LinteL | Automated laboratory equipment for quality control

Automatic Fraass Breaking Point Tester
LinteL® ATH-20

Operating manual

WIRELESS INTERFACE SUBSYSTEM

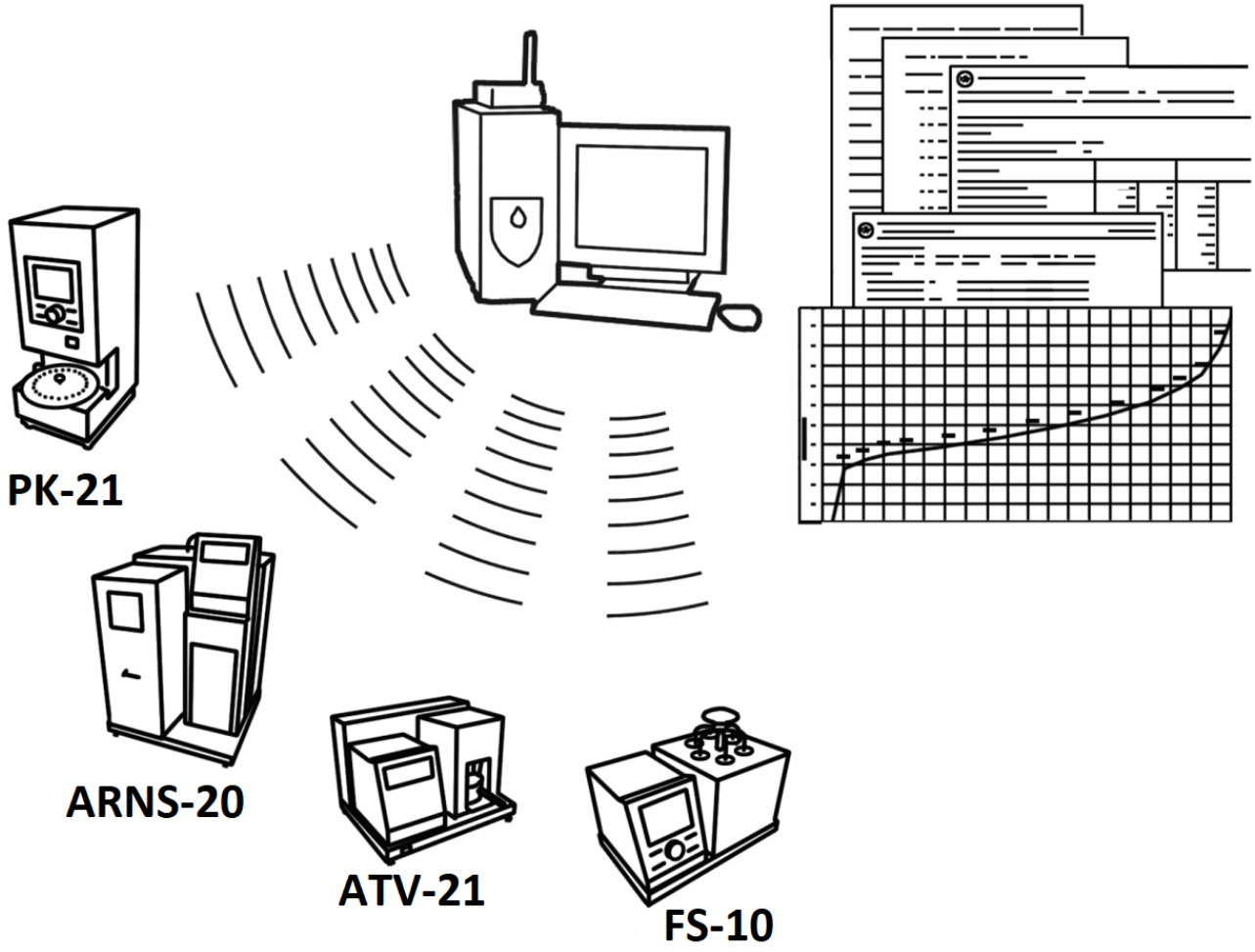
Wireless interface subsystem (further WIS) is designed for operation automation of petroleum product quality control laboratories.

Wireless interface subsystem has the following functions:

- automatic transfer of test results from the tester located in the laboratory to PC via wireless communications channel (IEEE 802.15.4/ZigBee standard);
- safe storage of information obtained from the tester in a common database;
- user-friendly, standardized representation of information to the user (in a table-oriented, graphical, printed view);
- providing tools for effective work with test results, tools for calculating accuracy parameters using standard methods.

Wireless interface subsystem provides communication at the distance up to 100 m indoors, all *LinteL*® tester can be integrated in a common network.

LinteL® tester are equipped with hardware and software providing tester operation with the Wireless Interface Subsystem[1].



System operation requires purchase and installation of a radio modem with USB interface and PC software. The software includes data communication protocol driver and *LinteL*® - LINK software. Test results are automatically transferred to the database, which simplifies access to data and schedules, improves the quality of work, and eliminates most routine operations.

[1] For additional information, please, call (347) 284-44-36, 284-27-47.

Up-to-date devices for petroleum product quality control

Thank you for purchasing and usage of ℒ*inte*ℒ® ATH-20 automatic laboratory tester for determining the temperature of breaking point of oil bitumen.

Since 1959, BSDO Neftehimavtomatika JSC has been manufacturing and supplying tester for quality control of petroleum products in the laboratories of factories, airports, and fuel and energy complex enterprises.

Our tester's implement STANDARD METHODS, have passed metrological certification, are included in MI 2418-97 "Classification and application of technical means of testing of petroleum products" and the corresponding GOSTs Standards as a means of implementing quality control methods.

The tester has special solutions that allow you to implement in addition to standard methods and methods for performing research, which is especially important when developing new types of products. LinteL uses the latest technologies and components to ensure consistently high quality of tester, convenience of their operation, in order to reduce the time spent on testing and increase the efficiency of your work.

CONTENT

The operating manual contains information about the design, operating principle, characteristics of the automatic *LinteL*® ATH-20 and instructions necessary for its correct and safe operation.

1 LIST OF ABBREVIATIONS

Tester – the tester is automatic *Lintel*® ATH-20.
PC – personal computer.

2 DESCRIPTION AND OPERATION

2.1 Purpose

The tester is automatic *Lintel*® ATH-20 (further tester) manufactured in accordance by TU 4211-015-0015785-2012, it is a desktop-type test equipment and is designed to determine the temperature of bitumen breaking point in accordance with the standards:

- GOST 11507. Oil bitumen's. The method of determining the temperature brittleness at Fraas;
- GOST EN 12593. Bitumen and bituminous binders. The method of determining the temperature brittleness at Fraas;
- GOST 33143. Public roads. Road oil bitumen's are viscous. The method of determining the temperature brittleness at Fraas;
- EN 12593. Bitumen and bituminous binders - Determination of the Fraass breaking point;
- IP 80. Bitumen and bituminous binders - Determination of the Fraass breaking point.

2.2 Specifications

2.2.1 Performance data of the tester given in Table 1.

Table 1 – Performance data

Parameters	Unit of measurement	Value
Refrigerant coolant[1] consumption at the assumed breaking point temperature up to -5°C	liters /min	from 1 to 2
Refrigerant coolant[1] consumption at the assumed breaking point temperature up to -15°C	liters /min	from 2 to 3
Refrigerant coolant[1] consumption at the assumed breaking point temperature -15°C and below	liters /min	from 4 to 5
Voltage	V	from 187 to 242
Frequency	Hz	from 49 to 51
Power consumption, max	W	450
Ambient temperature	°C	from 10 to 35
Relative humidity at +25°C, max	%	80
Barometric pressure	mm Hg	from 680 to 800

2.2.2 Weight and dimensions of the tester given in table 2.

Table 2 – Weight and dimension

Parameters	Unit of measure-ment	Value
Weight of the tester, max	kg	12,5
Dimensions of the tester in working order (width x height x depth)	mm	400x395x275
Dimensions of the device in the sample loading state (width x height x depth)	mm	400x555x275

[1] Running tap water can be used as a refrigerant.

2.2.3 The accuracy parameters of the tester given in table 3.

Table 3 – The accuracy parameters

Parameter	Unit of measurement	Value
The inner diameter of the working chamber of the thermostat	mm	from 36 to 38
The maximum distance between the grooves clips	mm	from 39,9 to 40,1
The minimum distance between the grooves clips	mm	from 36,4 to 36,6
Dimensions of the working plate made of steel tape (65G-SH-S-N-0.15 x 20 Russian standard): - length - width - thickness	 mm mm mm	 from 40,95 to 41,05 from 19,8 to 20,2 from 0,13 to 0,17
The tester evenly bends and straightens the working plate: - time of the bending process - time of the bending and straightening process	 sec sec	 from 10 to 12 from 20 to 24
Range of measurement of the breaking point temperature upper limit (at a refrigerant temperature of at least 28°C)	°C	+20
Range of measurement of the breaking point temperature lower limit (when the refrigerant temperature is not higher than 5°C and the ambient temperature is 20 °C)	°C	-45
Fallibility in determining the breaking point temperature, max	°C	1,0
The speed of lowering the temperature, with deviation, max	°C/min °C	1,0 1,0

The manufacturer guarantees that the accuracy parameters confirmed during the initial certification after transportation remain unchanged.

2.3 Arrangement and operation

2.3.1 Scope of supply:

1) Tester ℒinteℒ® ATH-20 AIF 2.772.008.
2) Operational documents:

- The operating manual for AIF 2.772.008 RE;
- Passport AIF 2.772.008 PS;
- Certification program and procedure AIF 2.772.008 MA.

3) Set of attachments.

2.3.2 Principle of operation

2.3.2.1 The principle of operation of the tester is based on cooling and periodic bending of the bitumen sample and determining the temperature at which cracks appear or the bitumen sample breaks.

2.3.3 The tester

2.3.3.1 The general view of the tester is shown in figure 1.

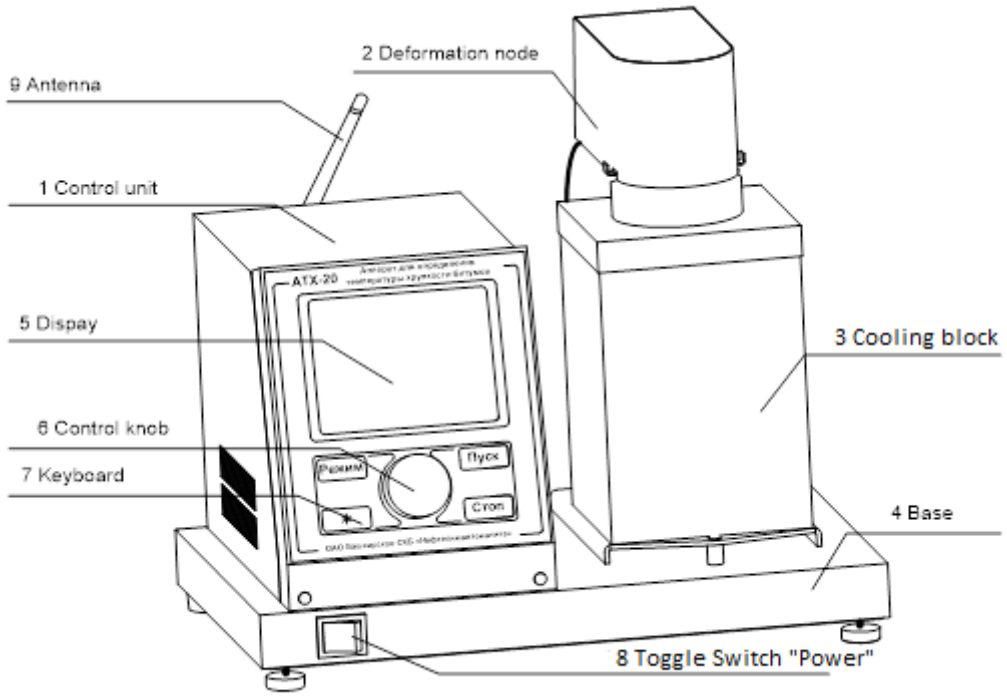


Figure 1 – The general view the tester

2.3.3.2 Structurally, the tester includes a control unit (1), a cooling block (3), and a deformation node (2) located on a base (4) mounted on adjustable legs. Toggle switch «**Power**» (8), located on the base (4).
2.3.3.3 The cooling block (3) is designed to cool the test sample. At the rear of the cooling block (see Figure 2) are the «**Inlet**» (4) and «**Outlet**» (5) fittings for connecting to an external refrigerant.

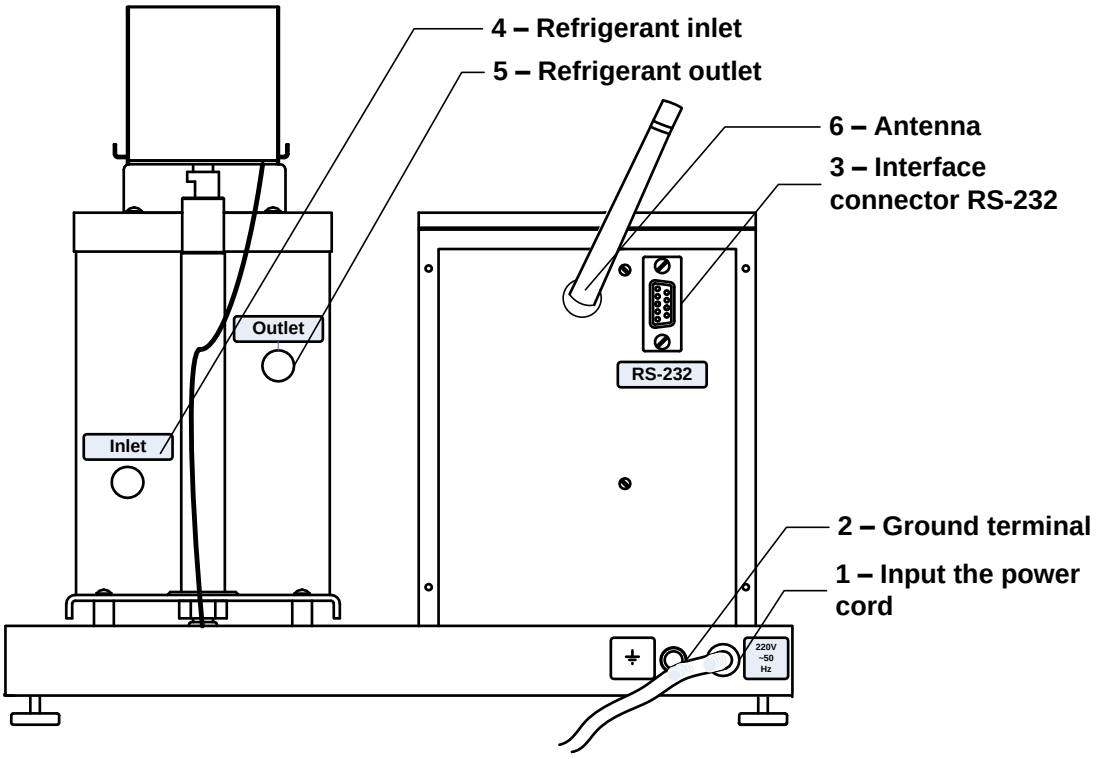


Figure 2 – Rear view

2.3.3.4 In the deformation node are located:
- device deformation of the plate;
- electromechanical drive of the deformation device;
- sensor Board;
- sensor measuring the temperature of the sample;
- the fragility of the sensor (piezo sensor).

2.3.3.5 On the back of the base (see figure 2) are:
- terminal (2) for grounding the device;
- input for the power cord (1).

2.3.3.6 In control unit are located:
- control card;
- the tester's power supply;
- liquid crystal graphic display (5) (see figure 1);
- control knob (6) (see figure 1);
- keyboard (7) (see figure 1);
- socket for connecting the antenna (6) (see figure 2);
- connector (3) (see figure 2) for connecting the tester to a PC via the RS-232 interface.

2.3.3.7 The placement of the keys and the control knob is shown in figure 3.

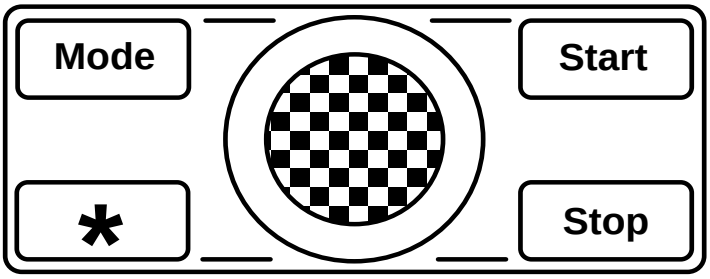


Figure 3 – The placement of the key and the control knob

2.3.4 Operation of the tester

2.3.4.1 After turning on the power, the display shows information with the name of the tester. After a while, information about the manufacturer appears on the display. At the same time, the tester performs self-testing and positioning of the plate bending mechanism.

2.3.4.2 If the tester detects a fault during self-testing, a corresponding message is displayed. In this case, operation of the tester is not possible until the fault is resolved.

2.3.4.3 After the end of the ad splash screen or after pressing the «**Stop**» key, the tester goes into waiting mode. Further operation of the tester depends on the selected test mode.

2.3.4.4 **Test Method «GOST 11507»**, **«GOST EN 12593», «GOST 33143», «EN 12593», «IP 80»**. In this mode, the standard method is implemented in according to the selected standard. The sample will be cooled at a rate of 1°C/min. After the sample reaches a temperature 10°C above the expected breaking point temperature, the bitumen sample will begin to deform.

2.3.4.5 **Test Method «Accelerated»**. In this mode, the sample begins to cool at a speed of 2 to 3 °C/min. As the sample temperature approaches the test start point, the cooling rate gradually decreases to 1°C/min. Then the sample will be cooled at a speed of 1°C/min. After the sample reaches a temperature 10 °C above the assumed brittleness temperature, the bitumen sample will begin to deform. The accelerated test mode allows you to reduce the time spent on the test, almost without reducing the accuracy of the result.

2.3.4.6 **Test Method «Express».** This mode allows you to quickly determine the approximate value of the breaking point temperature. In this mode, the sample is cooled at a rate of 2 to 3 °C/min. The sample deformations start at the same time as the start of cooling.

2.3.4.7 **Test Method «Deformations Control».** This mode determines the maximum number of deformations that the sample can withstand at a given temperature (fatigue test). This mode allows you to compare the mechanical characteristics of samples with the same or similar breaking point temperature, as well as get a qualitative idea of samples whose breaking point temperature is lower than the measuring range of the tester.

2.3.4.8 Depending on the selected mode, the operator will be required to enter additional data from the keyboard. In the modes «**GOST 11507**», **«GOST EN 12593», «GOST 33143», «EN 12593», «IP 80»** and

«**Accelerated**» you should enter the expected temperature breaking point of the sample and the maximum number of deformations. In the mode of «**Express**» maximum number of deformation. In the «**Deformations Control**» the temperature of the test sample and the maximum number of deformations.
After loading the prepared sample, turning on the refrigerant circulation and pressing the «**Start**» key, the automatic test will begin.
2.3.4.9 During the test, the tester automatically maintains the required cooling rate and the required deformation conditions for the sample.
2.3.4.10 The test ends automatically, after a crack is detected in the test sample. In this case, the test result is recorded on the display and in the tester's memory.

ATTENTION!
*In the mode **«Express»**, after a crack is detected in the test sample, the result is additionally recorded in the tester memory as the expected breaking point temperature.*

3 PREPARATION FOR OPERATION

3.1 Requirements for installation place

3.1.1 Tester design is intended for table-top installation.
3.1.2 The installation location is determined by the distance of connection to the power source, as well as its rational distance from the sample preparation facilities and the source of the refrigerant (water).
3.1.3 The installation Location of the tester should be excluding the impact of shaking, bumps and vibrations that affect operation.
3.1.4 Using the *LinteL*-Link[1] program, you should install the antenna (6) from the attachment kit on the tester (see figure 2).
3.1.5 To provide forced cooling of the tester with the built-in fan, located on the base, the distance between the base and the surface on which the tester is installed, should not be less than 8 mm. the Distance from the body to the surrounding objects should be at least 30 mm.

ATTENTION!
Sharp sounds (door slam, mechanical impact) can cause a false alarm of the fragility sensor.

3.1.6 The tester uses a graphical liquid crystal display. When selecting the installation location, to increase the service life of the tester, it is necessary to avoid direct sunlight on the display.
3.1.7 The keyboard of the tester is covered with a sealed polymer film, on which the images of the keys are applied. If the keyboard is dirty, it can be wiped using a gauze swab moistened with soap, alcohol, or oil solvent, depending on the nature and degree of contamination.

3.2 Visual control

Before using the tester:
1) unpack the tester;
2) check scope of supply;
3) perform visual control of the tester for damage;
4) check for supporting documentation.

An appropriate report is drawn up for all defects.

3.3 Test run

ATTENTION!
After entering a heated room from a zone with a temperature below 10°C, keep the tester in the package for at least 4 hours.

3.3.1 Connect the tester to the network and turn on the «**POWER**» toggle switch.

[1] It is delivered by the separate order.

3.3.2 After turning on the power, the tester begins to conduct a self-diagnosis. The display shows the name of the tester and an informational splash screen. You can interrupt the information screen saver by pressing the «**Stop**» key.
3.3.3 If the tester detects a malfunction during the self-diagnosis, then the corresponding message is displayed (see paragraph 4.8.2 of this manual). In this case, operation of the tester is not possible until the fault is rectified.
3.3.4 Next, the tester goes into waiting mode.
3.3.5 If necessary, adjust the brightness of the display by rotating the control knob. The set brightness is automatically stored in the memory of the device.

4 INTENDED USE

4.1 Additional equipment and materials

Additional materials for operation given in Table 4.

Table 4 – Additional materials

Materials	Purpose
Toluene (petroleum according by GOST 14710 or coal according by GOST 9880), TS-1 kerosene or «Galosha» petrol	cleaning of clips from traces of bitumen
Cotton napkin	

Additional equipment for operation given in Table 5.

Table 5– Additional equipment

Equipment	Purpose
Sample preparation device UPP-10[1]	for melting bitumen on a metal plate and cooling it on a horizontally mounted table in accordance with the requirements of GOST 11507, GOST EN 12593, GOST 33143, EN 12593, IP 80
Laboratory scales of the 3rd class of accuracy	for weighing steel plates
Ceramic plate size 100 x 100 x 5 mm	for holding plates after melting the bitumen

4.2 Operating limits

1) the **«Ground terminal»** on the back of the tester should be connected to an external ground strap, that is not connected to the power equipment;
2) it is forbidden to perform maintenance of the tester included in the network;
3) during work with the tester, the service personnel should perform safety regulations, working with electrical installations with a voltage of up to 1000 V;
4) Service personal should:
   - to be trained to operate the tester and obtain a permit to;
   - know how the tester works;
   - know the rules for safe maintenance;
   - know the procedure for a failure.
5) to avoid electric shock, work related to setting up, cleaning, and lubrication of components and parts of the tester, should be carried out only, when the power is turned off;
6) persons who are allowed to work with the tester should have safety training for working with tester of this type.

4.3 Sample preparation

Prepare the sample in accordance by GOST 11507, GOST EN 12593, GOST 33143, EN 12593, IP 80.

[1] Manufacturer- BSDO «Neftekhimavtomatika» JSC.

4.4 Tester preparation for testing

4.4.1 Selecting the connection diagram and the refrigerant temperature

4.4.1.1 Choice of a specific connection scheme depends on the range of bitumen samples tested and the temperature of the refrigerant.

4.4.1.2 Using an external thermostat with a stabilization temperature of 35°C at ambient temperatures from 10°C to 35°C is recommended for testing bitumen in the temperature range from 20 to -15°C.

It is recommended to use an external thermostat TS-20 (manufacturer- BSDO «Neftehimavtomatika» JSC).

The device is designed to maintain temperatures from +20 to +105^{0}C with the ability to work with an external object.

4.4.1.3 Use of running tap water with a temperature between 8°C and 15°C as a refrigerant source is recommended for testing bitumen with an assumed breaking point temperature:

- from -10 to -35°C at ambient temperature, no more than 25°C;
- from -10 to -28°C at ambient temperature, no more than 35°C.

The first deformation of the bitumen sample is performed 10°C before the expected crunch temperature, i.e. if the expected temperature is set to -10°C, the first deformation will be performed at 0°C.

4.4.1.4 Use of running tap water with the temperature from 4°C to 8°C or a thermocriostat with a stabilization temperature of 5°C as a refrigerant source is recommended for testing bitumen in the temperature range:

- from -15 to -45°C C at an ambient temperature of not more than 20°C;
- from -15 to -35°C at ambient temperature, no more than 35°C.

4.4.1.5 Dependence of the recommended refrigerant flow rate on the breaking point temperature given in table 6.

It is recommended to use the TKS-20 thermocriostat (manufacturer-BSDO «Neftehimavtomatika» JSC).

The device is designed to maintain temperatures from -20 to +100^{0}C with the ability to work with an external object.

Table 6 –Dependence of the recommended refrigerant flow rate on the breaking point temperature

The source of refrigerant	**The temperature of the refrigerant, ^{0}C**	**Expected breaking point temperature, ^{0}C**	**Recommended flow rate of the refrigerant, liter/min.**
External thermostat	+35	20 …11	-
		12 …0	-
		-1 …-15	-
Running tap water	8…15	-10 …-18	1,5…2,5
		-19 …-25	2,5…3,5
		-26 …-35	3,5…5,0
Running tap water or thermal cryostat	4…8	-15 …-25	2,5…3,5*
		-26 …-45	3,5…5,0*

* For thermocriostat (thermostat) flow rate of the refrigerant is not specified.

4.4.1.6 During the test, the change in the refrigerant temperature should not exceed 0,5°C in 5 minutes, 1,0°C in 10 minutes.

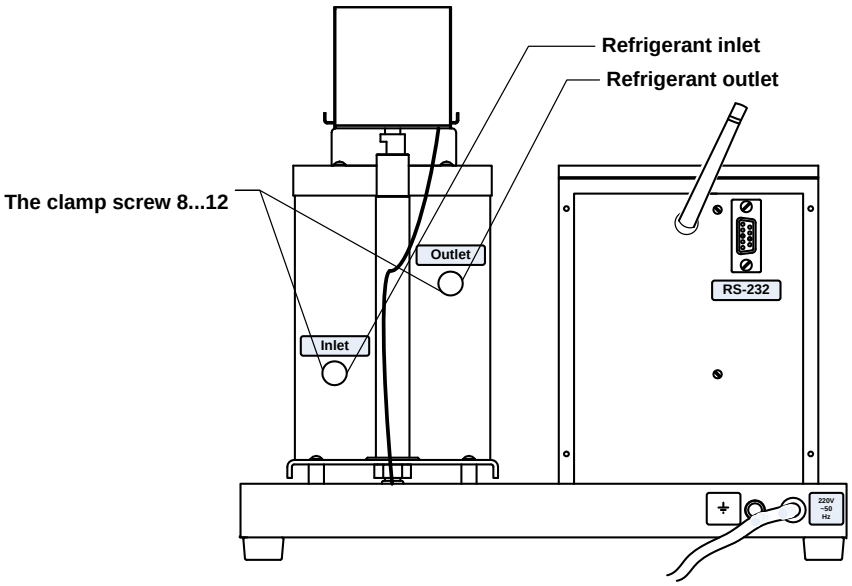


Figure 4 – The connection of the refrigerant

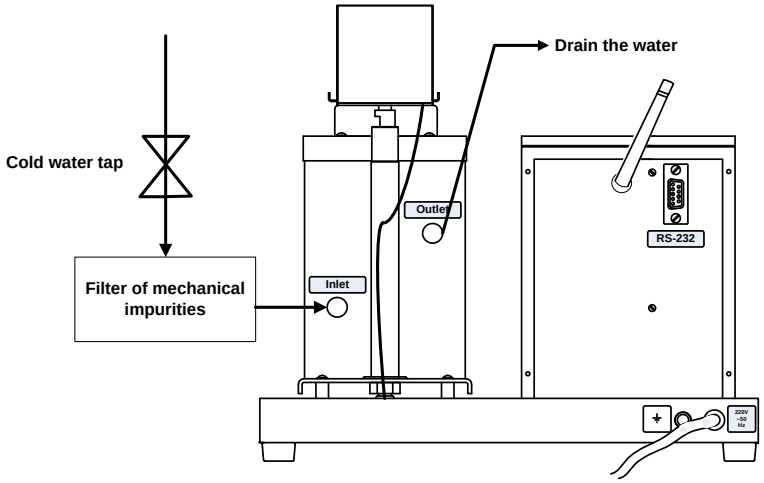


Figure 5 – The connection to the water supply

4.4.1.7 During connection ATH-20 to water supply, use medical polyvinyl chloride tubes to connect the water tap to the inlet of the cooling block (marked as **"Inlet"**), and the outlet of the cooling block (marked as **"Outlet"**) to the sewer for draining (see figure 4, 5).

4.4.1.8 Connected to an external thermostat (thermocriostat), it is necessary to connect medical tubes polyvinyl chloride inlet and outlet of the cooling block of the tester of the ATH-20 with the output and input external thermostat (thermocriostat), accordingly (see figure 6).

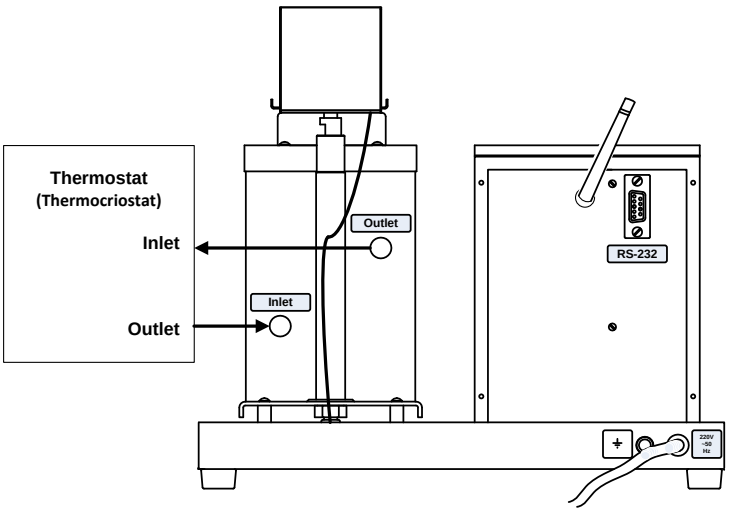


Figure 6 –Connection to an external thermostat (thermocryostat)

4.4.1.9 The dependence of the temperature of the refrigerant on the expected temperature of breaking point is shown in Figure 7.

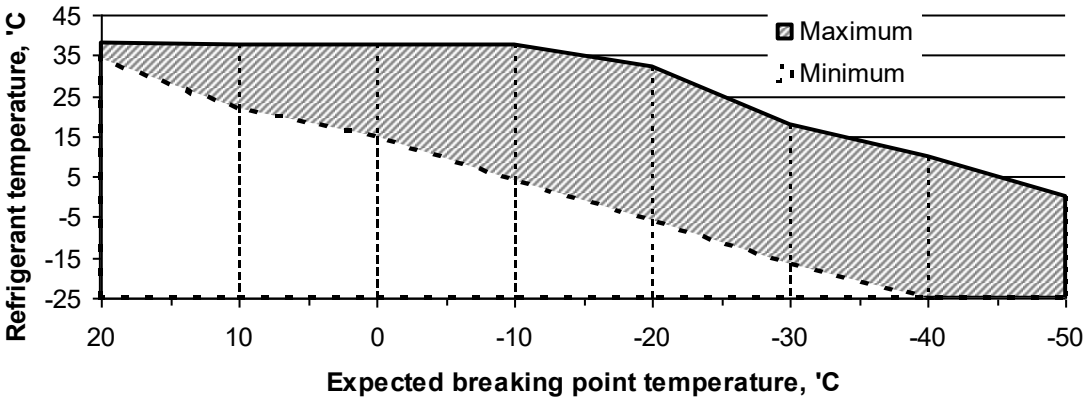


Figure 7 – The dependence of the temperature of the refrigerant on the expected temperature of breaking point

4.4.1.10 If the temperature of the refrigerant is too high, the cooling rate of the test sample may decrease. Conversely, if the temperature of the refrigerant is too low, the cooling rate will not have time to stabilize by the time the deformations of the bitumen sample begin.

ATTENTION!

If the test is carried out in the absence of refrigerant circulation or when the refrigerant temperature is higher than 40 ° C, the tester will switch to protection mode, which automatically turns off cooling while at the same time turning on an intermittent audible alarm and issuing a corresponding message on the display.

4.4.2 General information

4.4.2.1 Note that the following parameters influence the test results:

- setting of the deformation node (provided by the manufacturer);
- compliance with operating rules, including the absence of extraneous noise and vibration in the installation area of the tester, as well as the absence of contamination of the deformation node;

- cleaning of the traps of the deformation node from traces of bitumen after each test (toluene, «Galosha» petrol or TS-1 kerosene are allowed to be used as a solvent);
- size matching and characteristics of the working plate (see paragraph 9.5 AIF 2.772.008 MA);
- the quantity and uniform application of the bitumen sample on the surface of the plate (see paragraph 4.3 of this Operating manual);
- correct installation of a plate with a bitumen sample (see paragraph 4.5.4 of this Operating manual

4.4.3 Turning on the tester in accordance with paragraph 3.3 of this Operating manual.

4.5 Testing

4.5.1 Setting test conditions

4.5.1.1 In waiting mode, press **«*»** and select menu item **«Test conditions» → «Test method»**.

4.5.1.2 The tester goes to the test condition selection menu (see figure 8).

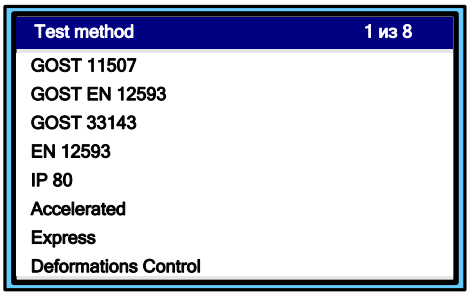


Figure 8 – The test condition selection menu

4.5.1.3 Select the necessary test mode by rotating the control knob and press "**Start**". This returns the tester to waiting mode.

4.5.1.4 When the «**Stop**» key is pressed, the tester returns to waiting mode without changing the test mode.

4.5.2 Setting the expected breaking point temperature

4.5.2.1 In waiting mode, press «*», select menu item «**Test conditions**» → **« Texpected ,^{0}C:»** and press «**Mode**». The tester enters the mode for entering the expected breaking point temperature (see figure 9).

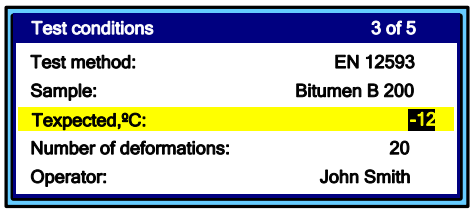


Figure 9 – Mode for entering the expected breaking point temperature

Changing the numeric parameter in 1^{0}C increments is performed by rotating the control knob.

When pressing the key **«*»** and when the control knob is rotated simultaneously, the step of changing the value is 10^{0}C.

4.5.2.2 Press «**Start**» to remember the expected breaking point temperature. In this case, the tester returns to the service menu.

4.5.2.3 When pressing the key «**Stop**» the tester returns to the service menu without changing the expected fragility temperature.

4.5.2.4 To exit the menu mode, press «**Stop**».

4.5.3 Changing the sensitivity threshold of the breaking point sensor

4.5.3.1 In waiting mode, press «*» and select menu item «**Setting**» → «**Threshold of sensitivity**» and press «**Mode**». The tester enters the mode of changing the sensitivity threshold of the breaking point sensor (see figure 10).

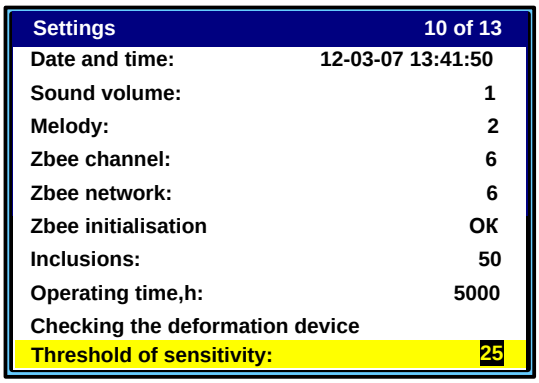


Figure 10 –Mode for changing the sensitivity threshold of the breaking point sensor

The sensitivity threshold value varies from **1 (high sensitivity)** to **1000 (low sensitivity).**
Changing the numeric parameter in increments of 1 is performed by rotating the control knob.
When pressing the key **«*»** and when the control knob is rotated simultaneously, the value change step is 10.
4.5.3.2 Initially, the tester is configured to work with non-modified bitumen's. In this case, the sensitivity threshold is less than 50 units.
When testing modified bitumen (with additives), during the bending of the plate with the sample, the bitumen is detached from the plate without forming a crack. The noise that occurs during this process can be perceived by the device as a crack formation.
In this case, you need to increase the sensitivity threshold.
The sensitivity threshold is determined experimentally by conducting tests in the methods «**GOST 11507**», **«GOST EN 12593», «GOST 33143», «EN 12593», «IP 80»** and increasing the value of the sensitivity threshold after each test by 10-20 units, until the tester stops to fix noises of bitumen peeling and clearly fix the formation of a crack on the sample.
If you need to continue working with non-modified bitumen's, we recommend that you enter the sensitivity threshold set by the manufacturer.
4.5.3.3 Press «**Start**» to remember the sensitivity threshold. In this case, the tester returns to the service menu.
4.5.3.4 When pressing the key «**Stop**» the tester returns to the service menu, without storing the sensitivity threshold
4.5.3.5 To exit the menu mode, press «**Stop**».
4.5.4 Installing a bitumen sample
To install a prepared plate with a sample of bitumen, follow these steps.
4.5.4.1 Rough plate installation
- Turn on the machine's power supply and wait for the program to enter waiting mode. In this case, the deformation node will be set to the state with the maximum distance between the clips.
- Put the deformation node in the sample loading state. To do this, you need to lift the deformation node up to the stop and turn it in any direction to fix it in the raised position.
- Move the distance limiter lever between the clips to the «**Open**» position (see figure 11).
- Clear the clips of any traces of bitumen that may have remained after previous tests. Toluene, TS-1 kerosene, and «Galosha» petrol can be used as a solvent.
- Bitumen with a breaking point temperature -20^{0}C is recommended to be pre-cooled to a temperature of 15^{0}C to prevent the displacement of the bitumen from the plate and it is sticking to the clips of the deformation device.
- Insert a plate with bitumen in the clips so that the bitumen layer is positioned outwards. In this case, the piezo sensor is pressed against the plate from the opposite side.

ATTENTION!

To avoid breakage and damage to the piezo sensor, it is recommended to install the plate with bitumen as follows: take the fingers of both hands for the side edges on both sides and install first in the lower clip, and then, slightly bending, in the upper clip.

- Move the distance limiter lever between the clips to the «**Close**» position to give the plate a preliminary deformation.
- Make sure that the plate is bent outwards.

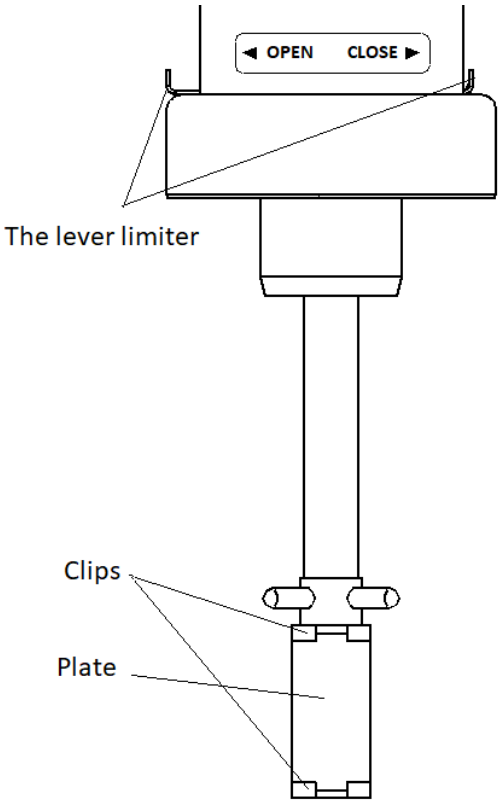


Figure 11 - Installing a bitumen sample

4.5.4.2 Accurate installation of the plate

- Install the plate in accordance with figures 12, 13.

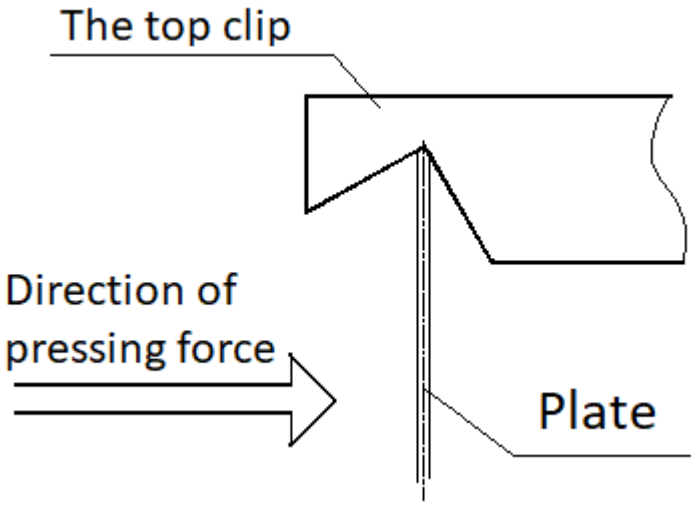


Figure 12 – Install the plate

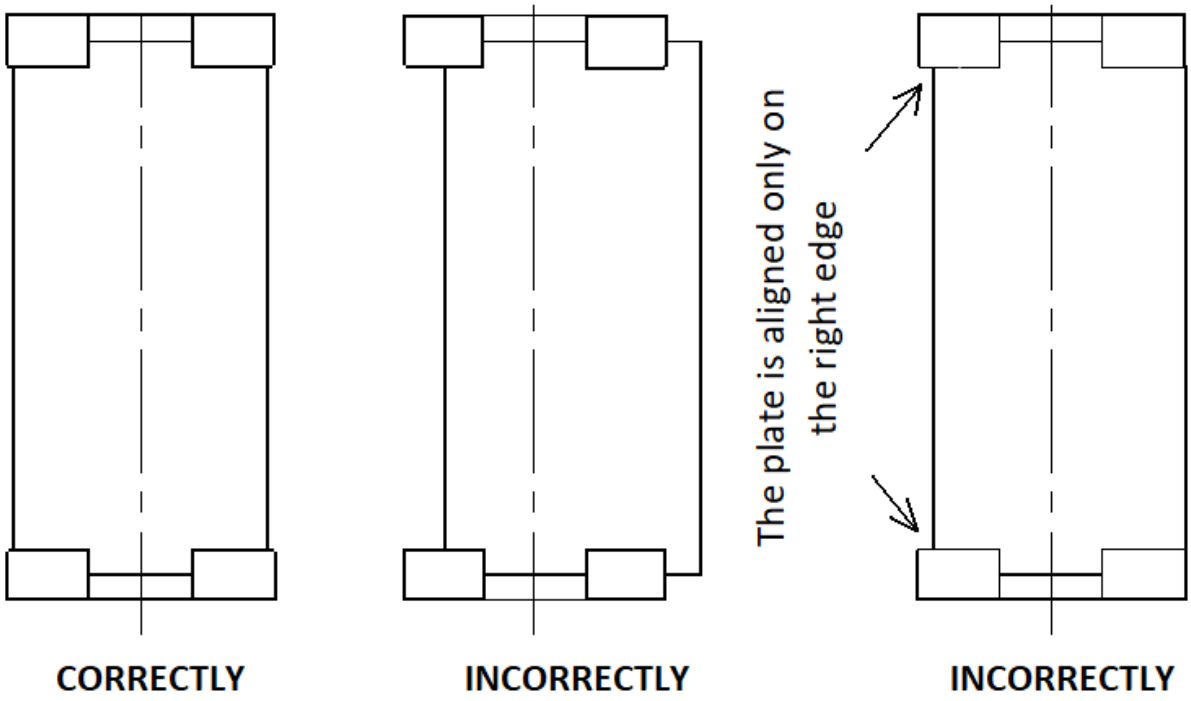


Figure 13 – Install the plate

– Move the deformation node to the working position. To do this, lifting the deformation node up, simultaneously turn it so that the plate with bitumen was above the cylinder of the cooling block, then gradually lower the deformation node to the lower position.

4.5.5 Operating procedure

4.5.5.1 Waiting mode

4.5.5.1.1 Information is displayed in the waiting mode, shown in figure 14

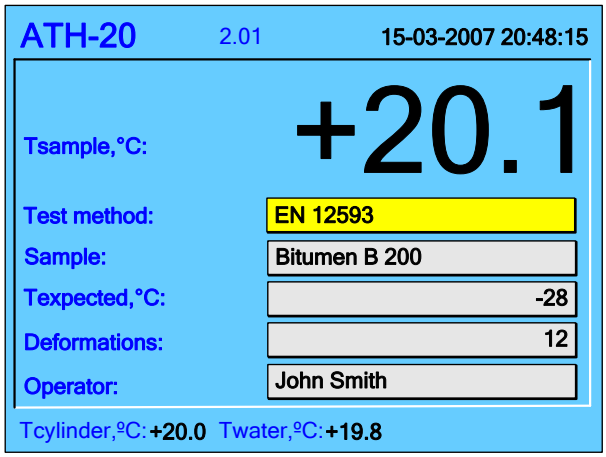


Figure 14 - Waiting mode

4.5.5.1.2 The following information is displayed at the top of the display:

– The name of the tester;
– Configuration;
– The current date and time.

4.5.5.1.3 The following information is displayed in the central part of the display:

– Sample temperature;
– Method of testing;
– Sample name;
– Expected breaking point temperature;
– The maximum number of deformations;
– Operator name.

4.5.5.1.4 The following information is displayed at the bottom of the display:
- The temperature of the cylinder;
- Water temperature.

4.5.5.1.5 There are two ways to select test parameters:
1) press **«Mode»**. In this case, the first parameter (selection window in the list) is selected (highlighted in yellow) and the value is selected by rotating the control knob. The transition to changing the next parameter is performed by pressing the «**Mode**» key»;
2) press **«*»**. Menu mode opens. The parameter value is selected in accordance with paragraph 4.10.1 of this Operating manual.

4.5.5.1.6 The test parameters set by the operator are saved and do not need to be entered again.
4.5.5.1.7 The test is started by pressing the «**Start**» key once.
4.5.5.2 Operation of the tester in the mode **«GOST 11507», «GOST EN 12593», «GOST 33143», «EN 12593», «IP 80».**
4.5.5.2.1 Turn on the tester power supply and refrigerant circulation in accordance with paragraph 4.4.1 of this Operating manual.
4.5.5.2.2 Set up the sample of bitumen in accordance with paragraph 4.5.4 of the Operating manual.
4.5.5.2.3 Select one of the test methods («GOST 11507», «GOST EN 12593», «GOST 33143», «EN 12593», «IP 80»).
4.5.5.2.4 If necessary, specify the test parameters.
4.5.5.2.5 Press **«Start»**. In this case, the deformation device will be positioned to its original position. The information shown in figure 15 will appear on the display.

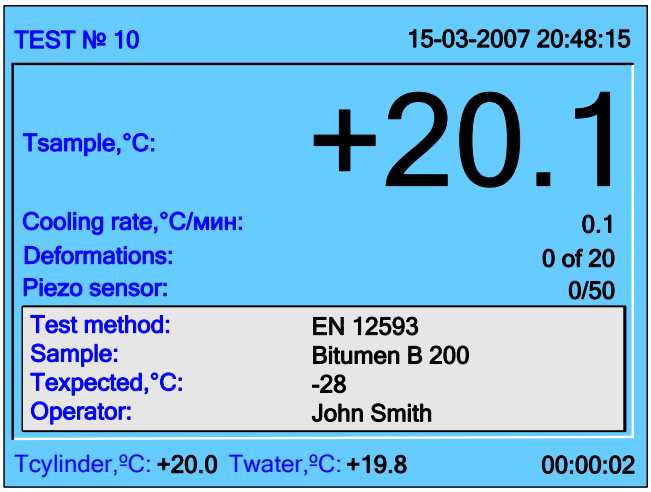


Figure 15 – «Test» mode

4.5.5.2.6 The following information is displayed at the top of the display::
- Test number;
- The current date and time.

4.5.5.2.7 The following information is displayed in the central part of the display:
- Sample temperature;
- The rate of cooling of the sample;
- Number of deformations performed and set;
- Piezo sensor readings / sensitivity threshold;
- Selected test method;
- Name of sample;
- Expected breaking point temperature;
- Operator name.

4.5.5.2.8 The following information is displayed at the bottom of the display:
- The temperature of the cylinder;
- Water temperature;

– Time elapsed since the start of the test.

4.5.5.2.9 After approximately (10…12) minutes, the sample cooling rate will be set to 1°C / min, and when the temperature reaches 10°C above the expected breaking point temperature, the first deformation of the bitumen sample will occur.

4.5.5.2.10 Each next deformation will be performed after lowering the temperature of the bitumen sample by 1°C.

4.5.5.2.11 You can stop the test at any time by pressing the «**Stop**» key, switching to the waiting mode and without saving the test result.

4.5.5.3 Operation of the tester in the **«Accelerated»** mode.

4.5.5.3.1 Turn on the power supply of the tester and the refrigerant circulation an accordance with paragraph 4.4.1 of this Operating manual.

4.5.5.3.2 Install a sample of bitumen in accordance with paragraph 4.5.4 of this Operating manual.

4.5.5.3.3 Select the **«Accelerated»**. Test method.

4.5.5.3.4 If it is necessary to specify the test parameters (see paragraph 4.5.5.1.5 of this Operating manual.

4.5.5.3.5 Press **«Start»**.

4.5.5.3.6 The deformation device will be positioned, and then the test window will appear on the display.

4.5.5.3.7 The sample will start to cool at a rate of 2,0 to 3,0°C/min.

4.5.5.3.8 As the sample temperature approaches the starting point of deformation (for 16…20°C) the cooling rate gradually decreases to 1°C/min.

4.5.5.3.9 By the time of the first deformation (for 10°C) the speed of 1°C/min is set with an error of no more than 5%.

4.5.5.3.10 Otherwise, the operation of the tester in the **«Accelerated»** mode does not differ from the mode **«GOST 11507», «GOST EN 12593», «GOST 33143», «EN 12593», «IP 80»**. The accelerated test mode allows you to reduce the time spent on the test, and practically does not reduce the accuracy of the test.

4.5.5.4 Operation of the tester in the **«Express»** mode.

4.5.5.4.1 Turn on the power supply of the tester and the refrigerant circulation in accordance with paragraph 4.4.1 of this Operating manual.

4.5.5.4.2 Install a sample of bitumen in accordance with paragraph 4.5.4 of this Operating manual.

4.5.5.4.3 Select the test method **«Express»**.

4.5.5.4.4 If it is necessary to specify the test parameters (see paragraph 4.5.5.1.5 of this Operating manual.

4.5.5.4.5 Press **«Start»**.

4.5.5.4.6 The deformation device will be positioned, and test window will appear on the display.

4.5.5.4.7 In this mode, the sample is cooled at a rate of 2,0 to 3,0°C/min and the sample deformations start simultaneously with the start of cooling.

4.5.5.4.8 Deformations of the sample will be repeated every 3 ° C during the cooling process.

4.5.5.4.9 The test Results obtained in this mode are only suitable for express determination of the preliminary breaking point temperature.

4.5.5.4.10 You can stop the test at any time by pressing the «**Stop**» key, switching to the waiting mode and without saving the test result.

4.5.5.5 Operation of the tester in the **«Deformations Control»** mode.

4.5.5.5.1 Turn on the power supply of the tester and the refrigerant circulation in accordance with paragraph 4.4.1 of this Operating manual.

4.5.5.5.2 Install a sample of bitumen in accordance with paragraph 4.5.4 of this Operating manual.

4.5.5.5.3 Select the test method «**Deformations Control**».

4.5.5.5.4 If it is necessary to specify the test parameters (see paragraph 4.5.5.1.5 of this Operating manual.

4.5.5.5.5 Press **«Start»**.

4.5.5.5.6 The deformation device will be positioned, and then the test window will appear on the display.
4.5.5.5.7 After cooling the bitumen sample to the set test temperature and holding the time required to stabilize the temperature, deformations of the sample will begin.
4.5.5.5.8 You can stop the test at any time by pressing the «**Stop**» key, switching to the waiting mode and without saving the test result.

ATTENTION!
*If you press the **«*»** key during the test, the piezo sensor signal measurement channel is turned off. This mode is required for certification of the temperature meter. Pressing the **«*»** key again connects the piezo sensor signal measurement channel.*

4.6 Processing test results

4.6.1 Processing of the results.
4.6.1.1 The breaking point temperature is the arithmetic mean of the two definitions, rounded to an integer. If the difference between the two consecutive definitions of more than 3°C, it is necessary to carry out the third definition.
4.6.1.2 When evaluating the reliability of the results, factors such as the shape of the crack on the bitumen sample, the total number of deformations, and the recorded breaking point temperature should be taken into account.
4.6.1.3 If no crack is detected on the bitumen sample at the end of the test, the result recorded by the tester is likely to be false. You can identify the following reasons for a false result:

- the tester was subjected to vibrations, shocks or bumps that coincided with the moment of deformation;
- the plate bending device and the cooling block cylinder were not sufficiently dried before the test, or the bitumen sample was poorly dehydrated during sample preparation. In this case, the tester records the breaking point temperature at a temperature of about 0°C;
- the plate with the bitumen sample is incorrectly installed or the geometric dimensions of the plate with the bitumen sample are violated.

4.6.1.4 The number of deformations of the bitumen sample recorded by the tester can also be used to assess the reliability of the result. The result is most reliable if the sample was deformed from 5 to 15 times during the test. The cause of a large number of deformations may be the setting of too high an expected breaking point temperature. Setting the expected breaking point temperature too low may be the cause of a small number of deformations.
4.6.2 Viewing test results
4.6.2.1 In waiting mode, press **«*»** and select menu item «**Results**» → «**View**».
4.6.2.2 The display shows the result of the last test performed (see figure 16).

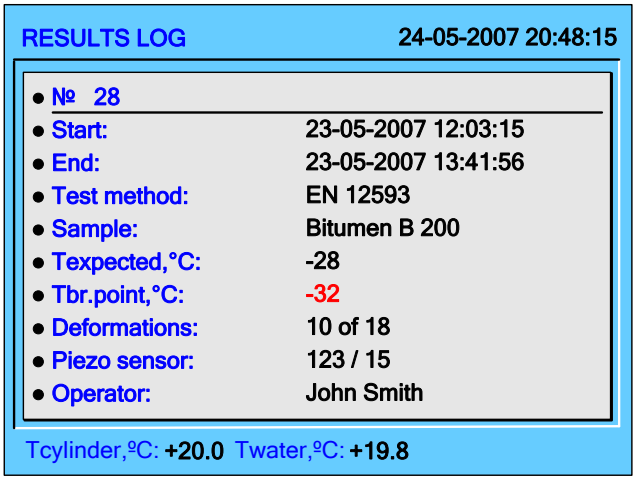


Figure 16 - The result of the last test performed

The display shows:
- Test number;
- Start date and time of the test;
- End date and time of the test;
- Test condition;
- Name of sample;
- Expected breaking point temperature, °C;
- Measured breaking point temperature, °C;
- The number of deformations performed and the specified number of deformations;
- Readings of the signal level of the piezo pickup / specified threshold;
- Operator name.

4.6.2.3 The tester stores the results of the last 100 tests in memory. Each test result is assigned its own number. The last test is assigned a number equal to the number of previous tests plus 1. When conducting more than 100 test results last stored in the first place, i.e. the result of test 101 will be written to location 1 of the test.

4.6.2.4 Enumeration of test numbers in step 1 is performed by rotating the control knob.

4.6.2.5 To calculate the arithmetic mean, it is necessary when viewing the desired test results, mark them by pressing the **«*»** key. In this case, the records of the test results are marked with an asterisk in the upper line, and the arithmetic average for all marked records, rounded to 1 °C and the value in brackets, rounded to 0.1 °C is displayed in the lower part of the screen. The mark is also removed by pressing the **«*»** key (see figure 17).

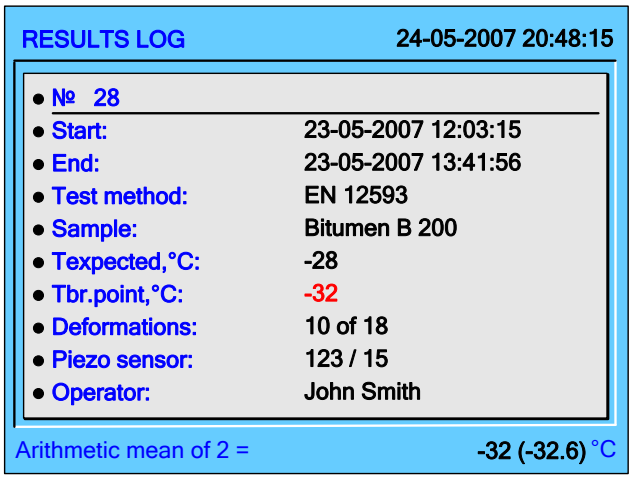


Figure 17 – Test log

4.6.2.6 If the log entry is checked there is a message **«Attention!!! The results differ by more than 3°C»**, which means that the last selected result differs from the previously selected results by more than 3°C and cannot be used for calculations.

4.6.2.7 In the test results view mode, when the «**Mode**» key is pressed, switching to the test results deletion mode occurs (see figure 18).

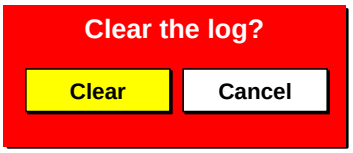


Figure 18 – Test results deletion mode

4.6.2.8 Select the desired action by rotating the control knob and press «**Start**».

4.6.2.9 When the «**Stop**» key is pressed in the test results view mode, the operator returns to the waiting mode.

4.6.3 Printing the test results

4.6.3.1 The tester has the ability to output information to an external device, for example a personal computer, for which you should first run the terminal - program on the personal computer (see Appendix A).
4.6.3.2 In waiting mode, press **«*»**, select menu item «**Results**» → «**Print**» and press «**Start**». All test results will be output to the RS-232 port.
4.6.4 Printing test results for the period.
4.6.4.1 In waiting mode, press **«*»**, select menu item «**Results**» → «**Print»** and press «**Mode**». The tester enters the mode print with selecting period time (see figure 19)

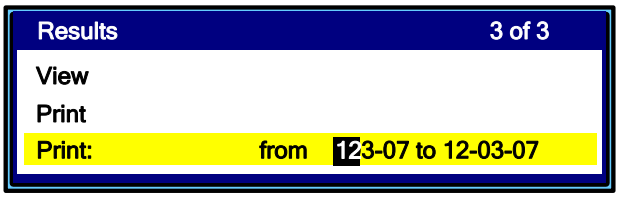


Figure19 – Print with selecting period time

Input format: **day-month-year**. Displacement between the position input is performed by pressing the "**Mode**".
Changing the numeric parameter in increments of 1 is performed by rotating the control knob.
When the **«*»** key is pressed and the control knob is rotated simultaneously, the value change increments is 10.
4.6.4.2 Press «**Start**» key to remember the period. In this case, the device returns to the service menu.
4.6.4.3 When the «**Stop**» key is presses, the tester returns to the service menu without changing the period.
4.6.4.4 Press again the «**Start**» key to print the results for the specified period. In this case, the RS-232 port will display the test results for specified period and return to waiting mode.
4.6.4.5 To exit the menu mode, press «**Stop**».

4.7 Work completion

4.7.1 End of the test.
4.7.1.1 Regardless of the selected test mode, the test ends either after the tester detects a crack in the bitumen sample, or when the maximum possible number of deformations is reached. In the first case, a message is displayed, accompanied by a melody that signals the end of the test (see figure 20).

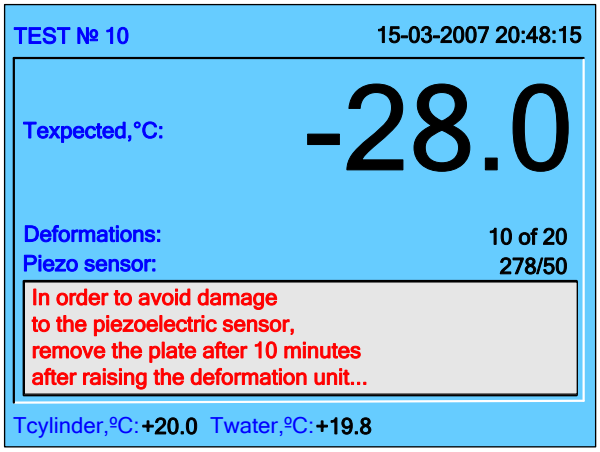


Figure 20 – End of the test.

In the second case, an error message is displayed (see figure 21).

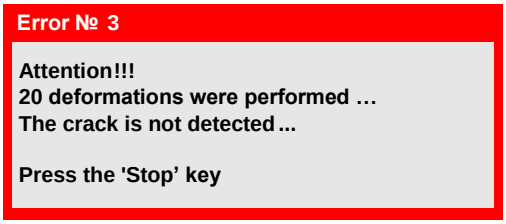


Figure 21 – Error message

4.7.1.2 At the end of the test, the tester deformation device leaves the plate in the state of greatest deformation for subsequent visual inspection.

4.7.1.3 Raise the deformation unit up to the stop and turn it in any direction to fix it in the raised position. If necessary, perform a visual inspection of the crack on the bitumen sample.

4.7.1.4 Press «**Stop**». This will automatically turn on the heating of the cylinder to room temperature to prevent condensation.

4.7.1.5 The deformation unit should be left in the raised state for 20 ... 30 minutes to dry the resulting condensate, or blow the deformation unit and the cooling block cylinder with compressed air for 3 to 5 minutes.

ATTENTION!

In order to avoid damage to the piezo sensor due to its freezing to the plate, remove the plate after 10 minutes after lifting the deformation node.

4.7.1.6 Perform the cleanup of clips from the remnants of bitumen. Toluene, «Galosha» petrol, or TS-1 kerosene may be used as a solvent.

4.7.2 Turn off the tester by pressing the «**Power**» toggle switch. Disconnect the tester from the network.

4.8 List of potential failures

4.8.1 Lack of convergence

The manifestation of a fault:

– the lack of convergence test results.

Possible causes of malfunction:

– the working plate does not meet the requirements;
– the clips setting is broken.

Methods for identifying the cause of the fault:

– check the size and quality of the working plate (see paragraph 9.5 of the AIF 2.772.008 MA);
– check the size between the clips with the calibration plates (see paragraph 9.6 AIF 2.772.008 MA);
– check the coaxially of the clips and their parallelism (see figure 22, 23).

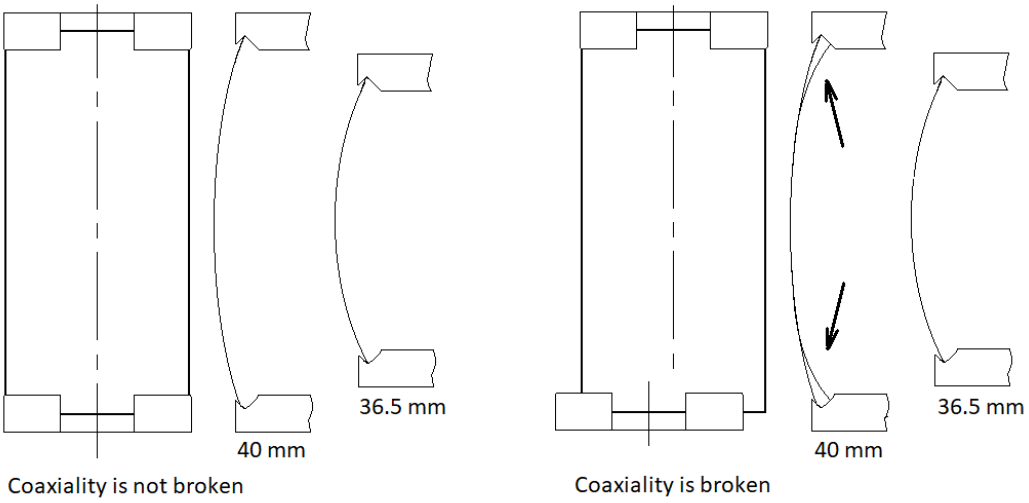


Figure 22 - Checking the alignment of the grippers

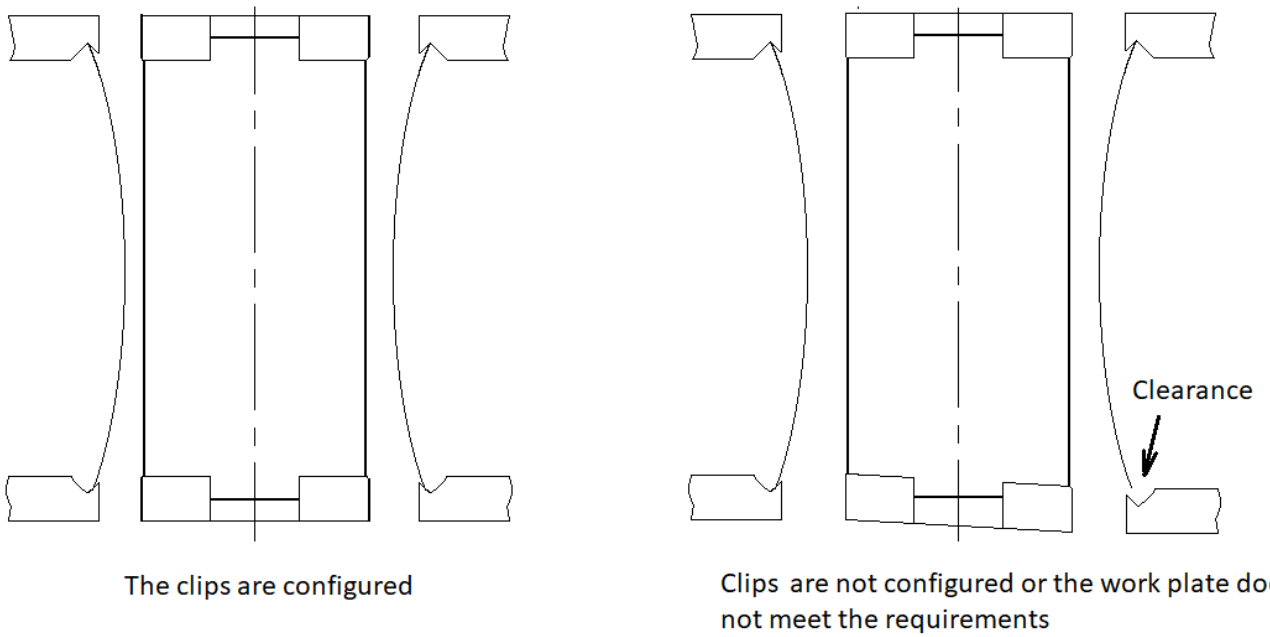


Figure 23 - Checking parallelism of the grips

To check the coaxiality t of the clips, install the plate in accordance with paragraph 4.5.4.1 of this Operating manual, placing the deformation node in the loading state of the sample.
By lifting the bottom clip with your finger from 3 to 4.5 mm, find a viewing point where the curved plate looks like a thin line from the side. The distance from the point of view to the plate should be at least 50 cm. Release the clip and it will return to the 40 mm position. If the curved plate looks like a thin line from the side – then the clip is set correctly. If there is a noticeable «**thickening**» at the top or bottom that exceeds two plate thicknesses (the «**propeller**» effect), then the setting of the clips is broken (see figure 22).
To check the quality of the plate installation, make sure that the plate touches the clips at four points (see figure 23).
If you find defects in the clip setting in the deformation node and other types of faults, contact the manufacturer. Replacement, repair and configuration of the tester are performed if you have a warranty card or passport. The tester is accepted for warranty repair only with the full set of delivery and in the manufacturer's packaging.

ATTENTION!
In case of failure of the tester due to the elimination of mechanical failures by the consumer, the manufacturer disclaims responsibility for warranty obligations.

4.8.2 Fault messages
This section contains messages (see table 7) that appear if further operation of the tester is not possible. In this case, you should turn off the tester and pause for at least 5 minutes before turning it on again.
If the message appears again, we recommend to contact the manufacturer.

Table 7 – Fault messages

№	Messages	Cause
1	**Flash memory error or timer chips….**	Error checking of the data flash memory.
2	**Peltier consumption current exceeds *XX.X A…***	The current consumption of Peltier elements exceeds the allowed value.
3	**Positioning sensor error…**	- the drive of the deformation device is faulty; - the end sensor is faulty.
4	**The deformation time mm:ss is wrong**	
5	**Error connection to sensor board…**	Exchange error with the sensor board.

4.8.3 Warnings

This section contains warning messages (see table 8).

Table 8 –Warning message

№	Messages	Cause
1	**The test results log is empty...**	Attempt to view test results without performing tests.
2	**The sample temperature is lower than expected.**	The sample temperature is higher than the expected breaking point temperature.
3	***NN* deformations were performed. The crack is not detected…**	During the test, the specified number of deformations was performed, and no crack was detected.
4	**Results differ by more than 3°C...**	During selecting test results to calculate the average value, the last selected result differs from the previously selected results by more than 3°C.
5	**The temperature of the cylinder below -58°C.**	The cylinder temperature is below the maximum permissible temperature of -58°C.
6	**The water temperature is above +40°C. Check refrigerant connection…**	The cylinder temperature is above the maximum permissible temperature of +40°C.
7	**Sample temperature below -50°C.**	The sample temperature is below the maximum permissible temperature of -50°C.

When you press «**Stop**», the tester returns to the waiting mode.

4.9 Contingency actions

If liquids or foreign objects get inside the tester, you should:

1) turn off the tester by pressing the power button on the tester;
2) lower the automatic switch control lever down;
3) remove the plug from the wall outlet;
4) remove the protective cover;
5) remove liquid or foreign objects;
6) install the cover in place.

NOTES!

It is recommended to use compressed air to remove the liquid. The faster the liquid is removed, the more likely it is that the tester will remain functional. After removing the liquid, the tester should be kept for at least 16 hours before switching on again.

4.10 Additional function

4.10.1 Service menu

4.10.1.1 Access to the modes for entering test conditions, viewing and printing results, as well as setting up the tester is provided using the service menu.

4.10.1.2 If you press **«*»**, in the waiting mode, the tester enters the service menu mode.

4.10.1.3 The menu structure is shown in figure 24.

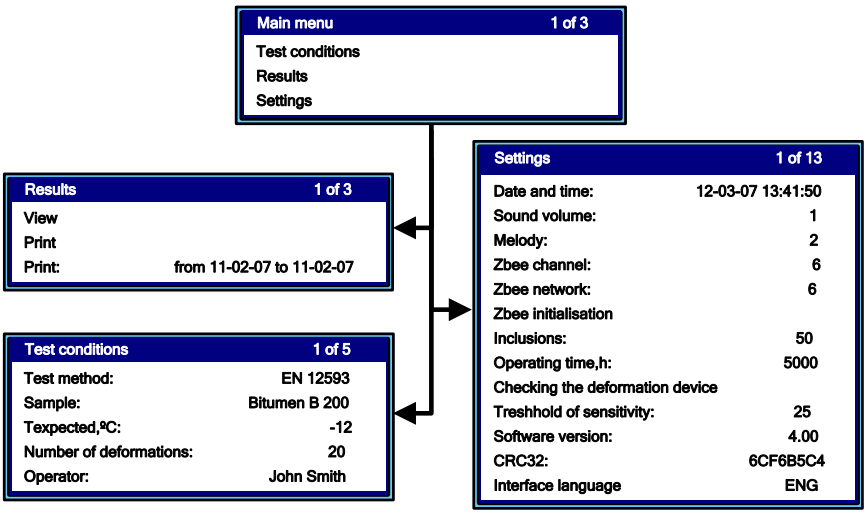


Figure 24 – The menu structure

4.10.1.4 Menu pointer (cursor) is a line with a yellow background and moves in the visible area of the window. The pointer is moved by rotating the control knob.

4.10.1.5 Selecting a menu item is performed by pressing the «**Start**» key.

4.10.1.6 To exit the menu mode, press «**Stop**».

4.10.2 Setting the sample name

4.10.2.1 In waiting mode, press **«*»** and select menu item «**Test conditions**» → «**Sample**».

The list displayed on the display consists of 20 lines with names of petroleum bitumen (see figure 25).

Figure 25 – List with names of petroleum bitumen

4.10.2.2 Select the required sample by rotating the control knob and press «**Start**». In this case, the tester returns to waiting mode.

4.10.2.3 If the list of names does not contain the necessary information, select any line (for example, **«BND-90 / 130»**) and press «**Mode**». In this case, the tester switches to line editing mode (see figure 26).

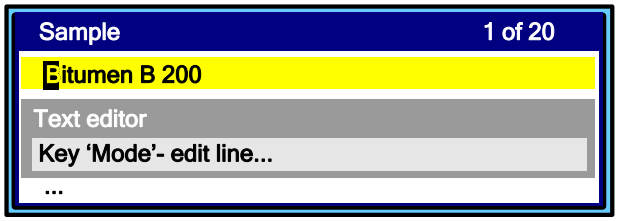


Figure 26 – Line edit mode

The cursor (a character highlighted in black) points to the character that will change.
Moving the cursor along the line is performed by rotating the control knob in both directions.
When you press **«*»** and simultaneously rotate the control knob counterclockwise, the characters located to the left of the cursor are deleted.
When you press **«*»** and simultaneously rotate the control knob clockwise, spaces are inserted to the left of the cursor position.
Pressing the «**Stop**» key returns to the list mode without saving the entered line.
Pressing the «**Start**» key returns to the list mode and saves the entered line.
4.10.2.4 To continue entering text, press «**Mode**» again. In this case, the tester switches to line entry mode (see figure 27).

Figure 27 – Line entry mode

The character you want to insert is selected by rotating the control knob (the cursor moves along the character set in the line of the editor window) and then pressing the **«*»** key to replace the character in the line you are editing.
Pressing the «**Mode**» key causes to a sequential change of the current character set in the editor window:
- uppercase Cyrillic;
- lowercase Cyrillic;
- Latin capital letters;
- lowercase Latin;
- symbols and numbers.

Pressing the «**Stop**» key closes the edit window without saving the entered line and returns to the position of the edited line.
Pressing the «**Start**» key closes the edit window, saves the entered line, and returns to the position of the edited line.
4.10.3 Setting the expected breaking point temperature
4.10.3.1 In waiting mode, press **«*»**, select the menu item **«Test conditions» → «Temperature expected (^{0}C):»** and press «**Mode**». The tester enters the mode for entering the expected breaking point temperature (see figure 28).

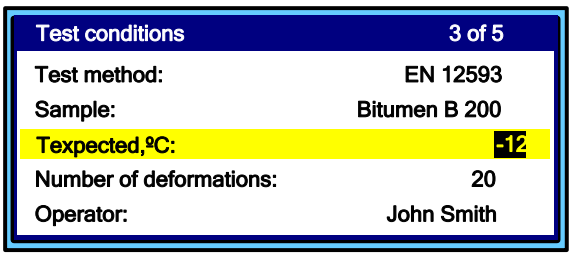


Figure 28 – Mode for entering the expected breaking point temperature

Changing the numeric parameter in 1^{0}C increments is performed by rotating the control knob.
When the **«*»** key is pressed and the control knob is rotated simultaneously, the value change step is 10^{0}C.
4.10.3.2 Press «**Start**» to remember the expected breaking point temperature. In this case, the tester returns to waiting mode.
4.10.3.3 Press «**Stop**» the tester returns to the service menu without changing the expected breaking point temperature.

4.10.3.4 To exit the menu mode, press «**Stop**».

4.10.4 Setting the number of deformations

4.10.4.1 In the waiting mode, press **«*»**, select the menu item «**Test conditions**» → **«Number of deformations»** and press «**Mode**». The tester enters the mode for entering the number of deformations (see figure 29).

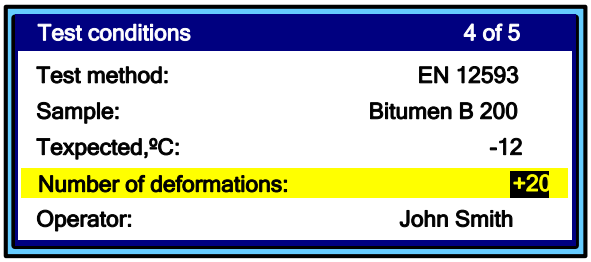


Figure 29 – Mode for entering the number of deformations

Changing the numeric parameter in increments of 1 is performed by rotating the control knob.

When the **«*»** key is pressed and the control knob is rotated simultaneously, the value change step is 10.

4.10.4.2 Press «**Start**» to remember the number of deformations. In this case, the tester returns to waiting mode.

4.10.4.3 When the «**Stop**» key is pressed, the tester returns to the service menu without changing the number of deformations.

4.10.4.4 To exit the menu mode, press «**Stop**».

4.10.5 Setting the operator name

4.10.5.1 In the waiting mode, press **«*»** and select the menu item «**Test conditions**» → «**Operator**». The list displayed consists of 10 lines with operator names (see figure 30).

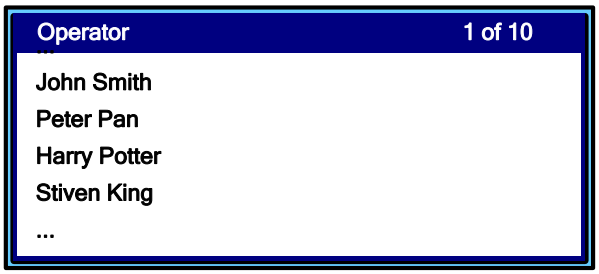


Figure 30 – List with operator names

4.10.5.2 Select the desired record by rotating the control knob and press «**Start**». This returns the tester to waiting mode.

4.10.5.3 If the required operator name is missing from the list, you can create a new record (see paragraphs 4.10.2.3, 4.10.2.4 of this Operating manual).

4.10.6 Adjusting the date and time

4.10.6.1 In waiting mode, press **«*»** and select menu item «**Setting**» → «**Date and time**» and press «**Mode**». The tester switches to the date and time adjustment mode (see figure 31).

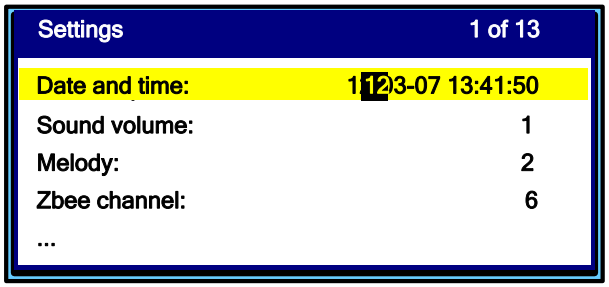


Figure 31 – Date and time adjustment mode

Input format: **day-month-year, hours: minutes: seconds**. Displacement between the position input is performed by pressing the «**Mode**».

Changing the numeric parameter in increments of 1 is performed by rotating the control knob.
When the **«*»** key is pressed and the control knob is rotated simultaneously, the value change step is 10.

4.10.6.2 Press «**Start**» to remember the date and time. This returns the tester to the service menu.

4.10.6.3 When the «**Stop**» key is pressed, the tester returns to the service menu without changing the date and time.

4.10.6.4 To exit the menu mode, press «**Stop**».

4.10.7 Adjusting the sound volume

4.10.7.1 In waiting mode, press **«*»** and select menu item «**Setting**» → «**Sound volume**» and press the «**Mode**». The tester switches to volume adjustment mode (see figure 32).

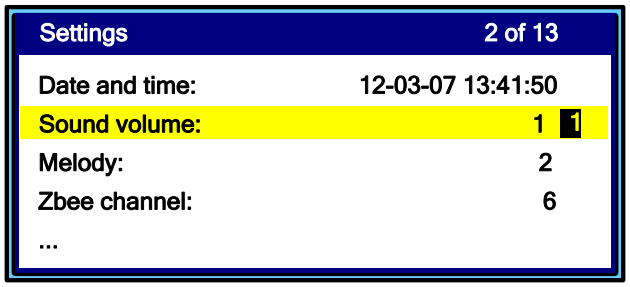


Figure 32 – Sound volume adjustment mode

The volume value changes from **0 (quiet)** to **3 (loud).**
Changing the numeric parameter in increments of 1 is performed by rotating the control knob.

4.10.7.2 Press «**Start**» to remember the set volume value. This returns the device to the service menu.

4.10.7.3 When the «**Stop**» key is pressed, the tester returns to the service menu without changing the sound volume.

4.10.7.4 To exit the menu mode, press «**Stop**».

4.10.8 Changing the melody

4.10.8.1 In waiting mode, press **«*»** and select the «**Setting**» → «**Melody**» and press «**Mode**». The tester goes into the mode of adjusting the number of the melody that sounds at the end of the test (see figure 33).

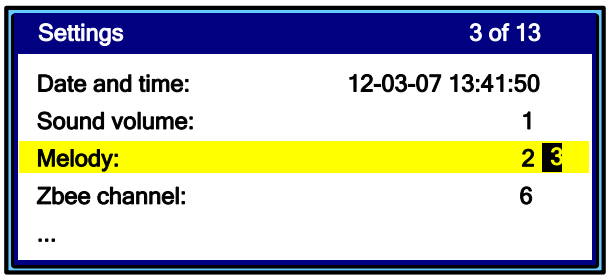


Figure 33 – Melody number adjustment mode

You can select a melody with a number in the range from **0** to **3**.
Changing the numeric parameter in increments of 1 is performed by rotating the control knob.

4.10.8.2 Press «**Start**» to remember the melody number. This returns the tester to the service menu.

4.10.8.3 When the «**Stop**» key is pressed, the tester returns to the service menu without remembering the melody number.

4.10.8.4 To exit the menu mode, press «**Stop**».

4.10.9 Changing the Zbee (Data Collection System) channel number

4.10.9.1 In waiting mode, press **«*»** and select menu item «**Setting**» → «**Zbee channel»** and press «**Mode**».

The tester switches to the Zbee channel number adjustment mode (see figure 34).

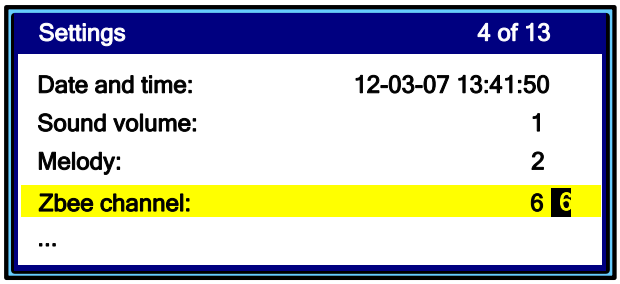


Figure 34 – Zbee channel number adjustment mode

The channel number should correspond to the ℒinteℒ®-Link[1] program setting.
Changing the numeric parameter in increments of 1 is performed by rotating the control knob.
4.10.9.2 Press «**Start**» to remember the channel number. This returns the tester to the service menu.
4.10.9.3 When the «**Stop**» key is pressed, the tester returns to the service menu without storing the channel number.
4.10.9.4 To exit the menu mode, press «**Stop**».
4.10.10 Changing the Zbee network number
4.10.10.1 In waiting mode, press **«*»** and select menu item «**Setting**» → «**Zbee network**» and press «**Mode**». The tester goes into the mode of adjusting the Zbee network number (see figure 35).

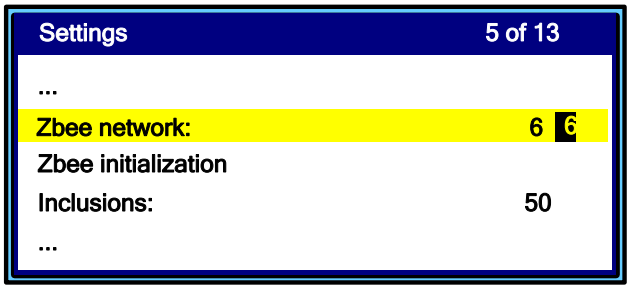


Figure 35 – Mode of adjusting the Zbee network number

The network number should correspond to the ℒinteℒ®-Link[1] program setting.
Changing the numeric parameter in increments of 1 is performed by rotating the control knob.
4.10.10.2 Press «**Start**» to remember the network number. This returns the tester to the service menu.
4.10.10.3 When the «**Stop**» key is pressed, the tester returns to the service menu without remembering the network number.
4.10.10.4 To exit the menu mode, press «**Stop**».
4.10.11 Zbee initialization
4.10.11.1 In the waiting mode, press **«*»** and select the «**Setting**» → «**Zbee initialization**» and press «**Start**». The tester goes into the Zbee initialization mode (see figure 36).

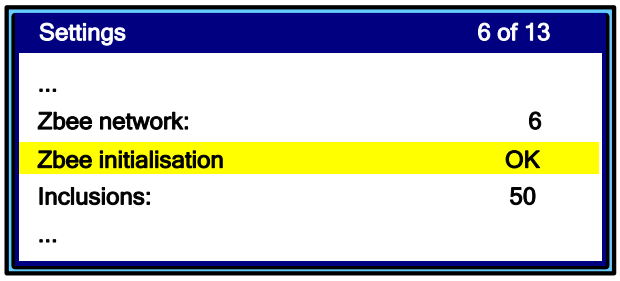


Figure 36 – Zbee initialization mode

4.10.11.2 During the initialization process, the numbers of process steps appear on the display sequentially
4.10.11.3 When initialization is complete, «**OK»** appears on the display.
4.10.11.4 To exit the menu mode, press «**Stop**».

[1] It is delivered by the separate order.

4.10.11.5 This mode should be performed if the tester is not connected to the *LinteL*®-Link[1] program.

4.10.12 Operating time and numbers of inclusions

4.10.12.1 In waiting mode, press **«*»** and select the «**Setting»** menu item item (see figure 37).

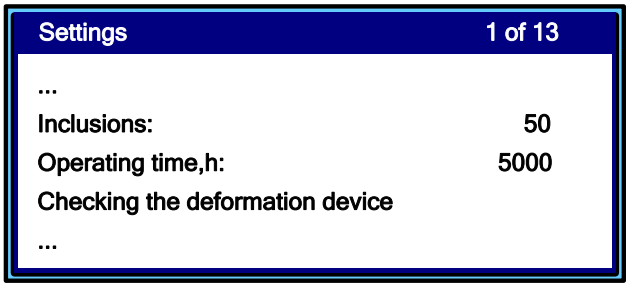


Figure 37 – Menu **«Setting»**

The number of inclusions on the tester is displayed in the «**Inclusions**» menu item.

In the «**Operating time, h**» menu item, operating time of the tester is displayed in hours.

4.10.12.2 To exit the menu mode, press «**Stop**».

4.10.13 Checking the deformation node

4.10.13.1 This mode is intended for checking the range of information during certification the tester and checking the operation of the deformation device.

4.10.13.2 In waiting mode, press **«*»** and select the «**Setting**» → «**Checking the deformation device**» and press «**Start**». The tester goes into the mode of checking the deformation node (see figure 38).

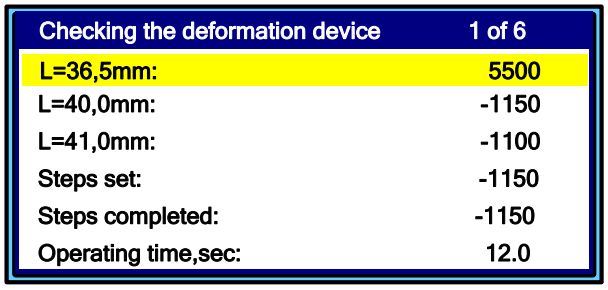


Figure 38 – Mode of checking the deformation node

The menu consists of the following items:

L=36.5 мм

- when selecting and pressing the «**Start**» key, the deformation device is positioned to the maximum deformation position (the distance between the clips is from 36.4 to 36.6 mm);
- when you select an item and press «**Mode**», the parameter corresponding to the maximum strain position is changed to edit mode.

L=40.0 мм

- when selecting and pressing the «**Start**» key, the deformation device is positioned to the minimum deformation position (the distance between the clips is from 39.9 to 40.1 mm);
- when you select an item and press «**Mode**», the parameter corresponding to the minimum deformation position is changed to edit mode.

L=41.0 мм

- when you select an item and press «**Start**», the device is positioned in an undeformed state;
- when selecting an item and pressing the «**Mode**» key, it enters the parameter editing mode, corresponding to the position of the undeformed state.

Steps set

- when the item is selected and the «**Start**» is pressed, the deformation device is positioned in the specified state;

[1] It is delivered by the separate order.

– when you select an item and press «**Mode**», it enters the parameter editing mode, corresponding to the current position of the clips. One unit corresponds to a change in the distance between the clips by 0.00052 mm.

Steps completed

– this item displays the actual number of steps performed by the stepper motor.

Operating time, sec

– this item displays the time when the clips were moved.

4.10.13.3 To exit the menu mode, press «**Stop**».

4.10.14 Version and checksum of the device software

4.10.14.1 In waiting mode, press the **« * »** key and select the **«Settings»** menu item (see figure 39).

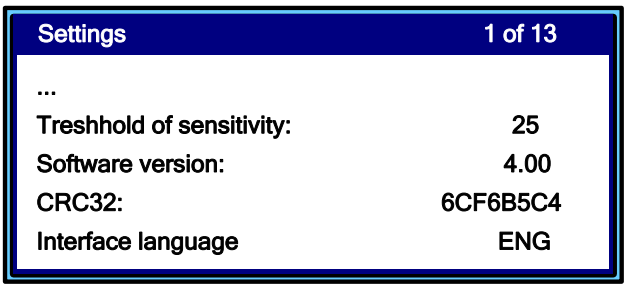


Figure 39 - Mode for checking the deformation node

The software version of the device is displayed in the menu item **«Software version:»**

The **«CRC32:»** menu item displays the checksum of the device's software.

To exit the menu mode, press the **«Stop»** key.

4.10.15 Change the interface language of the device

4.10.15.1 In waiting mode, press the **« * »** key and select the menu item **«Settings»** → **«Interface language»** and press the **«Start»** key. If the interface language **RUS** was specified, the interface language will be changed to English. If the interface language was specified as **ENG**, the interface language will be changed to Russian.

To exit the menu mode, press the **«Stop»** key.

5 MAINTENANCE

To increase the service life of the tester, it is necessary to carry out its maintenance. The frequency of maintenance depends on the intensity and operating conditions of the tester.

Maintenance should be carried out as necessary, but at least once a year.

Maintenance consists of removing bitumen fragments from the cooling block cylinder, cleaning the tester case from contamination, and washing the cooling block radiators with hot water.

5.1 Additional equipment and materials

The list of additional maintenance materials given in table 9.

Table 9 – List of additional materials

Material	Purpose
Ethyl alcohol, or an alcohol-toluene mixture, or a weakly soapy solution	cleaning the display, the tester case and mechanical components from contamination
Cotton napkin or gauze swab	
Kerosene TS-1 GOST 10227-86	cleaning the tester case and keyboard from bitumen's; removing small fragments of bitumen from cylinder of the cooling block
Cotton napkin or gauze swab	
Citric acid GOST 908-2004	descaling of the internal surfaces of radiators
Water	

The list of additional equipment for maintenance given in table 10.

Table 10 – List of additional equipment

Equipment	Purpose
Tweezers	removing large fragments of bitumen from the cooling block cylinder

5.2 General instructions and safety measures

5.2.1 When working with the device, operator should comply with the requirements of paragraph 4.2.

5.3 List of operations

The list of maintenance operations given in table 11.

Table 11 – List of operations

Operation	Paragraph	Periodicity
Cleaning the display from contamination	5.4	As required, if any contamination is present
Cleaning the case from contamination	5.4	As required, if any contamination is present
Removing bitumen from the cooling block cylinder	5.5	As required, in the presence of bitumen
Cleaning the tester's case and keyboard from bitumen	5.6	As required, in the presence of bitumen
Washing the radiators of the cooling block	5.7	As required, if any contamination is present
Descaling	5.8	As required, at formation scurf of the internal surfaces of radiators

5.4 Cleaning the display and housing from dirt

5.4.1 Wipe the display surface and the device body as it becomes dirty with a cloth dipped in ethyl alcohol.

5.5 Removing bitumen from the cooling block cylinder

5.5.1 Large fragments of bitumen are removed from the cylinder of the cooling block using tweezers. Small fragments of bitumen can be removed using a gauze swab dipped in kerosene. After cleaning the cylinder of the cooling block, it should be wiped dry before further use of the tester.

5.6 Cleaning the tester case and keyboard from bitumen

5.6.1 Use a gauze swab dipped in alcohol or a mild soap solution to clean the tester's case and keyboard. To clean places of contamination from bitumen, first use a gauze swab dipped in kerosene. Do not use metal or other objects that may damage the tester's case during cleaning. Do not allow cleaning fluid to enter the tester's control unit.

5.7 Washing the radiators of the cooling block

5.7.1 Flushing of the cooling block radiators is performed by passing hot water with a temperature from 70 to 90°C through the cooling block radiators. The flushing time is from 2 to 3 minutes. The flow rate is from 4 to 5 liters / min. No mechanical impurities are allowed in the water stream.

5.8 Descaling

5.8.1 During long-term operation, scurf's may form on the internal surfaces of radiators. This can lead to reduced performance and even failure of thermoelectric modules. It is recommended to pour a concentrated solution of citric acid into the radiators and leave them overnight. For this:

- disconnect the hoses from the water supply and drain the water from the radiators;
- pour 1 liter of solution into the inlet hose through the funnel, avoiding air bubbles (excess solution flows out of the drain hose);
- pinch the inlet and outlet hoses or raise their ends so that the solution does not leak out;
- leave the solution in the radiators for at least 8 hours, then drain.
-

ATTENTION!

Only specialists of the manufacturer should perform repair and adjustment of the tester. Operation of the tester without the top cover of the deformation node, which protects precision parts from dust, is not allowed. Washing and lubrication of the deformation node is not required when the tester is used correctly. Do not open the top cover unless necessary!

6 STORAGE AND TRANSPORTATION

6.1 Storage

6.1.1 The storage conditions of the tester in terms of the impact of climatic factors should be correspond to the group «L» of GOST 15150-69.

6.1.2 The tester should be stored in closed, heated rooms in a package on racks that are not subject to vibration or shock.

6.1.3 The tester should be stored at an air temperature of 5 °C to 40 °C and a relative humidity of 80 % at +25 °C.

6.1.4 Storage of the tester without packaging is not allowed.

6.1.5 Shelf life of the tester is 6 years.

6.1.6 The tester is preserved according to the version V3-10 of GOST 9.014-78, the packaging version is VU-5.

6.1.7 If after unpacking the tester was not used for its intended purpose, then it should be stored in a case made of polyethylene GOST 10354-82.

6.2 Transportation

6.2.1 Conditions for transporting the tester in terms of the impact of climatic factors should correspond to the group of storage conditions 5 (OZH4) according to GOST 15150-69.

6.2.2 The tester may be transported by all means of transport in covered vehicles (air transport in heated sealed compartments) for any distance.

APPENDIX A. Data transfer by RS-232

A1 General

To transfer data from the tester to a personal computer (PC) via the RS-232 interface, the PC should be equipped with:

1) RS-232 DB9M port (currently rare), the tester is connected by RS232 DB9F-DB9M cable (mouse extension cable, not included in the package);
2) USB port, the tester is connected via a USB – RS-232 interface converter, such as «**TRENDnet TU-S9**» (cable RS-232 DB9F-DB9M cable may also be required, for extension, the converter and cable are not included).

The terminal program should also be installed on the PC. This guide describes how to configure the "**PuTTY**" program.

Program page on the network: **«www.putty.org»**

Download link: **«http://the.earth.li/~sgtatham/putty/latest/x86/putty.exe».**

The program does not require installation, and can be started immediately, after downloading. In this example, after downloading the program, it is placed in a folder **«C:\Program files (x86)\PuTTY»**. The actual placement of the program is determined by the convenience of further use.

A2 Program setting

A2.1 Port definition

Before setting up the program, you need to determine the port number to which the tester is connected.

For this, press the buttons simultaneously on the PC keyboard  and  the «Run» program opens (see figure 2.1).

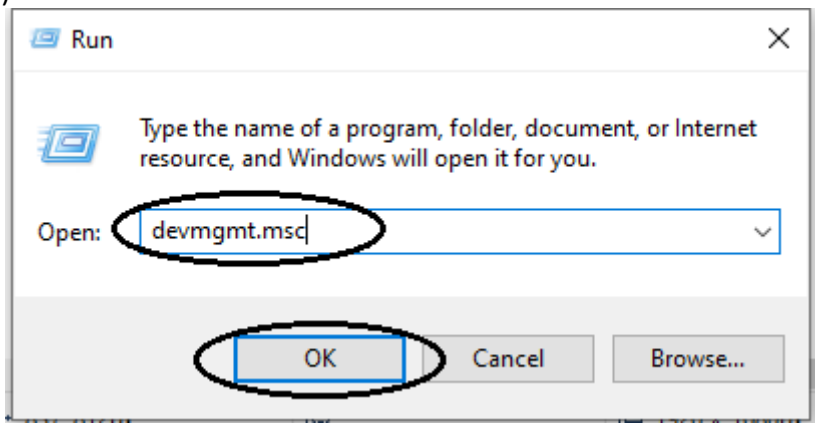


Figure A2.1 – Program **«Run»**

In the text field, type **«devmgmt.msc»** and click **[OK]** - the tester manager opens (see figure A2.2).

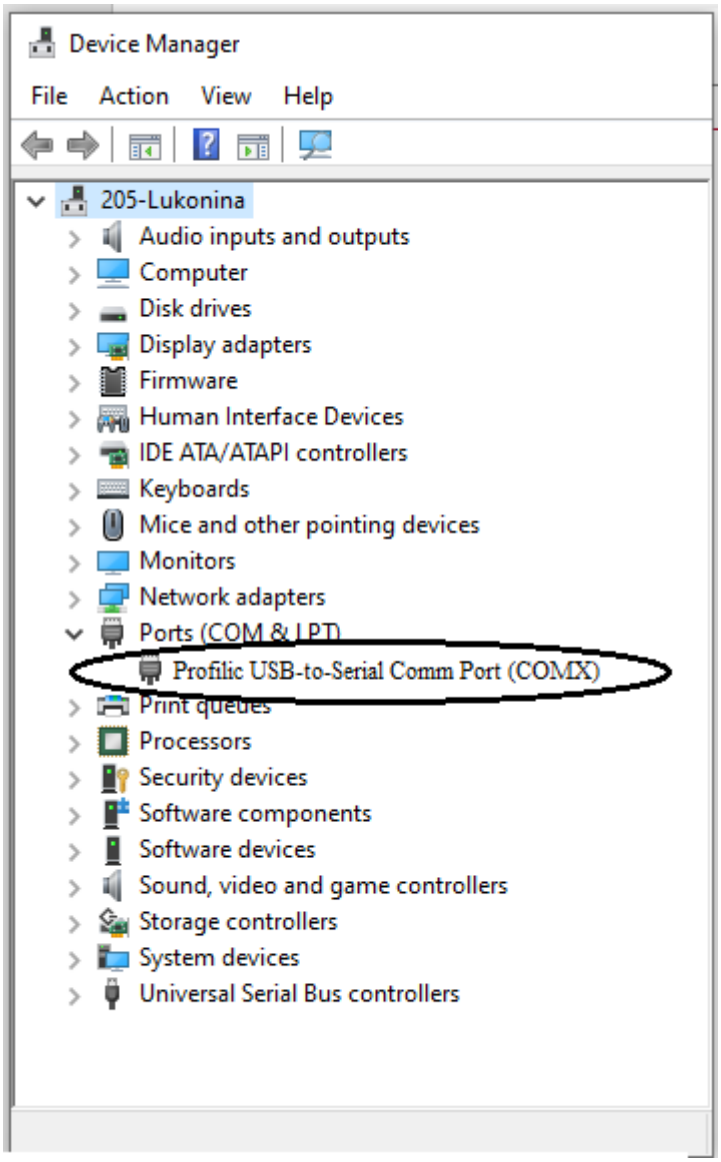


Figure A2.2 – Device manager

In the «**Ports (COM and LPT)**» section, find the port number to which the cable is connected: in the case of the TRENDnet TU-S9 pre-educator, the port will be called «**Profilic USB-to-Serial Comm Port (COMX)**», where **COMX** is the desired port number. When you disconnect the converter from the USB connector, the port disappears from the list of devices, and appears again when you connect it. You should always connect the converter to the same USB port, because otherwise the port number changes and you will have to configure it again.
If the computer is equipped with an RS-232 port and the tester is connected without a USB-RS-232 converter, you can only determine the port number by experimentally, setting the program to all the «**COM**» ports from the list of devices (the port name should not contain «**USB**»).

A2.2 Connection setup
Start the **«PuTTY»**, program, set the settings on the **«Session › Logging»** tab (see figure A2. 3).

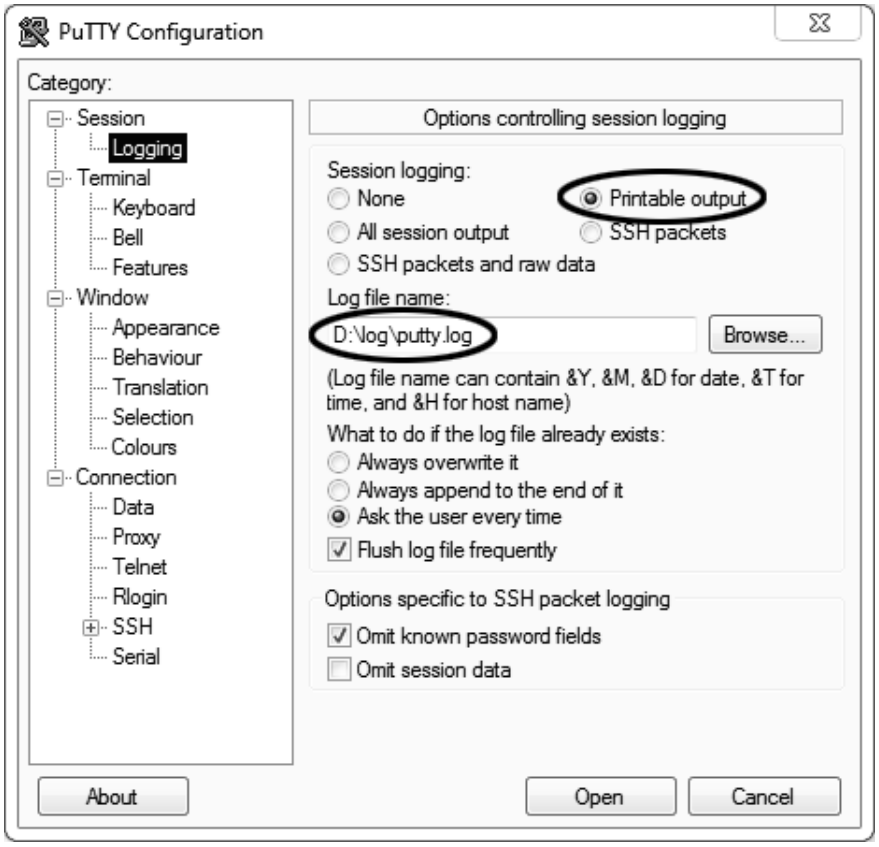


Figure A2.3 – Program **«PuTTY»**

«D:\log\putty.log» –a way of storing data received from the tester. The parameter can be changed if necessary.

Set settings on the tab **«Terminal»** (see figure A2.4).

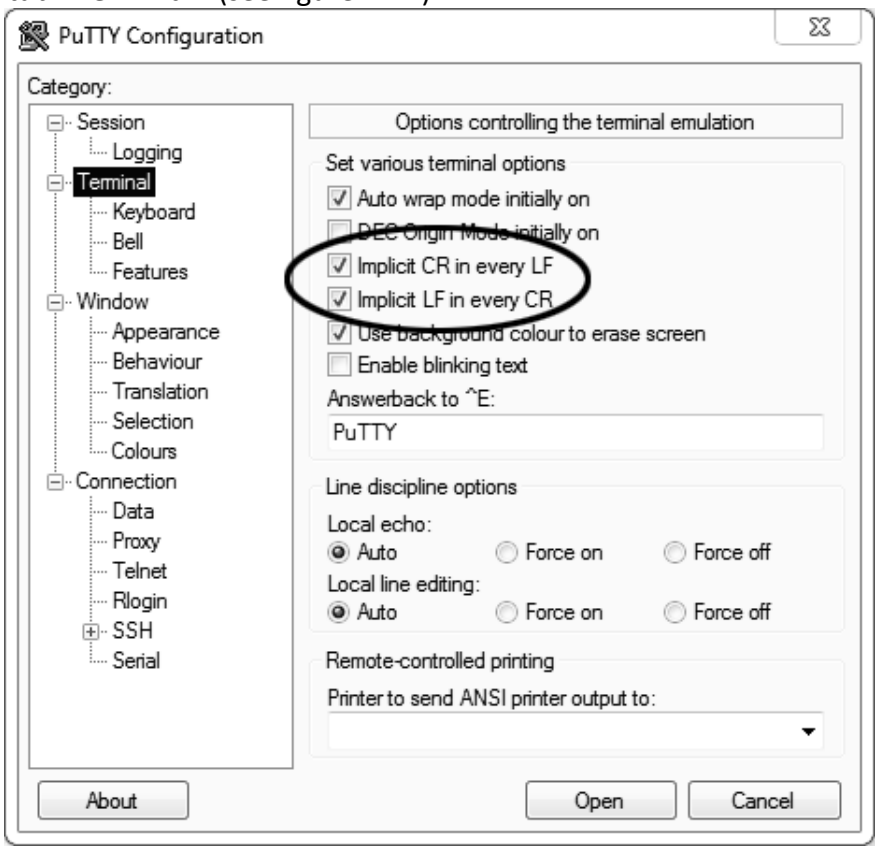


Figure A2.4 – Set setting

Set settings on the tab **«Window › Translation»** (see figure A2.5).

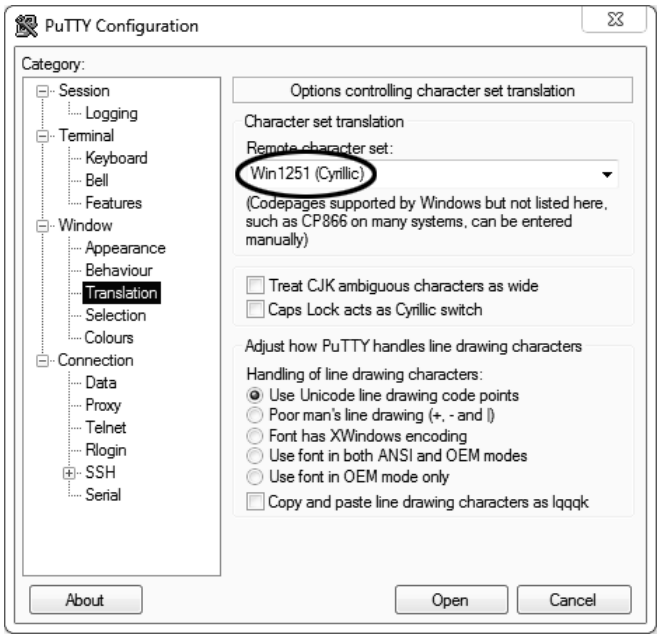


Figure A2.5 – Set setting

Open the tab **«Connection › Serial»** (see figure A2.6).

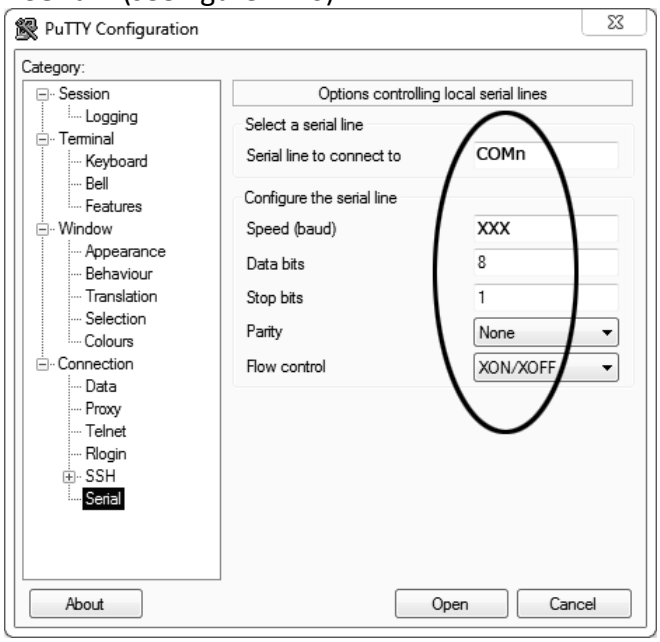


Figure A2.6

Specify the port number, defined earlier in paragraph 2.1 of this Appendix (for example, this is the COM8 port).

Configure other connection parameters:

- Speed 115200;
- Data bits 8;
- Stop bits 1;
- Parity None;
- Flow control XON/XOFF.

Open the tab **«Session»** (see figure A2.7).

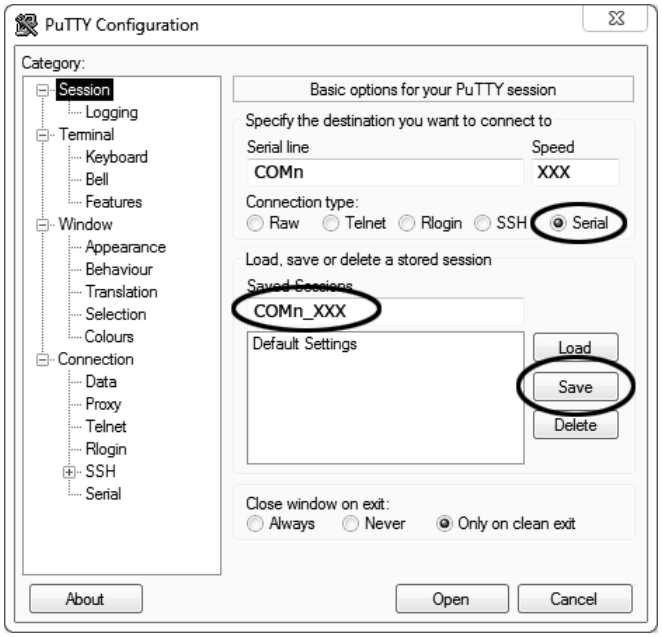


Figure A2.7 – Tab «Session»

Select the **«Serial»** connection type, name the connection according to the port number and data rate (for example, **«COM_8_115200»**), and click **[Save]**.
Close the **«PuTTY»** program.
In the free area of the desktop, right-click and select **«Create › Shortcut»** from the context menu (see figure A2. 8).

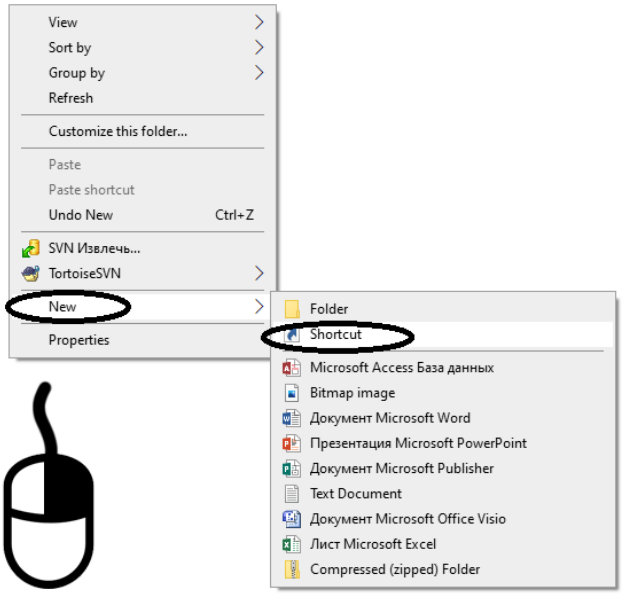


Figure A2.8 – Item selection

A dialog box opens (figure A2.9):

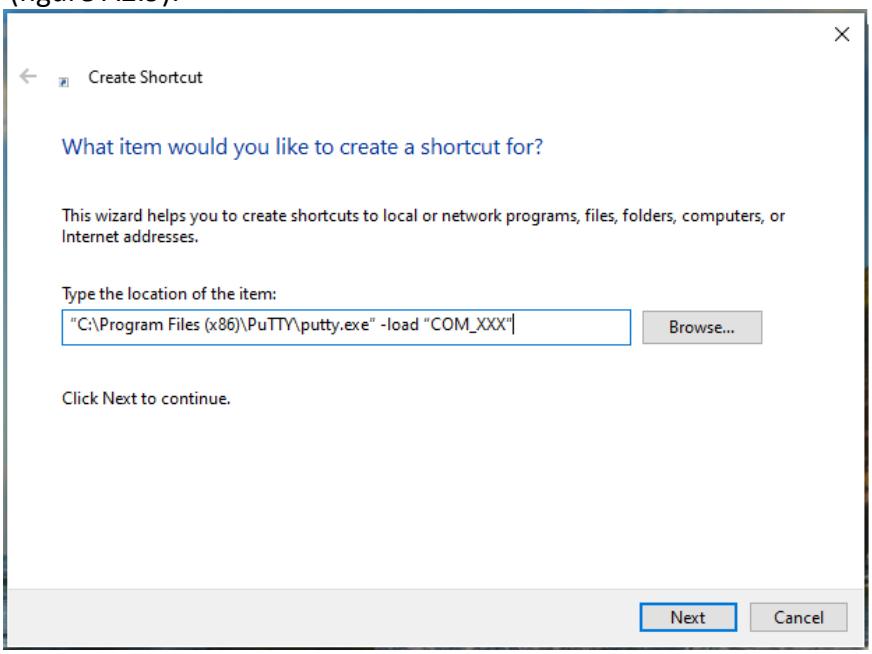


Figure A2.9 – Dialog box

In the text field, type the path to the program location and space-separated parameter **«-load "COM_8_115200"»**, where **«COM_8_115200»** is the name of the connection saved when setting up the "**PuTTY**" program. The name of the connection should be enclosed in quotation marks. If there are spaces in the program location path, then the path should also be enclosed in quotation marks. For example, the value is entered in the text field **«"C:\Program Files (x86)\PuTTY\putty.exe" -load "COM_8_115200"»**

Click **[Next]** to open the next window (figure 2.10):

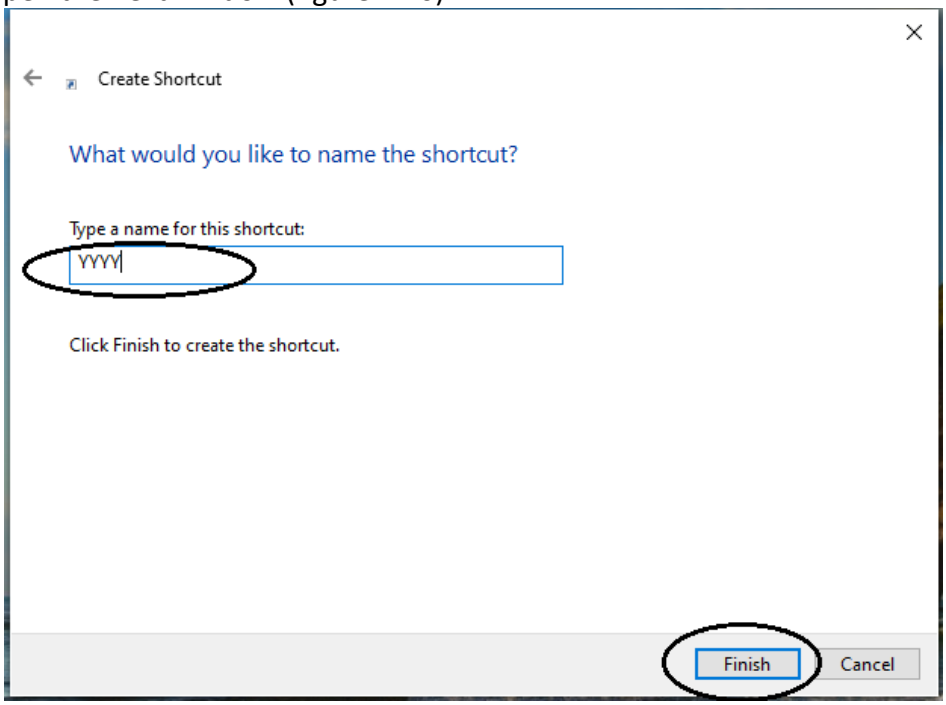


Figure A2.10

In the **YYYY** text field, enter a shortcut name that is convenient for further use.

Click **[Done]** to complete the shortcut setup.

Now the **PuTTY** program can be started by double-clicking on the shortcut (see figure 2.11).

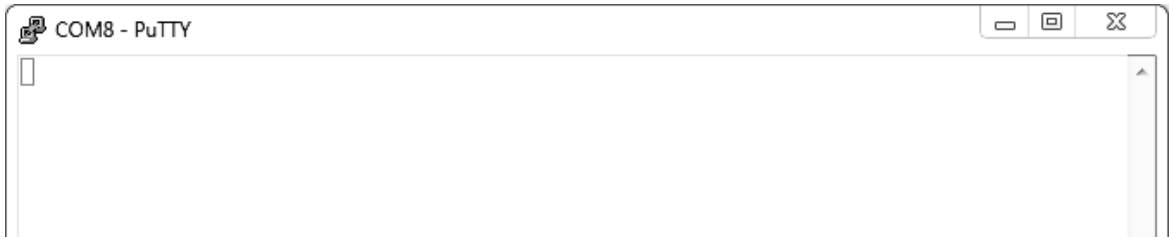


Figure A2.11

When you connect the tester and start transmitting, the received data will be displayed in the window that opens. They are automatically saved to the file specified when setting up the connection. To finish receiving data, close the **PuTTY** program with the **[x]** button in the upper-right corner of the window.