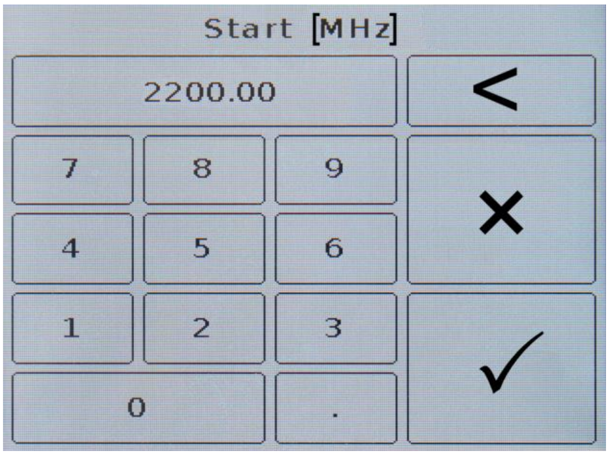
Stop – setting the final frequency of the scanned frequency range.

BW – choice of bandwidth of the digital filter of the intermediate frequency (IF).

Points – select the number of scan points.

9.2.3. Setting the frequency parameters (**Center**, **Span**, **Start** and **Stop**) is done by entering a numerical value in the opened submenu, as in Figure 9.3. Enter the numerical value of the frequencies and press ✓ or **Enter**. To delete erroneous or previously entered values, press **×** or **Del**. To refuse to enter a value, click **<** or **Cancel**. *In our example, in figure 9.3, the initial frequency of 2200 MHz of the scanned frequency range is set.*

Note – discreteness of frequency parameters is 10 kHz (0.01 MHz). In the case of entering an unacceptable value, a warning is displayed on the device that the input value is outside the allowable values.



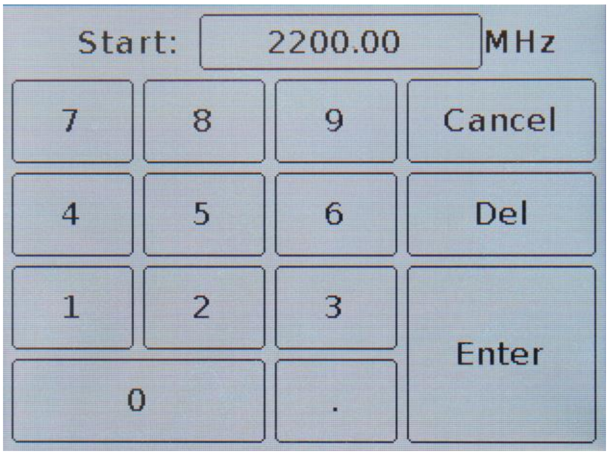


Figure 9.3 – Entering numerical values of frequency parameters of
ARINST VR 1-6200 and ARINST VR 23-6200

9.2.4. Frequency parameters are set in three ways:

- By entering the initial **Start** and final **Stop** frequencies, while the center frequency **Center** is automatically assumed equal to their half-sum. The range of scanned frequencies **Span** is automatically taken equal to the difference between the final and initial frequencies.
- Setting the **Center** frequency and **Span** scan frequency range. In this case, the **Start** and **Stop** frequencies will be set automatically as **Center ± Span / 2**.
- Loading custom settings from the **Presets** menu.

Note – If the frequency entered by the user is outside the working range, a corresponding warning is displayed on the device screen, as shown in Figure 9.4.

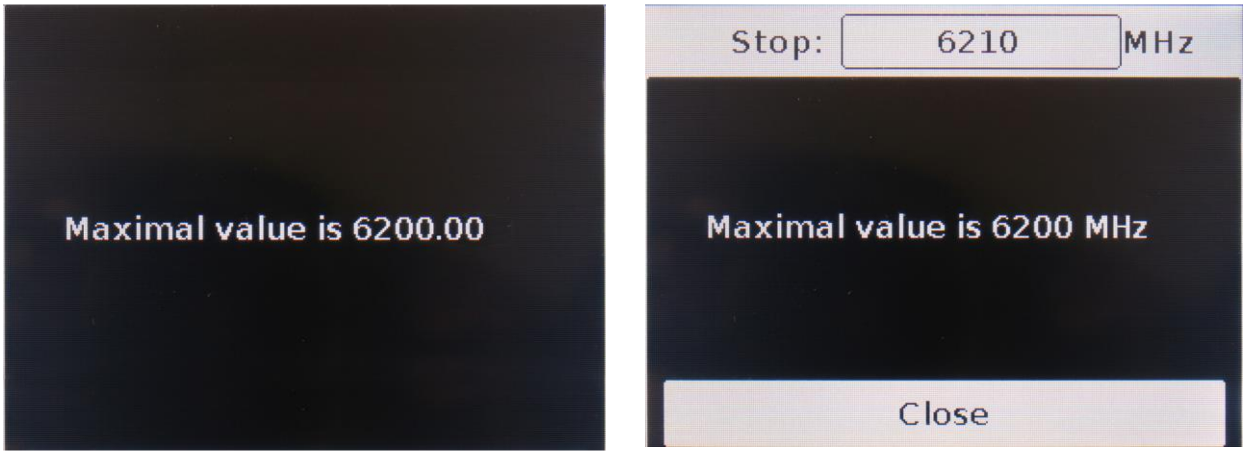


Figure 9.4 – Warning about exceeding the operating range of ARINST VR 1-6200 and ARINST VR 23-6200

9.2.5. In the **BW** menu (Figure 9.5), the bandwidth of the digital filter is selected. The narrower the digital filter bandwidth, the higher the measurement precision and the signal-to-noise ratio. This increases the scan time.

Note – Decreasing the bandwidth 10 times will increase the signal-to-noise ratio of the voltage by 3 times (or 10 dB) while increasing the scan time by 10 times.

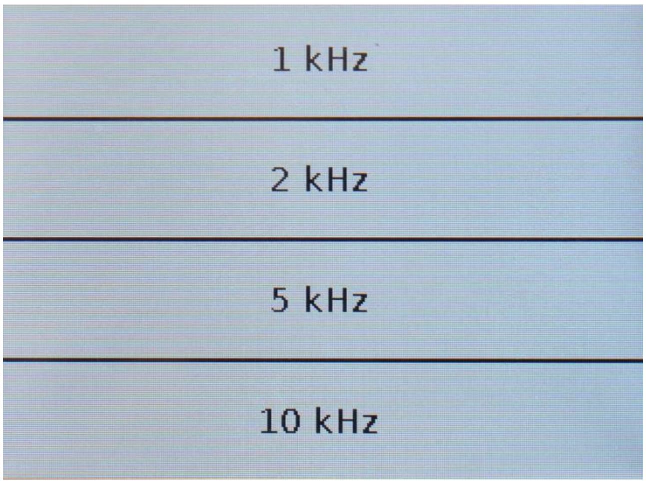


Figure 9.5 – Choosing the bandwidth in the BW menu

9.2.6. In the **Points** menu (Figure 9.6), the user sets the number of scan points. The scanning step in frequency and the scanning time depend on the specified number of points. The correct choice of the number of points and scanning range allows to improve the resolution at a number of measurements (**DTF, Loss**).

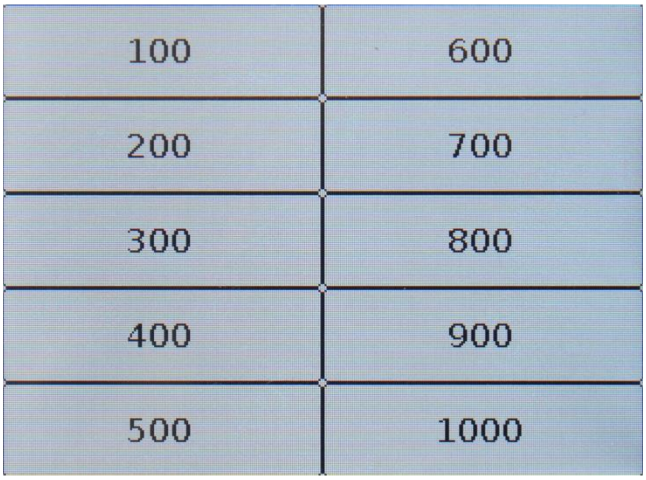


Figure 9.6 – Selection menu of scan points

9.3. Plots menu settings displayed on the screen plots

9.3.1. To select the plots displayed on the device screen and adjust the parameters displayed on these plots, enter the main menu of the device (Figure 9.1) by pressing the **"MENU"** button (12). Enter to the **Plots** section. The menu appears as in Figure 9.7.

Figure 9.7 – The setup menu for the displayed plots

9.3.2. In the **Plots** menu, the plots displayed on the screen are selected and the parameters displayed are set. To display the plot on the device screen, you need to check the box next to the plot name, and to disable it, uncheck it.

9.3.3. Clicking on the field with the name of the plot opens a menu of advanced settings for displaying the plot. A description of the plots and their additional configuration is described in section 10 of this Manual.

Note – In the case of setting the frequency plan, at which the maximum propagation time exceeds the value of 9999.99 ns, the **DTF** menu settings window will be blocked. For more information, see section 10.7. of this Manual.

9.4. Markers menu

9.4.1. Enter the main menu of the device (Figure 9.1) by pressing the **“MENU”** button (12). Enter the **Markers** section. A menu will appear on the screen, as in Figure 9.8.

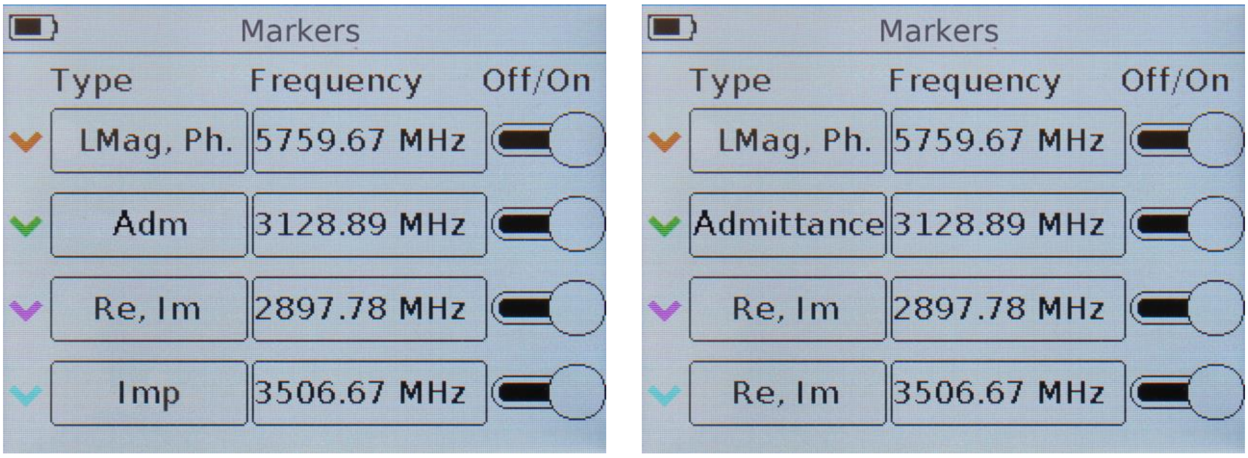


Figure 9.8 – Menu for setting parameters of markers displayed on plots
ARINST VR 1-6200 and ARINST VR 23-6200

9.4.2. On all plots displayed on the device screen, except for **DTF** and **Loss**, you can display up to four multi-colored markers to display numerical measurement results. Switching off and on the marker is made by moving the corresponding slider against the selected marker to the **Off / On** position. Markers are completely independent of each other and can be tuned by the type of values displayed by the marker and by frequency.

9.4.3. To adjust the marker by the type of displayed values, click on the corresponding marker in the **Type** column. The menu for selecting the type of values displayed by the marker will appear on the screen (Figure 9.9).

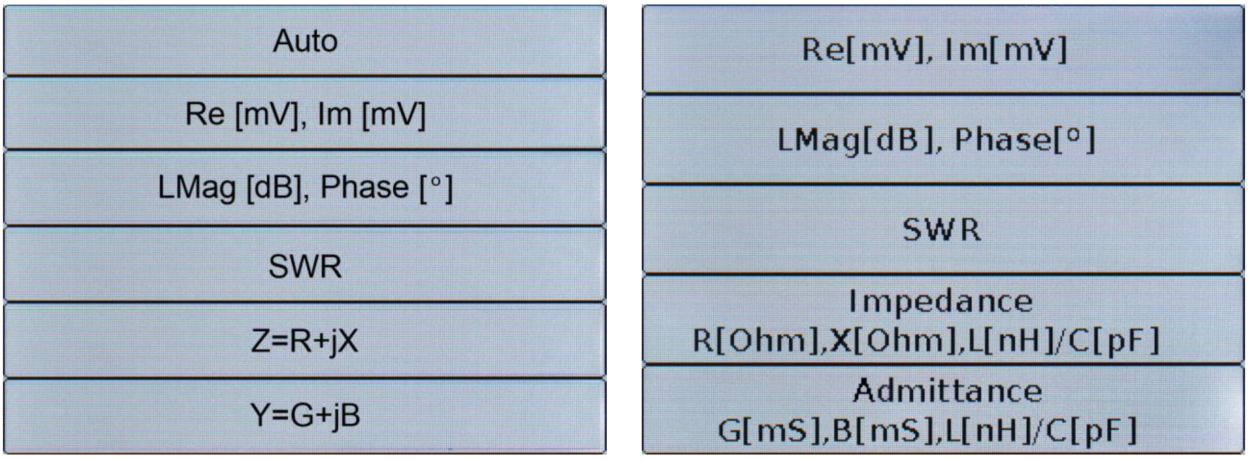


Figure 9.9 – Selecting the type of values displayed by the marker
ARINST VR 1-6200 and ARINST VR 23-6200

9.4.4. Select the type of value displayed by the marker according to table 3.

Table 3

Auto	The values of the complex reflection coefficient are displayed in the interpretation corresponding to the displayed graph. Switching the graph automatically changes the interpretation view.
Re[mV], Im[mV]	Displays the amplitude of the real and imaginary parts of the complex reflection coefficient in millivolts (mV). The total reflection corresponds to 1000 mV.
LMag [dB], Phase [°]	Displays magnitude at logarithmic scale and phase in degrees.
SWR	The standing wave ratio (VSWR).
Z=R+jX	Displays the active and reactive part of impedance in ohms (Ohm). Type of reactance - capacitance or inductance.
Impedance R[Ohm], X[Ohm], L[nH]/C[pF]	
Y=G+jB	Displays of the active and reactive parts of the admittance in millisiemens (mS). Type of reactivity - capacitance or inductance.
Admittance G[mS], B[mS], L[nH]/C[pF]	

9.4.5. To set the frequency on which the marker will be set, in the menu of markers (Figure 9.8) in the **Frequency** column, click on the corresponding marker. A submenu for entering numerical values will appear on the screen, as in Figure 9.10.

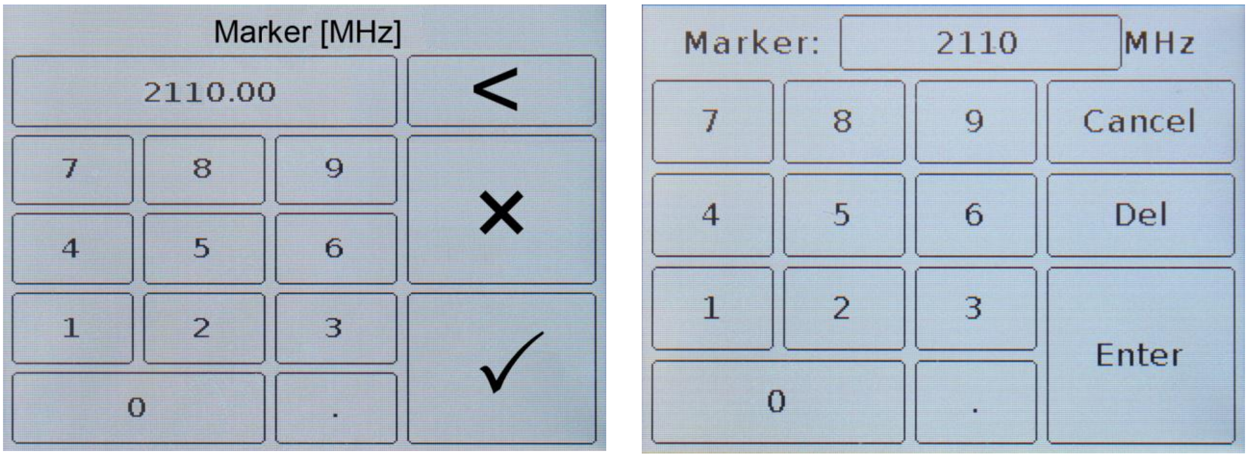


Figure 9.10 – Entering numerical values of the frequency to set the marker ARINST VR 1-6200 and ARINST VR 23-6200

9.4.6. Enter the numerical value of the frequencies and press ✓or **Enter**. To delete erroneous or previously entered values, press **×** or **Del**. To refuse to enter a value, click **<** or **Cancel**.
In our example, in figure 9.10, the frequency of 2110 MHz is entered to set the marker to this frequency value on the plot.

The markers can be moved left-right along the plot using the navigation buttons (8) and switching between the markers with the button (11) **"MKR"**. The marker will move in steps equal to:

$$Step = \frac{SPAN}{(N-1)}$$

where *Step – marker movement step*
SPAN – scanning frequency range
N – number of scan points.

9.4.7. The marker turned on and set to a user-defined frequency will be displayed on the measurement plot in the corresponding color. The parameters of the values displayed by the markers are displayed next to the measurement plot and change in real time (Figure 9.11).

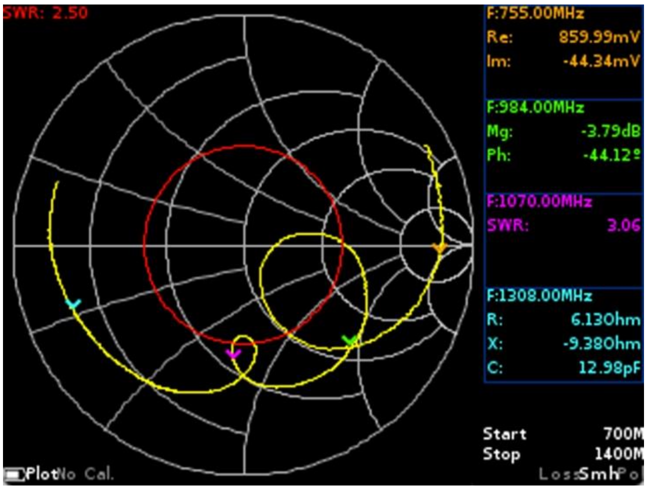


Figure 9.11 – Display of parameters measured by markers

To quickly change the displayed parameters or the frequency of one of the four markers displayed near the plot, click on the marker parameters area and go to the express settings menu of markers [7] (Figure 9.12).

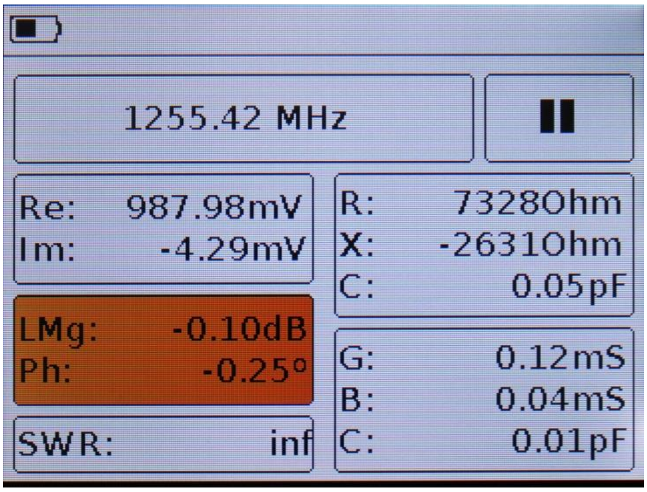


Figure 9.12 – Express menu for setting markers

Changing the frequency at which the marker is located is carried out in two ways:

- Pressing the block with the frequency display and then moving to the menu for entering numerical values, as in Figure 9.10.

[7] For all types of plots except DTF and Loss plots. These plots have their own express menus, which will be discussed below.

- By pressing the navigation buttons (8). The frequency change will occur in increments of 0.1% of the current frequency.

The "start / pause" button allows you to fix the values of each of the parameters constantly changing in real time.
The color highlights the parameters of the selected marker displayed on the plot. To change the display parameters of the selected marker, click on one of the four blocks with parameters without backlight. Clicking on the backlit block will result in the return of the display parameters. Pressing the **“MENU”** button (12) returns to the viewing plot.

Table 4 below shows the types of displayed parameters in the express menu.

Table 4 - The value of the parameters of the express menu of setting markers

<table>
<tr><th colspan="2">Marker Frequency (MHz)</th><th colspan="2">Start / Pause button</th></tr>
<tr><td rowspan="2">Re:
Im:</td><td rowspan="2">Amplitude of the complex RC</td><td rowspan="3">R:
X:
C:</td><td rowspan="3">Impedance</td></tr>
<tr></tr>
<tr><td rowspan="2">Mg:
Ph:</td><td rowspan="2">Magnitude and Phase</td></tr>
<tr><td rowspan="3">G:
B:
C:</td><td rowspan="3">Admittance</td></tr>
<tr><td rowspan="2">SWR:</td><td rowspan="2">VSWR</td></tr>
<tr></tr>
</table>

9.4.8. To quickly change the displayed parameters or the frequency of one of the four markers of the **DTF** plot, click on the area of the selected marker above the plot and go to the express menu (Figures 9.13 and 9.14). Press the button (12) **“MENU”** to return to the viewing plot.

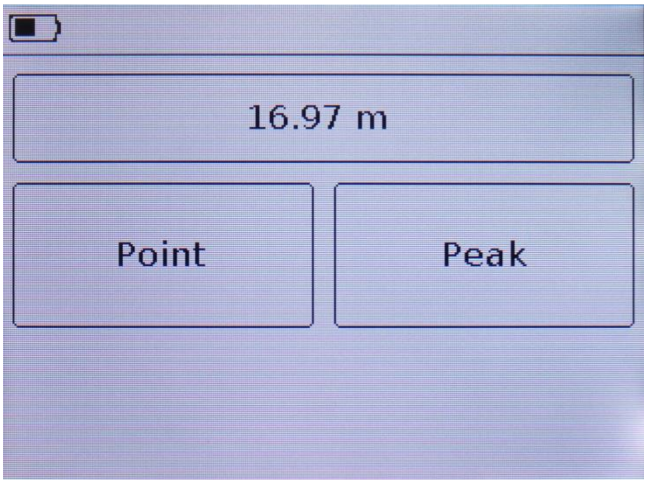


Figure 9.13 – Express menu for setting DTF plot distance parameters

Clicking on the top express-menu block, set the time (ns) or distance (m) from the reference point on the plot for measuring with the selected marker. Then, set the type of marker **Point** or **Peak**. By selecting **Point,** you place the marker at a plot point located at a specified distance or time from the start of the reference.

Select the value of the Peak (maximum) will lead to the placement of the marker on the peak (maximum) of the plot corresponding marker sequence number. In this case, the entered time or distance value is ignored by the device.

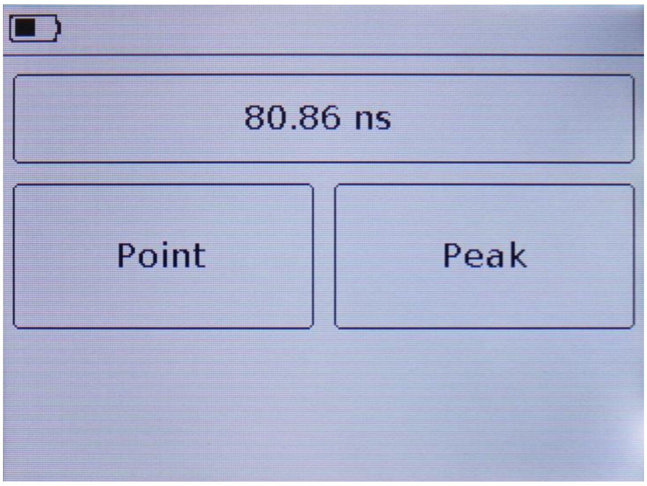


Figure 9.14 – Express menu for setting the time parameters of the DTF plot markers

Note – The parameters of the markers (time or distance) depend on the selected **Scale** units of measurement in the marker setting menu for the **DTF** plot (see par. 10.7. of this Manual).

In addition to entering numerical values, markers can be moved left-right along the plot using the navigation buttons (8) and switching between the markers with the button (11) **"MKR"**. The marker will be moved in increments of 1/1024 from the time or distance displayed on the plot.

Note – Moving with buttons (8) is possible only for markers of the Point type. **Peak** (maximum) type markers do not move.

9.4.9. To quickly change the displayed parameters or the frequency of one of the four markers of the **Loss** plot, click on the area of the selected marker above the plot and go to the submenu for entering the numerical values of this marker as in Figure 9.10

In addition to entering numerical values, markers can be moved left-right along the plot using the navigation buttons (8) and switching between the markers with the button (11) **"MKR"**. The movement of the marker will occur in steps equal to:

$$Step = \frac{SPAN}{(N-1)}$$

where *Step – marker movement step*
SPAN – scanning frequency range
N – number of scan points.

9.5. Device calibration menu

The device is initially factory calibrated, recorded in non-volatile memory, the relevant information **(No Cal)** is displayed in the lower information line of the screen. The calibration plane corresponds to the device port (1) for connecting the test devices and the load (**TEST PORT**). To increase the accuracy of measurements using additional adapters and cables, it is necessary to make a full single-port calibration using a set of calibration measures purchased separately.

9.5.1. To enter the calibration menu, enter the device main menu by pressing the **"MENU"** button (12) (Figure 9.1) and select the **Calibration** section. The screen will display the calibration menu as shown in figure 9.15.

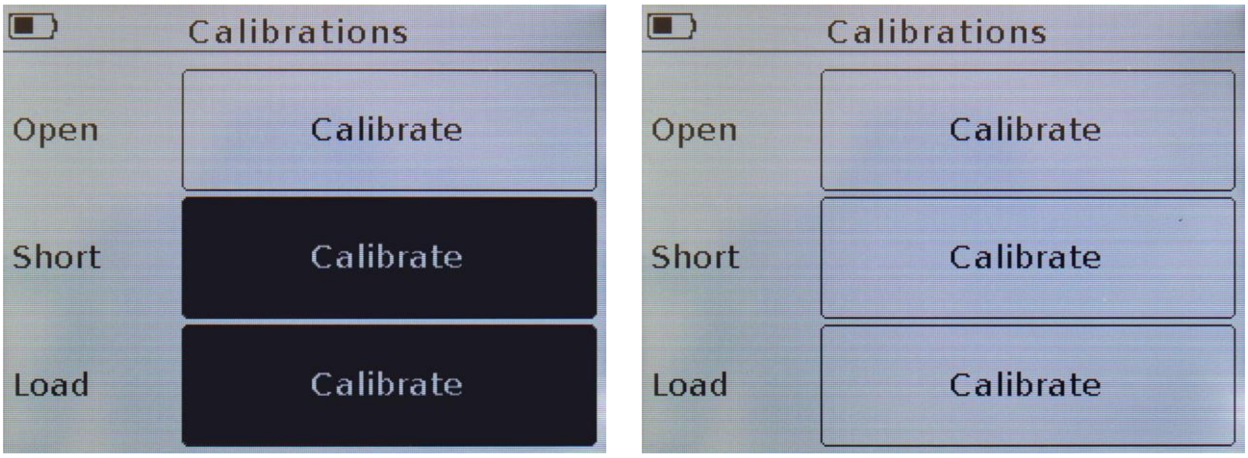


Figure 9.15 – Calibration Menu ARINST VR 1-6200 and ARINST VR 23-6200

9.5.2. To reduce the influence of connecting wires and connectors on the measurement results, it is necessary to calibrate.

Note - Calibration is performed after warming up the device for at least five minutes. The change in ambient temperature from the time of calibration to measurements should not exceed ± 3 °C. Before carrying out critical measurements, always calibrate the device to eliminate the influence of the ambient temperature.

9.5.3. Connect the connectors, adapters and cables through which the device will be connected to the test device to the port (1) of the device (**TEST PORT**).

Note – Thus, the device calibration plane is transferred from the test port (1) of the device (**TEST PORT**) to the required cable or connector.

Then connect the loads from the standard set of calibration measures (not included) to the required cable or connector:

- Open standard and press the **Open** command on the screen
- Short standard and press the **Short** command on the screen;
- Load standard, and click **Load** command.

After calibration, the background of the commands on the screen will turn black or green (depending on the model of your device), as in Figure 9.16.

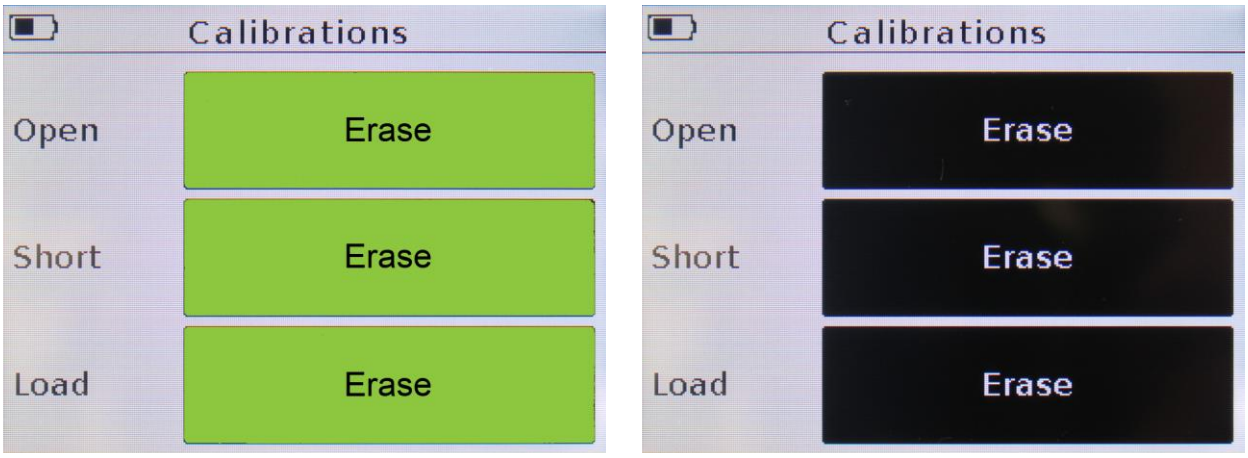


Figure 9.16 – Calibration of ARINST VR 1-6200 and ARINST VR 23-6200 devices

Note – To cancel (erase) this or that calibration, click on the **Erase** button, and reconnect the appropriate calibration measure, calibrate the device again.

9.5.4. On the screen in the plot display mode, the calibration information will appear in the lower information line:

- **No Cal** – custom calibration no. The device is factory calibrated.
- **Cal** – Calibrated by user. Calibration and frequency plan match. In this mode, the measurement results are the most accurate.
- **Cal. Int** – The frequency plan does not coincide with the reference at which calibration was performed, but the frequencies lie within the calibration range. The measurement accuracy is lower, since the device uses a mathematical method for calculating calibrations based on interpolation.
- **Cal. Ext** – The frequency plan does not coincide with the reference at which the calibration was performed, but the frequencies are outside the calibration range. Measurement accuracy is the lowest since the device uses a mathematical method for calculating calibrations based on extrapolation.

Note – When you exit the **Calibration** menu until the full calibration process is completed, a warning will be displayed on the screen, as in Figure 9.17. You must either return to the menu by clicking **Back** and complete the calibration process, or exit the menu by clicking **OK**. In the latter case, when carrying out measurements, the factory calibration of the device will be applied.

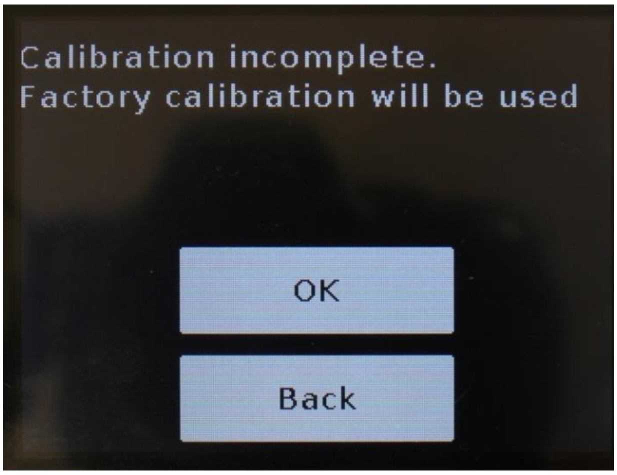


Figure 9.17 – Warning on the device screen

9.6. Custom settings menu

To save custom settings (frequency setting, calibrations, types of displayed plots of marker settings), enter the main menu by pressing the **"MENU"** button (12) (Figure 9.1) and select the **Presets** section. A menu of user settings will appear on the screen, as in Figure 9.18.

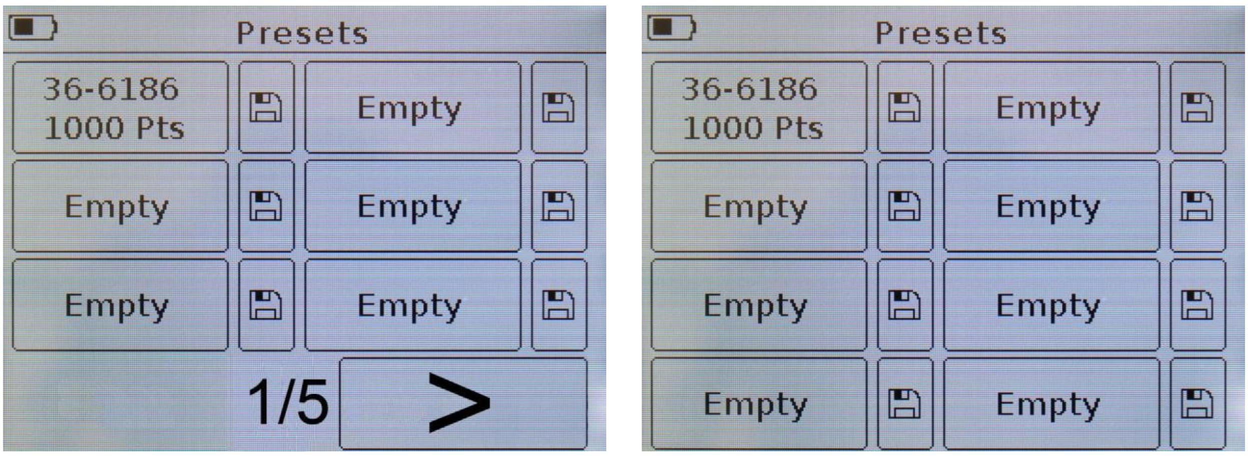


Figure 9.18 – Custom settings menu of ARINST VR 1-6200 and ARINST VR 23-6200 devices

9.6.1. The device **ARINST VR 23-6200** allows you to save up to eight user settings in memory. The **ARINST VR 1-6200** can store up to thirty user settings on five pages. To save the settings, click the floppy disk icon. The device will display a message about saving the settings. In the field to the left of the floppy icon, instead of the word **Empty**, the display of the user-configured frequency (frequency range and number of points) will appear.

9.6.2. To save the new settings, click on the floppy icon next to the field without settings. If all eight fields are occupied with user settings, overwrite them by clicking on the floppy icon next to outdated or unnecessary settings.

Note – Saving the user setting takes about 2 seconds, at this time the device does not respond to touching the screen and pressing buttons.

9.6.3. To load the saved settings, click on the field with the desired frequency plan. The device will load the saved data and go into the display mode of the plot that was displayed at the moment of saving the settings.

9.7. Device information

9.7.1. To enter the device information menu, enter the main menu of the device by pressing the **"MENU"** button (12) (Figure 9.1) and select the **Device** section. The screen will display information about the device, as in Figure 9.19.

- ID of the device;
- operating range;
- software version

9.7.2. In addition to the information about the device, in this section of the menu **ARINST VR 1-6200** there is an option of compensation of the electric cable length (Electrical delay) allowing compensating for the phase shift when connecting additional cables with low attenuation to the device. For more information on how to use this option, see subsection 9.9.

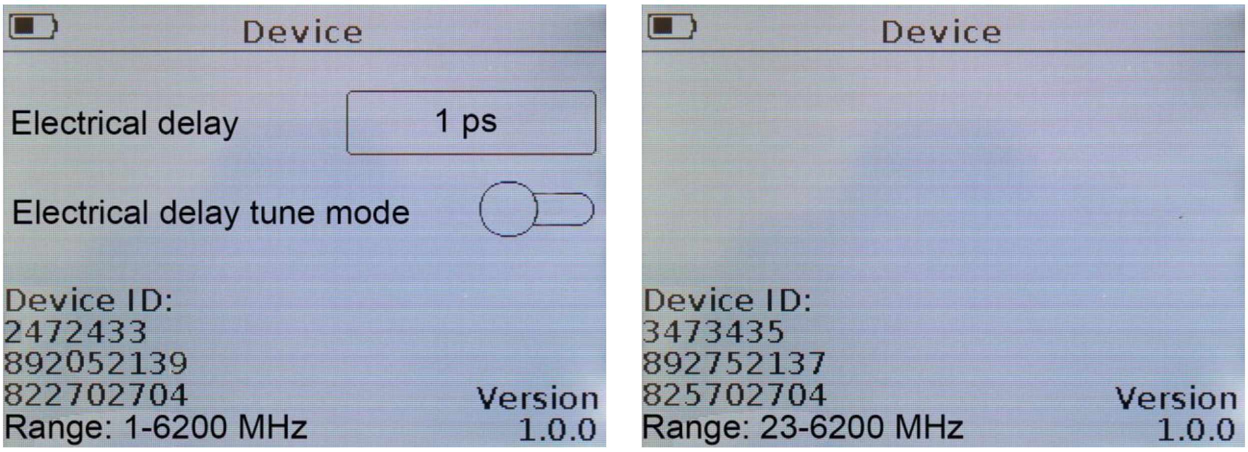


Figure 9.19 – Device Information in the Device menu ARINST VR 1-6200 and ARINST VR 23-6200

9.8. Displaying the VSWR limit line

9.8.1. When working with the Volpert-Smith chart, polar chart and VSWR plot, you can set the limit line of the voltage standing wave ratio or VSWR. This line will be displayed in red on **Smh**, **Pol** charts and **SWR** plot.

9.8.2. There are two ways to get to the menu of enabling the display of the limit line of the VSWR:

- Enter the **Plots** menu as indicated in section 9.3. and by clicking on the field with the designation of the chart **Smh**, **Pol** or **SWR** plot, go to the settings menu and display the VSWR limit line (Figure 9.20).

- In the **Smh**, **Pol** charts or **SWR** plot view mode, press and hold the button (14) **"PLOT"** for about two seconds and go to the setup menu and display the VSWR limit line (Figure 9.20).

9.8.3. Turning off and on the display of the VSWR limit line on the plots is performed by moving the slider to the **Off / On** position (Figure 9.20).

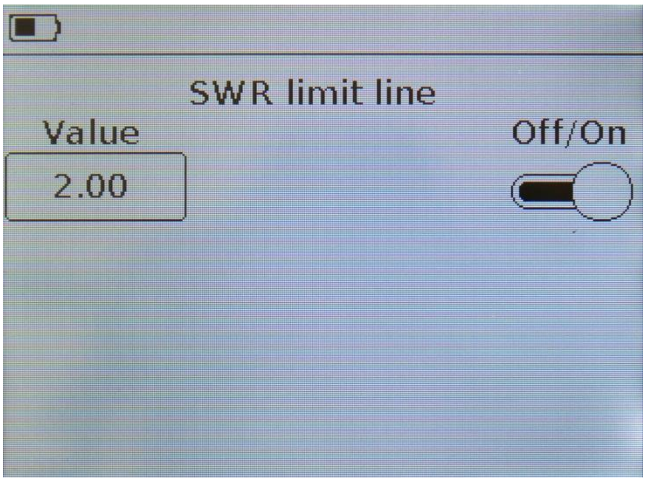


Figure 9.20 – Turning on the display of the VSWR limit line on the Smh, Pol charts and SWR plot

9.8.4. To change the display value of the level of the VSWR limit line, click on the numerical value **Value**, and in the appeared submenu (Figure 9.21), enter a numeric value in the range from 1.01 to 9.00.

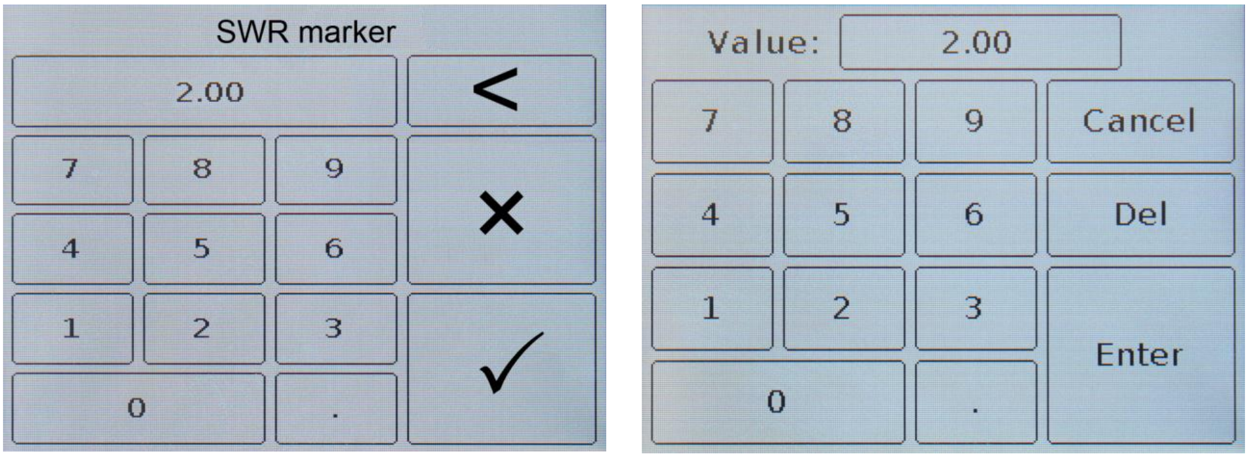


Figure 9.21 – Entering the numerical value of the displayed SWR limit line
ARINST VR 1-6200 and ARINST VR 23-6200

9.8.5. Enter the numerical value of the coefficient and press ✓ or **Enter**. To delete erroneous or previously entered values, press **×** or **Del**. To refuse to enter a value, click **<** or **Cancel**. *In our example, in figure 9.21, we enter the numerical value of the displayed VSWR limit line of the value on the charts.*

Note – If the coefficient value entered by the user is outside the working range (1.01 - 9.00), a corresponding warning is displayed on the device screen.

9.9. Compensation electric cable length (option in the device ARINST VR 1-6200)

The electrical cable length compensation option is designed to transfer the calibration plane of the device.

In the process of measurements, when forced to use an additional adapter cable with a small total attenuation of the signal (not more than 1 dB), a shift of the calibration plane occurs. To compensate for the phase shift when additional cables are connected to the instrument, it is necessary to transfer the measurement plane to the calibration plane.

Consider the example of the Volpert-Smith diagram, how this option works.

9.9.1. Perform a full single-port calibration of the device in accordance with paragraph 9.5 of this Manual. The Volpert-Smith graph, or polar chart, will shrink into a circle with a minimum radius if calibration is successful (figure 9.22).

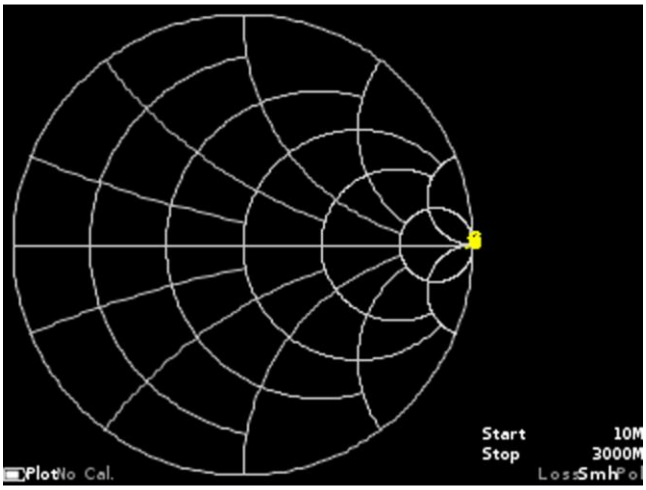


Figure 9.22 – The Smith chart after calibration of the device

Note – If the factory calibration parameters meet the measurement conditions, it is not necessary to calibrate.

9.9.2. Connect an additional (transition) cable of small length with a total signal attenuation of not more than 1 dB. In the Smith chart and the polar diagram, a circle with a minimum radius is converted to an arc (figure 9.23).

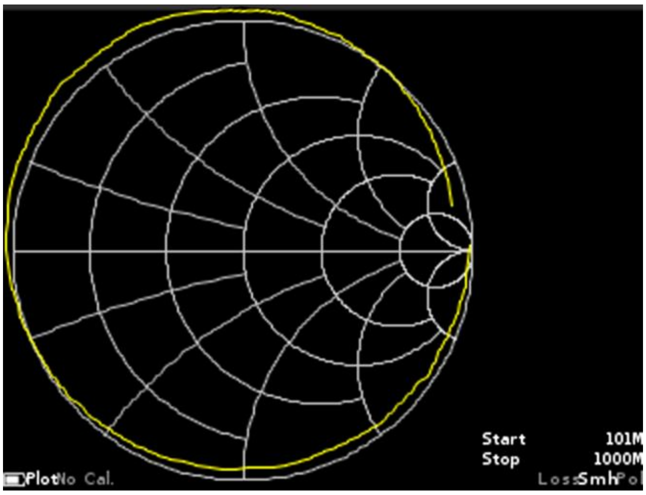


Figure 9.23 – Offset calibration plane by additional cable

This is due to the fact that additional cables arises phase shift proportional to the length of the cable. To compensate for this, you must set the options in the device approximate value of the delay in seconds.

The formula for calculating the propagation time compensation additional probing signal along cable:

$$T = \frac{2L}{C \times VF}$$

where *L - length of cable (m)*
C - the speed of light (m / s)
VF - The velocity factor has a value <1

To convert the values of T in picoseconds (ps), the resulting value is multiplied by 10^{12}.

9.9.3. For precise adjustment of the compensation value probing signal electrical delay time (T) to move from a display mode of a Smith graphs, or phase diagrams in polar profile information about the device **Device** in the main menu of the device (Figure 9.24).

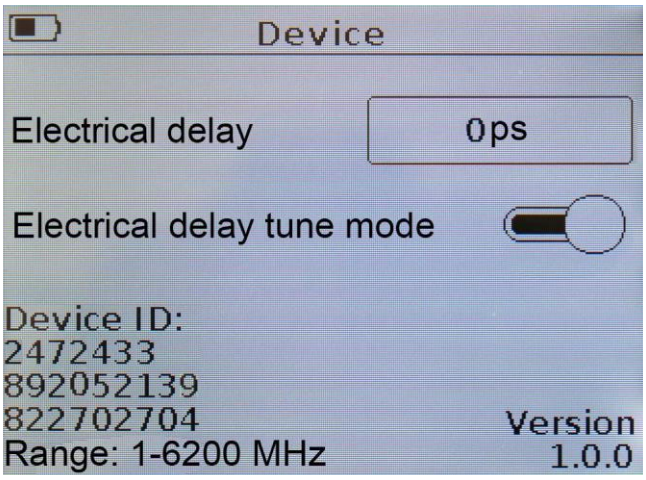


Figure 9.24 – Enabling Electrical delay tune mode

9.9.4. Type numerical time a compensation value (T) in picoseconds as calculated from the formula in box Electrical delay (Figure 9.25).

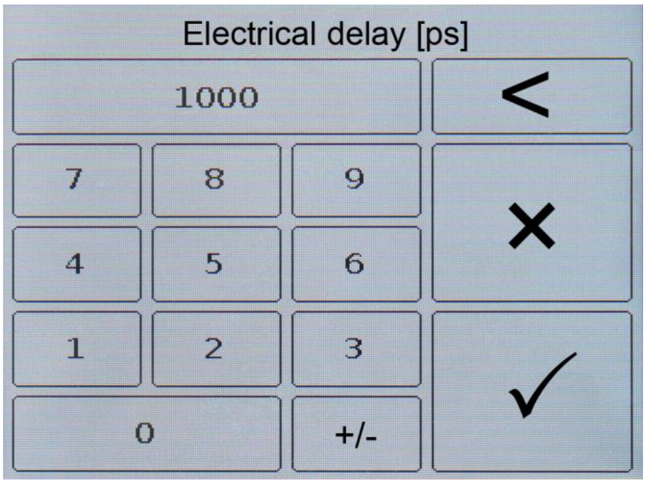


Figure 9.25 – Entering numeric value compensation electric cable length

9.9.5. Enter a numeric time compensation value and press ✓ or **Enter**. To delete erroneous or previously entered values, press **×** or **Del**. To refuse to enter a value, click **<** or **Cancel**. *In our example, in figure 9.25, a numerical value for cable length compensation is entered.*

Note – Entering a numerical value of the electrical length of the cable results in compensation of the phase foray on the graph.

9.9.6. Return to the Smith, phase, or polar chart display mode. If necessary, fine adjustment of the time compensation, set the Electrical delay tune mode, moving the slider and navigation buttons (8) perform fine adjustment of the time of payment, with the chart on the Smith chart and the polar diagram will now be drawn in a circle with minimum radius, and the phase graph will be horizontal (figure 9.26).

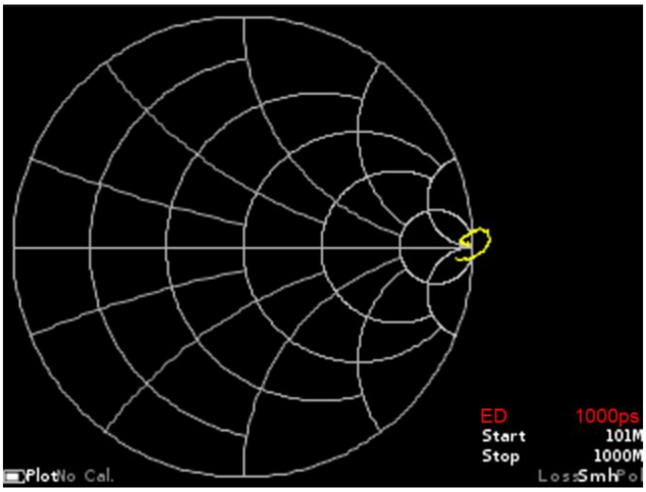


Figure 9.26 – The electrical cable length is compensated

9.9.7. Turning on the Electrical delay mode locks all the instrument buttons except the move buttons (8), **"PLOT"** (14) and **"MENU"** (12). Pressing **"PLOT"** (14), **"MENU"** (12) buttons or entering the graphs setting menu disables Electrical delay mode.

Note – The time compensation value is displayed on the device screen (ED value) and stored in **Presets** when the device is turned off. If you change the calibration plane, remove the electrical cable length compensation value by setting the value to zero.

9.10. Saving measurement results (ARINST VR 1-6200 option)

The **ARINST VR 1-6200** device provides the possibility of saving the measurement results with the possibility of subsequent viewing and comparison with the current measurement results.

9.10.1. To save the obtained measurement results, enter the main menu of the device by pressing button (12) **"MENU"** (Figure 9.1) and select **Traces**. The menu will appear as in Figure 9.27.

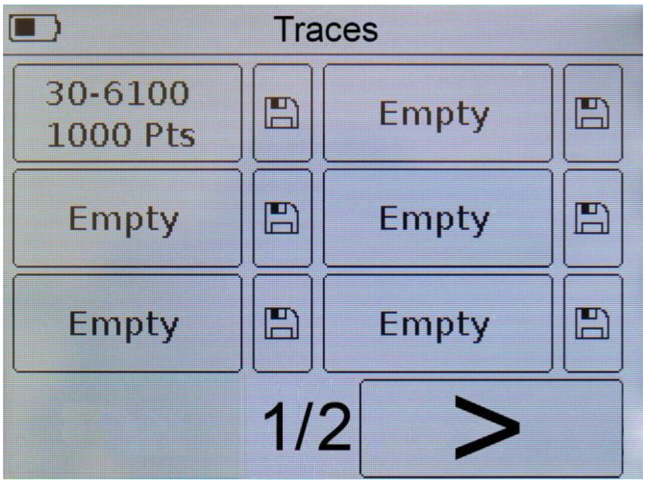


Figure 9.27 – Menu for saving measurement results

9.10.2. Device **ARINST VR 1-6200** can store up to twelve measurements. Click on the floppy disk icon to save the measurement results. On the screen of the device will display a message about saving the measurement results. At the left of the floppy disk icon instead of the word **Empty** will display a user-defined reference frequency (frequency range and the number of pixels) in the measurements.

9.10.3. To save the new results, click on the floppy icon next to the **Empty** field. If all fields are occupied by the saved results, overwrite by clicking on the floppy icon next to the outdated or unnecessary results.

9.10.4. To view the saved measurement results and compare them with the current ones, click on the frequency setting. The background of the field with the frequency assignment will turn black. Go to graphs with dimensions. The saved measurement results on the graph will be displayed as an orange graph (trace) (Figure 9.27).

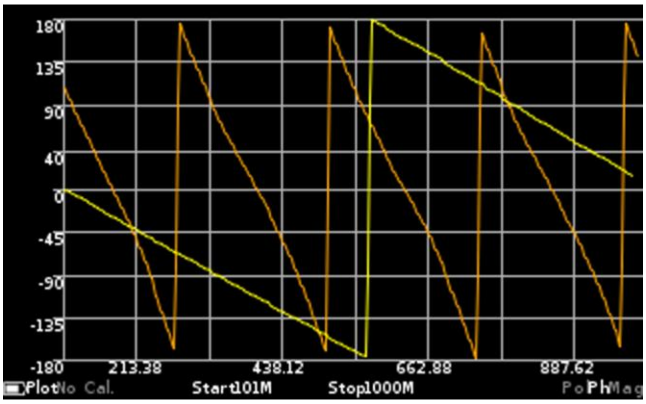


Figure 9.28 – Compare the saved dimension with the current one

Disabling the mode of viewing the measurement results is performed by clicking on the field with the measurement result enabled in the **Traces** menu.

10. CHARTS AND PLOTS

10.1. Volpert-Smith chart

10.1.1. The Volpert-Smith chart is used to determine the complex impedance of the test load and allows you to display the complex reflection coefficient in a graphical form on a plane. On the horizontal axis, the real part of the reflection coefficient (RC) is deposited, and on the vertical axis, the imaginary part of the RC.

10.1.2. The grid of the chart corresponds to the impedance 50 Ohm (Figure 10.1). On the screen of the reflectometer it is designated as **Smh**. Enabling or disabling the display of this chart on the screen is made as indicated in par. 9.3.

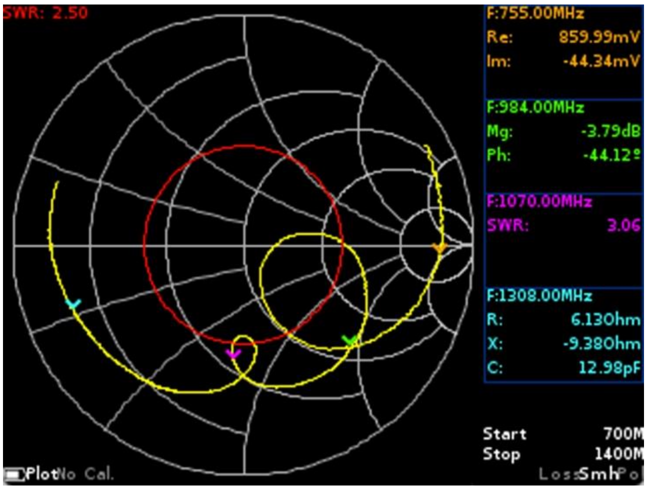


Figure 10.1 – Volpert-Smith chart on the device screen

10.1.3. In addition, in the **Plots** menu can be enabled displaying the VSWR limit line with the setting of a numerical value (see par. 9.8.). The red circle around the center of the chart corresponds to the constant VSWR. If the chart does not go beyond the VSWR limit line, then the VSWR of the measured load does not exceed the set value. The Volpert-Smith chart allows us to estimate the circuit mismatch and the type of the load: purely active, reactive-inductive, reactive-capacitive, or complex.

10.1.4. In addition to displaying the VSWR limit line, up to four markers can be displayed on the chart. The inclusion of markers and their adjustment is performed in accordance with par. 9.4.

Note – To quickly switch from the **Smh** chart viewing mode in the marker settings menu (Figure 9.8), press and hold the button (11) **"MKR"** for about two seconds.

In our example, in Figure 10.1, a GSM antenna with an operating frequency of 900 MHz is being tested. The chart includes four markers and the display of the VSWR limit line with a value of 2.5. Measurement values at a fixed marker frequency in specified units are displayed to the right of the chart.

10.2. Polar chart

10.2.1. The polar chart is intended to display the complex reflection coefficient in a two-dimensional coordinate system (Figure 10.2). The chart is similar to the Volpert-Smith chart, but its scale grid is reduced to specific values of the VSWR - 2; 5. On the device screen is indicated as **Pol**. Enabling or disabling the display of this chart on the screen is made as indicated in par. 9.3.

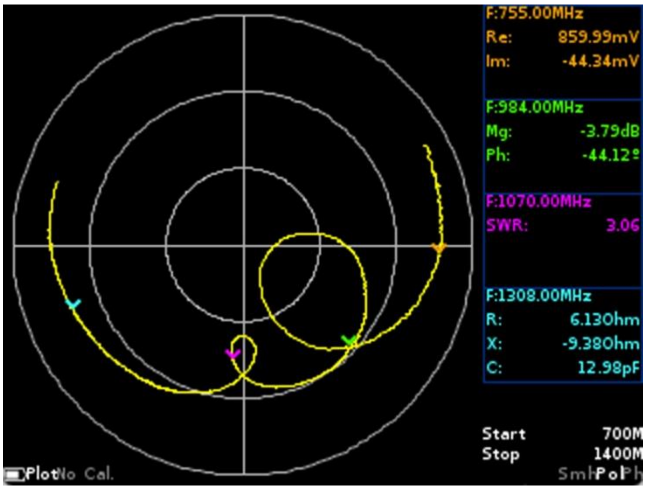


Figure 10.2 – Polar chart

10.2.2. Additionally, in the **Plots** menu, the display of the VSWR limit line with the setting of a numerical value can be turned on (see par. 9.8.). The red circle around the center of the chart corresponds to the constant VSWR. If the chart does not go beyond the VSWR limit line, then the VSWR of the measured load does not exceed this value.

10.2.3. In addition to displaying the VSWR limit line, up to four markers can be displayed on the chart. The inclusion of markers and their adjustment is performed in accordance with par. 9.4.

Note – To quickly switch from the **Pol** chart viewing mode in the marker settings menu (Figure 9.8), press and hold the button (11) **"MKR"** for about two seconds.

In our example, in Figure 10.2, a GSM antenna with an operating frequency of 900 MHz is being tested. The chart includes four markers, and the display of the VSWR limit line is disabled. Measurement values at a fixed marker frequency in specified units are displayed to the right of the chart.

10.3. Phase plot

10.3.1. The phase plot shows the dependence of the phase of the reflection coefficient (RC) on the frequency, relative to angles from -180 to 180 degrees (Figure 10.3). On the screen of the device is designated as **Ph**. Enabling or disabling the display of this plot on the screen is made as indicated in par. 9.3.

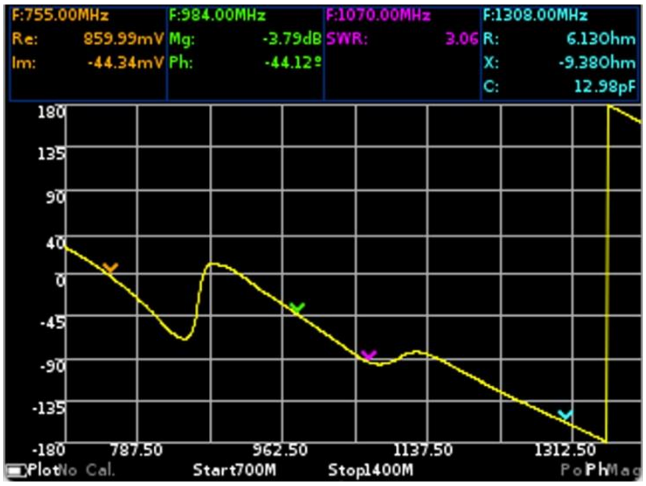


Figure 10.3 – Phase plot

10.3.2. Up to four markers can be displayed on the phase plot as well as on the Volpert-Smith chart and polar chart. Inclusion of markers and their adjustment is carried out according to par. 9.4.

Note – To quickly switch from the **Ph** plot view to the marker settings menu (Figure 9.8), press and hold the **"MKR"** button (11) for about two seconds.

In our example in figure 10.3 GSM antenna with operating frequency of 900 MHz is tested. Above the plot, the measurement values of the four included markers are displayed in the specified units.

10.4. Plot of the magnitude (module) of the reflection coefficient in a linear scale

10.4.1. This plot shows the dependence of the RC magnitude on the frequency in a linear scale (Figure 10.4). On the device screen is displayed as **Mag**. Turning on and off the display of this plot on the screen and its setting is performed as indicated in par. 9.3.

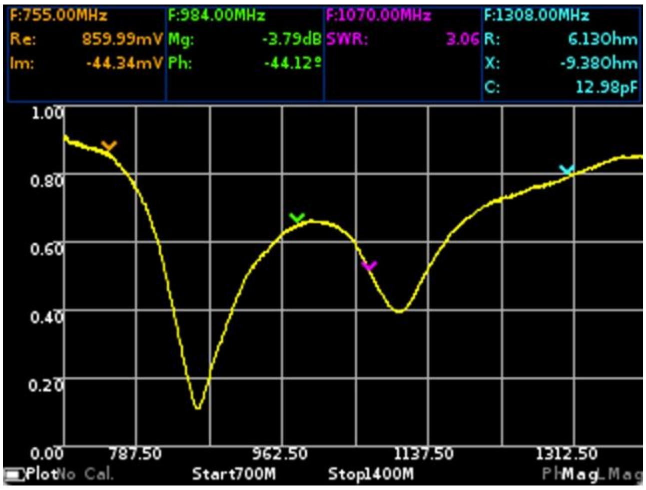


Figure 10.4 – Plot of the magnitude in a linear scale

In our example, in Figure 10.4, a GSM antenna with an operating frequency of 900 MHz is being tested. Above the plot of magnitude with a linear grid, the measurement values of the four included markers are displayed in specified units.

Note – To quickly switch from the **Mag** plot viewing mode in the marker settings menu (Figure 9.8), press and hold the **"MKR"** button (11) for about two seconds.

10.4.2. There are two ways to change the scale of the vertical grid of the displayed chart:

- Enter the **Plots** menu (Figure 9.6) and click on the field with the chart name. The device screen will display the vertical grid step selection menu in millivolts (mV), figure 10.5.
- To go from the **Mag** plot viewing mode to the vertical grid pitch change menu (Figure 10.5), press and hold the «**PLOT»** button (14) for about two seconds.

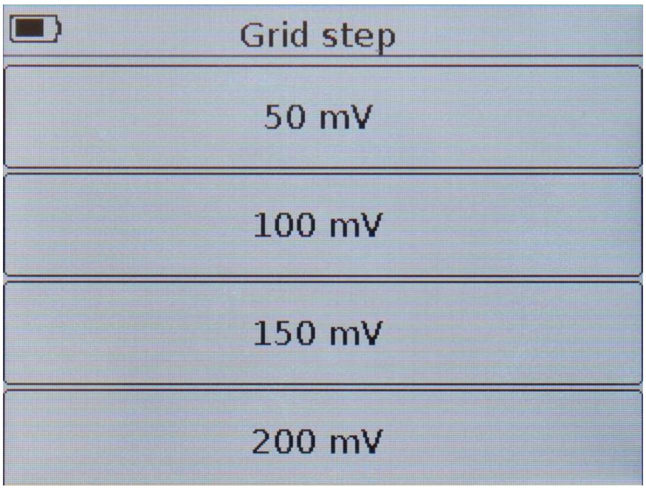


Figure 10.5 – Vertical grid step selection in mV

10.5. Plot of the magnitude (module) of the reflection coefficient in a logarithmic scale

10.5.1. This plot shows the dependence of the magnitude of RC on the frequency in a logarithmic scale, in dB (Figure 10.6.). On the device screen, the plot is displayed as **LMag**. Enabling or disabling the display of this plot on the screen and its setting is performed as described in par. 9.3.

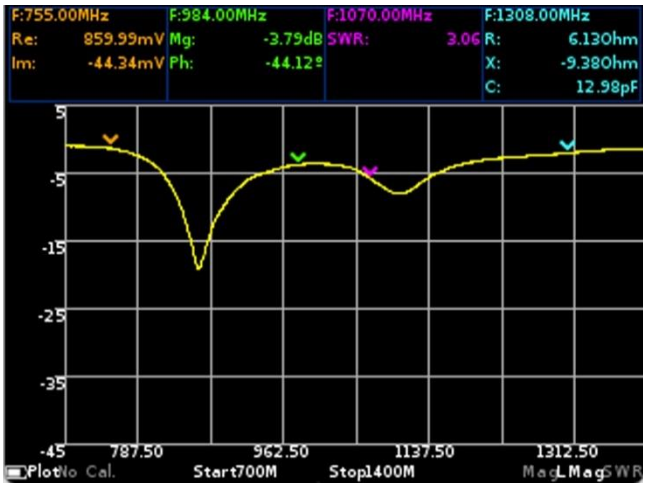


Figure 10.6 – Plot of the magnitude in a logarithmic scale

In our example, in figure 10.6, a GSM antenna with an operating frequency of 900 MHz is being tested. Above the magnitude plot placed on a logarithmic grid, the measurement values of the four included markers are displayed in specified units.

<u>Note</u> – For a quick transition from the **LMag** plot viewing mode in the marker settings menu (Figure 9.8), press and hold the **"MKR"** button (11) for about two seconds.

10.5.2. Change the scale of the vertical grid of the displayed plot in two ways:

- Enter the **Plots** menu (Figure 9.6) and click on the field with the name of the chart. The device will display the menu for selecting the vertical grid step in decibels (dB), Figure 10.7.
- To quickly switch from the **LMag** plot viewing mode in the vertical grid pitch change menu (Figure 10.7), press and hold the **PLOT** button (14) for about two seconds.

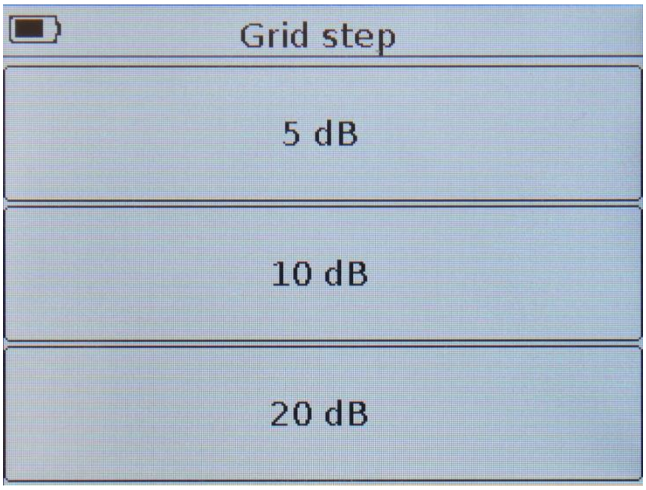


Figure 10.7 – Vertical grid step selection in dB

10.6. VSWR plot

10.6.1. The plot shows the voltage standing wave ratio (VSWR). The plot on the device screen (Figure 10.8) is displayed as **SWR**.

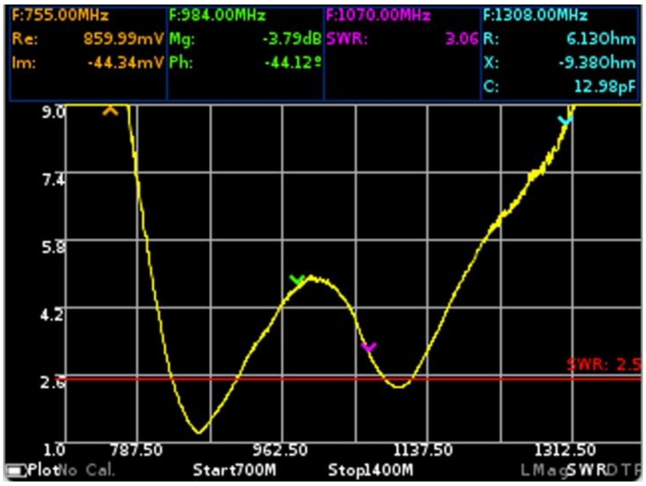


Figure 10.8 – Plot of VSWR

10.6.2. In addition, in the **Plots** menu, the display of the VSWR limit line with the setting of a numerical value can be turned on (see p. 9.8.). This line will be displayed on the plot in red. If the plot does not go beyond the VSWR limit line, then the VSWR of the measured load does not exceed the set value.

In our example, in figure 10.8, the VSWR of a GSM antenna with a working frequency of 900 MHz is measured. The chart includes four markers and the display of the VSWR limit line with a value of 2.5. Above the plot displays the measurement values of the four included markers in the specified units.

Note – To quickly switch from the SWR plot viewing mode in the marker settings menu (Figure 9.8), press and hold the **"MKR"** button (11) for about two seconds.

10.7. DTF plot

10.7.1. **DTF** – **distance to fault**. This plot (Figure 10.9) allows you to measure the distance to fault or heterogeneity of the cable in the communication lines. Calculated as the inverse Fourier transform of the frequency array of reflection coefficients. On the device screen, the plot is displayed as **DTF**.

Note – For a more detailed analysis of the plot, press the **"SPAN"** button (9) and use the navigation buttons (8) to change the scale of the displayed plot. To move around the plot within the selected range, press the **"FREQ"** button (10) and use the navigation buttons (8) to move the plot in the desired direction.

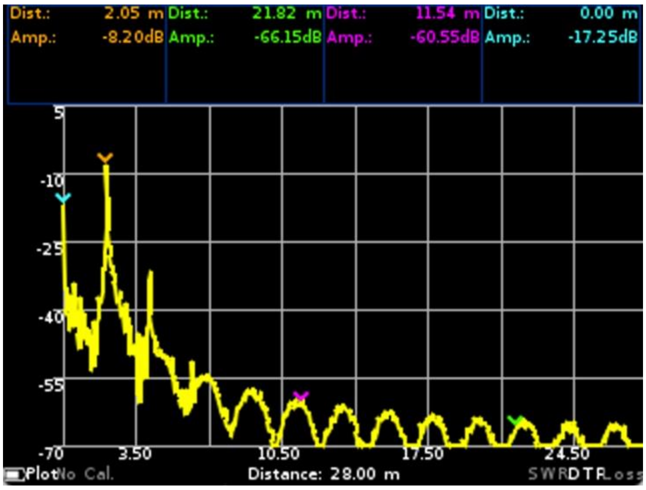


Figure 10.9 – Plot of distance measurement to cable fault

10.7.2. For measurements it is necessary to make settings. Entering the settings menu is possible in two ways:

- Enter the **Plots** menu (Figure 9.6) and click on the field with the name of the chart. A menu will appear on the device screen as in Figure 10.10.
- To quickly switch from the **DTF** plot view to the setup menu (figure 10.10), press and hold the **"PLOT"** button (14) for about two seconds.

The units of the markers to be set depend on the type of display of the horizontal scale - time or distance.

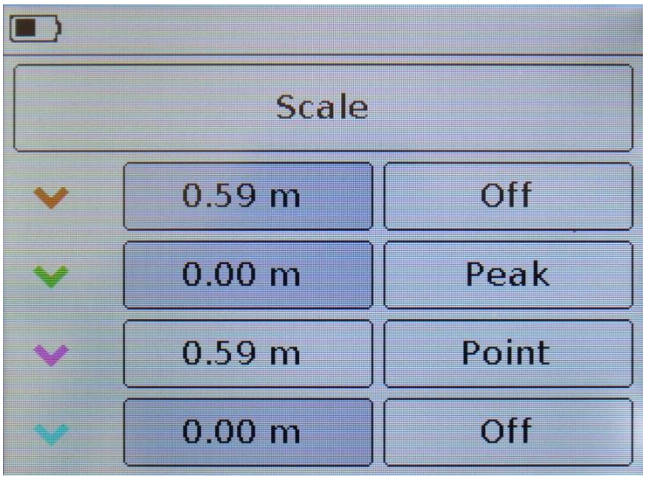


Figure 10.10 – Menu for selecting the measurement scale and setting markers

10.7.3. To display markers on a measurement plot, set the numeric values of the time or distance at which the markers will be installed. In addition to numeric values, the marker type is set:

Point – the marker is located at a fixed value of time or distance.

Peak – a marker that searches for the maximum peak value on the chart.

Off – the marker is off and does not appear on the plot.

10.7.4. To configure the measurement parameters, click on the **Scale** field, and the device will switch to the time settings menu (Figure 10.11.1) or the distance (Figure 10.11.2).

Note – Switching between the types of the displayed horizontal scale of the plot is carried out by clicking on the **Time** or **Distance** area in the corresponding menu.

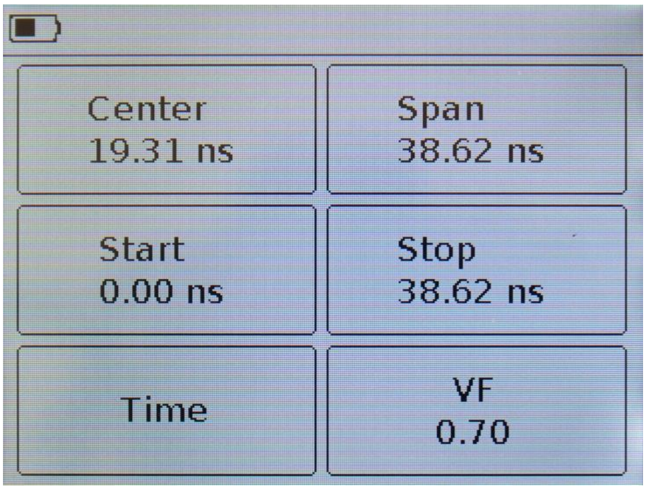


Figure 10.11.1 – Menu timeline setting

10.7.5. Configure the displayed plot with the time parameters (Figure 10.11.1):

VF (Velocity factor or speed factor) – the ratio of the propagation velocity of an electromagnetic wave in a cable to the propagation velocity of an electromagnetic wave in a vacuum. The range of values is in the range from 0.1 to 1.

Time – type of horizontal **Scale** displayed on the plot.

Start – the start time on the displayed plot (ns.)

Stop – final time on the displayed plot (ns).

Span – the range of displayed time on the plot (ns).

Center – the middle of the range of time displayed on the plot (ns).

Limitations of the device in the time display

Maximum time T_{max} (ns) is determined by the equation:

$$T_{max} = (N - 1)/(2 \times SPAN),$$

where N is the number of scan points.

SPAN – scanning frequency range (Hz), defined as the difference between the final and initial frequencies (F_{stop}-F_{start}). Herewith T_{max} cannot exceed the value of 9999.99 ns due to the limited digit capacity of the display menu

- *Time resolution is T_{max} / 1024;*
- *The minimum time shown on the display is T_{max} / 8;*

Attention! In the case of setting the frequency plan, at which the maximum propagation time T_{max} **exceeds 9999.99 ns, the DTF schedule settings window will be blocked.**

10.7.6. Adjust the displayed plot with the distance parameters (Figure 10.11.2):

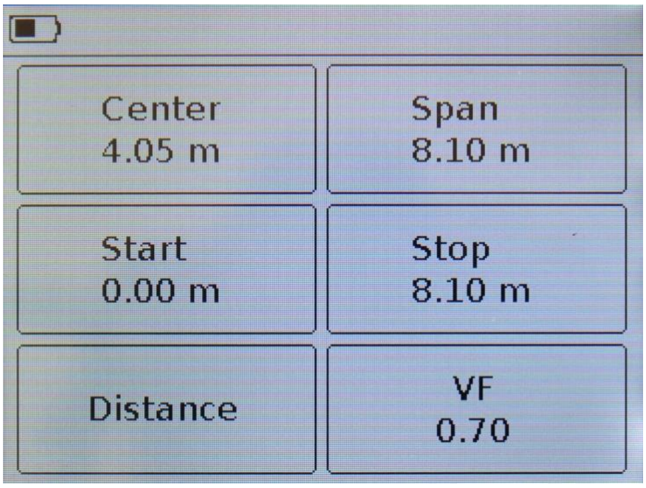


Figure 10.11.2 – Menu for setting the distance scale

VF (Velocity factor or speed factor) – the ratio of the propagation velocity of an electromagnetic wave in a cable to the propagation velocity of an electromagnetic wave in a vacuum. The range of values is in the range from 0.1 to 1.

Distance – type of horizontal **Scale** displayed on the plot.

Start – beginning of the displayed plot (m)

Stop – the end of the displayed plot (m).

Span – range of distance displayed on plot (m).

Center – the middle of the range displayed on the plot distance (m).

Limitations of the device in the display of the distance

- *Maximum display distance D_{max} depends on the speed factor VF. With VF=1, maximum displayed distance D_{max} = 3000m.*
- *Distance resolution - D_{max}/1024;*
- *The minimum distance displayed on the display is D_{max} / 8.*

To correctly measure time / distance, it is necessary to select the frequency plan so that the maximum displayed time / length exceeds the expected cable length. Otherwise, the estimate of the time / length of the cable will be incorrect and obviously less than the real.

10.7.7. Enter the speed factor value, time or distance value that determines the length of the horizontal plot scale (figure 10.12.).

10.7.8. Enter a numeric value and press ✓ or **Enter**. To delete incorrect or previously entered values, press **×** or **Del**. To refuse to enter a value, click **<** or **Cancel**.

In our example, in figure 10.12, we enter the length of the horizontal scale of the plot 14 meters.

Note – When setting the time or distance, the maximum value is displayed in the value entry menu, which cannot be exceeded. The maximum value is limited by the selected frequency plan.

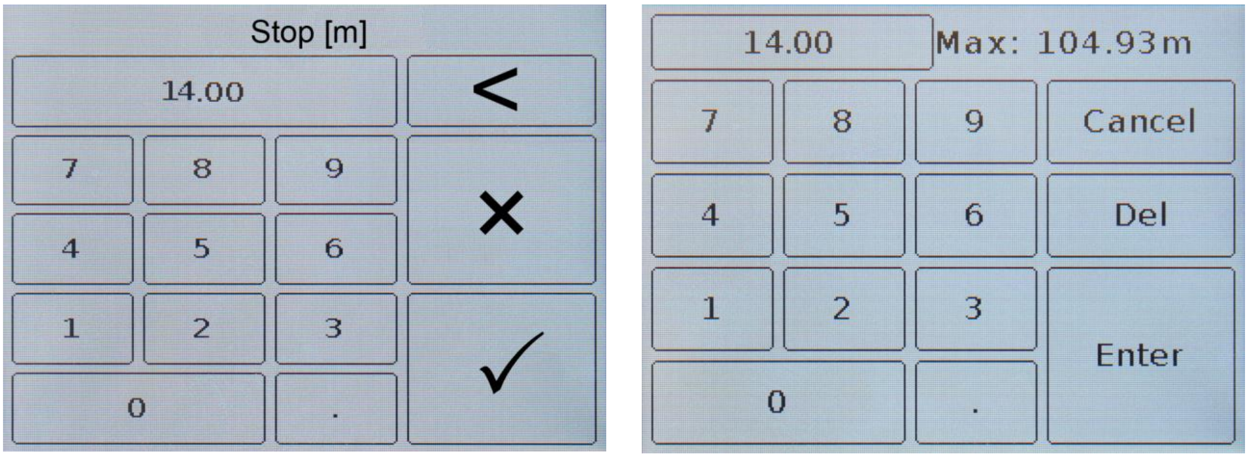


Figure 10.12 – Entering the distance displayed on the horizontal scale in devices ARINST VR 1-6200 and ARINST VR 23-6200

As a measurement result, the plot shows the dependence of the level of reflections (in the cable to fault) on time or distance to the fault.

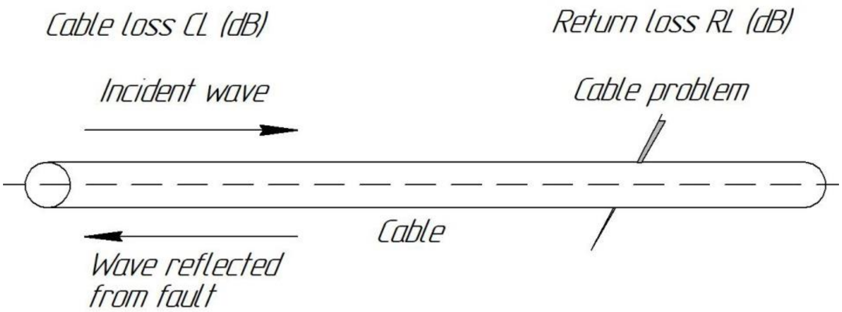


Figure 10.13 – Measurement scheme

The incident wave (the signal from the reflectometer) during the propagation through the cable is experiencing a fade. At the same time, as the signal frequency increases, so does the attenuation. Faced with fault in the cable, part of the incident wave is reflected and propagated back to the signal source (reflectometer), while it also attenuates in the cable during propagation.

Harmonic level (A_{dB}) in decibels (dB) on the plot, corresponding to the presence of inhomogeneity on the length L will be equal to:

$$A_{dB} = 2CL + RL$$

where *CL – attenuation in the cable when propagating to the place of inhomogeneity (dB)*
RL – return losses from inhomogeneity (dB)
A_{dB} – spectrum harmonic level (dB)

Since the attenuation in the cable depends on the signal frequency, and when calculating data, scanning is used in a certain frequency range, the average attenuation value in the scanning frequency range is taken as the CL value.

To improve the accuracy of determining the location of fault, it is necessary to choose the maximum resolution (Rez). The maximum resolution is inversely proportional to the doubled frequency range:

$$Rez = \frac{1}{2(SPAN)}$$

Thus, in order to obtain a high resolution and the maximum possible range for the required resolution, it is necessary to select as many scanning points as possible for this device - 1000 points.

To measure long cables, you must select an initial scan frequency F_{start} as small as possible, since in this case the attenuation of the signal in the cable will be minimal. At the same time, the initial scan frequency F_{start} will not affect the resolution Rez and range, because the resolution depends only on the scan range SPAN and does not depend on the initial F_{start} and final F_{stop} frequencies.

For more accurate measurements of the return loss RL is necessary to know the loss caused by attenuation in the cable. To do this, in the frequency plan, which will be used for real measurements, connect to the measuring port of the reflectometer a segment of a similar cable with a break at the end. In this case, the doubled value of the frequency-averaged attenuation CL will be measured, since the return loss corresponds to 0 dB. In actual measurement, twice the value of attenuation of the CL to the length of the damage must be subtracted from the level of harmonics A_{dB} in the spectrum, thereby getting exactly the return loss value (RL).

$$RL = A_{dB} - (2CL)$$

where *RL – return losses from inhomogeneity (dB)*
CL – attenuation in the cable when propagating to the place of inhomogeneity (dB)
A_{dB} – spectrum harmonic level (dB)

10.8. Cable loss plot

10.8.1. Cable loss is dependent on signal frequency. The higher the frequency, the greater the loss. Usually, cable manufacturers indicate the loss of their cables at one or more frequencies. To determine losses for a specific frequency range or when using a cable whose losses are unknown, a cable loss determination plot is used (Figure 10.14). On the device screen, the plot is displayed as Loss.

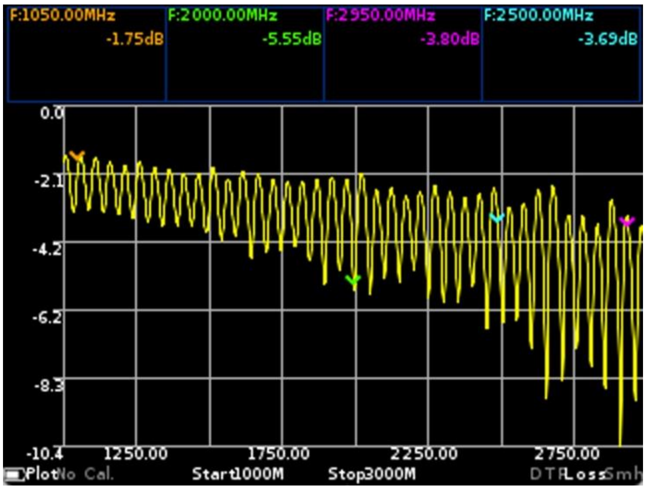


Figure 10.14 – Plot of measurements of cable losses

10.8.2. For measurements it is necessary to make settings. Entering the plot settings menu is carried out in two ways:

- Enter the **Plots** menu (Figure 9.6) and click on the field with the name of the plot. A menu will appear on the device screen as in Figure 10.15.
- To quickly move from the **Loss** plot viewing mode in the unit selection menu (Figure 10.15), press and hold the «**PLOT»** button (14) for about two seconds

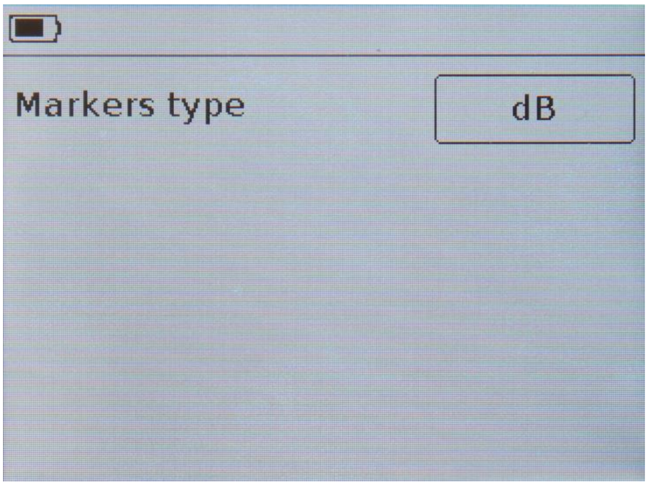


Figure 10.15 – Selecting the units in which cable loss is displayed

10.8.3. Select units of measure that represent cable losses, for example decibels (dB), Figure 10.15, if the cable length does not matter.

10.8.4. If the cable length is known, for example, measured using the DTF plot (par. 10.7), then in order to display the loss in decibels per linear meter (dB / m), change the units of measurement by clicking on them. A menu appears as in Figure 10.16.

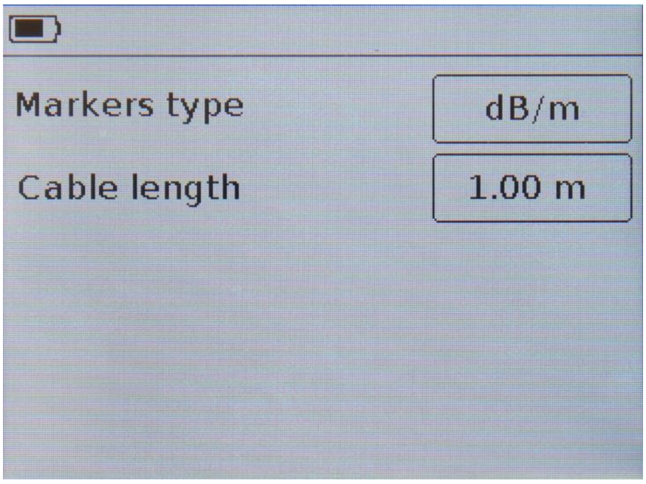


Figure 10.16 – Selecting units of measurement and setting cable length

Note. To work correctly with a plot when measuring in a cable, it is necessary to select a scanning step several times shorter than the period of phase oscillations. The oscillation period is equal to the ratio of the propagation velocity to the double value of the cable length.

$$\frac{SPAN}{N-1} < \frac{C \times VF}{2 \times L}$$

where SPAN – scanning frequency range, Hz is defined as the difference between the final and initial frequencies F_{stop}-F_{start}

N – number of scan points

C – light speed, m / s

VF – speed factor

L – cable length, m

Note. Press and hold the **"MKR"** button (11) for about two seconds to quickly switch from the **Loss** plot view to the marker settings menu (Figure 9.8).

10.8.5. Enter the cable length in which you want to measure the loss. The range of the measured cable 1 - 1000 m.

Note. When displaying data on a plot, the scale is selected by the device automatically.

11. CARE AND MAINTENANCE

11.1. General care of the device

11.1.1. When working with the device, use an adapter to protect the high-frequency connector of the device from excessive wear.

11.1.2. When working, do not allow moisture or dust to enter the device.

11.1.3. After completing work with the device, turn off the device, disconnect all connected cables and connectors from it. Wipe the unit with a clean rag. Remove heavy dirt with a cloth moistened with soapy water. To clean the device, it is recommended to use household wet wipes. Do not use alcohol-based or petroleum-based solvents to clean the screen and body of the device! These fluids can damage the outer cover of the screen and the case of the product.

11.1.4. Charge the device battery according to par. 11.2.

11.2. Charge the battery

11.2.1. To charge the battery, it is recommended to use a stabilized power source with an output voltage of 5 V and a current of at least 500 mA. To charge the battery during operation, it is recommended to use a stabilized power source with an output voltage of 5 V and a current of at least 800 mA.

11.2.2. Connect the supplied network cable to the USB type B (5) connector of the device. Connect the other end of the cable to the USB connector of the power supply unit or USB connector of the computer (laptop).

Note – instead of a USB 2.0 type A - USB 2.0 type B cable, you can use a USB 2.0 type A mini-USB cable for charging and working.

Simultaneous use of two USB ports of the device is strictly prohibited! Failure to comply with this requirement may result in device failure.

11.2.3. Turning on the LED indicator (7) **"CHARGE"**, informs about the beginning of the process of charging the battery. The process of charging the battery takes about 6 hours.

Note – The device is allowed to operate while the battery is charging, provided that the power source is capable of providing a charging current of at least 800 mA.

11.2.4. Upon completion of the charging process, the LED (7) **“CHARGE”** will go out, informing you that the charging process has been completed.

11.3. Battery replacement

11.3.1. After a certain period, the capacity of the Li-Ion battery is reduced, and long-term use of the device without recharging becomes difficult.

11.3.2. Replacing the battery is necessary when the following symptoms occur:

- The battery charges very quickly and discharges very quickly;
- The battery charges for a very long time (more than 8 hours);
- The battery does not accept charge;
- The device does not turn on offline (with the cord disconnected from the charger).

11.3.3. To replace, you must purchase a new Li-Ion battery with an operating voltage of 3.7 V, a capacity of at least 2000 mA and dimensions of not more than: height 4 mm, length 80 mm, width 50 mm (Figure 11.1).

Note – When purchasing and installing a battery with a capacity other than the one installed by the device manufacturer, it is necessary to take into account the fact that the battery charging time will also change up or down.

Attention! When using a battery of another capacity, the correspondence of the displayed charge level of the battery on the device screen to the real value is not guaranteed.

Figure 11.1 – New battery for the device

Attention! To replace the battery, you will need to disassemble the device. Ensure that you have the necessary tools, knowledge, and qualifications sufficient to carry out an independent repair of the device. With a lack of experience and qualifications, contact specialists with relevant qualifications.

11.3.4. Remove the 4 screws (15) of the front cover (16) of the device. Then unscrew the 2 upper screws (15) of the back cover (17) of the device. (Figure 11.2).

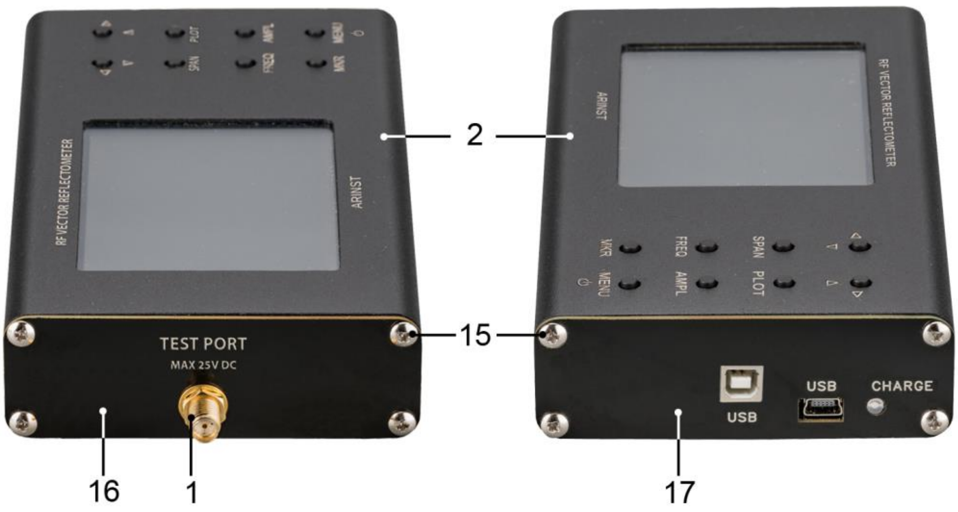


Figure 11.2 – Disassembly of the device case

11.3.5. Carefully remove the upper part of the housing (2). Slide along the guide slots from the bottom of the case (2), towards the high-frequency connector (1) of the device chassis assembly with the printed circuit board and modules (screen and control buttons).

11.3.6. The battery (18) is located on the chassis under the screen module and secured with double-sided tape. Carefully disconnect the battery connector (19) from the connector located on the circuit board, under the control button module (Figure 11.3). Remove the old battery (18) and remove the old double-sided tape that attached it to the chassis.

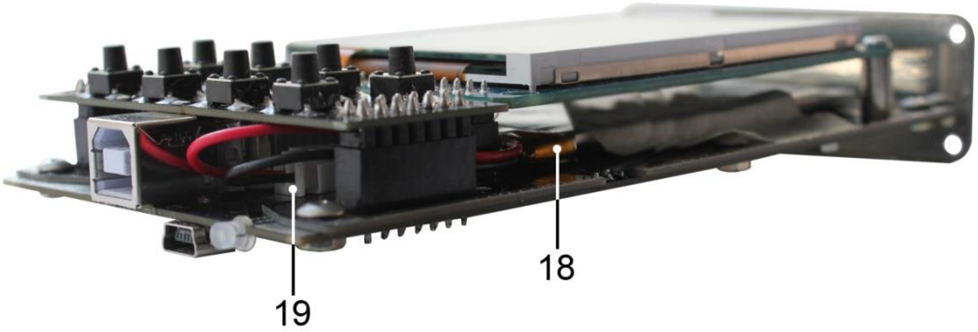


Figure 11.3 – Battery replacement

11.3.7. Apply a new double-sided adhesive tape and securely attach the new battery (18). Connect the battery connector (19) to the connector on the board. Assemble the device in the reverse order.
11.3.8. After assembling the device, charge the battery according to paragraph 11.2. this Manual.

11.4. Storage and transportation

11.4.1. Store the device in a dry place with a positive temperature and relative air humidity not exceeding 75%.
11.4.2. Before putting the device into storage, charge the battery.
11.4.3. With long-term storage, once every 3 months recharge the device battery. The ambient air temperature at which the device is stored can have a significant effect on the self-discharge rate of the battery.
11.4.4. Keep the device and its accessories out of the reach of children.
11.4.5. When transporting the device must be securely fastened. Shaking, knocking and dropping can cause the device to fail.

11.5. The criterion of the limit state

11.5.1. The criterion of the limiting state of the device is a sign, or a set of signs, upon reaching which:
- further operation of the device is not allowed;
- recovery to a healthy state is impossible or economically impractical.

11.5.2. Upon reaching the limit state, the device must be decommissioned and disposed of.

11.6. Utilization

11.6.1. The device, battery, cords and cables that have failed, should be transferred to special collection points for the disposal of electronic devices. Do not throw away broken devices, batteries, cables into household waste!

12. POSSIBLE MALFUNCTIONS AND METHODS OF THEIR ELIMINATION

If a malfunction occurs, check the possible causes of the fault in table 5.

Table 5.

Fault	Possible reason	Method of elimination
1. The device does not turn on.	Low battery.	Charge battery
	Faulty button **MENU**.	Contact the service center for repair.
2. The device does not turn on in autonomous mode.	Bad battery.	Replace battery.
3. The battery life is less than 1 hour.	The device is operated at extremely low ambient temperatures.	Operate the device at an ambient temperature of 0 to plus 40 °C.
	Discharged battery.	Charge battery
	Bad battery.	Replace battery.
4. The screen of the device does not respond to touch or reacts with a delay.	The device is operated at extremely low ambient temperatures.	Operate the device at an ambient temperature of 0 to plus 40 °C.
	Faulty on-screen device module.	Contact the service center for repair.
5. The test equipment/device is connected to the **TEST PORT** of the device, and there is no signal selection on the device charts.	Wrong measurement mode selected or incorrect frequency range specified.	Set the correct measurement mode or set the correct frequency range.
	There is no contact between the equipment cable and the **TEST PORT** of the device.	Ensure reliable contact of the cables of the test equipment with the connectors of the device.
	The input circuit of the device is faulty.	Contact the service center for repair.
6. Low or no sensitivity of the device.	The input circuit of the device is faulty due to exceeding the maximum voltage on the **TEST PORT.**	Contact the service center for repair.

13. RETURN THE DEVICE TO THE FACTORY SETTINGS

A hardware reset is a reboot of the device, which restores the factory settings of the system. Hardware reset is used when it is impossible to turn on the device or go to the main menu to change the settings. This removes the parameters of the main application.

Reset to factory settings is used by the user in case of software problems to restore the standard configuration of the device.

Resetting the device to factory settings is achieved by simultaneously pressing the buttons (11) **"MKR"** and (12) **"MENU"** for about 2 seconds with the device turned off. Hold down the **"MKR"** button (11) and then press down the **"MENU"** button (12) for about 2 seconds.

After downloading the device, all user settings, other settings and calibrations will be deleted. User-defined frequency settings in the **Presets** menu will be saved.

14. WARRANTY OBLIGATIONS

The company "Kroks Plus" guarantees conformity of this product with technical characteristics given in this document.

The warranty period is 12 months from the date of sale. During this period, the manufacturer provides free warranty service.

The warranty does not apply to the following cases:

- the warranty period of the product from the date of sale has expired;
- more than 12 months have passed from the date of production of the product (only if the product does not have documents confirming the date of sale, such as a cash voucher or a correctly filled warranty card containing information about the product and the seller);
- the product intended for personal needs was used for commercial activities, as well as for other purposes that do not correspond to its intended purpose;
- violations of the rules and conditions outlined in the user Guide and other documentation transferred to the Buyer included with the product;
- in the presence of the Product of the traces of improper repair or attempted opening outside of an authorized service center, but also because of tampering of the software;
- damage (defects) of the Goods caused by exposure to virus programs, interference with the software, or use of third-party software (non-original);
- defect caused by an act of force majeure (e.g., earthquake, fire, lightning, instability in the power grid), accidents, deliberate or reckless acts of consumer or third parties;
- mechanical damage (cracks, chips, holes) that occurred after the transfer of the product to the Buyer;
- damage caused by exposure to moisture, high or low temperatures, corrosion, oxidation, ingress of foreign objects, substances, liquids, insects;
- the defect has arisen due to the input connectors, terminal, housing signal that exceeds the allowable for this Item values;
- the defect is caused by natural wear and tear of the product (e.g. but not limited to: natural wear of the connectors due to frequent connection/disconnection of the adapters).

Warranty obligations apply only to defects caused by the fault of the manufacturer. Warranty service is performed by the manufacturer.

With warranty obligations read ____
(Buyer's signature)

Date of sale:________________ Seller ________________________________
(date) (store name or stamp)

APPLICATION A

(referential)

Update the software of the vector network analyzers ARINST VR 1-6200 and ARINST VR 23-6200

The firmware of the vector network analyzer is constantly being improved and optimized. Errors are corrected, additions are made that optimize the operation of the device and have a positive effect on the measurement accuracy. In addition to correcting errors and stabilizing work, a new functionality is added that expands the scope of use of the device.

It is recommended to regularly update the firmware of the device.

1. Installing update loader and virtual port driver on PC

1.1. Visit the official ARINST website by typing in the address bar of your browser www.arinst.net. Go to the DOWNLOAD section and click on the file *Arinst Firmware Updater* to update the firmware of the vector analyzer Arinst VR 23-6200 (Figure A1.1).

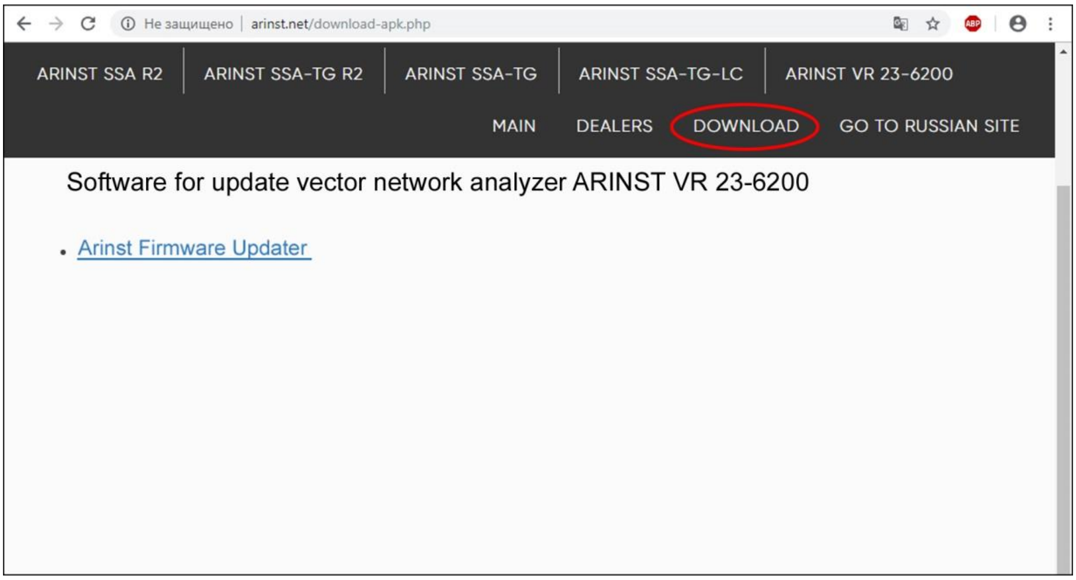


Figure A1.1 – Software download for updating the device

1.2. Specify the path where the compressed (archive) installer file should be downloaded and click **Save** (Figure A1.2).

In our example in Figure A1.3, the archive file ArinstFirmwareUpdater is saved to the ***Downloads*** *folder.*

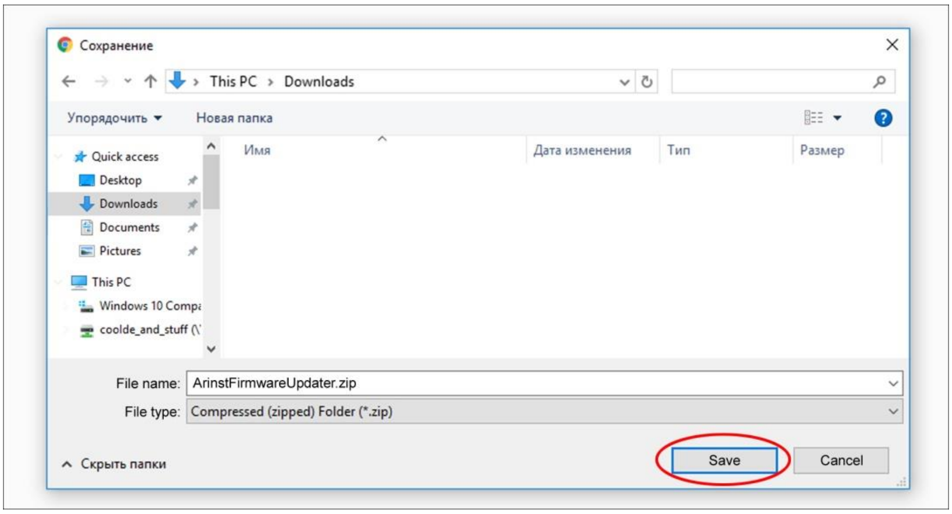


Figure A1.2 – Save the downloaded file

1.3. Enter the directory into which the archive file was uploaded and unzip it with the help of archiver (Figure A1.3).

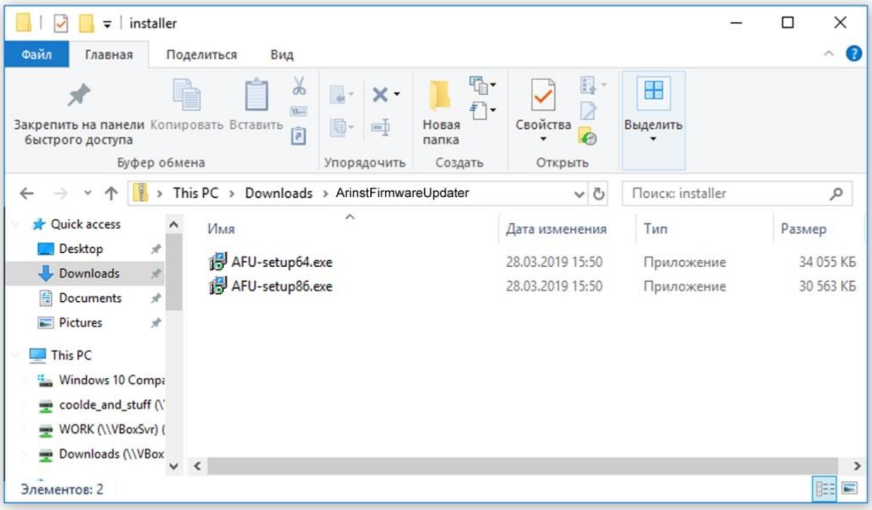


Figure A1.3 – The unzipped downloaded file

There are 2 objects in the unzipped file:

- Installation file of the update loader AFU-setup64.exe for 64-bit Windows operating systems.
- Installation file of the update loader AFU-setup86.exe for 32-bit Windows operating systems.

1.4. Install the update loader on your PC. To do this, double click on the installation file of the application, depending on the bit size of your Windows operating system.

Note – To determine which Windows operating system (32-bit or 64-bit) is installed on your PC, execute:

For Windows 7:

- Click the **Start** button, right-click the **Computer**, and then select **Properties**.
- In the **System** section, check which type of system is listed.

For Windows 8.1 and Windows 10:

- Click the **Start** button and select: **Settings** → **System** → **About system**.
- In the **Device Specifications** section, see what **Type of system** is listed.

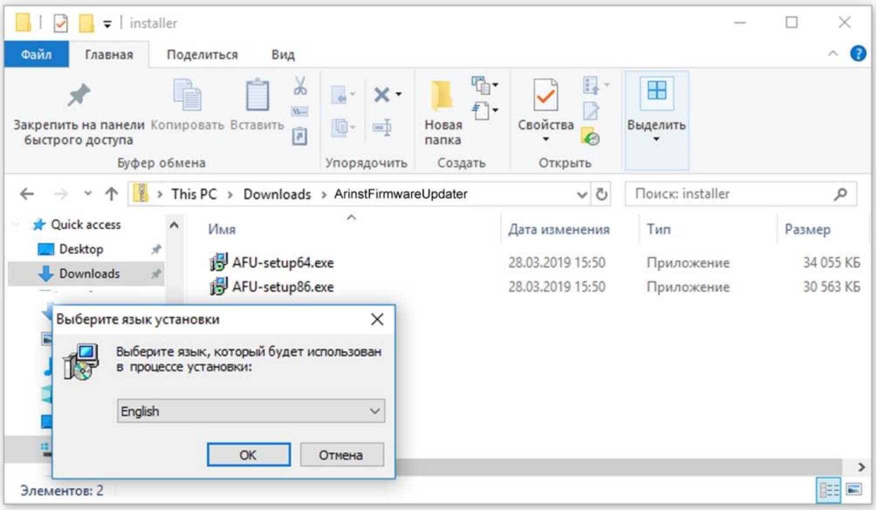


Figure A1.4 – Select the language to be used during the update loader installation

From the drop-down list, select the language (Russian or English) in which messages will be displayed during the installation of the application and click **OK** (Figure A1.4).

1.5. Carefully read the terms of the license agreement. To further install the application, accept the terms of the license agreement and click the **Next>** button (Figure A1.5).

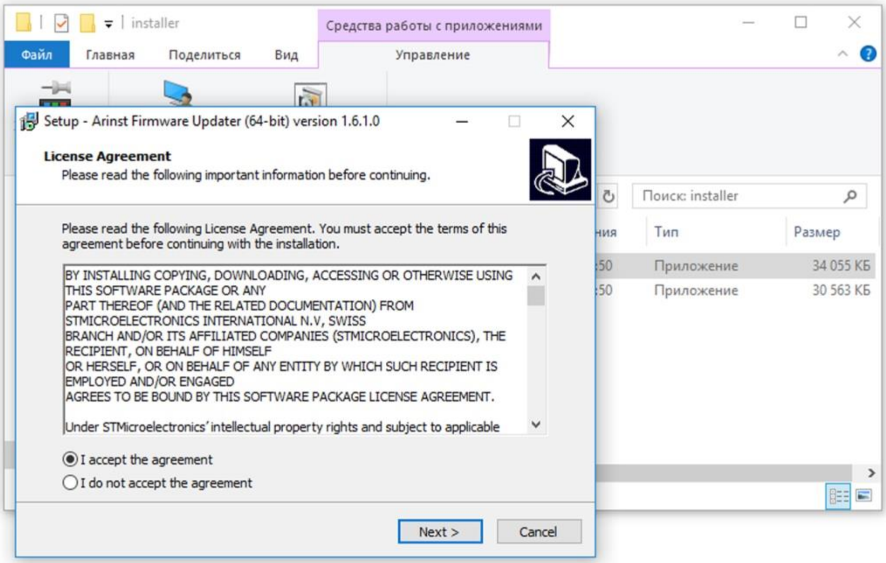


Figure A1.5 – License agreement

If you want the update loader shortcut to be placed on the desktop of your PC, check the box next to this option and click **Next>**.

Check the installation options of the application and click **Install** (Figure A1.6).

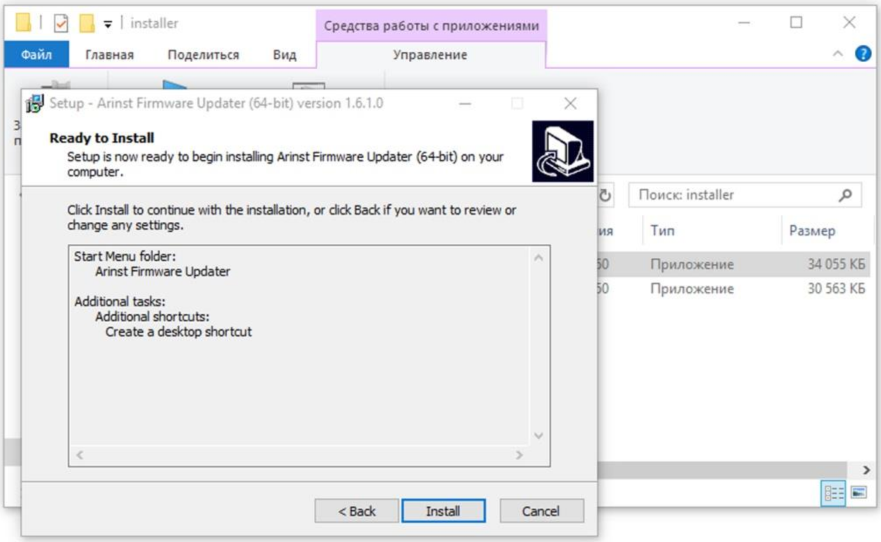


Figure A1.6 – Update loader installation options

1.6. The installation process of the virtual port will begin, which may take some time. In the installation wizard window that appears (Figure A1.7), indicate your actions:

- Modify - add new or remove already installed program components.
- Repair - reinstall all program components installed earlier
- Remove - delete all installed program components.

And press the button **Next>**.

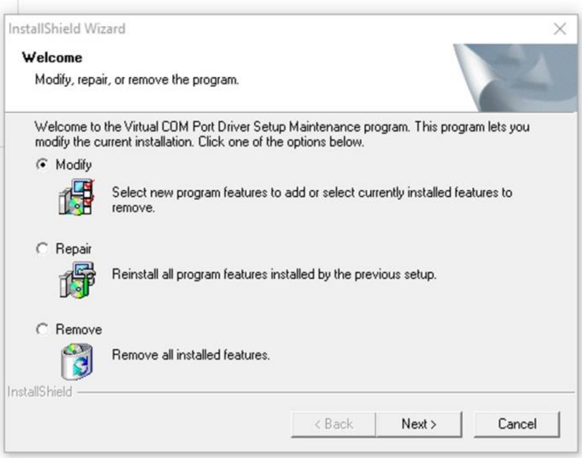


Figure A1.7 – Application setup wizard

1.7. After completing the installation of the virtual port *STMicroelectronics (usbser) Ports*, the installation wizard will inform the user that the virtual COM port is installed and ready for operation. Click **Finish** to exit the device driver installation wizard (Figure A1.8).

Figure A1.8 – Message of the drivers installation wizard

1.8. After completing the loader installation (Arinst Firmware Updater applications), the application installation wizard will inform the user that the application is installed. In order for the application to be launched immediately after exiting the installation wizard, check the box next to the corresponding option. Click **Finish** to exit from installation wizard (Figure A1.9).

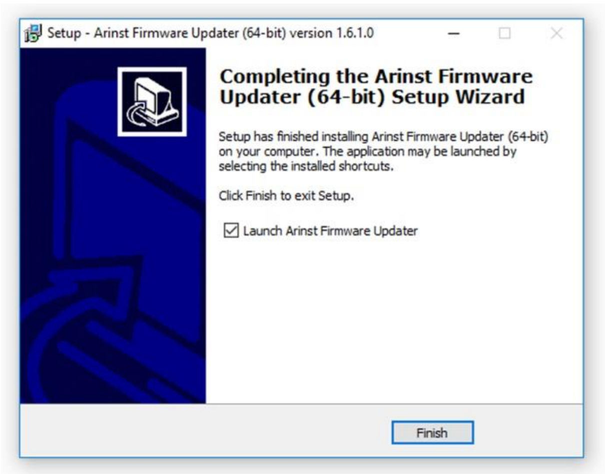


Figure A1.9 – Message from the application installation wizard.

2. Updating the device firmware

Attention! Before updating the firmware of the device, make sure that your PC has access to the Internet.

2.1. Connect the vector reflectometer to the USB port of your PC using a USB 2.0 cable - mini-USB or USB 2.0 - USB 2.0 type B. Turn on the device by pressing the button (12) «**MENU**».

Attention! The simultaneous use of two USB ports of the device is categorically forbidden! Failure to comply with this requirement may result in device failure.

2.2. Launch the **Arinst Firmware Updater** application by double-clicking the shortcut located on the desktop of your PC.

2.3. Click the button[8] to connect the device to your PC (Figure A2.1).

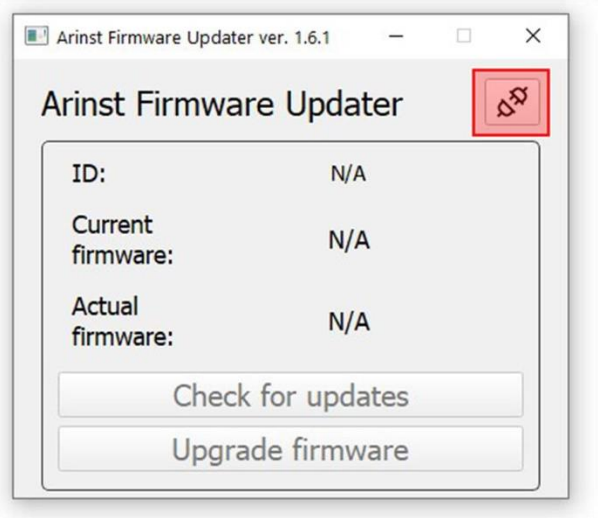


Figure A2.1 – Connecting the device to a PC

2.4. In the window that opens, select the virtual COM port for connecting the device from the drop-down list (Figure A2.2).

[8] The command buttons of the loader interface in this application are highlighted in red only for the convenience of reading.

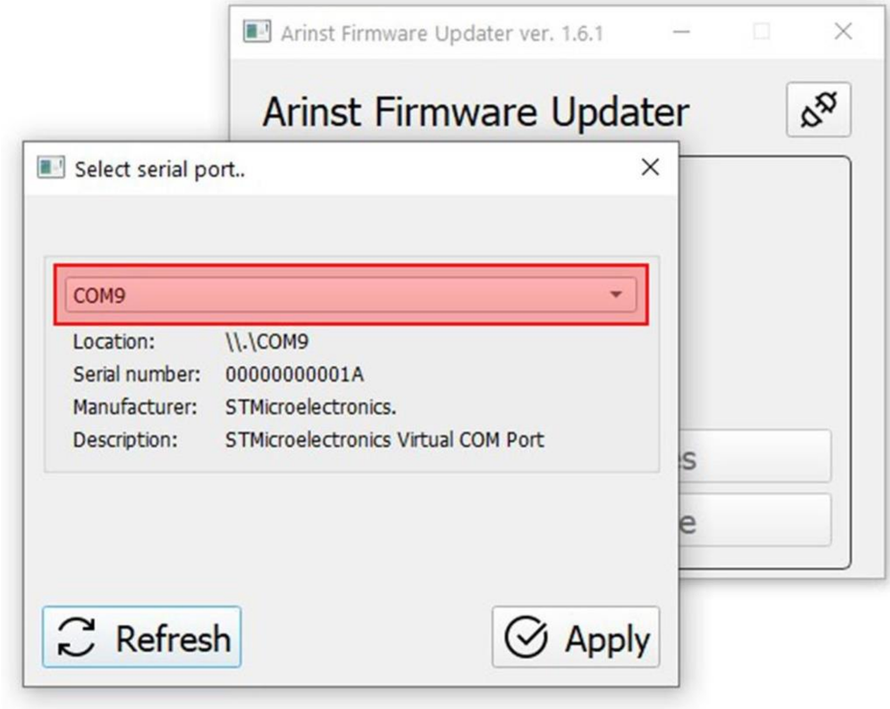


Figure A2.2 – Selection of a virtual COM port for connecting the device

In our example in figure A2.2, the virtual port COM9 is selected.

2.5. If the required port is not in the list of virtual ports, click the **Refresh** button, as shown in Figure A2.3.

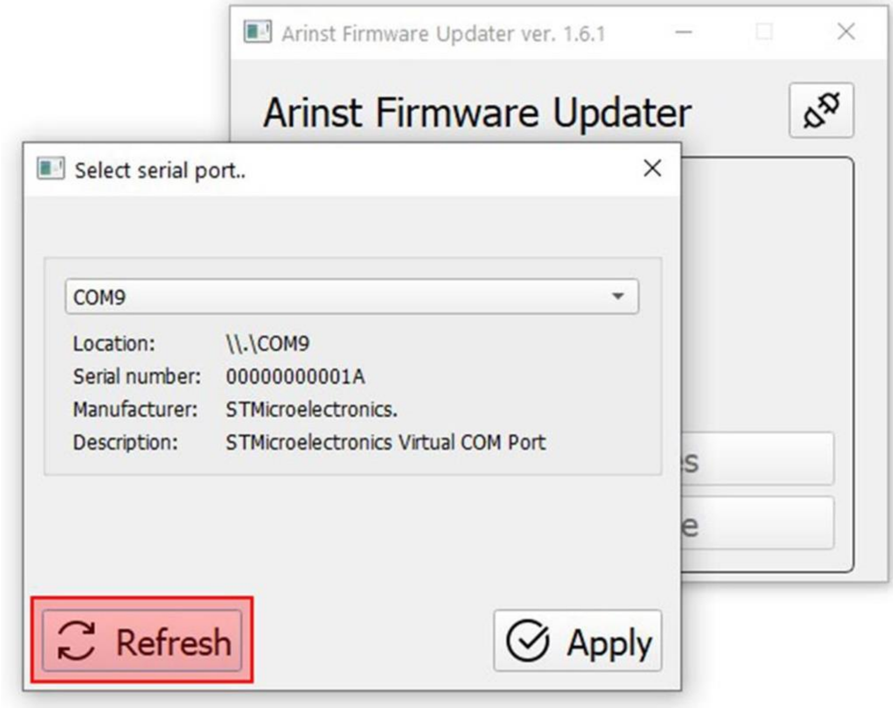


Figure A2.3 – Update the list of virtual PC ports

2.6. After selecting the port, make the connection by clicking the **Apply** button (Figure A2.4).

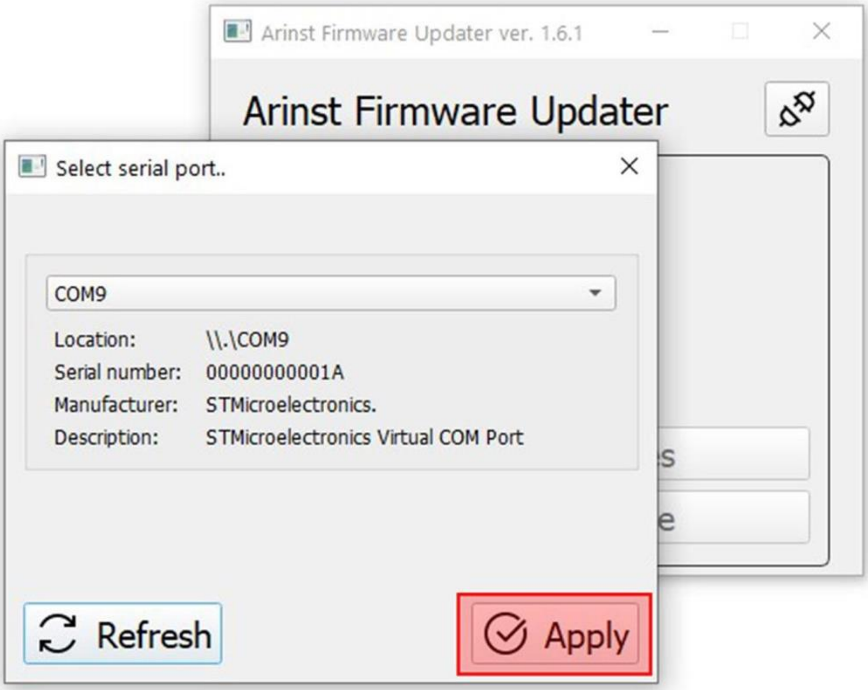


Figure A2.4 – Connection of the loader application to the device

2.7. After connecting to the device, its ID and firmware version will be determined. In addition, the **Check for updates** button will be active (Figure A2.5).

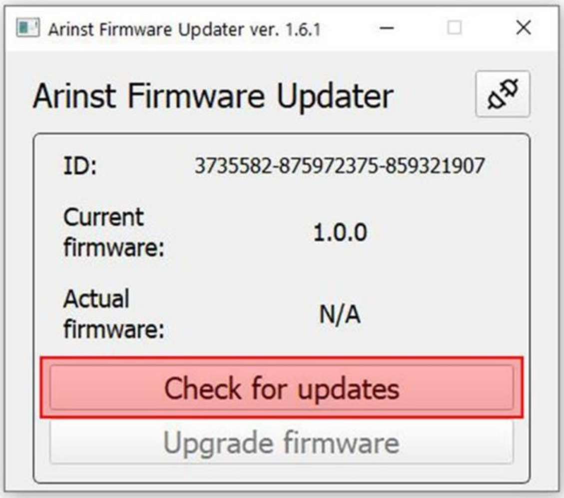


Figure A2.5 – The loader is connected to the device

Click the **Check for updates** button and if the current firmware version is below the current version, the loader will offer to update the firmware of the device (Figure A2.6).

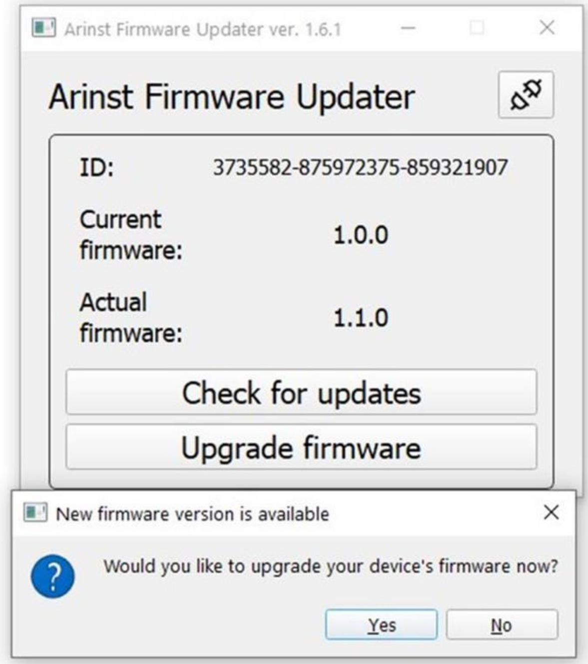


Figure A2.6 – Message about the existence of a later firmware version

2.8. If you want to update the firmware of the device in automatic mode, click **Yes**. If you plan to update the firmware later, click **No**.

To manually upgrade the firmware of the device, click the **Upgrade firmware button** (Figure A2.7).

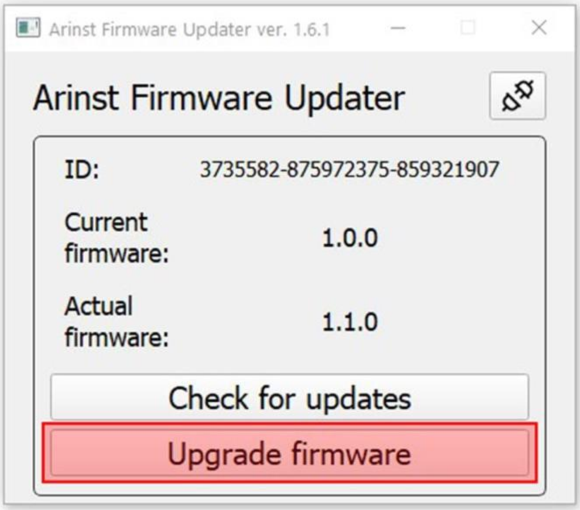


Figure A2.7 – Manually firmware updates

Note – If, when connected, the device was in application mode, it will automatically be reset to the firmware update mode. A corresponding loader message will be displayed on the PC screen (Figure A2.8).

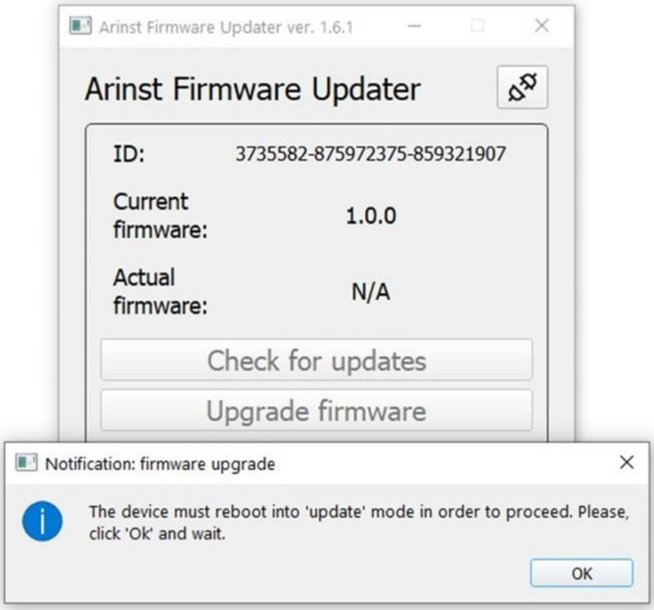


Figure A2.8 – Message from the loader about switching the device to update mode

2.9. During the firmware update of the device, the window will appear with the download progress (Figure A2.9).

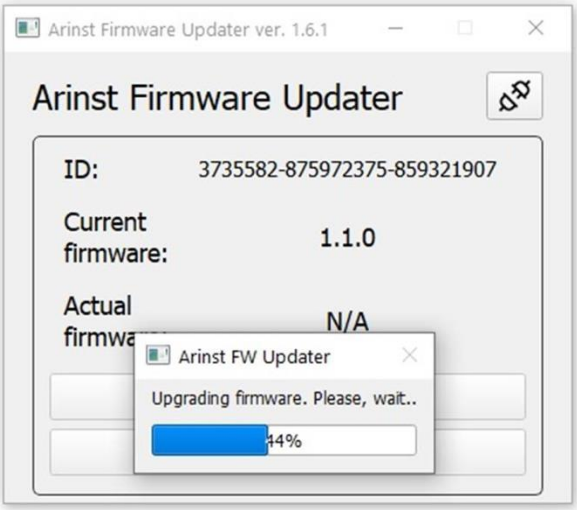


Figure A2.9 – The process of downloading updates

Note – When you finish downloading firmware updates, the device will automatically restart and go into application mode. A corresponding boot message will be displayed on the PC screen (Figure A2.10).

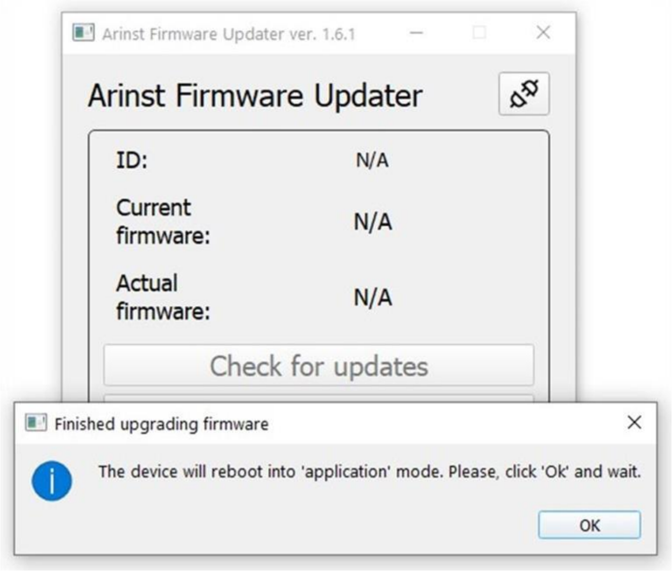


Figure A2.10 – Message from the loader about switching the device into application mode

2.10. After downloading and installing the new firmware, the latest installed software version of the device will be displayed in the loader application (Figure A2.11).

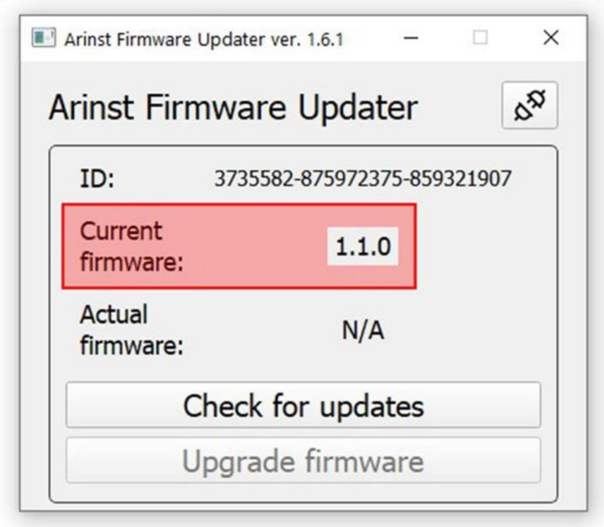


Figure A2.11 – Display of the device firmware version

Note – To make sure that the latest firmware version of the device is installed, click on the **Check for updates** button. The screen will display a message about the latest firmware version of the device installed (Figure A2.12).

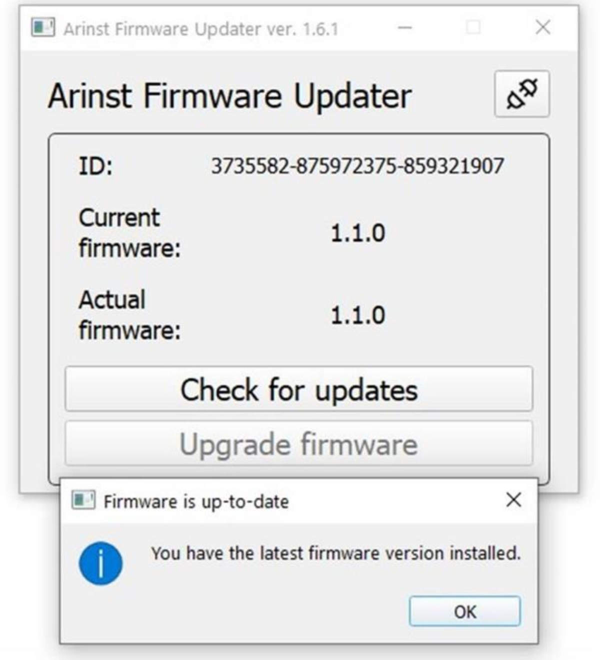


Figure A2.12 – Checking the version of installed firmware

3. Device status and messages displayed on the screen during the update.

3.1. Standard firmware download, without errors. The device number and the result of checking the downloaded update are displayed on the device screen (Figure A3.1).

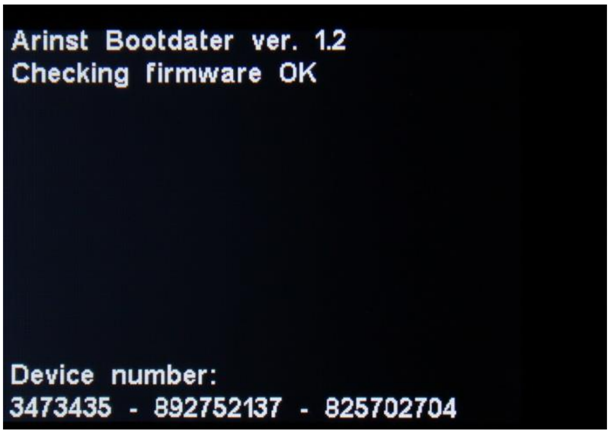


Figure A3.1 – Device screen after checking the downloaded firmware update

3.2. In case of unsuccessful download of the update, the message will be displayed on the device screen, as in Figure A3.2. Connect the device to your PC and update the firmware of the device again.

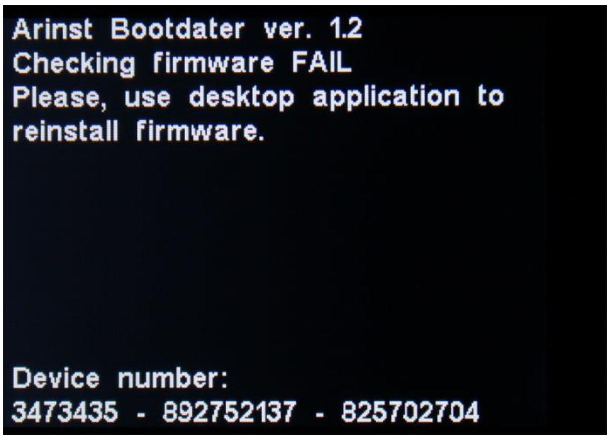


Figure A3.2 – The device screen when the firmware is unsuccessful

3.3. If the update process was interrupted, the device will run in update mode until the update process is completed. The device will display the update mode in which the device is located (Figure A3.3).

To exit this mode, you must perform the process of updating the firmware of the device again.

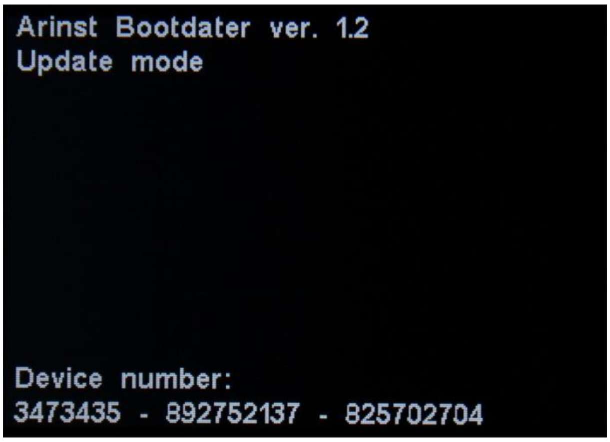


Figure A3.3 – The device is in update mode

3.4. After the upgrade process is completed, the device checks the installed firmware. If the checksums do not match, the message appears on the device screen as in Figure A3.4. After reboot, the device will be in the load error mode, as in par. 3.2 of this Manual. Connect the device to your PC and update the device firmware again.

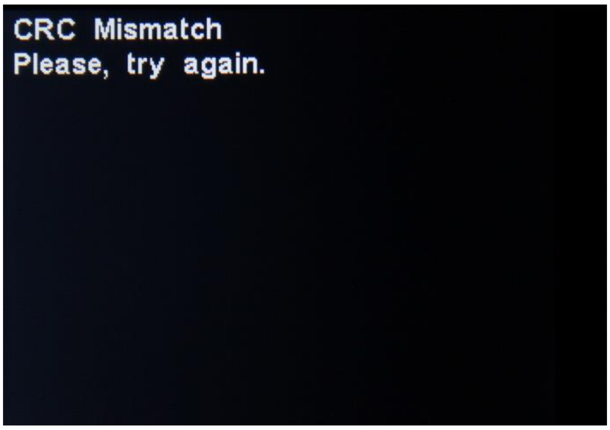


Figure A3.4 – Unsuccessfully installed firmware