OPERATIONAL MANUAL

# *TKM-459*

## PORTABLE HARDNESS TESTER


**BMS Bulut Makina Sanayi ve Ticaret Ltd. Şti.**
Kocaeli KOBİ OSB Köseler Mahallesi
6. Cadde No: 20/2 Dilovası / KOCAELİ / **TURKEY**
Phone: +90 262 502 97 73-76 / +90 262 503 06 51
Web: www.bulutmak.com e-mail: bms@bulutmak.com

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# 1DESCRIPTION OF THE HARDNESS TESTER

## 1.1Purpose of the Hardness Tester

The hardness tester is designed to perform on-the-spot measurement of structural carbon steels in Brinell (HB), Rockwell (HRC) and Vickers (HV) (main) hardness scales by means of dynamic (contact impedance) method.
The hardness tester is designed to perform (referential) hardness check of structural carbon steels in Rockwell (HRA), Rockwell (HRB) and Shore (HSD) hardness testing scales — by means of measurement results automatic conversion from main hardness scale units into respective hardness units according to user's or manufacturer's Tables.
The hardness tester is designed to perform (referential) checking of ultimate tensile strength (MPa) of pearlitic structural carbon steels – be means of measurement results automatic conversion from Brinell (HB) hardness scale into respective units according to Table.
The hardness tester is designed to perform hardness check of metals and alloys which differ in properties from carbon structural steels.
The hardness tester may be used to perform hardness check of:
Heat-resistant, corrosion-resistant, stainless, tool and other types of steels;
Non-ferrous metals and alloys;
Process-specific cast irons;
Strengthening and other layers which are coating the steel articles (cementation, nitrogenation, HFC hardening etc.)
Surface deposits and galvanic coatings (chrome etc.);
Articles made of fine-grained materials (during local investigation of materials properties).
If mechanical-and-physical properties of material under check differ from carbon structural steel properties it is supposed that measurements will be performed after set up of additional calibration (or additional scale) made by the device user with hardness samples made of respective material or at manufacturer's production facilities on user's request.
The hardness tester is intended for use in laboratory, shop and field environment.

## 1.2Hardness Tester Operating Principle

Hardness tester operating principle is based on UCI (ultrasonic contact impedance) method.
Basic components of the hardness tester are: sensor and electronic sensor data conversion and measurement data processing unit.
The metal shaft forming a part of the hardness tester has a diamond pyramid fixed on its and. The shaft is oscillating with its own resonance frequency. Load created by the user's hand enables the diamond pyramid to penetrate the material and to change the shaft's resonance frequency. Variation of shaft's own resonance frequency is proportional to shaft-into-material penetration depth. Since shaft-into-material penetration depth is the hardness factor one can see dependence between F (variation of shaft's resonance frequency) and H (material hardness): $H = f(F)$
The hardness tester electronic unit receives frequency signal from the sensor, converts it into hardness units, withdraws measurement results to the display and performs statistical processing and other functions of particular hardness tester.

## 1.3Hardness Tester Functions

Execution of checking:
-With main scales: Rockwell (HRC), Brinell (HB) and Vickers (HV) to measure hardness of carbon structural steels;
-With reference scales: Rockwell (HRA), Rockwell (HRB), and Shore (HSD) to perform carbon structural steels hardness check;
-With reference scale: yield strength (MPa) of perlitic carbon structural steels;
-With the use of additional calibrations for hardness tester scales: cases where mechanical-and-physical properties of material under check differ from carbon structural steel properties (high-alloy steels, process-specific cast irons, non-ferrous metals and alloys etc.);
-With additional scales put into service (preset) by the user or by the manufacturer on user's request enabling the user to perform check of required characteristics of articles under check provided that primary signal of hardness tester sensor and required characteristic are interrelated.
Calibration of the main scales in the event of additional error arising from long-lasting operation.
The hardness tester has and intense colored display and a shock-proof casing to provide dust and moisture protection.
The hardness tester enables the user to perform on-line calculation of the average value of measurement series results, inter alia, with rejection of the results of incorrectly performed measurements by user-selected algorithm.
The hardness tester enables the user to perform on-line additional statistical processing of measurement series results, namely, retrieval of minimum, maximum values, calculation of average value and calculation of mean square deviation from the average value.
The hardness tester enables the user to perform on-line displaying of additional information, namely, results of the preceding measurement series.
The hardness tester enables the user to organize data storage in the form of individualized blocks of measurement results, to store them with power off and to transfer the data to the computer.
The hardness tester enables the user to perform various types of stored measurement results analyses, to plot various types of charts directly on display.
The hardness tester enables the user to select information additionally displayed in the course of measurements.
The hardness tester enables the user to set up checking range and to set up measurement range overrun alarm.

The hardness tester enables the user to perform battery charge monitoring and to set up battery discharge alarm.
The hardness tester enables the user to set up automatic device tripping during timeout in order to save battery charge.
The hardness tester enables the user to adjust display illumination so as to save battery charge.
The hardness tester enables the user to select required display color and intensity range.
The hardness tester enables the user to select interface language from those preset by the manufacturer on user's request.

### 1.4Technical Characteristics

Basic technical characteristics.
Basic technical characteristics of the hardness tester are listed in Table 1.
Table 1.

| | |
|---|---|
| Hardness measurement range by scales: | |
| Brinell | 90 - 450 HB |
| Rockwell C | 20 - 70 HRC |
| Vickers | 240 - 940 HV |
| Limits of hardness measurement absolute error, main scales: | |
| Brinell | |
| Within (90...150) HB | ±10 HB |
| Within (150...300) HB | ±15 HB |
| Within (300...450) HB | ±20 HB |
| Rockwell C | ±2 HRC |
| Vickers | |
| Within (240...500)HV | ±15 HV |
| Within (500...800)HV | ±20 HV |
| Within (800...940)HV | ±25 HV |
| Hardness measurement range, reference scales: | |
| Ultimate tensile strength | 350…1500 MPa |
| Rockwell A | 70,5 - 85,5 HRA |
| Rockwell B | 51 - 100 HRB |
| Shore D | 35 - 102 HSD |
| Hardness tester electronic unit overall dimensions, maximum | |
| Model type TKM-459C | 121 x 69 x 41 mm |
| Hardness tester electronic unit mass: | |
| Maximum | 0,3 kg |
| Mass of the sensors | |
| Maximum | 0,3 kg |
| Hardness tester rated operation conditions | |
| Air temperature | From minus 15 to plus 35 °C |
| Relative humidity | 30 – 80 % |
| Atmospheric pressure | 84 – 106,7 kPa |
| Calibration period | 1 year |
| Hardness tester service life | 5 years |
| Number of hardness tester potential additional calibrations | |
| Model type TKM-459C | 5 for each scale |
| Hardness tester additional scales number | |
| Model type TKM-459C | 3 |
| Duration of one hardness measurement cycle (average) | 2 s |
| Number of measurement cycles required to calculate the average value | |
| Model type TKM-459C | 1 – 99 |
| Number of algorithms of incorrectly performed measurement results rejection in the course of average value calculation | 3 |
| Parameters of additional statistical processing of measurements series | Maximum, minimum, mean square deviation from average value, average value. |
| Additional information displayed (to be defined by the user) | |
| Model type TKM-459C | Previous results of the measurements series, results of additional statistical processing |
| Number of samples required to set up additional calibrations for hardness tester scales | 1 or 2 |
| Number of samples required for additional scales set up | 2 to 0 (to be defined by the user) |
| Intermediate interpolation of additional scales | Piecewise linear or piecewise –parabolic (to be defined by the user) |
| Measurement results overrunning alarm (model type TKM-459C only) | Color. Check limits to be set up by the user for each individual scale. Types of limits: greater, less, overrun. |
| Maximum number of measurements stored in the memory | |

| | |
|---|---|
| Model type TKM-459C | 12 400 |
| Maximum number of individualized blocks set up in the memory | |
| Model type TKM-459C | 100 |
| Displaying, statistical processing and plotting of charts of the measurement result blocks | |
| Displaying | all results in the block<br>results in the block which are greater or less than values set up by the user<br>results falling outside the specified range set up by the user |
| Statistical processing | maximum, minimum, mean square deviation from average value, average value average deviation from the value set up by the user, number of results bigger / less than specified value, maximum deviation from specified value to bigger/less side number of results falling outside the range set up by the user (outside bigger/less limit), maximum deviation from upper/lower limit |
| Plotting of charts | in reference to average value<br>in reference to value set up by the user<br>in reference to measurement range set up by the user |
| Computer interface connection | |
| Computer interface connection | USB |
| Hardness tester automatic turn-off | Turn-off time to be set up by the user |
| Monitoring of battery charging | Continuously. Continuous indication in the course of measurements |
| Display illumination | Time to be set up by the user |
| Display color and intensity | To be selected by the user |
| Interface language of the hardness tester | English ( German, French – optionally) |
| Hardness tester power supply | Autonomous, battery. Use of equivalent non-rechargeable batteries allowed. |

### 1.5Hardness Tester Sensors

The hardness tester incorporates a sensor and an electronic unit which is processing the signals transmitted from the sensor. Delivery set of the hardness tester may include additional sensors – on user's request.
Sensors are designed to form the frequency signal which is transmitting information regarding hardness of article under check.
Sensor is functionally incorporating a casing and a protective cap (ref. Figure A).
Inside the casing there is a resiliently pressed steel shaft with a diamond pyramid and a limit switch which is, being closed, gives a resonance frequency measurement command. Piezoelectric plates connected with the shaft are designed to excite and to receive the shaft oscillations.
The cap is designed to protect the shaft from overload and from touching it by foreign particles or user's hand in the course of measurements. Where measurements should be performed in hard-to-reach areas it is allowed to remove the protective cap.

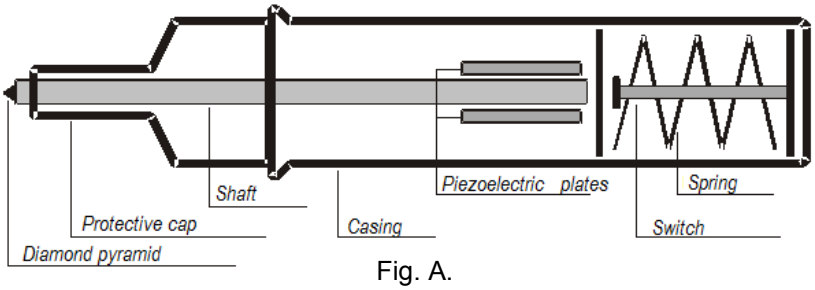



Fig. A.

On user's request, probes of the hardness tester may be equipped either with additional cap or with special caps enabling proper positioning of the tester on cylindrical surfaces.
Minimum mass of article under check — 1 kg.
Table 6

| Probe type | Surface roughness, maximum |
|---|---|
| A | Ra 1,6 |
| H | Ra 0,8 |
| C | Ra 3,2 |
| K | Ra 1,6 |

Minimum radius of curvature of article's convex surface under check — 4 mm.
In order to provide proper positioning of the sensor on convex surfaces subject to check it is recommended to make use of additional U-459 type cap.
Minimum radius of curvature of article's concave surface under check — 6 mm.
In order to provide proper positioning of the sensor on concave surfaces subject to check it is possible to make use of specialized caps fabricated on user's request.
Minimum diameter of area to carry out hardness measurement of article under check — 3 mm.

### 1.6General Information

Principle of hardness tester operation is based on ultrasonic contact impedance method – dynamic method of hardness measurement. Unlike hardness testers based on static principle of operation (stationary hardness testers) the measurement results are affected not only by metal properties revealed during plastic deformation of metal but also by other mechanical-and-physical properties. Basically – by modulus of elasticity of metal under check (Young's modulus

Recommended plate parameters are as follows:

- Mass and thickness — definitely exceeding minimum mass and thickness of article under check.
- Roughness – minimum possible. Optimal - maximum Ra 0.4 μm;
- Non-flatness - maximum 0,005 mm;
- Modulus of plate metal elasticity (Young's modulus)

Depending on the type of probe used and article hardness the sensor pyramid is penetrating the article at different depths plastic deformation of metal takes place at considerably larger depths. It is recommended to measure hardness of the layer with thickness which is **minimum by 5 times exceeds** pyramid penetration depth.

### 1.7Hardness Tester Menu

Menu image is presented in Figure 2.

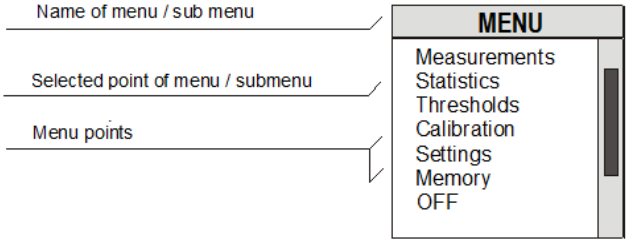



Fig. 2

Switching between menu points is performed with the use of buttons "⇧", "⇩". Selection of the menu point (changeover to parameters setting or to sub menu) is performed by button ⏎. The display will accordingly show parameter entry window (see below) or sub menu. Exit from sub menu to a higher level – by button "🗎".

Number of menu points indicated in the course of operation may differ and depends on what scale (main, reference, additional) or additional calibration has been selected at the moment.

General structure of the menu is represented in Table 8.

Entry to the menu is performed by pressing button "🗎"The hardness tester being turned on displays only points — <Settings>, <Memory>, <Turn off>.

### 1.8Settings Entry Mechanism

Settings and parameters of hardness tester operation are entered through parameters entry window:

–By selecting one of several possible setting options (for instance, averaging value);

–By entry of numeric or string value (for instance, additional scale name)

Example of parameter entry window is shown in Figure 3.

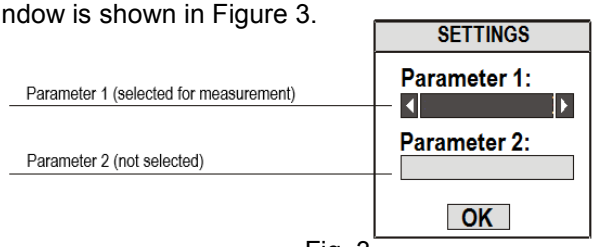



Fig. 3

In order to measure parameter 1 it is required to select it on the display with the use of buttons "⇧", "⇩". The selected parameter is shown on the display.

Parameter 1 is set up by selecting one of several options. To change it, use buttons "⇦", "⇨".

Parameter 2 is set up by entering the numerical value. To change it, select it on the display and press button "⏎".

Display is represented by Figure 4.

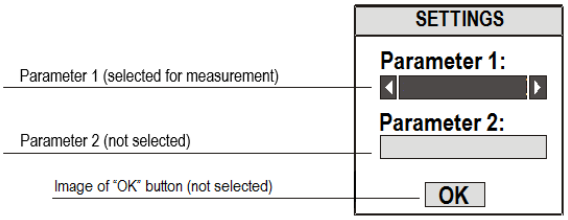



Fig. 4

Numerical value entry is performed by digit order selection in cursor position. Digit in respective digit order is changed by buttons "⇧", "⇩". Transition to other digit order is performed by buttons "⇦", "⇨". Entry of numerical value is

completed by pressing button “⏎” (cursor disappears, parameter 2 remains selected). Entry of string parameters is performed similarly.

Exit from parameters set up window to the menu is performed by pressing button “🗎”. Exit may be also performed by pressing button “⏎” provided that at this moment there is no parameter set up by numerical or string value entry.

One more way to exit the entry window – select “OK” button image on display and press button “⏎”.

**2OPERATION**

## 2.1Hardness Measurement Procedure

Carefully, **WITHOUT IMPACT** place the sensor normally (perpendicularly) to surface of article to be checked;
Smoothly pressing the sensor casing (pressing the sensor spring) dent the diamond pyramid into the surface to be checked;
After acoustic signal comes on and previous measurement results go off from hardness tester display (it should take place within a fraction of a second) **REMOVE** the sensor from the surface of article under check;
Results of hardness measurement will appear on the display approximately within 1 second.
After acoustic signal comes on avoid keeping the sensor on surface under check. Entire cycle of measurement (from pyramid touching the surface till unsticking) may be maximum 1 second.

Energize the hardness tester instantly pressing button “⏻”.Generally, the display image will be as follows, Figure 8.

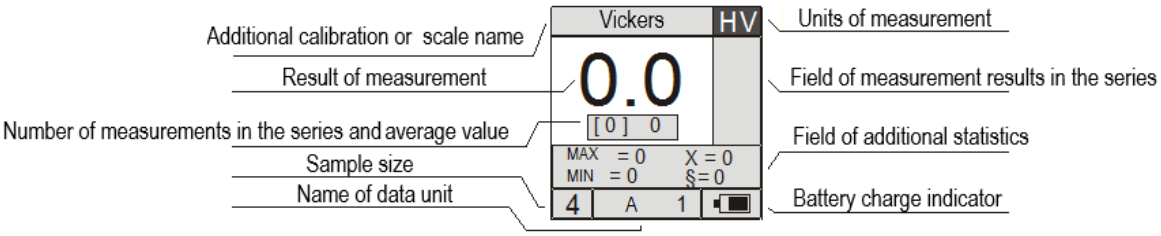



*Fig. 8*

***The display will show device settings menu if hardness tester is energized without sensor.***

## 2.2 Control and Results Submission in the Course of Measurements

When the device is energized (by instantaneous pressing of button “⏻”) with sensor connected the display will have image represented in Figure 9 depending on operation cycles, averaging parameters, scale selected or additional statistics set up at previous operation cycles.

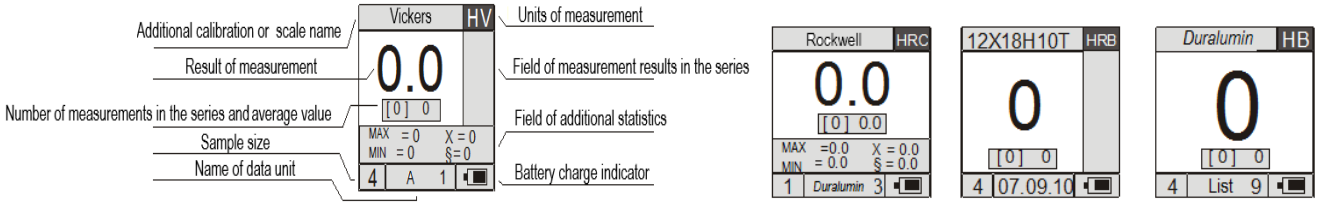



*Fig. 9*

Select the scale with the use of buttons “⇧”, “⇩”, at this, scale names and units of measure will be respectively displayed.

Quick selection of main scales may be performed by buttons “HV”, “HB”, “HRC”.
The hardness tester will convert the results into respective scale after scale selection.

Additional calibrations to scales are selected by buttons “⇦”, “⇨”, at this, scale calibration names will be respectively displayed.
Additional statistical processing— i.e. definition of maximum, minimum, average value (without “rejection”), mean square deviation from the average value.

Measurement series extent (sample size, number of measurements in the series) is selected in the menu button “⏎”.
If number of measurements is considerable it is supposed that only a number of recent results will be displayed. With activated field of additional statistical processing (see below) it is supposed than 7 recent (otherwise 12) results will be displayed.
The field is automatically cleared before new measurement series commencement. If sample size 1 is selected the field will be cleared after instantaneous pressing of button “⏎”
Filed “additional statistics” displays on-line results of additional statistical processing;
Max – maximum result in the series;
Min – minimum result in the series;
X — average value (calculated **without** the use of algorithms of incorrectly performed measurement results rejection);
δ — mean square deviation from the average value.

The field is automatically cleared at new measurement series commencement. If sample size 1 is selected the field will be cleared after instantaneous pressing of button“⏎”.

Measurement result recording in device memory is carried out by pressing and holding button “⏎”. In this case, the hardness tester will transmit a specific acoustic signal and result displayed will “blink”.
If, during button pushing, the series of measurements is still in progress the hardness tester will first complete the current series of measurements, as described above, calculate average value of the entire series – deliver the **result of the measurement** - and record the result in memory. If sample size is equal to 1 it is supposed that total statistics will be deleted and the last result will be recorded.
In device, results falling outside the specified limits (thresholds) are indicated by special colors provided that monitoring limits have been set up
Field “battery charge indicator” is displaying the on-line battery charge condition.

Switchover to the menu so as to perform settings is achieved by instantaneous pressing of button “🗎”.
Set up of statistical processing parameters in the course of measurements

### 2.3Set up of Averaging Parameters

In order to set up the size of series of measurements (sample size) and algorithm of **incorrectly performed** measurement results rejection it is required to select menu points <STATISTICS> - <SAMPLE>

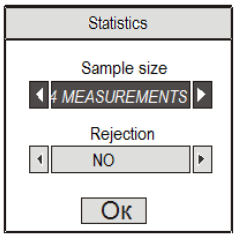



*Fig. 10*

The display will show parameter input window in conformity with Figure 10.
Sample size which can be set up - 1.2.3.4.5.6.7.8.9.10.15,”continuously”. If “continuously” is selected, it is supposed that sample size will not be capable to exceed maximum number of measurements while calculating the average value for the given model type.
In field “Rejection” select the algorithm of incorrectly performed measurement results rejection. Possible options:
“NO” – while calculating the average value - rejection is not performed;
“2σσ”–while calculating the average value – results which are more than two mean square deviation values distant from average value of the current measurement series are rejected;
“EXTREME” – maximum and minimum (if 5 and more measurements in the series) values are rejected.

### 2.4Additional Statistics Displaying

In order to set up displaying of the history of measurement series results and additional statistical processing results it is required to select menu points <STATISTICS> - <INFORMATION>.

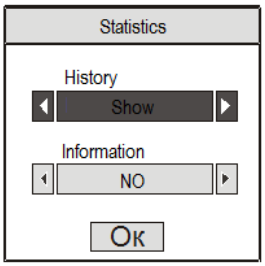



*Fig. 11*

The display will show parameters entry window according to Figure 11.
By field “History” the user whether selects or not (in the course of measurements) the history of measurement results in the series.
By field “Information” (available with model type TKM-459C only) the user whether selects or not displaying of additional statistical processing results.
If “Show” option is selected it is supposed that respective information will be displayed in the course of measurements.
If “NO” option is selected it is supposed that information will not be withdrawn to the display.

### 2.5Set up of Control Range

In order to set up the control range with overrun alarm it is required to select menu point <THRESHOLDS>.
The following alarm signals may be used:
Alarm off;
Result above threshold;
Result below threshold;
Alarm indicating measurement result overrunning the definite range;

Depending on the selected option, the data entry window may be represented as follows.

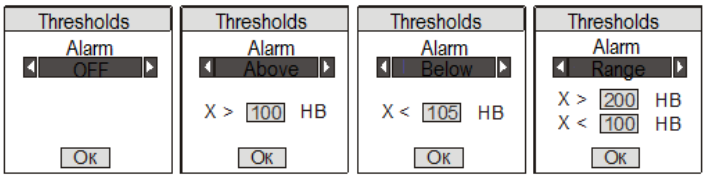



*Figure 12.*

Field “Alarm” is used to select the type of alarm. Digital fields are used to enter the threshold values Hardness tester scales calibration

**2.6Calibration of the Scale**

To enter calibration mode select proper scale of the hardness tester enter the MENU and select <CALIBRATION> - < CALIBRATION>. İt is supposed that hardness tester display’s image will be in conformity with Figure 13.

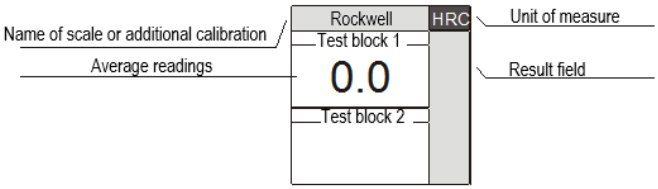



*Fig. 13*

Carry out several measurements (minimum 5) on test block at this, measurement results will be displayed in “results” field while “test block 1” field will display

By buttons “⇧”, “⇩” change average reading values to reach value of the test block and thus terminate calibration with one (first) test block pressing button “⏎”after that display will be represented by image below (Figure 14).

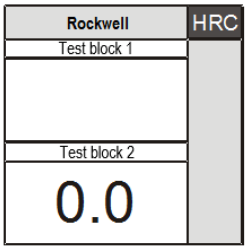



*Fig. 14*

On the second test block. Apply same procedure and press button “⏎”. The display will show the message confirming completion of calibration with two test blocks and after that hardness tester will return to the menu.

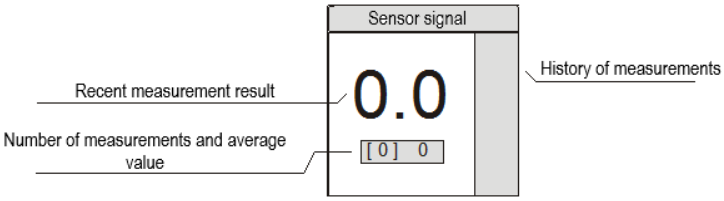



*Fig. 15*

During sample measurements, the display will show measurement result (sensor signal expressed in relative units), results of previous measurements (in field “history of measurements”), number of measurements and average value. Averaging is performed with the use of algorithm of incorrect measurement results rejection.

Pressing of button “⏎” will lead to previous measurements “setting to zero” and commencement of new averaging cycle.

Exit from operation mode to the menu pressing button “🗎”.

**2.7Hardness Tester Electronic Unit Settings**

Set up of automatic device and display illumination turn-off.
The hardness tester enables the user to set up device automatic and display illumination turn-off time during time outs. Well-considered setting of the said parameters allows to provide User’s comfort and save the battery charge.
To change the above settings select <SETTINGS> - <DEVICE>. In the entry window that appears make respective settings
Set up of display colors and intensity.

The hardness tester allows setting up the display colors and intensity. Well-considered setting of the said parameters allows to provide User's comfort and save the battery charge.
To change the above settings, select <SETTINGS> - <DISPLAY>. In the entry window that appears make respective settings.

### 2.8Language Selection

The hardness tester allows to select interface language from those uploaded by the manufacturer (on user's request). To choose the language select <SETTINGS> - < LANGUAGE SELECTION >. In the entry window that appears make respective settings.

### 2.9General Information

The hardness tester enables the user to organize versatile measurements data archive in hardness tester memory and transfer the data to the computer.
The archive is organized in the form of individualized memory blocks. Results of measurements are recorder into the memory blocks. Memory block may contain results of measurements in similar units of measure (by one scale).
Operations that may be performed with data archive are as follows:
-set up of memory blocks;
-Deletion of memory bocks;
-clearing of memory blocks;
-set up of measurement results record blocks;
-set up of memory block names;
-Data withdrawal to the display;
-Withdrawal of data satisfying pertinent requirements to the display
-Data analysis by means of various statistical processing methods
-Data analysis with the use of charts displayed
-Data archive clearing;
-monitoring of device memory state
-Data transfer to the computer.
Access to data archive handling is achieved via <MEMORY> point in hardness tester menu

***Set up of the block***

In order to set up the new data block select <MEMORY> - <BLOCK SET UP>.
In parameters entry window that appears set up the name of the new block together with units of measure corresponding to the scale.
If it is impossible to set up the block (hardness tester memory full or maximum number of blocks had been set up) the hardness tester will deliver a respective message.

***Set up of measurement results recording block***

In order to select data block for measurement results recording select <MEMORY> - <SELECT THE BLOCK >.
The display will show the list of data blocks (Figure 16) which can be selected for measurement results recording in the current scale (may contain data expressed in current units of measure).

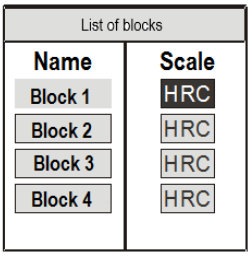



*Fig. 16*

By buttons "⇧","⇧","⏎" select the data block to record the measurement results according to the current scale.
If there are no result measurement blocks earlier set up in units of measure of the current scale the hardness tester will issue a dialog messageproposing to set up such block.
Another way to set up results recording block – select <MEMORY> - <DATA BLOCKS>. Select the necessary block. Select (in submenu) <SELECT> point. The block selected will be set up to measure the results with reference to respective scale.

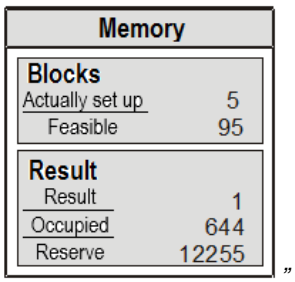
***Block clearing***

To delete all data from the block, select <MEMORY> - <CLEAR THE BLOCK>. By buttons available ("⇧","⇧","⏎") select the necessary block out of list of blocks available and confirm the selection. The block will be cleared.
Another way– select <MEMORY> - <DATA BLOCKS>. Select the necessary one out of list of blocks available. Select in submenu <CLEAR> point.

***Deletion of the block***

In order to delete data block from the memory, select the points <MEMORY> - <DELETE THE BLOCK >. Select the necessary one out of list of blocks available and confirm the selection. The block will be deleted.
Another way– select <MEMORY> - <DATA BLOCKS>. Select the necessary one out of list blocks available. Select in submenu <DELETE> point.

***Clearing of the memory***
In order to delete all data blocks from the memory, select <MEMORY> - <CLEAR THE MEMORY >, confirm the selection. The memory is cleared.
***Memory state information***
To receive information on current memory state select <MEMORY> - <STATE>.
Display will have image in conformity with Figure 17.



”

*Fig. 17*

In “Blocks” field: “Actually set up” – total number of data blocks actually set up. “Feasible”– maximum number of data blocks which may be set up as of the present moment.
In “Result” field – total number of measurement results recorded. “Reserve” – number of memory cells reserved for measurement results recording in available data blocks. “Feasible” – number of free memory cells not yet reserved for the data blocks.
Exit to menu – press button “” or””.
***Change of block name***
In order to change data block name, select <MEMORY> - <DATA BLOCKS>. Select the necessary one from the list of blocks. In submenu that appears select <NAME>. In parameters entry window set up the new name according to requirements set forth.
***Data viewing***
To view results of measurements recorded in memory block select <MEMORY> - <DATA BLOCKS>. Select the necessary one from the list of blocks. Select <RESULTS>.
Model type TKM-459M will provide displaying of all measurement results recorded in selected data block. In order to scroll the list, use buttons “”,”. Exit to menu using button “” or”
Model type TKM-459C – in parameters entry window (ref. Figure 18) select the condition of recorded results withdrawal to the display and set up limit values according to the requirements set forth.

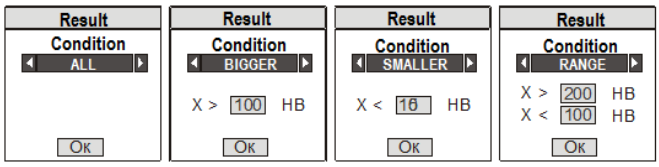



*Fig. 18*

The following selection options can be used:
-displaying of entire results;
-displaying of results exceeding the specified value;
-displaying of results below the specified value;
-displaying of results falling outside the specified range;
After set up of specified values, it is supposed that device display will show the list of entire measurement results satisfying the condition selected, or else, the hardness tester will give a message that such results were not found.
***Data Analysis***
The hardness tester allows carrying out different types of recorded measurement results analysis:
-Calculation of average value, mean square deviation from average value, retrieval of minimum and maximum values (view -“AVERAGE”);
-Calculation of average deviation from specified value (for instance, hardness value anticipated) upwards or downwards, retrieval of maximum deviation upwards or downwards (view -“VALUE”);
-In reference to the range (view -“RANGE”).
In order to enter measurement results processing mode select <MEMORY> - <DATA BLOCKS>. Select the required data block from the list. In submenu that appears select <ANALYSIS>.
In parameters entry window that appears select analysis type (“AVERAGE”,”VALUE”,”RANGE” – analysis type required) and initial values required.The display will show required calculations results.
***Graphical Output***
The hardness tester allows analyzing the stored results with the use of charts plotted on the display. For the ease of analysis, the charts may be plotted:
-In reference to average data value in the data block;
-In reference to value specified (for instance anticipated hardness);

-In reference to values range (for instance for instance, admissible hardness range).
To enter charts plotting mode, select <MEMORY> - <DATA BLOCKS>. Select the necessary one from the list. In submenu that appears select <CHART>.
In parameters entry window that appears select the chart type (“AVERAGE”,”VALUE” or “RANGE”) and initial values required.
The display will show the chart plotted according to data block. Horizontal lines specify initial values.

***Data Transfer to the Computer***

To transfer data to the computer use cable included in the delivery set and connects the hardness tester with the computer. Set up the software supplied with the hardness tester.
After that:
-energize the hardness tester;
-connect (to the plug located on electronic unit side wall) the data transfer cable included in delivery set. Connect other cable end to one of computer USB ports. The display will show that it is connected to the computer;
-start up the software.

### 2.10Battery Condition Monitoring and Charging

The hardness tester enables the user to perform on-line battery condition monitoring. Current battery charge is displayed in the course of screen.
When critical battery discharge is achieved, the display will show the blinking warning symbol of the battery followed by an acoustic signal and the hardness tester will turn off.
To charge the battery, open the battery compartment, remove the battery and charge it using battery charger included in the delivery set.
To charge the battery, connect battery charger to the plug located on electronic unit sidewall and charge the battery.
The display will keep showing battery symbol in the course of charging.

**ATTENTION!!!**

During charging don’t’ leave the charger **unattended**.

### 2.11Hardness Tester Turning Off

The hardness tester may be turned off:

-By pressing and holding (0, 5-1s) of button “⏻” with further releasing;
-By selecting <TURN OFF> in the menu;
-By omitting any activities (measurements, buttons activating). The hardness tester will turn off.

## 3MANUFACTURER’S WARRANTY

Hardness tester guarantee period amounts to 24 months from the date of purchasing
Guarantee and post-guarantee repairs are carried out at manufacturer’s facilities.
Hardness testers which have damages caused by the violation of operation, safety, technical maintenance, transportation and storage regulations, mechanical damages (with exclusion of mechanical wear caused by normal operation), traces of liquids ingress and other impacts leading to hardness tester breakdown are not subject to guarantee repairs.
Hardness testers which have diamond pyramid shearing evidence are not subject to guarantee repairs.
Hardness testers which have broken protective seals (stickers) on electronic unit and sensor casings as well as hardness testers having evidence of unattended opening and/or unauthorized repair attempts are not subject to guarantee repairs.
Manufacturer’s warranty is not covering batteries and appliances of third party manufacturers (chargers, grinding machines) supplied in one delivery set with the hardness tester.
Manufacturer’s warranty is not covering natural wear of hardness tester components (cables, sensors etc.) caused by heavy duty operation.
The guarantee repair will be carried out against presentation of this Operation Manual supported by the technical passport of the hardness tester.