

Ultrasonic Metal Hardness Tester

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Operation Manual

Model UCI 1000

(November 2010 Rev 0.0)

1. DESCRIPTION

1.1 Application

The hardness tester is intended for measuring of hardness of metals under laboratory and factory conditions using the contact impedance method.

The contact impedance method is used to control the hardness of hardsurfacing overlays. This method can be also used for measuring of hardness of products composed of fine materials practically of any shape and size, particularly in the local research of material properties.

Hardness is controlled on three main scales: Rockwell (HRC), Brinell (HB) and Vickers (HV). In the hardness tester there are introduced additional conversion scales: Rockwell (HRA), Rockwell (HRB), Shore (HSD), instantaneous strength σ_s (according to GOST 22761-77). The list and ranges of additional scales are agreed upon with the Customer. Besides, there are nine scales in the hardness tester which are programmed by the User to control products composed of materials which differ in physical-mechanical properties (in addition to hardness) from construction steel.

The hardness tester allows to arrange a data bank with control results, store the data for a long time with power supply off and transfer them to a computer.

The hardness tester allows performing statistical processing of control results.

1.2 Technical Characteristics

1.2.1 The range of hardness measurement on main scales is:

- on Brinell scale 90...450 HB
- on Rockwell scale 20...70 HRC
- on Vickers scale 240...940 HV

1.2.2. The limits of absolute accuracy of the hardness meter in measurements of hardness on main scales are:

- on Brinell scale: - in the range (90...150) HB ± 10 HB
- in the range (150...300) HB ± 15 HB
- in the range (300...450) HB ± 20 HB
- on Rockwell scale ± 2 HRC
- on Vickers scale: - in the range (240...500) HV ± 15 HV
- in the range (500...800) HV ± 20 HV
- in the range (800...940) HV ± 25 HV

1.2.3 Additional conversion (tabulated) scales (for reference): Rockwell (HRA), Rockwell (HRB), Shore (HSD), instantaneous strength σ_s .

1.2.4 Measuring accuracy on additional scales and scales programmed by the User is established based on the results of verification on individual metals.

1.2.5 Average measuring time is 3 seconds.

1.2.6 Requirements to controlled products

1.2.6.1 The minimum weight of the controlled product is 1 kg.

The minimum thickness of the controlled area of the product is 2 mm.

1.2.6.3 The unevenness of the controlled surface R_a is not more than 1.6 microns.

1.2.6.4 The minimum radius of curvature of the controlled surface is 4 mm.

1.2.6.5 The minimum diameter of the aisle on the controlled product where the sensor is installed is 3 mm.

1.2.7 The size of the impression on the controlled surface, on average, has the diameter of 0.1 mm.

1.2.8 The depth of penetration into the controlled product is 0.03 mm on average.

1.2.9 The life time (number of measurements) of the sensor is 300,000 measurements.

1.2.10 Requirements to specimens for the use of scales programmed by the User.

1.2.10.1 Number of specimens – 2 pcs.

1.2.10.2 The ratio of the maximum value of specimen hardness H_{max} to the minimum value of specimen hardness H_{min} – not more than 2.

1.2.10.3 Specimens should be manufactured according to GOST 9012-59, 9013-59 with the following limitations:

- the unevenness of the working surface R_a should be not more than 1.6 microns;
- in case the specimens thinner than 10 mm and lighter than 1 kg are manufactured the bearing area of the specimen should be surface-grinded;
- the range of hardness values should be according to GOST 9031-75.

1.2.10.4 The hardness of specimens should be measured by standard methods.

1.2.11 Communication with the computer should be via the interface RS-232C.

1.2.12 The number of measurements for the computation of the arithmetical average value should be from one to ten. Under normal conditions – four.

1.2.13 Processing of measuring results, their averaging, recording and data processing.

1.2.14 Storage of measuring results and modes of hardness meter tuning with power supply off.

1.2.15 The number of measuring results stored in memory – 10 blocks, 100 measurements in each.

1.2.16 The number of scales programmable by the User is nine, three for each main scale.

1.2.17. Power supply of the hardness tester is autonomous from a 8.4 V battery.

1.2.18 There is an option of a forced or automatic turning off of the hardness tester. The time of automatic disconnection of the power supply is determined by the User.

1.2.19 Power supply of the hardness tester is controlled.

1.2.20 Dimensions, not more than:

electronic block 160×80×30 mm

sensor: diameter26 mm.
 length 140 mm.

1.2.21 Weight, not more than

electronic block250 g
 sensor150 g.

1.2.22 Hardness tester operating conditions: the ambient temperature from minus 5 to plus 35°C.

1.2.23 The life time of the hardness tester is 5 years, service warranty is 24 months.

1.3 Composition of the Apparatus

1.3.1 The complete set of supply is given in Table 1.

Table 1

Description	Number	Note
Electronic block	1 pc	
Sensor	1 pc	
Cable for sensor connection	1 pc	
Cable for RS-232C interface	1 pc	
Battery 8.4 V	1 pc	Installed
Disc	1 pc	
Operating Manual	1 pc	
Case	1 pc	

2. OPERATION

2.1 Checking of Operability

2.1.1 Install the power supply element in the battery compartment observing the polarity of contacts.

2.1.2. Connect the sensor to the terminal on the side wall of the electronic block.

2.1.3 Activate the hardness tester momentarily pressing the «**⊕**» button. The graphic display will look like it is shown in Fig.3

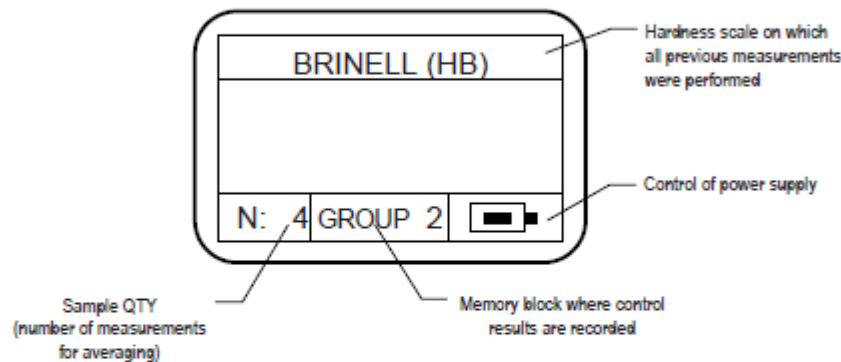


Figure 3

2.1.4 One of main measuring scales is selected by a simple pressing the relevant button on the keyboard. For instance, if the HRC scale should be used, the «HRC» button should be pressed.

2.1.5 Set the sample QTY (number of measurements for sampling 1-10) by pressing the «**▲**», «**▼**» buttons.

2.1.6 To accomplish this press the «**☰**» button. The menu of hardness tester operating modes will appear on the graphic display.

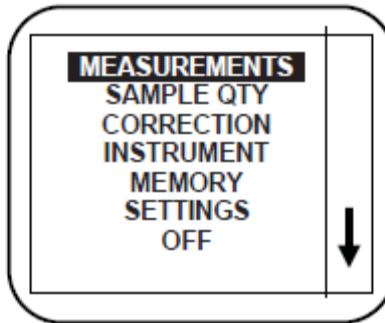


Figure 3

2.1.7 By pressing the «▼» button, place the cursor on the menu option named "SAMPLE QTY". Press the «↵» button. The graphic display will look like the one depicted in Fig. 5.

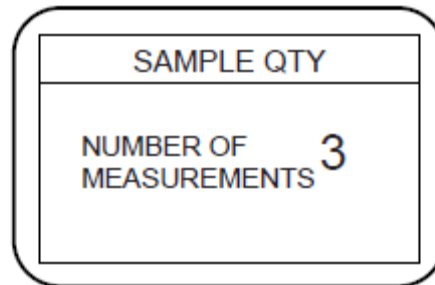


Figure 5

2.1.8 By pressing «▲», «▼» buttons select the number of measurements.

Press the «↵» button. The menu of the hardness tester operating modes will appear on the graphic display.

2.1.9 By pressing the «▲» button place the cursor on the menu option named "MEASUREMENTS". Press the «↵» button. The instrument will switch to the "MEASUREMENTS" mode. In the upper zone of the graphic screen there is the selected scale, in the lower left corner of the graphic display - the selected number of measurements.

2.1.10 According to the selected scale prepare a set of standard hardness gages of the second grade according to GOST 9031-75 and a lapping plate not lighter than 1 kg. Standard hardness gages should be re-grounded using the TSIATIM-221 lubricant according to GOST 9433-80.

2.1.11 Perform the measurement using the standard gage with the minimum hardness value.

2.1.12 Carefully, **without any impact**, place the sensor in a normal position on the controlled surface. Smoothly pressing the sensor body force the diamond tip into the controlled surface till the face of the cap reaches the surface of the part.




After the beep tone remove the sensor from the controlled surface. The number "1" will appear in the central zone of the graphic screen.

ATTENTION. The whole measuring cycle (from the moment of contact of the diamond pyramid with the controlled surface till its disengagement from the surface) should last not longer than 1 second.

Perform the measuring cycle three more times each time moving the sensor to a new location on the controlled surface. In the central zone of the graphic display the numbers "2", "3", "4" will appear sequentially followed by the result of measurements in the selected hardness units (average arithmetical value of four measurements).

2.1.13 Perform the measurements on the rest standard hardness gages repeating the operations described in the para. 2.1.12.

2.1.14 Evaluate the inaccuracy of hardness measurement. If the inaccuracy is within the tolerance limit proceed to measurements on the actual part. If the inaccuracy exceeds the admissible, it is necessary to correct the instrument readings.

2.1.15 In order to accomplish this operation, it is necessary to access the menu of the hardness meter operation modes by pressing the «» button. By pressing the «» button place the cursor on the menu option named "CORRECTION". Press the «» button. The graphic display will look like the one depicted in Fig. 6.

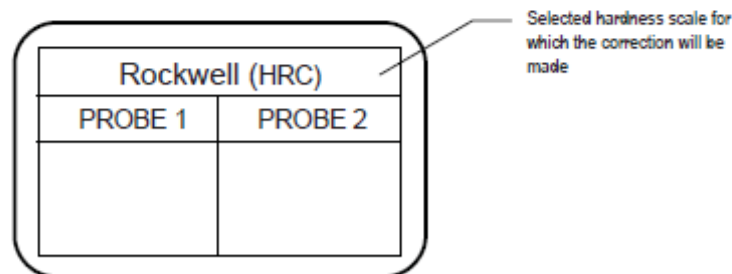


Figure 6

2.1.16 Take the standard gage with the minimum hardness value and perform the operations according to item 2.2.12.

2.1.17 On the graphic display in the lower left cell of the table there appears the hardness value of the standard gage measured by the instrument.

2.1.18 With «▲», «▼» buttons adjust the certified value of the standard hardness gage. For instance, the hardness value of the standard Brinell gage is 102 units and the instrument reading is 120 units. Hence, by pressing the «▼» button it is necessary to set the hardness value equal to 102 units. Press the «↵» button.

2.1.19 Take the standard gage with the maximum hardness value and perform the operations according to item 2.2.12.

2.1.20 On the graphic display in the lower left cell of the table there appears the hardness value of the standard gage measured by the instrument.

2.1.21 With «▲», «▼» buttons adjust the certified value of the standard hardness gage. Press the «↵» button. The menu of the hardness tester operating modes will appear on the graphic display.

2.1.22 Check the correction as described in paras 2.1.11-2.1.13.

2.1.23 Evaluate the reading error of the instrument. If necessary, repeat the operations described in paras 2.1.15-2.1.21.


2.1.24 Performed correction can be stored as long as desired, even with the power turned off. At the same time, it may be modified by performing the above operations.

2.2 Preparation of Hardness Tester for Operation on Main Hardness Scales

2.2.1 If necessary, perform the operations described in paras 2.1.2, 2.1.3.

2.2.2 Select the hardness scale on which measurements will be performed by pressing the appropriate button on the keyboard.

2.2.3 Select the required sample QTY (number of measurements for averaging).

To accomplish this press the «» button. The menu of the hardness tester operating modes will appear on the graphic display. By pressing the «▼» button, place the cursor on the menu option named "SAMPLE QTY".

Press the «↵» button. By pressing «▲», «▼» buttons select the number of measurements for averaging. Press the «↵» button. The menu of the hardness tester operating modes will appear on the graphic display.

2.2.4 If necessary organize a new memory block for recording of the control results.

To accomplish it by pressing the «▼» button place the cursor on the menu option named "MEMORY". Press the «↵» button. The graphic display will look like the one depicted in Fig. 7.

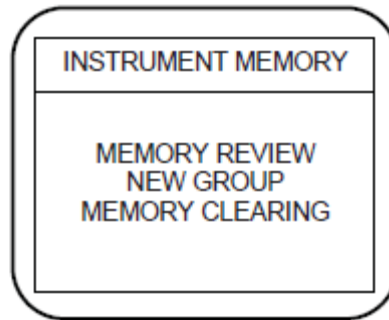


Figure 7

By the «▼» button place the cursor on the sub-menu option named "NEW GROUP". Press the «↵» button. The graphic display will look like the one depicted in Fig. 8.

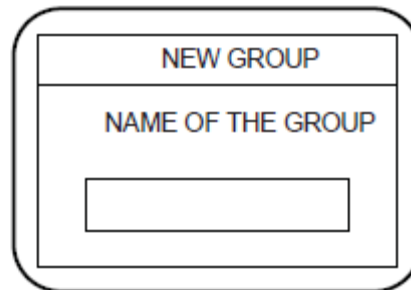


Figure 8

The cursor is located in the first position of the field to enter the name of the memory block. To enter the name of the memory block in the field perform the following operations:

- with «▲», «▼» buttons select the first letter and number of the block name;
- with the «▶» button move the cursor to the second position of the field to enter the name of the block;

- with «▲», «▼» buttons select the first letter and number of the block name and proceed further to enter the full name of the block; Press the «↵» button. The menu of the hardness tester operating modes will appear on the graphic display.

2.2.5 If necessary, activate the illumination of the graphic display and program the time of the instrument turn-off.

To accomplish it place the cursor on the menu option "SETTINGS" and press the «↵» button. The graphic display will look like the one depicted in Fig. 9.

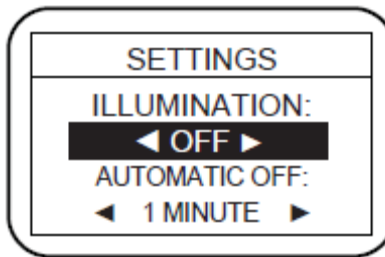


Figure 9

To turn on the illumination of the graphic display press the «▶» button and with «▶», «◀» buttons set the required illumination time of the data demonstrated on the graphic display (from 1 to 5 seconds).

In order to set the time of instrument turn-off press the «▼» button and with «▶», «◀»

buttons set the required time of automatic turn-off (from 30 seconds to 5 minutes).

For instance, if the time of automatic turn-off is set at 3 minutes, the instrument will turn off automatically when 3 minutes passed after the last measurement. If within next 3 minutes another measurement is performed, the turn-off time will be delayed accordingly.

2.2.6 After the completion of the above operations the instrument is ready for measurements.

2.2.7 Selected modes of operation can be stored as long as desired, even with the power turned off. At the same time, they may be modified by performing the above operations.

2.3 Preparation to Operation on Scales Programmed by User 2.3.1 Take two samples prepared according to para. 1.2.10.

2.3.2 If necessary, perform the operations described in paras 2.1.2, 2.1.3.

2.3.3 With appropriate buttons on the keyboard select the required hardness scale.

2.3.4 With the «◀» button select the cell in which the scale programmed by the User will be stored. There are nine programmable scales – three for each main hardness scale.

2.3.5 Press the «☰» button. The menu of the hardness tester operating modes will appear on the graphic display. Place the cursor on the menu option “SAMPLE SIZE” Select the sample size – number of measurement required for averaging (not fewer than four recommended). Press the «↵» button. The menu of the hardness tester operating modes will appear on the graphic display.

2.3.6 With the «▼» button place the cursor on the menu option “CORRECTION” and press the «↵» button.

2.3.7 Take the standard gage with the minimum hardness value and perform the operation according to item 2.1.12.

2.3.8 On the graphic display in the lower left cell of the table there appears the hardness value of the standard gage measured by the instrument.

2.3.9 With «▲», «▼» buttons set the certified value of the standard hardness gage. Press the button.

2.3.10 Take the standard gage with the maximum hardness value and perform the operation according to item 2.1.12.

2.3.11 On the graphic display in the lower left cell of the table there appears the hardness value of the standard gage measured by the instrument.

2.3.12 With «▲», «▼» buttons set the certified value of the standard hardness gage. Press the «↵» button. The menu of the hardness tester operating modes will appear on the graphic display.

2.3.13 Check the correction as described in paras 2.1.11-2.3.12.

2.3.14 Evaluate the reading error of the instrument. If necessary, repeat the operations described in paras 2.3.6-2.3.13.

2.3.15 After the completion of the above operations the scale programmed by the User is automatically recorded in the selected memory cell and stored there as long as desired, even if the power supply is disconnected. At the same time, it may be modified at any moment by performing of the above operations.

2.3.16 After the completion of the above operations change, if necessary, the sample size for the work on actual products.

2.3.17 After that complete operations described in paras 2.2.4, 2.2.5.

2.3.18 The hardness tester is ready for measurements of actual products on this scale.

2.4 Preparation of Hardness Tester for Operation on Additional Hardness Scales

2.4.1 If necessary, perform the operations described in paras 2.1.2, 2.1.3.

2.4.2 One of additional measuring scales (the list of additional scales is agreed upon with the Customer) is selected by pressing «▲», «▼» buttons until the name of desired scale appears in the upper zone of the graphic display.

2.4.3 Perform operations described in paras 2.2.3-2.2.5.

2.4.4 The harness tester is ready for measurements of the product on the additional scale.

2.5 Operation with Product

2.5.1 Evaluate the compliance of the controlled product with para. 1.2.6.

2.5.2 If the product's weight is less than required, it is necessary to grind it to the lapping plate with TSIATIM-221 lubricant according to GOST 9433-80.

2.5.3 In order to increase the equivalent mass it is allowed to fix the controlled product in a jaw vice.

2.5.4 If necessary, condition the controlled area to obtain the surface finish not rougher than necessary.

2.5.5 Put the hardness tester in place convenient for measuring.

2.5.6 Connect the required sensor to the hardness tester.

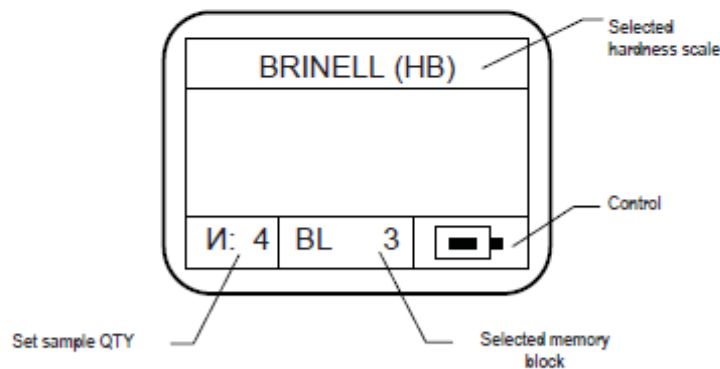


Figure 10

2.5.7 Activate the hardness tester. The instrument will enter the "MEASUREMENTS" mode which was programmed in accordance with one of paras 2.2, 2.3 or 2.4 and which was used during the last activation of the instrument. The graphic display will look like the one depicted in Fig. 10.2

2.5.8 Perform the measurement on the controlled product.

2.5.9 Carefully, **without any impact**, place the sensor perpendicularly to the controlled surface. Smoothly pressing the sensor body force the diamond tip into the controlled surface till the face of the cap reaches the surface of the part. After the beep tone remove the sensor from the controlled surface. The number "1" will appear in the central zone of the graphic screen.

ATTENTION. The whole measuring cycle (from the moment of contact of the diamond pyramid with the controlled surface till its disengagement from the surface) should last not longer than 1 second.

Complete the measuring cycle as many times as indicated in the "SAMPLE QTY" mode each time placing the sensor at the new place on the controlled surface. In the central zone of the graphic display the numbers "2", "3", etc. will appear sequentially followed by the result of measurements in the selected hardness units (average arithmetical value of measurements).

2.5.10 If it is required to record the given control result in the selected memory block, press the «**↵**» button after the result of the measurement appears on the graphic display.

2.5.11 Similarly, conduct the measurements in other areas of the controlled product.

2.6 Turning Hardness Tester off

2.6.1 There are three ways to turn the hardness tester off:

- automatic turning off;
- "manual" forced turning off;
- turning of using the "MENU" mode.

2.6.2 Automatic turning the hardness tester off (para 2.2.5) happens after a time interval, if no measurements are conducted or buttons pressed.

2.6.3 The hardness tester can be turned off "manually" forcibly in any operating mode by pressing and holding in pressed position the "⓪" button during 4-5 seconds. After the «⓪» button is released the instrument will turn off.

2.6.4 To turn the hardness tester off using the "MENU" mode select the "AUTOMATIC OFF" option from the hardness tester operating modes menu and momentarily press the «**↵**» button. The instrument will turn off.

2.7 Control of Hardness tester Power Supply


2.7.1 It is possible to perform an operative control of the power source condition.


2.7.2 The condition of the power source is characterized by the height of the column located in the symbolically depicted power source (see Fig. 3).


2.7.3. With the discharge of the power supply element the height of the column decreases. When the critical discharge condition is nearly reached, the symbol of the power source starts blinking.

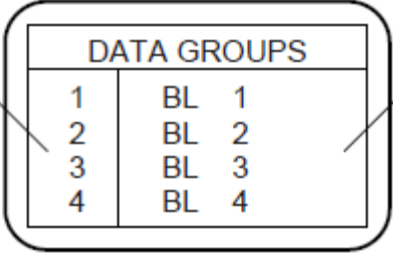
2.7.4 When the critical discharge condition is reached, the "BATTERY IS DISCHARGED" sign appears, the beep signal sounds and the hardness tester turns off. It is necessary to replace the power source.

2.8 Review of Results Accumulated in the Memory Block, Data Output to Computer, Memory Clearing

2.8.1 To review in real time the control results accumulated in the memory block it is possible to access the menu mode by pressing the «» button.

2.8.2 Place the cursor on the menu option "INSTRUMENT MEMORY". Press the «» button. The graphic display will look like the one depicted in Fig. 7.

2.8.3 Place the cursor on the sub-menu option "MEMORY REVIEW". Press the «» button. The graphic display will look like the one depicted in Fig. 11.



DATA GROUPS	
1	BL 1
2	BL 2
3	BL 3
4	BL 4

Figure 11

2.8.4 Select the required memory block by placing the cursor on it using the «▲», «▼» buttons. Press the «↵» button. The graphic display will look like the one depicted in Fig. 12.

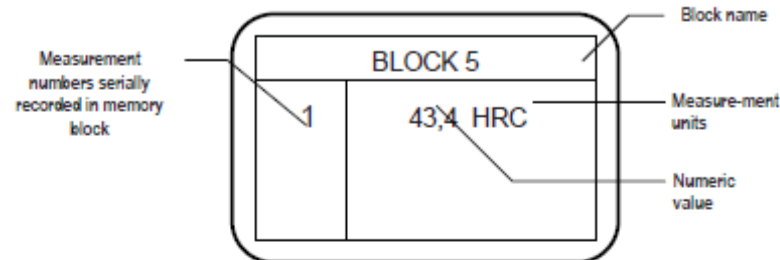


Figure 12

2.8.5 With «▲», «▼» buttons review all control results which are of interest.

2.8.6 To view the control results recorded in another memory block press the «☰» button. The graphic display will look like the one depicted in Fig. 11.

2.8.7 Select the required memory block and by performing operations described in paras 2.8.5, 2.8.6 review the control results recorded in this block.

In order to access the menu of the hardness tester operation modes press the «☰» button twice.

2.8.9 The above operations can be performed with the deactivated sensor. In this case after activation the hardness meter immediately enters the "MEMORY" mode and one more sub-menu option named "DATACOM" appears.

2.8.10 To review the control results recorded in the memory block perform the operations described in paras 2.8.3-2.8.7.

2.8.11 To transfer the control results to the computer the following operations should be performed.

2.8.12 Install on the computer the software program from the CD included in the scope of supply.

2.8.13 Activate the hardness tester, if it was turned off.

2.8.14 Connect the cable for data transfer via the RS-232C interface to the terminal on the side wall of the electronic block. The cable is included in the scope of supply. Connect the other end of the cable to one of the COM-ports of the computer.

2.8.15 Start the program installed on the computer and set it up in the mode of information reception.

2.8.16 Activate the hardness meter. The "MEMORY" mode will appear on the graphic display. Place the cursor on the "DATACOM" sub-menu option. Press the «**↵**» button. The graphic display will look like the one depicted in Fig. 11.

2.8.17 With buttons «**▲**», «**▼**» select the required memory block. Press the «**↵**» button. Information is transferred to the computer.

2.8.18 In the hardness meter there is an option of simultaneous removal of all the data recorded in the instrument memory.

2.8.19 To accomplish it, access the "MEMORY" mode from the operating modes menu. Place the cursor on the "MEMORY CLEARING" option in the sub-menu. Press the «**↵**» button. The graphic display will look like the one depicted in Fig. 13.

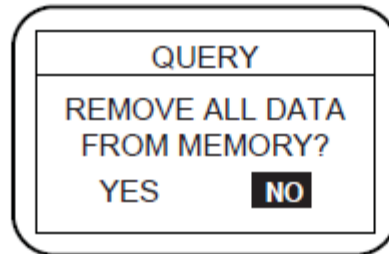


Figure 13

2.8.20 With buttons «**▶**», «**◀**» place the cursor on the "YES" option. Press the «**↵**» button. The data are removed from the instrument memory.