

# Digital Hardness Tester

Model No. PHT-1800

## Operation Manual



|  |    |
|--|----|
| <b>1 Overview</b> .....                                  | 3  |
| 1.1 Advantages.....                                      | 3  |
| 1.2 Main Application & Testing Range .....               | 3  |
| 1.2.1 Main Application .....                             | 3  |
| 1.2.2 Testing Range.....                                 | 3  |
| 1.3 Technical Specifications .....                       | 4  |
| 1.4 Configuration.....                                   | 5  |
| 1.5 Working Conditions.....                              | 5  |
| <b>2 Structure Feature &amp; Testing Principle</b> ..... | 6  |
| 2.1 Structure Feature.....                               | 6  |
| 2.1.1 D Type Impact Device .....                         | 6  |
| 2.1.2 Different Types of Impact Device.....              | 7  |
| 2.2 Main Screen.....                                     | 7  |
| 2.3 Keypad Definitions .....                             | 8  |
| 2.4 Leeb Hardness Testing Principle.....                 | 8  |
| <b>3 Preparation</b> .....                               | 9  |
| 3.1 Instrument Preparation and Inspection .....          | 9  |
| 3.2 Impact Device Selection .....                        | 9  |
| 3.3 Preparation of the Sample Surface.....               | 9  |
| <b>4 Testing Program</b> .....                           | 11 |
| 4.1 Start-Up.....  | 11 |
| 4.2 Loading .....  | 11 |
| 4.3 Localization .....                                   | 11 |
| 4.4 Testing.....   | 11 |
| 4.5 Read Measured Value .....                            | 12 |
| 4.6 Notification .....                                   | 12 |
| <b>5 Operation Detail</b> .....                          | 12 |
| 5.1 Power On/Off.....                                    | 12 |
| 5.2 Material Setting .....                               | 13 |
| 5.3 Hardness/Strength testing .....                      | 14 |
| 5.4 Impact Direction Setting.....                        | 14 |
| 5.5 Average Times Setting .....                          | 14 |
| 5.6 Data logging.....                                    | 14 |
| 5.6.1 Viewing stored file/Group.....                     | 14 |
| 5.6.2 Clearing selected file/Group .....                 | 15 |
| 5.7 Print Report.....                                    | 15 |
| 5.8 System Reset.....                                    | 16 |
| 5.9 EL Backlight.....                                    | 16 |
| 5.10 Auto Power Off.....                                 | 16 |
| 5.11 Battery Replacement.....                            | 16 |
| 5.12 Connecting to a Computer .....                      | 16 |
| 5.13 Error Code Reference .....                          | 16 |
| <b>6 Maintenance &amp; Servicing</b> .....               | 17 |

6.1 Impact Device Maintenance ..... 17  
6.2 Instrument Maintenance Program..... 17  
6.3 Fault Analysis & Evaluation ..... 17  
6.4 Notice of Transport and Storage Conditions ..... **Error! Bookmark not defined.**  
APPENDIX ..... 18  
Table 1 ..... 18  
Table 2 ..... 19  
Table 3 ..... 20  
Table 4 ..... **Error! Bookmark not defined.**

# 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<br>530±40HLD                         | ±6 HLD<br>±10 HLD        | 6 HLD<br>10 HLD |
| 2   | DC                    | 760±30HLDC<br>530±40HLDC                       | ±6 HLDC<br>±10 HLDC      | 6 HLD<br>10 HLD |
| 3   | DL                    | 878±30HLDL<br>736±40HLDL                       | ±12 HLDL                 | 12 HLDL         |
| 4   | D+15                  | 766±30HLD+15<br>544±40HLD+15                   | ±12 HLD+15               | 12 HLD+15       |
| 5   | G                     | 590±40HLG<br>500±40HLG                         | ±12 HLG                  | 12 HLG          |
| 6   | E                     | 725±30HLE<br>508±40HLE                         | ±12 HLE                  | 12 HLE          |
| 7   | C                     | 822±30HLC<br>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°C ~ +40°C;

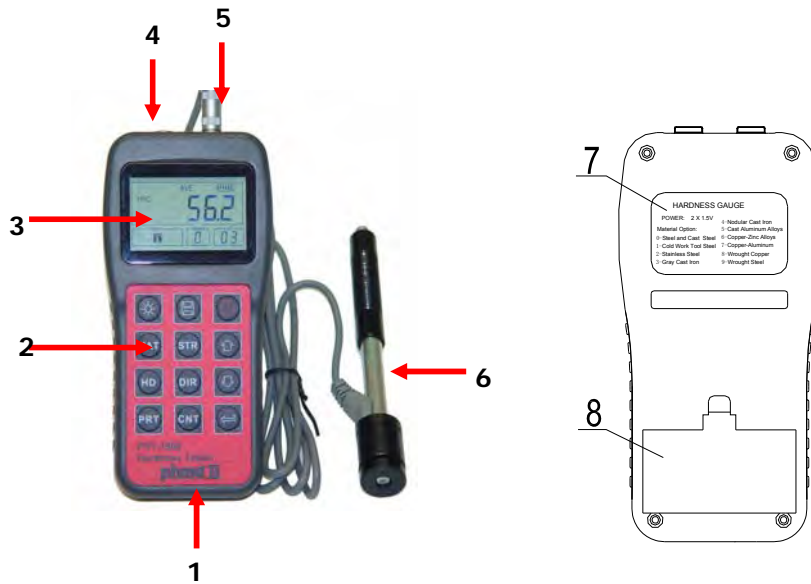
Storage temperature: -30°C ~ +60°C

Relative humidity: ≤90%;

The surrounding environment should avoid any vibration, strong magnetic field, viscous fluids, corrosive medium and heavy dust.

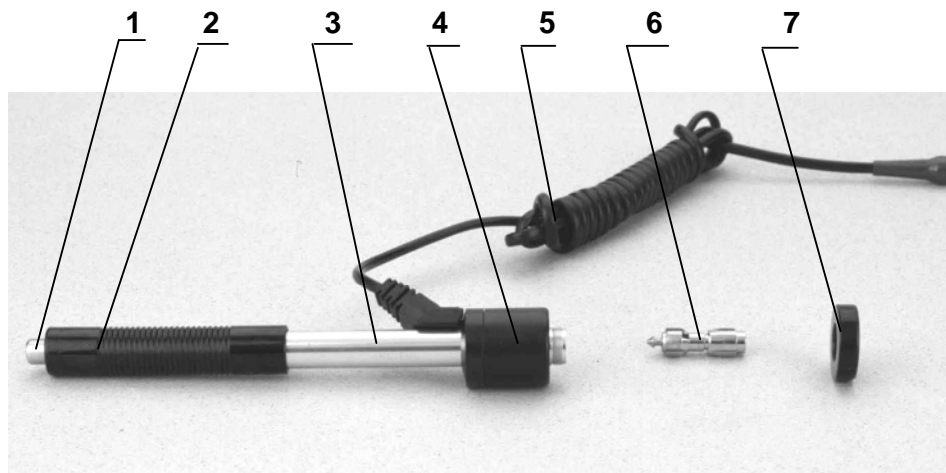
## 2 Structure Feature & Testing Principle

### 2.1 Structure Feature



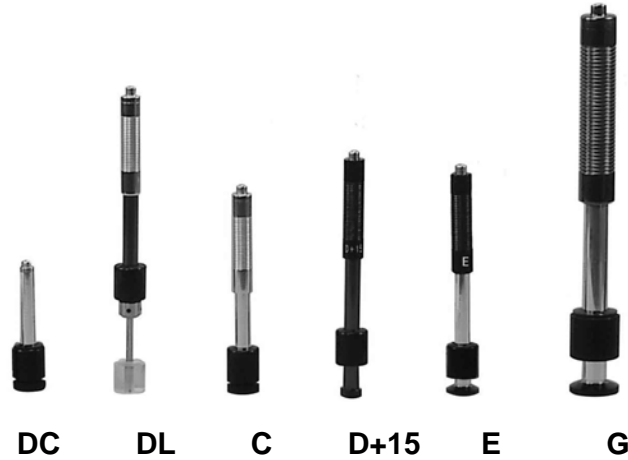
1. Main unit    2. Keypad    3. LCD display    4. Socket of USB  
 5. Socket of impact device    6. Impact device    7. Label    8. Battery cover

#### 2.1.1 D Type Impact Device



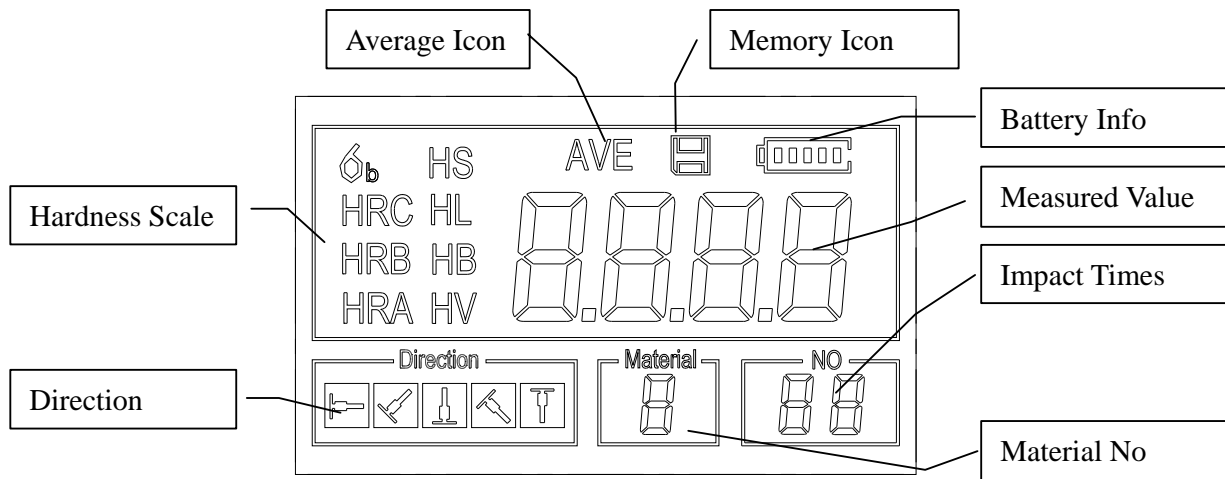
- 1 Release button    2 Loading tube    3 Guide tube    4 Coil unit  
 5 Connection cable    6 Impact body    7 Support ring

## 2.1.2 Different Types of Impact Device



## 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 backlight EL |  | 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

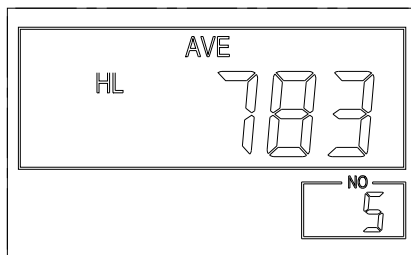
It is defined as the quotient of an impact body's rebound velocity over its impact velocity, multiplied by 1000. Harder materials produce a higher rebound velocity than softer materials. For a specific group of material (e.g. steel, aluminum. etc.). Leeb hardness value represents a direct relationship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

Range of adjustment:  $\pm 30HL$ .

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.

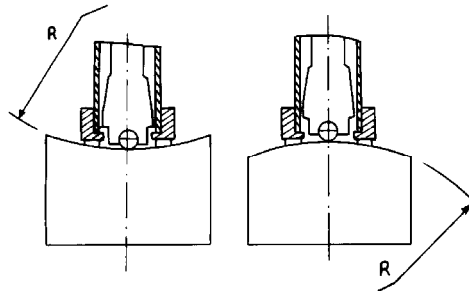
### 3.3 Preparation of the Sample Surface

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 2 $\mu$ m. 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.

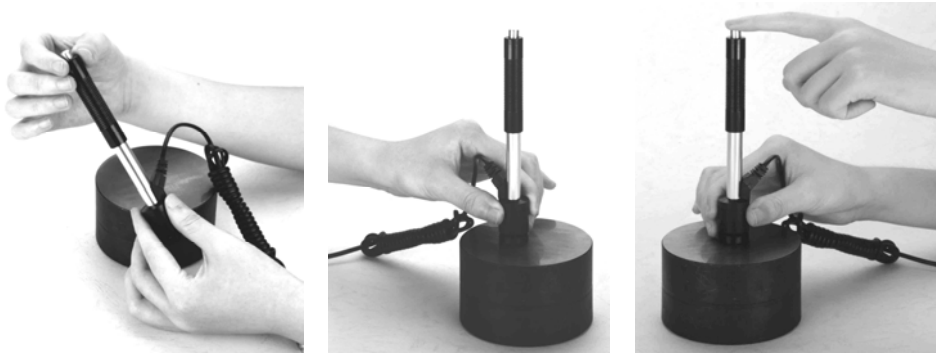
## 4 Testing Program

### 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  $\pm 15HL$ .
- 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 also notify you. After 2 seconds, the buzzer will alert a short howl, and display the mean measured value.

#### 4.6 Notification

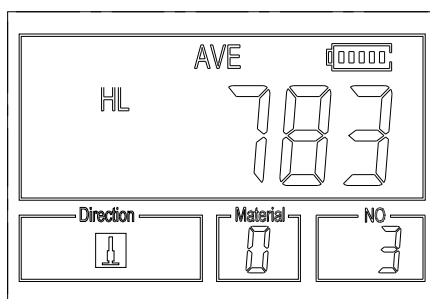
- Replacing the impact device must be done during Power off. Otherwise the main body could not identify the type of the impact device, and it may damage the circuit board of the main body.
- You can only save data after the average has been obtained.
- Only type D and type DC of impact device have the 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  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  key to switch between hardness testing and strength testing (6b).

**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  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  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  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  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  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  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  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  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  key to exit the data logging functions and return to measurement mode.




## 5.8 System Reset

Press down the  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. Then 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~<br>68.5    | 19.3~<br>67.9 | 20.0~<br>69.5  |               | 22.4~70.7      | 20.6~<br>68.2 |
|                                    | HRB    | 38.4~<br>99.6  |               |                | 47.7~<br>99.9 |                | 37.0~<br>99.9 |
|                                    | HB     | 127~<br>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~<br>99.5  | 33.3~<br>99.3 | 31.8~<br>102.1 |               | 35.8~<br>102.6 | 30.6~<br>96.8 |
| Cold work tool steel               | HRC    | 20.4~<br>67.1  | 19.8~<br>68.2 | 20.7~<br>68.2  |               | 22.6~70.2      |               |
|                                    | HV     | 80~898         | 80~935        | 100~<br>941    |               | 82~1009        |               |
| Stainless steel                    | HRB    | 46.5~<br>101.7 |               |                |               |                |               |
|                                    | HB     | 85~655         |               |                |               |                |               |
|                                    | HV     | 85~802         |               |                |               |                |               |
| Grey cast iron                     | HRC    |                |               |                |               |                |               |
|                                    | HB     | 93~334         |               |                | 92~326        |                |               |
|                                    | HV     |                |               |                |               |                |               |
| Nodular cast iron                  | HRC    |                |               |                |               |                |               |
|                                    | HB     | 131~<br>387    |               |                | 127~<br>364   |                |               |
|                                    | HV     |                |               |                |               |                |               |
| Cast aluminum alloys               | HB     | 19~164         |               | 23~210         | 32~168        |                |               |
|                                    | HRB    | 23.8~<br>84.6  |               | 22.7~<br>85.0  | 23.8~<br>85.5 |                |               |
| BRASS(copper-zinc alloys)          | HB     | 40~173         |               |                |               |                |               |
|                                    | HRB    | 13.5~<br>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!

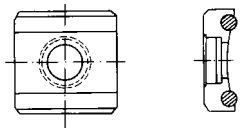
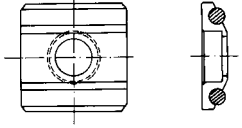
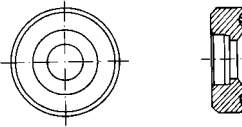
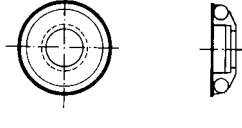
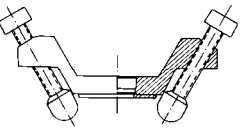
| No. | Material             | HLD     | Strength $\sigma_b$ (MPa) |
|-----|----------------------|---------|---------------------------|
| 1   | Mild steel           | 350~522 | 374~780                   |
| 2   | High-Carbon steel    | 500~710 | 737~1670                  |
| 3   | Cr steel             | 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**

| <b>Type of impact device</b>               |                      | <b>DC(D)/DL</b>  | <b>D+15</b>        | <b>C</b>   | <b>G</b>                                     | <b>E</b>                             |
|--|----------------------|--|--------------------|--|--|--------------------------------------|
| Impacting energy                           |                      | 11mJ   | 11mJ               | 2.7mJ  | 90mJ   | 11mJ                                 |
| Mass of impact body                        |                      | 5.5g/7.2g  | 7.8g               | 3.0g   | 20.0g  | 5.5g                                 |
| Test tip hardness:                         |                      | 1600HV   | 1600HV             | 1600HV   | 1600HV                                       | 5000HV                               |
| Dia. Test tip:                             |                      | 3mm  | 3mm                | 3mm  | 5mm  | 3mm                                  |
| Material of test tip:                      |                      | Tungsten carbide   | Tungsten carbide   | Tungsten carbide   | Tungsten carbide                             | synthetic diamond                    |
| Impact device diameter:                    |                      | 20mm   | 20mm               | 20mm   | 30mm   | 20mm                                 |
| Impact device length:                      |                      | 86(147)/   | 162mm              | 141mm  | 254mm  | 155mm                                |
| Impact device weight:                      |                      | 75mm<br>50g  | 80g                | 75g  | 250g   | 80g                                  |
| Max. hardness of sample                    |                      | 940HV  | 940HV              | 1000HV   | 650HB  | 1200HV                               |
| Mean roughness value of sample surface Ra: |                      | 1.6 μ m  | 1.6 μ m            | 0.4 μ m  | 6.3 μ m                                      | 1.6 μ m                              |
| Min. weight of sample:                     |                      |  |                    |  |  |                                      |
| Measure directly                           |                      | >5kg   | >5kg               | >1.5kg   | >15kg  | >5kg                                 |
| Need support firmly                        |                      | 2~5kg  | 2~5kg              | 0.5~1.5kg  | 5~15kg                                       | 2~5kg                                |
| Need coupling tightly                      |                      | 0.05~<br>2kg   | 0.05~2kg           | 0.02~0.5kg   | 0.5~5kg                                      | 0.05~2kg                             |
| Min. thickness of sample                   |                      |  |                    |  |  |                                      |
| Coupling tightly                           |                      | 5mm  | 5mm                | 1mm  | 10mm   | 5mm                                  |
| Min. layer thickness for surface hardening |                      | ≥0.8mm   | ≥0.8mm             | ≥0.2mm   | ≥1.2mm                                       | ≥0.8mm                               |
| <b>Size of tip indentation</b>             |                      |  |                    |  |  |                                      |
| Hardness 300HV                             | Indentation diameter | 0.54mm   | 0.54mm             | 0.38mm   | 1.03mm                                       | 0.54mm                               |
|  | Depth of indentation | 24 μ m   | 24 μ m             | 12 μ m   | 53 μ m                                       | 24 μ m                               |
| Hardness 600HV                             | Indentation diameter | 0.54mm   | 0.54mm             | 0.32mm   | 0.90mm                                       | 0.54mm                               |
|  | Depth of indentation | 17 μ m   | 17 μ m             | 8 μ m  | 41 μ m                                       | 17 μ m                               |
| Hardness 800HV                             | Indentation diameter | 0.35mm   | 0.35mm             | 0.35mm   | --   | 0.35mm                               |
|  | Depth of indentation | 10 μ m   | 10 μ m             | 7 μ m  | --   | 10 μ m                               |
| Available type of impact device            |                      | DC: Test hole or hollow cylindrical;<br>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~∞ |