Ultrasonic Hardness Tester

Operating Manual

Safety Information：

In order to ensure safe operation, and avoid potential safety hazards, please read the following safety information and properly keep this instruction before using the device:

- **This ultrasonic hardness tester is a high accurate precision measuring instrument. Please handle it lightly and must not exposed to shocks or impact load!**
- **The probe is inlaid with Vickers diamond of ultra-high hardness. Please avoid scratching valuables when using the probe!**
- **Measuring device and accessories should be kept out of reach of children!**
- **Please do not disassemble the host, probe or probe connection cable! Internal damage caused by self-disassembly is not covered by the warrant!**
- **Please use and keep the device within -10°C~40°C. If the ambient temperature is too high or too low, equipment failure may occur.**
- **Please do not expose the device and its battery to high temperature or around the heating device, such as sunshine, heater, microwaves or oven. Overheated batteries may cause an explosion!**
- **When charging is completed or is not charging, please disconnect the charger from the device and unplug the charger from the power socket!**
- **The device uses a non-removable internal battery. Do not replace the battery by yourself, in order to avoid device failure or damage to the device. If you need to replace the battery, please contact the manufacturer!**
- **Please dispose the device, include battery and its accessories according to local regulations. It cannot be treated as household garbage.**
- **Using uncertified chargers, charging cables, and batteries may cause equipment damage or other hazards!**
- **Only the accessories produced by the device manufacturer can be used, such as probe and probe connection cable.**

1. Metal Hardness Introduction

1.1 Static Test Methods

There are many hardness scales for metal hardness, commonly used are Brinell (HB), Rockwell (HR) and Vickers (HV). These three hardness test methods are all static test methods, which are applied to different materials and applications respectively. Workbench hardness tester designed and manufactured according to the definition of hardness scale has the advantages of accurate measurement and independent of the elastic constants of the material. However, there are also problems such as large volume, heavy weight and long testing time, which make it impossible to test on site and test large workpiece. The indentation of Brinell hardness tester and Rockwell hardness tester is larger and the damage to the workpiece is larger. Vickers hardness tester uses optical method, which needs very professional and technical personnel to operate.

1.2 Dynamic Test Methods

To solve the problems of static test methods, there are two commonly used portable dynamic test methods, which are Leeb (HL) and Shore (HS). These two kinds of dynamic methods have the advantages of small volume, light weight and easy to carry. However, due to the advantages of portability, the measured values are related to the elastic constants of the material being tested, and it is required to use a conversion table to convert the values to commonly used scales(Brinell (HB), Rockwell (HR) and Vickers (HV)), in this process, both the elastic constants and the conversion table will cause errors.

2.Vickers Hardness Introduction

Vickers hardness test method, refers to using a 136 ° diamond regular pyramid indenter to press against the surface of tested samples under the prescribed load F, keeping a certain time after the loading, then measuring indentation diagonal length d to calculate indentation surface area S, and calculating the average pressure of indentation on the surface, which is the Vickers hardness values of this metal, denoted by the symbol HV.

$$HV=0.102*F/S。$$

In actual test, there is no need to calculate, but according to the measured length d to directly look up the table to get the hardness value.
Diagonal length d is generally measured by a microscope which brings a huge technical demand for the operators. And cause the following problems: Long test time; The workbench Vickers hardness tester is bulky and heavy; Not suitable for test on site and test large workpiece

3.Ultrasonic Hardness Tester Test Theory

3.1 Theory Introduction—UCI Method

3.1.1 UCI method (Ultrasonic Contact Impedance)

In order to solve the problems of workbench Vickers hardness tester (Long test time; Bulky and heavy; Not suitable for test on site and test large workpiece; Huge technical demand for the operators), in 1961, Ultrasonic Contact Impedance, a hardness testing method was developed by Dr. Claus Kleesattel, and the hardness tester designed by UCI method is called Ultrasonic Hardness Tester.

UCI method uses a spring to generate the test force required for Vickers hardness test, test force is applied to the user's workpiece by means of a resonating rod which is inlaid with a 136 ° diamond regular pyramid indenter, the diamond indenter forms a Vickers diamond indentation on the workpiece. The diagonal length of the indentation corresponds to Vickers hardness, and the diagonal length also corresponds to the frequency change of the resonating rod, so the hardness of the workpiece can be known from the frequency change of the resonating rod.

Note: Because of the use of standard Vickers indenter and test force, ultrasonic hardness tester can test Vickers hardness of workpiece directly. So, ultrasonic hardness tester is a kind of Vickers hardness tester.

3.1.2 UCI hardness test

A hardness testing practice using a calibrated instrument by pressing a resonating rod with a defined indenter, for example, a Vickers diamond, with a fixed force against the surface of the part to be tested.

3.1.3 Calibration

Determination of the specific values of the significant operating parameters of the UCI instrument by comparison with values indicated by a standardized workbench hardness tester or by a set of certified reference test pieces.

3.1.4 Surface Roughness

Surface roughness (that is, Ra = average roughness value).

3.2 Significance and Use

- **The hardness of a material is a defined quantity having many scales and being dependent on the way the test is performed. In order to avoid the creation of a new practice involving a new hardness scale, the UCI method converts into common hardness values, for example, HV, HRC, etc.**
- **The UCI hardness test is a superficial determination, only measuring the hardness condition of the surface contacted. The results generated at a specific location do not represent the part at any other surface location and yield no information about the material at subsurface locations.**
- **The UCI hardness test may be used on large or small components at various locations. It can be used to make hardness measurements on positions difficult to access, such as tooth flanks or roots of gears.**

3.3 Instruments and Test Procedure for UCI Method

3.3.1 Instruments

Instruments used for UCI hardness tests generally consist of (1) a probe containing a rod with a defined indenter, for example, a Vickers diamond, attached to the contacting conform to Test Method E 92 and Test Method E 384, (2) vibration generating means, (3) vibration detecting means, (4) electronic means for the numerical evaluation, and (5) a digital display, indicating the measured hardness number.

3.3.2 UCI Probe

There are different probes available for UCI method. They typically cover static loads ranging from 1 N to 98 N. According to different purposes, there are different length of the sensor rods.

3.3.3 Summary of UCI Method

In conventional workbench hardness testing like Brinell or Vickers hardness test according to Test Methods E 10, E 92 and E 384, the hardness value is determined optically by the size of the indentation in the material generated by a certain test load, after the indenter has been removed. In the mobile hardness test under applied load according to the UCI method, however, the size of the produced indents are not determined optically. Instead the contact area is derived from the electronically measured shift of an ultrasonic resonance frequency. To carry out the UCI test, a probe containing the rod with the indenter is excited into a longitudinal ultrasonic oscillation of about 70 kHz by piezoelectric ceramics—the so-called zero frequency, which occurs when the indenter is vibrating in air.

A spring inside the probe applies the specified test load, the vibrating tip penetrates into the material creating an elastic contact, which results in a positive frequency shift of the resonating rod. This shift is related to the size of the indent area (contact area of the indenter with the material). The size, in turn, is a measure for the hardness of the test material at a given modulus of elasticity, for example, HV(UCI) according to Eq 1.

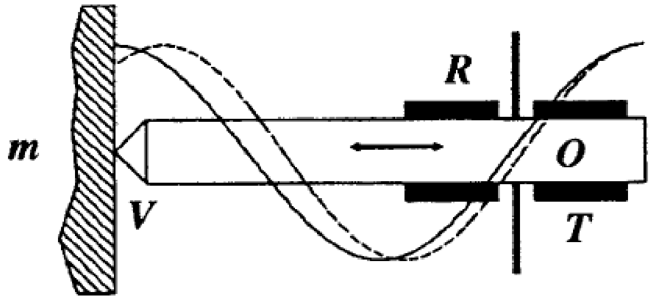


Figure 1 Schematic Description of the UCI Probe

——— longitudinal amplitude (no contact)

-------- longitudinal amplitude (in contact)

T = Piezo Transducer

R = Receiver

O = Oscillating rod

V = indenter, for example, Vickers diamond

m = test material

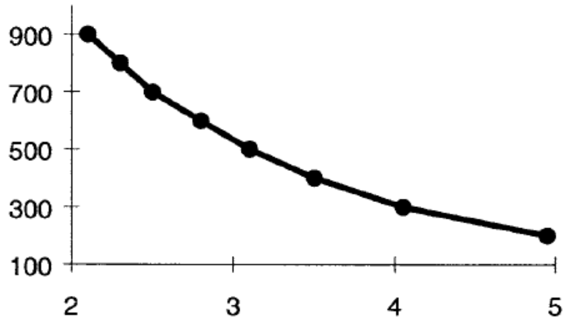
$$\text{UCI} \qquad\qquad \text{Vickers}$$

$$\Delta f = f(E_{eff} \cdot A) \quad \text{and} \quad HV = \frac{F}{A}$$

$$\uparrow\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\uparrow$$

Eq 1

Therefore, the frequency shift is relatively small for hard materials, because the indenter penetrates not very deep into the test material leaving only a small indent. The frequency shift becomes larger if the indenter penetrates deeper into the material, indicating medium hardness, in accordance with the larger test indentations. Analogously, the frequency shift becomes largest when soft materials are tested (see Figure. 2).



Frequency Shift（kHz）

Figure2 Hardness Value versus Frequency Shift of the Oscillating Rod

The instrument constantly monitors the resonance frequency, calculates the frequency shift when the specified test load has been reached either after the internal switch has triggered the corresponding measurement frequency in the case of handheld probes. The instrument carries out the evaluation and calculations, and displays instantaneously the hardness value, for example, HV(UCI).

The frequency shift is a function of the indentation size of a defined indenter, for example, a Vickers diamond, at a given modulus of elasticity of the measurement system.

Eq 1 describes the basic relation in comparison to the definition of the Vickers hardness value: Δf = frequency shift, A = indentation area, E_{eff} = effective elastic modulus (contains the elastic constants of both the indenter and the test piece), HV = Vickers hardness value, F = Force applied in the hardness test.

3.3.4 The Influence of the Elastic Constants

As can be seen in Eq 1, the frequency shift not only depends on the size of the contact area but also on the elastic moduli of the materials in contact. To allow for differences in Young's modulus, the instrument has to be calibrated for different groups of materials. After calibration, the UCI method can be applied to all materials, which have the corresponding Young's modulus.

As manufactured, the UCI instrument usually has been calibrated on non-alloyed and low-alloyed steel, that is, certified hardness reference blocks according to Test Method E 92. Besides this, some instruments may be calibrated quickly, also at the test site, for metals such as high-alloyed steels, aluminum or titanium.

3.4 Calibration to Other Materials

A test piece of the particular material is needed. The hardness value should be determined with a standardized workbench hardness tester like one for Vickers, Brinell or Rockwell according to Test Methods and Definitions A 370. It is recommended to take at least 5 readings and calculate the average hardness value. Now carry out a set of at least 5 single UCI measurements on your test material according to instructions in 10.6, adjust the displayed average value to the before measured hardness of the material and thus find the calibration value which is necessary for further measurements on this particular material in the desired hardness scale and range. Some instruments allow storing all calibration data and adjustment parameters for hardness testing of different materials. They can be recalled to the instrument as needed.

3.5 Comparison with Other Hardness Testing Methods

As opposed to conventional low load hardness testers, the UCI instruments do not evaluate the indentation size microscopically but electronically according to the UCI method. The UCI method yields comparative hardness measurements when considering the dependency on the elastic modulus of the test piece.

After removing the test force, an indentation generated by the UCI probe using a Vickers diamond as indenter and mounted in a test stand is practically identical to a Vickers indentation produced by a workbench tester of the same load.

3.6 Characteristics of UCI method

- **Directly test Vickers hardness value of workpiece, and there is no need to convert like Leeb or Shore hardness tester. The conversion error is eliminated.**
- **High test speed -- output test results within seconds**
- **Standard Vickers indentation, tiny indentation, little damage to the workpiece**
- **The test results are related to the elastic constants of the workpiece. New workpiece needs to be calibrated according to the elastic constants.**
- **Small volume, light weight and easy to carry.**
- **Easy to test on assembly line.**
- **It can be used for testing on site and testing large workpiece and can be used to make hardness measurements on positions difficult to access, such as tooth flanks or roots of gears.**
- **Only measuring the hardness condition of the surface contacted**
- **The development of microcontroller technology makes it easy to calibrate workpiece with different elastic constants.**

4. Ultrasonic Hardness Tester

4.1 Host and Accessories

Ultrasonic hardness tester is composed of host, probe and probe connection cable. The probe is connected to the host with an eight-core connection cable for signal transmission. The host adopts a color display with rich display content.

There are nine buttons on the front of the host to operate.

A USB interface is on the side of the host for charging and communication.

The charge lamp near the USB interface is used to indicate charging status.

4.2 Probe

Probe	1kgf manual probe	2kgf manual probe	3kgf manual probe	5kgf manual probe	10kgf manual probe
Accessory	Optional	Standard	Optional	Optional	Optional
Test force	9.8N	19.6N	29.4N	49N	98N
Diameter	22mm	22mm	22mm	22mm	22mm
Length	150mm	150mm	150mm	150mm	150mm
Resonating rod diameter	2.4mm	2.4mm	2.4mm	2.4mm	2.4mm
Maximum roughness of test surface	Ra<3.2µm	Ra<5µm	Ra<5µm	Ra<10µm	Ra<15µm
Minimum workpiece weight	0.3kg	0.3kg	0.3kg	0.3kg	0.3kg
Minimum workpiece thickness	2mm	2mm	2mm	2mm	2mm
Application	Ion nitriding die, formwork, fixture, thin-walled workpiece, bearing, tooth flanks, pipeline	Ion nitriding die, formwork, fixture, thin-walled workpiece, bearing, tooth flanks, pipeline	Ion nitriding die, formwork, fixture, thin-walled workpiece, bearing, tooth flanks, pipeline	Groove, tooth flanks, roots of gears	Small forgings, foundry materials, weld inspection, HAZ, low requirement for roughness

4.3 Functional Characteristics

- **Main hardness scale: HV**

  Convertible hardness scale: HRC, HRA, HRB, HBW
- **In multi-points calibration mode, any hardness scales can be chosen.**
- **Testing range: HV50~1599, HRC20~68, HB85~650**
- **Test direction：Support 360° test, as long as the angle between the indenter and the surface doesn't exceed 90° ± 3°.**
- **Battery: 3.6V, 3000mAh lithium battery**
- **Endurance: 10 hours**
- **Test data can be exported to computer terminal.**
- **Norms: DIN 50159-1-2008; ASTM-A1038-2005; JB/T 9377-2010; JJG-654-2013; JJF 1436-2013.**
- **High accuracy----±4%HV, ±4%HB, ±1.5HR.**
- **Tiny test indentation---- requires a high-power microscope to see.**
- **Little damage to the workpiece.**
- **High test speed----output test results in 1s at the soonest.**
- **New appearance design, innovative sculpt, convenient to hold and good craft.**
- **Full English display, menu-type operation, few keys, simple and convenient to operate.**
- **3.5 inches large LCD screen with 320×480 color graphics dot matrix, beautiful font and graphics, rich information and clear display.**
- **Directly display the current measured value, cumulative measured value, maximum value, minimum value, average value and conversion value.**
- **50 sets of data storage.**
- **Simple calibration----5 sets of one-block calibration data, 1 set of default calibration data and 5 sets of multi-blockss calibration data can be stored in the host.**

- **For materials with different elastic constants, just an one-block calibration is required to adapt to the new material.**
- **For unknown material or material without conversion table, the hardness scale can be arbitrarily selected for multi-points calibration to eliminate the systematic error brought by the conversion table.**
- **Easy to test on assembly line.**

4.4 Accuracy

<table>
<tr><td>Model</td><td>Ultrasonic Hardness Tester</td></tr>
<tr><td>Test range:</td><td>HV50-1599, HRC20-68, HB85-650, HRB41-100, HRA61-85.6, HS34.2-97.3, MPa255-2180</td></tr>
<tr><td>Accuracy</td><td>±4%HB, ±1.5HR, HV please refer to the table below</td></tr>
<tr><td>Accuracy</td><td>
<table>
<tr><td rowspan="2">Hardness value</td><td colspan="4">Maximum allowable relative error of hardness tester %</td></tr>
<tr><td>HV10</td><td>HV5</td><td>HV2</td><td>HV1</td></tr>
<tr><td><250HV</td><td>4</td><td>4</td><td>4</td><td>4</td></tr>
<tr><td>250HV-500HV</td><td>4</td><td>4</td><td>4</td><td>4</td></tr>
<tr><td>>500HV-800HV</td><td>4</td><td>4</td><td>5</td><td>5</td></tr>
<tr><td>>800HV</td><td>4</td><td>4</td><td>6</td><td>6</td></tr>
</table>
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4.5 Application

- **Hardness test of flange edge and gear root stamping parts, mold, thin plate, face-hardened gear tooth, gear groove and taper part**
- **Hardness test of axle and thin-wall pipes and vessels**
- **Hardness test of wheels and turbine rotors**
- **Hardness test of bit edge**
- **Hardness test of welding parts**
- **Measure the depth of deep hole with certain aperture, concave and convex with large radians, and irregular plane**
- **Hardness test of most ferrous and nonferrous metals and their alloys in industrial production**
- **Hardness test of thin coatings**
- **etc.**

5. Workpiece Requirements for UCI method

Because ultrasonic hardness tester is a kind of Vickers hardness tester, the requirements of Vickers hardness tester are also met by ultrasonic hardness tester.

5.1 Surface Preparation

While smooth, homogeneous surfaces can be tested with low test loads, rougher and coarse-grained surfaces require test loads as high as possible. However, the surface must always be free of any impurities (oil, dust, etc.) and rust.
The surface roughness should not exceed≈30 % of the penetration depth ($Ra \leq 0.3 \times h$) with:

$$\mathrm{h}[mm] = 0.062 \times \sqrt{\frac{F[N]}{H[HV]}}$$

5.1.1 Surface Roughness

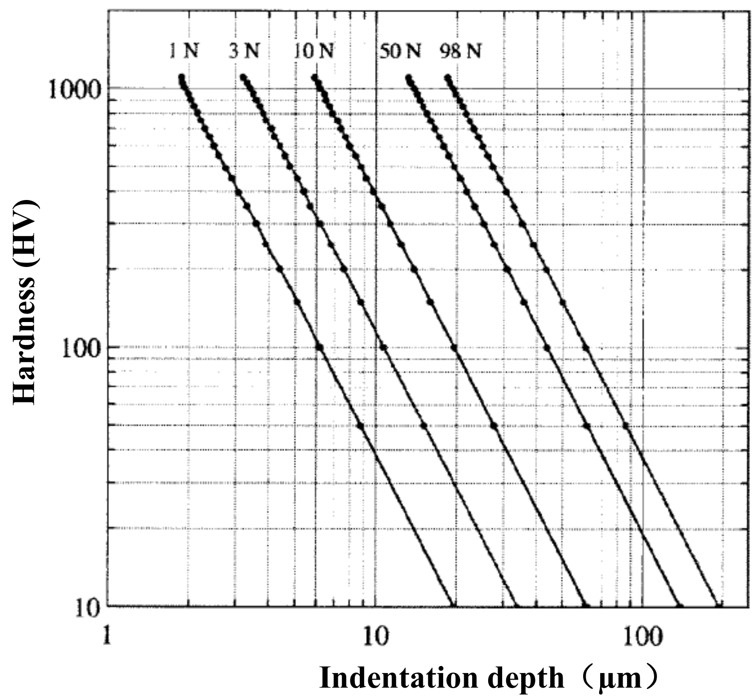
Surface roughness for different loads:

Test load	98 N	50 N	10 N	3 N
Ra	⩽15 µm	⩽10 µm	⩽5 µm	⩽2.5 µm

5.2 Minimum Thickness

Thin coatings or surface layers on bulk material must have a minimum thickness of at least ten times of the indentation depth of the indenter used (see Figure 3 for a Vickers indenter) corresponding to the Bueckle's rule:

Smin = 10×h (indentation depth)



5.3 Minimum Wall Thickness

Distinct reading variations may especially occur with a specimen thickness of less than about 15 mm if the test material is excited to resonance or sympathetic oscillations (for example, thin blocks, tubes, pipes, etc.). Most disturbing are flexural vibrations excited by the vibrating tip. These should be suppressed by

suitable means. Sometimes attaching the test piece to a heavy metal block by means of a viscous paste, grease or oil film suffices to quench the flexural waves. Nevertheless, a minimum wall thickness of 2 to 3 mm is recommended.

5.4 Influence of the Oscillation

The UCI method is based on measuring a frequency shift. Parts less than about 300 g can go into self-oscillating causing erroneous or erratic readings. Test pieces of weights less than the minimum or pieces of any weight with sections less than the minimum thickness require rigid support and coupling to a thick, heavier non-yielding surface to resist the oscillation of the UCI probe. Failure to provide adequate support and coupling will produce test results lower or higher than the true hardness value.

5.5 Surface Curvature

Test pieces with curved surfaces may be tested on either the convex or concave surfaces providing that the radius of curvature of the specimens is matched to the appropriate probe and probe attachment in order to ensure a perpendicular positioning of the probe.

5.6 Temperature of the Workpiece

The temperature of the test piece may affect the results of the UCI hardness test. However, if the probe is exposed to elevated temperature for only the time of measurement, measurements are possible at temperatures higher than room temperature, without influencing the performance of the UCI instrument.

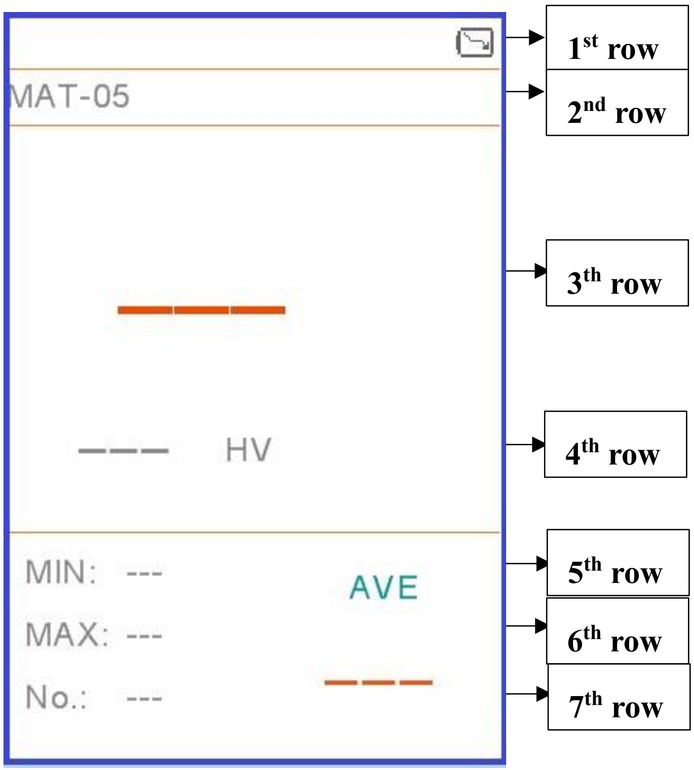
6. Operating Instructions

6.1 Turn on & Turn off

Press the "on/off" button in the upper right corner of the host to turn on and turn off. The host will shut down automatically after 5 minutes without any operation.

6.2 Main Interface

- **After turning on, the display shows probe connection accomplished and then enters the test interface.**
- **The first row shows the time, autosave or not, and battery power.**
- **The second row shows the name of the calibration file selected, conversion table and sampling time.**
- **The third row shows the hardness value of the selected hardness scale.**
- **The fourth row shows Vickers hardness values.**
- **The fifth row to seventh row show the minimum value, maximum value, number of tests, and average value.**



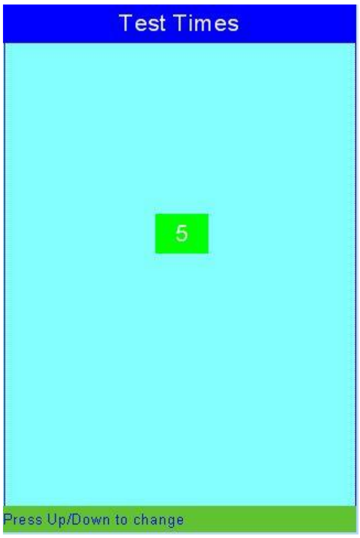
6.3 Main Menu

Press "menu" button to enter the main menu, and press up, down, left and right with confirm and exit button can select Meas Setup, System, Material, Storage and Menu.

6.4 Meas Setup

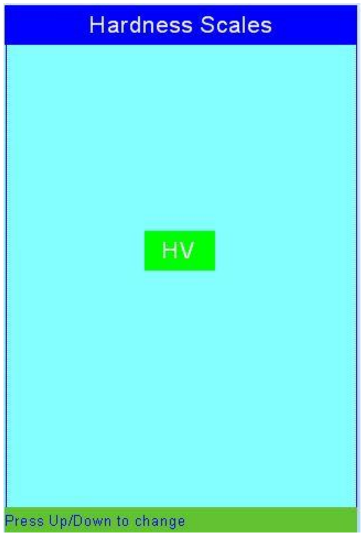
In this interface, user can choose to change the Test Times, Hardness Scales, Conversion Table and Sampling Time.

6.4.1 Test Times



Setting test times, the default value is 5 and the maximum is 32.

6.4.2 Hardness Scales



Optional hardness scales:

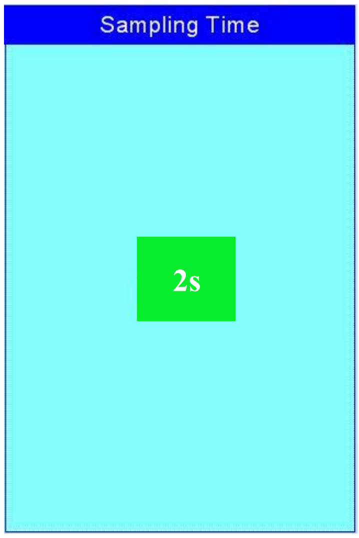
HV/HRA/HRB/HRC/HB/HS/MPa。

6.4.3 Conversion Table

There are three conversion tables, and these tables only for steel.

Optional conversion table: ASTM140/ISO18265/GB1172

6.4.4 Sampling Time

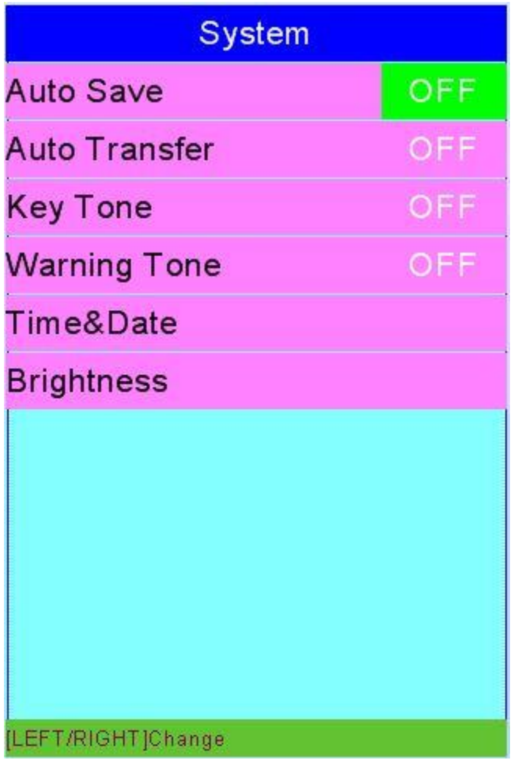


Sampling time Setting, system will begin testing the frequency after the probe contacts the workpiece for n seconds, default value is 2 seconds, optional 1s~5s and 0s(peak frequency).

Note: When sampling time is set to 0s, all test pieces need to go through the coupling process, and the first test value will be inaccurate. After the first test, the coupling is completed, and the test value will be correct from the second test.

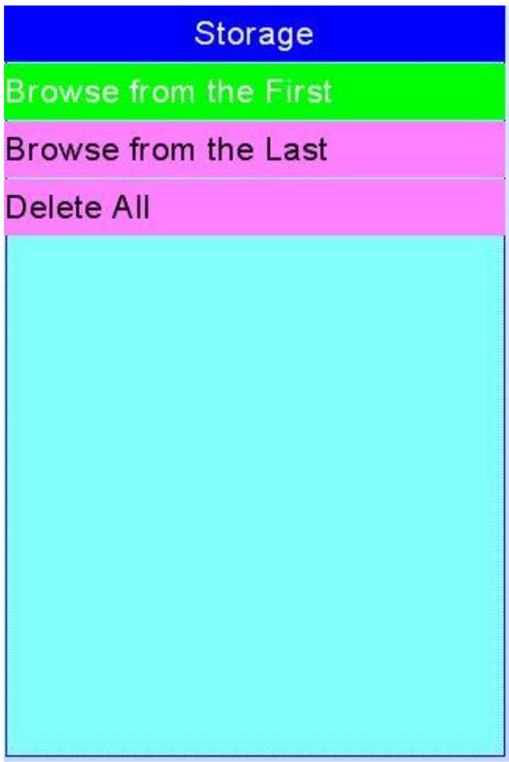
6.5 System

- Switch on auto save, can storage test data at any time.
- Switch on auto transfer, test data will be automatically transferred to the computer via USB after every set of tests.
- In Time&Date, you can set current time.
- Brightness option, default value is 20, increasing brightness of the display will increase battery power consumption.

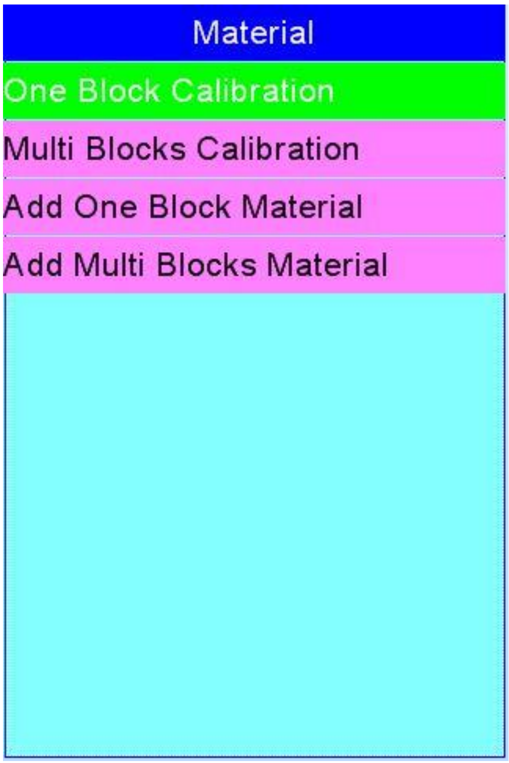


6.6 Storage

- After auto save is switched on, you can browse the test data from first or last set.
- You can delete a single set of data during browsing or delete all data in the interface on the right.



6.7 Material



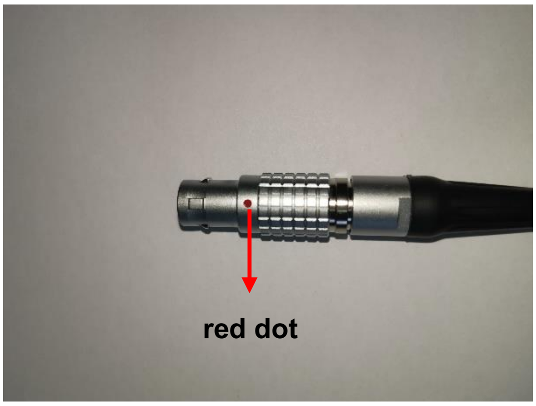
- **For materials with different elastic constants, only a one-block calibration is required to adapt to the new material.**
- **For unknown material or material without conversion table, the hardness scale can be arbitrarily selected for multi-points calibration to eliminate the systematic error brought by the conversion table.**
- **In the interfaces for selecting one block and multi blocks calibration, move the cursor to the calibration file and press delete can delete the selected calibration file.**

Please refer to next chapter for detailed operation!

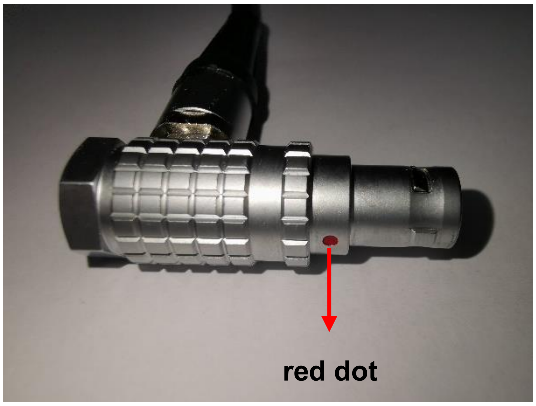
7. Detailed Operation for Actual Workpiece

7.1 Preparation

- Connecting the 90° plug of the connection cable to the eight-core socket on the end of the probe, then connecting the 180° plug of the cable to the eight-core socket on the host, please note that the red dot of both plug and socket must be on the same side, when a click is heard, the plug has been successfully inserted into the socket. Please be sure the red dot of both plug and socket must be on the same side, do not use brute force, in case of any damage to the plug and socket!



- After the probe is connected to the host, it can be started up to check whether the probe is connected successfully. If connected successfully, the display shows probe connection accomplished; If the display shows probe connection failed, please check if the plug has been properly connected to the socket, use may unplug the plug and try again. If the probe still failed to connect to the host, the device may be broken, please contact the manufacturer to repair.

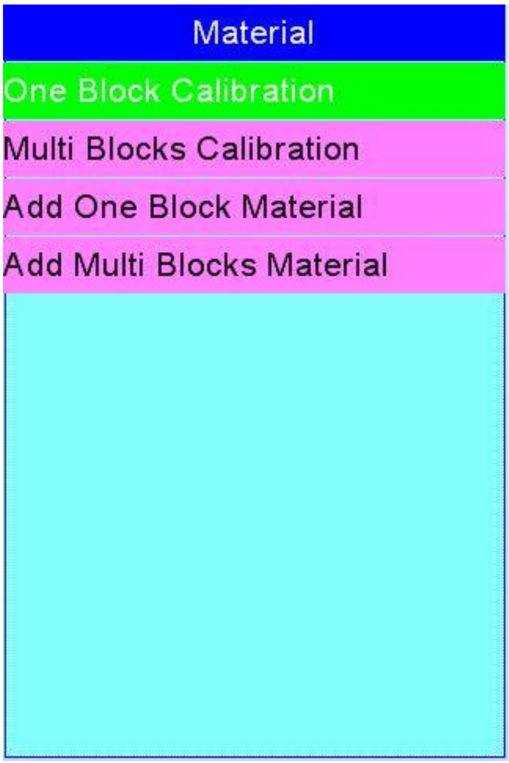


- Please note! The host of the device is one-to-one correspondence with the probe, please keep them for a complete set. please put the device in the ABS protection case for safekeeping.

7.2 Test Steel with Default Calibration File

Elastic Constant: 2.1*10^{5}MPa

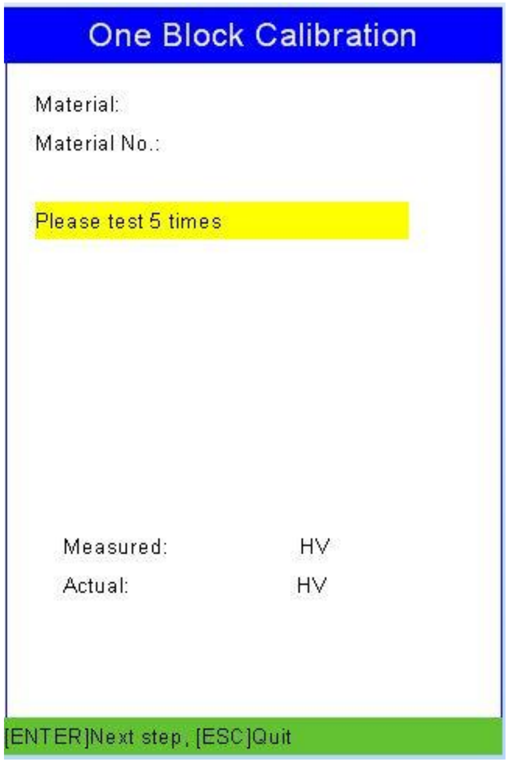
- **If the elastic constant of the workpiece is known to be about 2.1*10^5 MPa, user can directly use default calibration file(steel(default)) to test.**
- **Enter material interface, select "One Block Calibration".**
- **Select calibration file—steel(default).**
- **E.g.: Hardness scale is selected to HV, sampling time is 2s, test time is 5(can be changed in Meas Setup).**
- **Hold the probe in both hands, perpendicular down to the surface of the workpiece(angle of inclination≤ 3°), press down the probe to the workpiece at a constant speed within 2 seconds, then keep it pressed down and wait until the measurement process is complete, lift the probe while the display shows the measured value, repeat this step five times to get an average value。**
- **Other hardness scales (HR/HB) and conversion table (ASTM/ISO/GB) are available (The material must be steel).**



7.3*One Block Calibration (Consult Theory Chapter3.3.4)

7.3.1 Applicable Conditions

When the difference value of elastic constant between the actual workpiece and the standard hardness workpiece (Elastic Constant: 2.1*10^5MPa) in the case is large, the measured value will exist a deviation. This time, users can use one block calibration to correct. One block calibration is only used for Vickers hardness test, because it needs to do Vickers theoretical calculations.

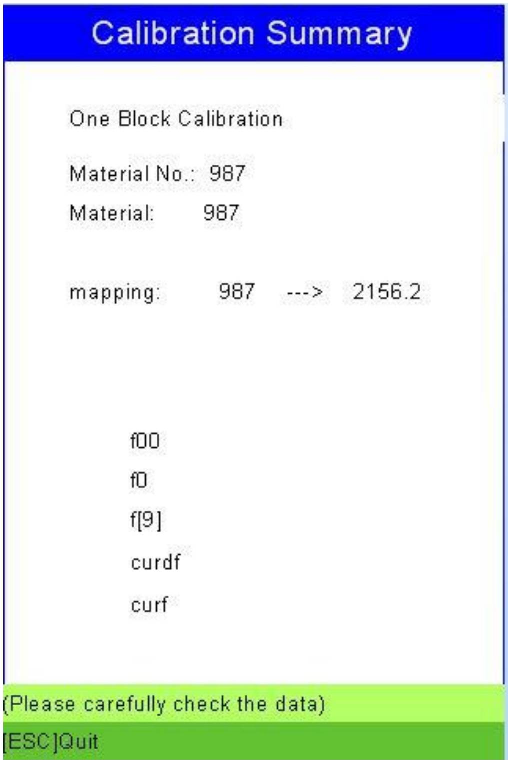


7.3.2 Operating Steps

1. **Enter material interface. Select "Add One Block Material", record the name of the file on "Add Basic Material" interface (for example MAT-01), which helps to select the calibration file for subsequent tests; A total of five sets of calibration files can be added.**

2. Press ENTER to continue.

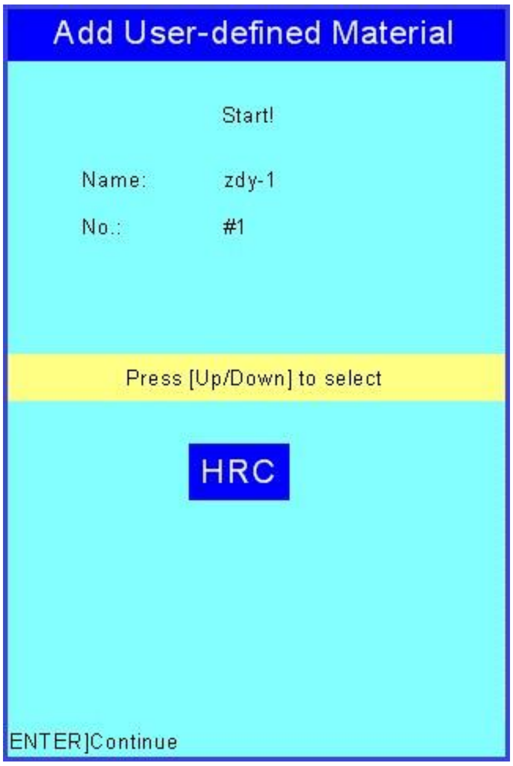
3. Test 5 times on a workpiece with a certain Vickers hardness value， hold the probe in both hands, perpendicular down to the surface of the workpiece(angle of inclination≤ 3°), press down the probe to the workpiece at a constant speed within 2 seconds, then keep it pressed down and wait until the measurement process is complete, lift the probe while the display shows the measured value, repeat this step five times to get an average value, measured values with large error in the test can be deleted directly by using the delete button. Adjust the measured value to the actual value by up, down, left, right buttons, then press enter button into calibration summary.



4. Please carefully check the calibration information, then press exit button to return to main interface, then users can measure the workpiece now.

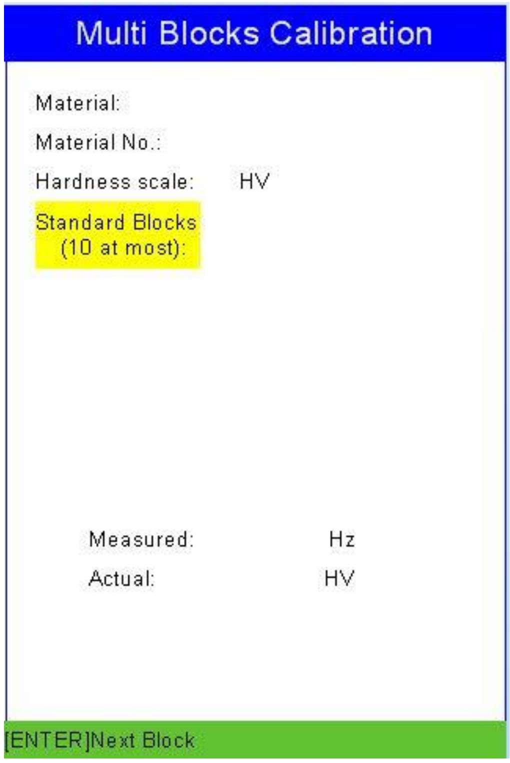
7.4* Multi Blocks Calibration (Consult Theory Chapter3.4)

7.4.1 Applicable Conditions



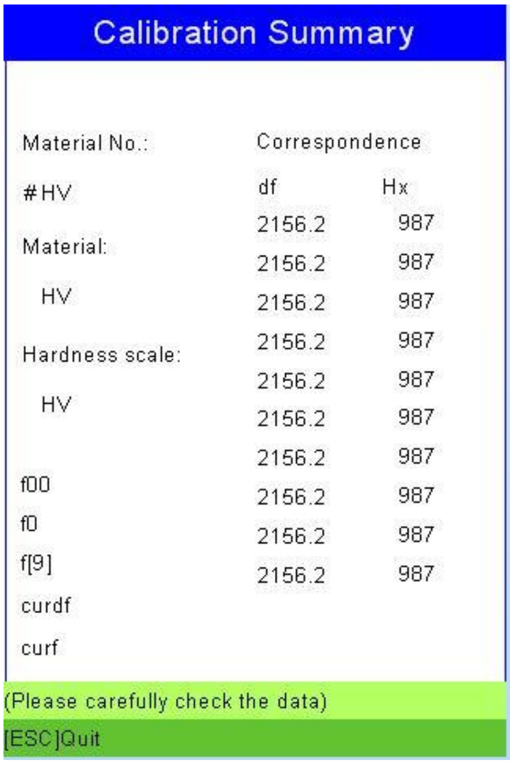
When the material of the workpiece is particular, one block calibration can not satisfy the test, at this time, users can adopt multi blocks calibration. Standard hardness blocks of the same material as the workpiece about to tested should be prepared (2~10 pieces), the hardness value should be determined with a standardized workbench hardness tester like one for Vickers, Brinell or Rockwell. The standard hardness blocks can be prepared by the users or contact the manufacturer and distributors.

7.4.2 Operating Steps



1. **Enter material interface. Select "Add Multi Blocks Material", record the name of the file on "Add User-defined Material" interface (for example MAT-06), which helps to select the calibration file for subsequent tests; A total of five sets of calibration files can be added.**

2. Press up and down buttons to select a hardness scale on "Add User-defined Material" interface.



3. Select hardness scale and press enter into calibration interface (Please prepare at least 2 standard hardness blocks, 10 at most).
4. Hold the probe in both hands, perpendicular down to the surface of the workpiece(angle of inclination≤ 3°), press down the probe to the workpiece at a constant speed within 2 seconds, then keep it pressed down and wait until the measurement process is complete, lift the probe while the display shows the frequency value, repeat this step five times to get an average value, measured values with large error in the test can be deleted directly by using the delete button. Adjust the measured value to the actual value by up, down, left, right buttons, then press enter button to calibrate next standard block.
5. Calibrating the remaining standard hardness blocks, after finishing all the calibrations, press enter button into calibration summary.
6. Please carefully check the calibration information, then press exit button to return to main interface, then users can measure the workpiece now.

8. Operating Conditions

a) Temperature: -10℃~40℃

b) Humidity: ≤ 90%RH

c) No strong electromagnetic interference

9. Specification

Battery: 3000mAh/3.7V

Host size: 170mm*70mm*20mm

Probe size: Ǿ22mm*150mm

Weight: 650g

10. Packing List

10.1 Standard Delivery

- Host
- Manual probe (2kgf)
- Probe connection cable
- 5V ac power adapter
- USB cable
- Standard hardness workpiece
- Equipment box
- Operating manual
- Certificate
- Warranty card
- Packing list

10.2 Optional Accessories

- Probe (1kgf, 3kgf, 5kgf, 10kgf)
- Operating platform

11. Referenced ASTM Standards

A 370 Test Methods and Definitions for Mechanical Testing of Steel Products

E 10 Test Method for Brinell Hardness of Metallic Materials

E 18 Test Methods for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials

E 92 Test Method for Vickers Hardness of Metallic Materials

E 140 Test Method for Hardness Conversion Tables for Metals

E 384 Test Method for Micro indentation Hardness of Materials

Declaration