OPERATION MANUAL

HARTIP 1600

PORTABLE HARDNESS TESTER

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1 Forewords

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.

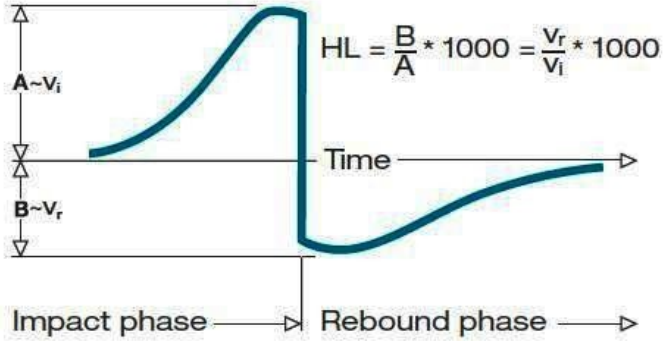
Leeb Hardness Test (definition)

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, Vickers, Brinell and Shore D).

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 another 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 Features and Applications

2.1 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 300 data which can be recalled and read on the tester easily.

It also has a very unique feature, which impact device can convert between D and DL simply by changing impact body. You can take measurement at very narrow surface such as slot bottom, gear tooth that probe D cannot match.

The 3.7V Li-ion rechargeable battery inside the tester can be charged via USB from PC or via individual battery charger from mains wall power.

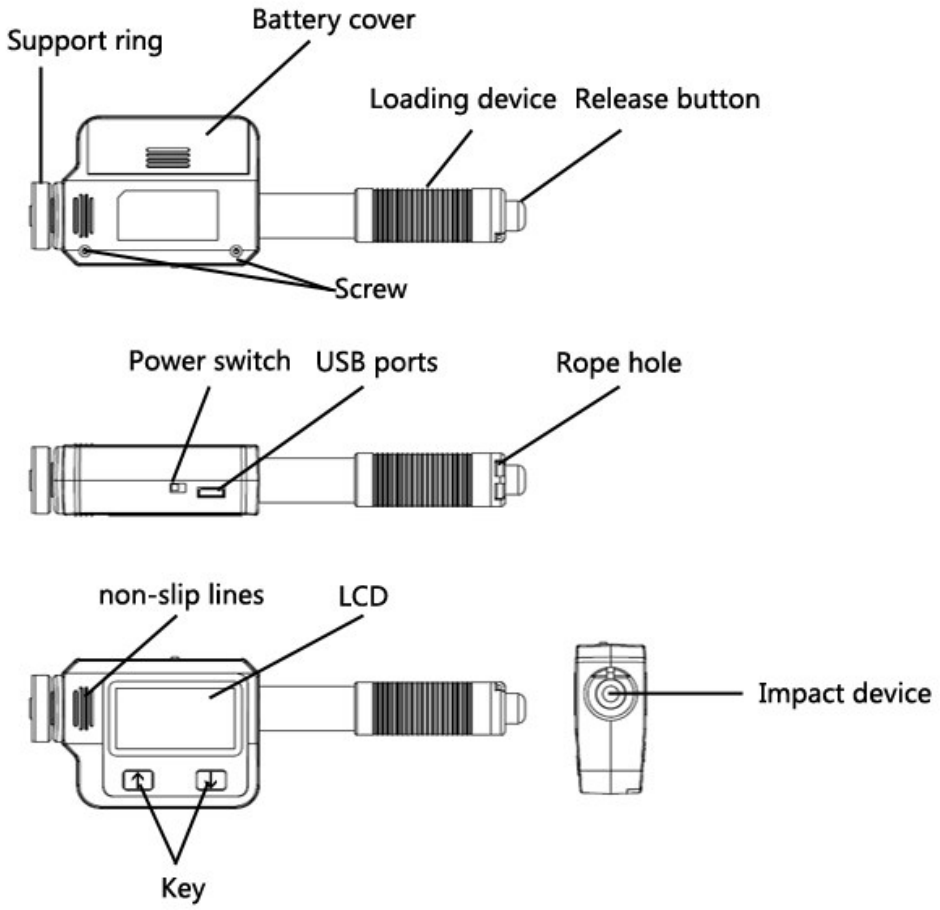
2.2 Specifications

- ✧ Principle: Leeb hardness measurement
- ✧ Accuracy: +/-2HL (or 0.3%@HL=800)
- ✧ Display: 126 x 64 LCD
- ✧ Hardness scale: HL / HRC / HRB / HB / HV / HS / HRA / σb
- ✧ Measuring range: HL170-960 / HRC1-74 / HRB1.2-140 / HB18-1027 / HV42-1220 / HS3.9-112 / HRA7-88.5 /σb (rm) 89-3300N/mm^2
- ✧ Impact device: D
- ✧ Materials: 10 common metal materials
- ✧ Memory: 999 data can be saved and re-readable
- ✧ Statistics: Average/Max/Min value can be calculated automatically
- ✧ Conversion table: 70
- ✧ Interface: USB for charging or connect to PC
- ✧ Recalibration: allowed by user
- ✧ Indicator: Battery capacity
- ✧ Power supply: 1.5V AAA battery *1
- ✧ Operating environment: -20^{0}C ~+45^{0}C
- ✧ Dimension (L x W x D): 148mm×45mm×21mm
- ✧ Net weight: 105g
- ✧ Standard: ASTM A956, DIN 50156, GB/T 17394-1998

2.3 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.

3 Layout of Instrument



4 Symbols and Illustrations

4.1 Symbols and Illustrations

Symbols	Illustrations
HLD	Leeb hardness value used with impact device D
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

4.2 Measurement and Conversion Table

Range for measurement and conversion:

IMPACT DEVICE D HL: 170-960							
MATERIALS	H R C	H R B	H B	H V	H S	HRA	σb (N/mm$^{2)}$
STEEL/CAST STEEL	0.1-74.7	1.2-140	28-1027	45-1230	4.0-112	7-88.5	118-3315
ALLOY TOOL STEEL	0.9-78.7		15-1878	32-1698	5.5-128		79-6599
STAINLESS STEEL	3.7-62.4	8.3-101.7	85-655	36-802	6-131		108-1725
LAMELLAR IRON	21-59	24-100	35-570	90-698	6-83		
NODULAR IRON	21-60	24-100	62-857	96-724	8-90		
CAST ALUMINUM	1-48	24-85	19-445	22-193	3-64		129-2618
BRASS	1-53	1.5-99.6	32-477	29-495	5-65	32-76	258-4146
BRONZE	1-56	14-100	15-505	11-535	2-68	29-76	190-1860
WROUGHT COPPER	1-54	14-100	35-569	38-590	6-73		
FORGING STEEL	1-72		50-1060	48-1110	7-103		200-3750

5 Preparation before Measuring

5.1 Requirements for the Sample

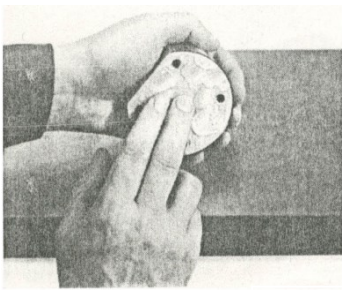
The surface temperature of sample should be less than 120 °C.
The samples must feature a metallic smooth, ground surface, in order to eliminate erroneous measurements brought about by coarse grinding or lathe scoring. The roughness of the finished surface should not exceed 2μm.

5.2 Requirements for the Weight of the Sample

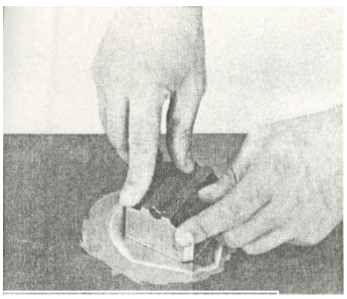
For samples weighing over 5 kg and of compact shape, no support is needed.
Samples weighing between 2-5 kg, and also for heavier samples with protruding parts or thin walls, should be placed on a solid support in such a manner that they do not bend or move by the impact force.
Samples weighing less than 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).

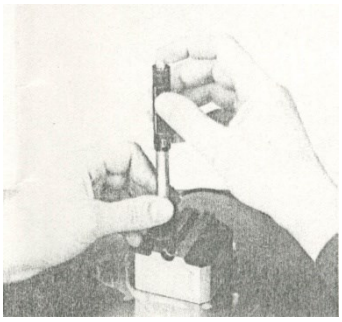
Proper Coupling:
Proper coupling requires a little experience. Insufficiently coupled samples produce large variations of individual measurements, L-values which are too low and the operation is characterized by a rattling noise upon impact of the test tip.
Example for coupling a test piece with a base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

5.3 Requirement for the Surface Hardened Layer of the Sample

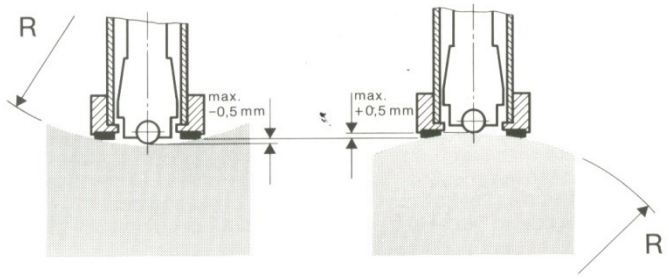
Surface -hardened steels and especially case-hardened steels produce L-values which are too low when case-hardening depth is small because of their soft core. When measuring with impact device D the depth of the hardened layer should be no less than 0.8 mm.
Surface of the test sample should not be magnetic.
For test sample of curving surface with radius of curvature R less than 30mm, a small support ring should be used.
Supporting the Samples during Testing

Type of impact device	Classification of samples		
	heavy	medium-weight	light-weight
D	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 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.

5.4 Samples with Curved Surfaces

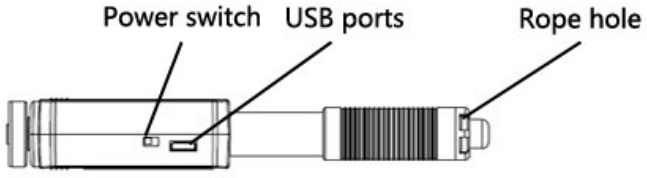
Impact testers only work properly, if the impact body has a certain position in the guide tube at the moment of impacting the test surface. In the normal position, automatically present when testing flat and convex-cylindrical samples (such as round samples), the spherical test tip is located exactly 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 R_{min}=30mm
For impact devices D, special support rings are available to accommodate smaller radii on convex or concave surface.

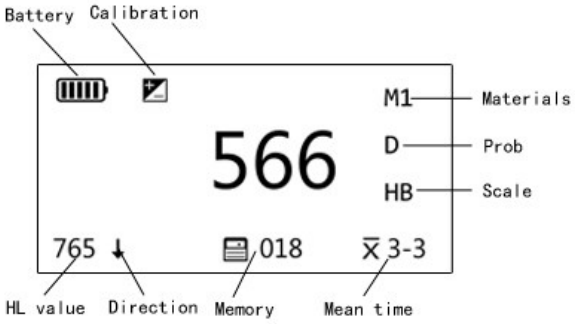
6 Operation

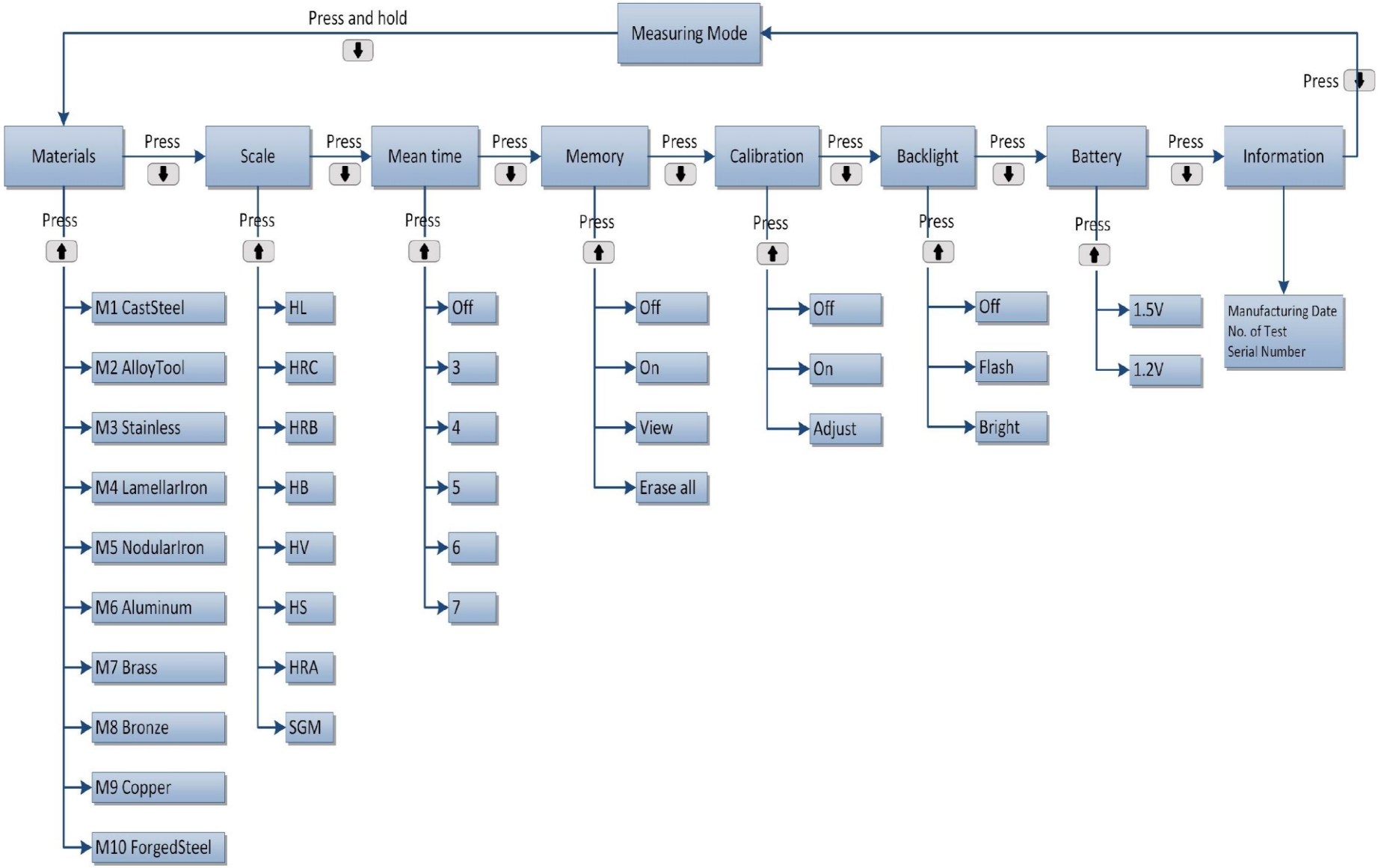
6.1 Power on /off the Instrument



Push POWER SWITCH to switch on/off the tester, after the tester is switched on, it will enter measuring mode automatically.

6.2 Diagram of Operation




Press and hold
Measuring Mode
Press
Materials
Press
Scale
Press
Mean time
Press
Memory
Press
Calibration
Press
Backlight
Press
Battery
Press
Information
Press
M1 CastSteel
M2 AlloyTool
M3 Stainless
M4 LamellarIron
M5 NodularIron
M6 Aluminum
M7 Brass
M8 Bronze
M9 Copper
M10 ForgedSteel
HL
HRC
HRB
HB
HV
HS
HRA
SGM
Off
3
4
5
6
7
Off
On
View
Erase all
Off
On
Adjust
Off
Flash
Bright
1.5V
1.2V
Manufacturing Date
No. of Test
Serial Number

6.3 Button Description

• In measuring mode, press it to enable/disable impact direction indicator • In menu mode, press it to change parameters	• In measuring mode, press it to switch among normal mode, big font mode and statistics mode • In measuring mode, press and hold it to enter main menu • In menu mode, press it to change to next menu item • In menu mode, press and hold it to save the settings and exit to measuring mode

6.4 Impact Direction

The instrument is designed to take measurement at any impact direction without individually setting up impact direction on the instrument during measurement. In measuring mode, press and hold to enable / disable impact direction indicator.

6.5 Display Mode

In measuring mode, press to switch among normal mode, big font mode and statistics mode.

Normal mode | *Big font mode* | *Statistics mode*

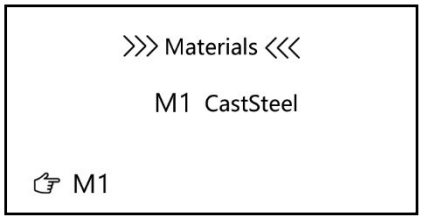
6.6 Parameters Setup

All parameters can be selected or changed from the menu system by operator. Press and hold button to enter Menu mode, then press to select different parameters in current menu item. Press to go to next menu item. Press and hold to save settings and exit menu mode.

Materials selection

The material must be selected properly when you want to have tests.

Press button to enter menu "Materials", then press to change materials from M1 to M10. Press to go to next menu item. Press and hold to save settings and exit menu mode.

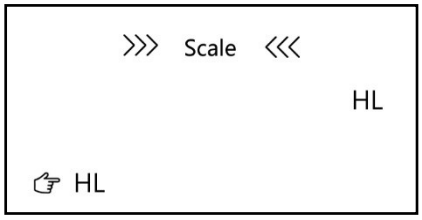


M1:	Steel & Cast Steel	M6:	Cast Aluminum
M2:	Alloy Tool Steel	M7:	Copper-Zinc (Brass)
M3:	Stainless Steel	M8:	Copper-Aluminum (Bronze)
M4:	Grey Cast Iron (GG)	M9:	Wrought Copper
M5:	Nodular Cast Iron (GGG)	M10:	Forging Steel

6.7 Hardness scale conversion

Hardness scale is based on the material selected. Not every material has same conversion. For example, for steel, it has conversions from HL to HRC / HRB / HB / HV / HS / HRA / σ; but for Grey Cast Iron (GG), only has conversions to HRC / HRB / HB /HV. The default hardness scale is Leeb hardness value (HL).

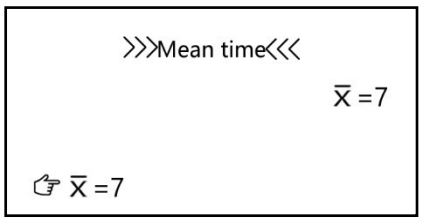
Press button ⬇ consecutively to enter menu until “Scale” displays on LCD, then press ⬆ to change scales orderly. Press ⬇ to go to next menu item. Press and hold ⬇ to save settings and exit menu mode.

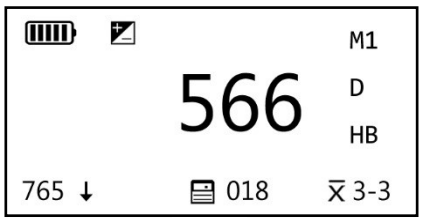


6.8 Statistics

6.8.1 Mean Times

Press button ⬇ consecutively to enter menu “Mean time”, then press ⬆ to change value orderly. Press ⬇ to go to next menu item. Press and hold ⬇ to save settings and exit menu mode. The default mean time is 0 time.





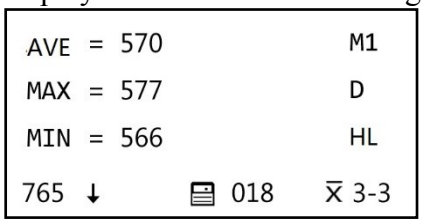
If the mean time is set to 3 times, an indicator X̄ 3-3 will be displayed on the lower-right corner.

6.8.2 Delete Measured Values

After mean time is set, in order to avoid the error caused by abnormal values involving in calculation, you can delete the current values by pressing and holding button⬆. If Memory is ON at this time, corresponding measured values in memory will also be deleted.

6.8.3 Read Statistics Info

After setting the meantime, an indicator will be showed on the measuring mode. When measuring times reach setting times, press ⬇ button to switch to statistics mode, the average, min. and max. value will be displayed. Press ⬇ button again to switch to normal measuring mode.



6.9 Memory Setup

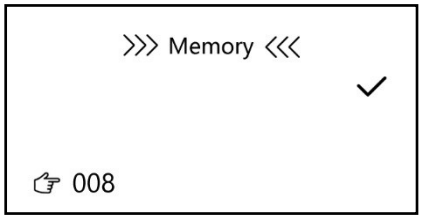
Press button ⬇ consecutively to enter menu “Memory”, then press ⬆ to select “✓”, “View”, “and Erase all “or“×” orderly. The default setting is memory off.

Memory off

×: Press and hold ⬇ to save settings and exit menu mode.

Memory on

✓: Press and hold ⬇ to save settings and exit menu mode.

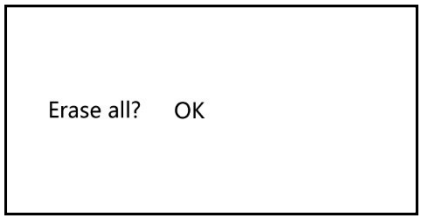


6.9.1 View

Press button ⬇ to enter “View” mode. In this mode, press ⬇ or ⬆ to turn the page forth or back. Press and hold button ⬇ to exit “View” mode and go back to “Memory” menu. Press and hold ⬇ to save settings and exit menu mode.

6.9.2 Erase All

Press ⬇ then “Erase all?” displays, press and hold ⬇ to delete all stored data.

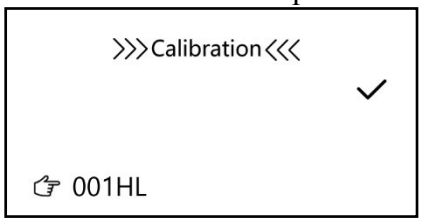


It will return to Memory mode after deleting data, press ⬇ to go to next menu item. Press and hold ⬇ to save settings and exit menu mode.

6.10 Calibration (compensation)

The measurement compensation is used for calibration of the instrument. After the instrument is used for some time, the ball tip on impact body may be worn out or the instrument recognize wrong angle of probe which would lead inaccuracy. In order to compensate such error, the tester is designed to re-calibrate by user.

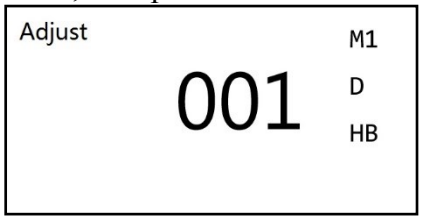
Press button ⬇ consecutively to enter menu “Calibration”, then press ⬆ to select “×”, “✓” or “Adjust” orderly. Press ⬇ to go to next menu item. Press and hold ⬇ to save settings and exit menu mode. The calibration procedure is only valid for current hardness scale.



6.10.1 Calibration Off

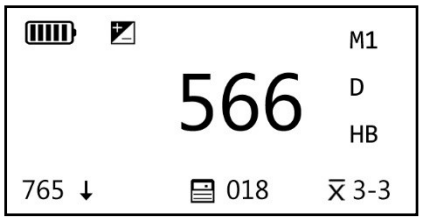
×: Press button ⬇ to go to next menu item. Press and hold ⬇ to save settings and exit menu mode.
Adjust

Adjust: Press button ⬇ to enter Adjust mode. In this mode, press ⬇ or ⬆ to adjust compensation value, then press and hold ⬇ to save settings and exit menu mode.



6.10.2 Calibration On

✓: Press button ⬇ to activate calibration indicator and go to next menu item. Press and hold ⬇ to save settings and exit menu mode. After calibration is activated, an indicator  will be displayed on LCD.



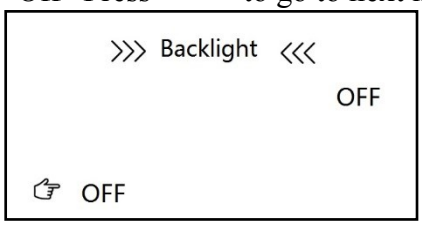
6.10.3 Calibration Procedure

- Turn off the calibration function
- Take measurements on the standard hardness block D and make sure the measuring direction is downward vertically
- If the hardness value of standard block is HL780, but the reading of tester is HL760, it means this tester need to be calibrated
- Enter the Adjust mode, Calibration → Adjust (Refer to 6.8.2), set the adjust value to 20 (Standard value – real testing value), then activate the calibration (Calibration → On). An  will be displayed in the LCD.
- In this mode, take measurements on the standard block again to check if the readings are acceptable.

Note: The user calibration procedure should be done every half year, if you don't use the tester for long time, before start to use it, you should also do a calibration.

6.10.4 Backlight

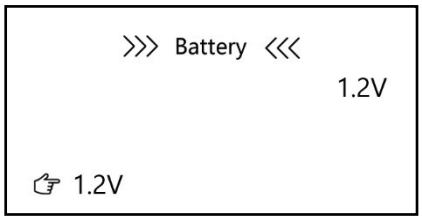
Press button  consecutively to enter menu "Backlight", then press  to select "Flash", "Bright" or "Off" Press  to go to next menu item. Press and hold  to save settings and exit menu mode.



- Flash: Turn on the backlight for normal or low frequency measurements
- Bright: Turn on the backlight for continuous or intensive measurements
- Off: Turn off the backlight

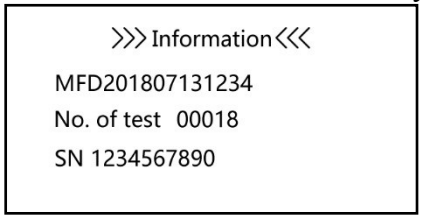
6.10.5 Battery

Press button  consecutively to enter menu "Battery", then press  to select "1.2V" or "1.5V" Press  to go to next menu item. Press and hold  to save settings and exit menu mode.



6.10.6 Information

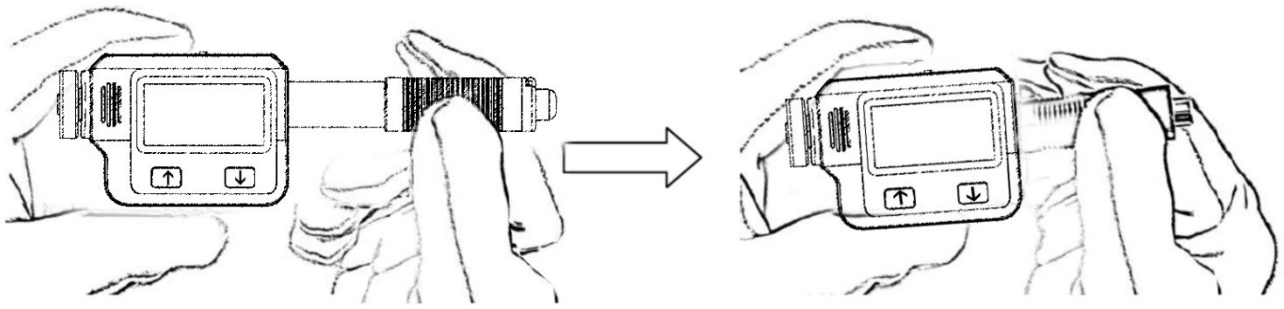
Press button  consecutively to display System Information. Press  to exit menu mode.



7 Take Measuring

7.1 Loading Spring

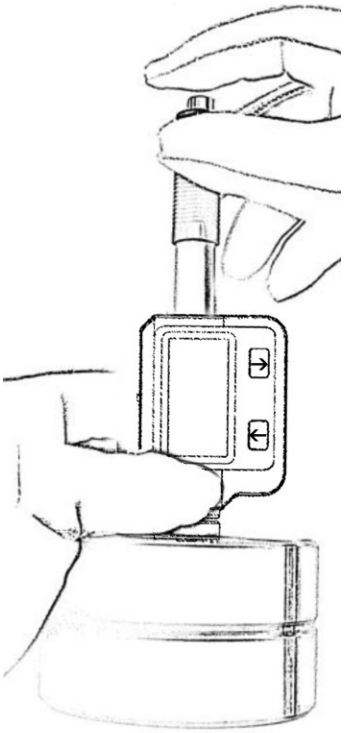
Hold the main body (the tester) with left hand while right hand is holding loading tube, then push the loading tube with a little force against spring force toward tester until to lock the impact body.



Loose the force and let the loading tube returns to the original position.

7.2 Take Measurement

Place the tester against 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.

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.

8 Maintenance and Repair

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

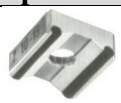
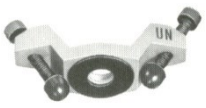
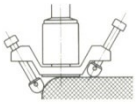
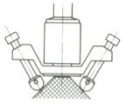
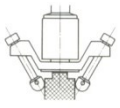
Maintenance of the Impact Device

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.

8.1.1 Replacing Battery

When a battery indicator displays that reminds you to replace the battery. However it is still possible to measure for some time. Please make sure to obtain suitable batteries.

9 Optional Accessories

Support Rings for Impact Device D			
Part designation and dimensions:			Suitable for the following surfaces
 D6	Φ 19.5×5.5mm	R≥60mm	plane cylindrical hollow-cylindrical spherical hollow-spherical
 D6a	Φ 13.5×5.5mm	R≥30mm	plane cylindrical hollow -cylindrical spherical hollow-spherical
Special Support Rings			
			Cylindrical
Z 10-15	20×20×7.5mm	R 10mm-15mm	R<10mm not possible R≥30mm D6/D6a
Z 14.5-30	20×20×6.5mm	R 14.5mm-30mm	
Z 25-50	20×20×6.5mm	R 25mm-50mm	
			hollow-cylindrical
HZ 11-13	20×18×5mm	R 11mm-13mm	R<11mm not possible R≥30mm D6a
HZ 12.5-17	20×20×5mm	R 12.5mm-17mm	
HZ 16.5-30	20×20×5mm	R 16.5mm-30mm	
			spherical
K 10-15	Φ 20×7.7mm	R 10mm-13mm	R<10mm not possible R≥30mm D6/D6a
K 14.5-30	Φ 20×6.7mm	R 14.5mm-30mm	
			hollow-spherical
HK 11-13	Φ 17×5mm	R 11mm-13mm	R<11mm not possible R≥30mm D6a
HK 12.5-17	Φ 18×5mm	R 12.5mm-17mm	
HK 16.5-30	Φ 20×5mm	R 16.5mm-30mm	
UN	Φ 52×20×16mm		
   			

10 Introduction of PC Software

Data communication software is designed for reading and processing the data of hardness tester. It can read the data from the memory of hardness tester, export the data to the computer and print the data from the computer printer.

System requirement: A PC with USB port

Windows 7 / Windows 8 / Windows 10

Connect PC and hardness tester by USB cable

Before using PC software, please make sure the tester is switched off and connect PC and hardness tester using USB cable supplied with the instrument.

Driver installation

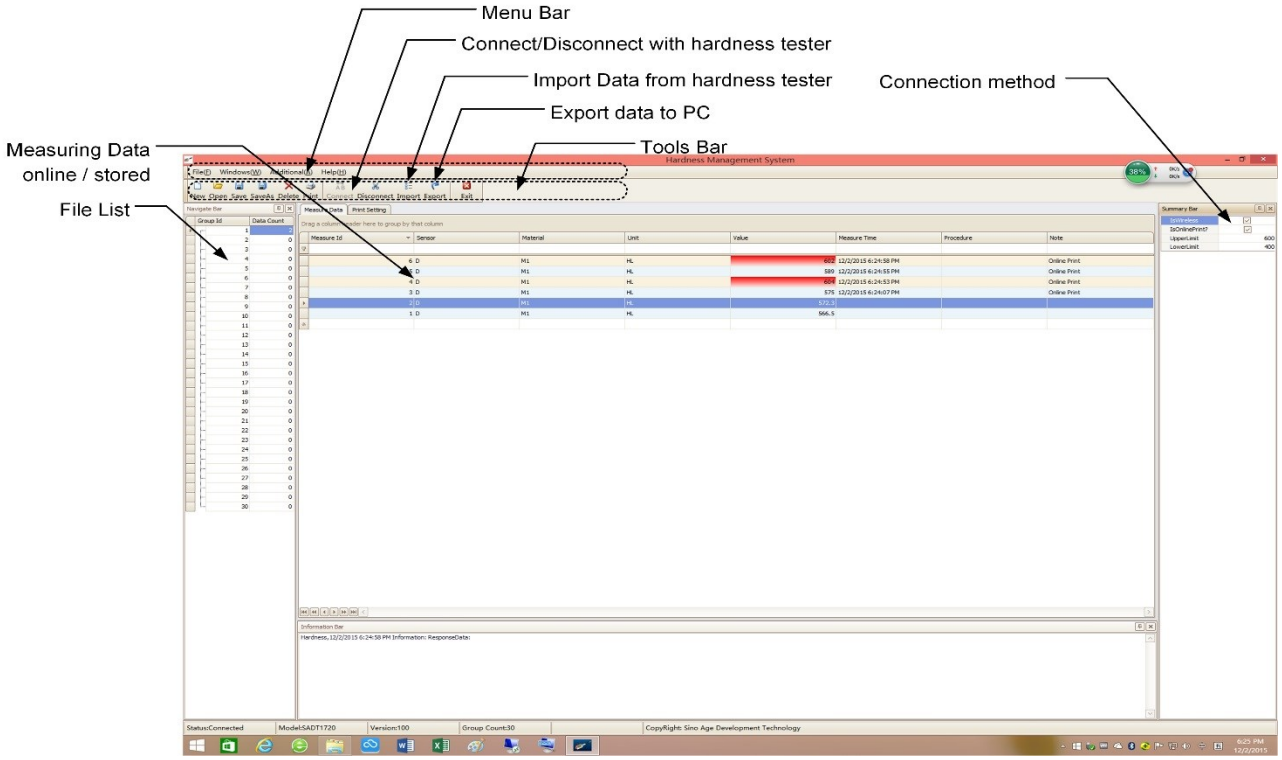
Computer will prompt "Found new hardware" while the hardness tester is connected to the computer first time, please install the driver located in X:\Drivers folder. (X: means CDROM drive letter).

Software Installation

Double click “setup.exe" to install the PC software. Please follow the installation wizard to finish it.

Start PC software

After the data communication software is installed, a shortcut will be created on the desktop automatically. Double click the shortcut to run the program.



The main interface of the software is a standard windows form, containing the title bar, menu bar and toolbar.