USER'S MANUAL

PHBR–200
MAGNETIC DIGITAL BRINELL AND ROCKWELL HARDNESS TESTER

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Contents

1. Safety

Before operating the instruments, please read and make a thorough understanding of the instruction on safety.

1.1 On Dropping of the Tester

The tester is made of iron and steel, leading to a heavy weight, therefore if dropped by accident; it could cause injuries to persons and severe damage to the instruments. Thus, please follow the safety precautions below strictly:

1.1.1 Place it in a plain and steady location when it is unused, in case of falling.

1.1.2 Move the tester cautiously, in case of falling down from hands.

1.1.3 Hold the tester firmly when testing a part with curved surface or tilted, especially when the magnetic switch is off, in case of potential injuries to persons.

1.1.4 Fix the iron seat of the tester in a steady place, in case of falling.

1.2 On Strong Magnetic Field

It could cause strong magnetic field in using. When you close the magnetic switch, magnetic field inside the hardness tester shows a closed loop, no magnet to outside. When the magnetic switch is on, tester affects magnet to outside. It equals to a strong magnet at this time. If by carelessness, tester would dash to the surrounded iron and steel products, and in this process it would cause possible injuries to persons and damage to tester. Thus in the stocking and operating of tester, please follow the regulations below strictly:

1.2.1 Only when the tester placed plainly and steadily, push the magnetic switch to "ON". On any other occasion, the magnetic switch is "OFF".

1.2.2 In the process of loading, if the suction is not strong enough, tester may leave the testing part, at this time the magnetic switch should be "OFF".

1.2.3 It is easy to push the magnetic switch to "ON", when it is placed in iron seat or suitable iron and steel test parts, so when the operator feel hard to do this, DO NOT do it by force. The operator should investigate the reasons and secure the safety of operation.

1.3 On Recharger

The tester supplies recharger which should be used following the instruction. Furthermore, one should also follow the below instructions:

1.3.1 The recharger could only be applied to regulated power on the body of tester.

1.3.2 Keep away from water or other liquids when recharging.

1.3.3 Do not touch the connector plugs in wet hands.

1.3.4 Do not disassemble the recharger, avoiding of electric shock.

2. General Description

PHBR-200 Magnetic Digital Brinell and Rockwell Hardness Tester is designed on the basis of PHR-200 Magnetic Digital Rockwell Hardness Tester; it has the same appearance and mechanical structure as PHR-200. The Hardness Tester improves the measurement system, using more advanced sensors to achieve the accuracy of force value and small displacement detection.

The instrument can use conventional Rockwell, Brinell hardness test method to make hardness testing. It also can be used to do rapid Brinell hardness testing through advanced depth-measuring method Brinell hardness test under a certain test accuracy conditions.

As to the Rockwell hardness testing, the instrument directly uses the Rockwell hardness test principle to test HRC, HRBW and HRA hardness value, and the test accuracy is compliance with the relevant standards ISO6508.2. During Rockwell hardness testing, the operator can load initial test force and total test force in one time together. The operation is very simple, and efficiency is improved a lot.

About traditional Brinell hardness testing method, the instrument directly use the Brinell hardness test principle, using 187.5kgf test force, 2.5mm ball indenter, pressing a precise Brinell hardness indentation on the work piece, and then use reading microscope or Brinell Indentation Measuring System to get the diameter of the brinell indentation; you can get an accurate Brinell hardness value. The accuracy complies with ISO6508.2.

About depth-measuring method Brinell hardness testing, the instrument is under the principle of depth-measuring method Brinell hardness test from American standard ASTM E103. Firstly, there is an indentation depth value at the initial test force, next we load till the total test force and then go back to initial test force, at this moment we get the other indentation depth value. We measure the difference value of these two indentation depth and then comparing the stored Brinell hardness, i.e. indentation depth curve, then you can get Brinell hardness value directly. This method eliminates the optical instrument used to measure the indentation and simplify the Brinell hardness test operation; test efficiency is greatly improved, achieving the rapid detection and direct reading Brinell hardness value. This rapid Brinell hardness testing method can be applied to test piece by piece inspection on the batch of heat treating parts. In this way you can achieve the quality control of heat treatment process.

Depth-measuring method Brinell hardness testing accuracy is determined by Brinell hardness, i.e. the accuracy of indentation depth curve, the accuracy of indentation depth curve is determined by the curve calibration, the condition of Brinell hardness block and reliable value transfer. The above curve will be changed when the material composition of the alloy or the curvature of work piece changing a lot.

Depth-measuring method is designed to achieve rapid test, to achieve the quality control during production process. The instrument can get acceptable accuracy on site quickly, which is the purpose of designing this instrument.

Depth-measuring method Brinell hardness testing is a new technique. The research of this method is not enough. However the ASTM E103 is not perfect. It is sure that change of alloying component of the work piece influence the testing result. The higher of hardness value, the bigger of the effect. Different curvature of the surface also affects the testing result. These factors will influence the accuracy. But, there is no official research data. The operators should gather experience and data, according to overall consideration of accuracy and testing efficiency to decide when you will use indentation method, when you will use simple calibrated method and when you will use curve correction method, and how long the loading time you will set. But it is necessary to check frequently depth-measuring method with indentation method.

The instrument has good stability and repeatability, which can achieve reliable value transfer. It can replace lower accuracy Hammer Brinell hardness tester and lower precision and reliability Richter hardness at the time of testing more important parts.

3. Working Principle and Structure

The tester is consists of two magnetic chucks and one intelligent hardness test unit. The instrument is fixed on the iron and steel part through its two magnetic chucks when testing. The operator load test force by hand wheel, and the force sensor detects the force simultaneously and display the test force value on screen. There is a depth-measuring unit which is consisting of accurate screw thread pair and rotary encoder. Using this depth-measuring unit to test the indentation depth, then after the load force released and indenter uplifted for a suitable distance, the hardness value which is calculated by micro-processor will be displayed on screen.
Physical appearance and names of parts refer to Figure 1and Figure 2.
Operation and display screen refer to Figure 3.

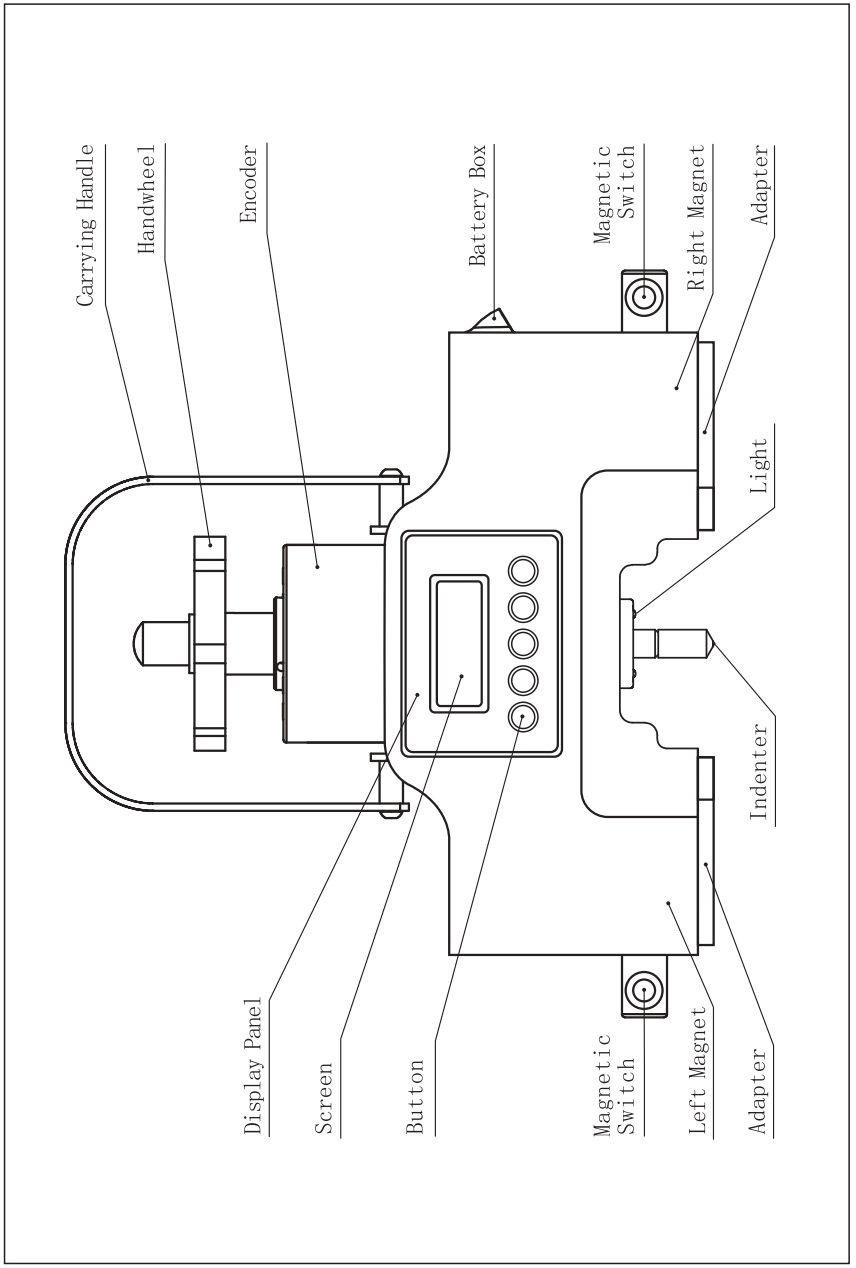

Figure 1. Front View of Instrument

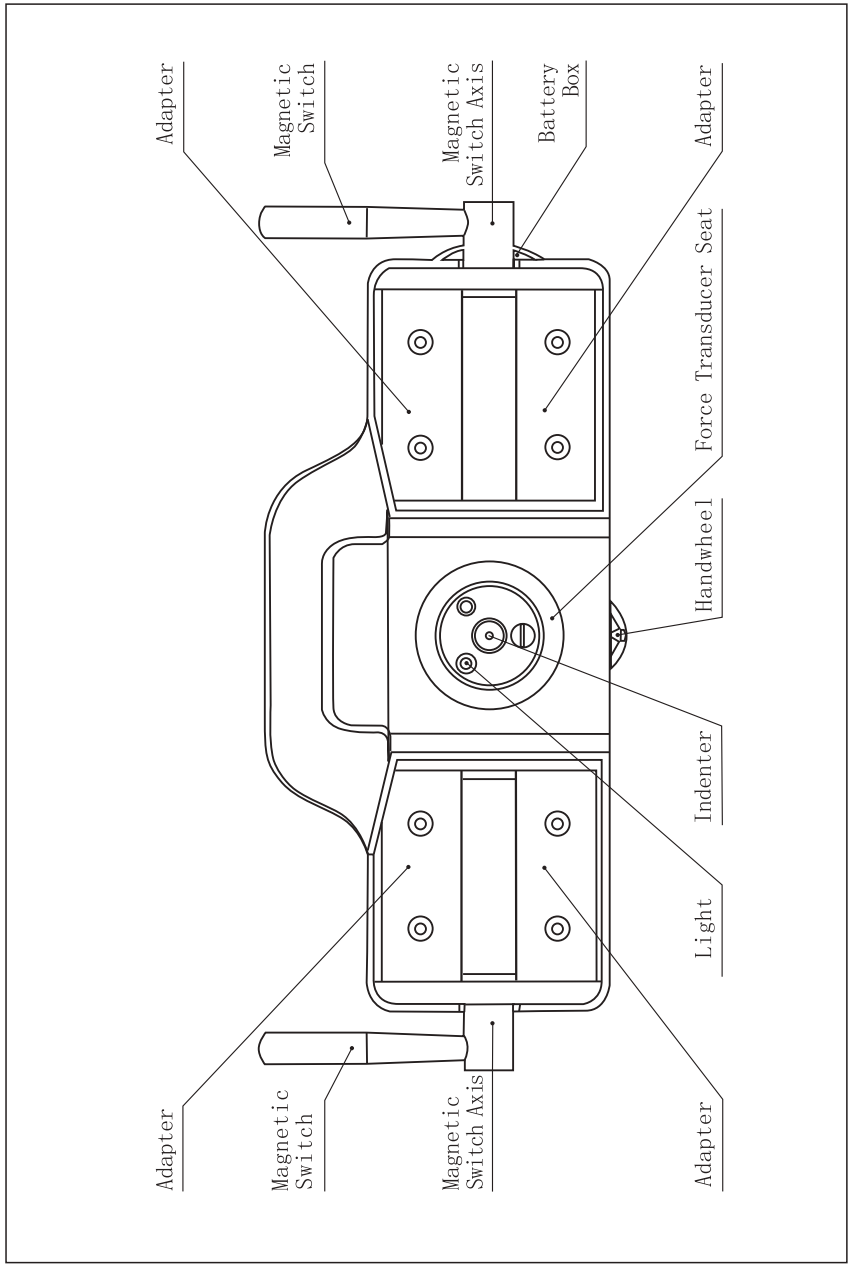

Figure 2. Bottom View of Instrument

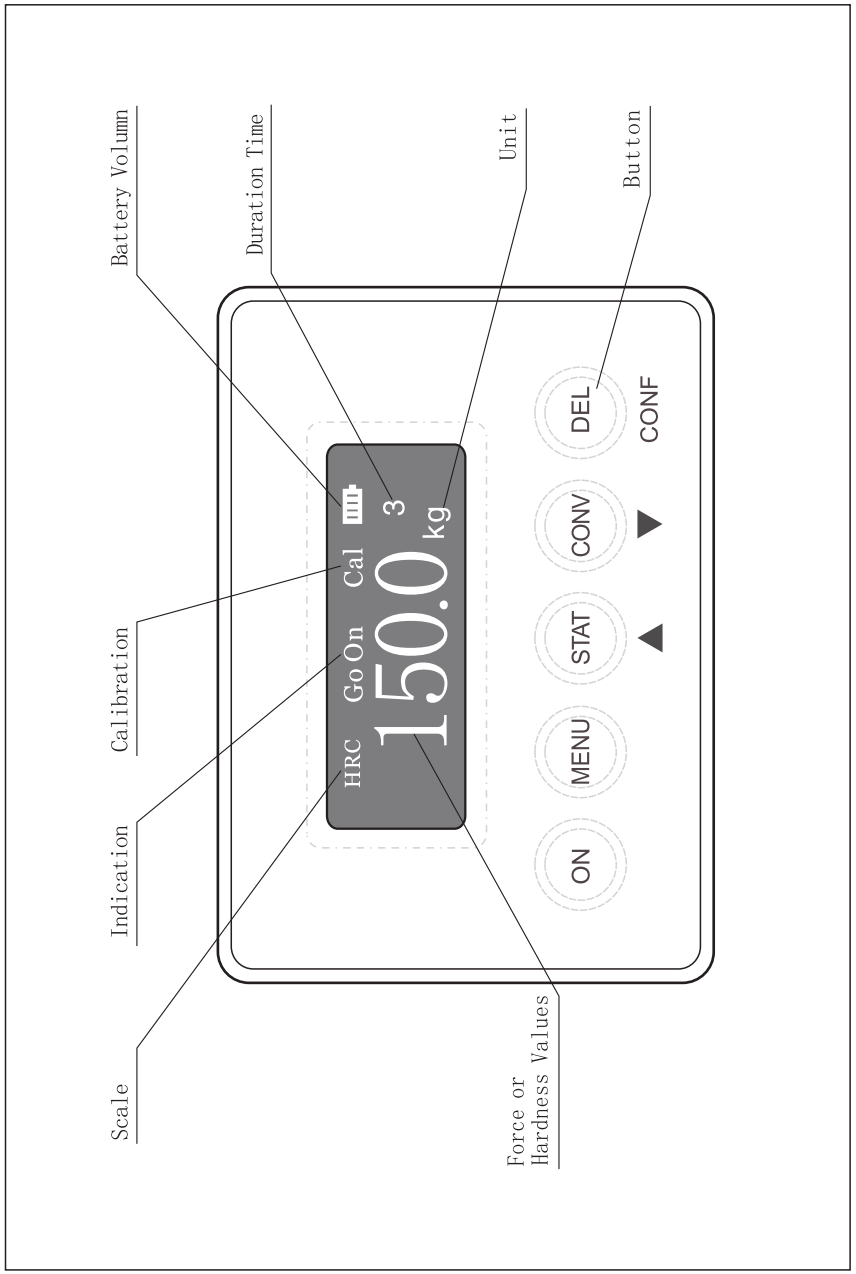

Figure 3. Keyboard and Screen

4. Main Technical Parameters

Table-1

Method / Parameter	Rockwell	Brinell	
		Indentation	Depth-measuring
Initial Test Force	10kgf	Non	10kgf
Total Test Force	60kgf, 100kgf, 150kgf	187.5kgf	187.5kgf
Indenter	diamond indenter, 1.588mm ball	2.5mm ball	2.5mm ball
Test Range	20-88 HRA 20-70 HRC 20-100 HRBW	100～650 HBW	120～400 HBW
Test Resolution	0.1HR	1HBW	1HBW
Indication Error	Comply with ISO6508.2	Comply with ISO6506.2	Determined by calibration, slightly lower than ISO6506.2
Repeatability Error			
Operation Temperature Range	5-45℃		
Weight	5.3kg		
Dimension	250mm(L)×105mm(W)×136mm(H)		
Min. Measure Area	Flat: Area≥195mm×60mm, Thickness≥5mm Cylinder: Diameter≥60mm, Length≥200mm Thickness≥8mm		

5. Buttons Illustration

"ON" It is to turn on or off the instrument. After the instruments without using more than three minutes, the power will be turned off automatically.

"MENU" It is to set the functions of the instruments. After pressing "MENU", the instrument is on status and the menu-displaying, then press "MENU" again, it would be on next level menu.

"STAT/△" It is a multi-functional button. On status of test, press it could realize the function of counting; on status of set-up, it could move the arrow upward; on the status of calibration, it could increase values.

"CONV/▽" It is a multi-functional button. On status of test, press it could realize

the function of exchanging; on status of set-up, it could move the arrow downward; on the status of calibration, it could decrease values.

"DEL/CONF" It is a double functional button. On status of test, it could delete current values; on status of set-up, it could enter the set result and end up the set status.

6. Test Operationn

6.1Preparation before testing.

Sand the test part until it is flat and smooth. It is forbidden to have scale, decarburized layer, steel pit or dust on the surface of the part.

Caution:

Please check the position of the indenter before testing. The pointed end of the indenter must be higher than the bottom surface of the tester to ensure there would be no touch with the test part. Otherwise, the indenter would be damaged.

6.2 The tester's attachment to test part

The tester should be attached to test part flatly and steadily with the indenter erected to the surface of test part. Turn the magnetic switch to "On", keeping the tester fixed onto the test part.

6.3 Start

Pressing "On", after displaying the company info, it would display" 0.0kg" and then be on test status. At this moment, it could directly test or run into set-up status by pressing "MENU".

6.4 Scales Selection

The current scale displays on the left corner of the screen. The default scale is HBW setting by factory, if customers need to change it into other scales, please refer to the steps as follows:

- Press "MENU" into set up status, function menu displays on screen. Arrow points at "Scale selection".
- Press "MENU" again into next level menu, the screen shows several scales.
- Press "△" or "▽" to move the arrow to select specific scale.
- Press "CONF" continuously until back to test status.

Four scales-HRC, HRBW, HRA and HBW- are available for this tester.

6.5 Time Duration Setup

Time duration of test force will affect test accuracy and efficiency. In certain range, longer duration, higher accuracy can be got, but with lower efficiency. Generally, it should keep long time for accuracy test, such as test the hardness blocks. Rockwell hardness should keep five seconds, Indentation Brinell hardness 10-15 seconds.

For quick on site test choose shorter time, such as Rockwell hardness keeps two or three seconds, depth-measuring Brinell hardness keeps five seconds or less. Operators should consider the accuracy and efficiency to set the time duration, the method is following:

- Press "MENU" into setup status, menu displays on screen.
- Press "△" or "▽" to move the arrow at "Setup", then press "MENU", "Time Duration" will display on screen.
- Press "MENU" into time duration setup status.
- Press "△" or "▽" to adjust time values.
- Press "CONF" continuously, until back to test status.

6.6 Operation Steps (e.g. HRC)

Turn the hand wheel to load test force steadily, observing the screen, when the test force reaches 150kgf, please stop or replenish the test force slowly to try to keep the test force around 150kgf for 2-5 seconds, now the time counting down will displays on the right of the screen. When the time counting down finished, please turn the hand wheel reversely to release test force steadily until hardness values display. Then one full operation is accomplished.

If you test Brinell hardness according to indentation method, please move the tester after testing and read the indentation diameter by reading microscope after finished above operation, then look-up the chart to find the Brinell value.

Notes:

1. **Time counting down is the minimum time duration set, in testing procedure test force it should be held until time values disappeared, otherwise the screen will display "Hold Not Enough", the test is not effective.**
2. **It is better to load the total test force in one time, without any pause.**
3. **When releasing test force, "Go On" will display on screen when test force arrives at 0.0kg. The indenter should be upward until hardness values display.**

6.7 Statistics

The function of statistics is available. It could count the average values, maximum values, minimum values and test times.

When times of test are more than one time, press "STAT" will get the above values.

6.8 Delete

The function of delete is available. If relatively bigger error or obvious error value appears in a group of data, press "Delete" to erase it and it will not count in statistics.

6.9 Conversion

It could convert the tested hardness values into Rockwell hardness value HRC, Brinell hardness value HBW, Vickers hardness value HV or strength of extension σb, conversion table comes from American standard ASTM E140 and ASTM A370.
For scale HRA, it is converted into HRC instead of σb.
When test times are more than one time, press "CONV", above values can be got.

6. 10 Acceptable Range of Test Force

For guarantee the test accuracy, it sets the acceptable range of test force. During loading and holding test force, it should be within the acceptable range. Regarding the scales of Brinell hardness and Rockwell hardness HRC, HRBW and HRA, the total test force for them can be set in the range of 187~190kgf, 148.5~152kgf, 99~101kgf, and 59~61kgf. When loading and holding test force, if it is higher the maximum value, "Over load" will display on the screen; if it is lower than minimum values, "Under load" will display on the screen.

7. Inspection of Tester

Iron seat and hardness block will be used during inspection.

7.1 Acceptable Indication Error and Repeatability Error

Tester complies with standard of ISO6508.2 and ISO6506.2. The requirements for the accuracy in the regulations please see Table-2 and Table-3.
The accuracy of the tester includes two parameters, indication error and repeatability error. Indication error means the differences between average hardness values after test several times and the marked hardness values on block should be within the acceptable range. Repeatability error means the differences between maximum and minimum values within the acceptable range.
If the error is not in acceptable range, firstly the operator should check whether the operations method is right. Please try to make the same test force loading condition each time, that is, make the same loading process, peak of test force, force holding, time duration, and releasing process as much as possible.
Due to manual test force loading, it is hard to make the same process each time, and the man-made error is inevitable. It is important to operate carefully and skillfully to minimize man-made error.

Table-2 Acceptable Error of Rockwell Hardness Tester

Scales of Rockwell Hardness	Hardness Range	Acceptable Indication Error	Acceptable Repeatability Error
HRA	20～75HRA 75～88HRA	±2HRA ±1. 5HRA	≤0. 02（100-$\bar{H}^a$） Or 0. 8HRA[b]
HRBW	20～45HRBW 45～80HRBW 80～100HRBW	±4HRBW ±3HRBW ±2HRBW	≤0. 04（130-$\bar{H}^a$） Or 1. 2HRBW[b]
HRC	20～70HRC	±1. 5HRC	≤0. 02（100-$\bar{H}^a$）or 0. 8HRC[b]

a: $\bar{H}$ average hardness value
b: subjects to bigger value

Table-3 Acceptable Error of Brinell Hardness Tester

Hardness Range	Acceptable Indication Error	Acceptable Repeatability Error
≤125HBW	±3%	≤3. 5%
125～225HBW	2. 5%	≤3. 0%
≥225HBW	2%	≤2. 5%

7.2 Indication Values Inspection

The indication values should be inspected frequently. A thorough inspection should be taken at regular intervals like 1 month; and a daily inspection should be taken every day before operation or when the accuracy is unsure.
All the blocks with tester will be inspected at regular intervals inspection. The error should comply with the relevant standards.
Only block with similar hardness to test-piece will be inspected in daily inspection. The error should comply with the relevant standards.

7. 3 Inspection of Rockwell Hardness Tester (e.g. HRC)

Iron seat is required in inspection of the hardness block. Hardness blocks and iron seat should be clean. Any dust or contaminant will cause additional error to measurement.

Put the iron seat on horizontal plane desk with concave upwards, and then lay on the tester, making the indenter aiming to the center of the iron seat. Switch on the magnetic system, the tester will be absorbed on the iron seat. Put HRC hardness block on the concave. **At this time, there should not be touch between the indenter and the block.**
Clockwise turn the hand wheel steadily to load test force, when it appears 150kgf on screen, hold the test force until time counting down finished or even longer.
Anticlockwise turn hand wheel steadily to release test force until hardness values display on screen.
Test 5 times according to above method; calculate errors of the indication and repeatability, which should be in the range of the acceptable range required by ISO6508.2.

Note:
Time duration of test force should be more than 5 seconds when testing hardness block.

7.4 Inspection of Indentation Methods of Brinell hardness Tester

As stated in 7.3, the inspection for Brinell Hardness Block, when test force reaches 187.5kgf, keep 10-15 seconds, and then release the test force. Remove the instrument, read the indentation diameter with optical instruments, check table then you can get the Brinell hardness value. Test three times following the same method; calculate the indication error and the repeatability error, which should be in the acceptable range required by ISO6506.2.

7.5 Inspection of Depth-measuring Method of Brinell Hardness Tester

When using depth-measuring method test Brinell hardness, please inspect the accuracy by indentation method frequently, which should be done before testing every day, or changing parts with different shape or material, or doubting the result.
The method is reading the indentation diameter using optical instruments (time duration should be set in 10-15 seconds), checking table then you can get the Brinell hardness value, comparing with the value displayed on the screen. If it is out of tolerance, calibrate the instrument according to the values by indentation method.

8. Calibration of Hardness Tester

8.1 Calibration of Rockwell Hardness Tester

The instrument can calibrate HRC, HRBW and HRA scale error separately.
When indication hardness value of block is beyond acceptable range, refer to user's manual clause.11(Factors Affecting Test Accuracy) to search for reasons.
When the reason is found, please calibrate as following steps:

- Press "MENU", move the arrow to "Calibration", and press "MENU".
- Choose appropriate hardness block then put it in the iron groove, test hardness block carefully aforementioned three times and get three effective average values.
- When "Average" appears on screen, press "△" or "▽" to adjust the value according to marked value on block, then press "CONF" continuously until back to test status. Calibration is finished.

Calibrate other blocks in the same way.

8.2 Calibration of indentation method of Brinell hardness Tester

Traditional Brinell hardness test cannot calibrate error directly. If the test value is out of range, please find the reason in user's manual clause.11(Factors Affecting Test Accuracy), also check the indenter, reading microscope, or Brinell Indentation Measuring System. If all is okay, maybe there is something wrong with the instrument. Please send back the instrument to manufacturer for inspection.

8.3 Calibration of Depth-measuring Method of Brinell hardness Tester

There is one Brinell indentation depth curve stored in the instrument (called Item No.0 curve). It should have high accuracy when testing standard Brinell hardness block. However, that curve is not suitable all materials. Please calibrate the accuracy frequently when using depth-measuring method.
There are two methods for calibrating depth-measuring method of Brinell hardness, one is single-point simple calibration, and the other is four-point curve calibration.

8.3.1 Single-point Simple Calibration of depth-measuring method of Brinell hardness Tester

Single- point calibration is based on single measurement value. This method is simple and flexible, can be accomplished by testing work piece, without using hardness blocks. Operators can calibrate at any time when needed. Single -point calibration operation method is as following

- Press "MENU", move the arrow to "Calibration", press" MENU".
- Test three times on the work piece (time duration should keep 10-15 seconds), get three Brinell indentations.
- Measuring three indentations with reading microscope or Brinell Indentation Measuring System, recording average hardness value and remember it.
- Measuring three times of the part by depth-measuring method (time duration maybe less than 10 seconds) to get the average value.
- Press "△" or "▽", adjust the value to the aforementioned hardness value measured by indentation method, continuously press "CONF" until return to test status. Single-point calibration is finished.

When you restart the instrument or measure again, it will use the adjusted Brinell hardness value, i.e. indentation depth curve. There is high accuracy around the calibrated value in a certain range.

8.3.2 Curve Correction of depth-measuring method of Brinell hardness Tester

The curve correction means we calibrate the Brinell indentation depth curve by 4 pieces test blocks which have known their hardness value. After calibration, the instrument will have higher accuracy within the hardness range of that 4 pieces test blocks.

When the alloy composition or surface curvature of the work piece change a lot, operators should check up the testing result of depth-measuring method by indentation method. When the error appears out of tolerance, new 4 pieces test blocks are required for making curve correction again.

In order to make the correction Brinell hardness---i.e. indentation depth curve can be reused; the instrument can store five correction curves permanently, which can be used at any time. Operators can store the most common of alloy material or making the curve corresponding to the radius of curvature and use it at any time. Regularly check the accuracy of these curves is necessary.

8.3.2.1 Conditions of making metal block

a. The composition and the radius of curvature of the 4 pieces test blocks material should be the same as or similar to the tested work piece.
b. Test block thickness should be 10 ~ 11mm. The block size should be placed inside the groove of seat iron. The two surface of the metal block should be smooth and parallel.
c. The hardness value of the 4 pieces test blocks should be evenly distributed, and the hardness value should be within the common hardness range of tested work piece and include the maximum value and minimum value at the same time.
d. The hardness of the 4 pieces test blocks should be measured with the laboratory Brinell hardness tester or indentation method of this instrument, and mark it on the piece of the test blocks.
e. Numbered the test block according to the hardness value from small to large from 1 to 4. These test blocks can be reused until it is full of indentation on the surface.

8.3.2.2 Call of the correction curve select for depth-measuring method of Brinell hardness Tester

The instrument can store six Brinell hardness i.e. indentation depth curve (No. 0 ~ No. 5). No. 0 curve is deposited in the instrument by the factory, which is used to

check up the accuracy of the test block of the instrument. No.1 to No. 5 can be stored by operators, who had better make a table to record the meaning of curve No. 1 to No. 5.

Call of the correction curve is as follows:

- Press "MENU", move the arrow to "Set up", press " MENU".
- Move the arrow to "Curve selection" press "MENU", current curve. number will be showed. Press "△" or "▽" to select the curve number.
- Press "CONF continuously to return to testing status.

8.3.2.3 Curve correction of depth-measuring method of Brinell hardness Tester

No. 0 curve cannot be amended. No. 1 ~ No. 5 curve should be chosen first, then modify them. Hardness curve correction method is as follows:

- Press "MENU", move the arrow to "Set up", press "MENU".
- Move the arrow to " curve revising ", press "MENU".
- Put No. 1 test block on the iron seat groove.
- Measure five times, average value will be showed.
- Use "△" or "▽" to adjust the value according to the value recorded on the block, then press "CONF".
- Check up No. 2 ~ No. 4 test block according to aforementioned method, adjust the average value according to the record on the metal block, press "CONF".

After corrected the forth test block, continuously press "CONF" until it return back to test status.

9. Calibration of Force Values

Force values calibration function is available.
Normally force calibration is done by tester manufacturer, which is a very important program for test. Every time when tester has been sent back to manufacturer for maintenance, engineers will inspect and calibrate the force values.

9.1 Conditions for Starting Force Values Calibration

Normally the function of force value calibration is not authorized to common users. The required condition for the functions is as follows:

9.1.1 A qualified mechanics laboratory with certificated mechanics laboratory technicians is necessary.
9.1.2 It requires a dynamometer with measuring scope of 200~500kgf, accuracy not lower than 0.2% and in period of validity. The force transducer of the dynamometer should be a strain gauge type (you can purchase it from manufacturer).
9.1.3 Special iron seat is required, which can be purchased from manufacturer or DIY.

9.1.4 Special flat indenter is required, which can be purchased from manufacturer.
If the above conditions are satisfied, you can require the authority from manufacturer to use the function and calibrate the force values by the instructions from technical engineers of manufacturer.

9.2 Method of Force Values Calibration

- Assemble the special flat anvil to tester.
- Put force transducer into groove of special iron seat.
- Put tester onto iron seat, aiming indenter at pressure point. At the time, indenter is apart from transducer. Turn the magnetic chuck switch to "On", attaching the tester to iron seat.
- Turn on the power of tester.
- Follow the instruction of manufacturer technical engineer. When arrow points at 10kgf, "10kgf, 60kgf, 100kgf, 150kgf" displays on screen.
- Spin hand wheel, and observe displayed force values. When dynamometer shows 10.0kgf, press "CONF" to accomplish calibration of 10kgf. Arrow points at 60kgf at this time. Repeat the steps above, and accomplish the calibration of 60kgf, 100kgf, 150kgf. When these all finish, tester backs to previous menu. Press CONF" continuously until back to testing status.

10. Misoperation, Faults and Solution

10.1 Misoperation

If misoperation occurred during force loading, it would display "Over load", "Under load", "Hold Not Enough" on screen. This test is invalid, and a new test should be taken in another spot.
When hardness value from test is beyond measuring range of relevant scale, it will display "Too hard" or "Too Soft". This test is invalid as well, and a new test should be taken in another spot. If the new test result is the same as before, it indicates the selection of scale is wrong. It should be tested again in other scales.

10.2 Faults and Solution

If it displays apparently wrong test force values or disorder, it indicates some faults occurred to tester. Press "Reset" to recover tester to state as delivered.
"Reset" operation steps are as follows:

- Press "MENU" into functional menu.
- Press "△" or "▽", move arrow at "Others", press "Menu" into next level menu.
- Press "△" or "□" to "Reset", press "CONF" continuously until back to test status.

If the operation above does not function, please contact manufacturer to get help.

11. Factors Affecting Test Accuracy

11.1 Surface of part: It will affect test accuracy if the surface of part is rough with oxide skin, decarburized layer, rust and contaminant.
11.2 Operation: It will affect test accuracy if it is not operated skillfully or carefully, or force loading, time duration and force releasing are respective inconformity from beginning to the end among several tests.

11.3 Total test force: The deviation of total test force in testing will affect result accuracy.
11.4 Test force measuring: After long time using, transducer or electric parts may drift, which may cause test force inaccurate measuring.
11.5 Time duration: When testing the accuracy of the instrument, duration of the test force should be up to the standard. When testing the work piece, it is permitted to shorten the time duration in order to raise the efficiency, but the accuracy will be influenced by the short of time duration.
11.6 Hardness block: It will affect test accuracy if block is in following condition: uniformity out of tolerance; bad stability; beyond inspecting valid time; too close distance between indentations; indentation existed in supporting surface; block or iron seat dirty.
11.7 Calibration: It will affect test accuracy if hardness value or test force calibration is not correct.
11.8 Environment: It will affect test accuracy if temperature changes in a large range; there is big temperature deviation between test and calibration; or there is vibration and dust on site.
11.9 Scale: Error in HRA is bigger than in HRC when test.
11.10 Conversion: When converting the testing hardness values into other testing scale, error may occur.

12. Parts Introduction

12.1 Adapter

12.1.1 General adapter is delivered with tester. This adapter is fit for flat and cylinder work piece. It should not be disassembled.
12.1.2 If tester could not be attached to irregular parts or attaching force is not big enough, please contact manufacturer which will help to design special adapter and extension indenter. In principle, special adapter and indenter are only for irregular parts in fixed size. For different sizes of tested work piece, there should be allocated

by different special adapter and indenter.

12.2 Iron Seat

12.2.1 Iron seat is made of high magnetic permeability material.

12.2.2 The function of it is to test block or small parts. Put block or small parts into the groove for test and the groove should be upward.

12.2.3 DO NOT try to test the hardness of iron seat.

12.2.4 It is easy to rust, so keep it dry and clean. Dust on it can enlarge the possibility of measuring error.

12.3 Hardness Block

12.3.1 It is the standard material for calibrating tester. Qualified Rockwell hardness block is calibrated by standard Rockwell hardness tester with its hardness values marked on the edge and signed on the certificate. The standard Rockwell hardness tester is traceable to National Standard Hardness Tester through hardness values transfer by block.

12.3.2 The valid time of block is 1 year. Expiry blocks should not be used because its hardness is possible inaccurate. It should be recalibrated by certificate center. Only the front side of it is permitted to use. Block with indentation on back side will cause error in test.

12.3.3 It should keep dry and clean. Rusted blocks will cause relatively big test error.

12.4 Magnetic switch

12.4.1 When not testing, handles of magnetic switch should be always on front horizontal position of "OFF", if not horizontal, magnetic switch will not close completely.

12.4.2 When testing, put it onto steel parts or iron seat and turn the handles to the back horizontal position of "ON", if not horizontal, magnetic switch will not open completely, which causes magnetic force not arriving at maximum values.

12.5 Battery

12.5.1 Common Sense of Battery

12.5.1.1 Please use dry or rechargeable battery required by this tester.

12.5.1.2 Do not drop battery into fire, for possible explosion.

12.5.1.3 Do not disassemble battery, for its electrolyte is corrosive and would hurt eyes or skin.

12.5.1.4 Dry battery is not rechargeable.

12.5.1.5 Keep battery away from conductive materials.

12.5.2 Specification of Battery

12.5.2.1 Power of the tester is supplied from 3 pieces of AA/5# battery, with voltage 1.2-1.5V. It could be alkaline or rechargeable Ni-MH battery.

12.5.2.2 Due to safety restriction of transportation, battery is not in the parts list. Please purchase it at local.

12.5.2.3 5# alkaline battery is easy to purchase and cheap.

12.5.2.4 Ni-MH battery is relatively expensive but rechargeable. It could provide longer continuous using time.

12.5.3 Electricity Consumption of Tester

One battery set in good quality (Nan Fu alkaline battery and Sanyo Ni-MH battery for example) will provide working time as following Table-4:

Table-4

Battery Type	Working Time	
	Continuous working	Stand by
5# Nanfu alkaline	8 ~ 10 hours	30 days
5# Sanyo Ni-MH	10 ~ 12 hours	40 days

12.5.4 Electric Quantity of Battery Indicator

Balanced electric quantity of battery will indicates on the right corner of screen as following Table-5:

Table-5

Symbol	Balanced Electric Quantity
	Good
	Medium
	Low(battery should be changed)

Notes: 1. When "  " displays, finish test within 10mins, change battery.
2. It will consume electric power when standby. The longer standby, the shorter continuous working.

12.5.5 Exchange Battery

- Battery is installed in the battery box on the right side of tester. Take battery box off when exchanging battery.
- Hold the edge of battery box and pull it off, then it is disassembled.
- Take off used battery and install new ones by the instruction of positive and negative sides.
- Push the battery box into tester; keep outside edge of battery box and

tester cell in the same surface.

Note:

There are two raised electrodes on the bottom of battery box, which are positive and negative electrodes of battery. It is forbidden to put the bottom of the battery box onto iron seat or other surface of metals which may cause short circuit and danger.

12.5.6 Recharging Battery

Recharge the power off battery in time when using Ni-MH battery.

For new Ni-MH battery, it should be "Recharge and Empty Completely" for 3 times. Recharge it continuously for at least 14 hours and empty the battery when " ▭ " displays on screen.

On daily use, try to make the battery work in "Recharge and Empty Completely". In this way, it would extend the lifetime of battery.

13. Other Instructions

13.1 About work piece to be tested

13.1.1 Materials

The tester is only applied to magnetic iron and steel materials.

It could not be applied to no or weak magnetic high manganese steels, austenitic stainless steels, other austenitic steels or nonferrous metals. Normally for steel materials, the lower carbon content, the better permeability is.

13.1.2 Surface

Surface of parts should be flat and smooth, and the roughness meets at least 6.3μm. If the roughness does not meet the requirement, it should be tested more times to decrease the influence to test accuracy.

Polish the oxide layer, decarburized layer, or rust in the surface of work piece rub down and polish the weld joint.

13.1.3 Shapes and Sizes of tested work piece

Parts to be tested could be in any shapes, but there must be a big enough test area, which could be flat or cylinder. The specific requirements are: flat area > 195mmx60mm, thickness > 5mm; cylinder-diameter > 60mm, length > 200mm, thickness > 8mm.

For special shapes, small test area, thin and low permeability parts, for instance thin track guide rail, minor axis, short pipes, thin axis, thin pipes, stepped shaft, non-cylindrical surface and other irregular shapes, some of them could test in scale HRA and then converted into HRC or HRB; for some others could test by adding special adapter and indenter if there are not so many specifications.

13.2 About Remanence

When magnetic switch is off, there will be a little remanence in tested parts, it will keep tester still attached to the parts. It cannot move the tester by pull the hoop handle.

At the time, do not try to use larger force to pull it, otherwise tester will be damaged. The solution is: horizontally push the tester backward on left or right front side until it slips.

Attention: do not push the key parts such as hand wheel, encoder or operation panel.

13.3 About Operation Environment

13.3.1 It should be operated under required environment.

13.3.2 It should be avoid of operating in environment of salt mist, high humidity, high temperature, rain, insolation, dust, vibration, strong magnetic field.

13.3.3 It could not be operated in the temperature of lower than 5℃ or higher than 45℃. Try to avoid of operating in the environment in a wide temperature change range.

13.4 Maintenance and Stock

13.4.1 Tester should be stocked in carry case when you do not use it.

13.4.2 The bottom of adapter and iron seat should keep dry and clean, resistance of rust. Paint a little grease on the surface of adapter and iron seat if not operating for a long time.

13.4.3 Do not fall forward the tester, in case of damage to the screen.

13.4.4 If it is predicted not to use for some time, pull out the battery from box in case of contaminating the tester by its weeping

13.4.5 It could not be stocked outdoors for a long time.

13.4.6 Do not use water or detergent to clean it.

13.4.7 Adapter is not permitted to disassemble, except special adapters needed. Other parts are forbidden to disassemble without instruction and authority.

13.5 Transportation

The tester is heavy per unit volume, and it consists of precision machinery and precision electronic circuit, therefore it should be very cautious during transportation. When repaired back to factory, it is very important to pack it in original package. Therefore, the original package should be kept in good condition, including carrying case, vibration-proof materials, and carton box. We are not responsible for the damage in transportation if not packed in original package.

14.Standard Package

1 Tester
1 Iron Seat
1 Diamond Cone Indenter
1 1.588mm ball indenter
1 2.5mm ball indenter
3 Rockwell Hardness Blocks
1 Brinell hardness Block
1 40x reading microscope
1 Battery Box
1 Carrying case

Appendix Brinell hardness table

Ball Diameter D/mm 2.5	Test Force F/kgf(N) 187.5(1839N)	Ball Diameter d/mm 2.5	Test Force F/kgf(N) 187.5(1839N)
Indentation Diameter d/mm	Brinell Hardness (HBW)	Indentation Diameter d/mm	Brinell Hardness (HBW)
0.60	653	1.05	207
0.61	632		
0.62	611	1.06	202
0.63	592	1.07	198
0.64	573	1.08	195
0.65	555	1.09	191
		1.10	187
0.66	538		
0.67	522	1.11	184
0.68	507	1.12	180
0.69	492	1.13	177
0.70	477	1.14	174
		1.15	170
0.71	464		
0.72	451	1.16	167
0.73	438	1.17	164
0.74	426	1.18	161
0.75	415	1.19	158
		1.20	156
0.76	404		
0.77	393	1.21	153
0.78	383	1.22	150
0.79	373	1.23	148
0.80	363	1.24	145
		1.25	143
0.81	354		
0.82	345	1.26	140
0.83	337	1.27	138
0.84	329	1.28	135
0.85	321	1.29	133
		1.30	131
0.86	313		
0.87	306	1.31	129
0.88	298	1.32	127
0.89	292	1.33	125
0.90	285	1.34	123
		1.35	121
0.91	278		
0.92	272	1.36	119
0.93	266	1.37	117
0.94	260	1.38	115
0.95	255	1.39	113
		1.40	111
0.96	249		
0.97	244	1.41	110
0.98	239	1.42	108
0.99	234	1.43	106
1.00	229	1.44	105
		1.45	103
1.01	224	1.46	101
1.02	219	1.47	99.9
1.03	215	1.48	98.4
1.04	211	1.49	96.9
		1.50	95.5