Hardness tester TQ-4 Combi

Operation manual

Table of contents:

The present operation manual, supported by the technical passport, contains data pertaining to the purpose, functional description, technical characteristics, operating principle, internal design and performance of TQ-4C Combi hardness testers (hereinafter referred to as "hardness tester") as well as respective operation, transportation, and storage rules. Based on ASTM and DIN norms.

1 Description of the hardness tester

1.1 Intended use and functions of the hardness tester

1.1.1 The hardness tester is designed for on-site measurement of carbon struc tural steels using the Brinell (HB), Rockwell (HRC), and Vickers (HV) basic hard ness scales through the dynamic contact impedance method.

1.1.2 The hardness tester is designed to perform referential hardness checks of carbon structural steels on the Rockwell (HRA), Rockwell (HRB), and Shore (HSD) hardness scales. This is achieved by automatically converting measurement results from the main hardness scale units into the respective hardness units, based on the user's or manufacturer's conversion tables.

1.1.3 The hardness tester is designed to perform referential checks using the Leeb (HL) scale.

1.1.4 The hardness tester is intended to be used for reference checks of the ten sile strength (MPa) of pearlitic carbon structural steels via automatic recalcula tion of the Brinell (HB) scale results to corresponding hardness units according to the ASTM E140 table.

1.1.5 The hardness tester is intended to be used for hardness control of metals and alloys that differ in characteristics from carbon structural steels.

The hardness tester can be used for hardness control of:

- Heat-resistant, corrosion-resistant, stainless, tool and other types of steels
- Non-ferrous metals and alloys
- Specialized cast iron
- Strengthening and other layers used in steel articles (electrolytic precipitation, nitrogen hardening, HFC hardening, etc.)
- Overlay welding and plated coating (chromium, etc.)
- Articles made of fine-grained materials (for local investigation of material properties)

When the physical and mechanical properties of the material being inspected differ from those of carbon structural steels, measurements should be carried out after setting up an additional correction (or additional scale). This additional correction can be programmed either by the user with test blocks made from the respective material or by the manufacturer upon the user's request.

1.1.6 The hardness tester is designed for use in laboratories, workshops, and field environments.

1.1.7 The hardness tester allows the user:

- To perform real-time calculations of the average value of measurement series results, including the option to reject incorrectly performed measurements using a user-selected algorithm.
- To perform real-time additional statistical processing of measurement series results, such as determining the minimum and maximum values, calculating the average value, and computing the mean square deviation from the average.

- To display additional information in real-time, including the results of the previous measurement series.
- To organise data storage in the form of individualised blocks of measurement results, retain them when the device is powered off, and transfer the data to a computer.
- To analyse stored measurement results in various ways and to plot different types of charts directly on the display.
- To select additional information to be displayed during measurements.
- To set up a measurement range and establish an alarm for range exceedance.
- To monitor battery charge and set up a battery discharge alarm.
- To configure automatic shutoff after a period of inactivity to conserve battery power.
- To adjust the display brightness to conserve battery life.
- To select the required display colour and intensity range.
- To select an interface language from those preset by the manufacturer at the user's request.

1.2 Hardness tester operating principle

The hardness tester's operating principle is based on the UCI (ultrasonic contact impedance) method.

The basic components of the hardness tester are the probe and the electronic unit for data conversion and measurement processing. The metal shaft, forming a part of the hardness tester, has a diamond pyramid fixed on its end.The shaft oscillates at its own resonance frequency.

The load created by the user's hand enables the diamond pyramid to penetrate the material and change the shaft's resonance frequency. The variation in the shaft's resonance frequency is proportional to the shaft-into-material penetration depth. Since the shaft-into-material penetration depth is the hardness factor, there is a relationship between F (variation in the shaft's resonance frequency) and H (material hardness):

$$H = f(F)$$

The hardness tester's electronic unit receives the frequency signal from the probe, converts it into hardness units, displays the measurement results, and performs statistical processing and other functions of the particular hardness tester.
Moreover, the device implements a dynamic Leeb hardness control method. This method determines the ratio of the rebound rate to the rate of incidence of a carbide indenter from the surface of the article under inspection.

1.3 Technical characteristics

1.3.1 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

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 σ_B	350…1500 MPa
Rockwell A	70,5 – 85,5 HRA
Rockwell B	51 – 100 HRB
Shore D	35 – 102 HSD
Leeb (HL)	300 – 900 HL
Hardness control ranges according to additional scales for various materials (for Leeb probes)	
Alloy, tool steel	80 – 900 HV 20 – 70 HRC
Stainless steel	80 – 850 HV 80 – 655 HB 20 – 70 HRC 45 – 100 HRB
Gray cast iron (with lamellar graphite)	90 – 335 HB
Ductile cast iron (with compact graphite), high-strength cast iron (with nodular graphite)	130 – 390 HB
Aluminium alloys	30 – 160 HB
Brass (copper-zinc alloys)	40 – 175 HB; 14 – 95 HRB
Bronze (copper-tin, copper-aluminium)	60 – 290 HB
Hardness tester electronic unit overall dimensions, maximum	121 x 69 x 41 mm
Hardness tester electronic unit mass, maximum	0,3 kg
Mass of the probe, maximum	0,3 kg

Hardness tester rated operation conditions	
Air temperature	From -15 to +35 °C
Relative humidity	30 – 80 %
Atmospheric pressure	84 – 106,7 kPa
Correction period	1 year
Hardness tester service life	5 years
Number of potential additional corrections for the hardness tester	5 for each scale
Number of additional scales for the hardness tester	3
Duration of one hardness measurement cycle (average)	2 s
Number of measurement cycles required to calculate the average value	1 – 99
Number of algorithms for rejecting incorrectly performed measurement results during average value calculation	3
Parameters of additional statistical processing of measurements series	Maximum, minimum, mean square deviation from the average value, average value.
Additional information displayed (as defined by the user)	Previous results of the measurement series and results of additional statistical processing.
Number of samples required to set up additional corrections for hardness tester scales	1 or 2
Number of samples required for additional scales setup	2 to 10 (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	Colour. 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	12 400
Maximum number of individualized blocks set up in the memory	100

Displaying	• All results in the block • Results in the block which are greater or less than values set up by the user • 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 • In reference to value set up by the user • In reference to measurement range set up by the user
Computer interface connection	USB
Hardness tester automatic shutdown	Shutdown time to be set up by the user
Monitoring of battery charging	Continuous. Continuous indication during measurement.
Display illumination	Time to be set up by the user
Display colour and intensity	To be selected by the user
Interface language of the hardness tester	According to the request: English, German, French.
Hardness tester power supply	Autonomous, battery. Use of equivalent non-rechargeable batteries allowed.

1.3.2 Hardness tester probes

The hardness tester incorporates a probe and an electronic unit that processes the signals transmitted from the probe. The delivery set of the hardness tester may include additional probes at the user's request.

Probes are designed to generate a frequency signal that transmitting information regarding the hardness of the article under inspection. The probe consists of a casing and a protective cap. Inside the casing, there is a spring-loaded steel shaft with a diamond pyramid and a limit switch, which, when closed, initiates a resonance frequency measurement command. Piezoelectric plates connected to the shaft are designed to generate and receive shaft oscillations.

UCI probe

The cap is intended to protect the shaft from overload and prevent contact with foreign particles or the user's hand during measurements. For measurements in hard-to-reach areas, the protective cap may be removed. It is also permissible to replace the protective cap with a U-4 or Z-3 type caps (see section 2.7 Probe type selection).

For optimal measurement conditions, additional probes (integrated into the hardness tester) may be used. These probes feature different dimensions and nominal loads, allowing automatic hardness measurements. The load is determined by the nominal strength of the spring. The probes are equipped with a built-in cable for connection to the electronic unit or with a built-in plug-and-socket coupler for cable attachment upon the user's request.

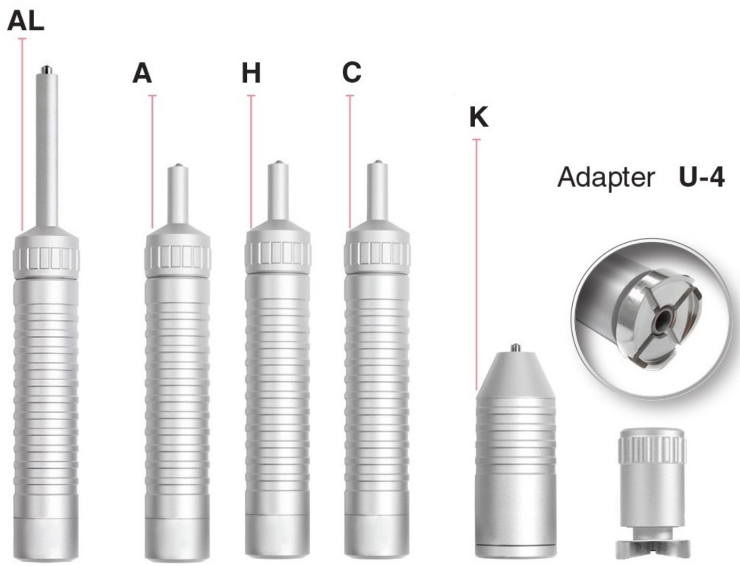
The characteristics of the probes are listed in Table 2.

Table 2

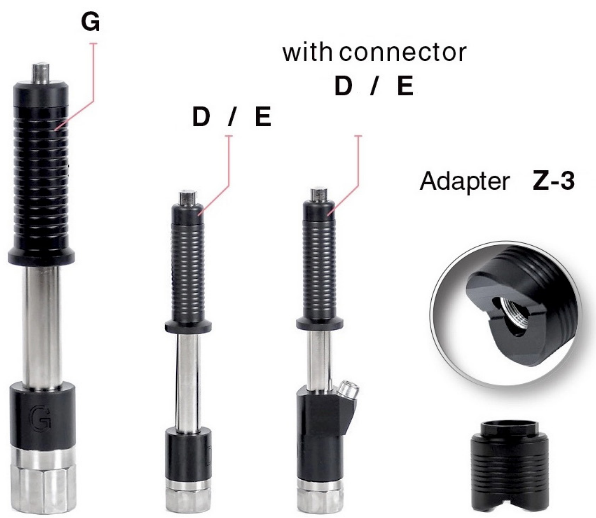
UCI probes			
Reference designation	**Load**	**Overall dimensions, maximum**	
		Length, mm	Diameter, mm
A	50 N (5 kg)	145	26
H	10 N (1 kg)	145	26
C	100 N (10 kg)	145	26
K	50 N (5 kg)	76	33
AL	50 N (5 kg)	190	26

Leeb probes					
Reference designation	**Description**	**Overall dimensions, maximum**			
		Length, mm		**Diameter, mm**	
		usual	With connector	usual	With connector
D	The probe, typically supplied with the Leeb hardness tester, is used for primary measurement tasks.	138	138	21	27
G	The probe has increased overall dimensions and impact energy (compared to the probe "D"). It is used to inspect materials with high structural heterogeneity and high surface roughness. **Can be used only at the hardness less than 450 HB**	200	-	29	-
E	The probe with the indenter made of a polycrystal of cubic boron nitride. For mass control of the materials with the increased hardness (≥450 HB)	138	138	21	27

Leeb probe



UCI probes and adapter



Leeb probes and adapter

Average nominal diameters of dents (mm) left on the surfaces of articles during hardness measurement are listed in Table 3.

Table 3

Reference designation of the probe	**103 HB (103 HV)**	**209 HB (212 HV)**	**406 HB (420 HV) (42,5 HRC)**	**763 HV (63,0 HRC)**
A, K, AL	0,23	0,16	0,13	0,09
H	0,11	0,09	0,07	0,05
C	0,33	0,24	0,17	0,13
D, E	0,80	0,72	0,67	0,57
G	1,29	1,22	0,93	-

Average nominal depth of dents (mm) left on the surfaces of articles during hardness measurement are listed in Table 4.

Table 4

Reference designation of the probe	**103 HB (103 HV)**	**209 HB (212 HV)**	**406 HB (420 HV) (42,5 HRC)**	**763 HV (63,0 HRC)**
A, K, AL	0,066	0,045	0,037	0,025
H	0,033	0,027	0,020	0,014
C	0,095	0,070	0,050	0,037
D, E	0,054	0,043	0,038	0,027
G	0,084	0,075	0,044	-

At the user’s request, specialized probes with characteristics different from those specified above can be manufactured and integrated into the hardness tester.

1.3.3 Additional devices and accessories

The «U-4» head facilitates the positioning of UCI probes A, H, C on cylindrical surfaces. It replaces the standard protective nozzle by screwing onto the probe.
The «Z-3» head facilitates the positioning of Leeb probes D, E on cylindrical surfaces. It replaces the standard support nut by screwing onto the probe.

A stand for measuring with UCI probes A, H, C enables precise positioning of the probes and articles being inspected. It ensures the probe is perpendicular to the test surface, prevents movement on surface during measurement. The use of a tripod enhances control and improves the accuracy of measurement of small articles.

1.3.4 Requirements for articles under inspection

The hardness measurement area of the article under inspection should be dry and free from scale, rust, dust, dirt, and grease. The minimum approximate weight of the article under inspection is according to Table 5.

Table 5

Probe reference designation	**Minimum thickness of the article under inspection, mm**
A, H, C, K, AL	1
D, E	3
G	8

If the weight of the article under inspection is less than specified above, it is necessary to adhere to the requirements listed in section 1.3.6 “Measurements on light and thin-walled articles”. The minimum approximate thickness of the article’s area under inspection is according to Table 6.

Table 6

Probe reference designation	**Minimum thickness of the article under inspection, mm**
A, K, AL	3
H	2
C	4
D, E	6
G	55

Specified thickness values may vary depending on the geometrical dimensions and hardness of the article.
If the thickness of the article under inspection is less than specified, during measurements it will be necessary to additionally adhere to the requirements of section 1.3.6 “Measurements on light and thin-walled articles”.

The maximum recommended roughness of the article (article area) subject to inspection is according to Table 7.

Table 7

Probe reference designation	Surface roughness, maximum
A, K, AL	Ra 1,6
H	Ra 0,8
C, D, E	Ra 3,2
G	Ra 7,6

If the article’s surface roughness exceeds the specified value, it is necessary to additionally adhere to the requirements of section 1.3.8 “Working with articles with excessive roughness”.
The minimum radius of curvature of article’s convex surface under inspection is according to Table 8.

Table 8

Probe reference designation	Radius of curvature, mm	
	Convex	Concave
A, H, C, AL	4	6
K	4	20
D, E	18	200 (without washer)
G	50	500 (without washer)

The minimum diameter of the spot of article’s surface under inspection is according to Table 9.

Table 9

Probe reference designation	Spot radius, minimum, mm
A, H, C, K, AL	1
D, E	21 (6 without washer)
G	29 (7 without washer)

1.3.5 Working with non-carbon structural steel articles

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

Additional errors arising in such cases necessitate adjusting the device (additional correction) to accommodate materials with elasticity modulus differing from carbon structural steels.

To determine the presence of additional errors, it is necessary to compare measurement results obtained using the hardness tester with results obtained using a static device. If the divergence in results does not exceed the maximum error of the hardness tester, it implies that these materials can be inspected without additional correction.

If the divergence exceeds the maximum error of the hardness tester, additional correction of the hardness tester (additional correction) with two hardness samples representing the material under inspection is required (procedure detailed in section 2.15 "Hardness tester scales correction").

During the use of the hardness tester, there may arise a need to measure the hardness (or other properties) of materials with specific mechanical and physical parameters. In such cases, it is possible that additional correction may not completely eliminate the resulting error. Therefore, it may be necessary to perform additional correction of the hardness tester (setting up an additional scale) with one or two hardness samples made of the material under inspection (procedure detailed in section 2.16 "Additional scale setup").

In cases where the material of the article under inspection exhibits high structural heterogeneity or a coarse-grain structure (such as grey cast iron, etc.), it is likely that the measurement method employed in the given hardness tester may not adequately inspect such articles. There will be significant dispersion in device readings. To conduct immediate checks on such materials, it is necessary to use Leeb probes (D, E, G) to inspect these objects.

These procedures may also not yield accurate results for articles with ultra-high or ultra-low hardness.

Requirements for samples used in additional hardness tester correction

The number of samples required for additional correction of hardness testers is 1 or 2 pieces. The recommended ratio of H_{max} (maximum sample hardness value) to H_{min} (minimum sample hardness value) is 2.
For setting up an additional hardness tester scale, 2 or more samples are required.

During sample fabrication, it is recommended to follow the ASTM E140 standards for hardness samples concerning roughness and geometric dimensions. This includes additional limitations, specifically a minimum sample thickness (height) of 10 mm.
In case of deviation from these standards (which is not recommended), the following conditions must be met:

- Roughness of the sample's working surface: 0.4 μm Ra.
- The sample's supporting surface must be plain ground.

When fabricating samples, ensure compliance with the ASTM E140 standards for hardness samples regarding surface hardness variation.

1.3.6 Measurements on light and thin-walled articles

Where an article under inspection, sample, or test block does not meet the requirements of the hardness tester probes regarding article mass and/or thickness, the hardness tester will conduct measurements with additional error. This error will increase with greater deviations from the specified requirements.

For articles with insufficient mass, the error depends on parasitic oscillations occurring when the diamond pyramid penetrates the article during measurement. These oscillations result from the article vibrating due to its insufficient mass.

To determine the occurrence of additional errors, measurements performed by the hardness tester should be compared with those conducted using a static device.

Elimination of additional errors on light and thin-walled articles

If the article thickness is insufficient, it is necessary (to eliminate additional errors) to secure the article to a massive, plain-ground plate.
Recommended plate parameters are as follows:

- Mass and thickness should significantly exceed the minimum mass and thickness of the article under inspection as specified in section 1.3.4 "Requirements for articles under inspection"
- Roughness should be kept to a minimum. Optimal roughness should not exceed Ra 0.4 μm
- Non-flatness should be maximum 0.005 mm

- The modulus of elasticity of the plate metal (Young's modulus) should be close to that of the article under inspection.
- The bottom part of the article should be plain ground

Before positioning the article, apply a thin layer of grease to the plate's supporting surface.
Then, secure the article to the plate through the grease layer, ensuring there are no air gaps between the surfaces. This grounding process should be tight enough to create a uniform and monolithic mass.

Elimination of additional errors on lightweight articles
For articles with insufficient mass, it is necessary to secure them in a sturdy metal vice. The vice should have a mass significantly greater than the minimum mass of the article under inspection as specified in section 1.3.4 "Requirements for articles under inspection".
To prevent damage to the article, attachable pads made of softer metal can be used.

Additionally, if there is insufficient mass, the article can be grounded to a massive plate using the method described above. The grounding method is suitable for thin articles (sheets), articles with a flat shape, and articles with mass comparable to the minimum specified in section 1.3.4 "Requirements for articles under inspection". An example is Rockwell scale test blocks as per ASTM E140.

Vice gripping should be used for small articles with insufficient mass and a volumetric shape.

In cases where articles have small mass and/ or thickness, implementing the above activities may not yield accurate results. To inspect such articles properly, it is necessary to use static-type hardness testers that apply small or ultra-small loads. The reliability of the inspection should be assessed by comparing readings from the hardness tester and the static device.

1.3.7 Measuring of hardened surface layers, galvanic coatings, and surface deposits hardness

Depending on the type of probe used and the hardness of the article, the probe pyramid penetrates the article to different depths (refer to section 1.3.2 "Hardness tester probes", Table 4).
Plastic deformation of the metal occurs at considerably greater depths.

For UCI probes, it is recommended to measure the hardness of the layer with a thickness **at least 5 times greater** than the pyramid penetration depth.

For Leeb probes, it is recommended to measure the hardness of the layer with a thickness of at least 1.5 mm beyond the pyramid penetration depth.

During hardness measurement, it is necessary to consider the requirements of section 1.3.5 "Working with non-carbon structural steel articles".

1.3.8 Working with articles with excessive roughness

When measuring an article with a significantly rough surface (exceeding the values specified in section 1.3.4 “Requirements for articles under inspection”) the user may observe high additional dispersion in device readings.

Dispersion in the readings can be eliminated by two methods:

- Grinding the surface area (for example, using a grinding machine as per section 1.3.3 “Additional devices and accessories”) to achieve the required roughness specified in section 1.3.4 “Requirements for articles under inspection”;
- Using a higher number of averaging cycles during measurements. This is recommended when it is not possible, for any reason, to properly grind the required surface area.

1.3.9 Influence of article surface layers properties

During the fabrication of articles under inspection, thin layers may be deposited on the surface that differ in hardness from the base metal. For example:

- Decarburized layers with low hardness, resulting from high-temperature thermal treatments (such as hardening, normalisation, hot rolling, forging, etc.).
- Burn marks, caused by faults in the article grinding process, where the surface layer becomes burnt, leading to reduced hardness.
- Cold work, occurring in the surface layer after lathe and mill machining and coarse grinding.
- Cold hardening
- Martensite spots with excessive hardness, occurring due to surface overheating.

The presence of these layers (detectable with the hardness tester) significantly affects UCI hardness tester readings more than Leeb probe readings.
Typically, the thickness of these layers does not exceed 0.2 mm. To ensure measurement accuracy when such layers are detected, it is necessary to remove them from the measurement areas using a grinding machine, for example.

1.4 Completeness of the hardness tester

The contents of the hardness tester delivery set are listed in Table 10.
Contents of additional sets to be defined together with hardness tester purchase order.

Table 10

Item	Q-ty (pcs)	Remark
Basic configuration		
Electronic unit		
A-type probe		№
D-type probe		№
Connecting cable for UCI probe		
Rechargeable battery		Li-Po 3,7 B 1100 mA/h (included in electronic unit)
Charger		
PC cable		USB
Soft case		
Strap for securing the device on the arm		
Carrying and storage bag		
Additional set		
A-type probe		
H-type probe		
C-type probe		
K-type probe		
AL-type probe		
D-type probe		
G-type probe		
E-type probe		
Connecting cable for Leeb probes		
Special head "U-4"		
Special head "Z-3"		

1.5 Design of the hardness tester

1.5.1 Construction

From a functional viewpoint, the hardness tester comprises an electronic unit and a probe (see section 1.3.2 “Hardness tester probes”).

The hardness tester electronic unit receives frequency signals transmitted by the probe, converts them into hardness units, displays measurement results, performs statistical processing, and other functions specific to the hardness tester.

The front panel of the electronic unit features a coloured display and a keyboard. A schematic image of the electronic unit is provided in Figure 1.
The side wall of the hardness tester houses the probe or cable plug-in connection for the computer.
The rear panel of the hardness tester displays a tag with the manufacturer’s serial number.

Figure 1

The hardness tester control — switching of scales and settings, additional corrections and scales setup, measurement results, memorisation, and analysis etc. - is performed by means of the device keyboard.

1.5.2 Hardness tester menu navigation

The complete setting list (operational parameters etc.) of the hardness tester, except for the selection of work scales, (see «General structure of the menu», Table 11), is accessed through the graphical menu. The device menu is multilevel, organised to enhance usability by grouping logically connected settings into categories, with sub--menus provided for each respective menu item. An illustration of the menu is shown in Figure 2.

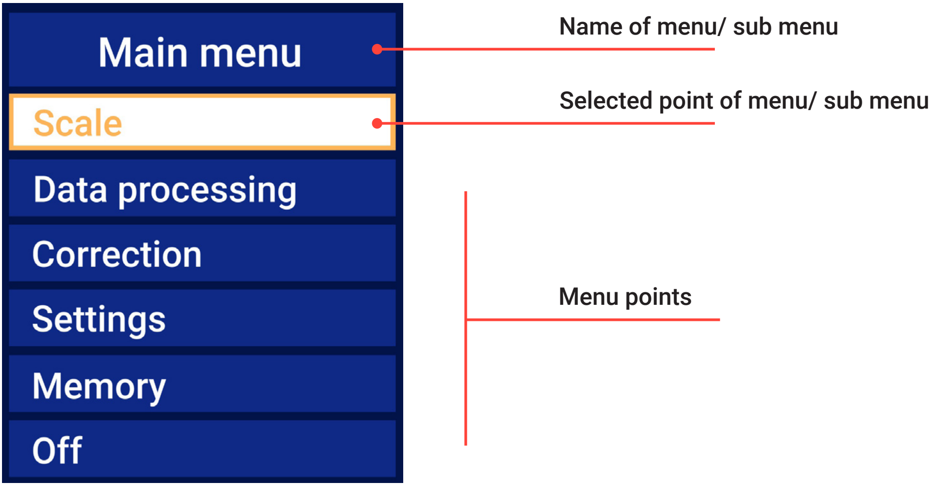


Figure 2

Switching between menu points is performed using of buttons [▲], [▼]. Selection of a menu point (to access parameter settings or sub-menus) is done with the button [↵]. The display will show a corresponding parameter entry window (see below) or sub-menu. Exiting from a sub-menu to a higher level is achieved by pressing the button [menu].
The number of menu points displayed during operation may vary depending on the currently selected scale (main, reference, additional) or additional correction.

The general structure of the menu is detailed in Table 11.

Menu point		Function	Para-graph
Meas-urement mode*	Probe type *	Probe type selection	2.7
	Angle *	Selection of measurement direction	2.8
	Material *	Selection of controlled material	2.9
	Scale*	Hardness scale selection	2.10
Scale ***		Hardness scale selection	2.10
Data process-ing	Average	Setting the averaging parameters (sample size and rejection of extreme values)	2.11
	Output settings	Setting the modes of displaying the results (numeric or diagram) and output statistics	2.12
	Limits	Setting control thresholds	2.13
	Figure	Setting the diagram	2.14
Correction	Correction	Scale correction. Introduction of an additional correction to the scale.	2.15.2, 2.15.3
	Clear	Deletion of correction (return to the original settings)	2.15.4
	Cell name **	Introduction of the name of the additional correction	2.15.5
Edit scale	Settings ***	Setting the curve scale parameters (number of points, interpolation type)	2.16.2
	Curve input ***	Correction curve recording	2.16.3
	Names ***	Introduction of the scale names and units	2.16.4
	Probe signal ***	Mode of primary probe's signal reading	2.16.5
Settings	Energy saving	Setting of automatic shutdown of the device, backlight mode	2.17
Memory		Functions for working with the data archive	2.18
Off		Hardness tester shutdown	2.20

* Visible only if Leeb probes are connected
** Visible for additional correction only
*** Visible for additional scale only (when UCI probes are connected)

1.6 Marking and sealing of the hardness tester

1.6.1 The rear panel of the electronic unit displays a tag indicating:

- Manufacturer's name
- Model type of the hardness tester
- Hardness tester serial number
- Measurement tools approval sign

1.6.2 The probes may bear the hardness tester serial number and a letter representing the probe type.
1.6.3 To prevent unauthorised access and attempts to carry out unqualified hardness tester repairs, the probe casings are sealed accordingly.

1.7 Packing of the hardness tester

During storage and handling the hardness tester's electronic unit and probes should be kept in a shock-proof casing.

2. Operation

2.1 General information (as per ASTM and DIN)

As described previously, the hardness tester enables the user to perform the following measurements:

- Using main scales
- Using reference scales
- With additional corrections to scales
- With additional scales

Measurements by the hardness tester are conducted following the hardness measurement procedure outlined below (section 2.2 "Hardness measurement procedure").
The hardness tester operates during measurement in accordance with the scale and settings selected by the user in the menu (see section 1.5 "Design of the hardness tester").

The hardness tester operation cycle should include the following steps:

- Preparation for operation and powering on
- Serviceability check
- Execution of settings (if required)
- Measurement of hardness on articles.

The contents and procedure of each step are described below.
Periodical technical maintenance of the hardness tester is required (see section 3 "Technical maintenance").

2.2 Hardness measurement procedure

UCI probe

According to the design of the hardness tester, the following procedure for hardness measurement is established:

- Carefully and **WITHOUT IMPACT**, place the probe perpendicularly onto the surface of the article under inspection
- **Smoothly** press the probe casing compressing the probe spring to indent the diamond pyramid into the surface being inspected
- After the acoustic signal sounds and previous measurement results clear from the hardness tester display (typically within a fraction of a second), **REMOVE** the probe from the surface of an article under inspection
- Hardness measurement results will appear on the display approximately within 1 second

If the probe is equipped with a protective cap or a U-4 adapter (ref. section 1.3.2 “Hardness tester probes”, 1.3.3 “Additional devices and accessories”) designed to protect the probe shaft from overload, you may continue pressing the probe until the cap limits the compression of the probe spring (press “as far as it will go” – the acoustic signal will sound beforehand).

ATTENTION !

- Avoid impacts and slipping of the probe against the surface under inspection when placing or removing the probe. This can **damage the diamond pyramid and consequently the probe itself**.
- Avoid positioning the diamond pyramid into the dent left by a previous measurement when placing the probe on the surface under inspection. This can introduce **errors** into the measurement results.
- While pressing the probe casing, avoid fluctuating and deviating the probe from its normal position relative to the surface under inspection.This can lead to additional **errors** in the measurement results.
- After the acoustic signal sounds, avoid keeping the probe on the surface under inspection. The entire measurement cycle (from the pyramid touching the surface to removal) should be no longer than 1 second.

Leeb probe

The hardness tester’s construction necessitates the following procedure for hardness measurement:

- Position the probe perpendicularly to the surface of the inspected article
- Press the probe housing (compressing the spring in the probe) to advance the probe into the working state
- Press the release button on the probe
- The hardness measurement results will appear on the tester display in approximately 1 second.

ATTENTION!

- During measurements, it is essential to avoid the indenter entering into the dent left after previous measurements (move the probe along the surface). This can lead to additional **imprecision** in the measurement results.
- When pressing the release button, ensure the probe does not detach from the test surface, deviate from its normal position on the surface, or compress the probe spring sideways. This can also result in additional imprecision in the measurement results.

2.3 Powering on and preparation for work

2.3.1 Visually inspect the hardness tester to ensure there are no mechanical damages to the electronic unit, probe, or connecting cable.
2.3.2 For probes with a built-in connecting cable plug, connect the cable to the plug located on the probe.
2.3.3 Connect the cable to the respective plug on the side wall of the electronic unit.
2.3.4 Switch on the hardness tester instantly by pressing button ⏻ .
2.3.5 The display will generally appear as shown in Figure 3.
2.3.6 Select the type of probe when using a Leeb probe.

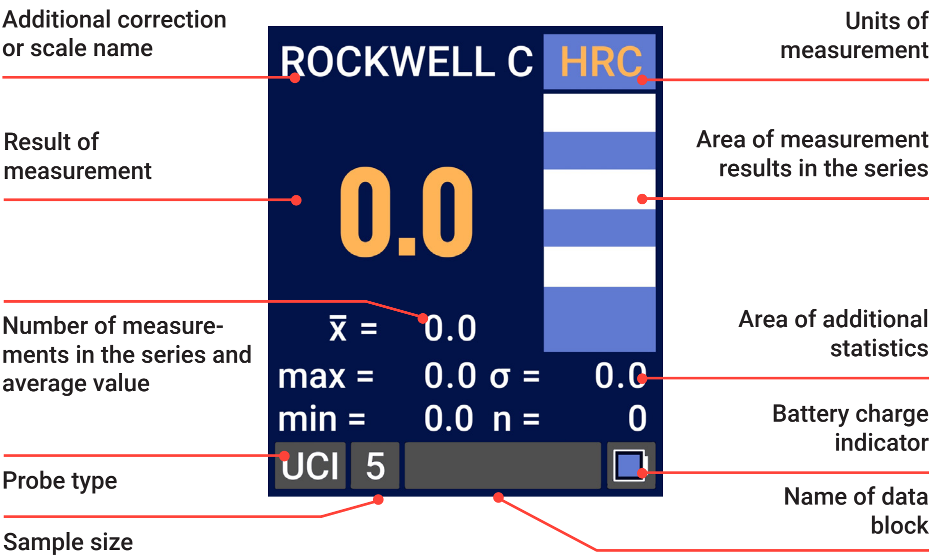


Figure 3

The display image may differ from that shown in Figure 3, depending on the previous settings of the hardness tester.

2.4 Hardness tester serviceability check

2.4.1 Prepare a set of hardness test blocks (samples) and secure plate as per your local standard according to the requirements of section 1.3.6 “Measurements on light and thin-walled articles”.
The test blocks should have valid metrological certification.
Secure the test blocks to the plate following the procedure set forth in section 1.3.6 “Measurements on light and thin-walled articles”.
2.4.2 To check serviceability of the hardness tester with reference to additional corrections of hardness tester scales or to additional scales, it is necessary to prepare the respective hardness test samples.
Handle the samples as required in section 1.3.6 “Measurements on light and thin-walled articles”.
2.4.3 Prepare and switch on the hardness tester according to the requirements set forth in section 2.3 “Powering on and preparation for work”.
2.4.4 With buttons [HV] [HB] [HRC], [▲], [▼] select the measurement scale used or additional correction of the scale (buttons [◀], [▶]). Control of the hardness tester during measurements is detailed in section 2.6 “Measurements mode”.
2.4.5 Perform minimum 5 measurements on each sample (test blocks) in accordance with section 2.2 “Hardness measurement procedure” and calculate the average value. It is recommended to calculate average value by selecting respective sample size and by using the respective hardness tester functions (see section 2.6 “Measurements mode”).
2.4.6 Estimate the measurement error and compare the obtained results with certificate data of the test blocks (samples).
2.4.7 If the difference between measurement results and certificate data of samples (test blocks) does not fall outside permissible limits, it is possible to start measuring the articles intended for inspection.

2.4.8 If the difference between measurement results and certificate data of the samples (test blocks) exceeds the permissible error, it is necessary to perform scale correction using reference hardness samples (additional correction with hardness samples – i.e. correctly set up an additional scale). Respective procedures are detailed in section 2.15.2 “Scales correction”, 2.15.3 “Additional correction set up”.

2.5 Procedure for hardness measurement on inspected articles

2.5.1 Check conformity of article(s) under inspection with requirements of section 1.3.4 “Requirements for articles under inspection”. If required, ensure conformity to the requirements by performing the necessary actions stated therein.
2.5.2 If necessary, prepare additional accessories as per section 1.3.3 “Additional devices and accessories”.
2.5.3 Additionally, refer to section 1.3.7 “Measuring of hardened surface layers, galvanic coatings, and surface deposits hardness” and section 1.3.9 “Influence of article surface layers properties”.

2.5.4 Check hardness tester serviceability as per section 2.4 “Hardness tester serviceability check”.
2.5.5 If necessary, select measurement scale and additional correction as per section 2.6 “Measurements mode”.
2.5.6 If necessary, set up averaging parameters (generally, recommended sample size - minimum 5) as per section 2.11 “Setting averaging parameters” and as per section 2.12 “Displaying data on the screen”.
2.5.7 If necessary, set up an alarm of measurement results falling outside the required range as per section 2.13 “Setting control thresholds”.
2.5.8 If necessary, set up or select the memory block to record measurement results as per section 2.18 “Memory management”.
2.5.9 If necessary, set up other service settings of the hardness tester.
2.5.10 Perform hardness measurement of article(s) under check in conformity with measurement and parameter averaging set up procedures as per section 2.2 “Hardness measurement procedure”.
Result of hardness measurement and additional statistical processing to be observed on display as per section 2.6 “Measurements mode”.
If necessary, store hardness measurement results in the memory as per section 2.6 “Measurements mode”.
Repeat such number of cycles as may be required.
2.5.11 If necessary, analyse and/or withdraw the stored data to the computer as per section 2.18 “Memory management”.
2.5.12 Power off the device as per section 2.20 “Hardness tester shutdown”.

2.6 Measurements mode

The hardness tester is ready for measurement immediately after switching on. Measurements are made in accordance with section 2.2. “Hardness measurement procedure”.

The scales are selected using the buttons [▲], [▼] with their names and units of measurement displayed in the appropriate place on the display.
Quick selection of the main scales is also performed using the buttons [HV] [HB] [HRC]
When switching scales, the hardness tester automatically converts the results into the selected scale. Scale selection can also be made through the hardness tester menu.
The choice of additional corrections to the scales of the hardness tester is made using the buttons [◀], [▶] , with their names displayed in the appropriate place on the display.
The choice of dynamic Leeb probe type is made through the hardness tester menu. The type of ultrasonic probe does not require selection.
The choice of the type of controlled material (only when using dynamic Leeb probes) is made through the hardness tester menu.

Sample size, the number of measurements in the series for which the readings are averaged, and additional statistical processing are performed through the hardness tester menu.

Presentation of data on the display - the presentation of results on the display (numeric or chart) and additional statistics displayed during the measurement process are configured through the hardness tester menu.

To access the menu, briefly press the button**.**

The thresholds for control are set through the hardness tester menu. All measurement results beyond these thresholds will be displayed in red.

When making a series of measurements equal to the set sample size, the display shows the average value of the entire series of measurements - **the measurement results**.

The mode for automatic rejection of maximum and minimum readings in a series of more than 5 measurements can be set through the menu.

To complete a series of measurements ahead of time press the button.

The recording of measurement results into memory is done by long pressing the button . The result will be recorded in the previously created and selected memory block.

2.7 Probe type selection

To set the type of Leeb probe used, select the menu items <**MEASUREMENT MODE**> - <**PROBE TYPE**>.

In the list that appears (Fig. 4), select the type of probe and click the or button.

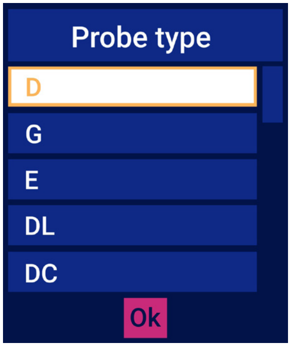


Figure 4

2.8 Setting the angle of measurement

To set the measurement angle with a Leeb probe (not required for an ultrasonic probe), select the <**MEASUREMENT MODE**> - <**ANGLE**> menu items.

In the list that appears (Fig.5), select the probe orientation and click the or button.

The availability of this setting depends on the type of Leeb probe connected.

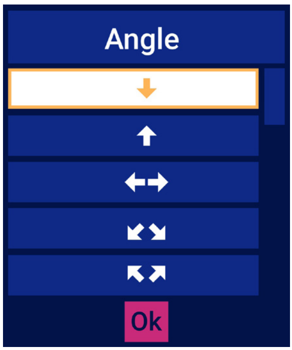


Figure 5

2.9 Selection of controlled material

To select the type of material to be inspected (not available for the ultrasonic probe), select the menu items <**MEASUREMENT MODE**> - <**MATERIAL**>.

In the list that appears (Fig.6), select material and click the ↵ or ▤ button.

Figure 6

2.10 Hardness scale selection

To select the hardness scale, you select the menu items <**MEASUREMENT MODE**> - <**SCALE**>.

In the list that appears (Fig.7), select the scale and click the ↵ or ▤ button.

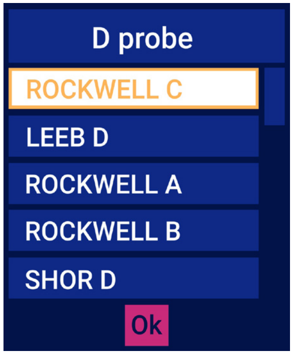


Figure 7

2.11 Setting averaging parameters

To enter the mode, select the menu items <**DATA PROCESSING**> - <**AVERAGE**>.

In the appeared window (Fig. 8), select the desired option using the buttons ▲, ▼. Set the desired value using the buttons ◀, ▶. Press ↵ or ▤.

To return to the menu, click the ▤ button, or select the "**Ok**" button image and press the ↵ button.

NOTE:
You can use the virtual keyboard to enter digits (e.g. the sample size).

To do this, select a numeric parameter and press the ↵ button. Set the value using the keypad (Fig. 9).

To remove the keyboard, press the ▤ button.

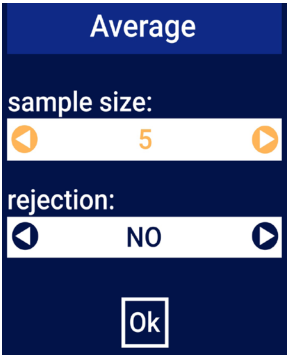
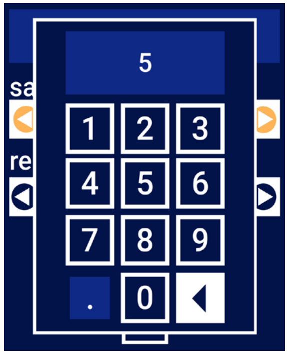


Figure 8

Figure 9

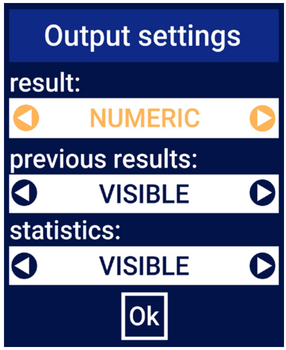


2.12 Displaying data on the screen

To enter the mode, select the menu items **<DATA PROCESSING>** - **<OUTPUT SETTINGS>**.

In the appeared window (Fig. 10), select the desired option using the buttons ▲, ▼.
Then press ◀, ▶ to set the desired value.
To return to the menu, press the ↵ or ▤ button.

Figure 10



2.13 Setting control thresholds

Select the menu items **<DATA PROCESSING>** - **<LIMITS>** to enter the mode.
In the appeared window (Fig. 11), choose the alarm type (no alarm, more/ less than the threshold, out of range) and the threshold values themselves using the buttons ◀, ▶ ▲ ▼. You can use the virtual keyboard to set numeric values (see note in section 2.11 “Setting averaging parameters”).

Press the ▤ button , or the “Ok” button image and press ↵ , to return to the menu.

Figure 11

2.14 Setting diagram thresholds

To enter the mode, select the menu items
<DATA PROCESSING> - <FIGURE>.

In the appeared window (Fig. 12), use the , , , buttons to set the limits of the figure.

Use the virtual keyboard to set numeric values. (see the note in section 2.11 “Setting averaging parameters”). To return to the menu, press the button , or select the “**Ok**” button image and press .

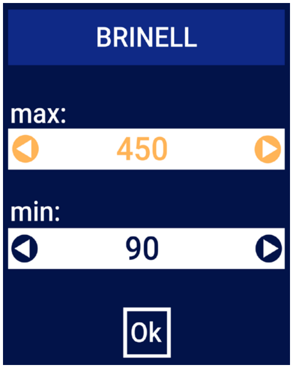


Figure 12

2.15 Scales correction

2.15.1 General information

The process of correcting hardness tester scales, including additional scales, involves aligning the **average** readings obtained from hardness test blocks (samples) with the nominal hardness specified in their certification.

The nature of the correction process involves adjusting the manufacturer’s initial settings.

Correction of hardness tester scales allows recovering accuracy of readings in case there is an additional error in measurements caused by natural wear of hardness tester mechanical parts.

Correction of hardness tester scales should be carried out with the use of test blocks as per standard. Test blocks should have valid metrological certification.

Correction of hardness tester scales does **not affect** additional corrections of hardness tester scales.

Correction of main hardness tester scales does **not affect** reference hardness tester scales.

Setting up additional corrections of hardness tester scales allows checking metal articles which differ in properties from carbon structural steels (ref. section 1.3.5 “Working with non-carbon structural steel articles”).

Additional corrections of hardness tester scales may be set up by the user or at manufacturer’s production facilities upon the user’s request.

Setting up additional hardness tester scales corrections should be carried out with the use of hardness samples fabricated in compliance with section 1.3.5 “Working with non-carbon structural steel articles”.

During the hardness tester supply process, all additional corrections are equal with correction of respective hardness tester scale (if not set up in advance upon user’s request).

Correction may be carried out either with two or with one test block (sample). Correction with one test block (sample) is possible in cases where such a procedure can provide permissible measurement errors within the required range.

ATTENTION!

- Correction of hardness tester's main and reference scales should be carried out **ONLY** if unacceptable error in the hardness tester's operation within the respective scales occurs. The presence of unacceptable error should be determined using test blocks as per standard, which have proper metrological certification as per section 2.4 "Hardness tester serviceability check".
- Before starting correction of the hardness tester's main or reference scales, **it is recommended** to ensure that unacceptable error is not caused by improper correction of the scale carried out earlier. For this purpose, restore hardness tester to factory settings of the said scale as per section 2.15.4 "Correction deletion". After that, check its serviceability as per section 2.4 "Hardness tester serviceability check".

2.15.2 Scale correction

To correct hardness tester scale, prepare the respective test blocks as per standard, which have valid metrological certification.

Before correction it is necessary to secure the test blocks on the support plate as per section 1.3.6 "Measurements performed on light and thin-walled articles".

To enter correction mode, select the appropriate scale of the hardness tester (see section 2.6 "Control and results submission during the measurement"), then enter the **MENU** and select <**CORRECTION**> - <**CORRECTION**>.

NOTE

Password is: [◄], [►], [▲], [▲], [↵].

Then, it is expected that the display of the hardness tester will conform to Figure 13.

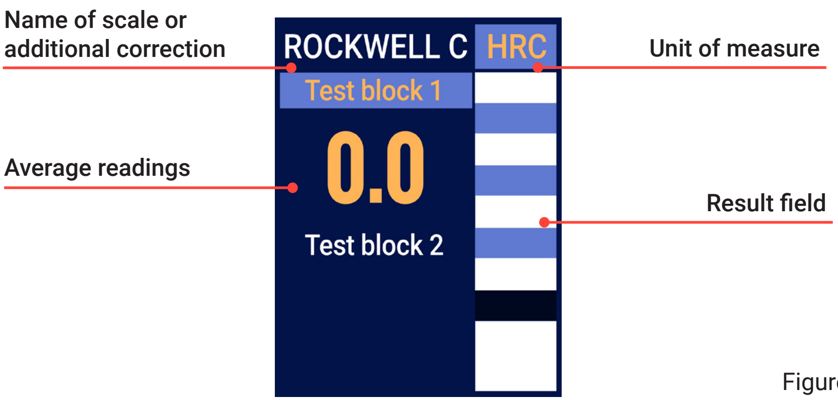


Figure 13

Carry out several measurements (at least 5) following section 2.2. "Hardness measurement procedure" on the test block with the lowest hardness value, moving the probe along the surface. During this process, measurement results will be displayed in the "Results" field, while the "Test block 1" field will show average readings (obtained using a rejection algorithm as per section 2.11 "Setting averaging parameters".

Use buttons [▲], [▼] to adjust the average reading values to match the certificate (nominal) values of the test block, thereby completing correction with the first test block by pressing button [↵] (if you press button [↵] without previously pressing buttons [▲], [▼] readings will be reset to zero, allowing for new measurements). After this, the display will resemble the image below (Figure 14).

If you are performing correction with one test block, press button [▤]. The display will confirm the completion of correction with one test block, after which the hardness tester will return to the menu.

If correction with two test blocks is being carried out, perform measurements on the second test block as described above. Set its certificate value and press button [↵]. The display will confirm the completion of correction with two test blocks, after which the hardness tester will return to the menu.

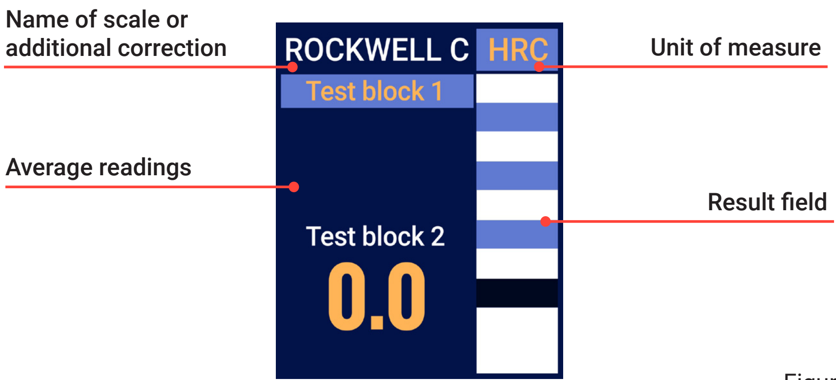


Figure 14

It is possible to cancel correction with the second test block at any moment by pressing button [▤]. The hardness tester will return to the menu and will provide a message in advance confirming the completion of correction with one test block. This option is available if, during measurements, it becomes evident that correcting with one test block is sufficient to correct the error.

After correction, it is necessary to check hardness tester's serviceability as per section 2.4 "Hardness tester serviceability check".

2.15.3 Additional correction setup

To set up an additional correction of the hardness tester scale, it is necessary to prepare hardness samples in accordance with the requirements outlined in section 1.3.5 "Working with non-carbon structural steel articles".

Before correcting with a hardness sample, it is necessary to follow the procedures outlined in section 1.3.6 “Measurements performed on light and thin-walled articles”.

To enter additional correction mode, select the necessary hardness tester scale and additional correction to be defined (see section 2.6 “Measurements mode”). Then, return to the menu and select <**CORRECTION**> - <**CORRECTION**>.

The subsequent procedure is similar to the hardness tester correction procedure detailed in section 2.15.2 “Scale correction”.

2.15.4 Correction deletion

The function to delete scale (or additional) correction is used to revert correction to the manufacturer’s settings.

To select this function, choose the required hardness tester scale (or additional correction) (see section 2.6 “Measurements mode”). Then, return to the menu and select <**CORRECTION**> - <**CLEAR**>.

Afterward, the hardness tester will prompt for confirmation of correction deletion. Upon confirmation, the correction will be deleted, and the hardness tester will display a confirmation message and return to the menu.

During additional correction deletion, only the correction itself will be deleted, while the correction name (see section 2.15.5 “Additional correction name setup”) will remain unchanged.

2.15.5 Additional correction name setup

To assign a name to the additional correction, first select the required one. Then, in the menu, navigate to <**CORRECTION**> - <**CELL NAME**>.

Using the virtual keyboard (Fig. 15), enter the name (refer to the note in section 2.11 “Setting averaging parameters”).

Figure 15

2.16 Additional scale setup

2.16.1 General information

The process of setting up an additional scale involves recording (in the hardness tester) the dependence (correction curve, characteristic) between the primary signal transmitted from the device probe and the parameter under evaluation (such as hardness). This dependence must be verified using samples fabricated in accordance with section 1.3.5 “Working with non-carbon structural steel articles”.

The curve is established in tabular form, using several functional pairs (points) – a signal transmitted from the probe and the corresponding value of the parameter under evaluation. The number of points (ranging from two to ten) is determined by the hardness tester settings, taking into account the shape of the curve and the number of available samples (see section 2.16.2 "Introduction of the additional scale parameters").

By converting the probe signal into the parameter value using the established curve, the hardness tester performs intermediate interpolation between the curve points. This interpolation can be achieved through piecewise linear (using the two nearest points to the signal value) or piecewise parabolic (using the three nearest points to the signal value) methods.

The dependency between the probe signal and the parameter under evaluation is established by measuring the available samples in the probe signal recording mode (see section 2.16.5 "Reading probe signals").

Measurement results are presented in Table 12.

Table 12

Sample number	Probe signal	Sample hardness
1	500	250 HV
2	570	200 HV
...	...	...

When data have been received, it can be further processed on a computer to understand the nature of the dependency. The resulting curve will then be stored in the hardness tester (see section 2.16.3 "Correction curve setup" below).

The use of piecewise parabolic interpolation allows for a smoother dependency. However, it is important to ensure that each calculated triplet of points lies on the same branch of the parabolic curve passing through them.

2.16.2 Introduction of the additional scale parameters

To set the number of curve points and the type of interpolation, select the additional scale to be determined, then navigate to the menu and choose
<**EDIT SCALE**> - <**SETTINGS**>.

Next, enter the password mentioned in the note in section 2.15.2 "Scale correction". Then, in the appeared window (Fig. 16), use the buttons ▲, ▼, ◀, ▶ to set the required values.

You can use the virtual keyboard to set numeric values (see note to section 2.11 "Setting averaging parameters"). To return to the menu, press the button, or select the "**Ok**" button image and press ↵.

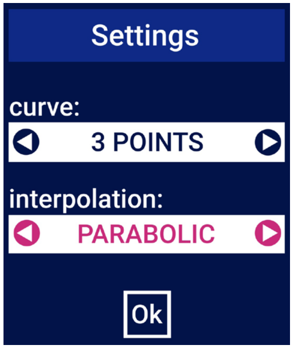


Figure 16

2.16.3 Correction curve setup

To set up the curve (dependency between probe signal and parameter under evaluation) select the additional definable scale, enter the menu, and choose <**EDIT SCALE**> - <**CURVE INPUT**> (Fig. 17).
Then, enter the password mentioned in note in section 2.15.2 “Scale correction”.

In appeared window (according to the Fig. 17) use the buttons , , , to set up the curve.
To return to the menu, press the button .

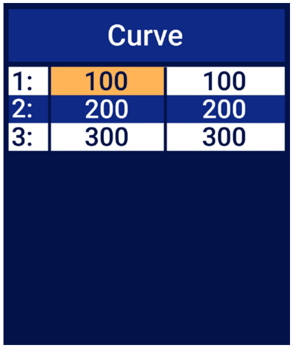


Figure 17

2.16.4 Additional scale name setup

Select the scale to enter the name and units of measurement of the additional scale. Go to the menu and choose <**EDIT SCALE**> - <**NAMES**> (Fig. 18).
To return to the menu, press the button , or select the “**Ok**” button image and press .

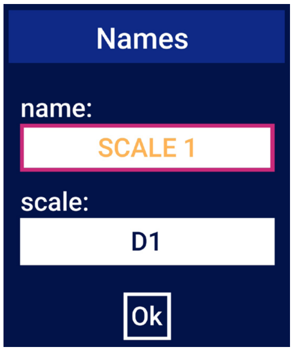


Figure 18

2.16.5 Reading probe signals

To read the probe signals on the samples, select a definable additional scale, enter the menu, and choose <**EDIT SCALE**> - <**PROBE SIGNAL**>.
Display will show an image consistent with Figure 19.

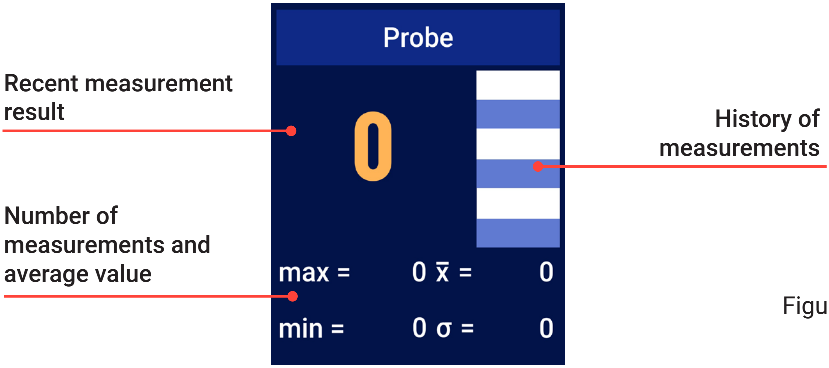


Figure 19

During sample measurements, the display will show measurement results (probe signal expressed in relative units), results of previous measurements (in the “history of measurements” field), number of measurements, and average value.
Averaging is performed using an algorithm that rejects incorrect measurement results, as specified in section 2.11 “Setting averaging parameters.”

Pressing button resets previous measurements to zero and starts a new averaging cycle.
Exit from the operation mode to the menu by pressing button .

2.17 Power-saving mode settings

To configure energy-saving modes, select the menu items <SETTINGS> - <ENERGY SAVING>.
Then, in the appeared window (Fig. 20), use the , , , buttons to set the automatic shutdown time and the duration for display backlight to turn off.

To return to the menu, press the button or .

Figure 20

2.18 Memory management

2.18.1 General information

The hardness tester enables the user to organise versatile measurement data archive in the hardness tester memory and transfer the data to a computer.

The archive is structured into individualised memory blocks. Measurement results are recorded into these memory blocks (see section 2.6 “Measurements mode”). The user defines the memory blocks (for example, a block containing hardness measurement results obtained from a specific article). Each memory block may contain results of measurements using the same units of measure (by a single scale).

Accessing the data archive is done via the <**MEMORY**> option in the hardness tester menu. The structure of the corresponding submenu is illustrated below (Fig. 21).

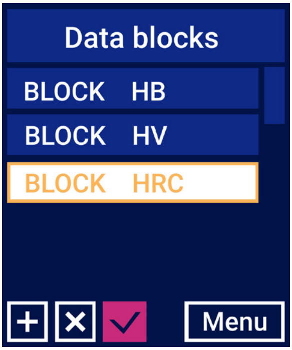
2.18.2 Creating a new block

To create a new block, select the **<MEMORY>** menu item.

Next, in the «Memory» window (Fig. 21), use the ◄ , ► buttons to select the “**+**” button image and press ↵ . Then, in the subsequent window (Fig. 22) enter the block name and select the scale.

To return to the «Memory» window, click the ≣ or “**Ok**” button image and click ↵.
To exit the «Memory» window in the menu, press the ≣ button.

Figure 21



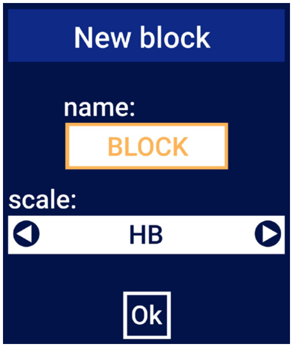


Figure 22

2.18.3 Selection of a block for recording

To choose a data block for recording measurement results, navigate to the “Memory” window (see section 2.18.2 “Creating a new block” and Fig. 21), using the buttons ◄ , ► , select the “**V**” button image and press ↵.

<u>NOTE:</u>
Alternatively, block selection can also be performed through the block’s menu. In the «Memory» window, use the ◄ , ► buttons, select “Menu” button image and press ↵. The block menu will appear on the display. Managing actions with in the block menu are identical to those in the main menu of the hardness tester.

2.18.4 Deletion of a block

To delete a data block, navigate to the «Memory» window (see section 2.18.2 “Creating a new block” and Fig. 21), use the buttons ◄ , ► , select the “**X**” button image and press ↵ .

2.18.5 Viewing block data

To view the recorded results within a block, select the <**RESULTS**> menu item within the block’s menu (see note in section 2.18.3 “Selection of a block for recording”).The saved measurement results will appear in the subsequent window.

Scroll through the table, using the , buttons.
If thresholds are set for this block, results beyond the threshold will be highlighted in red (Fig. 23).
Threshold values can be set via the block menu item <**SETTINGS**> <**LIMITS**>.
Statistics for this unit are displayed below the table.

To return to the menu, press the button or .

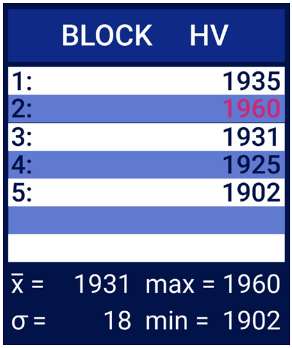


Figure 23

2.18.6 Diagram display

To plot a chart based on the results recorded in the block, select the <**FIGURE**> item in the block menu (see note to section 2.18.3 “Selection of a block for recording”).
A diagram (Fig. 24) will display based on the saved measurement results.
If thresholds are set for this block, columns outside the threshold will be highlighted in red.
Set the threshold values via the block menu item <**DATA PROCESSING**> <**LIMITS**>.
Adjust the chart’s threshold values through the block menu item <**DATA PROCESSING**> <**FIGURE**>.
Below the chart, you will find the statistical results for this block.
To return to the menu, press the button or .

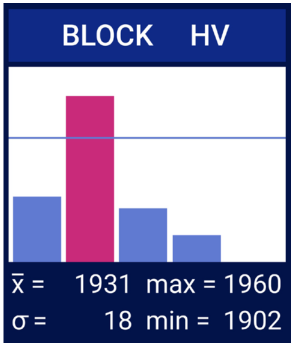


Figure 24

2.18.7 Clearing the block

To delete all data from the block, select the menu item <**CLEAR**> in the block menu.

2.18.8 Block name change

To change the name of the block, select the menu item <**NAME**> in the block menu.

2.18.9 Data transfer to a computer

To transfer data to a computer, install and launch the software provided with the hardness tester. Follow these steps:

- Ensure the hardness tester is turned on if it is currently off
- Connect the supplied USB cable to the connector located on the side wall of the electronic unit.
- Connect the other end of the cable to one of the USB ports on your computer.

2.19 Battery charge monitoring

Operational monitoring of the battery status is provided. The current battery charge is displayed in the measurement mode.

When the battery charge reaches a critical low level, a flashing battery icon will appear on the display accompanied by an audible beep, after which the hardness tester will automatically turn off.

To recharge the battery, connect the hardness tester to a charger or a USB port on a computer using a USB cable. While charging, the battery icon on the display will periodically fill with colour.

> **ATTENTION!**
> Do not leave the device unattended during the charging.

2.20 Hardness tester shutdown

The hardness tester can be ⏻ned off in the following ways:

- Press and hold button for 0,5-1 second, then release
- Select < **OFF**> from the menu
- Allow the device to automatically turn off after a period of inactivity, as specified in section 2.17 “Power saving mode settings”

3. Technical maintenance

Regular technical checks ensure the hardness tester operates reliably throughout its service life. Follow these steps at least once a year:

- Verify the hardness tester’s completeness as per section 1.4 “Completeness of the hardness tester”.
- Conduct a visual inspection to ensure there are no mechanical damages to the electronic unit, probe, and connecting cable.
- Check the hardness tester’s functionality as described in section 2.4 “Hardness tester serviceability check”.
- Address any identified defects that cannot be resolved to the manufacturer.

4. Transportation and storage

4.1.The hardness tester may be transported using railway, road, sea, or air transport, ensuring it is securely packaged according to relevant shipping regulations for the chosen method of transport. For air transport, ensure the device is transported in sealed and heated compartments.

4.2. Store the hardness tester inside its case in a closed, heated room with an air temperature of 25±10°C, relative humidity between 45% and 80%, and atmospheric pressure of 630 to 800 mm Hg. The storage area should be free from fungus, acid vapours, reagents, paints, and other chemicals. Avoid sharp fluctuations in air temperature and relative humidity to prevent dew formation in the storage area.

4.3. If the storage period exceeds two months, the batteries should be removed from the electronic unit.

5. Safety measures

5.1 The hardness tester is a technically sophisticated device that requires careful handling. It should be protected from:

- Impacts or loads that could cause mechanical damage
- Exposure to aggressive chemicals
- Ingress of liquids
- Prolonged exposure to sunlight
- Other factors that may compromise its operation

5.2 During measurements, it is crucial not to deviate from the hardness measurement sequence outlined in section 2.2 “Hardness measurement procedure”, as this could lead to diamond pyramid shearing and subsequent breakdown of the hardness tester.

5.3 Using the hardness tester in conditions of sharp fluctuations in ambient air temperature is not permissible. In case of such fluctuations, the hardness tester should remain switched off for at least 1 hour.

5.4 Using batteries that are not authorized by the manufacturer with the hardness tester is prohibited.
5.5 Opening the electronic unit or probe compartments and attempting repairs on the hardness tester without supervision is strictly prohibited.

6. Recycling

Upon expiry of its service life, the hardness tester poses no hazard to human life, health, or the environment and does not require specific recycling procedures.
Hardness tester batteries are disposed of in accordance with relevant applicable regulations.

7. Manufacturer’s warranty

7.1 The manufacturer hereby guarantees that the hardness tester complies with producer requirements, “The hardness testers: portable, ultrasonic, model type TQ-4Combi (TQ-4C, TQ-3C) for the entire warranty period.
The warranty period for the hardness tester is 24 months from the date of purchase (up to a maximum of 30 months from the date of manufacture), provided that the operation, maintenance, transportation, and storage requirements specified in this Operation Manual and the accompanying technical passport are observed.

7.2. Warranty and post-warranty repairs are carried out at the manufacturer’s facilities.

7.3. If defects are detected in the hardness tester during the warranty period, the user must present an Act specifying the need for defect correction. The hardness tester, along with a copy of the Act, should be delivered to the manufacturer or the manufacturer’s representative (supplier).

7.4. Hardness testers that have been damaged due to the violation of operating, safety, maintenance, transportation, or storage regulations, mechanical damage (excluding normal mechanical wear), or exposure to liquids or other conditions leading to tester failure are not covered under warranty.

7.5. Hardness testers with evidence of **diamond pyramid damage** are not covered under warranty.

7.6. Hardness testers with broken protective seals (stickers) on the electronic unit or probe casings, or with evidence of tampering or unauthorized repair attempts, are not covered under warranty.

7.7. The manufacturer's warranty does not cover batteries or third-party accessories (such as chargers and grinding machines) included in the same delivery set as the hardness tester.

7.8. The manufacturer's warranty does not cover natural wear of components (such as cables and probes) due to heavy-duty operation.

7.9. Warranty repairs will only be carried out upon presentation of this Operation Manual along with the hardness tester's technical passport.

8. Acceptance certificate

The hardness tester TQ-4Combi, serial number ______________________________, complies with the requirements and is certified as fit for operation.

Date of issue: Person in charge for acceptance:

__________________20_____ __________________/_________________

Stamp

Date of sale *: Supplier:

__________________20_____ __________________/_________________

Stamp

The "date of sale" field must be completed by the hardness tester supplier. If this field is left blank, the **release date** of the hardness tester will be considered the date of sale.

TEQTO

TEQTO Estonia OÜ

Reg. N 16476638
EU VAT EE102483538

+372 553 6202
teqto@teqto.pro

https://www.teqto.pro