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Digital Hardness Tester

Model # **PHT-2500**

Instruction Manual

(201)933-6300
www.phase2plus.com

** Precision Measuring Tools * Indexing Fixtures * Workholding Fixtures **
*** Hardness Testers * Ultrasonic Thickness * Surface Finish * Coating Thickness ***

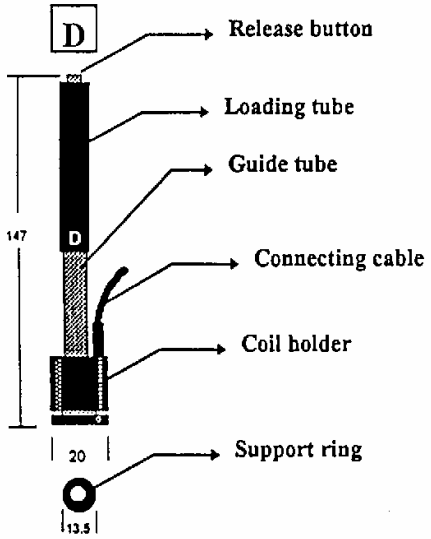


Figure 2: Type D Impact Device

2. Functions of the Phase II PHT-2500 Hardness Tester

Phase II PHT-2500 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 PHT-2500 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 ±0.8% at LD=900

  $$\frac{(\text{Value display} - \text{Value actual} \times 100)}{\text{Value Actual}}$$

- Relative repetitive display error 0.8% at LD=900

  $$\frac{(\text{Value max} - \text{Value min.} \times 100)}{\text{Value Average}} = \text{Error}$$

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 1-7 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.

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!**

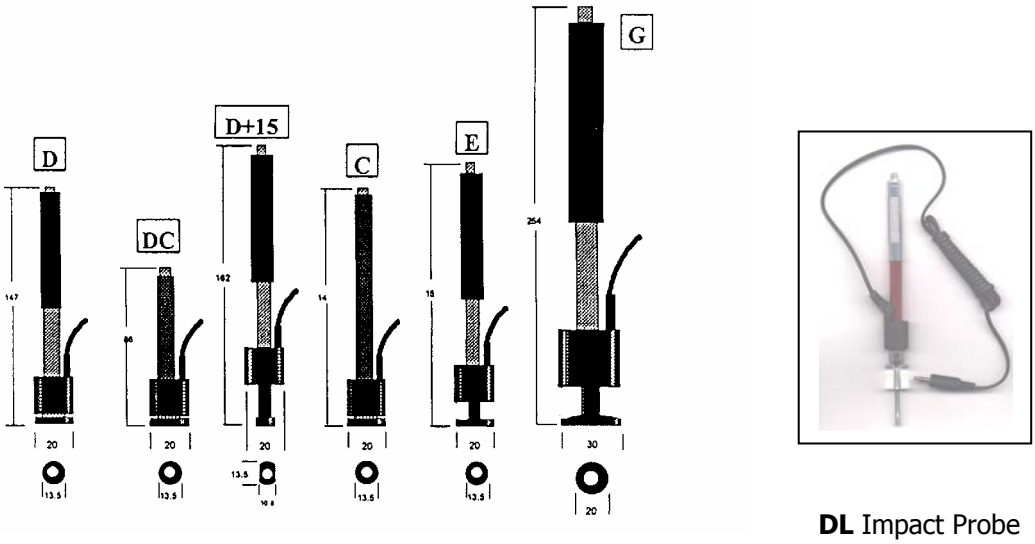


Figure 3: Optional Impact Devices

Table 2: Impact Device – D, DC Measuring Range LD:200-900

Material	HRC	HRB	HB	HV	HSD
Steel	17.9-68.5	59.6-99.5	93-651	83-976	32.2-99.5
C.W. Tool Steel	20.4-67.1			80-898	
Gray Cast Iron			93-334		
Nodular Cast Iron			131-387		
Cast Aluminum			30-159		
Brass		13.5-95.3	40-173		
Bronze			60-290		
Copper			45-315		

Table 3: Impact Device – D+15, Measuring Range LD+15: 300-900

Material	HRC	HRB	HB	HV	HSD
Steel & Cast St.	19.3-67.9		80-638	80-937	33.3-99.3

Table 4: Impact Device – C, Measuring Range LC: 350-950

Material	HRC	HRB	HB	HV	HSD
Steel & Cast St.	20.0-69.5		80-683	80-996	31.9-99.6

Table 5: Impact Device – G, Measuring Range LG: 300-750

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

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:

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

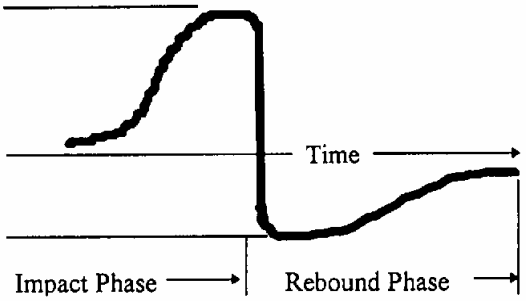
Where: HL is Leeb Hardness

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



3.2 Leeb's Hardness Tester (definition)

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 then 2μm. PHASE II **SRG-1000** 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.

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 8.

Table 8: 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, D_C, 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

Shown in Fig 6 are the keypad function buttons.

Top left button	Scroll up (Back light)
Top right button	Delete last test
Middle left button	Scroll down
Middle right button	Memory recall
Bottom left button	Power on/off
Bottom right button	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.

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.

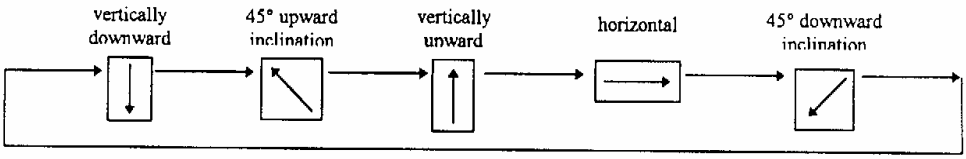


Figure 7: Impact Direction

- *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  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

IMPORTANT: 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  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  button to scroll down to: **10. Memory**. Press the  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  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 PHT-2500. 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. Follow instructions below.

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:

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. (Fig 9)

Figure 9: Loading the PHT-2500

(2) **Placement**

Place the support ring on the surface to be measured. The distance between two test points should not be less than 0.1 in (3mm) (Fig 10).

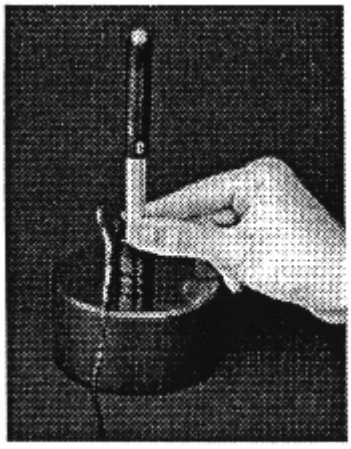


Figure 10: Placement of Tester

(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 (Fig. 11).

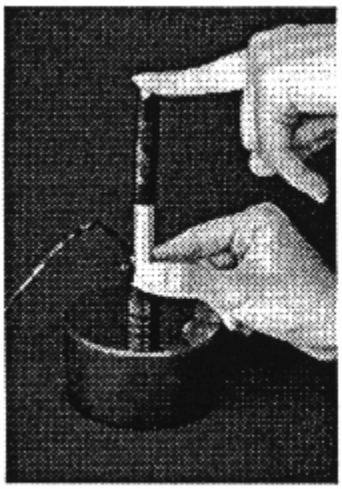


Figure 11: Starting a Measurement

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 **Arithmatic Mean of Hardness of Current Measurements**
Usually the arithmatic mean of measurements should be the average of 5 to 33 or more sets of measured data.

6.5 **Shutting off the PHT-2500**
Press the Red power button to terminate use of the **PHT-2500.**

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 PHT-2500 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 **PHT-2500** 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**.

Thank you for choosing phase II+ "The Source of Quality"
as your supplier of quality measuring tools

Revised operational instructions for the DL impact probe

If you purchased your PHT-2500 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 PHT-2500 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.

If you need further assistance, please contact Phase II customer service at (201)933-6300

ASTM Hardness

Round Correction Factors

Corrections to be added to test results in the following scales for various diameter parts

Corrections to be added to Rockwell C, A, and D values

Hardness	Diameter of Convex Cylindrical Surfaces								
Reading	1/4 inc	3/8 in	1/2 in	5/8 in	3/4 in	7/8 in	1 in	1-1/4 in	1-1/2 in
	6.4 mm	10 mm	13 mm	16 mm	19 mm	22 mm	25 mm	32 mm	38 mm
20	6.0	4.5	3.5	2.5	2.0	1.5	1.5	1.0	1.0
25	5.5	4.0	3.0	2.5	2.0	1.5	1.0	1.0	1.0
30	5.0	3.5	2.5	2.0	1.5	1.5	1.0	1.0	0.5
35	4.0	3.0	2.0	1.5	1.5	1.0	1.0	0.5	0.5
40	3.5	2.5	2.0	1.5	1.0	1.0	1.0	0.5	0.5
45	3.0	2.0	1.5	1.0	1.0	1.0	0.5	0.5	0.5
50	2.5	2.0	1.5	1.0	1.0	0.5	0.5	0.5	0.5
55	2.0	1.5	1.0	1.0	0.5	0.5	0.5	0.5	0
60	1.5	1.0	1.0	0.5	0.5	0.5	0.5	0	0
65	1.5	1.0	1.0	0.5	0.5	0.5	0.5	0	0
70	1.0	1.0	0.5	0.5	0.5	0.5	0.5	0	0
75	1.0	0.5	0.5	0.5	0.5	0.5	0	0	0
80	0.5	0.5	0.5	0.5	0.5	0	0	0	0
85	0.5	0.5	0.5	0	0	0	0	0	0
90	0.5	0	0	0	0	0	0	0	0

Corrections to be added to Rockwell B, F, and G values

Hardness	Diameters of Convex Cylindrical Surfaces						
Reading	1/4 in	3/8 in	1/2 in	5/8 in	3/4 in	7/8 in	1 in
	6.4 mm	10mm	13mm	16 mm	19 mm	22 mm	25 mm
0	12.5	8.5	6.5	5.5	4.5	3.5	3.0
10	12.0	8.0	6.0	5.0	4.0	3.5	3.0
20	11.0	7.5	5.5	4.5	4.0	3.5	3.0
30	10.0	6.5	5.0	4.5	3.5	3.0	2.5
40	9.0	6.0	4.5	4.0	3.0	2.5	2.5
50	8.0	5.5	4.0	3.5	3.0	2.5	2.0
60	7.0	5.0	3.5	3.0	2.5	2.0	2.0
70	6.0	4.0	3.0	2.5	2.0	2.0	1.5
80	5.0	3.5	2.5	2.0	1.5	1.5	1.5
90	4.0	3.0	2.0	1.5	1.5	1.5	1.0
100	3.5	2.5	1.5	1.5	1.0	1.0	0.5

When testing cylindrical specimens, the accuracy of the test will be seriously affected by alignment of elevating screw, Vee-anvil, indenters, surface finish, and the straightness of the cylinder. These corrections are approximate only and represent the averages, to the nearest 0.5. Rockwell and Rockwell superficial numbers, of numerous actual observations.

The above tables are from ASTM E 18

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100 Harbor Drive, West Conshohocken , PA 19428-2959

ASTM Hardness Conversion Chart

Rockwell C Hardness Range

Approximate Hardness Conversion Numbers for Non-Austenitic Steels, According to ASTM E-140

The Conversion Values contained herein should be considered approximate only and may be inaccurate for specific applications

C 150 kgt diamond	A 60 kgt diamond	D 100kgt diamond	15N 15kgt diamond	30N 30 kgt diamond	45N 45 kgt diamond	Vickers Hardness	Knoop Hardness 500gr and over	Brinell Hardness 3000kgt 10mm ball	Tensile Strenght 1000 lbs/ square in
68	85.6	76.9	93.2	84.4	75.4	940	920	..	..
67	85.0	76.1	92.9	83.6	74.2	900	895	..	..
66	84.5	75.4	92.5	82.8	73.3	865	870	..	..
65	83.9	74.5	92.2	81.9	72.0	832	846	(739)	
64	83.4	73.8	91.8	81.1	71.0	800	822	(722)	
63	82.8	73.0	91.4	80.1	69.9	772	799	(705)	
62	82.3	72.2	91.1	79.3	68.8	745	776	(688)	
61	81.8	71.5	90.7	78.4	67.7	720	754	(670)	
60	81.2	70.7	90.2	77.5	66.6	697	732	(654)	
59	80.7	69.9	89.8	76.6	65.5	674	710	(634)	351
58	80.1	69.2	89.3	75.7	64.3	653	690	615	338
57	79.6	68.5	88.9	74.8	63.2	633	670	595	325
56	79.0	67.7	88.3	73.9	62.0	613	650	577	313
55	78.5	66.9	87.9	73.0	60.9	595	630	560	301
54	78.0	66.1	87.4	72.0	59.8	577	612	543	292
53	77.4	65.4	86.9	71.2	58.6	560	594	525	283
52	76.8	64.6	84.4	70.2	57.4	544	576	512	273
51	76.3	63.8	85.9	69.4	56.1	528	558	496	264
50	75.9	63.1	85.5	68.5	55.0	513	542	481	255
49	75.2	62.1	85.0	67.6	53.8	498	526	469	246
48	74.7	61.4	84.6	66.7	52.5	484	510	455	237
47	74.1	60.8	83.9	65.8	51.4	471	495	443	229
46	73.6	60	83.5	64.8	50.3	458	480	432	221
45	73.1	59.2	83.0	64.0	49.0	446	466	421	215
44	72.5	58.5	82.5	63.1	47.8	434	452	409	208
43	72.0	57.7	82.0	62.2	46.7	423	438	400	201
42	71.5	56.9	81.5	61.3	45.5	412	426	390	195
41	70.9	56.2	80.9	60.4	44.3	402	414	381	188
40	70.4	55.4	80.4	59.5	43.1	392	402	371	182
39	69.9	54.6	79.9	58.6	41.9	382	391	362	177
38	69.4	53.8	79.4	57.7	40.8	372	380	353	171
37	58.9	53.1	78.8	56.8	39.6	363	370	344	166
36	68.4	52.3	78.3	55.9	38.4	354	360	336	161
35	67.9	51.5	77.7	55.0	37.2	345	351	327	156
34	67.4	50.8	77.2	54.2	36.1	336	342	319	152
33	66.8	50.0	76.6	53.3	34.9	327	334	311	149
32	66.3	49.2	76.1	52.1	33.7	318	326	301	146
31	65.8	48.4	75.6	51.3	32.5	310	318	294	141
30	65.3	47.7	75.0	50.4	31.3	302	311	286	138
29	64.8	47.0	74.5	49.5	30.1	294	304	279	135
28	64.3	46.1	73.9	48.6	28.9	286	297	271	131
27	63.8	45.2	73.3	47.7	27.8	279	290	264	128
26	63.3	44.6	72.8	46.8	26.7	272	284	258	125
25	62.8	43.8	72.2	45.9	25.5	266	278	253	123
24	62.4	43.1	71.6	45.0	24.3	260	272	247	119
23	62.0	42.1	71.0	44.0	23.1	254	266	243	117
22	61.5	41.6	70.5	43.2	22.0	248	261	237	115
21	61.0	40.9	69.9	42.3	20.7	243	256	231	112
20	60.5	40.1	69.4	41.5	19.6	238	251	226	110

Hardness values in Brackets are outside the range recommended for Brinell testing in ASTM E-10.

The above tables is from ASTM E-110 except values for E-scale and Tensile Strength which are not from or according to ASTM Standards.

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ASTM Hardness Conversion Chart

Rockwell B Hardness Range

Approximate Hardness Conversion Numbers for Non-Austenitic Steels, according to ASTM E-140

The conversion values contained herein should be considered approximate only and may be inaccurate for Specific applications.

	Rockwell		Superficial Rockwell			Vickers	Knoop	Brinell	Tensile	Brinelll
B	A	E	15T	30T	45T	Hardness	Hardness	Hardness	Strength	Hardness
100kgf	60 kgf	100 kgf	15 kgf	30 kgf	45 kg f		500gf	3000 kgf	1000 lbs/	500 kgf
1/16"ball	diamond	1/8" ball	1/16" ball	1/16"ball	1/16" ball		and over	10mm ball	square in	10mm ball
100	61.5		93.1	83.1	72.9	240	261	240	116	201
99	60.9		82.8	82.5	71.9	234	246	234	114	195
98	602		92.5	81.8	709	228	241	228	109	189
97	59.5		92.1	81.1	699	222	236	222	105	184
96	58.9		91.8	80.4	689	216	231	216	102	179
95	58.3		91.5	79.8	67.9	210	226	210	100	175
94	57.6		91.2	79.1	669	205	221	205	98	171
93	57		90.8	784	659	200	216	200	94	167
92	56.4		90.5	77.8	64.8	195	211	195	92	163
91	55.8		90.2	77.1	63.8	190	206	190	90	160
90	55.2		89.9	76.4	62.8	186	201	186	89	157
89	54.6		89.5	76.8	61.8	180	196	180	88	164
88	64.0		89.2	75.1	60.8	176	192	176	86	151
87	53.4		88.9	74.4	59.8	172	188	172	84	148
86	52.8		88.6	73.8	58.8	169	184	169	83	145
85	52.3		88.2	73.1	57.8	165	180	165	82	142
84	51.7		87.9	72.4	56.8	162	176	162	81	140
83	51.1		87.6	71.8	55.8	159	173	159	80	137
82	50.6		87.3	71.1	54.8	156	170	156	76	135
81	50		86.9	70.4	53.8	153	167	153	73	133
80	49.5		86.6	69.7	52.8	150	164	150	72	130
79	48.9		86.3	69.1	51.8	147	161	147	70	128
78	48.4		86.0	68.4	50.8	144	158	144	69	126
77	47.9		85.6	67.7	49.8	141	155	141	68	124
76	47.3		85.3	67.1	48.8	139	152	139	67	122
75	46.8		86.0	66.4	47.8	137	150	137	66	120
74	46.3		84.7	65.7	46.8	135	147	135	66	118
73	45.8		84.3	65.1	45.8	132	145	132	64	116
72	45.3		84.0	64.4	44.8	130	143	130	63	114
71	44.8	100	83.7	63.7	43.8	127	141	127	62	112
70	44.3	99.5	83.4	63.1	42.8	125	139	125	61	110
69	43.8	99.0	83.0	62.4	41.8	123	137	123	60	109
68	43.3	98.0	82.7	61.7	40.8	121	135	121	59	108
67	42.8	97.5	82.4	61	39.8	119	133	119	58	106
66	42.3	97.0	82.1	60.4	38.7	117	131	117	57	104
65	41.8	96.0	81.8	59.7	37.7	116	129	116	56	102
64	41.4	95.5	81.4	59	36.7	114	127	114		100
63	40.9	95.0	81.1	58.4	35.7	112	125	112		99
62	40.4	94.5	80.8	57.7	34.7	110	124	110		98
61	40.0	93.5	80.5	57.0	33.7	108	122	108		96
60	39.5	93.0	80.1	56.4	32.7	107	120	107		95
59	39.0	92.5	79.8	55.7	31.7	106	118	106		94
58	38.6	92.0	79.5	55	30.7	104	117	104		92
57	38.1	91.0	79.2	54.4	2.97	103	115	103		91
56	37.7	90.6	78.8	53.7	28.7	101	114	101		90
55	37.2	90.0	78.6	53.0	27.7	100	112	100		89
54	36.8	89.5	78.2	52.4	26.7		111			87
53	36.3	89.0	77.9	51.7	26.7		110			86
52	35.9	88.0	77.5	51.0	24.7		109			85
51	35.5	87.6	77.2	50.3	23.7		108			84
50	35.0	87.0	76.9	49.7	22.7		107			83
49	34.6	86.5	76.6	49.0	21.7		106			82

48	34.1	85.5	76.2	48.3	20.7	105	81
47	33.7	85	75.9	47.7	19.7	104	80
46	33.3	84.6	76.6	47.0	18.7	103	80
45	32.9	84	76.3	46.3	17.7	102	79
44	32.4	83.5	74.9	45.7	16.7	101	78
43	32.0	82.5	74.6	45.0	15.7	100	77
42	31.6	82	74.3	44.3	14.7	99	76
41	31.2	81.5	74.0	43.7	13.6	98	75
40	30.7	81	73.6	43.0	12.6	97	75
39	30.3	80	73.3	42.3	11.6	96	74
38	29.9	79.5	73.0	41.6	10.6	95	73
37	29.5	79	72.7	41.0	9.6	94	72
36	29.1	78.5	72.3	40.3	8.6	93	72
35	28.7	78.0	72.0	39.6	7.6	92	71
34	28.2	77.0	71.7	39.0	6.6	91	70
33	27.8	76.6	71.4	38.3	5.6	90	69
32	27.4	76.0	71.0	37.6	4.6	89	69
31	27.0	75.5	70.7	37.0	3.6	88	68
30	26.6	75.0	70.4	36.3	2.6	87	67

Hardness values in brackets are outside the range recommended for Brinell testing in ASTM E-10.
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ASTM Hardness

Minimum Thickness Requirements

Minimum allowable thickness for a corresponding hardness in the respective scales

Minimum thickness in.	Minimum thickness mm	- C	Rockwell A	- B	- 15N	- 30N	Superficial 45N	Rockwell 15T	- 30T	- 45T
0.006	0.15				92					
0.008	0.20				90					
0.010	0.25				88			91		
0.012	0.30				83	82	77	86		
0.014	0.36				76	78.5	74	81	80	
0.016	0.41		86		68	74	72	75	72	71
0.018	0.46		84			66	68	68	64	62
0.020	0.51		82			57	63		55	53
0.022	0.56	69	79			47	58		45	43
0.024	0.61	67	76	94			51		34	31
0.026	0.66	65	71	87			37			18
0.028	0.71	62	67	80			20			4
0.030	0.76	57	60	71						
0.032	0.81	52		62						
0.034	0.86	45		52						
0.036	0.91	37		40						
0.038	0.96	28		28						
0.040	1.02	20								

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LEEB - BRINELL CONVERSION CHART

LEEB	BRINELL	LEEB	BRINELL	LEEB	BRINELL	LEEB	BRINELL
300	81	550	269	400	137	650	389
302	82	552	271	402	139	652	391
304	83	554	273	404	140	654	394
306	83	556	275	406	142	656	397
308	84	558	277	408	143	658	400
310	85	560	280	410	144	660	402
312	86	562	282	412	146	662	405
314	87	564	284	414	147	664	408
316	88	566	286	416	149	666	411
318	89	568	288	418	150	668	414
320	90	570	291	420	152	670	417
322	91	572	293	422	153	672	420
324	92	574	295	424	155	674	423
326	92	576	297	426	157	676	426
328	93	578	299	428	158	678	429
330	94	580	302	430	160	680	432
332	95	582	301	432	161	682	435
334	97	584	306	434	163	684	438
336	98	586	309	436	164	686	441
338	99	588	311	438	166	688	444
340	100	590	313	440	168	690	447
342	101	592	315	442	169	692	450
344	102	594	318	444	171	694	453
346	103	596	320	446	172	696	456
348	104	598	322	448	174	698	459
350	105	600	325	450	176	700	462
352	106	700	462	452	177	800	688
354	108	702	466	454	179	802	693
356	109	704	469	456	181	804	698
358	110	706	172	458	182	806	703
360	111	708	475	460	184	808	708
362	112	710	479	462	186	810	714
364	113	712	482	464	187	812	719
366	115	714	485	466	189	814	724
368	116	716	489	468	191	816	729
370	117	718	492	470	193	818	734
372	118	720	496	472	194	820	740
374	120	722	499	474	196	822	745
376	121	724	502	476	198	824	751
378	122	726	506	478	200	826	756
380	124	728	509	480	201	828	761
382	125	730	513	482	203	830	767
384	126	732	517	484	205	832	773
386	128	734	520	486	207	834	778
388	129	736	524	488	209	836	784
390	130	738	527	490	210	838	790
392	132	740	531	492	212	840	795
394	133	742	535	494	214	842	801
396	134	744	538	496	216	844	807
398	136	746	542	498	218	846	813
400	137	748	546	500	220	848	819
500	220	750	550	600	325	850	825
502	221	752	553	602	327	852	831

LEEB	**BRINELL**	**LEEB**	**BRINELL**		**LEEB**	**BRINELL**	**LEEB**	**BRINELL**
504	223	754	557		604	330	854	837
506	225	756	561		606	332	856	843
508	227	758	565		608	334	858	849
510	229	760	569		610	337	860	855
512	231	762	573		612	339	862	862
514	233	764	577		614	342	864	868
516	235	766	581		616	344	866	874
518	237	768	585		618	347	868	881
520	239	770	589		620	349	870	887
522	241	772	593		622	352	872	894
524	243	774	597		624	354	874	900
526	245	776	601		626	357	876	907
528	247	778	606		628	359	878	914
230	249	780	610		630	362	880	920
532	251	782	614		932	365	882	927
534	253	784	618		634	367	884	934
536	255	786	623		636	370	886	941
538	257	788	627		638	372	888	948
540	259	790	631		640	375	890	955
542	261	792	636		642	378	892	
544	263	794	640		644	380	894	
546	265	796	645		646	383	896	
548	267	798	649		648	386	898	
		800	654					