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Manual
Hardness Tester PCE-2500

Version 1.2
26.02.2016

Content

1 Introduction

Thank you for purchasing a PCE-2500 hardness tester from PCE Instruments.

1.1 Forewords

1.1.1 History

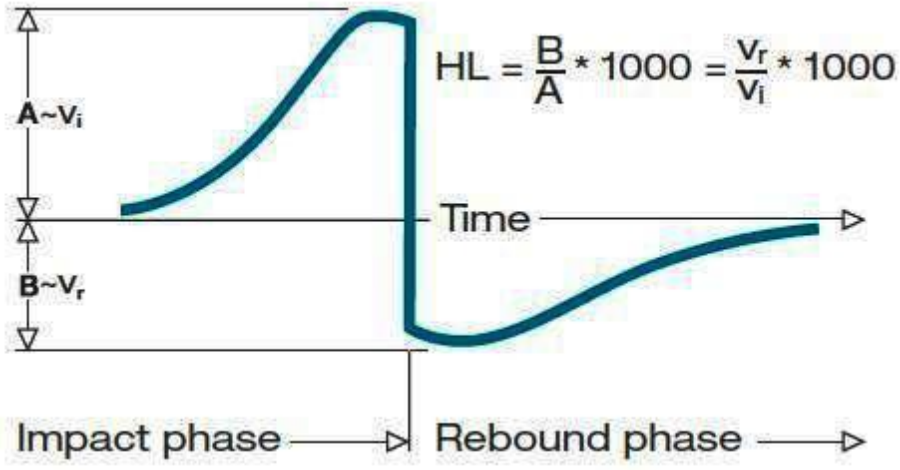
The Leeb measuring method was first brought into measurement technology in 1978. It is defined as the quotient of an impact body's rebound velocity over its impact velocity, multiplied by 1000. Harder materials produce a higher rebound velocity than softer materials. For a specific group of material (e.g. steel, aluminum. etc.), Leeb hardness value represents a direct relationship to its hardness properties. For ordinary metal, conversion curves of hardness HL versus other standard static hardness (HB, HV, HRC, etc.) are available, enabling you to convert HL into other hardness values.

1.1.2 Leeb Hardness Test (definition)

An impact body with a spherical test tip made of tungsten carbide is propelled against the sample surface by a spring force and then rebounds back. At a distance of 1mm from the sample surface, the impact and rebound velocity of the impact body are measured by the following method: A permanent magnet embedded in the impact body, when passing through the coil in its coil holder, induces in the coil an electric voltage proportional to the velocities of the magnet. Leeb hardness is expressed by the following formula:

$$HL = \frac{Vr}{Vi} * 1000$$

Where: HL is Leeb Hardness
Vr is the rebound velocity of the impact body
Vi is the impact velocity of the impact body
The voltage characteristic of output signal, when the impact body passes through the induction coil is illustrated in the following figure:



Voltage characteristic of output signal

A Leeb's Hardness Tester measures the hardness of sample material in terms of Hardness Leeb (HL), which can be converted into other Hardness units (Rockwell B and C, Vicker, Brinell and Shore D).

1.1.3 Notation of Leeb's Hardness

When measuring the hardness of a sample material using the traditional static hardness testing method, a change of applied pressure will result in a change in the hardness reading. This will also happen during a Leeb's Hardness test when one changes the impact device. In hardness measurement of the same test sample with different impact devices, the Leeb's hardness values obtained will vary.
For example: 720HLD≠720HLC
Because different converting curves are obtained from different impact devices, when converting hardness HL into different hardness values, the notation for the converted hardness value should include the impact device used.
For example:
Hardness HRC converted from hardness L using impact device D should be written as 35, 9 HRCLD.
Where: 35=Hardness value HL
9=Hardness value HRC
L=Leeb's Method
D=Impact device

2 Safety information

Please, read this user's handbook carefully and completely, before you put it into service for the first time. The device may only be used by carefully trained staff. We do not assume any liability for damage and injuries caused by non-observance of this manual.

- This meter must only be used in the way described in this manual. If used otherwise, this can lead to dangerous situations for the user or damage / destruction of the device.
- The device may only be used in the specified temperature / humidity range. Do not expose it to extreme temperatures, direct sunlight, extreme air humidity or moisture.
- Never use the device when your hands are wet.
- The case should only be opened by qualified personnel of PCE Instruments.
- The instrument should never be placed with the user interface facing an object (e.g. keyboard side on a table).
- You should not make any technical changes to the device.
- The appliance should only be cleaned with a damp cloth / use only pH-neutral cleaner, no abrasives or solvents.
- The device must only be used with original PCE spare parts or equivalent.
- Do not use the meter in explosive atmospheres.
- When the battery is flat (battery level indicator), please do not use the device anymore as false readings can cause life-threatening situations. You can carry on with your measurement after inserting new batteries.
- Before each use, check the device by measuring a known factor.
- The limit values for the measuring variables stated in the specifications must under no circumstances be exceeded.
- When not using the device for a longer period of time, please remove the batteries to avoid damage due to battery leakage.

This user's handbook is published from PCE Instruments without any guarantee.

We expressly point to our general guarantee terms which can be found in our general terms of business.

If you have any questions please contact PCE Instruments.

3 Features and Application

3.1 Introduction

This instrument is an advanced state-of-the-art palm sized metal hardness tester with many new features which are light weight, easy operation, integrated design, high contrast display, low operating temperature, auto compensating for impact direction and etc. It can be widely used for measuring hardness of almost all ferrous and non-ferrous metal materials for scale of Leeb hardness, Rockwell C, B &A, Brinell, Vickers, Shore and Strength.
It has a memory which can be downloaded to computer via USB port or wirelessly. All stored data can be recalled and read on the tester easily.
The 3.7V Li-ion rechargeable battery inside the tester can be charged via USB from PC or via individual USB charger from mains wall power. With data software for PC, customers can download measuring values from the tester to PC and make process such as save, delete, create testing report and export them to Excel.

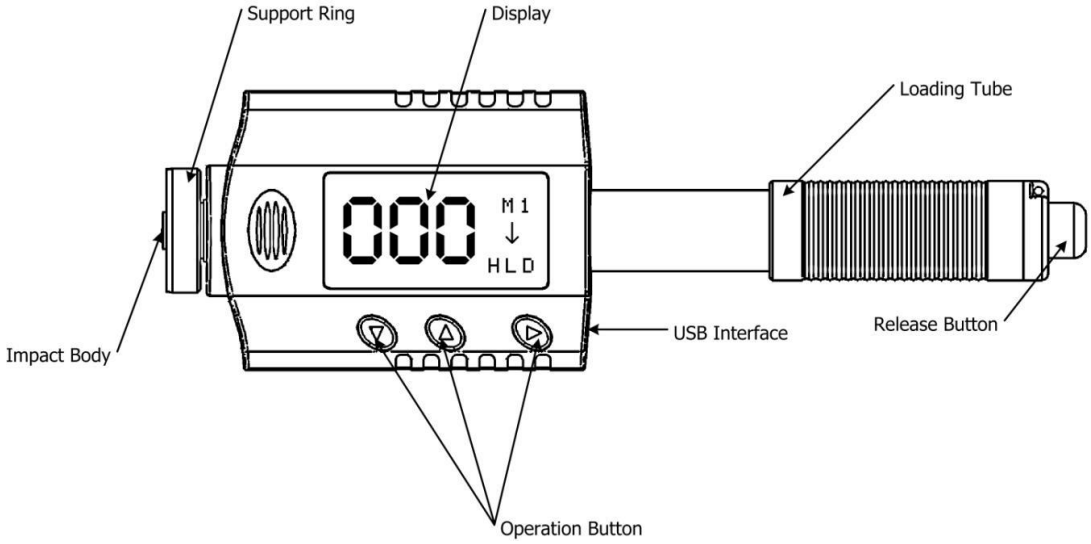
3.2 Specifications

Accuracy	+/-2HL (or 0.3%@HL=800)
Display	Digital with high contrast OLED
Impact direction	Universal angle, no need to setup impact direction
Display mode	Normal/flip or upward/downward
Hardness scale	HL / HRC / HRB / HB / HV / HS / HRA / σb
Measuring range	HL170-960 / HRC17-70 / HRB13-109 / HB20-665 / HV80-940 / HS32-99.5 / HRA30-88 / σb(rm)255-2639N/mm^2
Impact device	D
Materials	10 common metal materials
Memory	30 files, 100 data (measurement value, material, …) for each file
Interface	USB for charging
Alarm	Up or down limit
Indicator	Low battery
Power supply	3.7 V Li-ion rechargeable battery
Power on/off	Auto
Operating environment	-40 ... +70 ^{0}C
Dimensions (L x W x D)	148 mm × 44 mm × 22 mm
Net weight	110 g
Standards	Conforming to ASTM A956, DIN 50156, GB/T 17394-1998

3.3 Applications

- Hardness tests on installed machines or steel structures: e.g. on heavy and large work-piece or on permanently installed system parts.
- Rapid testing of multiple measuring areas for examination of hardness variations over larger regions. Measuring hardness for produced parts at production line.
- Identifying metallic material stored in a warehouse.
- Ineffectiveness analysis of permanent parts, pressure -vessel, turbo generator.

4 Device description



5 Symbols and Illustrations

5.1 Symbols and Illustraions

Symbols	Illustrations
HLD	Leeb hardness value used with impact device D
LDL	Leeb hardness value used with impact device DL
HB	Brinell hardness value
HRB	Rockwell B hardness value
HRC	Rockwell C hardness value
HS	Shore hardness value
HV	Vickers hardness value
HRA	Rockwell A hardness value
σb (N/mm2)	Strength value

5.2 Measurement and Conversion Table

Range of measurement and conversion:

IMPACT DEVICE D	HLD: 170-960						
MATERIALS	H R C	H R B	H B	H V	H S	HRA	σb (N/mm²)
STEEL/CAST STEEL	20.0-67.9	59.6-99.5	80-647	80-940	32.5-99.5	30-88	375-1710
ALLOY TOOL STEEL	20.5-67.1			80-898			1170-2639
STAINLESS STEEL	19.6-62.4	46.5-101.7	85-655	85-802			740-1725
LAMELLAR IRON	21-59	24-100	93-334	90-698			
NODULAR IRON	21-60	24-100	131-387	96-724			
CAST ALUMINUM		24-85	30-159	22-193			
BRASS		13.5-95.3	40-173				
BRONZE		14-100	60-290				
WROUGHT COPPER		14-100	45-315				
FORGING STEEL			142-651				
IMPACT DEVICE DL	LDL: 560-950						
MATERIALS	H R C	H R B	H B	H V	H S	HRA	σb (N/mm²)
STEEL/CAST STEEL	20.6-68.2	37.0-99.9	81-646	80-950	30.6-96.8		
ALLOY TOOL STEEL	20.5-67.1						

6 Preparation before Measuring

6.1 Requirements for the sample

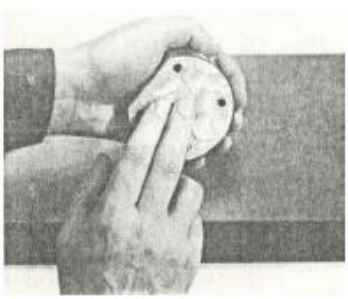
6.1.1 The surface temperature of the sample should be less than 120 °C.

6.1.2 The sample must feature a metallic smooth, ground surface, in order to eliminate erroneous measurements brought about by coarse grinding or lathe scoring. The roughness of the finished surface should not exceed 2 µm.

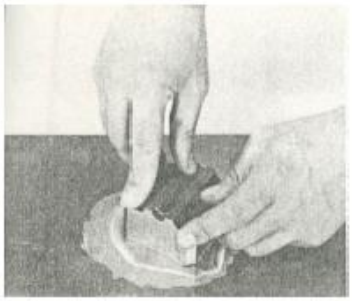
6.2 Requirements for the weight of the sample

For samples weighing over 5 kg and of compact shape, no support is needed.
Samples weighing between 2-5 kg, and also for heavier samples with protruding parts or thin walls, should be placed on a solid support in such a manner that they do not bend or move by the impact force.
Samples weighing less than 2 kg should be firmly coupled with a stable support weighing over 5 kg.
For coupling purposes,
- the coupling surface between the sample and base plate should be flat, plane parallel and ground.
- A thin proper layer of coupling paste is to be applied to the contact surface of the sample.
- The sample should be firmly pressed against the surface of the base plate by moving it with a circular motion.
- The direction of impact should be perpendicular to the coupling surface.
- For the coupling operation, the following prerequisites must be fulfilled:
- The contact surface of the sample and the surface of the base plate must be flat, plane parallel and ground.
- The direction of the test impact must be perpendicular to the coupled surface.
- Minimum thickness of the sample for coupling (5mm).

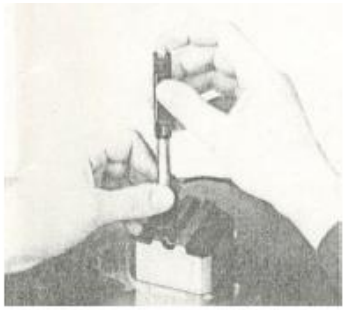
Proper Coupling:
Proper coupling requires a little experience. Insufficiently coupled samples produce large variations of individual measurements, L-values which are too low and the operation is characterized by a rattling noise upon impact of the test tip.
Example for coupling a test piece with a base plate:



Application of the coupling paste (As thin as possible).



Mutual rubbing of both parts while firmly press the sample against the base plate.



A particular advanced of coupling is the possibility of obtaining a very uniform, rigid connection between the sample and the support, totally eliminating stresses at the sample surface. The resulting variation in measured values is very low.

6.3 Requirement for the surface hardened layer of the sample

Surface -hardened steels and especially case-hardened steels produce L-values which are too low when case-hardening depth is small because of their soft core. When measuring with impact device D/DL the depth of the hardened layer should be no less than 0.8 mm.

Surface of the test sample should not be magnetic.

For test sample of curving surface with radius of curvature R less than 30mm, a small support ring should be used.

6.4 Supporting the Samples during testing

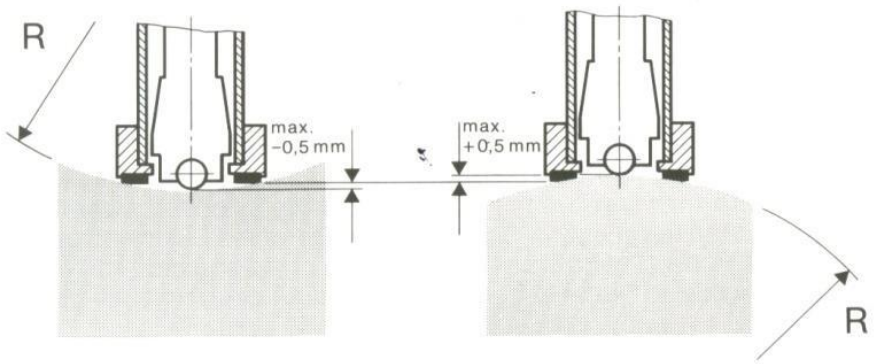
Type of impact device	Classification of samples		
	heavy	medium-weight	light-weight
D/DL	more than 5 kg	2 - 5 kg	0.05 - 2 kg

When measuring hardness with this tester, the following has to be noticed: Despite the low mass of the impact body and low impact energy, a relatively large impact force of short duration is generated when the impact body hits the measuring surface. The max. impact force of impact device D/DL is 900N.
For heavy samples of compact shape, no particular precautions are necessary.
Smaller and lighter samples or work pieces yield or flex under this force, producing L-values which are too small and of excessively large variation. Even with big or heavy work pieces it is possible for thin-wall regions or thinner protruding parts to yield upon impact. Depending on the frequency of the resilient yielding action, the measured L-value may be too small or too large. In many situations, potential problems can be checked in the following manner:

a) Medium-weight samples and also heavier samples with protruding parts or thin walls should be placed on a solid support in such a manner that they do not move or flex during the test impact.
b) Light-weight samples should be rigidly “coupled” with a non-yielding support such as a heavy base plate. Clamping in a vice is of no value, since the samples become exposed to stress and because complete rigidity is never attained. As a rule, the measured L-values would be too small and show excessive variations.

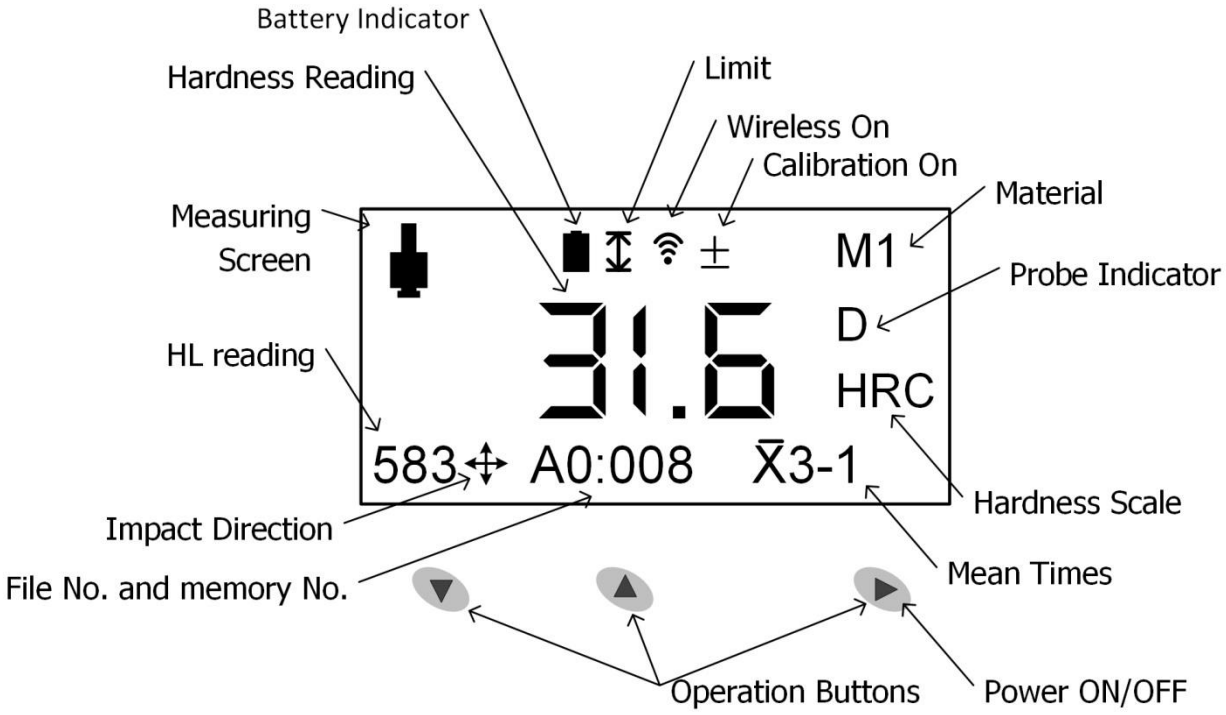
6.5 Samples with Curved Surfaces

Impact testers only work properly, if the impact body has a certain position in the guide tube at the moment of impacting the test surface. In the normal position, automatically present when testing flat and convex-cylindrical samples (such as round samples), the spherical test tip is located exactly at the end of the guide tube.
However, when testing spherically or cylindrically shaped concave surfaces, the impact body remains further within the guide tube or protrudes further therefore. Thus, with such types of curved surfaces, it is to be observed that radii of curvature do not drop below the values indicated in the following Fig.
Curved surfaces should always be tested with the small support ring.



Impact device types D Rmin=30mm
For impact devices D, special support rings are available to accommodate smaller radii on convex or concave surface.

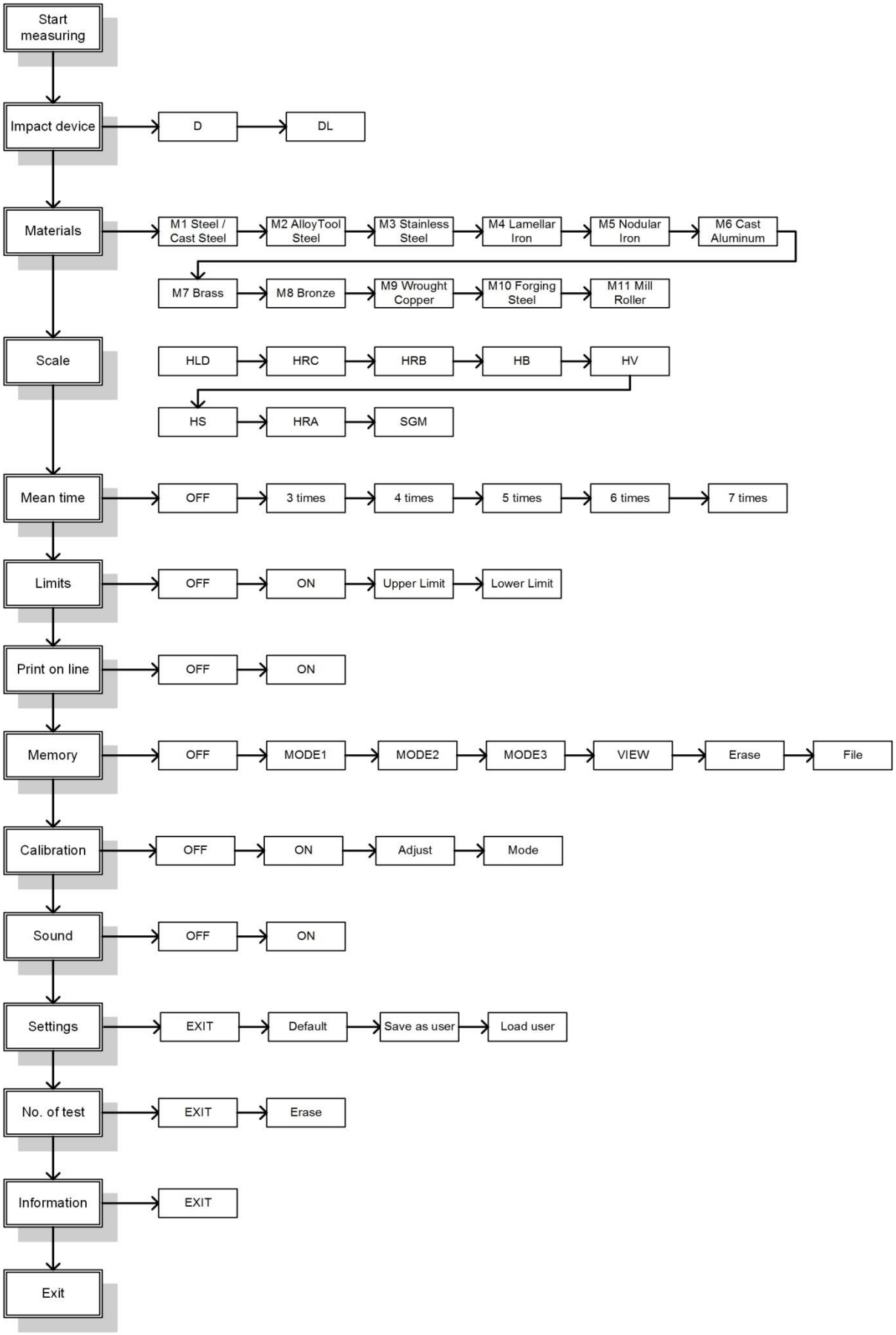
7 Operation



7.1 Button description

▼	▲	►
- Menu key, press it to enter main menu - Downward key, press it to move cursor downward - Press and hold the key to save the settings and exit - Press it and ▲ simultaneously in the measuring screen to display the measuring direction	- Upward key, press it to move cursor upward - Press and hold it to save the settings and exit - Press it in measuring screen to switch in different display modes - Press and hold it to delete measurement - Press it and ▼ simultaneously in the measuring screen to display the measuring direction	- Press it to switch on the tester - Press and hold it to switch off the tester - Confirm the selection - Press and hold the key to save the settings and exit

7.2 Diagram of operation



7.3 Power on the instrument

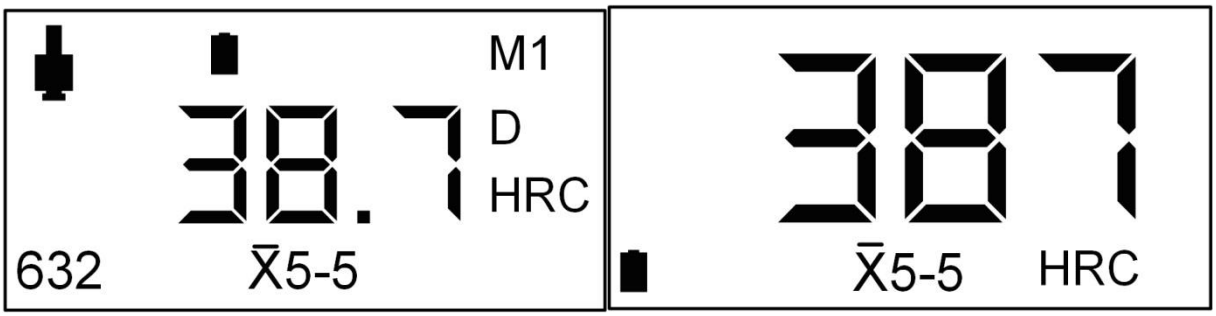
Method 1: Press ► to turn on the instrument.
Method 2: Push the loading tube toward tester slowly until locking the impact body inside the probe. Then let the loading tube back to original position. The instrument will be powered on.
The screen will display the measuring window after it is switched on, you can start measurement. At this moment, all parameters will be performed by factory default (new tester) or by last settings before closed.

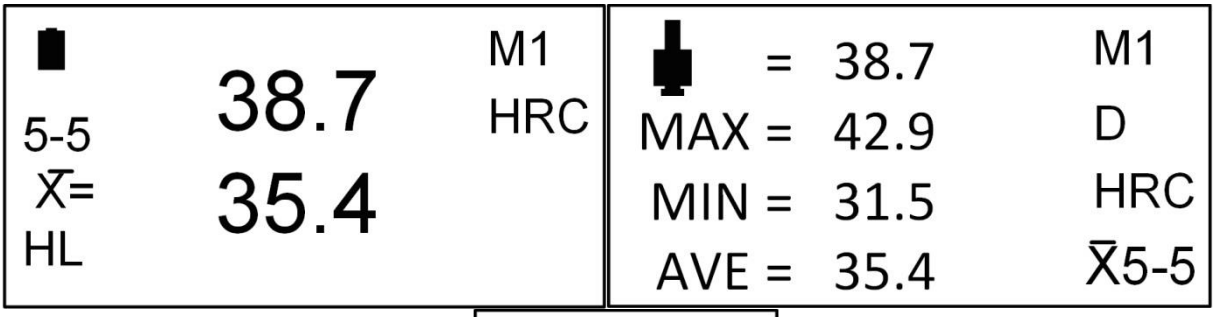
7.4 Power off the instrument

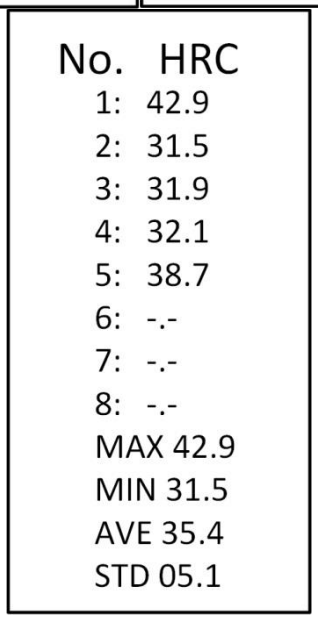
Method 1: Press and hold ► for several seconds till the instrument is powered off.
Method 2: The instrument will automatically shut down after about 2 minutes without operation.

7.5 Display Modes

In measuring mode, press ▲ in turn to switch between different display modes.







7.6 Settings

Press ▼ to enter the Menu screen. Press ▼ or ▲ to select Settings and press ► to enter. Press ▼ or ▲ again to select in cycle: Exit → Default → Save as user → Load user.
Exit: Return to the Measure screen without modification. Press ► to return to the Menu screen, or press and hold any key to save and return to the Measure screen.
Default: Restore factory settings.
Save as user settings: User can save the set parameters, such as the impact device, materials, mean times, Upper/Lower Limit etc.
Load Settings: Load the saved user settings.
Press ► to return to the Menu screen, or press and hold any key to save and return to the Measure screen.

7.6.1 Impact Device

There are two kinds of impact device can be selected. Impact device D is for normal application and DL is for some specific situation, such as narrow step or deep blind hole. When you select impact device DL, you need to change impact body D to DL. (The impact body DL is optional, you need to order separately). Press ▼ to enter the Menu screen. Press ▼ or ▲ to select Impact device and press ► to enter. Press ▼ or ▲ again to select D or DL in cycle. Press ► to confirm and return to the settings menu, press and hold any key to save and exit to the measure screen.

7.6.2 Material selection

Press ▼ to enter the Menu screen. Press ▼ or ▲ to select Material and press ► to enter. Press ▼ or ▲ again to select the material in cycle. Press ► to confirm after selection and return to the Menu screen, or press and hold any key to save and return to the Measure screen. The symbol of the chosen material will display at right upper of Measure screen.

M1	STEEL/CAST STEEL	M6	CAST ALUMINUM
M2	ALLOY TOOL STEEL	M7	BRASS
M3	STAINLESS STEEL	M8	BRONZE
M4	LAMELLAR IRON	M9	WROUGHT COPPER
M5	NODULAR IRON	M10	FORGING STEEL

7.6.3 Hardness scale conversion

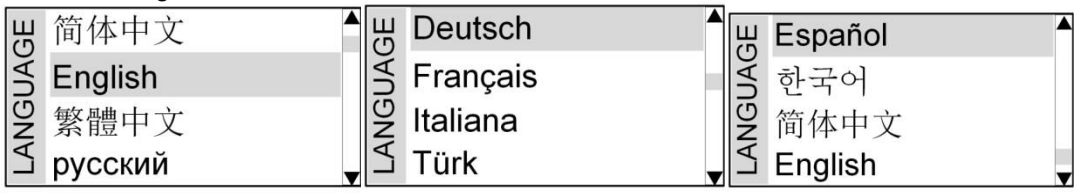
Press ▼ to enter the Menu screen. Press ▼ or ▲ to select Scale and press ► to enter. Press ▼ or ▲ again to select the hardness scale in cycle: HL→HRC→HRB→HB→HV→HS→HRA→SGM
Press ► to confirm after selection and return to the Menu screen, or press and hold any key to save and return to the Measure screen. The symbol of the chosen unit will display at right of Measure screen.

7.7 No. of test

Press ▼ to enter the Menu screen. Press ▼ or ▲ to select No. of Test option and press ► to enter, then you can view the current measurement counts for convenient maintenance of the instrument. Press ▼ or ▲ to select Exit or Erase. Press ► to confirm. Select Erase to clear the measurement counts.

7.8 Language selection

Press and hold ▼ to enter Language screen. Press ▼ and ▲ to select suitable language, press ► after selection to return to the measuring screen, or press and hold any key to exit without saving and return to the measuring screen.



7.9 Mean Time Setup

Press ▼ to enter the Menu screen. Press ▼ or ▲ to select Mean time and press ► to enter. Press ▼ or ▲ again to select the mean times in cycle:
X(Off) →x=3→x=4→x=5→x=6→x=7.
Press ► to confirm after selection and return to the Menu screen, or press and hold any key to save and return to the Measure screen. The symbol of the mean will display at bottom of Measure screen. For example, as x=3 is chosen, display x3-0. Display the mean value after three measurements are got.

7.10 Upper / Lower Limit

Press ▼ to enter the Menu screen. Press ▼ or ▲ to select Limits and press ► to enter. Press ▼ or ▲ again to select the upper/lower limit in cycle:
X(Off) → (On) → Upper → Lower. Select “Off” to disable Upper/Lower limit alarm. Select “On” to enable Upper/Lower limit setting, and the audio alarm will be enabled automatically, prompting alarm sound after overrunning. Select “Upper” or “Lower” and press ► to enter limits setting screen. Press ▼ or ▲ to adjust value. Press and hold ▼ or ▲ for fast adjustment. Press ► to confirm after adjustments and return to Limits menu, select On and press ► save changes and return to the upper-level menu, or press and hold

any key to save and return to the Measure screen. The symbol  will display on the instrument screen after Upper/Lower limit alarm is enabled.

7.11 Memory

Press ▼ to enter the Menu screen. Press ▼ or ▲ to select Memory and press ► to enter. Press ▼ or ▲ again to select in cycle: X(Off) → MODE1(Save single)→ MODE2(Save Mean) → MODE3(Manual Save) → View → Erase → File.
X (Off): Do not save the measurement. Press ► to confirm and return to the Menu screen.

7.11.1 MODE1 (Save single)

Save each measurement. Press ► to confirm and return to the Menu screen.

7.11.2 MODE2 (Save Mean)

Only save the mean value. Press ► to confirm and return to the Menu screen.

7.11.3 MODE3 (Manual Save)

Save the data by pressing ► after measuring. Press ► to confirm and return to the Menu screen.

7.11.4 View

To view the stored data. Press ▼ or ▲ for Page/Up/Down. Press ► to return to the upper-level menu.

7.11.5 Erase

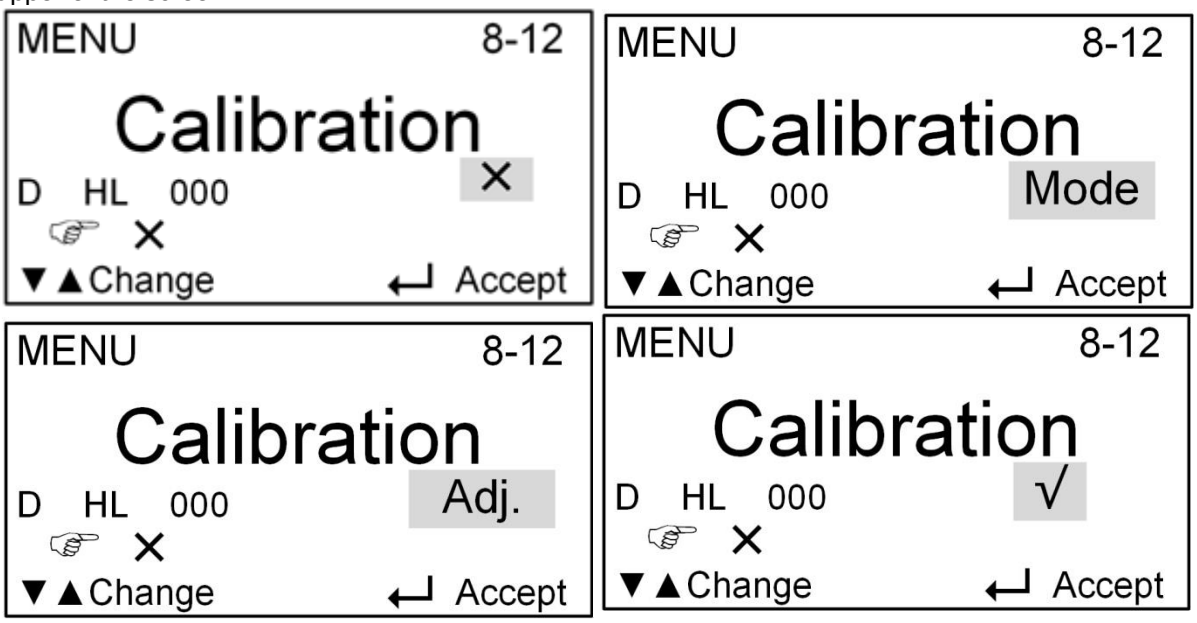
Clear all data of current file. For example, as file A0 is displayed, all data of file A0 will be deleted. Press ► to display “Erase All”. Press ► to confirm and delete the data. Press ▼ or ▲ to cancel.

7.11.6 File

Press ► to enter the File menu. Press ▼ or ▲ to select the file. Press ► to confirm and return to the upper-level menu.
After setting, press ► to confirm and return to the upper-level menu, or press and hold any key to save and return to the Measure screen.

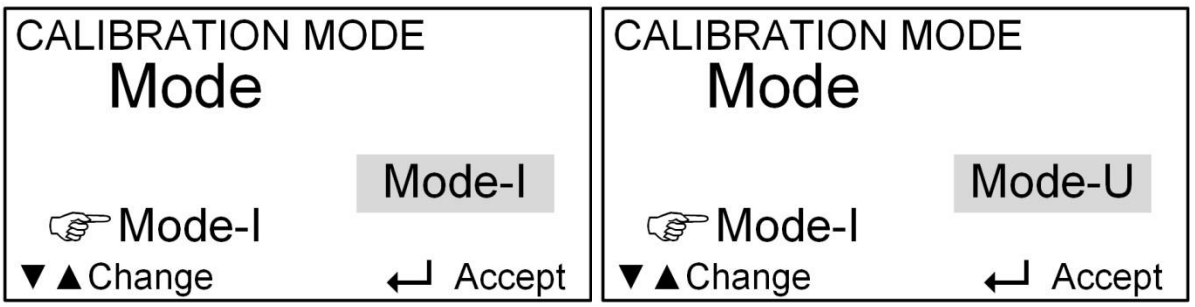
7.12 Calibration

After long time of use, the ball tip on impact body may worn which would lead inaccuracy. In order to compensate such error, the tester is designed to re-calibrate by user.
Press ▼ to enter the Menu screen. Press ▼ or ▲ to select Calibration and press ► to enter. Press ▲ to select in cycle: X(Off) → Mode → Adj.(Adjust) → √(On).
The calibration will function only switch on the calibration in menu. You can switch on/off the calibration function at any time. Before activating the calibration function, you need to select calibrate mode – Unified (MODE-U) or Individual (MODE-I). If select MODE-U, only HL value can be adjusted, and if select MODE-I, each scale value can be adjusted. Of course once you switch off the calibration function, all readings will be back to original although you made changes in calibration settings. Then adjust value according to the accuracy, finally press ► to accept changes. . After Calibration is done, the symbol ± will display at upper of the screen.



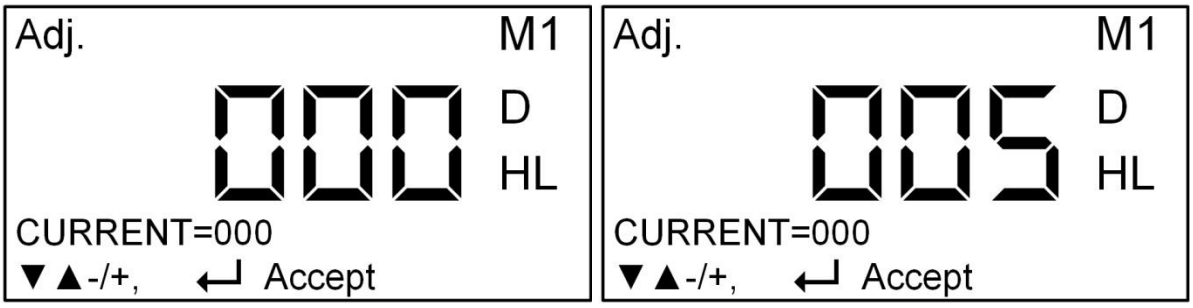
7.12.1 Calibration mode

Press ▼ to enter the Menu screen. Press ▼ or ▲ to select Calibration and press ► to enter. Press ▲ to move to “Mode” item then press ► to enter modes selection. Press ▼ or ▲ again to select different modes.
There are two modes of calibration: Individual Calibration (MODE-I) and Unified Calibration (MODE-U). Select Unified Calibration, only calibrate the HL value and all other scales will be calibrated accordingly. Select Individual Calibration, each scale can be calibrated individually.
After selecting the mode, press ► to accept it and go back to the calibration menu.



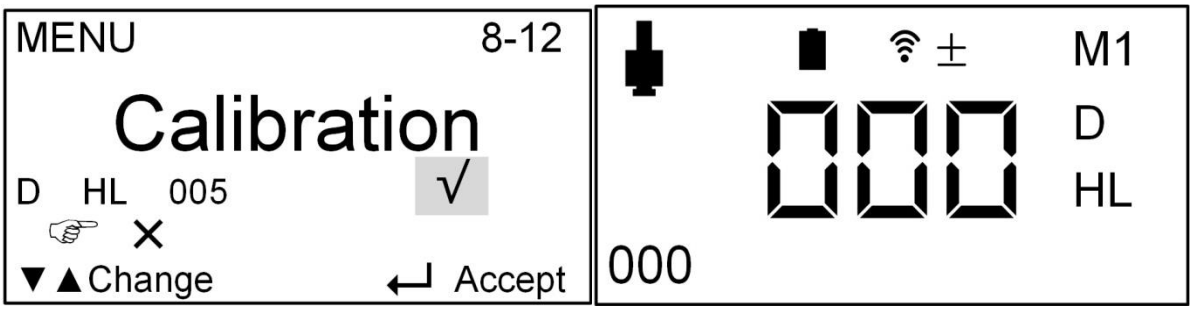
7.12.2 Adjust

In calibration menu, press ▲ to move to “Adj.” item then press ► to enter Adjust screen. Press ▼ or ▲ to adjust the value. If the hardness reading is 5 HL lower than the standard value, please press ▲ to increase 005 to calibrate it. If the hardness reading is 5 HL higher than the standard value, please press ▼ to decrease 005 to calibrate it. . Press and hold ▲ or ▼ for fast adjustment.
Then press ► to accept the adjustments and return to the calibration menu.



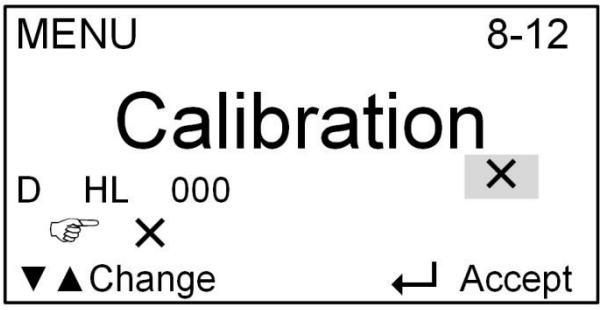
7.12.3 Calibration on

In calibration menu, the current item is "√"(Calibration On), press ► to switch on the Calibration and return to the Menu screen. After Calibration is done, the symbol ± will display at upper of the measuring screen.



7.12.4 Calibration off

If you want to switch off the calibration, in calibration menu, press ▲ to move to "X", then press ► to switch off the Calibration function and return to the Menu screen.



7.12.5 Calibration for DL probe

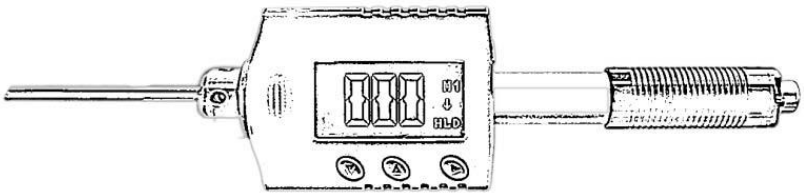
For DL probe, you need to make calibration individually by same procedure like D probe.

7.13 Prompt Sound

Press ▼ to enter the Menu screen. Press ▼ or ▲ to select Sound and press ► to enter. Press ▼ or ▲ to select X(Off) → √(On).
Press ► to confirm after selection and return to the Menu screen, or press and hold any key to save and return to the Measure screen.

8 Changing impact body

This tester has a very unique feature, which impact device can convert between D and DL simply by changing impact body. This two-in-one probe is equivalent to two individual probes. With this optional accessory, you can take measurement at very narrow surface such as slot bottom, gear tooth that probe D cannot match. Please refer to the following steps to change impact body. Unscrew the support ring from the tester and let the impact body D out. Insert the impact body DL into probe and screw the guide tube onto the probe.



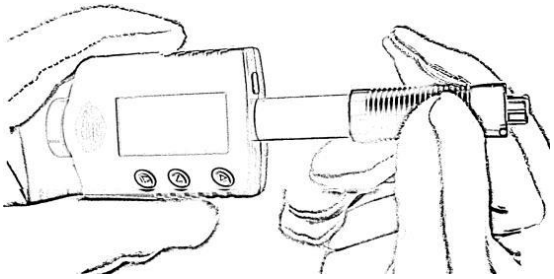
Tester equipped with DL impact device

Note: The block D supplied with the new tester indicates the standard HLD value instead of LDL value, when measuring on standard block D with DL probe, the reading is LDL value, which is different from the HLD value marked on the block. If you need standard LDL value, please contact with the manufacturer.

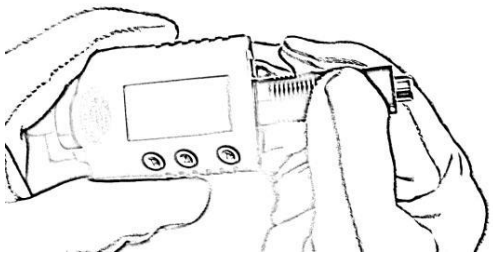
9 Take a measurement

9.1 Loading spring

9.1.1 Hold the main body (the tester) with left hand while right hand is holding the loading tube.



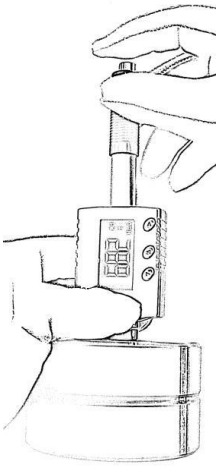
9.1.2 Push the loading tube with a little force against spring force toward tester until to lock the impact body.



9.1.3 Loose the force and let the loading tube return to the original position.

9.2 Take measurement

Place the tester onto the surface of object to be measured by the support ring.



Please note: the proper way of holding is important for obtaining better readings.

Attention: the tester must be placed against object surface firmly and perpendicularly. A slight gap between support ring of tester and surface of object will lead inaccurate reading.

9.3 Release the testing force

After firmly placing the tester onto the surface of object with left hand, hold the loading tube with thumb and middle finger of right hand and press the release button with forefinger.
The impact body inside probe will impact the surface of object with spring force. Then the hardness reading will be displayed on the screen.

Attention: when pressing the release button, please make sure not to press the release button only by single forefinger which may affect the testing accuracy.

10 Maintenance and repair

Do your best to avoid shock, heavy dust, damp, strong magnetic field and oil stain.

10.1 Maintenance of the impact device

The devices do not require any particular care other than periodic cleaning of the impact body and the guide tube after performing approximately 1000-2000 tests. During cleaning, the following procedures need to be observed:
- Unscrew support ring and remove impact body from guide tube.
- Clean off any dirt and metallic dust from the impact body and the spherical test tip.
- Clean guide tube with the special brush provided.
- Do not apply oil to any parts for the impact device.

10.2 Charging battery

When a low battery indicator displays that reminds you to charge the battery. However it is still possible to measure for some time. Please make sure to obtain additional or replacing battery from the manufacturer. Otherwise it may cause the instrument to get un-accuracy value. Please connect the instrument with USB charger or PC to charge the battery.

In order to avoid damage of battery due to over discharged, please charge the battery at least once every half year after long time of non-use.

Note: The instrument will enter screen saver mode during charging.

11 Disposal

For the disposal of batteries, the 2006/66/EC directive of the European Parliament applies. Due to the contained pollutants, batteries must not be disposed of as household waste. They must be given to collection points designed for that purpose.

In order to comply with the EU directive 2012/19/EU we take our devices back. We either re-use them or give them to a recycling company which disposes of the devices in line with law.

If you have any questions, please contact PCE Instruments.

12 Contact

If you have any questions about our range of products or measuring instruments please contact PCE Instruments.

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