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HARDNESS TESTER
PCE-3000U / PCE-3000UL

Operating Manual

CONTENTS

1. Introduction

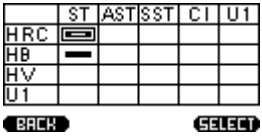
The following operation manual explains the preparation, setup, principles of operation, usage, and troubleshooting of the hardness tester PCE-3000U / PCE-3000UL.
Please, read this instructions carefully for operate the hardness tester PCE-3000U / PCE-3000UL functions quickly and effectively.
In doing this you will be able to take full advantage of the function range of the instrument. At the same time, you will also avoid errors and wrong operation which in turn would cause incorrect test results and thus could lead to injury and damage.

2. Appointment

The hardness tester PCE-3000U / PCE-3000UL is handy, easy to operate and can carry out tests quickly without any difficulties.
Hardness tester PCE-3000U / PCE-3000UL is mainly suitable:
• for measurement hardness of low and non-alloyed steels;
• for measurement hardness of high-alloyed steels;
• for measurement hardness of nonferrous metals.

3. Specifications

3.1. Calibration scales
Device has 20 calibration scales of hardness that conventionally divided into four scales and five materials for each:



Each of the scales can be additionally calibrated by 1 or 2 points. Also, the unit measures in Leeb scale (with rebound probe) and Tensile strength, through the automatic recalculation from the Brinell scale.

3.2. The limits of permissible basic error of measurement

Hardness scale	Error (%)
Rockwell C	± 1,5
Brinell	± 3,0
Vickers	± 3,0
Leeb	± 3,0
Tensile strength	Not rated

3.3. Working conditions: -20°C to +40°C

3.4. Overall dimensions

Name	*Overall dimensions, mm*
Information processing unit	125x65x25
UCI probe	Ø25x140
Rebound probe	Ø20x150

3.5. Weight of the instrument and probe

Name	*Weight, kg*
Information processing unit	0,10
UCI probe	0,25
Rebound probe	0,10

3.6. Power supply
Battery operation: two 1.5V AA cells:

- AlMn (approx.15 hours operation);
- Alkaline (approx.8 hours operation);
- NiCd (approx. 15 hours operation);
- NiMH (approx. 20 hours operation).

3.7. To save battery charge in the menu there is setting of device auto switch off.

3.8. Requirements of the test material

Surface roughness, not more, Ra	
UCI (10N) probe U1	1,5
UCI (50N) probe U1	2,5
Rebound probe D1	3,2
Radius of curvature of the surface, mm	
UCI probe U1	5,0
Rebound probe D1	10,0
Weight of the test material, not less, kg	
UCI probe U1	0,1
Rebound probe D1	5,0
Thickness of the test material, not less, mm	
UCI probe U1	1,0
Rebound probe D1	10,0

4. Packing list

4.1. Information processing unit 1 pc
4.2. Probes: PCE-3000U / PCE-3000UL: UCI (50N) 1 pc
PCE-3000UL: Rebound (Leeb) 1 pc
4.3. Charger 1 pc
4.4. Batteries 2 pc
4.5. USB cable 1 pc
4.6. Operation manual 1 pc
4.7. Carrying case 1pc

The software can be downloaded here:
https://www.pce-instruments.com/english/download-win_4.htm

5. Principle of operation

5.1. Rebound method

Rebound probe consists of an impact body and the capture. The impact body has a carbide tip and a permanent magnet for generating a voltage pulse; the impact device has a spring

mechanism for loading and impelling the impact body, and an induction coil for detecting the magnet in the impact body. In the rebound hardness testing method, the speed variation caused by the impact of the impact body against the material surface is measured.
The impact energy is adjusted via the spring for the measurement. The impact body contained in the tube of the impact device is impelled against the test surface by means of the release button. In the course of this, the magnet of the impact body induces in the coil a voltage signal whose height is proportional to the impact phase speed. The impact causes a plastic deformation of the material and a permanent spherical indentation is produced in the surface. This plastic deformation leads to a loss of energy of the impact body and thus to a lower speed after the actual rebound phase.
The speed ratio is determined exactly at the moment of impact/rebound by means of the special signal processing. The speed ratio is therefore unaffected by the impact direction. As opposed to this, other rebound hardness testers require presetting of the impact direction in fixed steps (influence of gravitation on the speed ratio) - which constitutes a considerable disadvantage with frequently changing test positions.

5.2. UCI method

The Vickers diamond is fixed to the tip of a round metal rod. This metal rod is excited, to its resonant frequency of approx. 78 kHz, into longitudinal oscillations. When the Vickers diamond contacts the sample surface, the resonant frequency will change. This change happens in relation to the size of the indent area from the Vickers diamond. The size, in turn, is a measure for the hardness of the tested material. Resonant frequencies can be measured very accurately. This is why the UCI method is suited to make the evaluation of Vickers indents, and thus of the complete test procedure, so much easier and quicker.

There are also two additional advantages:
- the measurement is made under load. (No impairment of the measurement due to elastic resilience);
- the hardness measurement is based on the area of the indent and not on the length of the indent diagonals.
The measurement is thus less affected by surface roughness; even gunmetal-finished surfaces can be measured.
Concerning the UCI method, the measurement value is also dependent on the Young's modulus of the material.

6. Preparations for operation

6.1. Battery supply
The hardness tester PCE-3000U / PCE-3000UL is powered by batteries or accumulators. For this you need two AA 1.5 V:
- dry cells (AlMn) or rechargeable (Nickel-Cadmium or Nickel-Metalhydrid).

NOTE! The batteries must be fully charged before first use.

Using of batteries and accumulators.
Open the battery compartment. Insert the batteries, observing the correct polarity. Close the battery compartment.

Used or defective batteries are special refuse and must be disposed of according to the governing laws!

6.2. Connection of probes.
Socket for the probe is at the top of the information processing unit. Connect the probe cable to the PCE-3000U / PCE-3000UL socket in accordance with the marks on the connector.

7. Basics of operation

7.1. Keys


Turn on/off; left soft key


Right soft key


Modes switch


Selection of hardness scale


Navigation key; increase


Navigation key; decrease

7.2. Selection of measurement method.
7.2.1. Rebound method of measuring hardness is appropriate for:
- testing objects weighing more than 5 kg and a wall thickness more than 10 mm;
- massive products, products with a coarse-grained structure, forged and cast products;
- testing objects with minimal preparation of the surface.

7.2.2. UCI method of measuring hardness is appropriate for:
- testing objects with low mass and small wall thickness;

- testing objects with a glossy surface (with special requirements to the minimum size of the imprint);
- surfaces of the testing objects with hardened layers.

8. Operation

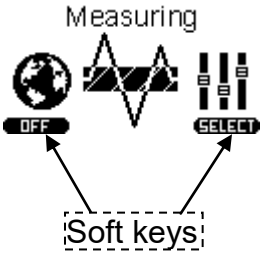
8.1. Preparation of the test material.
The surface must be clean and free of oil, grease and dust.
The surface roughness of the material should meet the requirements of a specific probe (paragraph 3.8).

8.2. Features of the methods of measurement of metal hardness:
8.2.1.UCI method:
Distinct reading variations may especially occur with a mass lower than 0.1 kg and a specimen thickness of less than 1 mm if the test material is excited to resonance or sympathetic oscillations. Otherwise, such test materials must be fixed to a solid base, e.g. using a viscous paste. The same applies to the hardness test blocks.
8.2.2. Rebound method:
With smaller and less heavy test objects, the impact effect of the impact device may cause vibrations which could produce distorted measurement results.
- Test objects weighing less than 2 kg must in any case be fixed to the support using couplant so that there are no any vibrations.
- Test objects weighing between 2 kg and 5 kg must be placed on a large metal support (e.g. a table) in such a way that they are not moved or caused to vibrate by the impact.

8.3. Device menu

After connecting the probe, hold **TURN ON** button  until logo appears on the display:

Then, you get to the main menu of the device:



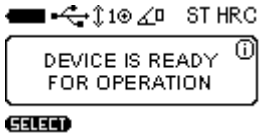
The menu consists of 6 sections:

1. Measuring
2. Calibration
3. Archive
4. Settings
5. Memory card
6. Information

Scroll through the menu using the navigation keys  and  , for entering press soft key **SELECT** using  .

8.3.1. Measuring

Selecting **Measuring**, you go to the measurement of hardness mode, depending on the probe at the top of the screen will display the angle of the probe (for rebound probe), or the state of the diamond indenter (for UCI probe).



Detailed description of the measurement of hardness, see paragraph 9.

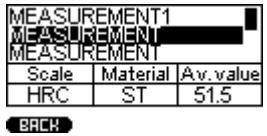
8.3.2. Calibration

Selecting **Calibration**, you go to the table of calibrations where the scale conventionally divided into four hardness scales: Rockwell (HRC), Brinell (HB), Vickers (HV), User (U1). Each of the scales can be calibrated to 5 conventional materials: Steel (ST), Alloy Steel (AST), Stainless steel (SST), Cast Iron (CI), User material (U1).

Detailed description of the calibration process, see paragraph 11.

8.3.3. Archive

Selecting **Archive** you go to the list of saved measurements, which displays Measurement name, Scale, Material and Average Value.



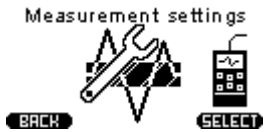
You can store in memory up to 1024 measurements.

Scroll through the list using the navigation keys  and  .

8.3.4. Settings

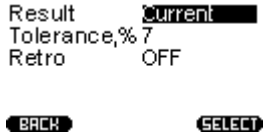
Selecting **Settings** you go to the settings menu, there are 2:

- **Measurement settings**:



- **Device settings**:

8.3.4.1. Measurement settings



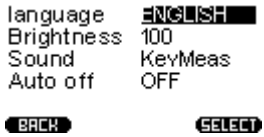
By selecting **Measurement settings** you can configure the following settings:

Result: displaying measurement results can be Current (display instantaneous values of measurements) and Average (unit accumulates the series of measurements and display average value of hardness).

Tolerance, %: This parameter is used only for Smart mode. Set the % value adjusts the range of deviations of measurements to be included in the calculation of the average for the series in Smart mode. Detailed description of the Smart mode, see paragraph 10.3.

Retro: allows you to return to the measurement mode with saved last measurements after restarting of the device.

8.3.4.2. Device settings



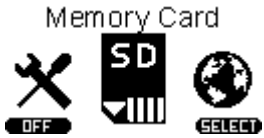
Language: selection language of the device menu (available English and Russian).

Brightness: setting the brightness of the backlight.

Sound: there are 4 modes of device sound (Off, Key, Measurement, Key and Measurement)

Auto Off: setting of the automatic shutdown device when it is not in use.

8.3.5. Memory Card



Selecting **Memory Card** you go to the menu of memory.

8.3.5.1. Create backup copies of calibrations.

After calibration of the probe is recommended to create a backup copy of the calibration (usually the manufacturer makes the calibration of 1-2 scales, to check the probe). This is done in order to be able to resume adequate calibration after incorrect settings in the future.

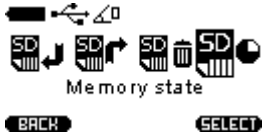
8.3.5.2. Load backup copies of calibrations.

After the initial save of calibrations you can always download it to the probe. This function is needed for the resumption of adequate calibration in case of wrong settings of the probe.

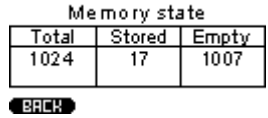
8.3.5.3. Clear SD card

Clearing saved records in the archive, after clearing SD card the archive will be empty.

8.3.5.4. Memory state

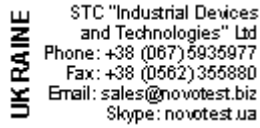


This menu displays the total, used and empty memory cells.



8.3.6. Information

In this menu you can view information about the manufacturer and offices around the world.



Scroll through the list using the navigation keys  and  to see PCE Instruments dealers and general information about the device.

9. Hardness measurement

9.1. Using of the UCI method

The design of UCI Probe is shown in Figure 1a. Probe has a special removable collapsible nozzle with the puck (Figure 1b). The puck provides the convenience of positioning the probe relative to the testing object and a clip for the measurements

Figure 1a. UCI Probe U1
1 – Probe's body; 2 – Collapsible nozzle;
3 – Puck; 4 – Place for fingers

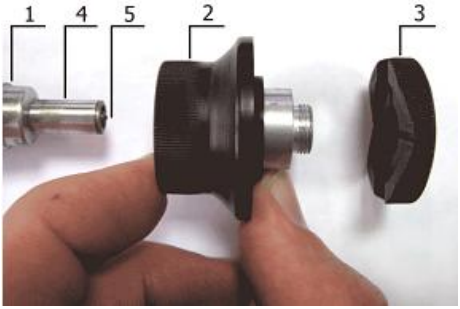


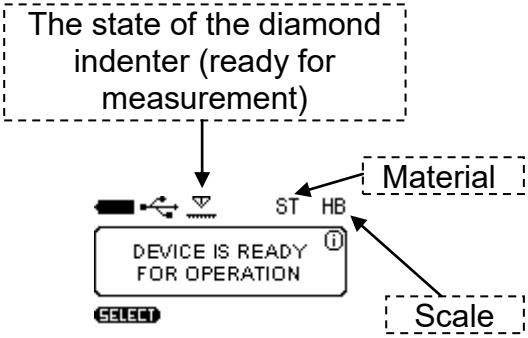
Figure 1b. Demounted nozzle
1 – Probe's body; 2 – Nozzle main part;
3 – Puck; 4 – Protective tube;
5 – Diamond.

One side of the puck is flat to using probe on flat surfaces. Another side has grooves for using a probe on cylindrical surfaces.
It is marked slots designed for ease of measurement of hardness on cylindrical products of various diameters. Probe with demounted nozzle is usually using to measure hardness in difficult places, such as narrow or deep groove.

The probe may be removed from the nozzle is used for measuring the hardness in the narrow and hard to reach places.

Figure 2

Turn on the hardness tester pressing  , and select the measurement mode by pressing  . Detailed description of the modes, see paragraph 10.



Then select the scale and material hardness for which there is a proper calibration (How to calibrate device see paragraph 11). For select the hardness scales press  and chose the scale by

keys  and  , then press  and chose the material.
During the measurement you can select other hardness scale. The displayed measurement reading will be converted according with the new hardness scale if it is calibrated.

NOTE! Calibration of UCI probe is carried out by the direct method, so the conversion is carried out on the basis of pre-calibration, and does not correspond to any standard.

Install the probe puck on the sample surface, keeping it in the tough skirt as shown in Figure 3a. By clicking on the skirt thrust both hands to bring the diamond tip of the probe perpendicularly to the sample surface to the touch (Figure 3b). Slowly (in about 0.5 seconds) by pressing with a force of (5 or 1 kg depending on probe type) thrust skirt, push the diamond tip into the metal surface, preventing swinging (Figure 3c). After the beep, remove the probe from the tested object.

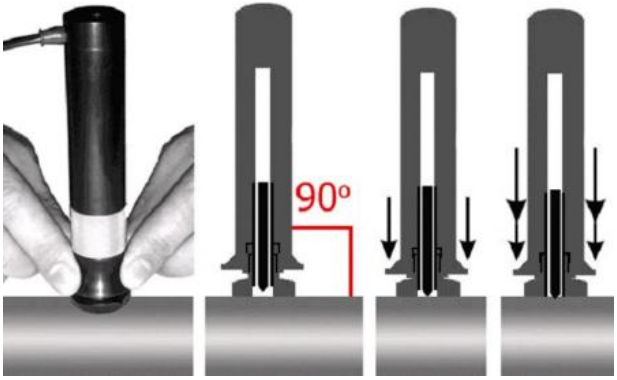


Figure 3

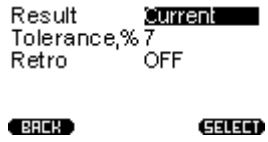
The display shows the value of hardness. The result of measurement is displayed on the display until the next measurement.

This symbol indicates that the diamond indenter is in contact with the testing object or device is not ready for the next measurement

WARNING! Not allowed a sharp click and scratching sample by indenter, this may lead to exceeding the allowable value of error and damage the diamond indenter.

NOTE! The "exciter" in the probe is powered from the batteries. If the batteries are depleted you will get erratic test results.

You can get the value of the current measurement or the average for the series of measurements, depending on the settings in **Measurement settings** menu *Current* or *Average*:



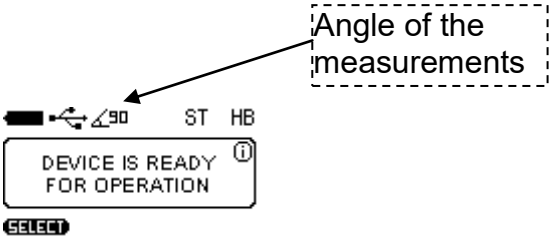
After the measurement, you can save measurement (series of measurements) in the archive by pressing **SAVE** with key  .

Move the cursor over the keyboard with keys  and  and selecting a symbol by pressing the  . Then select **SAVE** by cursor. The record is stored in the archive.

9.2. Using of the Rebound (Leeb) method

Select scale and material with the existing calibration. Load the impact body using charging mechanism.

Press the buttons  and  to set the angle of the measurement. Fixed angle is displayed in the upper part of the display.



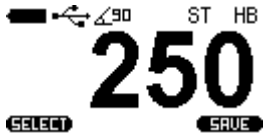
Position of the probe perpendicular to the ground plane corresponds to the angle **0°**.

Place the rebound probe vertically onto the test surface and press it slightly against the surface. Charge the impact body by a charging

mechanism pressing the probe enclosure until the clicks, as shown below:

Figure 4. Rebound probe

Press the release button on top of the impact device by finger of your free hand.
After pressing the shutter release button and the impact body hitting in the area of measurement sounds a beep and the display shows the value of measured hardness.



WARNING! The minimum distance between the imprints of measurements must be not less than 3 mm.

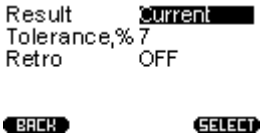
10. Measurement modes

To selecting the measurement mode go to the **Measurement** and press  . The device will offer you the following measurement modes:
- NORM – normal operation mode;
- STAT – statistics mode;
- SMART – mode of filter incorrect measurements;
- SYGNAL – the display signal mode (only for Leeb).

To select the measurement mode, press  .

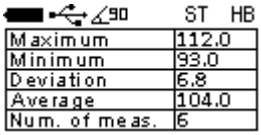
10.1. Normal mode

In normal mode, the device displays the current measurement value or average of series of measurements, depending on selected the Current or Average in Measurement settings menu:



10.2. Statistics mode

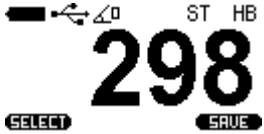
Statistics mode allows to monitoring the following parameters of measurement series:
- Maximum;
- Minimum;
- Deviation;
- Average;
- Number of measurements.



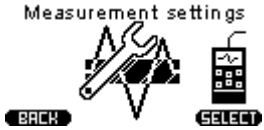
10.3. Smart mode

Smart mode allows the user to identify the general sequence of measurements. The device selects the first three series of measurements that do not exceed the specified tolerance. After that, the following measurements that exceed a given tolerance will be excluded from the series and will not be taken into account when calculating the average of the series.

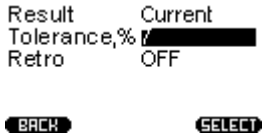
Filled with the color readings indicate that the device has fixed the general sequence and Smart mode is active.



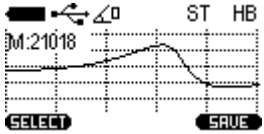
To set the tolerance of Smart Mode, go to **Measurement Settings**:



And set the percentage tolerance values from 1 to 10.



10.4. Signal mode



Mode is active only for Leeb probe and shows the voltage produced during the impact and rebound of impact body. **M** is the maximum value of the conditional code number which corresponds to the received signal.

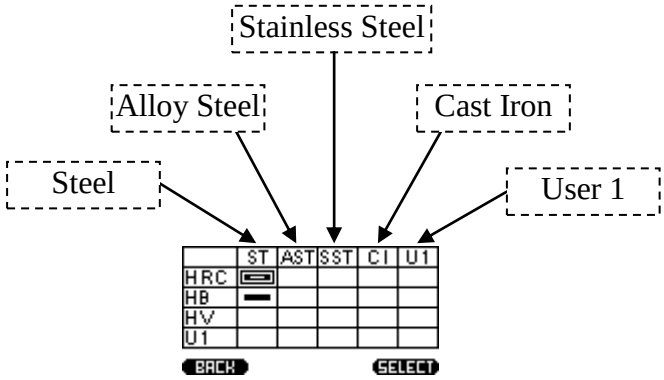
11. Calibration

11.1. Main calibration

To calibrate the probe you will need 3 samples of material with a known hardness. Hardness range should be wider than the hardness of the materials which will be measured (The values should be the maximum or more, minimum or less and average).

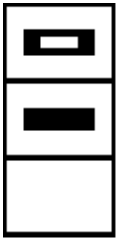
Select in the main menu **Calibration**:

The device goes to the table, each cell of the table corresponds to the certain scale of calibration for the certain material:



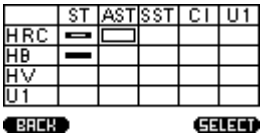
All calibrations of the device can be calibrated for any materials and any scales, and are divided in this way just for practicality.

Cells may be 3 states:

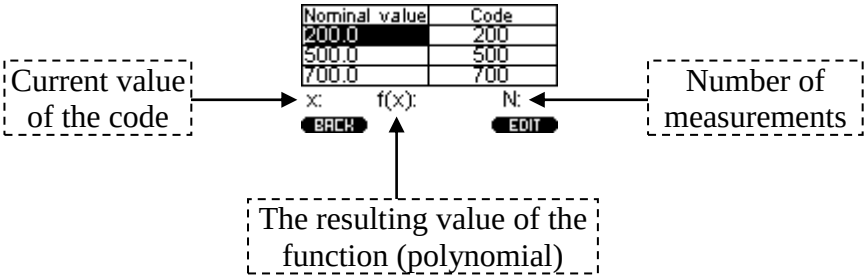


- User calibration (1 or 2 point)
- Calibration
- Empty cell

Press the buttons  and  to choice cell for calibration, for example HRC for Alloy Steel:

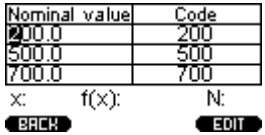


Press **SELECT** by  and **EDIT,** the table appears:

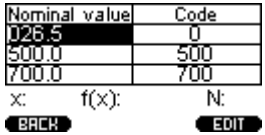


The device, making the measurement, gets the nominal codes, the purpose of calibration - is to find the correlation between the nominal code and hardness values (construction of the relation function).

To start the calibration, enter the real values of the samples. Press **EDIT** by  and select **EDIT** in the window:

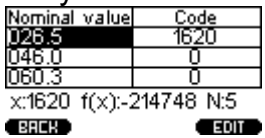


Press the buttons  and  for setting real values of hardness, to go to the next digit number, press **EDIT** by  :



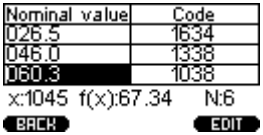
Press the buttons  for adjusting the values of the next samples.

Then, move your selection on the hardness value according to the sample, and make at least 5 measurements. Make sure that the value of **X** would not varied by more than 5%.

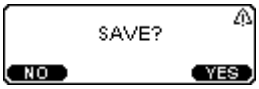


If you get an obvious error measurement, press **EDIT** by  and press **DELETE**, the last measurement will be removed from the series.

Go to the next nominal pressing  , and make the same procedure with other samples, you end up with:



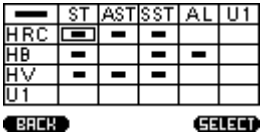
To save, press **BACK** by  , window will appear:



Press **YES** by  . Calibration is saved. Select the appropriate material and scale, and device is ready for operation.

11.2. Calibration of rebound (Leeb) probe

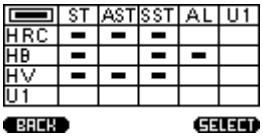
Leeb probe pre-calibrated for some scales by manufacturer. All available scales are converted in accordance with ASTM E140 from the basic Leeb scale.



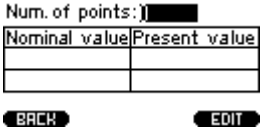
Each scale can be calibrated by direct method the same way as described at p.11.1.

For calibration Leeb scale (and all corresponded other available scales converted from the main Leeb scale) press 

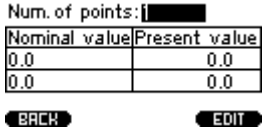
button. In the upper left part of the table will be highlighted segment:



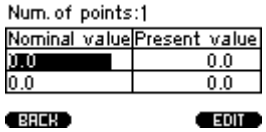
Press **SELECT** by  , and then select **USER**. The table appears:



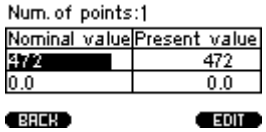
Press **EDIT** for select the number of calibration points 1 pressing button  and  , then again **EDIT** by  :



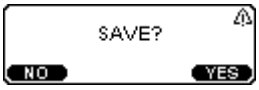
Move the cursor by pressing  to select the first row in the column **Nominal value**:



Take about 5 measurements on the test block, the instrument will display the average of the series:



Press **EDIT** by  and by pressing  and  set the nominal value of the hardness test block. To go to the next digit number, press **EDIT** by  . To save, press **BACK** by  , window will appear:

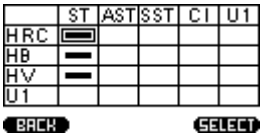


Press **YES** by  . Calibration is saved. Leeb and all converted scale are calibrated.

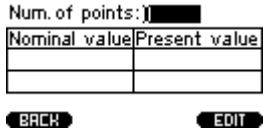
11.3. User (additional) calibration

Each of the saved main calibration may be further corrected. Additional calibration is recommended in the following cases:
- If the measurements of the device on the samples are constant, but differ from the nominal value of the standard block;
- After extended storage (more than 3 months.);
- After intensive operation;
- With a significant change in the operating conditions (temperature, humidity, etc.).

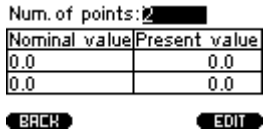
For the calibration of hardness needed one (single-point calibration) or two (two-point calibration) standard hardness test with the maximum and minimum values for the controlled range of the hardness.
For example, we have two steel sample with known hardness of HRC, and device shows a stable deviation for hardness measurements on it. For making user two-point calibration select in main menu **Calibration**:



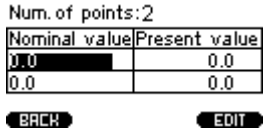
Press **SELECT** by  , and then select **USER**. The table appears:



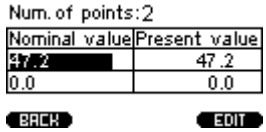
Press **EDIT** for select the number of calibration points, as we have two sample - set 2 with pressing button  and  , then again **EDIT** by  :



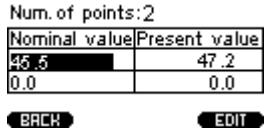
Move the cursor by pressing  to select the first row in the column **Nominal value**:



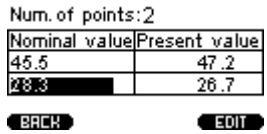
Take about 5 measurements on the first sample, the instrument will display the average of the series in accordance with the current calibration:



Press **EDIT** by  and by pressing  and  set the nominal value of the sample. To go to the next digit number, press **EDIT** by  . After adjusting the value of the first sample you get:



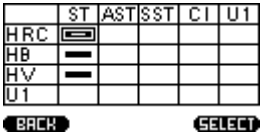
Press  to adjust the second sample value, and perform the same operation. In the end, get:



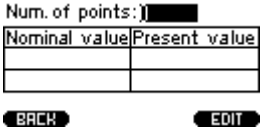
To save, press **BACK** by  , window will appear:

Press **YES** by  . Calibration is saved. Select the appropriate material and scale, and device is ready for operation.

About the stored user calibration will symbolize the next state of the cell:



To delete user calibration, go to the user calibration mode and set to **0** for **Num. Of points**:



12. Technical maintenance, special conditions of operation

12.1 On the whole, hardness testers do not require any special maintenance. However, for the purpose of hardness tester stable operation, regular maintenance is advisable.

12.2. Probe maintenance
Clean hardmetal ball and diamond pyramid from dust, mud and oil traces. Use soft cloth impregnated with alcohol solution.
Check the probe operation regularly by conducting hardness measurements on hardness reference blocks. Do not use reference test block with expired period between verifications (more than 2 years).
12.3. Information processing unit maintenance

To clean from any pollution, use soft dry cloth. Do not use the water, since the hardness tester is neither spray-proof nor water-proof due to the joints on its body.
Do not use any solvents, they can damage indication signs and writings on the front and back sides of the body.

12.4. Battery maintenance
The battery average life is not less than 3years. The battery used in compliance with the "C" or "AA" international standard. It is done for the convenience of it s replacement when it is required or sharp reduction of the continuous operation time (paragraph 3.6) independently of the country. Replacement is possible only by the battery with similar characteristics in compliance with the marking on it. From environmental protection point of view, the best thing is to use the battery.

12.5. Storage
12.5.1. Hardness tester shall be kept in the carry case, the probe and the batterys shall be disconnected.
12.5.2. If hardness tester is kept in the carry case for than 14 days, the battery shall be taken out from its compartment in the information processing unit.
12.5.3. It is recommended to keep hardness testers in closed premises with the relative humidity not more than 80%, there shall be no mold, paints, acids, chemical agents and other chemicals, the evaporation of which my give a harmful effect. Sharp fluctuations of temperature and humidity which can result in dew formation are not allowed.
12.6. Transportation
12.6.1. Hardness tester transportation in the carry case shall be only in closed vehicles, where the possibility of mechanical damage or atmospheric precipitation is excluded.

12.6.2. The way packed in carry cases hardness testers are located inside the vehicle shall exclude.

12.7. Putting into operation after storage and transportation
12.7.1. After storage or transportation under the temperature lower than -5°C, before starting hardness tester operation, it is necessary to keep it not longer than 1 hour under the temperature higher than +10°C and not less than 2 hours under the temperature higher than 0°C.
12.7.2. Before operating hardness tester which was stored for more than 3 months and transported for more than 2 months, it is necessary to check such hardness tester on the reference hardness test blocks. If the measured AVEARGE value of the hardness tester does not correspond to the reference hardness test block NOMINAL value within the error limits, it is necessary to calibrate the hardness tester.

12.8. Special operation conditions
12.8.1. Increased dust content and humidity. Put the information processing unit of hardness tester into a transparent plastic bag. Tighten it at the level of connective cable a bit lower than the probe plug.
After the work under such conditions is finished, information processing unit shall taken out of the plastic bag and air it.
12.8.2. Frost (<0°C). Information processing unit is the most sensitive to low temperature part of hardness testers, especially LCD. If there is a possibility, keep hardness tester closer to your body and protect id with your coat or keep in the inside pocket, taking it out time from time for inputting the data into the archive.

13. Precautions and trouble shouting

13.1. Treat the hardness tester with care. Any wrong treatment may result in the violation of the present Technical Reference and Operation Manual regulations and, thus, lead to the manufacturer hardness tester warranty cessation.

13.2. Always check the integrity of the cables, Information processing unit and probes. Provide immediate replacement of the damaged parts by the original ones. This job shall be performed by skilled personnel.

13.3. Do not expose the hardness tester to aggressive chemical medium.

13.4. Do not leave the hardness tester in the direct Sun.

13.5. Do not sink the hardness tester into any liquids. If the hardness tester gets wet, take the battery out and leave for 24 hours to get dry. If the hardness tester is used under the increased humidity or dust conditions, place the information processing unit into the plastic bag. After work period is over, it is mandatory to get the hardness tester dry.