Digital Hardness Tester

DHT-100

Instruction Manual

Content

1. Summary

DHT-100 Leeb hardness tester, based on the principle of Leeb theory, can be used for hardness testing of various metals. With the feature of compact size, it is suitable for working on various circumstances. The Leeb hardness values can be easily converted to HRC, HRB, HV, HS and so on normal hardness scales.

In order to operate the instrument correctly and properly, users are required to read this instruction manual completely before using it.

2. Functions

DHT-100 is an advanced, handheld hardness tester that provides high accuracy and simplicity of operation for a wide measuring range. It is suitable for testing the hardness of ordinary metals and is widely applied in many industries including the petroleum, chemical, industrial machining and electric power industries, etc.

2.1 Typical Applications

Typical hardness testing applications of the DHT-100 include:

- Inspection of installed machinery, permanent parts of assembled systems and heavy workpieces
- Inspection of the moulding surface of a die
- Analysis of pressure vessels, turbo generator sets, etc.
- Inspection of bearing and other mass produced parts on a production line
- Obtaining original records of test data

- Identification of metallic materials stored in a warehouse

2.2 Technical Data

- Display error $\pm0.8\%$ at LD=900

  $(\underline{\text{Value display} - \text{Value actual}} \times 100)= \text{Display error}$
        Value Actual

- Relative repetitive display error 0.8% at LD=900

  $(\underline{\text{Value max} - \text{Value min.}} \times 100) = \text{Relative repetitive display error}$
        Value Average

2.3 Available Functions

- Automatic identification of integrated impact device (D, DC, DL, D+15, C, G)
- Quick entry of a series of test numbers, test dates, sample material type and impact direction via the keypad.
- Deletion of erroneous or incorrect previously stored test data.
- Display of the current test mode and its corresponding test data.
- Quick print out of all test results via an optional mini-printer
- User selectable display of test data in any hardness value (*HL, HRC, HRB, HB, HV, HSD)*
- Low Battery Indicator

2.4   Measuring and Converting Ranges

Shown in Tables 1-4 are the impact devices, the corresponding measuring ranges for each (D, DC, DL, D+15, C, G) and their allowable conversion ranges in terms of other static hardness values (*HRC, HRB, HB, HV, HSD*) for different metals.

Table 1: Impact Device – D, DC D+15 Measuring Range LD:200-900

Material	HLD	HRC	HRB	HB	HV	HS
Steel	200-900	20.0-68.0	38.4-99.5	80-647	80-940	32.5-99.5
C.W. Tool Steel	200-900	20.4-67.1			80-898	
Stainless ST	200-900	19.6-62.4	46.5-101.7	85-655	85-802	
Gray Cast Iron	200-900			93-334		
Nodular Cast Iron	200-900			131-387		
Cast Aluminum	200-900			20-159		
Brass	200-900		13.5-95.3	40-173		
Bronze	200-900			60-290		
Copper	200-900			45-315		

Table 2: Impact Device – C, Measuring Range LC: 350-950

Material	HLC	HRC	HRB	HB	HV	HS
Steel & Cast St.	350-950	20.0-69.5		80-683	80-996	31.9-99.6

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Table 3: Impact Device – G, Measuring Range LG: 300-750

Material	HLG	HRC	HRB	HB	HV	HS
Steel & Cast St.	300-750		47.7-99.9	90-646		
Gray Cast Iron	300-750			92-326		
Nodular Cast Iron	300-750			127-364		

2.5 Impact device parameters

Probe	Application
D	Universal standard unit. Will handle the majority of hardness testing applications. Weight: 75g
DC	Very short impact device for those confined areas, i.e. inside bores for internal measurements. Conforms to the D measuring range. Weight: 50g
D+15	Very narrow contact area with a set backed measurement coil. This device is used to measure hardness in grooves and recessed surfaces. Weight: 80g
C	A reduced impact energy impact device(approximately ¼ of the D Type 2 ft-lb.) for measuring the hardness of surface hardened components, coatings, thin wall or impact sensitive components. Applies a small superficial indentation. Weight: 75g (will not function at –180 degrees)
G	This device has an enlarged test tip, and an increased impact energy range (approx. 9 times the D, 72 ft-lb.). Can be used on lower quality finishes for measuring hardness in the Brinell range only (max. 650 HB). Designed to be used with heavy components such as heavy castings and forgings. Weight: 250g
DL	This model features a needle front section with a diameter of 4mm and a length of 50mm. It is suitable for testing in extremely confined spaces, the base of grooves and of special components such as gear wheels. For use on steel and cast steel only!

3. Leeb Measuring Method

3.1　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.

3.2　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:

$HL = 1000 \times (V_B/V_A)$

Where: HL is Leeb Hardness

　　　V_B is the rebound velocity of the impact body

V_A 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:

Figure 4: Voltage characteristic of output signal
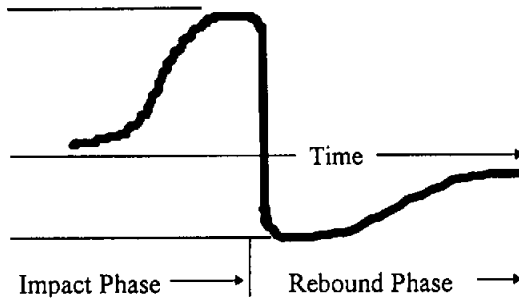
A Leeb's Hardness Tester measures the hardness of sample material in terms of Hardness Leeb (HL), which can be converted into other Hardness units (Rockwell B and C, Vicker, Brinell and Shore D).

3.3   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 you change the impact device. In measuring the hardness of the same test sample with different impact devices, the Leeb's hardness values obtained will vary.

  For Example: 720 HLD≠720 HLC

- Because different converting curves are obtained from different impact devices, when converting hardness L into another hardness value the notation for the converted hardness value should include the impact device used.

  For example:
  Hardness HV converted from hardness L 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
  LD+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

4 Pretreatment of Samples

4.1 Pretreatment of Sample Surface

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. The test surface should be clean and free from oil stains.

4.2 Curved Surface

When testing a curved surface with a radius of curvature **R** less than 1.2 in (30mm), a special small support ring washer should be used to compensate the curvature.

4.3 Supporting a Test Sample

When using impact devices D, DC or D+15 (Impact energy=9ft/lbs), please refer to the following support requirements:

- For test samples weighing over 11 lbs. (5 kg), no support is required.

- Samples having a cantilever or thin shell shape and weighing between 4.4 to 11 lbs. (2 to 5 kg) must be firmly coupled to bearing supports weighing over 11 lbs. (5 kg) in order to prevent bending, deformation or displacement due to the impact force.
- Test samples weighing less than 4.4 lbs. (2 kg) should be firmly coupled to a support weighing over 11 lbs. (5 kg).
- The coupling surface between the sample and the support should be smooth.
- A moderate, non-excessive amount of coupling paste should be applied between the coupling surfaces when testing thin cross section pieces with larger massed support plates.
- The direction of impact should be perpendicular to the coupled surface.
- Minimum weight of a test sample should be 0.2 lbs. (100 g).
- Minimum thickness of a test sample should be 0.2 in (5 mm).
- Minimum depth of hardened layer should be 0.03 in (0.8 mm).
- The testing surface of the sample should be perpendicular to the impact direction.

Note: The above restrictions referring to the rigidity of test samples can be decreased when Type **C** (2ft/lbs) impact device is used as should be increased when Type G (72 ft/lbs.) is used.

4.4   Large Test Samples

When the test sample is a large plate, long bar or bent work piece, the impact force can cause a deformation or instability when the impact device is released. This may bring about an error in measurement, even if the weight or thickness of the test sample seems applicable. In this case, a reinforcement should be attached to the back of the sample surface opposite to the impact force.

4.5   Test Sample Properties

Requirements for a sample's weight thickness and roughness differ for each impact device, as shown in Table 5.

Table 5: Sample Requirements for Hardness Testers

Sample	Sample Weight(kg)			Min. Thickness (mm)		Max. Roughness (or Min. Fineness)			
Impact Device	*Needs Support*	*Needs to be stabilized*	*No strength-eing needed*	*Sample*	*Hardened layer*	*ISO*	*Ra*	*Rz*	
D, DC, D+15	0.05-2	2.5	>5	3	0.8	N_7	2µ	10µ	∇6
G	0.5-5	5-15	>15	10		N_9	7µ	30µ	∇4
C	0.02-0.05	0.5-1.5	>1.5	1	0.2	N_5	0.4µ	2.5µ	∇8

5. Keypad Functions

$\wedge$ Scroll up (Back light)

$\curvearrowleft$ Delete last test

$\vee$ Scroll down

Memory recall

Power on/off

Menu display/Save entry button

6. Operation of the Instrument

6.1 Starting

Insert the plug of the impact device into the processor and switch on the power .
The LCD will display the same settings that were previously set. If the display meets your current testing requirements, you can start the test immediately. If not, you can enter your required settings using the keypad.

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6.2   Setting of all Parameters

- *Choosing an Impact Device*

Press the 🔲 button to go to the main menu. Use the ⋁ button to scroll down to: **2. Impact Device.** Press the 🔲 button to enter this parameter. Press the ⋀ button to scroll across to the desired impact device. When the desired device is highlighted, you must press the 🔲 button to save entry.

- *Setting your Impact Direction*

While in the main menu, use the ⋁ button to scroll down to: **3. Direction**. Press the 🔲 button to enter this parameter. Use the ⋁ button to move the cursor until you reach the desired direction. Press the 🔲 button to save this entry.

Impact Direction

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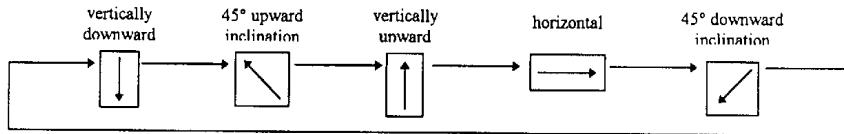
- *Obtaining an Average*

While in the main menu, use the ⊻ button to scroll down to: **4. Average Times**. Press the 🗐

button to enter this parameter. Use the ⋀ button to change the test/average times from 2 times to

8 times. Press the 🗐 button to save entry. This function allows you to view the average of the
amount of tests you entered.

Example: If you chose "3". The tester will show the average after 3 consecutive tests. All test
results will be shown on the display.

- *Selecting a Material*

While in the main menu, press the ⊻ button to scroll down to: **5. Material**. Press the 🗐 button

to enter this parameter. Use the ⊻ button to scroll down the list until the desired material is

reached. Press the 🗐 button to save entry.

- *Choosing a hardness Scale*

While in the main menu, press the [↓] button to scroll down to: **6. Scale.** Press the [▤] button to enter this parameter. Use the [↑] [↓] buttons to scroll across the 6 choices of hardness scales. When the desired scale has been highlighted, you should press the [▤] button to save this entry.

- *Setting Limitations* **(upper & lower)**

While in the main menu, use the [↓] button to scroll down to: **7. Tolerance**. Press the [▤] button to enter this parameter. Using the [↑] button to change the numbers and the [↓] button to change columns, you can enter your desired upper and lower limitations. What this parameter allows the tester to do is signal you when a particular test has fallen outside the set limitations. The LCD display will read as follows:

over range-repeat

- *Entering Date & Time*

While in the main menu, use the [↓] button to scroll down to: **8. Date and Time**. Press the [▤] button to enter this parameter. Use the [↑] button to change the numerical values. Use the [↓]

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button to move to the next column. When your entry has been completed, press the ⬚ button to save your entry.

- *Setting Memory Locations*

While in the main menu, use the ⬇ button to scroll down to: **9. Location**. Press the ⬚ button to enter this parameter. Use the ⬆ button to change the numerical value. Use the ⬇ button to move to the next column. When your entry has been completed, press the ⬚ button to save this entry.

- *Memory Recall*

While in the main test screen, press the 📖 button to recall stored data

<u>IMPORTANT</u>: this feature allows the user to keep track of previous measured values for future references or printing purposes. Always keep note of your selections to quicken the process of finding your desired measurement.

- *Error Modify* **(deletions)**

When an error occurs in your test grouping, you can push the [icon] button to delete the previous test result. This will only allow one deletion per test

Example: If you take 3 tests and the second test result is erroneous, you can push the *button to delete that last test. You will not be able to immediately change the first test.

- *Memory Function*

While in the main menu, use the [icon] button to scroll down to: **10. Memory**. Press the [icon] to enter this parameter.

1) Auto Store:
This function will allow the user to automatically store each test result in the next available memory location by ascending order.

2) Close store:
This function will allow the user to perform tests without any results being saved in memory. If memory or printing functions are not needed, then this is the parameter that should be set.

When the desired memory function is set, press the [icon] to save this entry.

Printing stored Data using a PC or optional mini-printer
Optional Mini-printer:

Connect the included power supply in the back end of the printer. Using the supplied data port connections, connect the single port end into the side of the DHT-100. Connect the 9-pin female end to the included dual male end adapter. Connect the 25-pin adapter male end to the 25-pin female end data port of the mini-printer.

Printing to a PC:

All instructions are the same as the mini-printer except you must connect the 25-pin male end to the printer port of your PC. The desired program needed to run this operation should be left to the discretion of the end user.

- **Printing stored Data**

While in the main menu, press the ⋁ button to scroll down to: **11: PRINT.** Press the 📋 to enter this parameter. The display will show a starting location and an end location. Using the ⋀ button, you can change the numerical value to the desired memory location needed to print. Press the ⋁ button to change columns. Using this method, Enter the memory location of the first test result needed *(starting location)* and then enter the memory location of the last test result (*end location*)needed to print.

Example: If you chose memory location 0150 to start a set of 10 tests, this would mean that you have stored your last test result in memory location 0160. In order to print these test results, you must enter 0150 as your start location and 0160 as your end location.

Begin Testing:

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While in the main menu, use the to go to: **1. Measurement**. Press the to enter the main testing screen. Begin Testing

6.3   Measuring Procedure

Use standard test block to check your hardness tester prior to a hardness test.

(1) Loading
Press down the loading tube to lock the impact body.
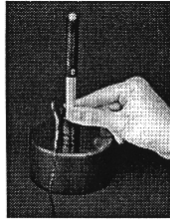
(2) Placement
Place the support ring on the surface to be measured. The distance between two test points should not be less than 3mm.

(3) **Starting**
Trigger the release button while the work piece, the impact device and the impact body are all stable and the starting force coincides with the axis of the impact device

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When one measurement of a set is finished, the hardness value measured will be displayed on the LCD screen and the number of measurement times will increase by one.

If the test data lies outside of the conversion range it will be displayed as:

> **over range repeat**

on the LCD screen and will then be nullified.

6.4   Arithmetic Mean of Hardness of Current Measurements

Usually the arithmetic mean of measurements should be the average of 5 to 33 or more sets of measured data.

6.5   Shutting off the DHT-100

Press the Red power button to terminate use of the **DHT-100.**

6.6   Additional Features

- Set time and date and serial number of the test can be modified during a measuring procedure, as necessary.

- Alteration of parameters including hardness value and type of sample material can be performed during any measurement set. The output results of the measurement set will conform to the newly modified setting. All the displayed results from the current test set will follow the newly set parameters, except for the impact direction.
- The setting of the impact direction can be changed at any time during a testing procedure. However, only the input data after the change will be processed according to the new setting. Data from the set impact direction before the change will remain unchanged.

6.7 Trouble Shooting

- If the LDC screen continuously blinks, this may suggest a low battery voltage. Simply turn off the power and change the batteries.

7. Maintenance and Repair

Avoid placing the DHT-100 near locations where it can be exposed to shock, heavy dust, dampness, strong magnetic fields and oil stains.

7.1 Impact Device

- Using the included brush, clean the guide tube and impact body after it has performed 1000-2000 tests using the following procedure:
    - Screw off the support ring and take out the impact body.

- Clean the tube by winding the brush counter-clockwise into the tube until it reaches the bottom and then pull it out. Repeat this procedure 5-6 times.
- Replace the impact body and support ring.
- Release the impact spring after each test.

Never apply lubrication of any kind to impact body!

7.2 Repair

- When the tester is calibrated against the Rockwell standard test block and issues a reading over 1 HRC, it *could* mean the spherical ball of the tester is worn out and should be replaced.
- Upon coming across any functional problems not mentioned in this manual, contact a Phase II Customer Service Representative at (201)933-6300.
- **DO NOT** open the **DHT-100** or dismount any of its fixed parts. This precision instrument should only be serviced by a factory trained service representative.
- **If the unit is opened, its warranty will automatically become void**.

Revised operational instructions for the DL impact probe

If you purchased your DHT-100 hardness tester prior to ordering your optional DL impact probe, you must follow the instructions below before performing any tests. Without these instructions, the outcome of hardness values will display higher than the actual hardness value of the sample test

piece.

Due to the special shape and design of the optional **DL** impact probe, the outcome of hardness values will vary when compared to that of the standard **D** impact probe. The hardness scale for the **DL** impact probe is known as **HLDL.** This change is how the gage can compensate for the longer impact tube. When using the standard **D** impact probe, you use the **HLD** scale for hardness. Typically, this is the hardness scale shown on all supplied test blocks. The **HLD** value will range from 750-830 Leeb. If you had purchased the optional **DL** impact probe with the gage, you should have the **HLDL** value already shown on the test block. If not, you need to follow the directions below.

> **Equation: HLD + 120 = HLDL**
> *Example:* **HLD 785 = HLDL 905   (785 + 120 =905)**

By following this equation, you can then calibrate the hardness tester to the supplied test block by using you new **HLDL** value. Once the gage has been calibrated, you can begin testing at your convenience.

The following instructions are recommended for calibrating the DHT-100 hardness tester.
Make sure the gage is reading correctly with the standard **D** probe. If the reading is within +/- 1 HRC or +/- 8HLD, you are within acceptable tolerance. Perform a minimum of 5 consecutive tests to get an accurate average. It is always recommended to perform between 5 and 30 consecutive tests to provide you with the closest possible average.