

DIGITAL BRINELL HARDNESS TESTER

USER' S MANUAL

MODEL iBrin-412C

ISO: ISO6506-2

Metallic materials-Brinell hardness

test-part2:Verification and calibration of testing machines

1. A Brief Introduction to the Tester

Hardness is one of important mechanical properties of metallic materials, while hardness determination is a principal index to judge the quality of metallic materials and mechanical parts made thereof. Hardness means material's capability to resist the pressure applied by another object of no residual deformation itself. Higher resistance corresponds higher hardness, and vice versa.

Ball hardness test is mainly used in hardness determination of cast iron, steel, non-ferrous metals and soft alloys, also can be used for some other nonmetallic materials such as hard plastics, bakelite etc. It is suitable for applications in factories, workshops, laboratories, colleges and research institutes.

In ball test, a ball with specified diameter (D) is pressed by a specified force (F) onto surface of the object to be tested (Fig. 1). The test force is removed after keeping a specified hold period, then the dent diameter (d) shall be measured by the microscopic ocular lens and the average pressure (N/mm²) acted on spherical surface can be calculated as the ball hardness value. Ball hardness can be obtained from the following equation:

$$HB=0.102 \times \frac{2F}{\pi D(D - \sqrt{D^2 - d^2})}$$

where: F- test force applied on specimen by steel ball, N

D- diameter of steel ball, mm

d- dent diameter, mm

0.102— a fixed coefficient.

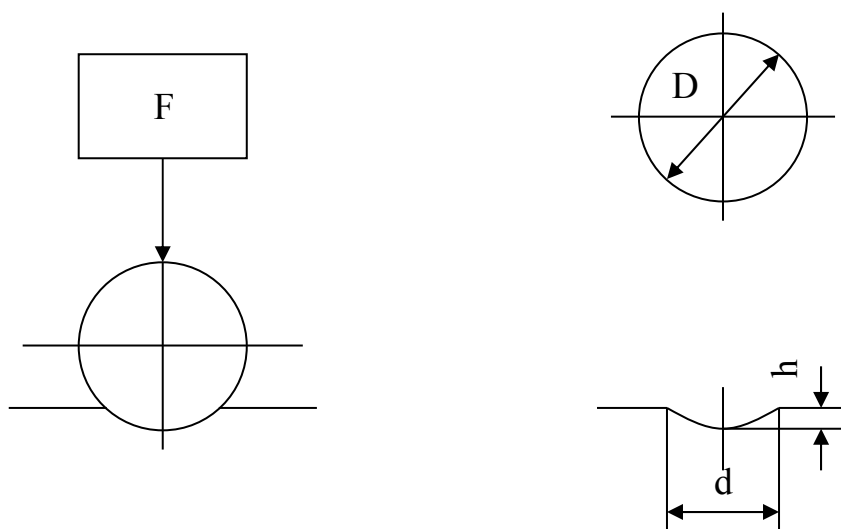


Fig. (1-1)

2. Main Technical Specifications

2.1 Test force classification:

612.9N(62.5kgf)	4900N(500kgf)
980N(100kgf)	7355N(750kgf)
1226N(125kgf)	9800N(1000kgf)
1839N(187.5kgf)	14700N(1500kgf)
2452N(250kgf)	29400N(3000kgf)

2.2 Applicable hardness range: (8~650) HBW

2.3 Reading accuracy:

Standard hardness block HBW	Maximum indicating error (δ /%)	Repeatability H_{cf} /%
≤ 125	± 3	≤ 3.5
$125 < \text{HBW} \leq 225$	± 2.5	≤ 3.0
> 225	± 2	≤ 2.5

$$\delta = \frac{\overline{H_j} - \overline{H_k}}{\overline{H_k}} \times 100\%$$

Where:

δ — indicating error

$\overline{H_j}$ — indicating of hardness tester

$\overline{H_k}$ — number of hardness block

$$H_{cf} = \frac{H_{\max} - H_{\min}}{\overline{H_j}} \times 100\%$$

Where:

H_{cf} — repeatability of indicating value

H_{\max} — Maximum hardness number(five test)

H_{\min} — Minimum hardness number(five test)

$\overline{H_j}$ — arithmetic mean of hardness number

2.4 Multiply factor of microscopic ocular lens: 20X

2.5 Minimum graduation of ocular lens drum: 0.00125mm

2.6 Maximum height of specimen: 225mm

2.7 Maximum distance between center of indenter and the column: 135mm

2.8 Power voltage: AC 220V

2.9:Outline size: (789×543×225)mm

2.10 Weight: 130kg

3. Apparatus Installation and Adjustment

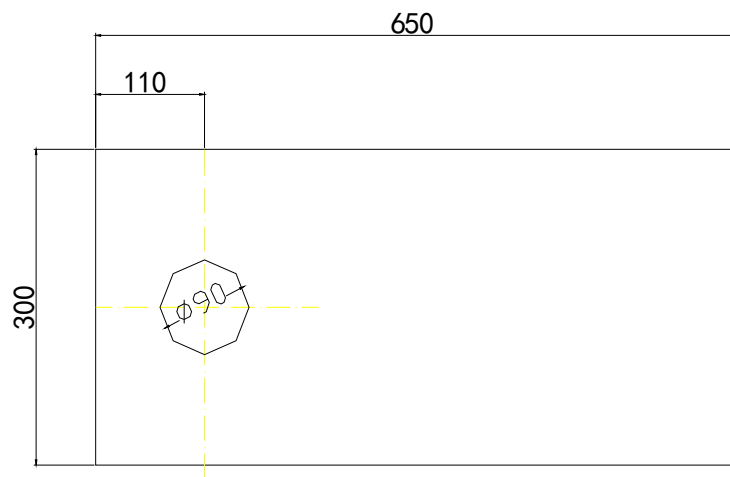
3.1 Working Environment of the tester

3.1.1 Hardness test shall be carried out under ambient temperature of $(23\pm 5)^{\circ}\text{C}$ and relative humidity of less than 70%. If the test temperature is out of the specified range, it shall be recorded in the test report;

3.1.2 The tester shall be installed in a clean environment free from vibration;

3.1.3 No corrosive medium shall be allowed in surrounding;

3.1.4 The tester shall be mounted on stable bench with outline size as shown in the figure below for reference and leveled to a slope less than 0.2/1000. A $\phi 90\text{mm}$ hole shall be drilled on the bench at suitable position to enable proper operation of the lifting screw.



(Fig. 3-1)

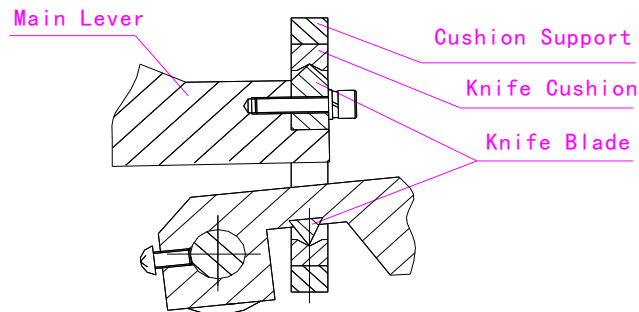
3.2 Unpacking and Installation

3.2.1 Loosen the four (4) nuts on bottom of the packing box, then lift the box upward with the tester hung up, remove the four (4) fix screws and place the tester on leveled bench.

3.2.2 Remove the spacer between lifting screw and indenter axis, wipe off the anti-rusting oil from lifting screw with gasoline and then, after dried out, apply a coat of thin lube oil instead.

3.2.3 Open the upper cover and remove the foam spacers at both sides of the lever. Check the knife support to assure that knife blade rests on the knife cushion. If the blade is out of the cushion support (such case will only be caused by severe shake and vibration), push down the main lever with hand and slide the blade into cushion support (see Fig. 3-2). Then close the upper cover.

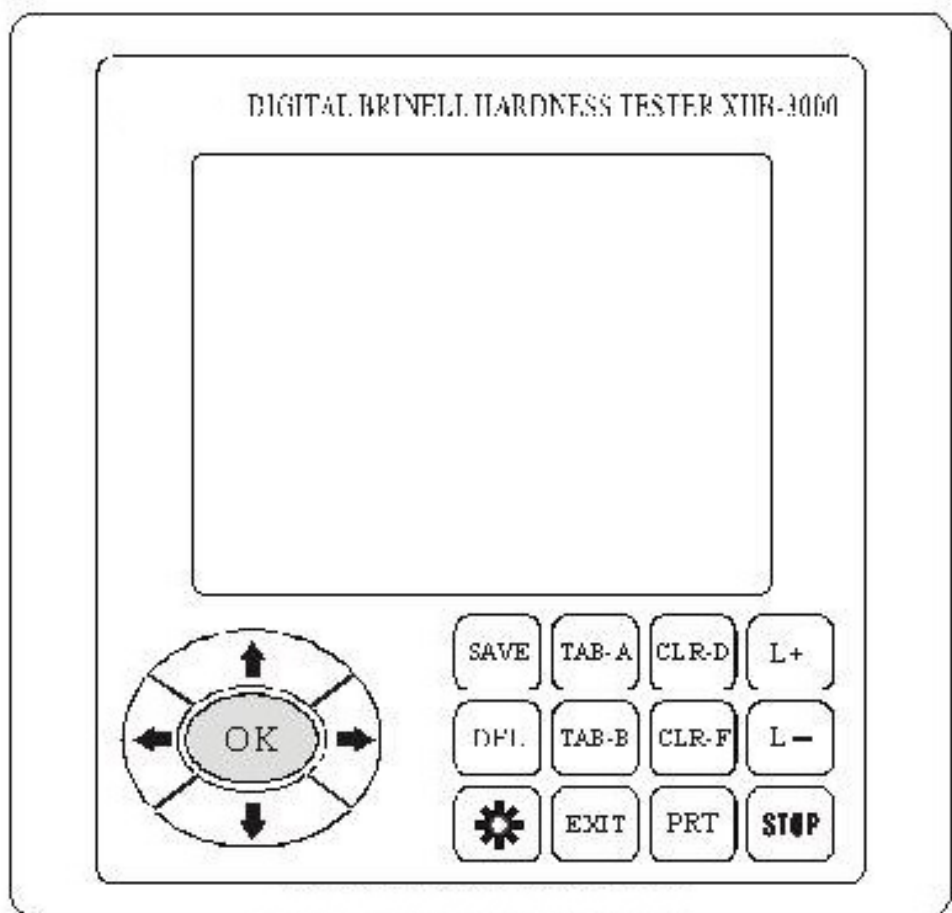
3.2.4 Open the accessory box, take out the microscopic ocular lens (6) and installed it into the hole on ocular lens well (7) above the tester. Then insert the plug of ocular



lens' power cord into the socket at upper part of the tester' s right side.

3.2.5 Connect the power source, turn on the switch, and the tester will enter operation mode automatically.

3.3 Description of Panel Key Functions (Refer to Fig.3-3)



(Fig.3-3)



SAVE key: to save file. Saving a file means to store the current test data into memory as a whole page. Up to 5 pages can be stored and the pages will be automatically numbered by 00~05 for retrieval. When the 6th page is stored, the earliest stored page (No. 00) will be rejected. If you want to retain this page, you shall at first press TAB-B to enter DATA SAVE page, then press SAVE and the data of this page will be automatically saved, while the display returns to home page as in initial state. Up to 20 groups of data can be stored in a single page (exceeding part of data will be automatically deleted). For instance during the 21st time of test, the test serial number shown on the display will remain as 20 however all displayed data will be for the current test (i.e. the 21st test), and the same will continue for following tests. If you want to keep more than 20 groups of data, you shall save the data of first 20 groups in a page, then return back to home page and start again. Only in such manner can all the data be maintained valid and be saved.



DEL key: to delete the current data and/or current page. If the obtained data of current test are thought as undesirable, they can be deleted by pressing DEL key. If the data of the whole current page are no longer needed, you may press TAB-B to enter DATA SAVE page, then press DEL key to delete these data (i.e. to delete the whole page) and return back to home page.



Display brightness adjusting socket. Use a small screwdriver to adjust the brightness as needed.



TAB-A key: to enter the force & indenter choose page. In this page you may press individual arrow keys to choose required test force and indenter as shown in Fig (3-4). Depress OK/ESC key after confirmation to escape and return back to home page.

iBrin-412C Digital Brinell Hardness Tester							
F/D ²	30	15	10	5	2.5	1.2 5	1
D (mm)		TESTER FORCE					
10	3000	1500	1000	500	250	125	100
5	750		250	125	62.5		
2.5	187.5		62.5				
HRC		NO. 00		2005/3/15_15:15:18			
Loading	Indenter	Dwell	Light	Change	Time		
3000	10mm	10s	40%	HRC	MIN		

(Fig 3-4)

iBrin-412C Digital Brinell Hardness Tester						
Measurement			Loading			
D1:	0.000mm		F:	0.0		
D2:	0.000mm		Range 95.5—653HBW			
HBW						
C	HR	NO. 00	2005/3/15_15:15:18			
Loading	Indenter	Dwell	Light	Change	Time	
3000	10mm	10s	40%	HRC	MIN	

(Fig 3-5)

TAB-B

TAB-B key: to enter DATA SAVE page. This page shows NO (number of tests), D (in mm, average of D1 and D2) and HB (hardness value) (Fig 3-15). When you need to retrieve or save data, press TAB-B key to enter DATA SAVE page, then find the desired page by pressing↑or↓arrow keys. If you press OK/ESC you will leave the current page unsaved and return to home page, and if you press SAVE key the current page will be saved and then the home page turns on.



EXIT key: to exit the system. In normal exit procedure, this key is first depressed to quit CPU from operation following by switching off the power. Direct switch off may cause error in computer program.



CLR-D key: calibration key. It is used to set zero for both graduation lines on microscopic ocular lens, or calibration.

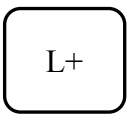


CLR-F key: clear key. If there is a residual test force left on display when the whole test force is removed (the indenter is separated from specimen), use this key to clear it.

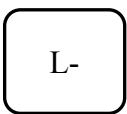


PRT key: print and serial interface data loading key. Press this key to print out the data of current test or send the data through RS232 to PC' s COM interface.

Note: Refer to below for the setting of PC' s Hypertrm.



L+ key: to increase the brightness of light source. A beeper will sound by each depressing of the L+ key to indicating that brightness is increasing. A light value changing from 10% to 100% is displayed on the lowest line of home page. When the beeper sounds continuously it means maximum brightness has been reached.






L- key: to decrease the brightness of light source. A beeper will sound by each depressing of the L- key to indicating that brightness is decreasing. A light value changing from 10% to 100% is displayed on the lowest line of home page. When the beeper sounds continuously it means minimum brightness has been reached.







STOP key: for emergency stop/display of original data. Depress this key when need to stop operation during the tester' s loading period. The tester will stop loading and return back to initial settings. STOP key shall not be carelessly depressed other than the loading period, or the program' s original data will be displayed as F= XXX.X. In such case CLR-F shall be depressed to return the display back to set working state (original data are only used for design and later extension of

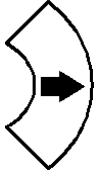

functions, and of no relation with the use of tester).

 OK/ESC key: When TAB-A or TAB-B page is on display, depressing this key may cause to exit and return back to home page. Depressing OK/ESC key on home page the cursor will flash at Dwell, Light, Change, Time, and Loading etc, and pushing the arrow keys by this time enables the mode selection or parameter setting. After confirmation, depressing OK/ESC key will end the selection and cause the cursor disappeared. **Note: Do not depress the arrow keys when cursor is flashing at Loading because this function is provided only for the apparatus adjustment at factory, careless use of this function will cause damage of apparatus or decrease of accuracy. Depress OK/ESC key to end or left arrow key to return back.**

  key: arrow key. When cursor is flashing at the positions of Dwell, Light, Change and Time, depressing ↑ arrow key may increase the value in years, months, days, hours and minutes (Time), or up the hardness conversion scale (Change), or intensify the brightness of light source (Light), or extend the load holding time (Dwell). Press this key on TAB-A page to choose larger test force and press it on TAB-B page to retrieve the previous page from memory.

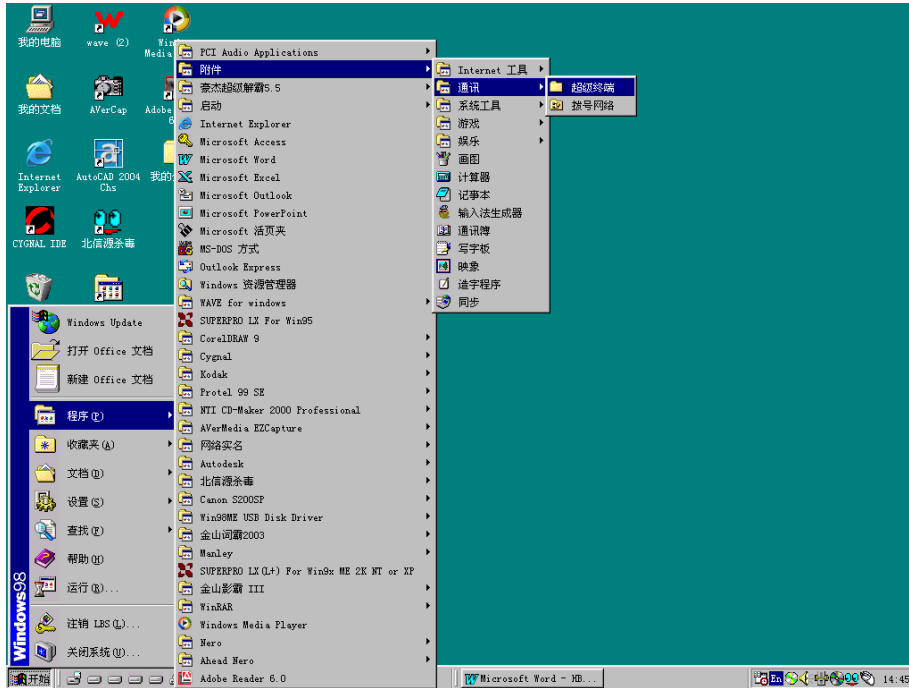
  key: arrow key. When cursor is flashing at the positions of Dwell, Light, Change and Time, depressing ↓ may decrease the value in years, months, days, hours and minutes (Time), or turn down the hardness conversion scale (Change), or weaken the brightness (Light), or reduce the holding time (Dwell). Press it on TAB-A page to choose lower test force and press it on TAB-B page to retrieve the next page from memory.

  key: arrow key. When cursor is flashing on home page or TAB-A page, depressing this key makes cursor shifting to left.

  key: arrow key. When cursor is flashing on home page or TAB-A page, depressing this key makes cursor shifting to right.

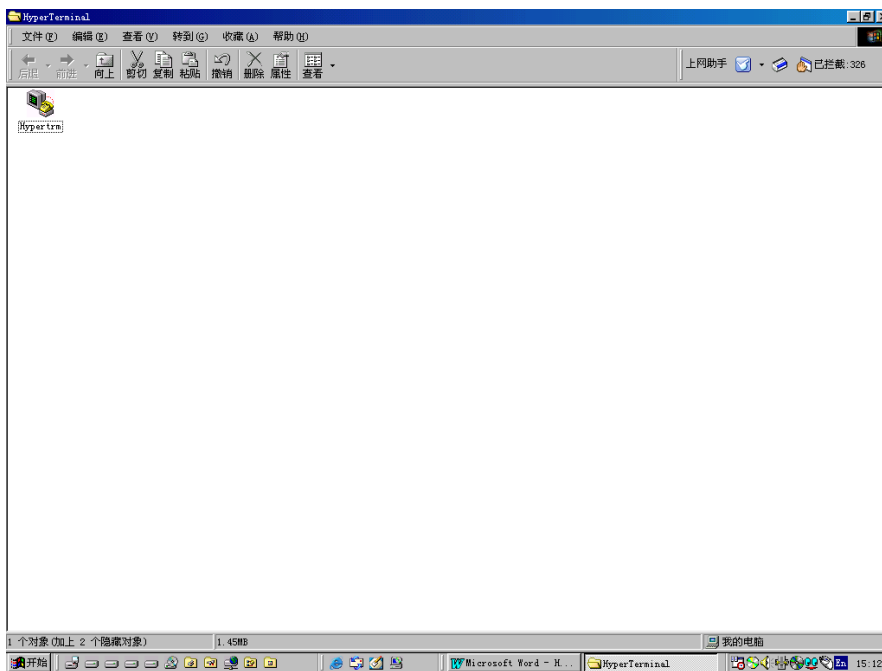
3.4 Setting of RS232 Hypertrm

3.4.1 Click → Start, choose Programs → Accessories → Communications → Hypertrm, as shown in Fig (3-6).



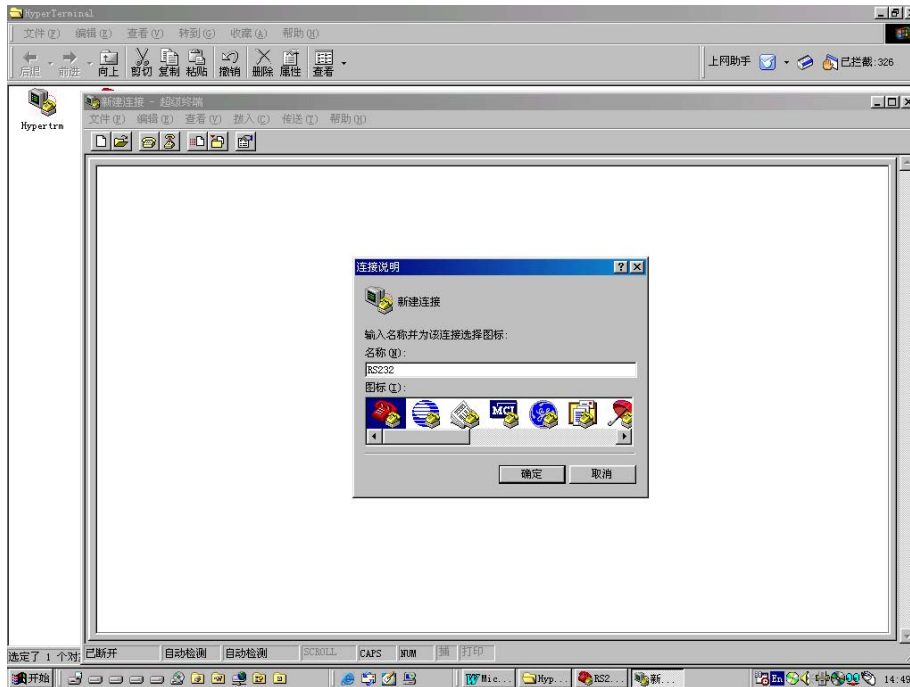
(Fig 3-6)

3.4.2 Single click the left button on Hypertrm as shown in Fig (3-7).

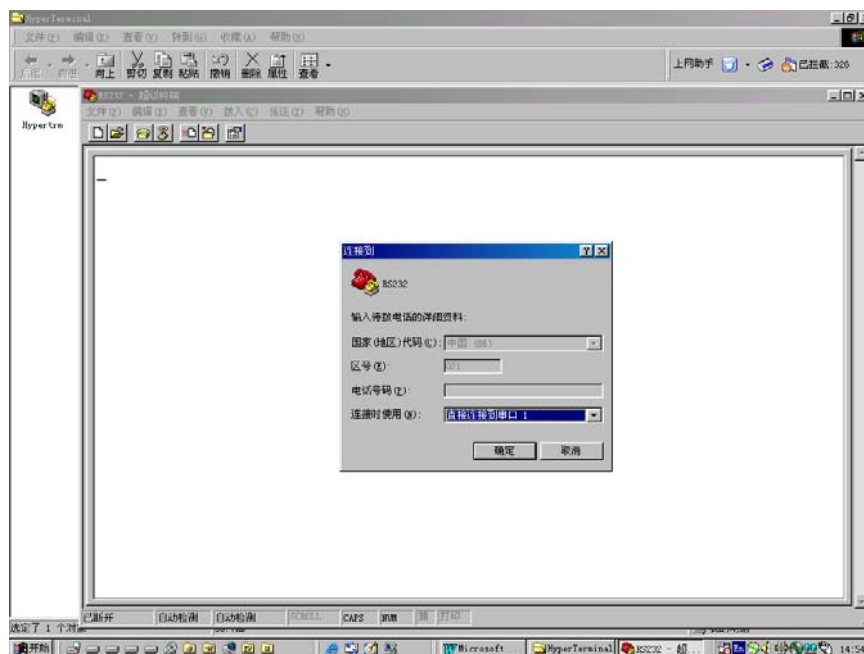


(Fig 3-7)

3.4.3 Double click on Hypertrm to display the Fig (3-8). Enter “RS232” in the field of name (N), press ENTER key to display Fig (3-9).



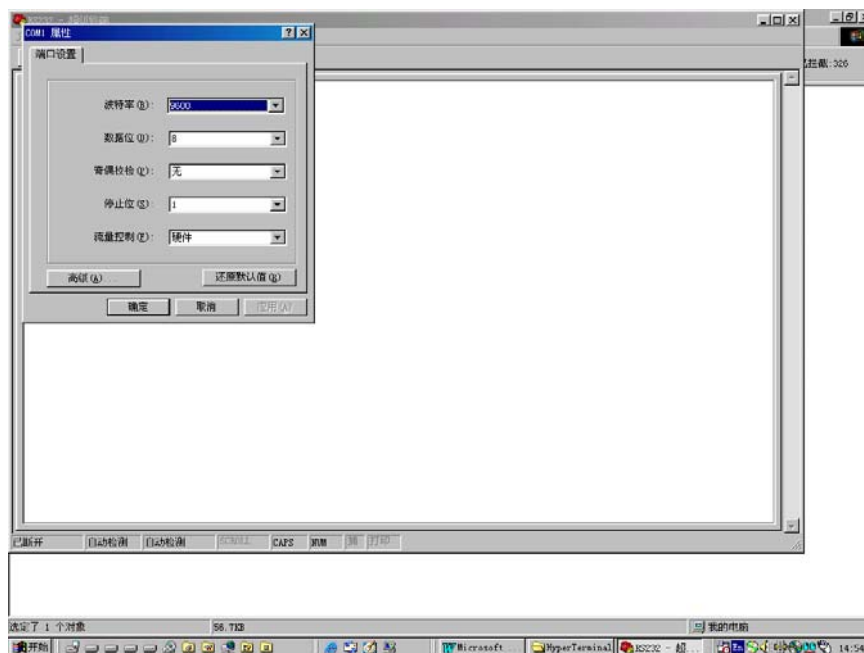
(Fig 3-8)



(Fig 3-9)

3.4.4 When use dialogue box for connection, N (neutral) is directly connected to serial interface 1/2, then press the confirmation key. Refer to Fig 3-10 for the attribution dialogue box of COM1/2. Select 9600 for Baud rate (B) and keep others unchanged. Press the confirmation key to enter RS232 Hypertrm interface and save the dialogue RS232.

3.4.5 If there is no Hypertrm installed in the program, click to choose Start → Setting → Control Panel → Add/Delete Program → Install Hypertrm.



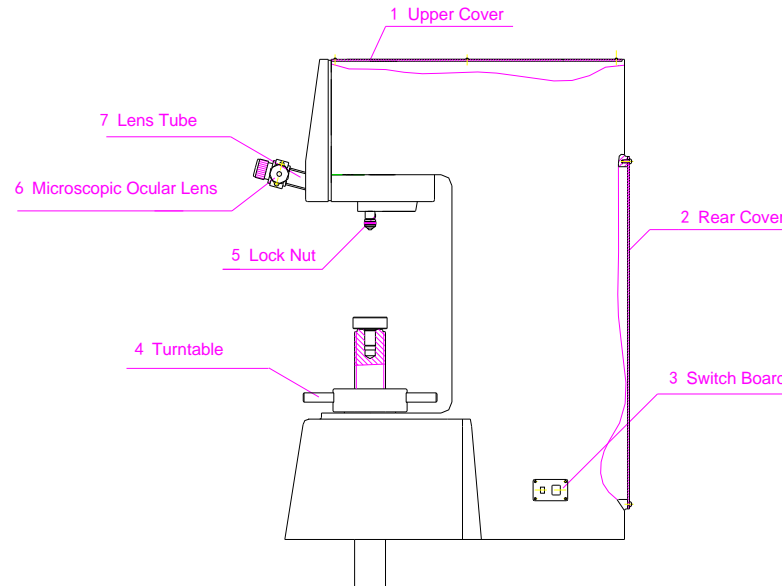
(Fig 3-10)

3.5 Operation of the Tester

3.5.1 The power source shall be reliably grounded and equipped with voltage stabilizing device.

3.5.2 Indenter installation: Rotate the indenter axis to the forward direction, put the indenter into the axis hole, turn in the set screw (5) to fix it snugly onto the flat portion of the indenter axis (see Fig 3-11). Install the specimen stock directly onto the lifting screw, then place the specimen on the stock in a stable position to ensure it will not move or warp during the test process. Rotate the hand-wheel (4) to lift the stock slowly till the specimen is in contact with indenter. **(Note: There are two ways to install the indenter: one is to set the test force at 500 kilograms or larger, or cut-off the power, the other is to install before switching on the tester' s power supply,)** Then tighten the set screw (5) on the flat portion of the indenter and rotate the hand-wheel (4) in counter direction to separate the indenter from specimen. The installation of indenter is completed.

3.5.3 The switch board is located at the right side of the tester (see Fig 3-11) while a printer is installed at the left side. Turn on the power supply switch, the lever will be automatically adjusted into the operation position.



(Fig 3-11)

3.5.4 The display will turn on immediately after switching on of the power source to show the home page(see Fig 3-12).

iBrin-412C Digital Brinell Hardness Tester					
Measurement			Loading		
D1:	0.000mm		F:	0.0	
D2:	0.000mm		Range 95.5—653HBW		
HBW					
C	HR	NO. 00	2005/3/15_15:15:58		
Loadi ng	Inden ter	Dwell	Light	Chang e	Time
3000	10mm	10s	40%	HRC	YEAR

(Fig 3-12) Home Page

3.5.4 Depress TAB-A key, select test force and indenter by using arrow keys as needed (see Fig 3-13). Depress OK/ESC key after all selections are completed to return back to Home Page (Fig 3-12)..

iBrin-412C Digital Brinell Hardness Tester							
F/D ²	30	15	10	5	2.5	1.2 5	1
D (mm)		TESTER FORCE					
10■	3000■	1500	1000	500	250	125	100
5	750		250	125	62.5		
2.5	187.5		62.5				
HRC		NO. 00		2005/3/15_15:15:58			
Loading	Indenter	Dwell	Light	Change	Time		
3000	10mm	10s	40%	HRC	YEAR		

(Fig 3-13) TAB-A

3.5.5 Default settings of the Home Page are: Test force F>Loading): 3000kgf; Hardness range: (653-95.5)HBW; Indenter: Φ 10mm; Holding time (Dwell): 10s; Brightness (Light): 40%; Conversion scale (Change): HRC; Date: 2005/3/15 15: 15: 58. If these are not in compliance with actual test conditions, depress OK/ESC key to cause the cursor flashing at the field of Dwell. Then choose the proper load holding time by \uparrow or \downarrow key and press OK/ESC to confirm, the cursor will move to the field of Light. Use the same procedure to choose Light, Change and Time. After completion of selection, press OK/ESC to enter normal working state.

3.5.6 In prior to normal operation, the tester shall use test load of 3000kgf to carry out 2 or 3 times of trial press to eliminate the gaps between individual mechanisms, and confirm that all electronic components are working properly to reduce test errors.

3.5.7 When all the preparations are completed, place the specimen stably on the stock, rotate the hand-wheel and the test load will be shown on display as soon as the specimen is in contact with the indenter. The ascending of lifting screw shall be kept very slow when test load display is approaching to automatic loading value, and stop rotating the hand-wheel when the beeper sounds to indicate the automatic loading value is reached. The tester then enters the automatic loading period and a

flashing downward arrow is shown on display (to indicate the loading state). Load holding period begins when the specified test load is reached and the arrow is no longer flashing while the Dwell timer starts to counter backward. The test load gradually decreases after Dwell period expired and a flashing upward arrow is displayed. Finally the load is wholly removed, the arrow is disappeared and the lever returns to its original position. Rotate the hand-wheel in counter direction (about half turn) to separate the specimen from the indenter by a distance of around 1 mm.

10 grades of test load are available in this tester, matching with 2 classes of automatic loading value respectively. The loads of 62.5kgf ~ 250kgf are of the

first class with the automatic loading value of 30kgf, and 500kgf ~ 3000kgf are of the second class with the automatic loading value of 90kgf. **Note: When use the first class of test loads and the applied force is too much and exceeding the automatic loading value of 30kgf, the tester will not work. In such case please turn the wheel in counter direction to remove the applied and repeat the above described procedure. The ascending of lifting screw shall be kept very slow when test load display is approaching to automatic loading value.**

3.5.8 Rotate the turn table to position the light source at the frontward direction. Turn the knob slowly and observe the image of dent in the ocular lens until a clear image is formed.

3.5.9 Watch the two moving graduation lines in the field of vision, and adjust the focus of lens to make the lines distinct (Adjustment of lens may cause the dent image obscure, it needs to turn knob to form clear image again).

3.5.10 Turn the drums at both sides of the microscopic ocular lens and watch the two lines moving towards each other. When the transmission light between two lines become less and less till to a critical state, press CLR-D key (calibration key) to set the zero position (**If the tester is to be used by another operator, the zero shall be recalibrated to prevent the measurement error caused by different individual's vision**).

3.5.11 Turn the two drums in counter direction to separate two moving graduation lines. First turn the left drum to make the left line tangential to left edge of the dent, then make the right line tangential to dent's right edge. Press the button on ocular lens and the measurement of D_1 is finished. Then turn the ocular lens by an angle of 90° (**be careful to keep the focus unchanged**), and determine another diameter D_2 by the same procedure. The tested hardness value will be displayed after completion of the test cycle.

3.6 Hardness Application Example: Choose load of 3000kgf and indenter of 10mm to proceed the test.

3.6.1 Switch on the power supply. Home Page appears on the display as shown on Fig 3-12. If default settings of the Home Page can meet the general test requirements (where no printing and save functions are needed), then scroll down to the next page to proceed the test.

D1	Dent diameter along the X axis	Dwell	Load holding period
D2	Dent diameter along the Y axis	Light	Brightness of the light source
HBW	Ball hardness value	Range	Hardness range
HRC	Rockwell hardness value	Change	Hardness conversion scale
NO	Number of test times	Time	Clock and calendar
Indenter	Diameter of indenter	F	Test Force

3.6.2 If you need to make selection, press TAB-A key to enter TAB-A page (Fig 3-13) to choose test load and/or indenter. Choose desired test load or indenter diameter by the arrow keys (↑, ↓, →, ←), then press OK/ESC key to confirm and return back to Home Page (Fig 3-12). Only test load or indenter diameter can be set on TAB-A page.

3.6.3 After back to Home Page, if you need to change the displayed setting(s), press OK/ESC key followed by arrow keys (↑, ↓, →, ←) to choose Time, Change, Light, Dwell respectively. Press OK/ESC key again as all test conditions are settled. The flashing cursor is disappeared when the tester is ready for start.

3.6.4 Each key operation, if it is proper, will cause a short beeper sound while if the operation is improper or the selection is made out of selectable range, the beeper will make longer and continuous as a remind.

3.6.5 An example is shown as below: Place the specimen on stock, rotate the turntable to position the specimen right below the indenter, rotate the hand-wheel clockwise to let the specimen in contact with indenter, slowly rotate the wheel further and a beeper sound will be heard when a test load of 90kgf is reached, and an indication of $F \geq 90\text{kgf}$ shall be displayed. Stop rotating of hand-wheel and start the motor, a flashing downward arrow appears on display to indicate the loading state. As the load value reached 3000kgf, the motor stops and the tester enter a load holding stage. When the holding period is expired the load force is gradually removed and a flashing upward arrow appears on display. The arrow is disappeared when the load is wholly removed, then turn the wheel counterclockwise to separate specimen from indenter by a distance of about 1 mm [Several times of pretests with the load of 3000kgf are recommended where no dent diameter measurement is needed, press the button on microscopic ocular lens twice after completion of loading stage and directly start loading again (without this step the second loading can not be started). The NO counter will increase along with the pretests, however the recorded N can be

cancelled by following steps: press TAB-B to display TAB-B page with the recorded N on it, then press DEL key to delete all data on this page and return back to Home Page, the number of tests (NO) is reduced to 00].

Make ocular lens calibration as necessary, then measure the dent diameters along X and Y axes respectively. For instance D1=3.421mm is obtained, then press the button on ocular lens once to confirm D1, and D2 starts to flash. Turn the lens by 90° to measure D2 (for instance D2=3.423mm).. Press the button again to confirm D2. By this time Ball hardness value 316.26 HBW, converted value 33.6 HRC, and number of tests NO. 01 will displayed on Home Page as shown in Fig 3-14 below:

iBrin-412C Digital Brinell Hardness Tester					
Measurement			Loading		
D1: 3.421mm			F: 3002.0		
D2: 3.423mm			Range 95.5—653HBW		
316.26 HBW					
33.6 HRC		NO. 06	2005/3/15_15:15:58		
Loadi ng	Indent er	Dwell	Light	Chang e	Time
3000	10mm	10s	40%	HRC	YEAR

(Fig 3-14)

3.6.6 The test cycle is finished. Press TAB-B key to enter DATA SAVE page to store the present data. The operator may view all obtained test data in this page as shown in Fig 3-15. Press SAVE key to save this page and return back to Home Page. If more tests shall be done press OK/ESC key, and further test data can be saved by the same procedure.

iBrin-412C Digital Brinell Hardness Tester						
No	D(mm)	HB				
01	3.428	315.11				
02	3.426	315.49				
03	3.412	318.19				
04	3.423	316.00				
05	3.420	316.77				
06	3.422	316.26				
MIN=315.11		AV=316.30		MAX=318.19		
P=05						
34.6 HRC		NO. 06		2005/03/15_15:15:58		
Loading	Indenter	Dwell	Light	Change	Time	
3000	10mm	10s	40%	HRC	YEAR	

(Fig 3-15) . TAB-B

No. Number of tests

D (mm) . Average of dent diameters

MIN. minimum value

AV average value

MAX. Maximum value

P. pages

3.6.7 If a print-out is needed, press PRT key.

3.6.8 If the operator wants to change the setting of test load or indenter after 6 successive tests under previous settings, data of previous tests shall be saved in prior to change of the settings. Failure to do this will cause loss of these data. After saving, press TAB-A key to enter the page as shown in Fig 3-4, then press OK/ESC key and return to Home Page. The displayed NO will be 00 and the tester is ready for new tests.

3.6.9 A close loop control system is employed in the apparatus as electric control which can dynamically indicate the actual load variation during the test. In the entire Dwell period the displayed test load is continuously changing, and gradually reduced as the indenter pressing into the specimen. The tester can make compensation automatically to keep the test load within specified range till the minimum specified

value is reached.

Note: No key operation, other than the emergency STOP key, shall be allowed during the period of loading, holding and unloading.

4 Technical Data Related to Hardness Determination

4.1 Test load shall be properly selected to ensure that the diameter of indenter will be within the following range:

$$0.24D < d < 0.6D \quad (d - \text{dent diameter, } D - \text{ball diameter})$$

the ratio of $0.102F/D^2$ 的 shall be chosen from Tab 1.

Table for Selection of Value $0.102F/D^2$ Tab 1

Material	Ball Hardness	$0.102F/D^2$
steel & cast iron	<140	10
	≥ 140	30
copper & cupric alloys	<35	5
	35~130	10
	>130	30
light metals & their alloys	35	2.5
	35~80	5,10
	>80	10

4.2 Multiple grades of test load are available for this tester, and they shall be properly selected as the nominal values specified in Tab 2.

Relationship between Ball Diameter and Test Load Table2

Hardness	Ball Diameter mm	$0.102F/D^2$ (F/D ²)	Test Load F N(kgf)
HBW 10/3000	10	30	29400(3000)
HBW 10/1500	10	15	14700(1500)
HBW 10/1000	10	10	9800(1000)
HBW 10/500	10	5	4900(500)
HBW 10/250	10	2.5	2450(250)
HBW 10/100	10	1	980(100)
HBW 5/750	5	30	7350(750)
HBW 5/125	5	5	1225(125)
HBW 2.5/187.5	2.5	30	1837.5(187.5)
HBW 2.5/62.5	2.5	10	612.5(62.5)

4.3 The acting direction of test load shall be perpendicular to the specimen surface. The test load holding time shall be 10-15 sec for ferric metals, 30 sec for non-ferric metals

and 60 sec for materials with hardness of less than 35HBW.

4.4 The minimum distance between center of dent and edge of specimen shall be 2.5 times of the average dent diameter. Pitch of two adjacent dents shall be at least 3 times of the average dent diameter. For materials with hardness of less than 35HBW, the above values shall be enlarged to 3 and 6 times of average dent diameter respectively. Failed to meet these requirements, deviation from correct hardness value may be caused by asymmetric dents. Diameter shall be measured along two perpendicular axes, and their arithmetic average shall be taken as the test result. The error between two measurements shall be less than 1% of the smaller diameter.

4.5 Specimen shall have a smooth surface with the roughness no less than $\frac{1.6}{\sqrt{R_a}}$, and for a ball diameter of $\Phi 25$.mm, the roughness of specimen shall not be less than $\frac{0.8}{\sqrt{R_a}}$ to make the dent clearly edged and ensure the accuracy of test result. No oxidation scale, plated layer or other dust shall be allowed on surface of the specimen.

4.6 The minimum thickness of specimen can be found in Tab 3. In general the specimen thickness shall be at least 8 times of the depth of dent. The dent depth h may be determined by the following equation to check if the h value is less than 1/8 of the specimen thickness:

$$\therefore HBW = F / (\pi D h) \qquad \therefore h = F / (\pi d \times HBW)$$

or it may be determined by visual inspection to see if there is deflection on back or at edge of the specimen. If so, the test result shall be judged as invalid, and different ball diameter or test load shall be reselected to start another test.

Minimum Thickness of Specimen

Tab 3

Average Dent Diameter d	Minimum Specimen Thickness			
	Ball Diameter			
	D=1	D=2.5	D=5	D=10
0.2	0.10			
0.3	0.23			
0.4	0.41			
0.5	0.68			
0.6	0.8	0.36		
0.7		0.50		
0.8		0.66		
0.9		0.84		
1		1.04		
1.1		1.28		
1.2		1.54	0.73	
1.3		1.83	0.86	
1.4		2.15	1.00	
1.5		2.5	1.15	
1.6			1.31	
1.7			1.49	

1.8			1.68	
1.9			1.88	
2			2.09	
2.2			2.55	
2.4			3.08	1.47
2.6			3.65	1.73
2.8			4.29	2.00
3			5.00	2.30
3.2				2.62
3.4				2.98
3.6				3.35
3.8				3.75
4				4.18
4.2				4.63
4.4				5.10
4.6				5.60
4.8				6.14
5				6.70
5.2				7.29
5.4				7.91
5.6				8.58
5.8				9.28
6				10.00

5 Maintenance, Adjustment & Special Attentions

The instruction manual shall be thoroughly read in prior to use of the tester to understand detailed operation steps, applicable modes and special attentions and prevent any property damage and/or personal injury caused by improper use of the apparatus.

5.1 Maintenance of the Tester

5.1.1 A coat of light lube oil shall routinely applied on lifting screw and other moving surfaces of the tester.

5.1.2 Cut off power source each time after finishing the test work.

5.1.3 Turn the hand-wheel in counter direction to take the stock away from light source. Apply a thin coat of oil on the stock surface and cover it with a antirust paper to protect the stock from rust and also prevent the oil vapor bringing adverse effect on the lens and light source.

5.1.4 When the tester is not in use, wrap the microscopic ocular lens with a lens tissue and cover the tester with a cloth to prevent dust from entering the tester. If the tester will not be used for a long period, desiccant shall be place in the optical part of the tester to protect the lens.

5.1.5 If the tester has not been used for a long period, several minutes of warm up shall be allowed after turn on the power to ensure the apparatus accuracy.

5.2 Adjustment of the Tester

The apparatus has been comprehensively tested at factory as conforming to all technical requirements specified in applicable national standard. However some variation may be caused by transportation, disassembly or voltage difference etc, and the user may make general adjustments as the following:

5.2.1 The surface of specimen and the indenter shall be kept clean, any oil or dust may have impact on the accuracy of measurement. Use ether or ethanol to clean specimen and indenter.

5.2.2 Every time after switching on, use the test load of 29400N(3000kgf) to make several trial tests, to eliminate gaps between different parts, ensure proper function of electronic components and reduce test error.

5.2.3 Loading/unloading signals are feedback by a sensor. The sensor's output is rather weak and we have therefore designed interference resistant components in the circuit to ensure proper signal reception. However, strong electromagnetic interferences shall be avoided at nearby place of the tester during its operation. Cut off power after finishing of measurement. The sequence of switching off shall be pressing EXIT key at first then followed by cut off power.

5.2.4 After start up, the lever will make automatic adjustment and enter the initial operation position. If the lever does not make this movement, cut off the power and open the rear cover and upper cover to find a mount board at the rear side with two proximity switches on it (refer to Fig 6-1). The proximity switches are designed to control the initial position of the main lever and has been adjusted to proper position at factory. In case that the position was shifted during transportation and handle, the signal transmission between proximity switches may be interfered and can not achieve proper position control. In such case, loosen the lock nut on the upper proximity switch (A) and make distance adjustment, then start up the tester again to check the signal transmission. The lever shall be able to return to its original position if the signal is properly received. Replace the upper and rear covers after adjustment. (Note that the initial lever position shall be 25 mm above the main body of the tester).

5.2.5 All screws and lock nuts have been tightened at factory. However they may be got loosen during operation due to the repeated rotation in both directions. If abnormal sound is heard during the rotation, check if the two lock nuts on the pulley for looseness and tighten them with proper tool as necessary. See Fig 5-1.

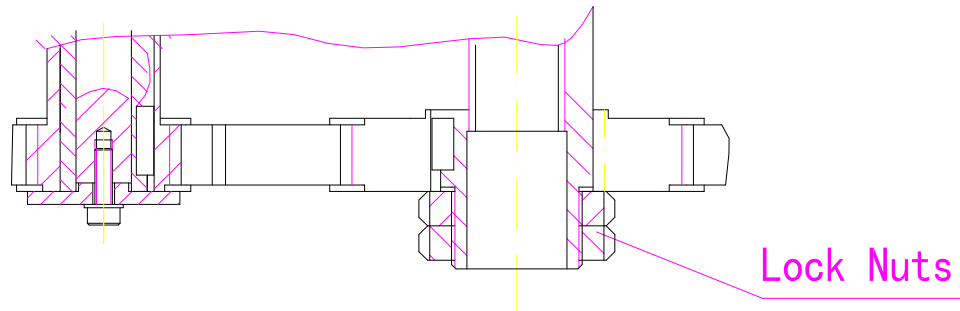


Fig (5-1)

5.3 Special Attentions

- 5.3.1 Do not tamper the installation position of electronic components, switches and sockets etc. The manufacturer shall not be liable for damages caused by unauthorized disassembly.
- 5.3.2 The turntable shall never be rotated during the test cycle, otherwise the apparatus may be damaged. The turntable can be rotated only after the beeper sound is heard indicating the end of test cycle.
- 5.3.3 When measure the ball dent, a light cycle may be observed in the dent. This is a normal physical phenomenon and will not impact the measurement accuracy.
- 5.3.4 Test load shall not be applied when tester is in measurement mode. If a wrong key is depressed (other than EXIT key) the beeper will sound and other pages may appear on display. In such case just press OK/ESC key to return Home Page and the tested data will not be affected. If EXIT key is pressed by mistake, the tester will be shut down and unsaved data are lost.
- 5.3.5 When cursor is flashing at Dwell, Light, Change or Time on the Home Page, the tester is not in ready state to start test. Press OK/ESC key and wait for disappearance of the cursor, then the apparatus is ready for normal test operation.
- 5.3.6 Some slight clicks may be heard during loading/unloading. This is a normal phenomenon caused by the self adjustment of loading mechanism.
- 5.3.7 The two graduation lines in ocular lens shall be calibrated in the first measurement after start up. During the sequential tests no more calibration will be needed even if the test load or indenter is changed. This is a memory program designed in software package to facilitate the test operation which can keep only the current data, and the data will volatilize once power is cut off and shall be re-calibrated after next start up.
- 5.3.8 Data in memory is backed up by a lithium battery and may also be lost if the battery is used up. We suggest to transfer all data in the apparatus to an external device through the RS232 interface. After replacement of battery, the tester will

restore the Home Page by pressing SAVE key. However since no data is retrievable in the memory, you must carry out tests and save the data to enable the retrieve function of SAVE key.

- 5.4 The manufacturer is making continuous efforts to improve the quality and function of the apparatus and some design structures may be updated. Therefore trivial differences may exist between instruction manual and actual device, but these will cause no influence to the operation and functions in any way.

6. Working Principle of the Electric Parts

XHB-3000 Ball Hardness Tester employs a new loading procedure other than the conventional pendulum pressing loading. The new loading procedure uses a close loop control system, which is controlled by CPU, with a sensor to collect signal and a step motor for loading. PHILIPS P89C51RD2 is used as the CPU. AD 574 chip is used as AD converter, with a typical conversion time of 25 μ s and non-linearity of $\pm 1/2$ LSB.

BB company' s INA114AP is used as the algorithm amplifier.

The electric working principle can be described as following: Electronic signals are collected by LF-3T spoke type sensor and, after being amplified by INA114, output to AD574 for AD conversion. Then the analogue voltage signals are changed into the 12-digit signals and sent to CPU for computation processing and finally used to control the motor' s loading, dwell and unloading actions.

There are 10 grades of test load, namely 62.5, 100, 125, 87.5, 250, 500, 750, 1000, 1500, and 3000 kgf available for use in HBS-3000 Digital Ball Hardness Tester, the lower 5 grades (62.5~250 kgf) with a resolution of 0.1kgf, and the upper 5 grades (500~3000 kgf) with a resolution of 1 kgf, to ensure the test loading force more stable and reliable, The tester uses a Japan made DMF-50081 320x240 LCD as display, user may choose desirable test load and indenter on the display after start-up of the tester. Other data including D1 and D2 (dent diameter), HBW hardness and corresponding converted value are also shown on the display. After completion of the test cycle, the data may be output through RS232 serial interface into a PC' s Hypertrm terminal for display or printing out, or directly saved into CPU' s internal memory for permanent store.

There are two limitation positions for the ascending and descending movement of lifting screw respectively. A magnetic sensor base is installed at rear of the main lever (see Fig 6-1). Two proximity switches are installed on the right side near to the rear cover to control the initial position of main lever and the total stroke. Both proximity switches (A and B) are placed in adjacent positions near the switch A. After power on, the motor starts and lifts the lever whereby the switch A will receive signal from magnetic sensor and feed it to CPU. Thereafter the motor will stop at first and then rotate in counter direction for several turns to return the lever back to its original position.

Please do not change the position of proximity switches. Switch B is installed to form a lower limit for lever's movement, i.e. when the lever moves approaching to B switch during the loading period, the switch will stop the motor and cause it rotating in counter direction, thus to ensure the automatic unloading and return the lever to its original position.

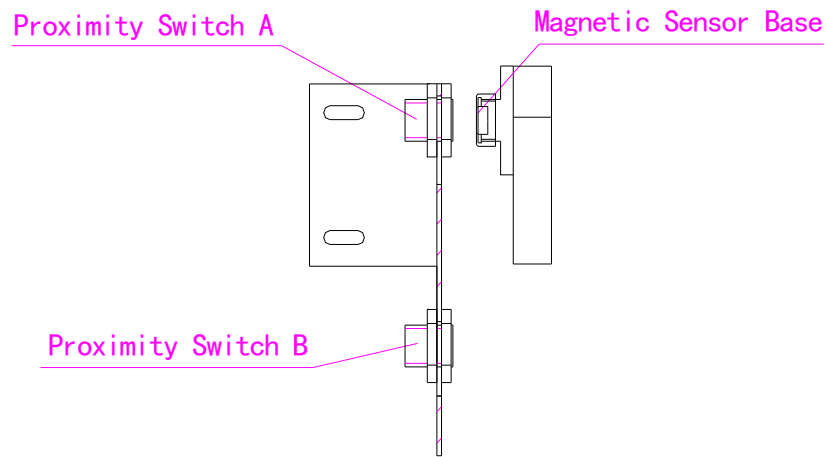


Fig (6-1)

In fact the circuit in XHB-3000 is a computer controlled close loop system, in which different types of digital signals (such as test load, displacement etc) are promptly processed, feedback and re-processed by the computer to ensure stable and reliable operation of the apparatus.

7. Packing List

Serial No.	Packing Box No.	Packing Box Size: 893x720x470	
1 Box Only		Gross Weight: 160kg	Net
Weight:130kg			

Accessories included:

ϕ 2.5、 ϕ 5、 ϕ 10mm ball indenter		1 for each diameter
Large, small and V-type test stock		1 for each type
Standard hardness block		1
HBW/3000/10	150~250	1
HBW/750/5	75~125	1
Fuse		3 (2A)
Power cord		1
Printer operation manual		1
Quality certificate		1

Instruction manual	1
20 ^x microscopic ocular lens	1
RS232 cord	1
Plastic dust-proof cover	1

Packing Date

Packing Inspector