PCE-3000ULS

HARDNESS TESTER

OPERATING MANUAL

This operating manual contains information on the purpose, functions, technical characteristics, the principle of operation, design, and operation of the portable hardness tester PCE-3000ULS (hereinafter - the hardness tester) and the rules of its operation, transportation and storage.

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1. DESCRIPTION OF THE HARDNESS TESTER

1.1 Purpose of the hardness tester

Universal hardness tester PCE-3000ULS is designed to control the hardness of metal products.

The PCE-3000ULS hardness tester combines two methods of hardness measurement: ultrasonic and dynamic. This makes the instrument the most versatile and efficient solution for incoming, in-operational and outgoing material quality control.

The universal hardness tester is used for various tasks. For example, it is well suited for measuring carbon and structural steels, surface-hardened products, heat-resistant, corrosion-resistant, stainless steels, galvanic coatings, surfacing, products of complex configuration, thin-walled and compact products.

The device is pre-calibrated Leeb scale for steel, cast iron, stainless steel, aluminum, bronze and brass, copper. Standard Rockwell, Vickers, Brinell, and Shore calibrations are also available. The user can create and correct (if required) additional calibrations for different materials. The UCI method is pre-calibrated for steel

The hardness tester can be used to control hardness:

- high-alloy, heat-resistant, corrosion-resistant, stainless, and other steels
- non-ferrous metals and alloys
- cast iron
- surface-hardened and other layers on steel products (HFC hardening, carburizing, nitriding, etc.)
- products from fine-grained materials

In the case when the properties of the controlled material differ from the material set as sample material, measurements are carried out after programming an additional adjustment (or additional scale) on hardness samples of the corresponding material by the user of the device or at the manufacturer, by the user's order.

The PCE-3000ULS is available with pre-installed optional scales for testing a range of different materials.

The hardness tester is designed for use in laboratory, workshop and field conditions.

1.2 The principle of operation of the hardness tester

The hardness tester consists of a probe and an electronic unit for converting signals from the probe and processing the measurement results.

The electronic unit receives a frequency signal from the probe of the device, converts it into units of hardness, and displays the measurement results on the display, statistical processing, and other functions.

The principle of operation of the hardness tester is based on two methods of measuring hardness - dynamic and ultrasonic.

Dynamic method

The technique is to determine the rebound rate of the carbide indenter from the surface of the controlled product.

The components of the hardness tester are a probe and an electronic unit for converting signals from the probe and processing the measurement results.

The main parts of the probe are the indenter and the electromagnetic coil. When the rebound of the indenter from the test product in the coil is the EMF, which is proportional to the rate of rebound of the surface of the product. The rebound speed is determined by the hardness of the producty.

Since the bounce rate of the indenter is an indicator of hardness, there is a relationship between the bounce rate V and the hardness of the material H:

$$H = f(V)$$

The electronic unit of the hardness tester receives a signal from the probe of the device, its conversion into units of hardness, the output of results of measurements on the display, statistical processing, and other functions of this hardness tester.

Ultrasonic method

The principle of operation of ultrasonic probes of the hardness tester is based on the method of measuring ultrasonic contact impedance (UCI - ultrasonic contact impedance).

At the end of the metal rod, which is part of the hardness tester probe, a diamond tip is fixed. The rod oscillates at its own resonant frequency. When a load is created by the user's hand, the diamond tip is embedded in the material and changes the resonant frequency of the rod. The change in the natural resonant frequency of the rod is proportional to the depth of penetration of the tip into the material. Since the penetration depth of the tip into the material is an indicator of hardness, there is a relationship between the change in the resonant frequency of rod F and the hardness of the material H: H = f (F).

1.3 Hardness tester functions

The control is carried out:

- according to the main scales: Rockwell (HRC), Brinell (HB), Vickers (HV), and Shore for measuring the hardness of carbon structural steels;
- scale conversion: Rockwell (HRA), Rockwell (HRB), to control the hardness of carbon structural steels;
- on additional scales set in the hardness tester by the manufacturer for hardness control or scales created by the user:
- alloy, tool steels,
- aluminum alloys in Brinell units (HB),
- brass (copper-zinc alloys) in Brinell units (HB),
- bronzes (copper-tin, copper-aluminum) in Brinell units (HB);
- using custom scales of hardness tester (UCI) - for cases when the physical and mechanical properties of the controlled material differ from carbon structural steels (high-alloy steels, specialized cast irons, non-ferrous metals, alloys, etc.).

It is possible to calibrate the main scales in the event of an additional error after prolonged use.

The hardness tester is equipped with a bright color display and a strong case for protection against dust and moisture.

Hardness tester during measurements allows calculating the average value of a series of results of measurements and filtering incorrect measurements that are out of range.

Hardness tester during measurements allows to carry out additional statistical processing of a series of results of measurements - search of the minimum, maximum values, calculation of average value, construction of graphs and display of data in the form of the table.

Hardness tester during measurements allows you to display additional information – previous measurement results.

The device allows you to organize the data archive in the form of nominal blocks of measurement results, save it when the power is off and transfer data to a computer.

Allows to carry out various types of the analysis of the saved results of measurements, to carry out the construction of various types of graphs directly on the device display.

The hardness tester allows selecting the information which is in addition displayed on the device display in the course of measurements.

The hardness tester constantly displays the battery charge status and signals its discharge during operation.

The device allows you to set the time of automatic shutdown of the device during pauses in its operation to further save battery power.

The hardness tester allows you to choose the type of probe.

Allows you to adjust the display backlight mode to further save battery power.

The hardness tester allows you to set the backlight brightness of the display.

Allows you to select the language of the interface.

1.4 Technical specifications

Table 1.1

Measuring scale	Rockwell	Brinell	Vickers
Measuring range	20 – 70 HRC	30 – 650 HB	230 – 940 HV
Accuracy	2 HRC	10 HB – in range 90-180 HB 15 HB – in range 180-250 HB 20 HB – in range 250-460 HB	15 HV – in range 240-500 HV 20 HV – in range 500-800 HV 25 HV – in range 800-940 HV
Standards	ASTM A1038 and ASTM A956		
Indenter	Probe UCI – Diamond indenter Leeb Probe - Hardened Ball		
Diameter of the platform for installing the probe	For ultrasonic probe: - From 1 mm on the plane, – from 5 mm/0.197" in a blind hole (groove)	For dynamic probe: from 10 mm/0.394" on the plane	
Materials	Ultrasonic Sensor (UCI) - pre-calibrated for steel Dynamic (Leeb) with pre-calibration for steel, cast iron, stainless steel, aluminium, bronze, brass, copper Additional Custom Calibration Materials		
Algorithm for discarding incorrect measurements	Yes		
Calculation	Average value from 1 to 20 measurements Minimum, maximum, average value search for results of incorrect measurements		
Scale conversion	Converting the measured hardness into different scales		
Instrument housing	Drop-proof plastic housing with rubber bumper		
Operating temperature	- 20 ... +45 °C / -4 …113 °F / non-condensing		
Graphs	All points in the series included in the calculation of the average		
Display	LCD TFT 3.5" 320x480 px		
Language	English, German, Turkish, Spanish, Ukrainian, Russian		
PC connection	USB-C		
Product surface roughness	for probe type "UCI": 1,6 Ra	for probe type "D": 3.2 Ra for probe type "G": 7.2 Ra for probe type "E": 1.6 Ra	
Power supply	built-in battery		
Working hours	approx. 9h		
Dimensions	183×93×42 mm / 7.2 x 3.7 x 1.7 "		
Weight	300 g / < 1 lb. (without probe)		

1.5 Hardness tester probes

The standard delivery set includes 2 probes – ultrasonic contact impedance and dynamic probe type "D" (Leeb).

The Rebound Leeb Probe – purposed for hardness measurement by dynamic method. It is intended for measuring hardness of large-sized objects and also coarse-grained materials.

To ensure optimal measurement conditions on products, hardness testers can use additional dynamic probes with different dimensions and different spring stiffness, which provide different impact energy of the indenter against the tested product.

In a dynamic probe, the support washer can be removed (unscrewed) from the probe to reduce the area required for its placement on the surface of the product during measurement.

The Ultrasonic Contact Impedance Probe – measurement of hardness by Ultrasonic Contact Impedance method. The use of a diamond indenter allows the probe to be mounted precisely at any tiny point, and leaves a small-size imprint, making the measurement of the UCI probe the least destructive.

The probe is perfectly suited for the following tasks: measuring the hardness of complex shapes, fine-grained materials, heat-treated materials, thin layers and coatings, surface hardened parts, thinwalled pipes, small parts, etc.

In the ultrasonic probe, the protective nozzle (nose) serves to protect the rod from overload and contact with a foreign object or the user's hand during the measurement. When measuring hardness in hard-to-reach places, it is permissible to remove the protective cap, while the permissible parameters of the holes/grooves will be changed (table 1.5).

Probes are manufactured with built-in connecting cables for connection to the electronic unit. The list of typical probes is given in Table 1.2. Only the D and UCI probe are available at PCE Instruments.

Table 1.2

Model	Features	Main application
D	The universal probe comes standard with the hardness tester.	Used for the main number of measurement tasks
G	The probe with increased impact energy (relative to probe "D")	For coarse grained materials up to 450 HB with high surface roughness.
E	Probe with reduced (to probe "D") impact energy and diamond indenter	For testing very hard materials up to 72 HRC
UCI	The main type of ultrasonic probe for solving most hardness measurement tasks. 5kg/11lb. load is to be applied for measurement (automatically controled by the probe). Average surface cleanliness requirements.	- Heat-treated and cemented parts, for example, shafts, turbines, gears, teeth, welds, heat affected zones. - Measuring in grooves, on teeth, in grooves, on radius surfaces. - Measurement on the blades, on the internal surface of the pipes, openings.
UCI-S	The reduced load probe is designed to measure the hardness of material with increased requirements to the print size (polished surfaces), to the hardness measure of surface hardened layers. 1 kg / 2.2 lb. load is to be applied for measurement (automatically controlled by the probe). More sensible to the surface cleanliness	- Control of the hardness of galvanic coatings: chrome, copper, tin, nickel, zinc - Nitrided and cemented surface layers of molds, stamps, stamps, thin-walled parts. - Bearings, lateral surfaces of saws teeth. - Measurement of hardness of hardening coatings. - Measurement on the blades, on the inner surface of the pipes, inside the holes.
UCI-R	Control of the products hardness with a rough surface up to Ra5. 10 kg / 22 lb. load is to be applied for measurement (set automatically by the probe). Low requirements for surface cleanliness.	- Heat-treated and cemented details. - Measuring in grooves, on teeth, on radius surfaces. - Measurement on the blades, on the internal surface of the pipes, openings.
UCI-L	Measurements in hard-to-reach places	- on products with teeth, grooves, notches
UCI-P	Measurements in other hard-to-reach places	in the middle of containers and pipes from 80 mm / 3.2"

The average conditional diameters of the impressions (mm) created on the surface of the product when measuring different hardness (for carbon structural steels) are shown in table 1.3.

Table 1.3

Marking of the probe type	103 HB (103 HV)	209 HB (212 HV)	406 HB (420 HV) (42,5 HRC)	763 HV (63,0 HRC)
D	0.80	0.72	0.67	0.57
G	1.29	1.22	0.93	-
E	0.80	0.72	0.67	0.57
UCI	0.23	0.16	0.13	0.09

The average conditional depths of impressions (mm) created on the surface of the product when measuring different hardness (for carbon structural steels) are shown in table 1.4.

Table 1.4

Marking of the probe type	103 HB (103 HV)	209 HB (212 HV)	406 HB (420 HV) (42,5 HRC)	763 HV (63,0 HRC)
D	0.054	0.043	0.038	0.027
G	0.084	0.075	0.044	-
E	0.054	0.043	0.038	0.027
UCI	0.066	0.045	0.05	0.037

Table 1.5 - Parameters of holes/grooves for the Ultrasonic probe

Hole/groove diameter from, µm		**Hole/groove depth up to, µm**	
with spout (normal)	without spout	with spout (normal)	without spout
10	5	18	23

1.6 Requirements for the controlled product

The minimum recommended weight of the controlled product is in table 1.6

Table 1.6

Marking of the probe type	Minimum weight, kg	Minimum weight, lb.
D	5	11
G	15	33
E	5	11
UCI	0.3	0.67

If the weight of the controlled product is less than the specified - at measurements it is necessary to be guided in addition by paragraph 1.10 "Measurements on light and thin-walled products".

The minimum recommended thickness of the controlled area of the product - is according to table 1.7.

Table 1.7

Marking of the probe type	Minimum thickness, mm	Minimum thickness, inch
D	25	1
G	70	2.8
E	25	1
UCI	5	0.2

If the thickness of the controlled product is less than specified - when measuring must be further guided by paragraph 1.10 "Measurements on light and thin-walled products".

The maximum recommended surface roughness of the product (surface area) on which measurements are made by table 1.8.

Table 1.8

Marking of the probe type	Surface roughness, no more
D	Ra 3.2
G	Ra 7.2
E	Ra 3.2
UCI	Ra 1.6

If the surface roughness of the product is higher than specified, the measurements must be additionally guided by paragraph 1.11 "Work on products with high roughness".

The minimum radius of curvature of the convex controlled surface is 18 mm /0.7" (for probes D, and E). For the UCI probe - 4 mm / 0.15".

The minimum radius of curvature of the concave controlled surface is 200 mm/ 7.9" (with the support washer removed, for probes D, and E). For UCI probe - 6 mm/0.23".

Minimum diameter of the platform for measuring the hardness on the surface of the controlled product (for installation of the probe).

Probes D, E - 21 mm/ 0.82". (with removed support washer - 6 mm/0.23".).

G probes - 29 mm/1.14". (with removed support washer - 7 mm/0.27".).

The surface of the inspected product must be dry, free of scale, rust, dust, dirt and degreased.

In case of deviation of material properties of the controlled product from carbon structural steels (heat-resistant, corrosion-resistant, stainless, etc. steels, non-ferrous metals, and alloys, etc.), the measurements must be additionally guided by the requirements of 1.7 "Work with products that differ from carbon structural steel".

1.7 Measurement of specimens that differ in properties from carbon steel

The hardness tester's operation principle is based on the rebound method according to Leeb. Unlike static hardness testers (benchtop hardness testers), the measurement results are influenced not only by the properties of the metal during plastic deformation but also by other physical and mechanical properties. Mostly - the modulus of elasticity of the controlled metal (Young's modulus). In hardness tester according to Leeb, material characteristic curves are saved for the different metals.

The specific material characteristic curves of the various metal materials to be tested may deviate from the pre-installed material characteristic curves under certain circumstances. Deviations may occur in particular due to different heat treatments or alloys.

1.8 Requirements for samples for additional adjustment of the hardness tester

At least 3 measurements are required for additional adjustment.From these 3 tests, the average is calculated and set accordingly (adjustment).

The surface of the sample must fulfil the following requirements:

- metallic bright without colour or scale coating
- the surface roughness of the sample - is not worse than defined in the table 1.8.
- the test surface must be even.

When control specific samples it is necessary to be guided in addition by paragraph 1.10 "Measurements on light and thin-walled products".

1.9 Measurements on light and thin-walled products

Elimination of error on light and thin-walled products

In case of the insufficient thickness of a sample for the elimination of an additional error, it is necessary to couple a sample to a massive basic flat plate. Recommended hob parameters:

Weight and thickness - greater than the minimum mass and thickness of the controlled product specified in paragraph 1.6 "Requirements for the controlled product ".

The surface roughness should be approx. Ra 0.4 μm.

The modulus of elasticity of the plate metal (Young's modulus) is close to the modulus of elasticity of the controlled product.

"Coupling" the product to the surface of the plate through a layer of coupling gel so that there are no, even small, stains of air layers between the surfaces of the product and the plate.

It may be required to affix a workpiece which is not heavy enough to a hevier base plate.

The thickness of the coupled sample - is according to table 1.9.

Table 1.9

Marking of the probe type	Minimum thickness, mm (Coupled)	Minimum thickness, inch (Coupled)
D	3	0.12
G	10	0.4
E	3	0.12
UCI	1	0.04

The "Coupling" method should be used for thin products (in the form of sheets), products having a flat shape and a mass comparable to the minimum weight of the controlled product specified in paragraph 1.6 "Requirements for the controlled product".

It is necessary to affix small products of insignificant weight having "volume" form to a heavier base plate. The weight of the sample with using rigid support is in table 1.10

Table 1.10

Marking of the probe type	Minimum weight, kg (rigid support)	Minimum weight, lb. (rigid support)
D	3	6.6
G	6	13.2
E	3	6.6
UCI	0,1	0.2

In cases where the products have a small weight and/or thickness, these measures may not give the desired results. For control of such products, it is necessary to use hardness gauges of the static principle of action with the created small and ultralow loading.

1.10 Measurements on materials with high surface roughness

When measuring a product with a high surface roughness (above specified in paragraph 1.6 "Requirements for the controlled product"), there may be high additional variance in the readings of the device.

There are two ways to eliminate the additional deviation:

Finish the measuring surface (for example, using a grinder) to obtain the required roughness in the area defined in item 1.6 "Requirements for the controlled product".

If required, make some aditional measurements on initial adjustment (odd number) to get a more accurate average value.

1.11 Influence of surface properties of coatings and hardened layers

Unlike devices of the static principle of action when carrying out measurements, the indenter of the probe of the hardness tester creates prints of small depth (see item 1.5 "H ardness tester probes", table 1.4). Therefore, the hardness of the surface layer of the product is measured directly.

On the controlled product in the manufacturing process may be thin surface layers that differ in hardness from the bulk of the metal. Example:

– Carbon-free layer with low hardness formed due to high-temperature heat treatment (hardening, normalization, hot rolling, forging, etc.).

– Work hardening - can be formed in the surface layer after turning and milling, as well as rough grinding.
– Hardening - the presence of such layers (the presence, in some cases, can be determined using a hardness tester) has a much greater impact on the readings of the hardness tester than the readings of static instruments.

The thickness of such layers usually does not exceed 0.2 mm / 0.4". To ensure the accuracy of the measurements, if any, they must be removed from the measuring area by grinding.

1.12 Hardness measurement of the reinforced surface layers

Depending on the type of probe used and the hardness of the product, the indenter creates prints of different depths (see section 1.5 "Probes of the hardness tester", table 1.4). Plastic deformation of the metal is formed at much greater depths.

As a rule, the hardness of the surface reinforced layers differs sharply from the hardness of the base metal of the product (for example, HDTV hardening). It is recommended to measure hardness in such cases when the thickness of the layer is not less than 1.5 mm.

To measure the hardness of reinforced surface layers, it is recommended to use only probes of types D and E, or specialized probes made for this purpose.

When measuring hardness, it is necessary to additionally take into account paragraph "1.7 Measurement of specimens that differ in properties from carbon steel."

The device corresponds to: ASTM A956 “Standard Test Method for Leeb Hardness Testing of Steel Products”; ASTM A 1038 “Standard Test Method for Portable Hardness Testing by the Ultrasonic Contact Impedance Method”.

1.13 Delivery set of the hardness tester

1 x Hardness tester PCE-3000ULS

1 x UCI measuring probe

1 x Rebound probe type D

1 x charger

1 x USB cable

1 x Carrying case

1 x instruction manual

1.14 Hardness tester design

Functionally, the hardness tester consists of an electronic unit and a probe.

The electronic unit of the hardness tester receives a signal from the electromagnetic coil of the probe, converts it into units of hardness, and displays the measurement results, statistical processing, and other functions of this hardness tester.

The front panel of the electronic unit has a color graphic display and keyboard shown in Figure 1.1.

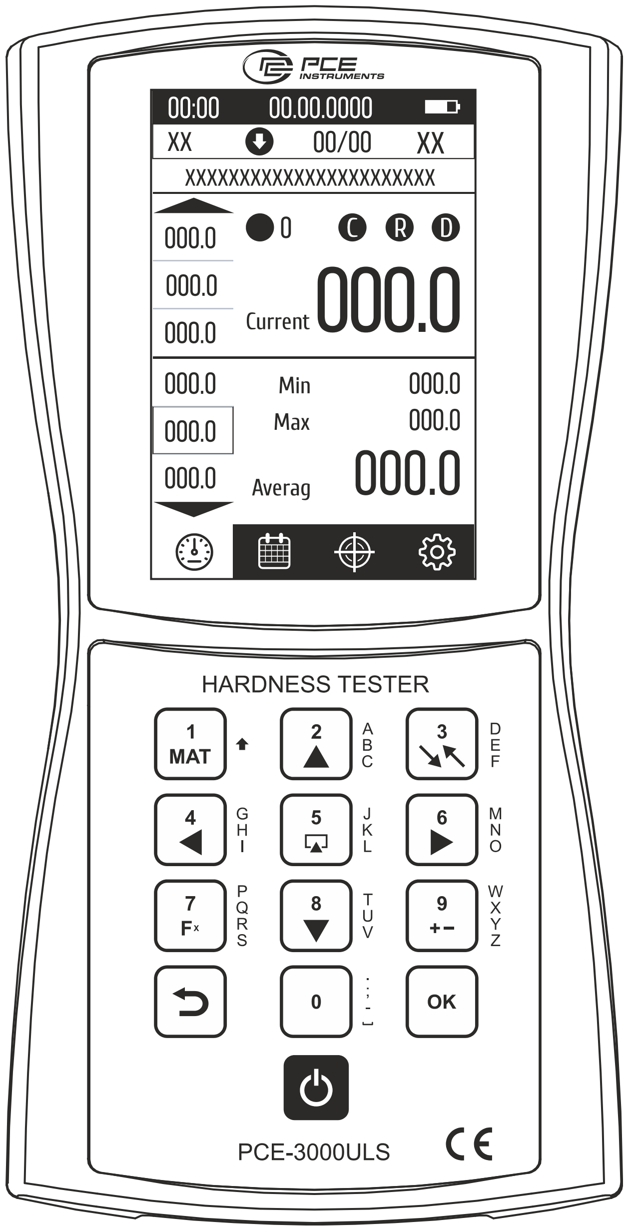

Figure 1.1 - The front panel of the electronic unit

. A schematic representation of the electronic unit body is shown in Figure 1.2.

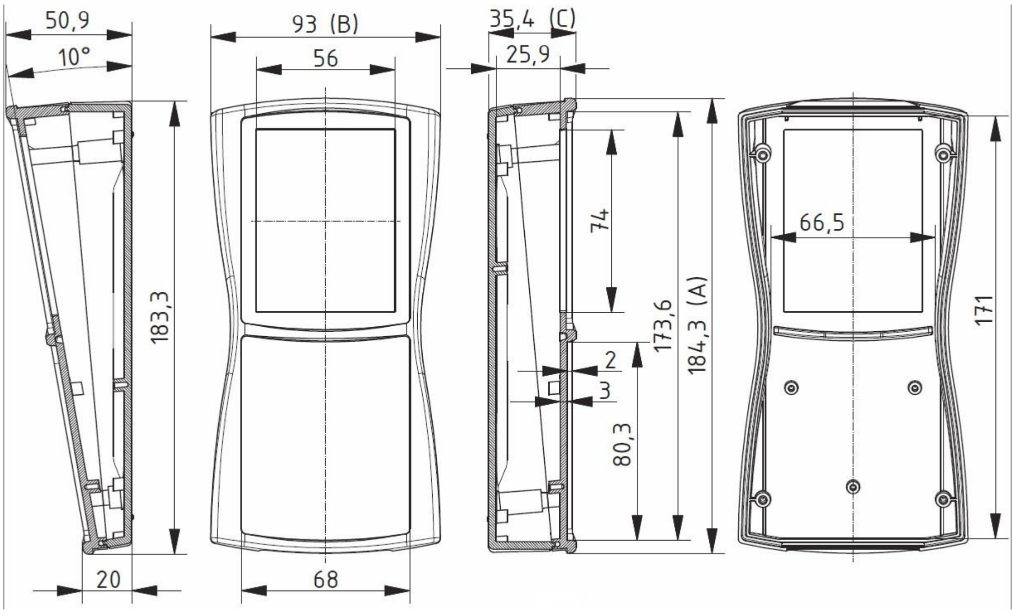

Figure 1.2 - Schematic representation of the body of the electronic unit

On the upper-end wall of the hardness tester, there is a button for turning on the hardness tester.

On the lower end wall of the hardness tester is a connector for connecting a probe and a cable for connecting to a computer.

On the rear panel of the hardness tester is a plate containing the serial number of the hardness tester.

Control of work of hardness tester - switching of scales, installations, creation of additional calibrations and scales, a record of results in memory, the analysis of results, etc., occurs on the display using the keyboard of the device.

To facilitate the use of the hardness tester, the electronic unit implements an interactive user interface that meets generally accepted standards used in modern computer technology.

1.15 UCI Probe handling

The protective sleeve of UCI probe serves two purposes: It protects the UCI rod against damages (as distortion). Furthermore, during the measurements, it functions as a mechanical stop for the deflection of the rod. To carry out a measurement, the probe must be held perpendicular to the specimen surface. The Vickers diamond may touch the surface slightly, but not for too long (otherwise an error occurs). Then the probe is pressed to the specimen until the protective sleeve hits the surface. An acoustic signal indicates the completion of the measurement. To achieve an accurate measurement, the probe must be pressed steadily and vertically onto the specimen. The load is set by the built in the probe controlled load spring.

The distance between the imprint center and the edge of the specimen or adjacent indentation should be at least 2.5 diagonal length imprint

1.16 Rebound Leeb Probe handling

Set the probe onto the surface of the material at the zone of control (Fig. 1.3).

Figure 1.3 – Setting the probe   Figure 1.4 – Charging the spring of the probe

Hold the bottom part of the probe housing with one hand, and charge the spring of the probe by mowing the upper part of the housing down with the other hand (Fig. 1.4).

Smoothly push the trigger button on the top of the probe (Fig. 1.5). Make sure that the probe does not move and secured to the surface of the controlled zone.

Figure 1.5 – Pushing the trigger button of the probe

After pushing the trigger button and the Impact Body hits the surface the measured hardness value will appear on the display.

The minimal distance between the points of measuring should be not less than 3 mm/0.118". Do not repeat measurements on the same point, because repeated measurements give overestimated indications of the hardness of the product due to metal cold work in the imprint zone

2. OPERATION OF HARDNESS TESTER

Before starting work, make sure that the device has no external damage and is ready for use.

2.1 Preparation for use

To get started - connect the probe and turn on the device.

The appliance is switched on by pressing the power button at front panel of the appliance for 1-2 seconds. After switching on the device, the following image will appear on the display (Fig. 2.1):

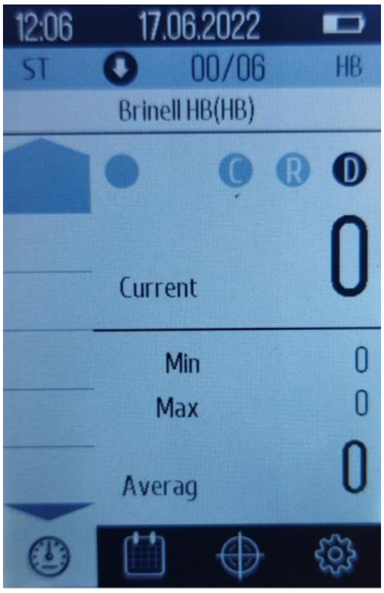

Figure 2.1 - Image on the display of the hardness tester when turning on the device

If the appliance does not switch on, check the battery charge. If the battery is low, charge the device.

To charge the battery, connect the charger cable connector to the USB type-C connector located on the bottom end of the device, and connect the charger to the AC mains with an operating voltage of ~ 220V and a frequency of 50 Hz.

2.2 Hardness tester buttons

In the "Measurements" tab, the , , , buttons perform the following functions:

The button allows you to select the calibration scale for a given material.

The button allows you to select the measurement scale to which you want to convert values.

The button is used to select the direction of the probe.

The button is used to enter the number of measurements.

In other tabs, the buttons perform the following functions:

The button are used to move up / down the tabs of the hardness tester and enter data.

The buttons are used to move up / down the tabs of the hardness tester and enter data.

The button allows you to enter data.

The buttons are used to move left / right on the tabs of the hardness tester and data entry.

The button allows you to switch between the main tabs of the device and enter data.

The button allows you to enter data.

The button allows you to enter data.

The button allows you to make a space, put a period, comma, dash or enter the desired data.

The button is used to cancel the action, to delete one or more graphic characters, to return to the previous tab.

The button is used to select an item in the tab, submit a command, confirm an action or user readiness.

2.3 Switching the tabs of the hardness tester

2.3.1 General description of hardness tester tabs items

There are 4 tabs in this hardness tester:

1) Measurements (Figure 2.1)

2) Archive (Fig. 2.2)

Figure 2.2 – “Archive” tab

3) Calibration (Fig. 2.3)

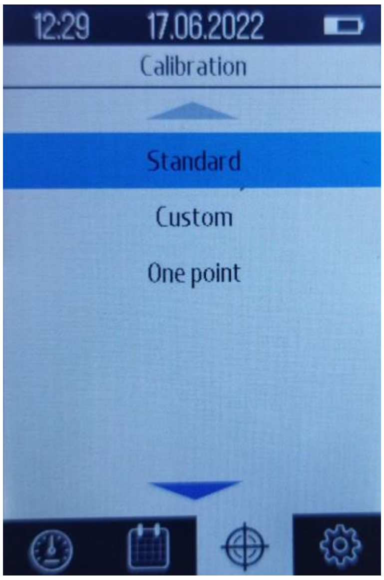

Figure 2.3 – “Calibration” tab

4) Settings (Fig. 2.4)

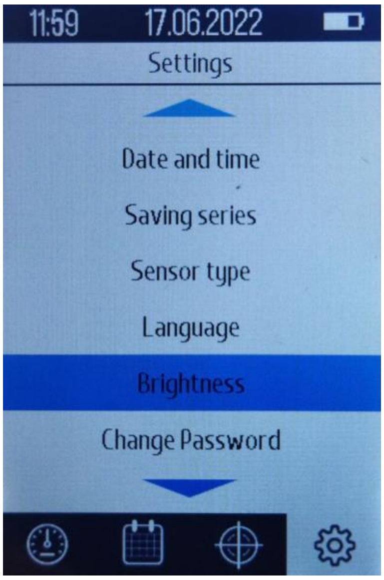

Figure 2.4 - "Settings" tab

Select the desired tab of the hardness tester by briefly pressing the button . When pressed, the icons are highlighted in blue (Fig. 2.5).

Figure 2.5 - Select the desired item in the hardness tester tab

Once the desired tab is selected, you need to press the button to enter it.

Use the up / down or left / right arrows to select the desired items in the tab, then press the login button or the cancel button .

2.4 Measurement tab

In the measurements tab you can choose:

- calibration on a given scale,
- scales for measurement conversion,
- probe directions,
- a number of measurements in series.

2.4.1 Selection of calibration scale

To select the calibration according to a given scale, press the button, then the calibration selection window will open (Fig. 2.6)

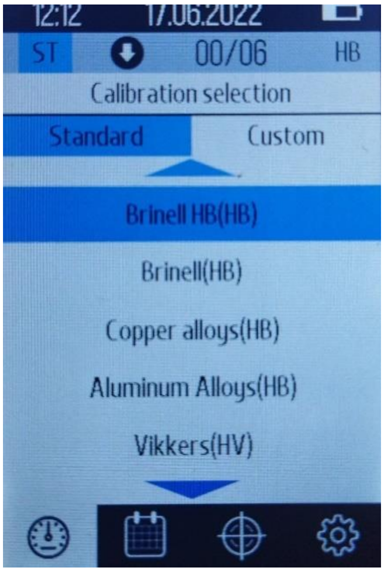

Figure 2.6 - Calibration selection window

You can use the buttons to select standard or custom calibration. Use the buttons to select the desired calibration value and press the button, then return to the "Measurements" tab. If calibration has not been selected, press the button to return to the "Measurement" tab.

2.4.2 Selecting the scale for measurement conversion

To select the scale to convert the measurement, press the button . The required window will open (Fig. 2.7). Use the buttons to select the desired value of the scale, then press the button . The values obtained will now be automatically converted from HRC to the scale we selected. To return to the "Measurements" tab, click .

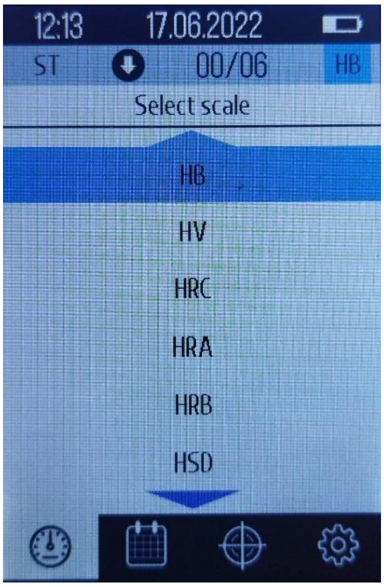

Figure 2.7 - Scale selection window for measurement conversion

2.4.3 Select the direction of the probe

To select the direction of the probe, press the button . In the window that opens (Fig. 2.8) use the buttons to select the desired direction, then press the button . To return to the "Measurements" tab, click the button .

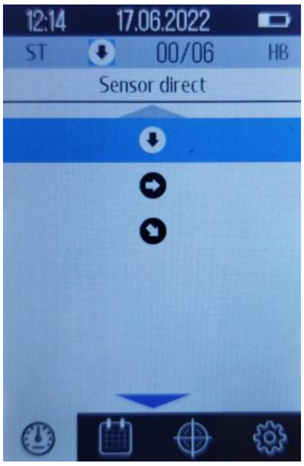

Figure 2.8 - Probe direction selection window

2.4.4 Choice of number of measurements

To select the number of measurements, press the button . In the window, use the buttons to enter the required number of measurements, but not more than 20. Then press the button . To return to the "Measurements" tab, click the button .

2.5 Archive tab

To enter the "Archive" tab, press the button , select the appropriate icon on the screen of the hardness tester (Fig. 2.9) and press the button .

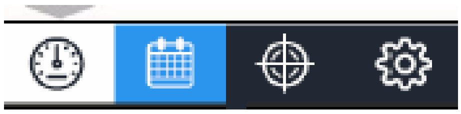

Figure 2.9 - Archive tab icon

In the window (Fig. 2.10) you can select previously saved measurements.

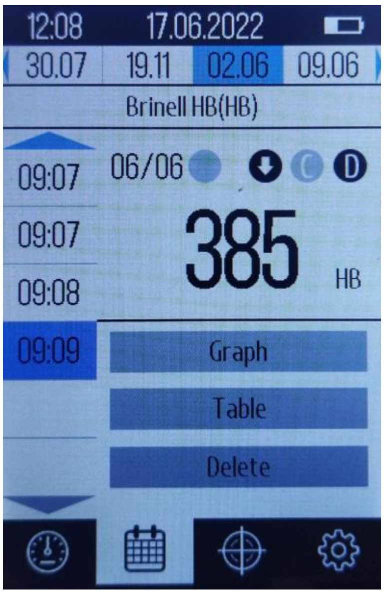

Figure 2.10 - "Archive" tab

Measurements are sorted by date and time. Use the buttons to select the desired date, and use the buttons to select the desired value of the time when the measurement was made. After the desired value is selected, press the button . There will be an entrance to the tab with the saved values of measurements (fig. 2.11).

Then you can use the buttons to select the following values: "Graph" - display of saved values in the form of a graph, "Table" - display of saved values in the form of a table, "Delete" - delete saved values from the device memory (Fig. 2.12).

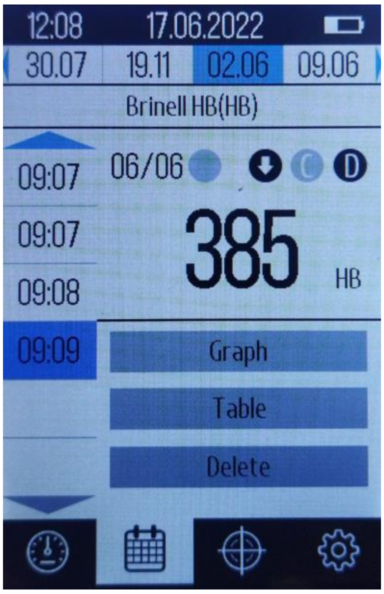

Figure 2.11 - Entrance to the tab with saved measurement values

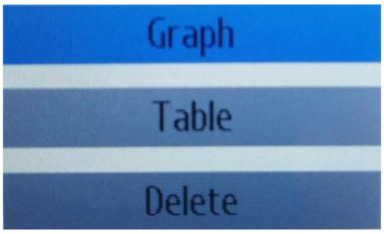

Figure 2.12 - Options for displaying saved measurement values

To enter the "Graph", "Table" or "Delete" tabs, select the desired value and press the button . To go back, press the button .

2.6 Calibration tab

To enter the "Calibration" tab, press the button  to select the appropriate icon on the screen of the hardness tester (Fig. 2.13) and press the button . After that, the "Calibration" tab will be entered (Fig. 2.14)

Figure 2.13 - Calibration tab icon

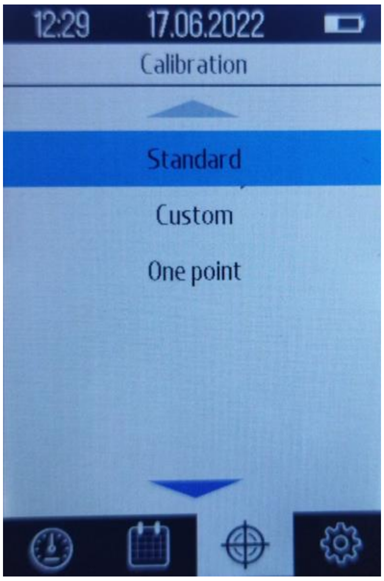

Figure 2.14 - "Calibration" tab

There are three ways to calibrate in this tab:

- Standard **(only for service technician of PCE Instruments!)**
- Custom **(only for service technician of PCE Instruments!)**
- One point calibration

2.6.1 Standard calibration

This function is only to be used by trained PCE Instruments service staff! This applies to chapters 2.6.1 to 2.6.3

Figure 2.15 - Service password entry window

2.6.1.1 "Create scale" item

Use the buttons to select "Create scale" and click in the window that opens, the user will be prompted to enter the calibration name (Fig. 2.17).

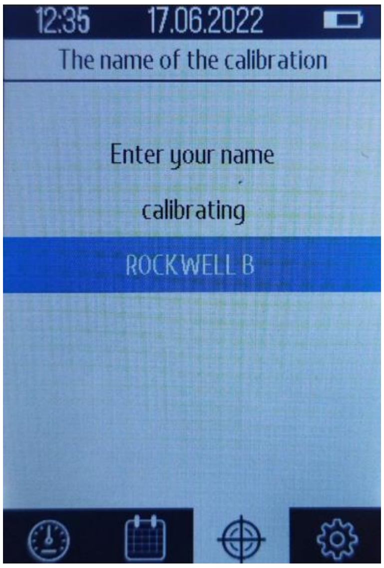

Figure 2.17 - Enter the calibration name

Use the buttons to enter the calibration name and press the button .

The next step is to select the hardness measurement scale (Fig. 2.18), use the buttons to select the desired hardness measurement scale and press

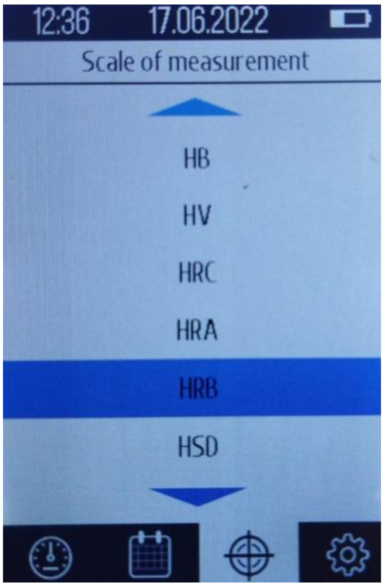

Figure 2.18 - Choice of hardness measurement scale

Then a window will open where you need to enter the number of hardness measures for calibration (Fig. 2.19), use the buttons 1 MAT, 2, 3, 4, 5, 6, 7, 8, 9, 0 to enter the desired number of measures and press OK.

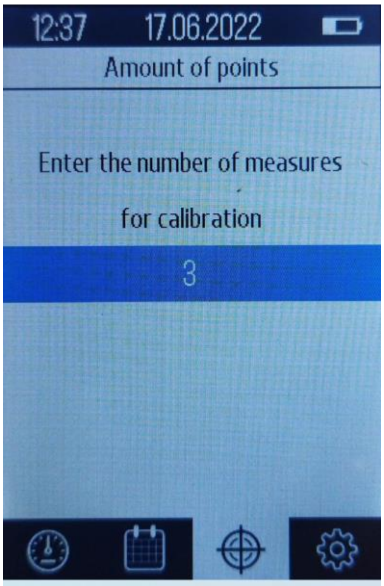

Figure 2.19 - Enter the number of hardness measures for calibration

A window will appear (Fig. 2.20), where measurements should be made on calibration measures one after another. After carrying out several impacts on one of the measures of hardness it is necessary to press the button OK and in a window (Fig. 2.21) by means buttons 1 MAT, 2, 3, 4, 5, 6, 7, 8, 9, 0 to enter the specific value of a measure and to press OK.Then you need to repeat the same steps on the remaining measures.

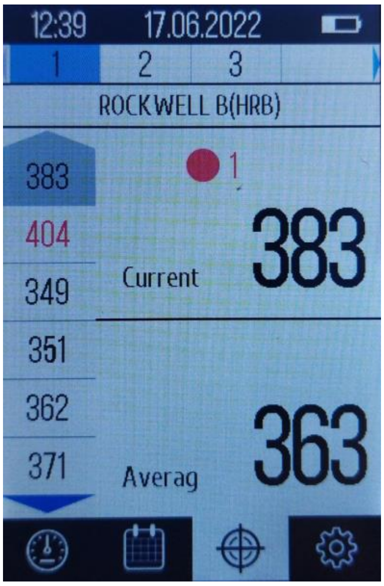

Figure 2.20 - Calibration of the device on calibration measures

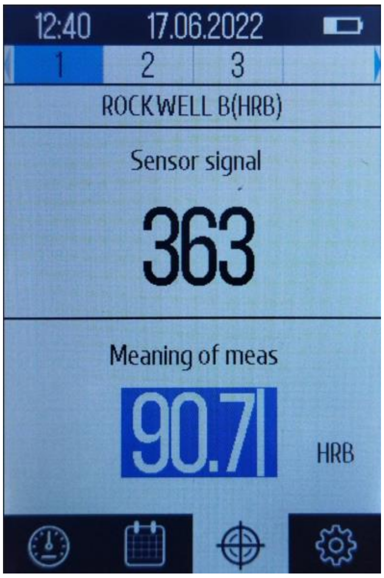

Figure 2.21 - Enter the specific value of the calibration measure

After performing these steps, a calibration completion message will be displayed.

In order to exit the process of creating a new calibration, you need to press the button , a dialog box will appear (Fig. 2.22) where you need to use the buttons 2 ABC 8 TUV to select "Yes" or "No" and press the button OK.

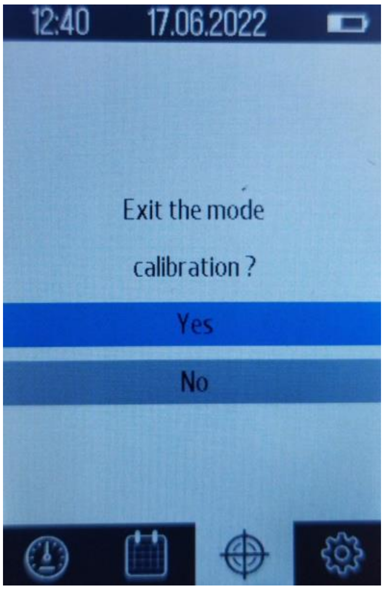

Figure 2.22 - Exit the calibration mode

2.6.2 "Change scale" item

To change an already saved scale, use the buttons to select "Change scale" and press . The following items will appear in the window (Fig. 2.23): "Adjustment", "Change name", "Restore settings".

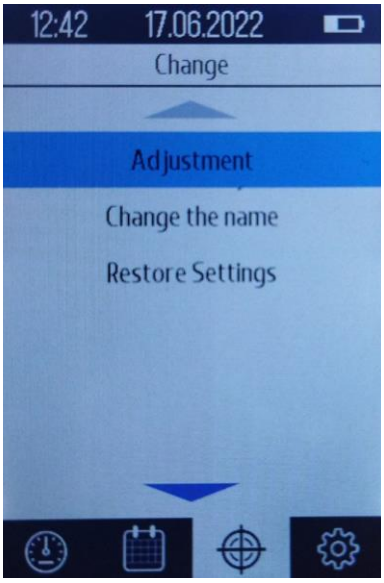

Figure 2.23 - Scale change window

2.6.2.1 Calibration adjustment

To adjust the calibration, use the buttons to select the "Adjustment" item and press the button (Fig. 2.24.

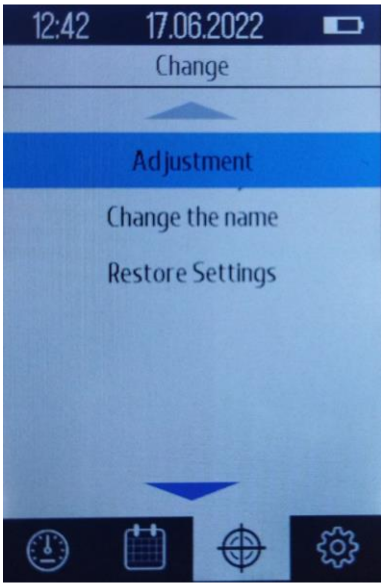

Figure 2.24 - Selecting the item "Adjustment"

In the window that opens (Fig. 2.25) - use the buttons to select the desired calibration and press .

Figure 2.25 - Select the desired calibration scale

Then, using the buttons in the window (Fig. 2.26), enter the number of adjustment points and press . Then make measurements as hardness, then press and adjust the value (Fig. 2.27).

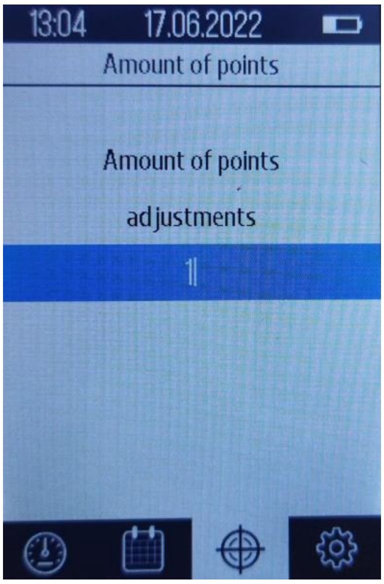

Figure 2.26 - Enter the number of points (measures of hardness) adjustment

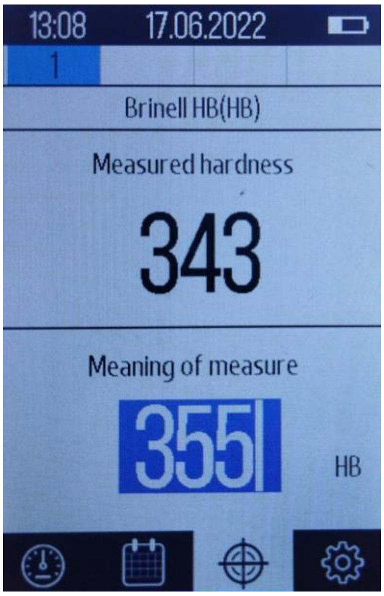

Figure 2.27 - Value adjustment

Press , repeat the measurement on another sample, adjust the hardness value, and press the button . The calibration will then be adjusted.

2.6.2.2 Change the calibration name

To change the name of the calibration, use the buttons , to select "Change name" (Fig. 2.24). In the window (Fig. 2.28), use the buttons to select the name of the calibration you want to change and press the button .

Figure 2.28 - Calibration name change window

Use the buttons to enter the desired calibration name and press . Then, by pressing the button you can return to the "Calibration" tab.

2.6.2.3 Restore settings

Select "Restore settings" (Fig. 2.24) and press . Then the tab with calibration will open (Fig. 2.29). Use the buttons , to select the desired scale and press , and the message "Factory settings loaded" should appear.

To return to the Calibration tab, double-click the button .

Figure 2.29 - View the "Restore Settings" tab

2.6.3 Delete scale item

To delete the calibration scale, use the buttons , to select "Delete scale" and press the button (Fig. 2.16). In the tab that opens, select the scale you want to delete and click (Fig. 2.30). After that the window of confirmation of removal of calibration will open (fig. 2.31), buttons select "Yes" or "No" and press .

Figure 2.30 - View tab "Delete scale"

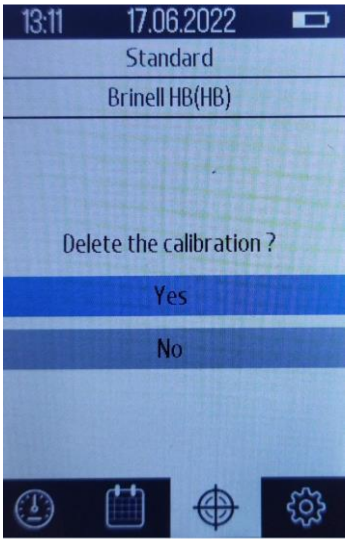

Figure 2.31 - Delete calibration

2.7 Custom calibration

Custom calibration is intended for the the service technician of PCE Instruments only to create their calibrations on their materials. This applies to chapters 2.7 to 2.73. The user can add new calibrations for different materials and adjust the values of custom calibrations already created by him. To do this, use the buttons to select "Custom" (Fig. 2.32), then press the button . A window for entering the password will appear (Fig. 2.33), enter the password using the buttons . After entering the password, a window will open with three options: "Create scale", "Edit name" and "Delete scale" (Fig. 2.34).

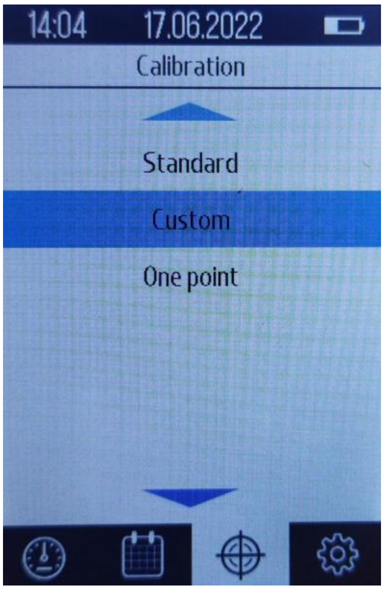

Figure 2.32 - Calibration" tab

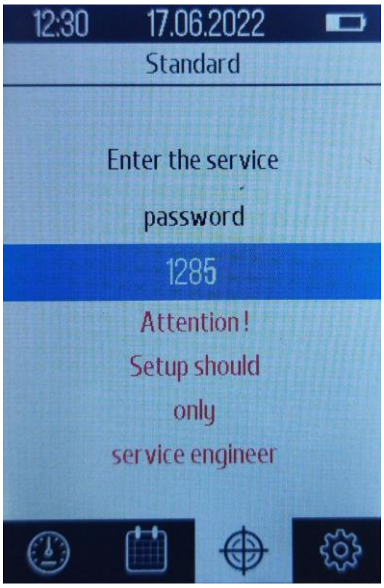

Figure 2.33 - Password entry window

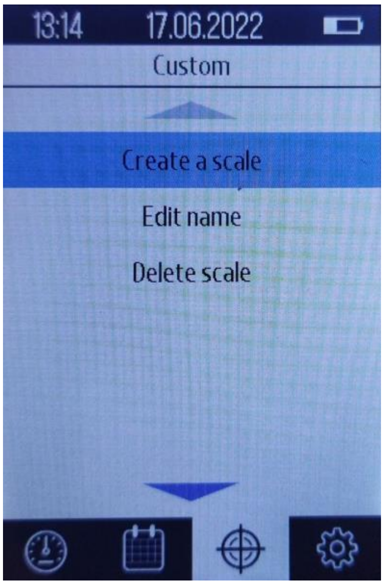

Figure 2.34 - Items in the custom calibration

2.7.1 "Create scale" item

Use the buttons to select "Create scale" and click on the window that opens, the user will be prompted to enter the calibration name (Fig. 2.35).

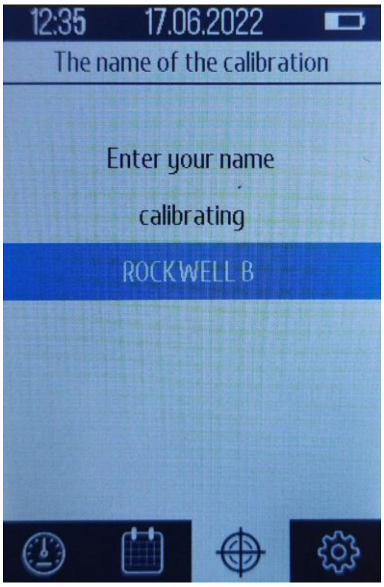

Figure 2.35 - Enter the calibration name

Use the buttons 1 MAT, 2 ABC, 3 DEF, 4 GHI, 5 JKL, 6 MNO, 7 PQRS, 8 TUV, 9 WXYZ o enter the calibration name and press the button OK.

The next step is to select the hardness measurement scale (Fig. 2.36), use the buttons 2 ABC, 8 TUV to select the desired hardness measurement scale, and press OK.

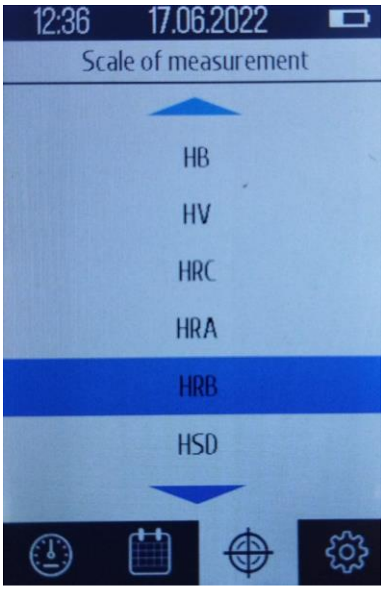

Figure 2.36 - Choice of hardness measurement scale

Then a window will open where you need to enter the number of hardness measures for calibration (Fig. 2.37), use the buttons to enter the desired number of measures, and press .

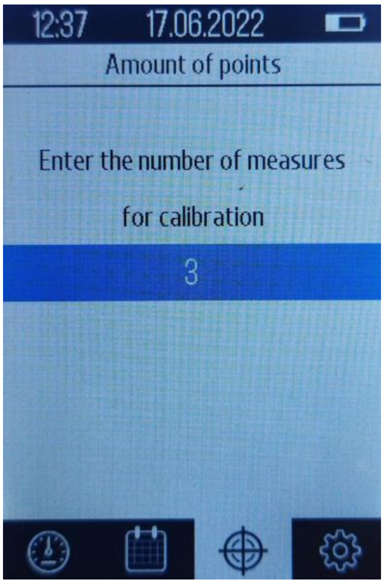

Figure 2.37 - Enter the number of measures to calibrate

A window will appear (Fig. 2.38), where measurements should be made on calibration measures one after another. After making several impacts on one of the measures, press the button and in the window (Fig. 2.39) use the buttons to enter the specific value of the measure and press . Then you need to repeat the same steps on the remaining hardness measures.

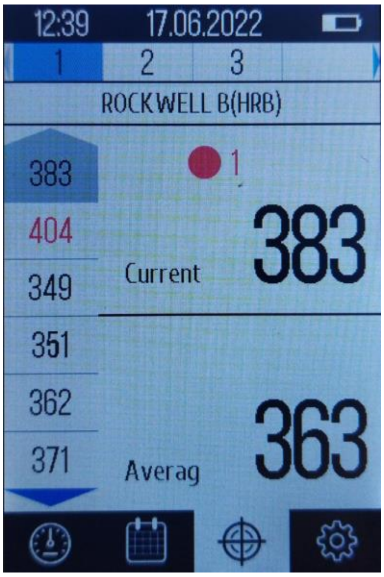

Figure 2.38 - Calibration of the device on calibration measures

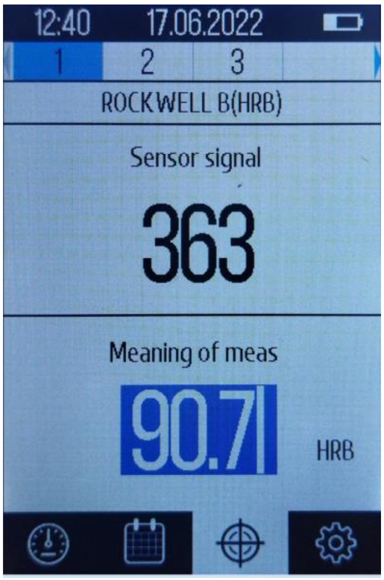

Figure 2.39 - Enter the specific value of the calibration measure

After performing these steps, a calibration completion message will be displayed.

To exit the process of creating a new calibration, you need to press a button OK, on an empty line of name or number, and a dialog box will appear (Fig. 2.40), 2 ABC 8 TUV where you need to select "Yes" or "No" and press the button OK.

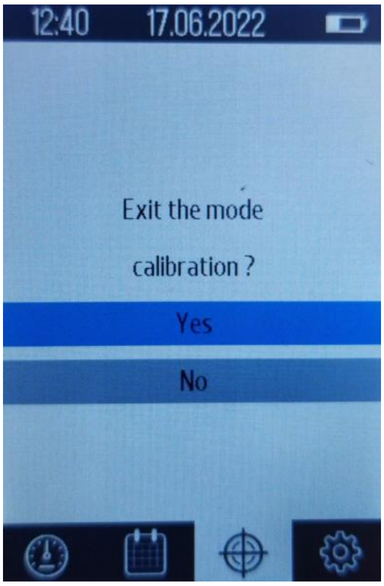

Figure 2.40 - Exit the calibration mode

2.7.2 Edit name

To change the calibration user name, use the buttons 2 ABC ▲, 8 TUV ▼ to select "Edit name" and press the button OK (Fig. 2.34). In the tab that opens (Fig. 2.41), use the buttons 2 ABC ▲, 8 TUV ▼ to select the calibration whose name you want to change and press OK. A window will open where you will be prompted to enter the calibration name (Fig. 2.42).

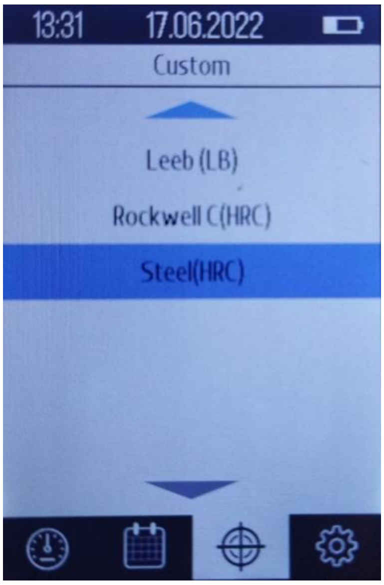

Figure 2.41 - "Edit name" tab with user calibration names

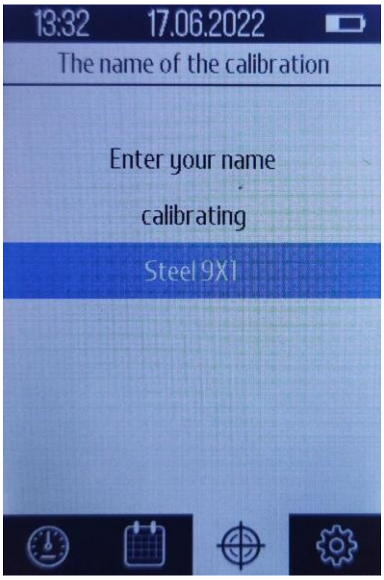

Figure 2.42 - Editing the calibration username

Use the buttons 1 MAT, 2 ABC, 3 DEF, 4 GHI, 5 JKL, 6 MNO, 7 PQRS, 8 TUV, 9 WXYZ, 0 to enter a new calibration name and press OK. To exit the calibration name, change mode without making name changes, press the button ↩, only the blinking cursor should remain, then press OK You will go to the "Edit name" tab without renaming the calibration.

2.7.3 Delete scale item

To delete a custom calibration scale, use the buttons 2 ABC 8 TUV, to select "Delete scale" and press the button OK (Fig. 2.43). In the tab that opens, select the scale you want to delete and click OK (Fig. 2.44).

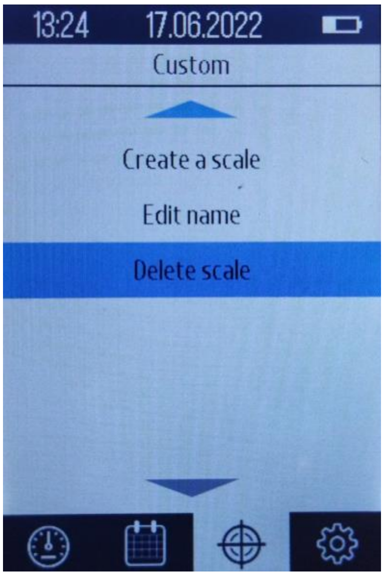

Figure 2.43 - Items in the custom calibration

Figure 2.44 - View tab "Delete scale"

After that the confirmation window of calibration removal will open (fig. 2.45), buttons 2 ABC 8 TUV select "Yes" or "No" and press OK.

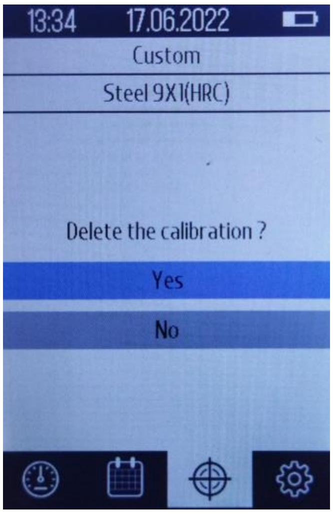

Figure 2.45 - Deleting the calibration

2.8 One point calibration

If the device is calibrated to standard measures, for example, carbon steel 35, the readings on products made of similar steels, with the same heat treatment - will not differ much. But the values of the hardness of alloy steels and other alloys, which have a completely different alloy compared to standard measures - will differ significantly.

One point calibration is designed to adjust the standard calibration scale of a specific material for a similar material (alloy; mechanical properties).

The accuracy of the new scale from the specific measure to which the calibration was performed is 15-20%.

To perform one point calibration in the tab "Calibration" (Fig. 2.46) use the buttons to select the item "One point" and press the button .

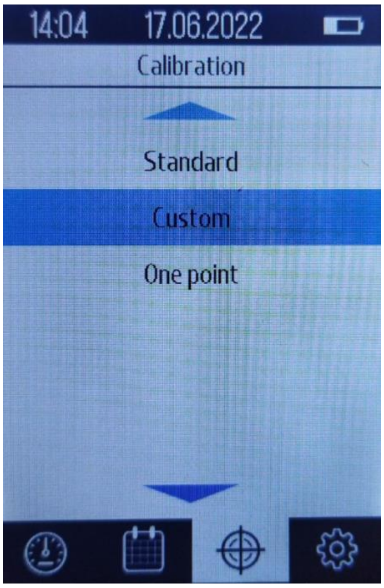

Figure 2.46 - "Calibration" tab, item "One point"

To access the calibration, you will be prompted to enter the user password (Fig. 2.47). Use the buttons to enter the user password and press . The password is 1111.

In the window that opens (Fig. 2.48), use the buttons to select an existing calibration, Standard or Custom, and press .

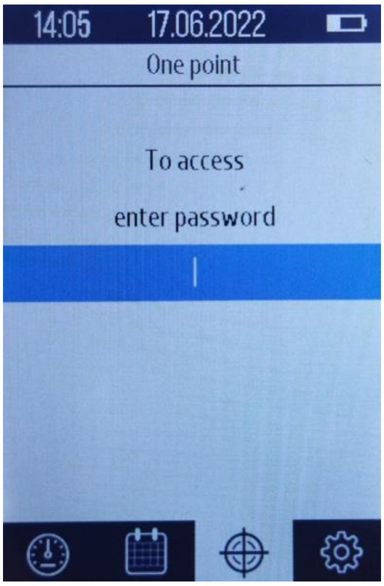

Figure 2.47 - Password entry window

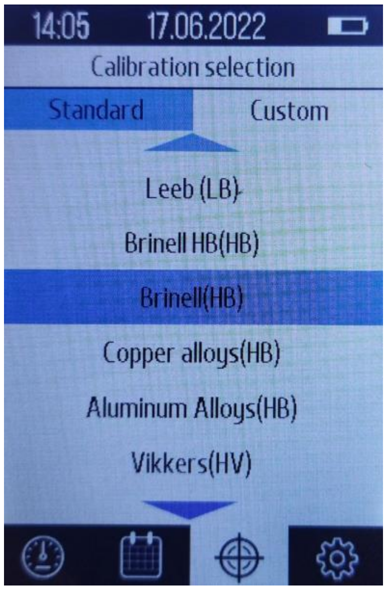

Figure 2.48 - Calibration selection

You will then be prompted to enter a new calibration name. Use the buttons to enter the new calibration name and press the button.

A window will appear (Fig. 2.49), where you should take a series of measurements. After a series of strikes press the button, and in the window that opens (Fig. 2.50) using the buttons to enter the avg value of the event and press.

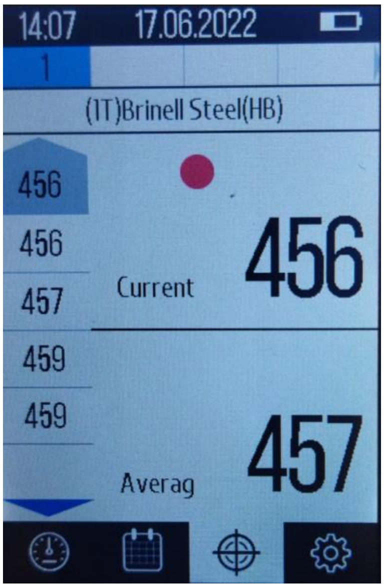

Figure 2.49 - One point calibration of the device

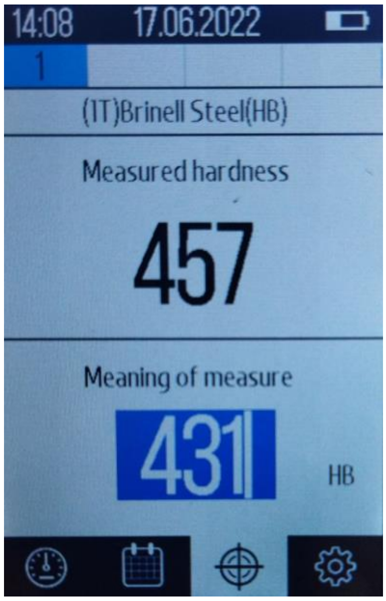

Figure 2.50 - Enter the specific value of the calibration measure

After performing these actions, a message will be displayed stating that the calibration has been adjusted, and it will be saved in the "Custom" section under a new name.

To exit the process of creating a calibration on one reading, you need to press the button , a dialog box will appear (Fig. 2.51) where you need to use the buttons   to select "Yes" or "No" and press the button .

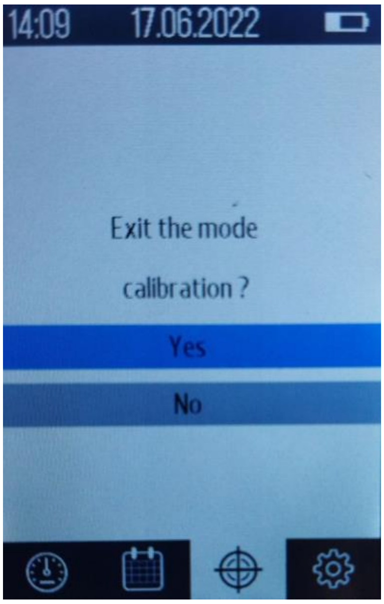

Figure 2.51 - Exit the One-point calibration mode

2.9 Settings tab

To enter the "Settings" tab, press the button  to select the appropriate icon on the screen of the hardness tester (Fig. 2.52) and press the button . After that, enter to the "Settings" tab (Fig. 2.53).

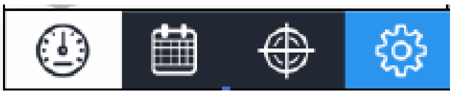

Figure 2.52 - Settings tab icon

Figure 2.53 - Settings tab

2.9.1 Description of the "Settings" tab items

- Date and time
- Save series
- Probe type
- Language
- Brightness
- Change password - only for use by PCE Instruments!
- Sound settings
- Shutdown
- USB settings
- Service menu - only for use by PCE Instruments!

2.9.2 Date and time

To enter the tab, use the buttons to select "Date and time" and press . A window will open (Fig. 2.54), where you need to set the date using the keyboard, then press the button , then you need to set the time and press . The date and time will change signaling it with a sound signal.

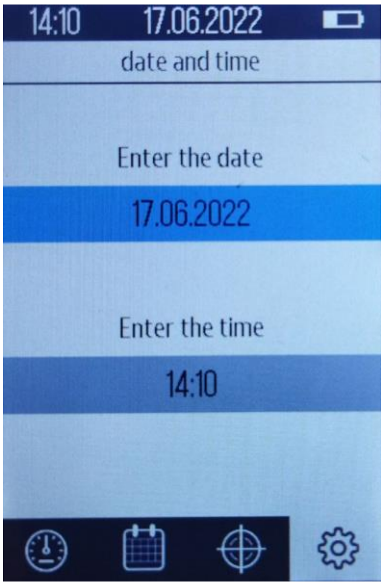

Figure 2.54 - Tab window "Date and time»

2.9.3 Saving a series of measurements

This device allows you to enable or disable the automatic recording of a complete series of measurements.

To enter the tab, use the buttons to select "Saving the series" and press . A window will open (Fig. 2.55), where you need to use the buttons , to select "Yes" or "No", then press .

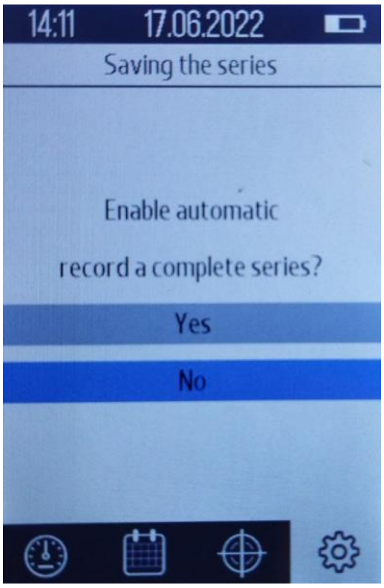

Figure 2.55 - "Save the series" tab window

2.9.4 Probe type

On this tab, you can select from four different probe types: Type D probe, G probe, E probe, and UCI probe.

To enter the tab, use the buttons to select "Sensor type" and press . A window will open (Fig. 2.56), where you need to use the buttons , to select the type of probe. Once the probe type is selected, press the button and the desired probe will be selected.

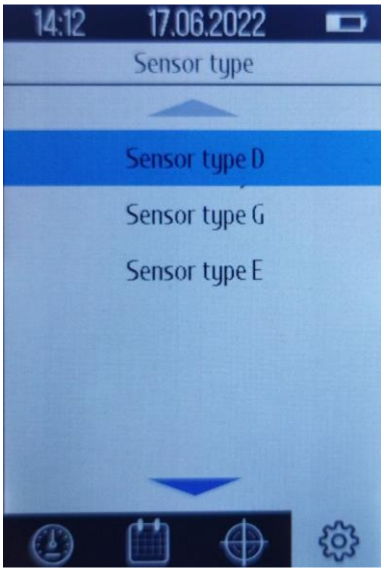

Figure 2.56 - "Sensor type" tab window

2.9.5 Language

In this tab, you can choose English, German, Turkish, Spanish, Russian or Ukrainian language.

To change the interface language, use the buttons to select "Language" and press the button , in the window (Fig. 2.57), use the buttons to select the desired language and press the button .

Figure 2.57 - "Language" tab window

2.9.6 Backlight brightness

In this tab, you can change the backlight brightness of the display.

Select "Brightness" with the buttons then press the button In the window that opens (Fig. 2.58) use the buttons to increase or decrease the brightness.

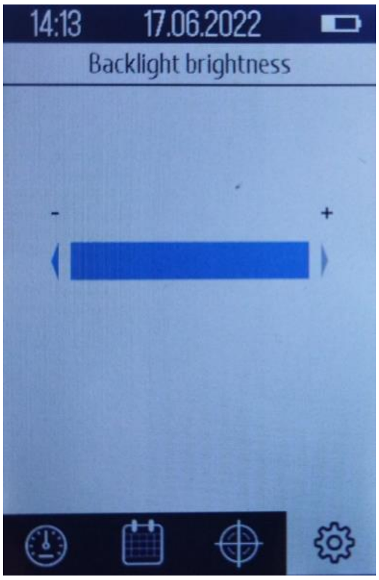

Figure 2.58 - "Brightness" tab window

2.9.7 Change password

This tab is only for use by PCE Instruments service personnel!

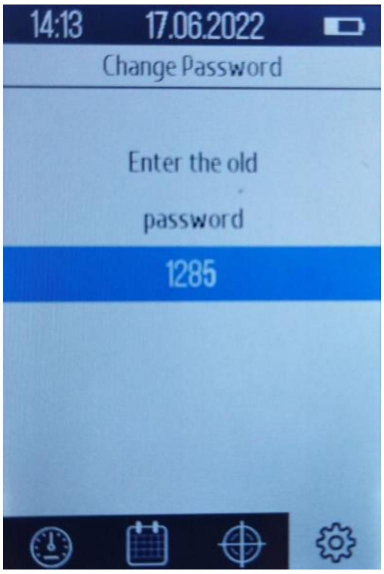

Figure 2.59 - "Password change" tab window

2.9.8 Sound settings

In this tab, the user can enable or disable audible confirmation of actions.

To turn the audible confirmation on or off, use the buttons to select "Sound Settings" and press the button . In the window (Fig. 2.62), use the buttons to select "Yes" or "No" and press .

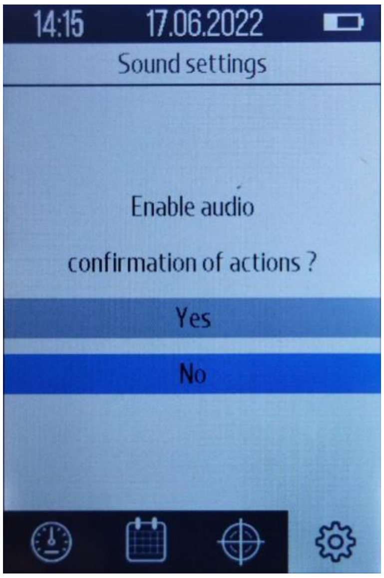

Figure 2.61 - "Sound settings" tab window

2.9.9 Auto-shutdown time

In this tab, the user can set the time to turn off the device. You can select items such as:

- Off
- 1 minute
- 2 minutes
- 5 minutes
- 10 minutes
- 15 minutes

To set the auto-shutdown time, use the buttons to select "Auto-off time" and press the button . In the window that opens (Fig. 2.62), select the desired item with the buttons and press .

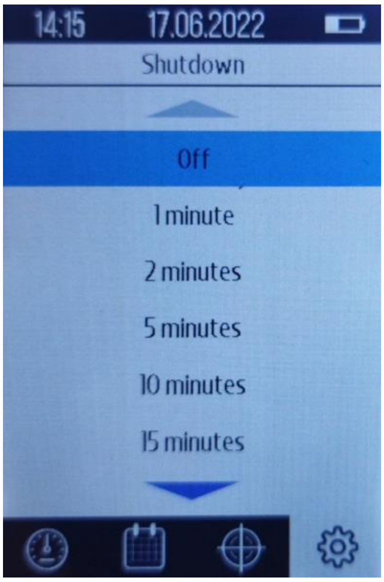

Figure 2.62 - "Auto-shutdown time" tab window

2.9.10 USB settings

In this tab, the user can enable or disable the USB-C port to connect to a PC.

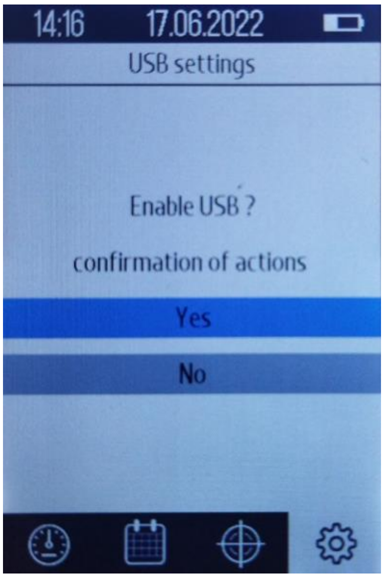

Figure 2.63 - "USB Settings" tab window

To turn the USB-C port on or off, use the button to select "USB Settings" and press the button . In the window (Fig. 2.63), use the buttons to select "Yes" or "No" and press .

2.9.11 Service menu

The service menu is only to be used by authorised PCE Instruments service staff! (Fig. 2.64).

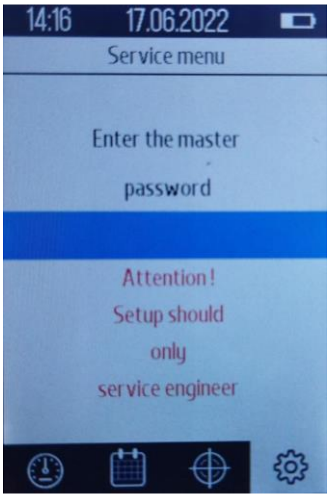

Figure 2.64 - "Service menu" tab window

2.9.12 Statistics

This tab is only to be used by authorised PCE Instruments service personnel (Fig. 2.65).

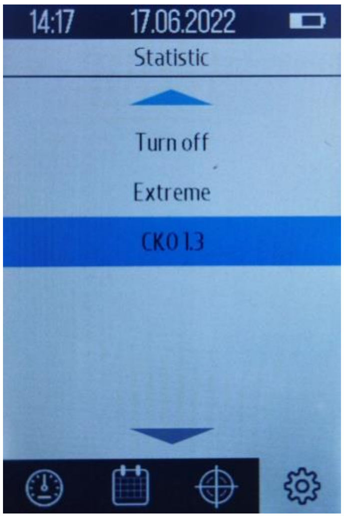

Figure 2.65 - "Statistics" tab window

2.9.13 About the device

In this tab, the user can view information about the device (Fig. 2.66). The user can see: the gain of the probe, the coefficient of standard deviation, the error after calibration at one point, and the firmware version.

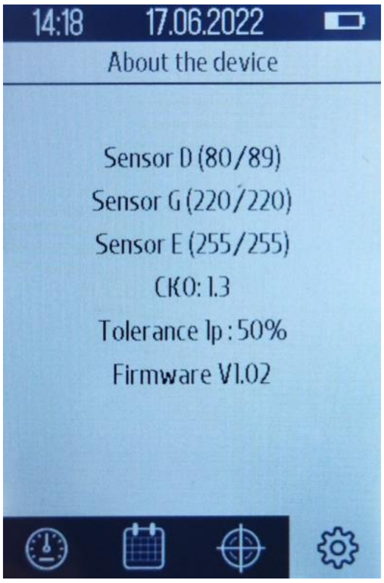

Figure 2.66 - "About the device" tab window

2.11 Hardness tester packaging

To avoid mechanical damage to the cable and connectors of the device, it is necessary to disconnect the sensor from the device before packing it into the package.

3. MAINTENANCE

Checking the technical condition of the hardness tester is carried out at least once a year in the following sequence:

– check the completeness of the hardness tester according to clause 1.13 "Delivery set of the hardness tester";
– Carry out visual external inspection of the hardness tester, make sure that there are no mechanical damages to the electronic unit, the connector and the connecting cable;
– No parts of the probes should have any signs of corrosion and mechanical damage.
– Check performance;
– compliance with the operating conditions;
– battery charge level;

To eliminate the identified deficiencies you should contact PCE Instruments.

4. TRANSPORTATION AND STORAGE

Packed instruments can be transported by any rail, road, sea, or air transport provided the following conditions are met:

- transportation is carried out in factory packaging;
- there is no direct exposure to moisture;
- the temperature does not exceed -50 ° C to +50 ° C / -58 ° F to 122 ° F
- humidity does not exceed 95% at temperatures up to 35 ° C / 95 ° F;
- vibration in the range from 10 to 500 Hz with amplitude up to 0.35 mm and acceleration up to 49 m / s2;
- impacts with a peak acceleration value of up to 98 m / s2;
- the devices placed in the transport are fixed to avoid falling and collision.

In the case of air transport, the transport must be carried out in sealed heated compartments.

To prevent moisture condensation inside the hardness tester when transporting it from frost to a warm room, it is necessary to hold the device for 6 hours at room temperature.

The hardness tester is stored in a case indoors with an air temperature (25 ± 10) ° C, relative humidity from 45 to 80%, and atmospheric pressure from 630 to 800 mm Hg/0,84 to 1,07 bar. The room should not have mold, acid fumes, reagents, paints, and other chemicals. Abrupt changes in temperature and humidity because of dew should not be allowed in the room.

For long-term storage, the device must be preserved, for which the electronic unit, probe, charger and hardness measures, cleaned of dirt and oil, are placed in separate plastic bags and placed in separate pockets of the transportation bag of the device.

5. PRECAUTIONS

A hardness tester is a technically complex measuring device that requires careful handling. It must be protected from:

- shocks, loads that can lead to mechanical damage to the hardness tester;
- exposure to chemically aggressive environments;
- ingress of liquids;
- prolonged exposure to direct sunlight;
- other influences which can cause damage to the functionality of the device.

The use of a hardness tester in the conditions of the sharp difference in temperatures is not allowed. After transporting the device to the place of operation at a negative ambient temperature and placing it into a room with a positive temperature, it is necessary to keep the product in its packaging for at least 6 hours in order to avoid failure due to condensation of moisture.

Do not use batteries or chargers that are not approved by the manufacturer in the hardness tester.

Dissection of the electronic unit and probes, and self-repair of the hardness tester is not allowed.

6. RECYCLING

The hardness tester does not contain in its design any dangerous or poisonous substances that can harm human health or the environment and do not pose a threat to life, health of people and the environment at the end of their service life. In this regard, the recycling of the product can be made according to the rules for the disposal of general industrial waste. Recycling is carried out separately by groups of materials: plastic elements, metal fasteners.

The content of precious metals in the components of the product (electronic cards, connectors, etc.) is extremely small, so it is not appropriate to produce their secondary processing.

Hardness tester batteries are disposed of in accordance with the current regulations for the disposal of products.