Sino Age Development Technology

HARDNESS TESTER
HARTIP 2000

OPERATION MANUAL

CONTENT

1. Forewords

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.

1.2. 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:

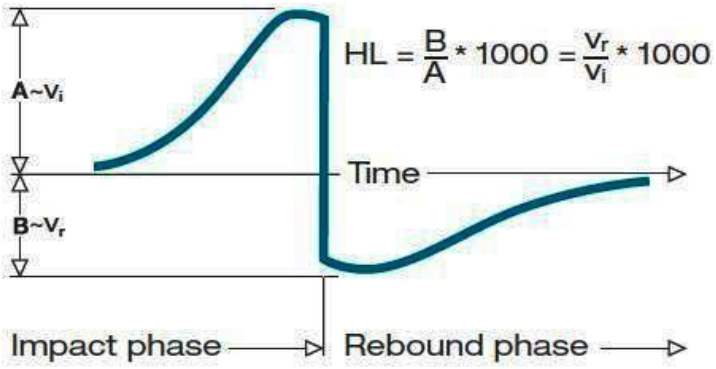
$$HL = \frac{Vr}{Vi} * 1000$$

Where: HL is Leeb Hardness

V_r is the rebound velocity of the impact body

V_i 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).

1.3. 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 another hardness values, the notation for the converted hardness value should include the impact device used.

For example:
Hardness HV converted from hardness HL using impact device D+15 should be written as 22, 8 HV LD+15.
Where: 22=Hardness value HL
8=Hardness value HV
L=Leeb's Method
D+15=Impact device
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

HARTIP 2000 is an innovative portable Leeb hardness tester with our new patent technology which makes HARTIP 2000 a universal impact direction hardness tester. It is no need to set up impact direction when taking measurement by any angle. Therefore, HARTIP 2000 offers a linear accuracy comparing to the angle compensating method. HARTIP 2000 is also a cost saving hardness tester and has many other features.

2.2. Specifications

Principle	Leeb hardness measurement
Accuracy	±0.3% @ HL=800
Repeatability	±2HL
Display	Digital LCD with backlight
Impact direction	Universal angle type
Hardness scale	HL/HRC/HRB/HB/HV/HS/σb
Measuring range	HL170-960 / HRC17-70 / HRB13-109 / HB20-655 / HV80-940 / HS32-99.5 / σb(rm)255-2639N/mm^2
Impact device	D(U) (External) /DL, D+15, G, C(External, optional)
Materials	10 common metal materials
Memory	300 data can be stored and re-readable
Statistics	Calculated automatically
Recalibration	Allowed by user
Indicator	Low battery
Communication interface micro-printer	RS232 to micro-printer, Bluetooth (optional) to Bluetooth
Auto power off	Auto
Power supply	1.5V AA alkaline battery x 2
Working environment	-10ºC ~+45ºC
Dimension (mm)	124x67x30

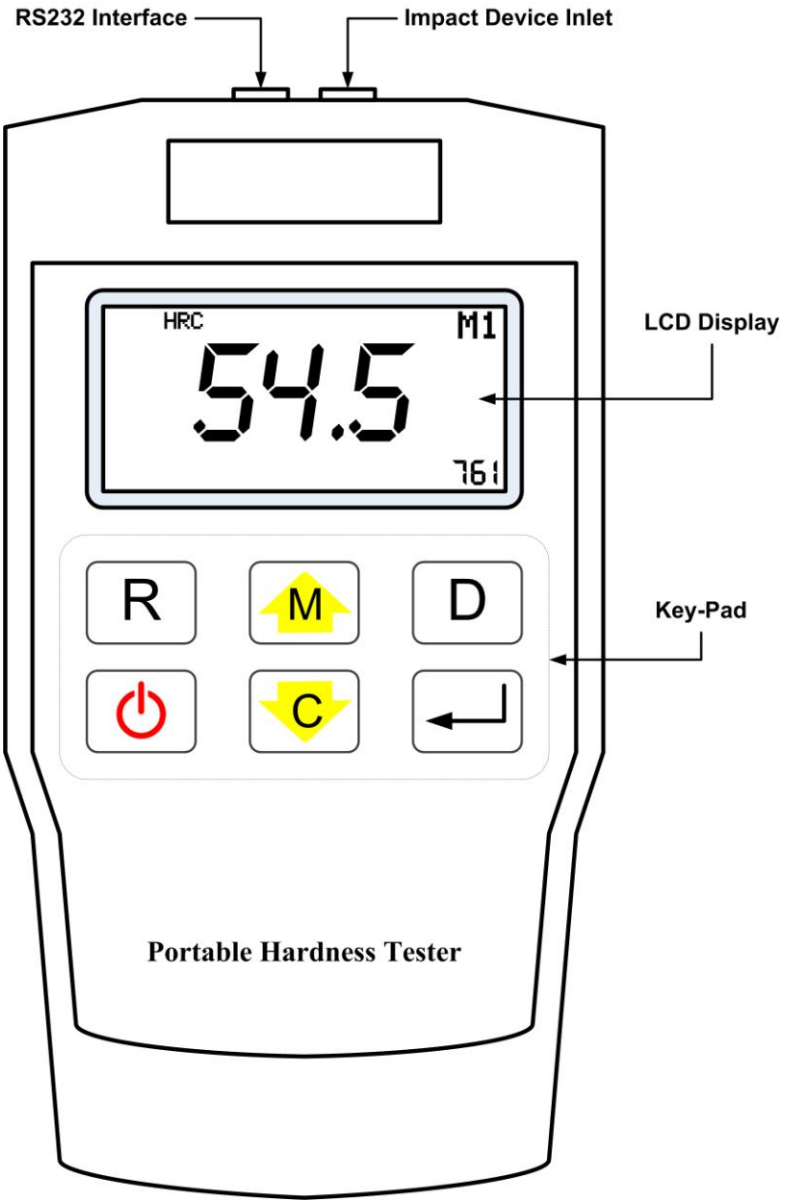
Net weight (g)	240
Standards	Conforming to ASTM A956, DIN50156, GB/T 17394-1998

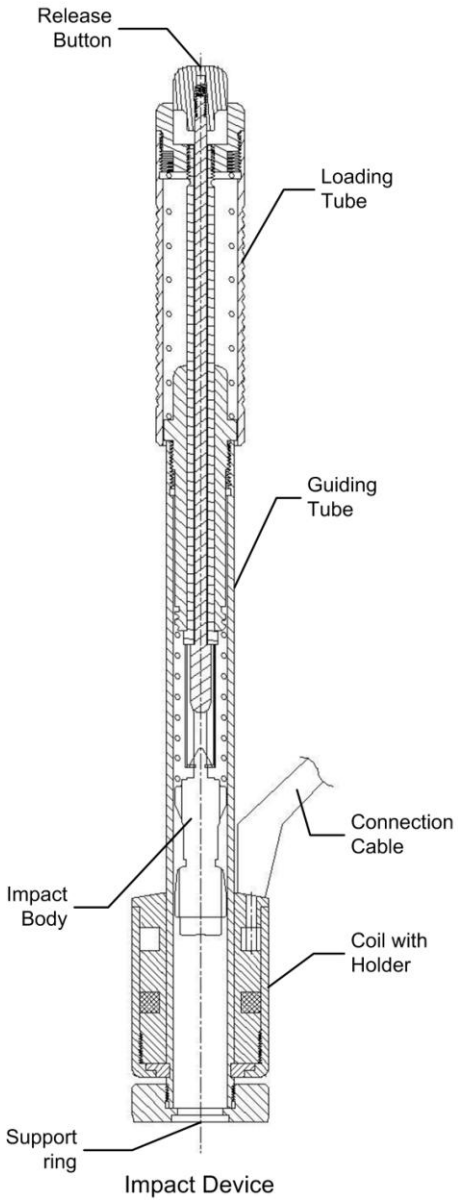
2.3. Applications

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 and Key-pad Description

3.1. Layout of HARTIP 2000





3.2. Function of Key

: Read the memory

: Menu
Increase the value
Turn the page forth

: Delete the current reading
Delete the stored values
Press for 3 seconds to activate/deactivate direction indicator

: Power On
Power Off

: Change parameter
Decrease the value
Turn the page back

: Confirm the setup
View the statics values

3.3. Special Features of Impact Devices

Type	Brief Description	
D	Universal standard unit for majority of hardness testing assignments.	
D+15	Slim front section	
	Application:	- grooves and recessed surfaces.
DL	Extremely slim front section	
	Application:	- extremely confined spaces - base of grooves
C	Reduced impact energy (compared with type D).	
	Application:	- surface hardened components, coatings - minimum layer thickness: 0.2mm. - thin walled or impact sensitive components (small measuring indentation).
G	Increased impact energy(approx. 9 times that of type D)	
	Application:	- Brinell hardness range only - heavy cast and forged parts with lower demands on surface finish.

4. Symbols and Illustrations

4.1. Symbols and Illustrations

Symbol	Meaning
LD	Leeb hardness value obtained with impact device D
LG	Leeb hardness value obtained with impact device G
LC	Leeb hardness value obtained with impact device C
LD +15	Leeb hardness value obtained with impact device D+15
LDL	Leeb hardness value obtained with impact device DL
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	Vicker hardness value
σb (N/mm²)	Strength value

4.2. Measurement and Conversion Table

Range for measurement and conversion:

IMPACT DEVICE D			**HLD: 170-960**			
MATERIALS	**HRC**	**HRB**	**HB**	**HV**	**HS**	**σb (N/mm²)**
Steel & cast steel	20.0-67.9	59.6-99.5	80-647	80-940	32.5-99.5	255-1710
Cold work tool steel	20.5-67.1			80-898		1170-2639
Stainless steel & High-temp. resistant steel	17-62.4	46.5-109	85-655	85-802		740-1725
Cast iron with lamellar graphite (GG)	21-59	24-100	93-334	90-698		
Cast iron with nodular graphite (GGG)	21-60	24-100	131-387	96-724		
Cast aluminum alloys		23-85	20-159	22-193		
Copper-zinc alloys (Brass)		13-95.3	40-173			
Copper-aluminum / Copper-tin alloys (Bronze)		14-100	60-290			
Wrought copper alloys		14-100	45-315			
Forging steel			142-651			

IMPACT DEVICE DL			**LDL: 560-950**			
MATERIALS	**HRC**	**HRB**	**HB**	**HV**	**HS**	**σb (N/mm²)**
STEEL	20.6-68.2	37.0-99.9	81-646	80-950	30.6-96.8	

IMPACT DEVICE D+15			LD+15: 300-900			
MATERIALS	**HRC**	**HRB**	**HB**	**HV**	**HS**	**σb (N/mm²)**

STEEL	19.3-67.9		80-638	80-937	33.3-99.3	
CW. ST.	19.8-68.2			80-935		

IMPACT DEVICE	**G**		**L G: 300-750**			
MATERIALS	**HRC**	**HRB**	**HB**	**HV**	**HS**	**σb (N/mm2)**
STEEL		47.7-99.9	90-646			
GC.IRON			92-326			
NC.IRON			127-364			

IMPACT DEVICE	**C**		**L C: 350-950**			
MATERIALS	**HRC**	**HRB**	**HB**	**HV**	**HS**	**σb (N/mm2)**
STEEL	20.0-70		80-683	80-996	31.9-102.3	
CW. ST.	20.7-68.2			100-941		

5. Preparation before Measuring

5.1. Requirements for the sample

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

5.1.2. The samples must feature a metallic smooth, ground surface, in order to eliminate erroneous measurements brought about by coarse grinding or lathe scoring. Roughness of the finished surface should not exceed values shown in following table:

Types of impact devices	Max surface roughness of sample Ra
D/D+15/DL	2μm
G	7μm
C	0.4μm

5.2. Requirements for the weight of the sample

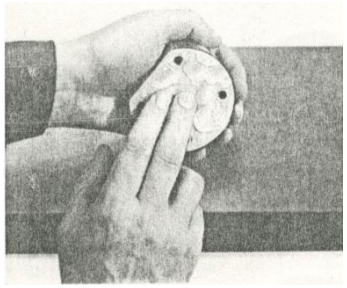
For samples weighing over 5 kg and of compact shape, no support is needed.
Samples weighing between 2-5 kg, and also for heavier samples with protruding parts or thin walls, should be placed on a solid support in such a manner that they do not bend or move by the impact force.
Samples weighing less than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

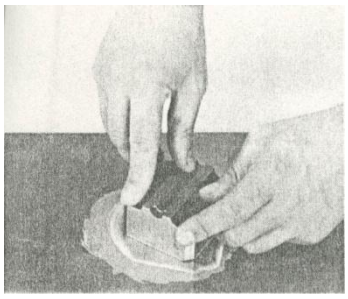
For the coupling operation, the following prerequisites must be fulfilled:
The contact surface of the sample and the surface of the base plate must be flat, plane parallel and ground.
The direction of the test impact must be perpendicular to the coupled surface.
Minimum thickness of the sample for coupling under various impact devices are shown in following table:

Types of impact devices	Minimum thickness
D/D+15/DL	3mm
G	10mm
C	1mm

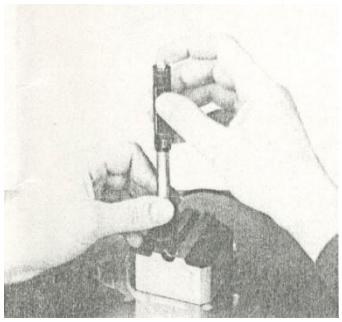
Proper Coupling:
Proper coupling requires a little experience. Insufficiently coupled samples produce large variations of individual measurements, L-values which are too low and the operation is characterized by a rattling noise upon impact of the test tip.
Example for coupling a test piece with a base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



Application of the coupling paste



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, 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 devices D, D+15 or DL, depth of the hardened layer should be no less than 0.8 mm. When measuring with impact device C, the depth of the hardened layer should be no less than 0.2 mm.

Types of impact devices	Min. layer thickness for surface hardening
D/D+15/DL	0.8mm
C	0.2mm

5.4. Surface of the test sample should not be magnetic.

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

5.6. Supporting the Samples during Testing

Types of impact devices	Classification of samples		
	Heavy-weigt	medium-weight	light-weight
D/D+15/DL	>5kg	2 - 5kg	0.05 – 2kg
G	>15 kg	5 - 15kg	0.5 – 5kg
C	>1.5kg	0.5 - 1.5kg	0.02 - 0.5kg

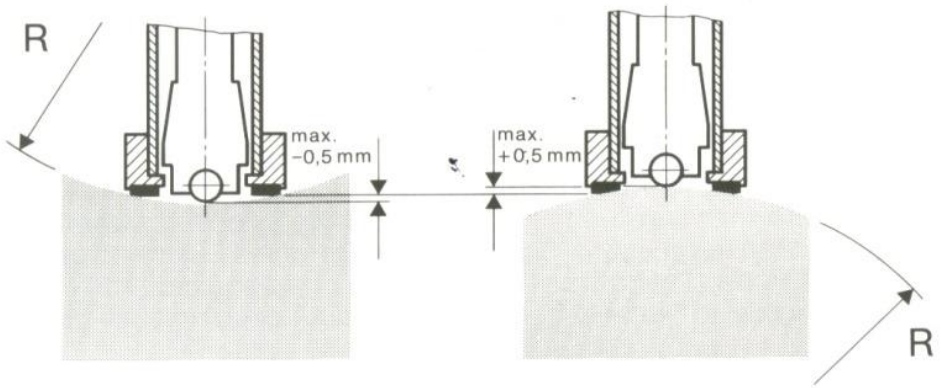
When measuring hardness with HARTIP 3000, the following has to be noticed: Despite the low mass of the impact body and low impact energy, a relatively large impact force within short duration is generated when the impact body hits the measuring surface.

Types of impact devices	D/D+15/DL	G	C
Max. impact force	900N	2500N	500N

No particular precautions are necessary for heavy-weight samples with compact shape.
Smaller and lighter samples or workpieces may yield or flex under this force, producing too-low L-values with excessively large variation. Even with big or heavy workpieces, 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 abnormally low or high. Under many situation, 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.

5.7. 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, D+15 and C Rmin =30mm
Impact device type G Rmin =50mm
For impact devices D, D+15 and C, special support rings are available to accommodate smaller radii on convex or concave surface.

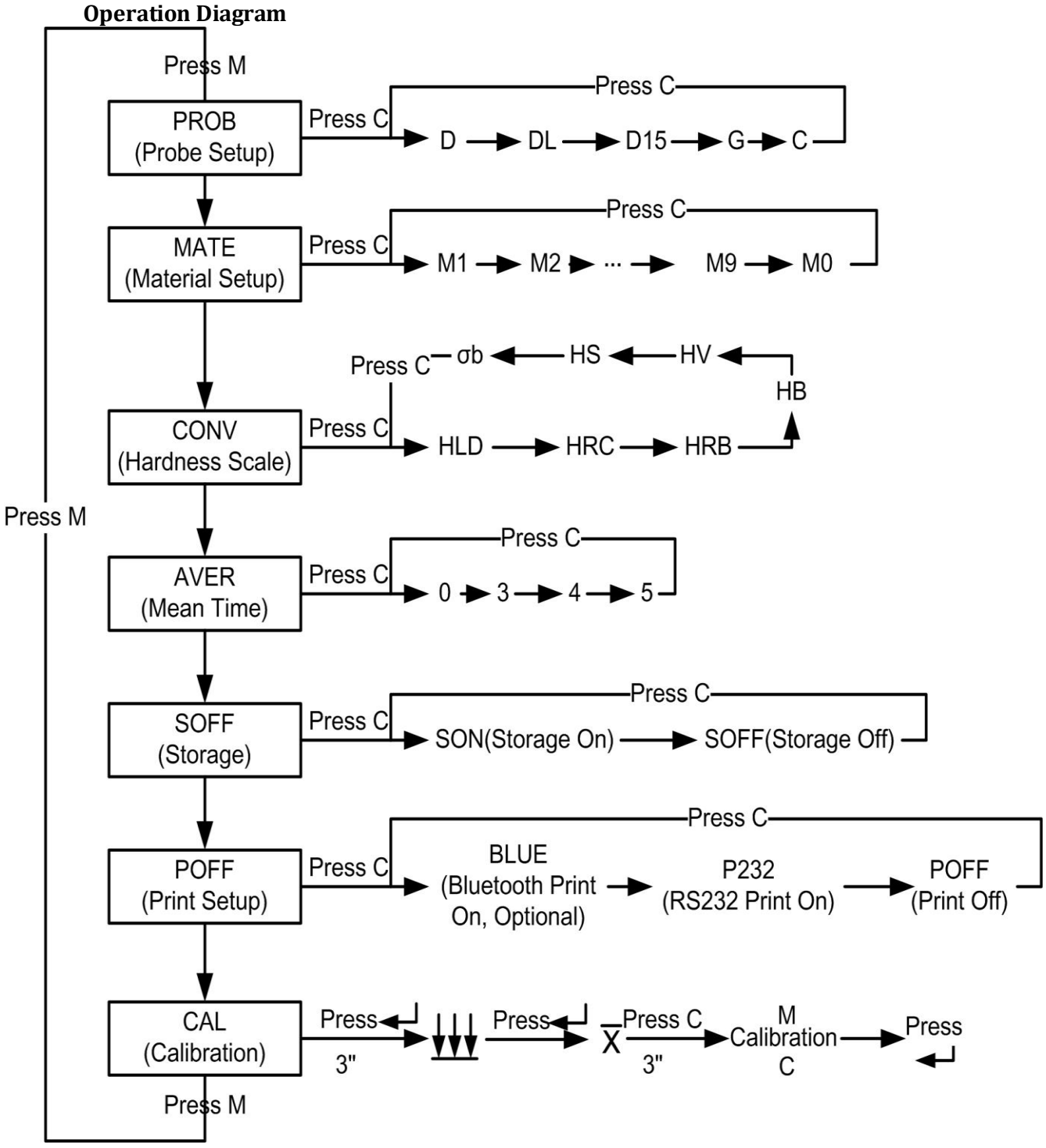
6. Operation

6.1. Switch on the tester

Press the key  to switch on the tester and press the key  again to switch off the tester. When the tester is switched on, the tester will enter into measuring mode.

6.2. Parameter Setup

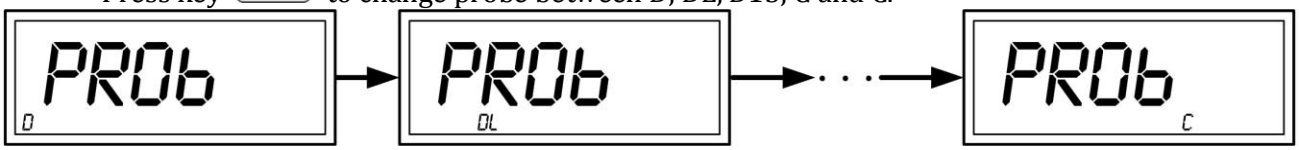
Operation Diagram



6.2.1. Probe Setup

Press key M to enter the Probe setup menu.

Press key C to change probe between D, DL, D15, G and C.



Press key ↵ to confirm the setting or press key M again to change probe.

6.2.2. Materials Selection

The material selected is prior to the conversion from HL value to other scales.

Press key M to enter into the menu until "MATE" displays on LCD.

Press key C to change material from M1→M2→M3→ ... →M11 with each pressing key C.

Press key ↵ to confirm the setting or press key M again to change other parameters.

M1: Steel & Cast Steel
M2: Cold Work Tool Steel
M3: Stainless Steel & High-temp. Resistant Steel
M4: Cast Iron with Lamellar Graphite (GG)
M5: Cast Iron with Nodular Graphite (GGG)
M6: Cast Aluminum Alloys
M7: Copper-Zinc Alloys (Brass)
M8: Copper-Aluminum / Copper-Tin Alloys (Bronze)
M9: Wrought Copper Alloys
M0: Forging Steel

6.2.3. Hardness Scale (Conversion)

Hardness scale is based on the material selected. Not every material has same conversion. For example, for steel, it has conversions to HRC, HRB, HB, HV, HSD; but for cast iron, only has conversions to HB.

Press key M consecutively to enter into the menu until "CONV" displays on LCD.

Press key C to change the hardness scale from HLD→HRC→HB→HV→HS→σb with each pressing key C.

Press key ↵ to confirm the setting or press key M again to go to next item of menu.

6.2.4. Mean Time

With HARTIP2000, the statics values can be calculated automatically after setup mean time.

Press key M consecutively to enter into menu until "AVER" displays on LCD.

Press key C to select mean time from 0→3→4→5 circularly by each pressing key C.

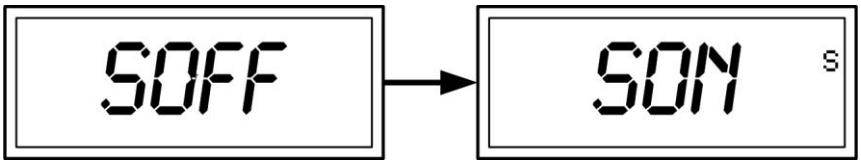
Press ↵ to confirm the setting or press key M again to go to next item of menu.

6.2.5. Storage

The HARTIP2000 has a memory capacity of 999 data. The stored values can be re-readable on LCD.

Press key M consecutively to enter into menu until "SOFF" displays on LCD.

Press key C to change the setting between "SOFF" and "SON" alternatively.

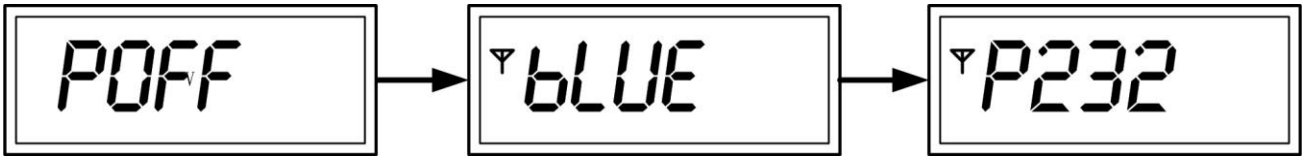


Press key ↵ to confirm the setting or press key M again to go to next item of menu. When select "SON", a "S" appears on LCD which means the function of storage is activated.

6.2.6. Printing Setup

Press key M consecutively to enter into the menu until "POFF" displays on LCD.

Press key C to change the setting between "POFF", "bLUE" and "P232" alternatively.



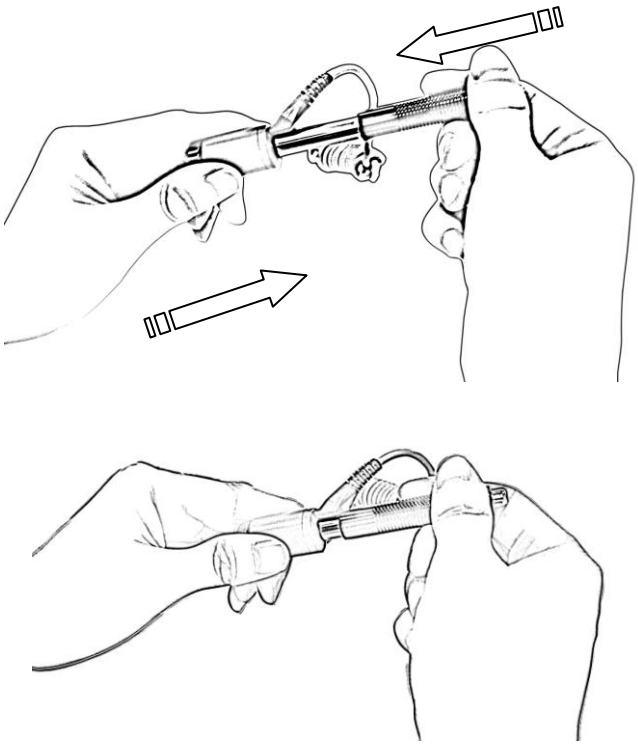
Press key ↵ to confirm the setting or press key M again to go to first item of menu. When selecting “PON”, an indicator “ ” will appears on left side of LCD which means the communication function is activated for printing.

6.3. Operation

6.3.1. Take measurement

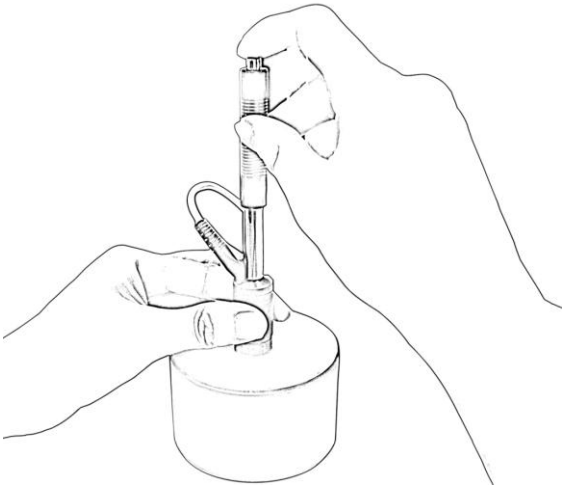
Switch on the tester, the instrument will go into measuring mode automatically. If the parameters are needed to change, please refer to 6.2.

6.3.2. Load spring force



Hold the impact device with left hand while push the loading tube with right hand toward to the end. Then loose the force and let the loading tube back to original position.

6.3.3. Release



Place the impact device against the object to be measured. Then press the release button on top of the impact device with finger of right hand. The measuring value will display on LCD.

Please note：During the measurement, the impact device must be placed vertically with a little force against the surface of workpiece. Otherwise, it may affect the accuracy.

6.4. Data storing and re-reading

6.4.1. Set the storage function of tester to be activated. Please refer to 6.2.5. A "S" displays on LCD. At this time, all measuring values will be stored automatically into the memory.

6.4.2. During the tester power on, press key R after "MEMR" displays and then the last stored value will display.

6.4.3. Press key M or C to turn the page and view measuring values. When "EOF" or "bOF" displays with turning page, it reminds you it is at the end.

6.4.4. Clear the memory

Delete the stored data from memory.

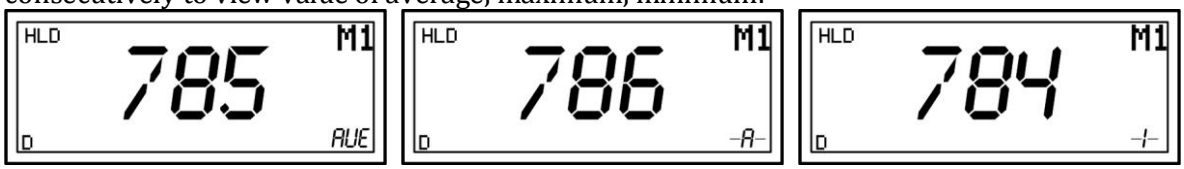
Under the re-readable mode, press and hold the key [D] until "dELE" displays on LCD. Then press key [↵] to confirm the deletion.

6.5. Statics

With this function, the statics values will be calculated automatically by the tester. Please refer to 6.2.4 Mean Time to activate this function.

6.5.1. View statics value

After mean time was setup in the tester, the mean time number will display on LCD. With each measurement, the number will increase one by one until all finished. Then press key [↵] consecutively to view value of average, maximum, minimum.



6.5.2. Delete the non-realistic value

When mean time was setup, in order to avoid wrong calculation, if there are random values occurs, you should delete the random value. Press key [D], the current value will be deleted.

6.6. Print-Out

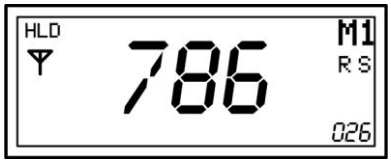
The tester is designed to print our measuring values by two ways. One is print-out all from memory and the other is print-out online while measuring.

6.6.1. Printing stored values

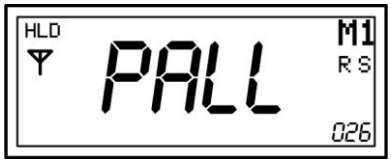
Activate the storage function on the tester, there is a "S" displays on the right side of LCD. Please refer to 6.2.5 Storage.

Connect the tester to the printer with cable and then power on the printer. For Bluetooth connection, the printing cable is not necessary. (The printer and cable will be ordered optionally)

Press key [R], a "R" displays on LCD which means the tester is in the re-readable mode, at this time, the last value will display on LCD.



Press and hold key [R] until "PALL" displays on LCD.



Press key ↵ to print out all data.

6.6.2. Printing on line

Activate the communication on the tester, there is a "Ψ" displayed on LCD. Please refer to 6.2.6 Printing Setup.
Connect the tester to the printer with cable.
Take measurements, all values will be printed out one by one with each measurement.

6.7. Calibration

After long time of use, the ball tip on impact body may be worn out which would lead inaccuracy. In order to compensate such error, the tester is designed to re-calibrate by user.

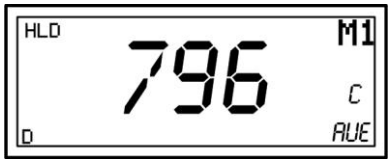
Press key M in turn to display "CAL" on the LCD.

Press and hold Key ↵ for 3 seconds to enter into the mode of calibration.

At the mode of calibration, you are asked to take 3 measurements(impact direction: downward↓) on standard test block in total. Please follow up the direction indication on LCD to take measurements.

During the measurements, you can delete the unsatisfied reading by press key D.

After taking 3 measurements on test block, press key ↵ to display average value. At this time, the arrow disappears and an indicator "AVE" is displayed on the right bottom of LCD.



If the average value differs from the standard value of test block, you can press and hold key C for 3 seconds, "CALD" will flash once on the screen, and then an indicator "ADJ" will display on the right bottom of the LCD, you can press key M or C to increase or decrease the value on LCD until the value is same as the value of test block.

Press key ↵ to finish the calibration and turn back to normal measuring mode.

6.7.1. Calibration for probe DL

Set probe as DL. Please refer to 6.2.1 Probe Setup.

Press key M in turn to display “CAL” on the LCD.

Press and hold Key ↵ for 3 seconds to enter into the mode of calibration.

Take 3 measurements(impact direction: downward↓) on standard test block in total. During the measurements, you can delete the unsatisfied reading by press key D.

After taking 3 measurements on test block, press key ↵ to display average value. At this time, the arrow disappears and an indicator “AVE” is displayed on the right bottom of LCD.

If the average value differs from the **LDL value of test block**, you can press and hold key C for 3 seconds, “CALD” will flash once on the screen, and then an indicator “ADJ” will display on the right bottom of the LCD, you can press key M or C to increase or decrease the value on LCD until the value is same as the value of test block.

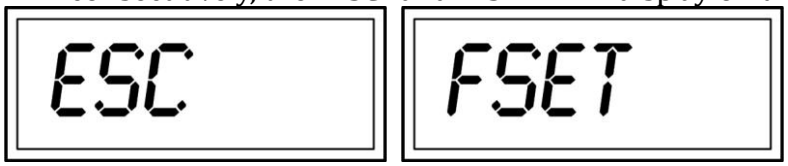
Press key ↵ to finish the calibration and turn back to normal measuring mode.

6.8. Restore factory settings and check serial no.

6.8.1. Restore factory settings

1. Press and hold button C while turning on the tester, "ESC" will display on the LCD after release C.

2. Press C consecutively, the "ESC" and "FSET" will display on the LCD in turn.



3. Press  key to restore factory settings when "FSET" displays on the LCD, and then the tester will return to the measuring mode.

6.8.2. Check serial no.

1. Press and hold button  while turning on the tester, serial no. will display on the LCD.

2. Release  and press  , the tester will return to the measuring mode.

7. Maintenance and Repair

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

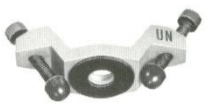
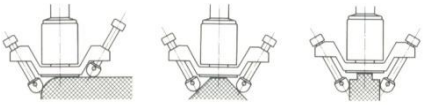
7.1. Maintenance of the Impact Device

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.
Please make sure to keep the spring of impact device at releasing position, do not let the spring pressed by locking impact body after working and being storage.

8. Optional Accessories

Support Rings for Impact Device D

Part designation and dimensions:		Suitable for the following test 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
			
		cylindrical	
Z 10-15	20×20×7.5mm	R 10mm-15mm	
Z 14.5-30	20×20×6.5mm	R 14.5mm-30mm	
Z 25-50	20×20×6.5mm	R 25mm-50mm	
		R<10mm not possible R≥30mm D6/D6a	
		hollow-cylindrical	
HZ 11-13	20×18×5mm	R 11mm-13mm	
HZ 12.5-17	20×20×5mm	R 12.5mm-17mm	
HZ 16.5-30	20×20×5mm	R 16.5mm-30mm	
		R<11mm not possible R≥30mm D6a	
		spherical	
K 10-15	Φ 20×7.7mm	R 10mm-13mm	
K 14.5-30	Φ 20×6.7mm	R 14.5mm-30mm	
		R<10mm not possible R≥30mm D6/D6a	
		hollow-spherical	
HK 11-13	Φ 17×5mm	R 11mm-13mm	
HK 12.5-17	Φ 18×5mm	R 12.5mm-17mm	
HK 16.5-30	Φ 20×5mm	R 16.5mm-30mm	
		R<11mm not possible R≥30mm D6a	
UN	Φ 52×20×16mm		
			

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