Digital Hardness Tester

Model No. PHT-1800

Operation Manual

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1 Overview

1.1 Advantages

- Wide measuring range. Based on the principle of Leeb hardness testing theory. Capable of measuring Leeb hardness of all metallic materials.
- Large screen LCD, showing all functions and parameters. With background light.
- Seven impact devices are available for special application. Automatic identification of impact device upon plug in.
- Test at any angle, even upside down.
- Direct display of hardness scales HRB, HRC, HV, HB, HS, HL
- Large memory could store 100 groups (Relative to average times 1-32) of information including single measured value, mean value, impact direction, impact times, material and hardness scale etc.
- Battery symbol showing the capacity of the battery.
- User calibration function.
- Output via USB port. Micro printer support.
- Compact plastic case, suitable for use under poor working conditions
- Continuous working period of no less than 100 hours with two alkaline batteries(AA size)；Auto power off.
- Outside dimensions：150×74×32 mm
- Weight：245g

1.2 Main Application &Testing Range

1.2.1 Main Application

- Die cavity of molds
- Bearings and other parts
- Failure analysis of pressure vessel, steam generator and other large equipment
- Large, hard work piece
- Testing of installed machinery and permanently assembled parts.
- Material identification based upon hardness range
- Rapid testing in large range and multi-measuring areas for large-scale work piece

1.2.2 Testing Range

Testing range refer to Table 1 and Table 2 in the Appendix.

1.3 Technical Specifications

- Error and repeatability of displayed value see Table1-1 below.

Table 1-1

No.	Type of impact device	Hardness value of Leeb standard hardness block	Error of displayed value	Repeatability
1	D	760±30HLD 530±40HLD	±6 HLD ±10 HLD	6 HLD 10 HLD
2	DC	760±30HLDC 530±40HLDC	±6 HLDC ±10 HLDC	6 HLD 10 HLD
3	DL	878±30HLDL 736±40HLDL	±12 HLDL	12 HLDL
4	D+15	766±30HLD+15 544±40HLD+15	±12 HLD+15	12 HLD+15
5	G	590±40HLG 500±40HLG	±12 HLG	12 HLG
6	E	725±30HLE 508±40HLE	±12 HLE	12 HLE
7	C	822±30HLC 590±40HLC	±12 HLC	12 HLC

- Measuring range：HLD（170～960）HLD
- Measuring direction：0~360°
- Hardness Scale：HL、HB、HRB、HRC, HV、HS
- Display：4-Digit LCD
- Data memory：max. 100 groups（relative to impact times 1-32）
- Working power：3V（2 AA size alkaline batteries）
- Continuous working period：about 100 hours（With backlight off）
- Communication interface：USB

1.4 Configuration

Table 1-2

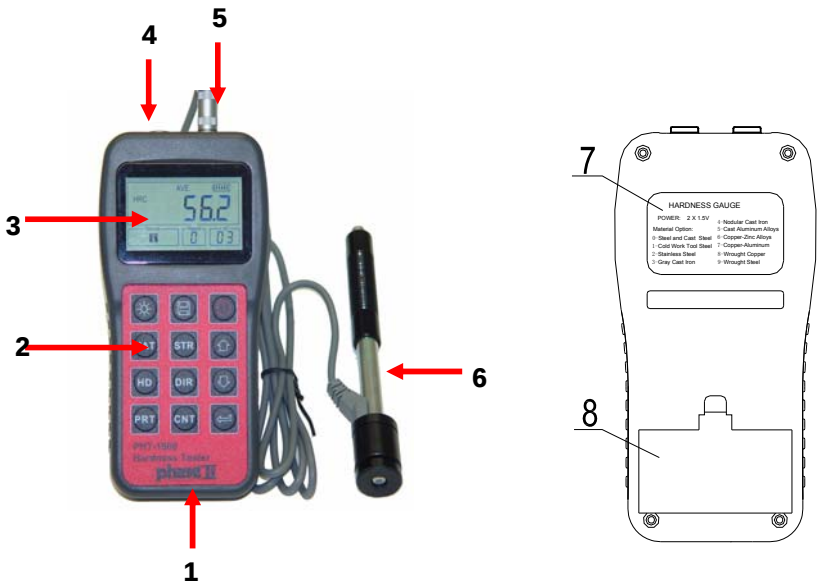
	No.	Item	Quantity	Remarks
Standard Configuration	1	Main unit	1	
	2	D type impact device	1	With cable
	3	Standard test block	1	
	4	Cleaning brush (I)	1	
	5	Small support ring	1	
	6	Alkaline battery	2	AA size
	7	Manual	1	
	8	Instrument package case	1	
	9			
Optional Configuration	11	Cleaning brush (II)	1	For use with G type impact device
	12	Other type of impact devices and support rings		Refer to Table 3 and Table 4 in the appendix.
	14	Communication cable	1	
	16	Print cable	1	

1.5 Working Conditions

Working temperature： 0℃～＋40℃；
Storage temperature：-30℃～＋60℃
Relative humidity: ≤90%；
The surrounding environment should avoid any vibration, strong magnetic field, viscous fluids, corrosive medium and heavy dust.

2 Structure Feature &Testing Principle

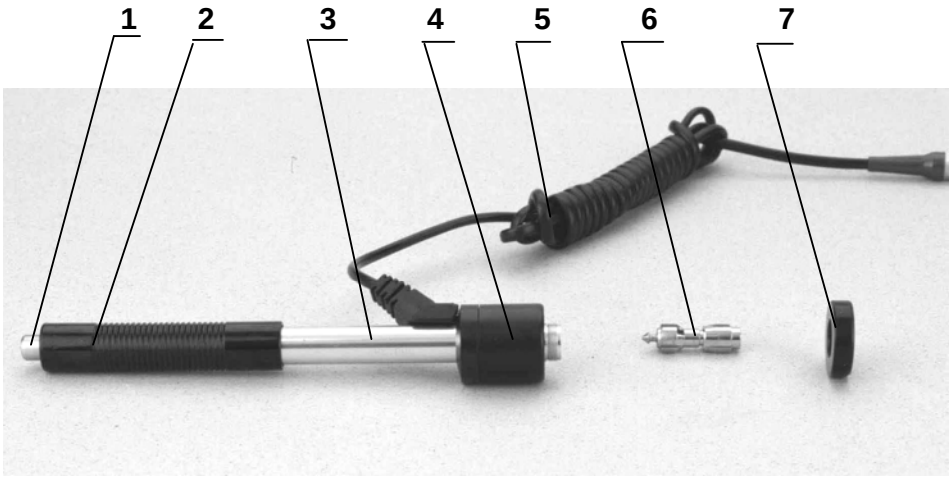
2.1 Structure Feature



1. Main unit 2.Keypad 3. LCD display 4 Socket of USB

5. Socket of impact device 6. Impact device 7 Label 8. Battery cover

2.1.1 D Type Impact Device



1 Release button 2 Loading tube 3 Guide tube 4 Coil unit

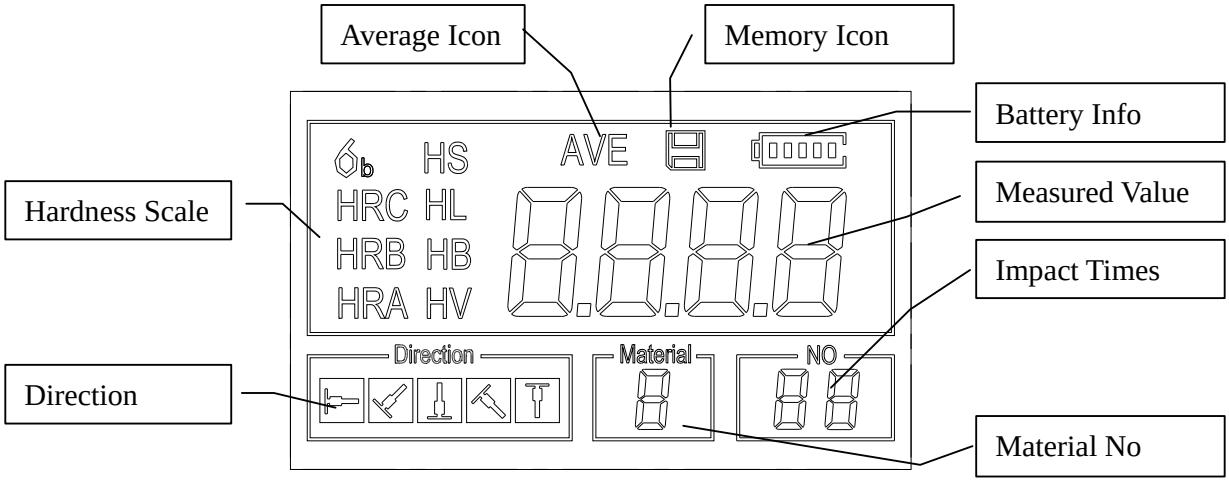
5 Connection cable 6 Impact body 7 Support ring

2.1.2 Different Types of Impact Device

DC DL C D+15 E G

2.2 Main Screen

Below is the main display screen：



Instruction of the Main Display Screen:

Material：The present presetting material.

Impact direction：The present impact direction.

Hardness scale：Hardness scale of the present measured value.

Battery information：Showing the remaining capacity of the battery.

Measured value：Display present single time measured value（without showing average icon），or display the present mean value (with average icon prompting). “-HI-” means over conversion value or measure range. “-LO-” means lower than conversion value or measure range.

Impact times： Times that have been impacted.

Average Icon：It will appear when showing the mean value of the measured values after reaching the presetting impact times.

Memory Icon: It appears when operating the instrument memory.

2.3 Keypad Definitions

Table 2-1

	Turn on/off the EL backlight		Data Save or Data Delete		Turn the instrument on/off
	Material Selection		Hardness/Strength switch		Plus or Up
	Hardness Scale Selection		Direction change		Minus or Down
	Print data		Impact Times set		Data logging or Enter

- Press  key to store present group of measured value into memory. This operation is only valid after displaying the mean value.
- Press key  and  could display single measured value.
- Press  key could switch on of off the background light of LCD.
- Press  key to set the impact direction.
- Press  key to change the impact times in one group. The impact times item will flash when first pressing the  key, and then the impact times value will plus or minus when pressing the  or  key. Press  key finally to exit from changing the impact times process.
- Press  key to change the hardness scale.
- Press  key to change the material. Presetting hardness scale recovers to HL automatically after material presetting changed.
- Press  key to switch between hardness test and strength test. Only D and DC type of impact device has the function of strength testing. So hardness testing is the only selection if the impact device is not D or DC type.
- Press  key to print out the measured values after measurement.

2.4 Leeb Hardness Testing Principle

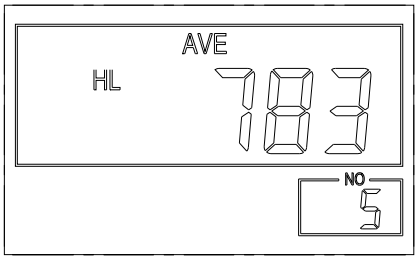
It is defined as the quotient of an impact body's rebound velocity over its impact velocity, multiplied by 1000. Harder materials produce a higher rebound velocity than softer materials. For a specific group of material (e.g. steel, aluminum. etc.). Leeb hardness value represents a direct relationship 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.

3 Preparation

3.1 Instrument Preparation and Inspection

Verification of the instrument is performed by using a standard calibrated test block. The error and repeatability of displayed value should be within the regulation of Appendix table 2. The instrument and impact device must be calibrated using a standard hardness block prior to first usage or having reset the instrument system.

Press ⏻ key, meanwhile pressing down the ↵ key to power on the system. Then the user calibration screen shows as left below.



Test for 5 points on the standard hardness block. It would display the average measured value after measuring 5 times. Press ⇧ ⇩ key to change to its nominal value. Press ↵ key to confirm the calibration finally. Or press the CNT key to cancel the calibration.

Range of adjustment: ±30HL.

The measurement parameters, including the material setting, the hardness scale and the impact direction can't be changed during calibration.

> **Note：For Verification, Take 5 tests around the test block and get your average. This average value should be within the acceptable tolerance of the test block value.** ***If this value exceeds the allowable tolerance of the test block, a calibration should be performed.***

3.2 Impact Device Selection

Refer to Appendix Table 1 and Table 3 for selection of impact device.

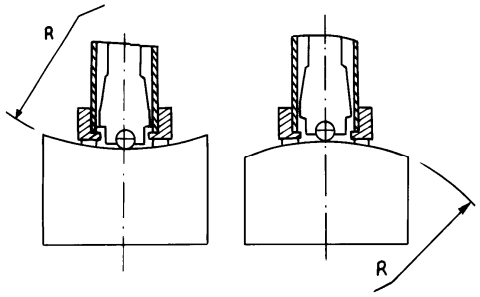
3.3 Preparation of the Sample Surface

Preparation for sample surface should conform to the relative requirement in Appendix Table 3.

- Test surfaces should be at or close to room temperature for optimal performance

To eliminate hardness errors resulting from the roughness of a sample's surface when using impact device D, DC or D+15, the test surface should be polished until its roughness **Ra** is no more than 2μm. PHASE II **SRG-2000** handheld surface roughness tester or any other suitable instrument may be used to measure the surface roughness of the sample material. The test surface should be clean and free from oil stains.

- Support of test sample. Support is not necessary for heavy samples. Lighter weight parts must be set on the flat, smooth surface of a larger mass metal object. The sample must be completely stationary and without any gaps between the two parts.
- Curved surface: The best testing surface of sample is flat. When the curvature radius R of the surface to be tested is smaller than 30mm (D, DC, D+15,C, E and DL type of impact device) and smaller than 50mm (G type of impact device), the small support ring or the shaped support rings should be chosen.
- The sample should have enough mass. Minimum thickness of sample should conform to Table 3.
- For the sample with hardened layer on surface, the depth of hardened layer should conform to Table 3.



- Coupling. Light-weight sample must be firmly coupled to a part with much larger mass. Both coupled surface must be flat and smooth. The impact direction must be vertical to the coupled surface. When the sample is a big plate, or long rod, it can be deformed and become unstable, even though its weight and thickness is within allowable ranges, and accordingly, the test value may not be accurate. So the sample should be reinforced or supported at its back.
- AVOID any object that has a strong Magnetic Force.

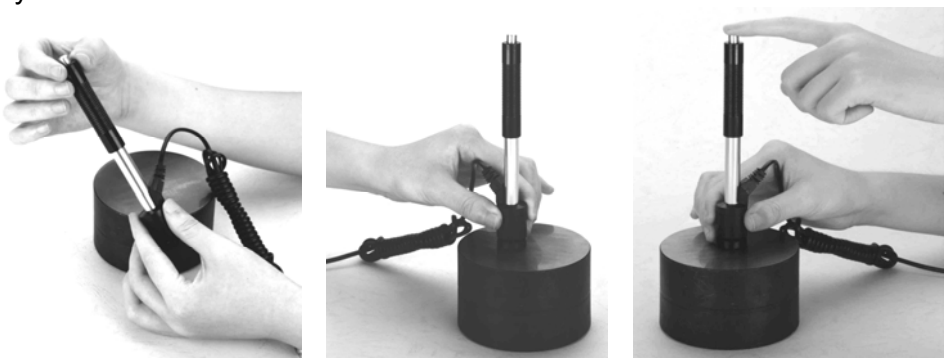
4 Testing Program

4.1 Start-Up

- Insert the plug of the impact device into the socket of impact device on the instrument.
- Press the ⏻ key，now power is on. The instrument is in working mode.

4.2 Loading

Pushing the loading-tube downwards until contact is felt. Then allow it to slowly return to the starting position or using other method locking the impact body.



4.3 Placement

Press the impact device supporting ring firmly on the surface of the sample, the impact direction should be vertical to the testing surface.

4.4 Testing

- Press the release button on the upside of the impact device to test. The sample, the impact device as well as the operator are all required to be stable. The action direction should pass the axis of the impact device.
- Each measured area of the sample usually need 3 to 5 times of testing operation to obtain an average. The result data dispersion should not more than mean value±15HL。
- The distance between any two impact points or from the center of any impact point to the edge of testing sample should conform to the regulation of Table 4-1.

Table 4-1

Type of Impact Device	Distance of center of the two indentations	Distance of center of the indentation to sample edge
	Not less than (mm)	Not less than (mm)
D、DC	3	5
DL	3	5
D+15	3	5
G	4	8
C	2	4

4.5 Read Measured Value

After each impact operation, the LCD will display the current measured value, impact times plus one, a beep will alert you if the measured value is not within the valid range. When reaching the presetting impact times, the beep will alsonotify you. After 2 seconds, the buzzer will alert a short howl, and display the mean measured value.

4.6 Notification

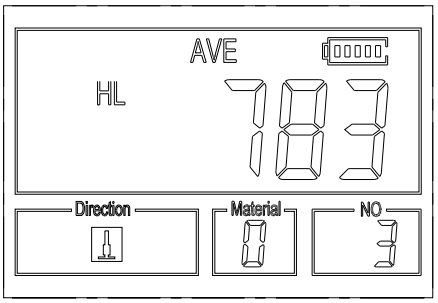
- Replacing the impact device must be done during Power off. Otherwise the main body could not identify the type of the impact device, and it may damage the circuit board of the main body.
- You can only save data after the average has been obtained.
- Only type D and type DC of impact device have the function of tensile strength test option. You can not change the setting to strength testing when using other types of impact device.
- Not all materials can convert to all hardness scale value. The hardness scale is reset to HL automatically after changing the material. So select material prior to changing the hardness scale.

5 Operation Detail

5.1 Power On/Off

Plug in the impact device FIRST. Press ⏻ to power on the instrument. The unit will automatically detect the type of the impact device during power up, and would display this information on the screen. Users should pay attention to the probe type displayed on the screen. After pausing for several

second, the screen will then enter the main testing screen as shown below:



The instrument can be turned off by pressing the ⏻ key while it is working. The tool has a special memory that retains all of its settings even when the power is off.

5.2 Material Setting

Press MAT key to change the material to the one you want to preset. Hardness scale defaults to HL automatically after material presetting changed. Please select material first, then select hardness scale.

You can select your material among the following selections: Steel and Cast Steel、Cold Work Tool Steel、Stainless Steel、Gray Cast Iron、Nodular Cast Iron、Cast Aluminum Alloys、Copper-Zinc Alloys、Copper-Aluminum Alloy and Wrought Copper. The relationship between the material number displayed on the instrument screen and the material is as follows:

Table 5-1

Material No.	Material	Material No.	Material
0	Steel and cast steel	5	Cast aluminium alloys
1	Cold work tool steel	6	Copper-Zinc alloys
2	Stainless steel	7	Copper –Aluminium alloys
3	Gray cast iron	8	Wrought copper
4	Nodular cast iron		

In strength testing, the following materials are selectable: Mild Steel、High-Carbon Steel、Cr Steel、Cr-V Steel、Cr-Ni Steel、Cr-Mo Steel、Cr-Ni-Mo Steel、Cr-Mn-Si Steel、Super Strength Steel and Stainless Steel. The relationship between the material number displayed on the instrument screen and the material is as follows:

Table 5-2

Material No	Material	Material No	Material
0	Mild steel	5	Cr-Mo steel
1	High carbon steel	6	Cr-Ni-Mo steel
2	Cr steel	7	Cr-Mn-Si steel
3	Cr-V steel	8	Super strength steel
4	Cr-Ni steel	9	Stainless steel

5.3 Hardness/Strength testing

Press STR key to switch between hardness testing and strength testing (бb) .

Note: Only D and DC type of impact device has the function of strength testing. So hardness testing is the only selection if the impact device is not D or DC type.

In hardness testing, Press HD key to change the hardness scale. The supported hardness scale includes: HL, HV, HB, HRC, HS and HRB.

Note：

- ***This displays the valid hardness scale for the present selected impact device and material. It would not display the hardness scale which is not valid.***
- ***Please select material first, then select hardness scale.***
- ***Presetting hardness scale recovers to HL automatically after presetting material is changed.***

5.4 Impact Direction Setting

Press the DIR key to move to the impact direction that you will work in.

5.5 Average Times Setting

You could modify average times within the range of 1 to 32 as following:

1) Press CNT key in testing state. The impact times item will begin to flash;
2) Press ⇧ or ⇩ key to set the average times to the number you want.
3) Press CNT key finally to exit from the operation.

5.6 Data logging

At most one hundred files (F00-F99, one group as one file) can be stored inside the gauge. By simply pressing the 🖫 key after a new measurement finishes-the screen showing the “AVE” icon, the measured hardness/strength group values will be saved to memory. The new saved file is appended as the last file of the memory. This function provides the user with the ability to view/delete a file/group previously saved in memory.

5.6.1 Viewing stored file/Group

To view the memory data, follow the steps:

1) Press the ↵ key to activate the data logging function. The memory icon will appear. It will display the current file name, the test parameter of the group data and the mean value of the group. If there is no data in the memory, it will display: <E04>, which means no memory data, and then return back.

2) Use the ⇧ key and the ⇩ key to select the desired file to view.

3) Press the ↵ key to see details of that group data.

4) Use the ⇧ key and the ⇩ key to view each single measured data in that group while viewing details.

5) Press the CNT key to return to previous screen at any time during data logging.

5.6.2 Deleting selected file/Group

The user may require deleting a file from the instrument memory. The procedure is outlined in the following steps.

1) Press the ↵ key to activate the data logging function. The memory icon will appear. It will display the current file name, the test parameter of the group data and the mean value of the group. If there is no data in the memory, it will display: <E04>, which means no memory data, and then return back.

2) Use the ⇧ key and the ⇩ key to scroll to the file that will be deleted.

3) Press the 🖫 key on the desired file. It will automatically delete the file, and display "-DEL".

4) Press the CNT key, at any time, to exit the data logging function and return to measurement mode.

Note：Do not shut down the instrument while deleting data. It could lead to loss of all data if shut down while deleting.

5.7 Print Report

At the end of the inspection process, or end of the day, the user may require the readings be printed.

Before printing, please insert one connection plug of the print cable into the socket on the upper left side of the main body, and insert the other plug into the communication socket of your PC. You can print out the measurement result immediately after each testing process, by easily pressing the PRT key.

If you want to print the data stored in the instrument memory, then follow these steps:

1. Press the ↵ key to activate the data logging function. The memory icon will appear.

2. Use the ⇧ key and the ⇩ key to select the desired file.

3. Press the PRT key to print the selected file. This operation will send all the data in current file to the mini printer via RS232 port and print them out.

4. Press the CNT key to exit the data logging functions and return to measurement mode.

5.8 System Reset

Press down the HD key while powering on the instrument will restore factory defaults. The only time this might possibly helpful is if one of the parameters in the gauge were somehow corrupted.

5.9 EL Backlight

With the EL background light, it is convenient to work in darker conditions. Press key ✱ to switch on or switch off the background light at any moment as you need after power on. Since the EL light will consume more power, turn on it only when necessary.

5.10 Auto Power Off

The instrument features an auto power off function designed to conserve battery life. If the tool is idle (neither measuring nor any key operation) for 5 minutes, it will turn itself off. Before powering off, the LCD display of the instrument will continue flashing for 20 seconds. To prevent the unit from powering off you can press any button Except ⏻ Power.

When the voltage of the battery gets too low, the display will show <E00>, then power off automatically.

5.11 Battery Replacement

The PHT-1800 uses standard AA batteries. After several hours of usage, the battery symbol on the screen will begin to show less dark tabs which is shown as  . When the batteries are drained, the battery symbol will be shown as  and will begin to flash. When this occurs, the batteries should be replaced.

Pay attention to the polarity of the batteries!

Please properly dispose of used batteries accordingly.

5.12 Connecting to a Computer

The Instrument is equipped with a USB serial port. Using the output cable the gauge has the ability to connect to a computer, or external storage device. Measurement data stored in the memory of the gauge can be transferred to the computer through the USB port.

5.13 Error Code Reference

Error Code	Explanation	Error Code	Explanation
E00	Replace Battery	E05	Can't print
E01	Value out of range	E06	
E02	Measurement not finished	E07	
E03	Data already saved	E08	
E04	No memory data	E09	

6 Maintenance & Servicing

6.1 Impact Device Maintenance

- After the impact device has been used for 1000--2000 times, please use the nylon brush provided to clean the guide tube and impact body. When cleaning the guide tube, unscrew the support ring first, then take out the impact body, spiral the nylon brush in counter-clockwise direction into the bottom of guide tube and repeat a few times to remove any dust or small chips inside the tube.T hen install the impact body and support ring again.
- Release the impact body after use.
- **NEVER USE LUBRICANT OR CLEANERS ON IMPACT DEVICE!**

6.2 Instrument Maintenance Program

- When testing in the Rockwell C hardness scale your error amount should not exceed 2 Rockwell C points. Changing the spherical test tip or impact body should be considered.
- **Warranty will be VOID if unit has been dismantled by someone other than an authorized repair person**

6.3 Fault Analysis & Evaluation

Fault Appearance	Fault Analysis	Repair method
Failure to power on	Low or dead Battery	Replace the batteries
No measured value	Impact device cable failure	Replace the cable

APPENDIX

Table 1

Material	Method	Impact device					
		D/DC	D+15	C	G	E	DL
Steel and cast steel	HRC	20～68.5	19.3～67.9	20.0～69.5		22.4～70.7	20.6～68.2
	HRB	38.4～99.6			47.7～99.9		37.0～99.9
	HB	127～651	80～638	80～683	90～646	83～663	81～646
	HV	83～976	80～937	80～996		84～1042	80～950
	HS	32.2～99.5	33.3～99.3	31.8～102.1		35.8～102.6	30.6～96.8
Cold work tool steel	HRC	20.4～67.1	19.8～68.2	20.7～68.2		22.6～70.2	
	HV	80～898	80～935	100～941		82～1009	
Stainless steel	HRB	46.5～101.7					
	HB	85～655					
	HV	85～802					
Grey cast iron	HRC						
	HB	93～334			92～326		
	HV						
Nodular cast iron	HRC						
	HB	131～387			127～364		
	HV						
Cast aluminum alloys	HB	19～164		23～210	32～168		
	HRB	23.8～84.6		22.7～85.0	23.8～85.5		
BRASS(copper-zinc alloys)	HB	40～173					
	HRB	13.5～95.3					
BRONZE(copper-aluminum/tin alloys)	HB	60～290					
Wrought copper alloys	HB	45～315					

Table 2: Leeb to Tensile Strength Conversion Chart:

This is an Approximation only!

No.	Material	HLD	Strength σ_b(MPa)
1	Mild steel	350～522	374～780
2	High-Carbon steel	500～710	737～1670
3	Cr steel	500～730	707～1829
4	Cr-V steel	500～750	704～1980
5	Cr-Ni steel	500～750	763～2007
6	Cr-Mo steel	500～738	721～1875
7	Cr-Ni-Mo steel	540～738	844～1933
8	Cr-Mn-Si steel	500～750	755～1993
9	Super strength steel	630～800	1180～2652
10	Stainless steel	500～710	703～1676

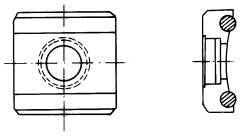
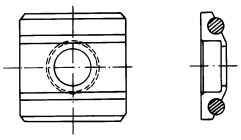
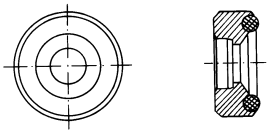
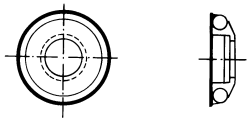
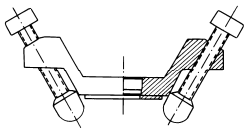
Table 3

Type of impact device	DC(D)/DL	D+15	C	G	E
Impacting energy Mass of impact body	11mJ 5.5g/7.2g	11mJ 7.8g	2.7mJ 3.0g	90mJ 20.0g	11mJ 5.5g
Test tip hardness: Dia. Test tip: Material of test tip:	1600HV 3mm Tungsten carbide	1600HV 3mm Tungsten carbide	1600HV 3mm Tungsten carbide	1600HV 5mm Tungsten carbide	5000HV 3mm synthetic diamond
Impact device diameter: Impact device length: Impact device weight:	20mm 86(147)/ 75mm 50g	20mm 162mm 80g	20mm 141mm 75g	30mm 254mm 250g	20mm 155mm 80g
Max. hardness of sample	940HV	940HV	1000HV	650HB	1200HV
Mean roughness value of sample surface Ra:	1.6 μm	1.6 μm	0.4 μm	6.3 μm	1.6 μm
Min. weight of sample: Measure directly Need support firmly Need coupling tightly	 >5kg 2～5kg 0.05～2kg	 >5kg 2～5kg 0.05～2kg	 >1.5kg 0.5～1.5kg 0.02～0.5kg	 >15kg 5～15kg 0.5～5kg	 >5kg 2～5kg 0.05～2kg
Min. thickness of sample Coupling tightly Min. layer thickness for surface hardening	 5mm ≥0.8mm	 5mm ≥0.8mm	 1mm ≥0.2mm	 10mm ≥1.2mm	 5mm ≥0.8mm

Size of tip indentation						
Hardness 300HV	Indentation diameter Depth of indentation	0.54mm 24 μm	0.54mm 24 μm	0.38mm 12 μm	1.03mm 53 μm	0.54mm 24 μm
Hardness 600HV	Indentation diameter Depth of indentation	0.54mm 17 μm	0.54mm 17 μm	0.32mm 8 μm	0.90mm 41 μm	0.54mm 17 μm
Hardness 800HV	Indentation diameter Depth of indentation	0.35mm 10 μm	0.35mm 10 μm	0.35mm 7 μm	-- --	0.35mm 10 μm
Available type of impact device		DC: Test hole or hollow cylindrical; DL:Test narrow groove or hole	**D**+15: Test grooves	C: Test small,light,thin parts and surface of hardened layer	**G:** Test large, ,heavy and rough surface steel	**E:** Test super high hardness material

Optional 12pc Support Ring Set

Part No. PHT1500-300

No.	Type	Sketch of non-conventional Supporting ring	Remarks
1	Z10-15		For testing cylindrical outside surface R10～R15
2	Z14.5-30		For testing cylindrical outside surface R14.5～R30
3	Z25-50		For testing cylindrical outside surface R25～R50
4	HZ11-13		For testing cylindrical inside surface R11～R13
5	HZ12.5-17		For testing cylindrical inside surface R12.5～R17
6	HZ16.5-30		For testing cylindrical inside surface R16.5～R30
7	K10-15		For testing spherical outside surface SR10～SR15
8	K14.5-30		For testing spherical outside surface SR14.5～SR30
9	HK11-13		For testing spherical inside surface SR11～SR13
10	HK12.5-17		For testing spherical inside surface SR12.5～SR17
11	HK16.5-30		For testing spherical inside surface SR16.5～SR30
12	UN		For testing cylindrical outside surface,radius adjustable R10～∞

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