Model No. 900-385 **Model No. 900-386**

Digital Rockwell Hardness Tester

Instruction Manual

phase II+
"The Source of Quality"

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1 General description

1.1 Scope of application

The Phase II multi-functional 900-385/900-386 hardness testers can be used directly to measure Rockwell and superficial Rockwell hardness and change those values of Rockwell hardness into HB, HV, HLD, HK and σ_b values.

Loaded with features such as ultra precise measurements, wide measuring range, automatic main test force loading/unloading, digitally displayed results, automatic printing, RS232/USB output, etc. the 900-385/6 is suitable for testing hardness on carbon steel, alloy steel, cast iron, non ferrous metal and engineering plastics. A perfect performer suited for any environment including heat treat facilities, tool rooms, workshops, laboratories and inspection labs.

1.2 Product features

- The indenter design is ideal for testing inside diameters and recesses, often impossible with more traditional hardness testers. Inside diameters as small as 1-1/2-inches can be tested with the standard indenter. Operators can test close to vertical surfaces, to within 1/4-inch with the standard indenter. Testing is fast, accurate and there are fewer broken diamonds due to an outstanding viewing area.
- Wide measurement range: 30 hardness scales in total, HRA, HRB, HRC, HRD, HRE, HRF, HRG, HRH, HRK, HRL, HRM, HRP, HRR, HRS, HRV, HR15N, HR30N, HR45N, HR15T, HR30T, HR45T, HR15W, HR30W, HR45W, HR15X, HR30X, HR45X, HR15Y, HR30Y and HR45Y.
- Auxiliary functions: The 900-385 is capable of upper and lower limit settings; data statistics, the computing for average value, standard deviation, maximum and minimum; scale conversion (the testing results can be converted into the values of HB, HV, HLD, HK and σ_b (strength); curved surface correction will automatically correct the measuring results for cylindrical surface and spherical surface.

2 Key performance parameters

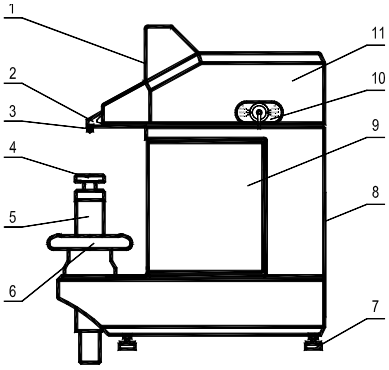
- Test resolution: 0.1HR Rockwell unit;
- Operation temperature: 50° - 95°F (10°C～35°C)
- Ambient environment: clean, no vibration, no strong magnetic field, and no corrosive medium;
- Power supply: single phase, AC, 1100V（can be changed as 220V, the original power supply is 110V）, 50～60Hz, 4A;
- Net weight: 120kg;
- Maximum dimension: 720mm×240mm×825mm.

3 Basic configuration and structure

3.1 Standard configuration

Base machine
Standard hardness block for A scale
Standard hardness block for B scale
Standard hardness block for C scale
Standard hardness block for 15N scale
Standard hardness block for 30N scale
Standard hardness block for 30T scale
Carbide ball indenter (1/16″)
Rockwell C 120°cone diamond indenter
Mounting screws for indenter
Round plane anvil
"V "shape anvil
Power supply wire
Screwdriver for indenter mounting
Dust cover

3.2 Structure schematic diagram



1- screen and keyboard **2-** indenter base **3**- indenter **4-** anvil **5-** leadscrew and protecting sleeve **6-** handwheel **7-** leveling feet **8-** switch and power panel **9-** side door **10-** handlever for load selection **11-** canopy

Figure 3.1

Included Indentors:

Rockwell B Indentor
1/16" Carbide Ball

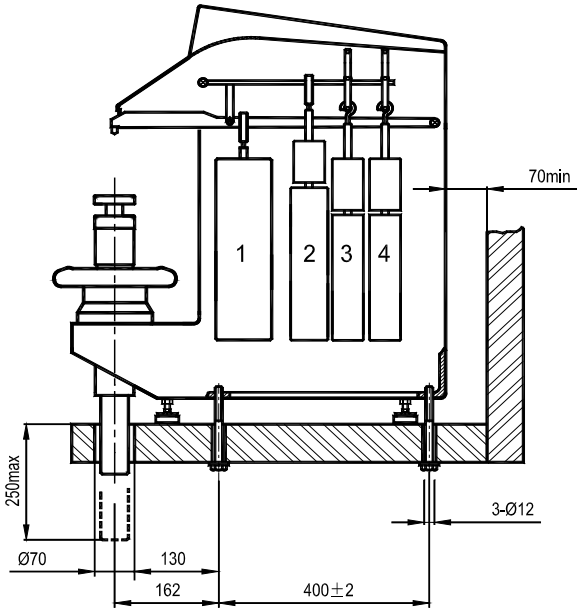
Rockwell C Indentor
Diamond

4 Installation and adjustment

4.1 Remove top cover of wood crate, then remove the three M10 screws from the underside of the base. Lift the machine very carefully from the bottom. Do not lift from the head, the side doors or other points any time. Remove all accessories and the weights that are attached to the baseboard by the straps. SAVE CRATE FOR FUTURE TRANSPORTATION NEEDS.

4.2 The machine should be mounted on a firm bench or table in a clean area, free from vibration or shock, recommended height 800mm. The machine can be positioned with its leadscrew overhanging the edge of the bench, otherwise a hole must be provided in the top of the bench to provide working clearance for the leadscrew. See diagram 4.1.

4.3 Place the tester on a prepared platform, turn the hand wheel counter-clockwise to lower the anvil, remove the anti vibration pad; then place a precise level on the anvil, adjust the leveling feet of tester to make the level within 1mm/m, then lock the nuts. It is recommended that the machine be secured to the top with three M10 bolts, screwed into the undersurface of the machine housing. Refers to figure 4.1.



Optional Cabinet/Support Stand

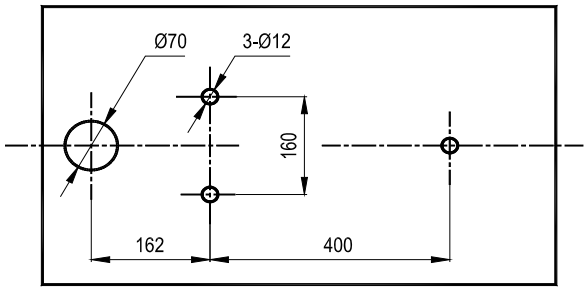
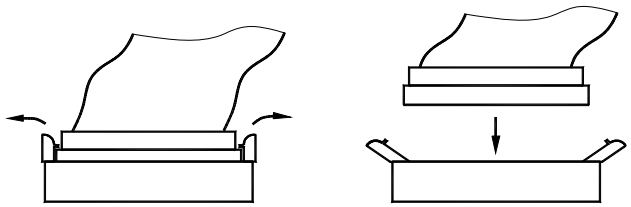


Figure 4.1

4.4 Remove the screw on top of the machine that holds the canopy; Slightly lift the canopy from front; remove the canopy after removing connecting cables out; remove all elastic packaging belts from lever.

Method of extracting and plugging cable is as figure 4.2. For extracting cable, part the barbs by exerting force on both sides, then the plug of cable will eject out. See figure 4.2.a; when plugging cable is necessary, force the plug downward directly. See figure 4.2.b.



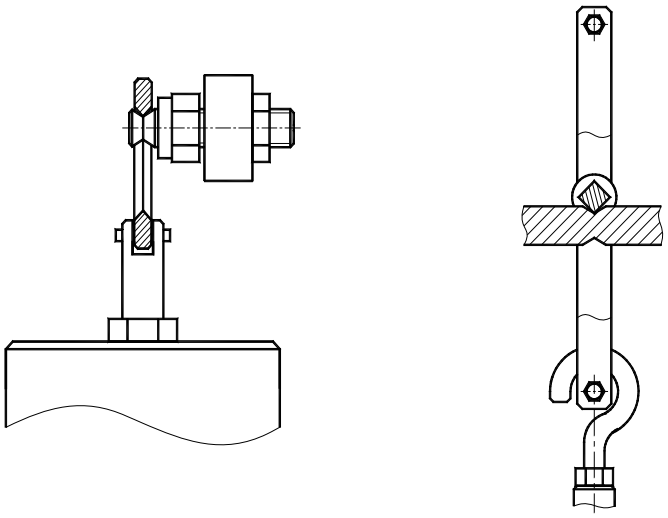
4.2.a 4.2.b

Figure 4.2

4.5 The tester has been provided with four weights in total with each being indentified with a number 1thru 4 (equates to hanging position) Weight #1 is a single weight design while 2,3,&4 are dual weight designs. For installation, open the side door of tester and set out to place weights in the following sequence: suspend weight No.1 at the corresponding suspending groove on lower lever; then place weights of No.4, No.3 and No.2 at the corresponding suspending grooves of upper lever. The suspending mode of No.1 and No.2 weight is shown in figure 4.3.a; the suspending mode of No.3 and No.4 weights is are shown in figure 4.3.b. Make sure the blade on weight bar is correctly placed in the V groove.

4.6 Correctly reconnect the cables pulled out in step 4.4; replace the canopy and tighten screw.

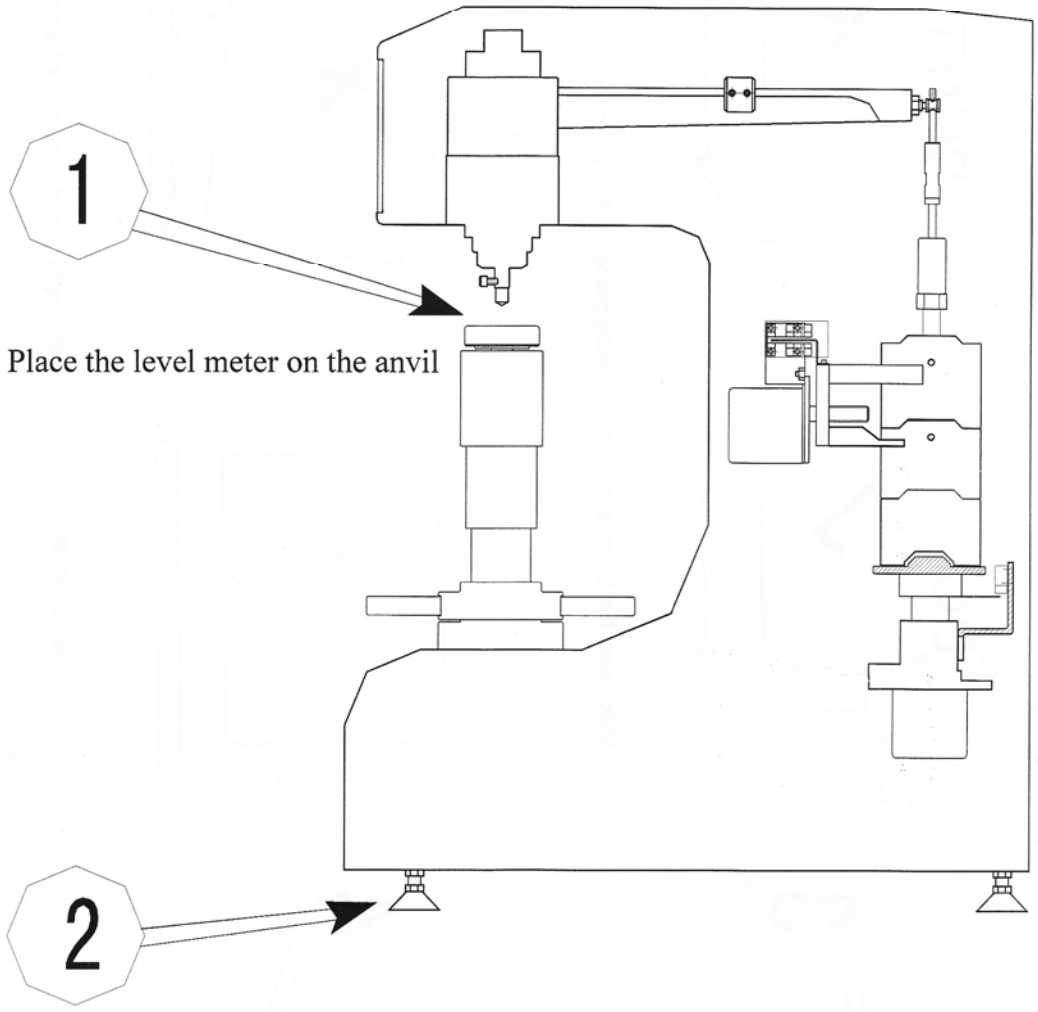
4.7 Connecting the power supply wire; select the power supply of 220V or 110V according to the local power condition. The power supply status when leaving factory is 110V.



4.3.a 4.3.b

Figure 4.3

VERY IMPORTANT!



Use adjustable feet to level the machine. Be sure to lock nuts when completed
Sturdy Cabinet/Stand shown below:

5 Operating methods

5.1 Testing preparation

Connect power supply and turn machine on. The 900-385 will perform a self check and relative information such as type, serial number of the tester, software version will be displayed on screen. Tester will come to main menu after self-checking; current (last used) test parameters will be displayed on screen. Figure 5.1.1 is the typical display of Rockwell C testing parameter; showing the current scale, indenter type, test force, load dwell, as well as current date and time.

Figure 5.1.1

When installing indenter, make sure the shank of the indentor is clean and free of oil, dust, etc.
Pay close attention to the display as it goes through self check since it will display the weight load, indentor and scale that has been set previously. Make sure they concur with your application.
The test can be immediately performed providing all parameters are set for your application. See method 5.3
The following procedures should be observed if modification of parameters are necessary.

5.2 Test parameters setting

Press "**Setup**" key, figure 5.2.1 will be showed on screen, the parameter setting is ready.

5.2.1 Scale selection

Press"⇧"or"⇩"key to move cursor to "1" in figure 5.2.1, press " ↵ " key ,then the cursor move to "HRC". Press "⇧"or"⇩"key at this time the optional 15 Rockwell scales HRC、HRA、HRB、HRD、HRE、HRF、HRG、HRH、HRK、HRL、HRM、HRP、HRR、HRS、HRV will be appear in sequence. When the desired scale appears as figure 5.2.2, press " ↵ "to finish the selection.
Prompt will be shown automatically on the screen to allow for scale and indentor changes.

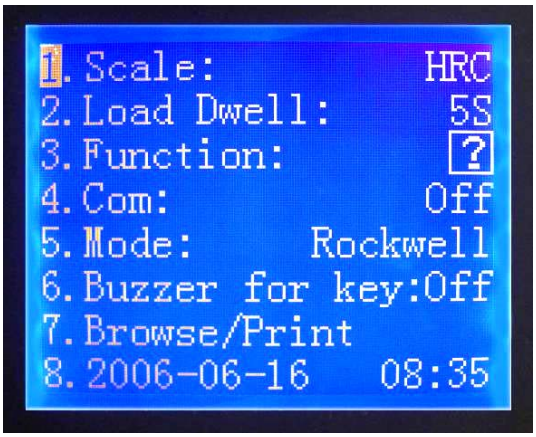


Figure 5.2.1

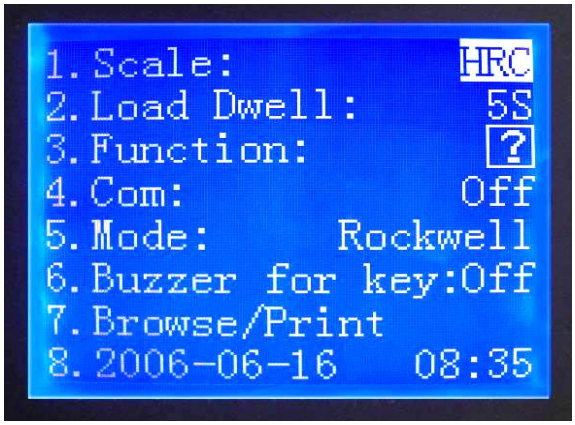


Figure 5.2.2

The selection of test force is automatically adjusted once you select your hardness scale. There are three test forces of 60kgf(588.4N), 100kgf(980.7N) and 150kgf(1471N) for Rockwell hardness measurement, and also three test forces of 15kgf(147.1N), 30kgf(294.2N) and 45kgf(441.3N) for Rockwell superficial hardness measurement. When selecting test force, the "R" identifications on left are applicable for Rockwell hardness measuring mode, and the "RS" identifications on right are applicable for Rockwell superficial hardness measuring mode.

Press "**Setup**" key to return to figure 5.1.1； or press "🡅"or"🡇"key to reset the other parameters.

5.2.2 Load Dwell Setting:

Load dwell refers to the duration of total test force (i.e. time of primary test force and main test force). For hard metals without the possibility of flex, creep or elastic recovery of test material dwell times should be set between 2-3 seconds. For materials that may exhibit slight flex or creep should set the dwell between 6-8 seconds. For material with obvious distortion with time after main test force has been loaded, the dwell time should be set between 20～25s.

Press "🡅"or"🡇"key to move cursor to "2" in figure 5.2.1, press " ↵ " key ,then the cursor move to "5S"as figure 5.2.4. Press "🡅"or"🡇"key at this time to select the dwell time range from 2s～50s,then press " ↵ "to finish the setting.

Press "**Setup**" key to return to figure 5.1.1； or press "🡅"or"🡇"key to reset the other parameters.

Figure 5.2.4

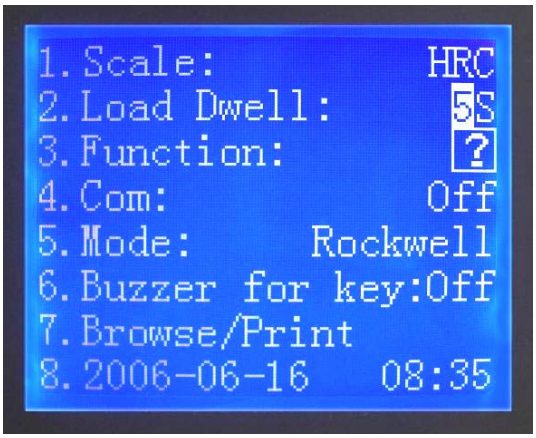
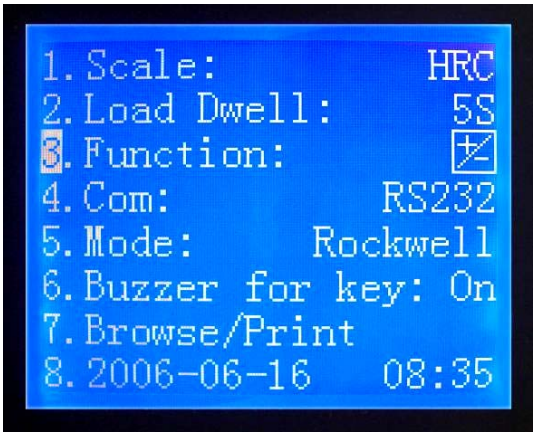


Figure 5.2.5



5.2.3Auxiliary functions

The tester has four auxiliary functions, which can be used individually, multi selected or all selected. Press "↑"or"↓"key to move cursor to "3" in figure 5.2.1, press "↵" key ,then the cursor move to the position of "±" and change to "?" as figure 5.2.5. Press "↑" or"↓" key at this time to select the desired auxiliary functions, then press "↵"to conform and into next menu as 5.2.6~5.2.10. There four auxiliary functions marked as "±、Σ、▥、⌀", which represent limit setting, data statistics, scale conversion and curved surface correcting respectively.

5.2.3.1 Limit setting

Press "↑" or "↓" key to reset the value of upper limit and the value of lower limit in the figure5.2.6, then press "↵" to confirm.

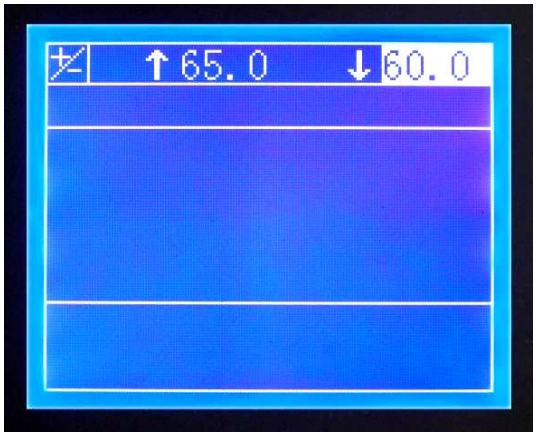


Figure 5.2.6

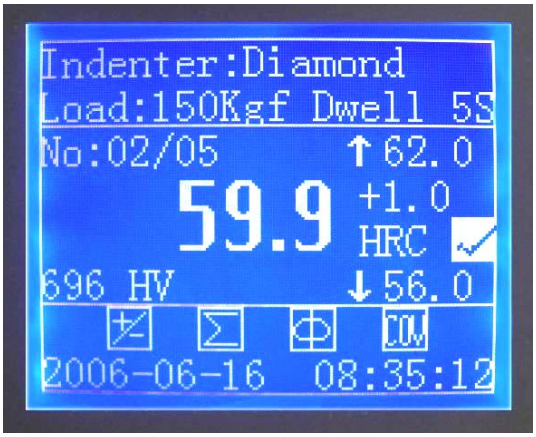


Figure 5.2.7

The upper limit and lower limit will be shown simultaneously with the display of measured results each time after the function setting has taken effect. As figure 5.2.7, the testing result is 59.9HRC, upper limit is set as 62.0HRC, lower limit is 56.0HRC. If the result is beyond the set limits, the machine will simultaneously show on display and produce a buzzer sound.

5.2.3.2 Data statistics

The statistics for one group of data is possible by pressing "↑" or "↓" key to determine the value of N (the applicable scope is 2～99) in figure5.2.8; then press"↵" to confirm.

The values of serial number n and N will be shown simultaneously with the display of measured result each time after the function setting has taken effect. Refer to figure 5.2.7, 5 measurements will be performed completely, and the current measurement is the 2nd. In case of n=N, that is to say the last measurement had been completed, the tester will automatically calculate the average $\overline{X}$, standard deviation S, maximum (Max), minimum (Min) and the range R as figure 5.2.9 showing after the hand wheel had been unloaded by turning counter-clockwise.

The mean value, standard deviation and range can be calculated according to the following equation.

$$\overline{X}=\frac{1}{N}\sum X_i \ ,$$

$$S=\sqrt{\frac{1}{N-1}\sum(\overline{X}-X_i)^2} \qquad R=Max-Min$$

Normally, the serial number will increase 1 after each measurement until the n is equal to N (i.e. all of the N measurements were completed), then begin with statistical calculation. In event of an erroneous result, press "⬆" or "⬇" key in the

figure 5.2.7 when the "√" change to "×", then unload (i.e. Lowdown the anvil). For this condition, n will not be added by 1, and the current measurement will not take part in the statistical calculation.

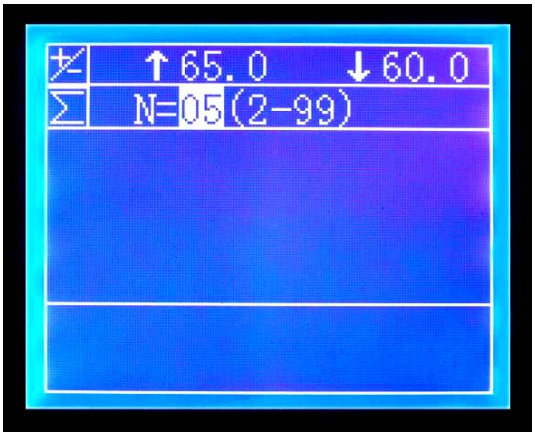


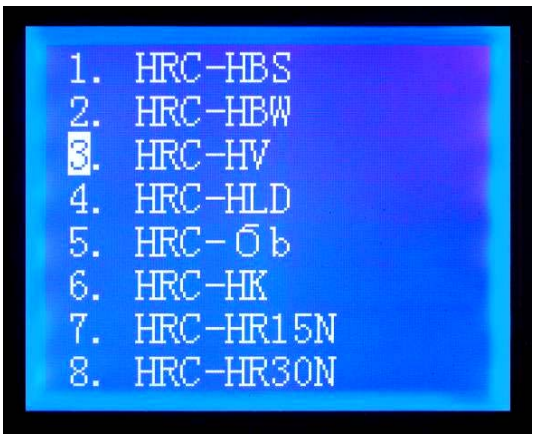
Figure 5.2.8

Figure 5.2.9

5.2.3.3 Scale conversion

This function allows the user to convert the measured Rockwell hardness value to other scales or even tensile strength. In the Rockwell measurement mode, the following functions can be attained: changing the value of HRA scale into HBS, HBW, HV and HK value; changing the value of HRB scale into HB10, HB30, HV, HLD, σ_b and HK value; changing the value of HRC scale into HBS, HBW, HV, HLD, σ_b and HK value; changing the value of HRD scale into HV, HK, HB value; changing the value of HRE scale into HV, HK, HB value; changing the value of HRF scale into HV, HB value. In the Rockwell superficial measurement mode, following function can be realized: respectively changing the value of HR15N, HR30N, HR 45N, HR15T, HR30T and HR45T scale into HV, HB, σ_b and HK value. For instance, if we intend to convert the HRC value to HV value, press "⬆"or"⬇"key to move the cursor to "3. HRC—HV" in figure 5.2.10, and then press " ↵ " to confirm.

Once this function has been set, the conversion value will be shown simultaneously with the test results each time. As figure 5.2.7, the hardness value measured is 59.9HRC, conversion value is 696HV. Each change is performed within the applicable scope when a conversion is possible; "E" will be shown on the display if the conversion is not possible.



5.2.3.4 Curved surface correcting

The testing results should be corrected if the surface of sample measured is the external surface of cylindrical or spherical part. Press "▲"or"▼" key to select cylindrical surface or spherical surface, then press " ↵ " to confirm as figure 5.2.11.
After that, press "▲"or"▼"key to determine curvature radius or the diameter of sphere, and press " ↵ " to confirm.

The measuring result as well as the correction value will be given in the course of each measurement. Note: screen will display respectively testing value (the direct testing result without correction) and correction value. As figure 5.2.7, the measuring result is 59.9HRC and the correcting value is "+1.0" HRC.

5.2.3.5 Press "**Setup**" key to return to figure 5.1.1； or press "▲"or"▼"key to reset the other parameters.

5.2.4 Communication status setting

The tester is provided with series digital communication port RS232 (transmission rate 9600bps), which can be connected with printer or external computer. After setting, test results can be printed in real time or sent to external computer.
Press "▲"or"▼"key to move cursor to "4" in figure 5.2.1, press " ↵ " key then the cursor move to "Printer". Press "▲" or "▼" key at this time, the options "Printer"、"RS232"、"USB"、"Off" will be appear in sequence. When the desired optional appears, as figure 5.2.12, press " ↵ "to finish the selection.
Press "**Setup**" key to return to figure 5.1.1； or press "▲"or"▼"key to reset the other parameters.

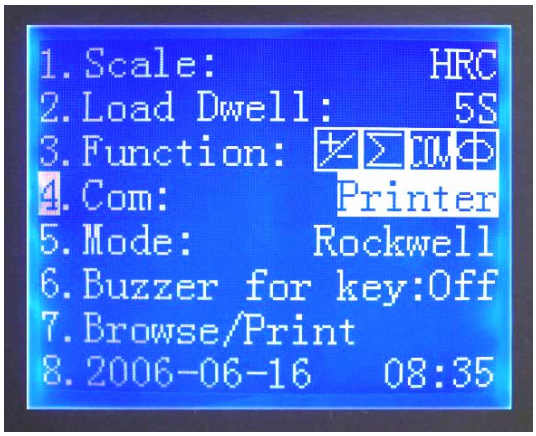


Figure 5.2.12

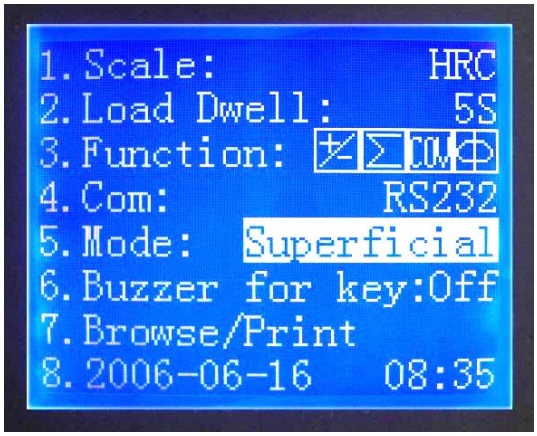


Figure 5.2.13

5.2.5 Mode selection of Rockwell or Rockwell Superficial

The tester was provided with two modes of Rockwell measuring and Rockwell superficial measuring. Press "↑"or"↓"key to move cursor to "5" in figure 5.2.1, then press " ↵ " key, the cursor move to "Rockwell". Press "↑"or"↓"key to select the measuring mode as figure 5.2.13, and press " ↵ " key to confirm. The tester will changeover automatically.
Press "**Setup**" key to return to figure 5.1.1； or press "↑"or"↓"key to reset the other parameters.

5.2.6 Buzzer for key

Press "↑"or"↓"key to move cursor to "6" in figure 5.2.1, press " ↵ " key, then the cursor move to "On". Press "↑"or"↓"key to select the "On" or "Off" for the key buzzer, press " ↵ " key to confirm.
Press "**Setup**" key to return to figure 5.1.1； or press "↑"or"↓"key to reset the other parameters.

5.2.7 Browse through/printing memory

Press "↑"or"↓" key to move cursor to "7" in figure 5.2.1, then press " ↵ " key. The latest 8 test results will display on the screen as figure 5.2.14. The serial number and time of the test are displayed simultaneously. The 900-385 has a maximum memory for 500 test results. Press "↑"or"↓" key to scroll the items. The item of record which the cursor pointed can be printed by press " ↵ " key.
Press "**Setup**" key to return to figure 5.1.1； or press "↑"or"↓"key to reset the other parameters.

5.2.8 Time setting

Press "↑" or "↓" key to move cursor to "8" in figure 5.2.1, press " ↵ " key, figure5.2.15 appears. Press "↑" or "↓" key to move cursor to "1" in figure 5.2.15, then press " ↵ " key, press "↑" or "↓" to select the year, and press " ↵ "key to confirm.
The month , also the date, hour, minute and second can be reset in the same way.
Press "**Setup**" key to return to figure 5.1.1； or press "↑"or"↓"key to reset the other parameters.

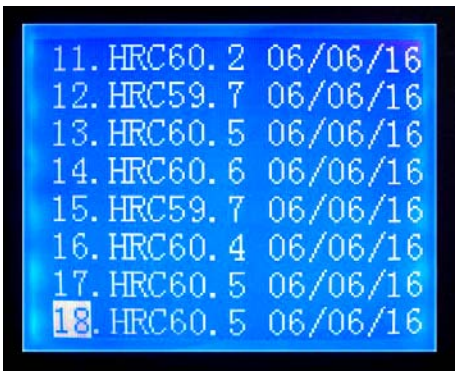


Figure 5.2.14

Figure 5.2.15

5.3 Testing

5.3.1 The preload loading

Place the sample to be tested on the anvil, and rotate the hand wheel clockwise to lift the anvil as figure 5.3.1, showing the anvil moving course. Rotate the hand wheel smoothly until the anvil in figure reaches the end position as figure 5.3.2. Immediately stop rotating once buzzer sounds. This indicates that the automatic brake has locked the machine so it can begin performing the test.

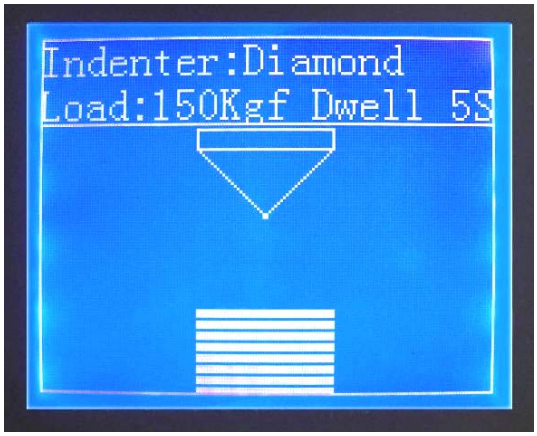


Figure 5.3.1

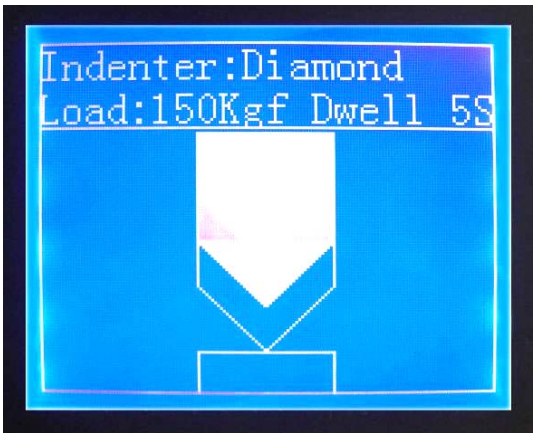
Figure 5.3.2

5.3.2 Automatic testing

After the completion of loading primary test force, test will be performed automatically as follows: loading main test force, as figure 5.3.3; holding with dwell time counting down after loading, refer to figure 5.3.4. Finally, unloading is performed immediately when the dwell time has finished. Test results will be showed on screen, refer to figure 5.2.7.

5.3.3 Unloading

Rotate the hand wheel counter-clockwise to lower the anvil, and the test force will be unloaded completely; the screen returns to figure 5.1.1, and all test parameters are stored for the next testing.



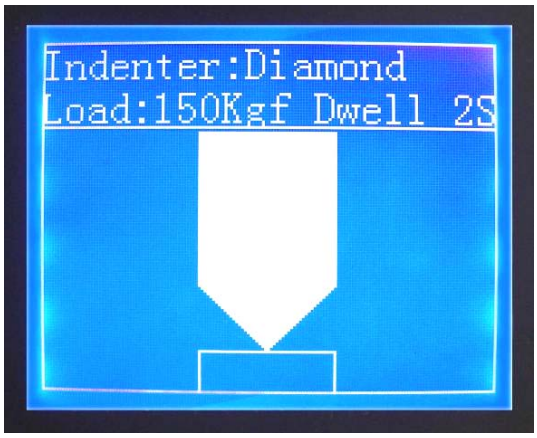


Figure 5.3.3

Figure 5.3.4

5.4 Shut down

Remove the test force completely, and switch off the power supply. Remove power cord if machine is to be idle for an extended period of time

6 Maintenance and attentions

6.1 When transporting the hardness tester, the weights and the indenter must be removed, and a shockproof rubber pad must be put between the indenter “nose” and the anvil. If it is to be transported for a long distance, the original packaging should be used.

6.2 When performing any adjustments and examinations such as loading/unloading weight, removing canopy, plugging/ extracting cables or opening the side door for inspection, the power supply should be cut off.

6.3 The changing of test force while the indenter is contacting sample for measurement.

6.4 When changing the indenter, pay close attention to ensure the tip avoids damage and contamination, and the mounting surface should be clean without any oil, dust, dirt, etc The indenter should be removed and stored carefully in the carry case if idle for a long term; In that case, rust protection measures are necessary.

6.5 The surface of anvil and standard hardness block should be clean without any scratches, scoring and bruising; When stored for an extended period of time, these should be lightly oiled to prevent rust.

6.6 Tested specimen must be placed flat on the anvil and supported properly to prevent any displacement or distortion during the test.

6.7 Dustproof and corrosive medium prevention should be considered in its daily operating environment. Regular rust prevention measures should be adopted in humid areas.

6.8 The leadscrew of the anvil should be lubricated periodically. Remove the anvil and lower leadscrew cover. Lower leadscrew to lowest point. Apply a few drops of light machine oil, then run the leadscrew up and down a few times to distribute the oil. Finally, refit the leadscrew dustcover.

6.9 The regular verification and calibration of hardness tester should be performed according to the relevant standards.

6.10 Please don’t disassemble or adjust any fixed parts as this will cause the warranty to be void.

Approximate Hardness Conversion Numbers for Non-Austenitic Steels

(Rockwell C Hardness Range)[A]

	Brinell Hardness Number[C]				Rockwell		Superficial Rockwell Number			
Rockwell C 150kgf (HRC)	Vickers (HV)	10-mm Standard ball 3000kgf (HBS)	10-mm Carbide ball 3000kgf (HBW)	Knoop 500-gf and Over (HK)	A Scale 60 kgf (HRA)	D Scale 100kgf (HRD)	15-N Scale 15-kgf (HR15N)	30-N Scale 30-kgf (HR30N)	45-N Scale 45-kgf (HR45N)	Scleroscope Hardness[B]
68	940	...	...	920	85.6	76.9	93.2	84.4	75.4	97.3
67	900	...	...	895	85.0	76.1	92.9	83.6	74.2	95.0
66	865	...	...	870	84.5	75.4	92.5	82.8	73.3	92.7
65	832	...	(739)	846	83.9	74.5	92.2	81.9	72.0	90.6
64	800	...	(722)	822	83.4	73.8	91.8	81.1	71.0	88.5
63	772	...	(705)	799	82.8	73.0	91.4	80.1	69.9	86.5
62	746	...	(688)	776	82.3	72.2	91.1	79.3	68.8	84.5
61	720	...	(670)	754	81.8	71.5	90.7	78.4	67.7	82.6
60	697	...	(654)	732	81.2	70.7	90.2	77.5	66.6	80.8
59	674	...	634	710	80.7	69.9	89.8	76.6	65.5	79.0
58	653	...	615	690	80.1	69.2	89.3	75.7	64.3	77.3
57	633	...	595	670	79.6	68.5	88.9	74.8	63.2	75.6
56	613	...	577	650	79.0	67.7	88.3	73.9	62.0	74.0
55	595	...	560	630	78.5	66.9	87.9	73.0	60.9	72.4
54	577	...	543	612	78.0	66.1	87.4	72.0	59.8	70.9
53	560	...	525	594	77.4	65.4	86.9	71.2	58.6	69.4
52	544	(500)	512	576	76.8	64.6	86.4	70.2	57.4	67.9
51	528	(487)	496	558	76.3	63.8	85.9	69.4	56.1	66.5
50	513	(475)	481	542	75.9	63.1	85.5	68.5	55.0	65.1
49	498	(464)	469	526	75.2	62.1	85.0	67.6	53.8	63.7
48	484	451	455	510	74.7	61.4	84.5	66.7	52.5	62.4
47	471	442	443	495	74.1	60.8	83.9	65.8	51.4	61.1
46	458	432	432	480	73.6	60.0	83.5	64.8	50.3	59.8
45	446	421	421	466	73.1	59.2	83.0	64.0	49.0	58.5
44	434	409	409	452	72.5	58.5	82.5	63.1	47.8	57.3
43	423	400	400	438	72.0	57.7	82.0	62.2	46.7	56.1
42	412	390	390	426	71.5	56.9	81.5	61.3	45.5	54.9
41	402	381	381	414	70.9	56.2	80.9	60.4	44.3	53.7
40	392	371	371	402	70.4	55.4	80.4	59.5	43.1	52.6
39	382	362	362	391	69.9	54.6	79.9	58.6	41.9	51.5
38	372	353	353	380	69.4	53.8	79.4	57.7	40.8	50.4
37	363	344	344	370	68.9	53.1	78.8	56.8	39.6	49.3
36	354	336	336	360	68.4	52.3	78.3	55.9	38.4	48.2
35	345	327	327	351	67.9	51.5	77.7	55.0	37.2	47.1
34	336	319	319	342	67.4	50.8	77.2	54.2	36.1	46.1
33	327	311	311	334	66.8	50.0	76.6	53.3	34.9	45.1
32	318	301	301	326	66.3	49.2	76.1	52.1	33.7	44.1
31	310	294	294	318	65.8	48.4	75.6	51.3	32.5	43.1
30	302	286	286	311	65.3	47.7	75.0	50.4	31.3	42.2
29	294	279	279	304	64.8	47.0	74.5	49.5	30.1	41.3
28	286	271	271	297	64.3	46.1	73.9	48.6	28.9	40.4
27	279	264	264	290	63.8	45.2	73.3	47.7	27.8	39.5
26	272	258	258	284	63.3	44.6	72.8	46.8	26.7	38.7

Approximate Hardness Conversion Numbers for Non-Austenitic Steels

(Rockwell B Hardness Range)[A]

Rockwell					Superficial Rockwell Number			
Rockwell B 100kgf (HRB)	Vickers (HV)	10-mm Standard ball 3000kgf (HBS)	Knoop 500-gf and Over (HK)	A Scale 60 kgf (HRA)	F Scale 60kgf (HRF)	15-T Scale 15-kgf (HR15T)	30-T Scale 30-kgf (HR30T)	45-T Scale 45-kgf (HR45T)
100	240	240	251	61.5	...	93.1	83.1	72.9
99	234	234	246	60.9	...	92.8	82.5	71.9
98	228	228	241	60.2	...	92.5	81.8	70.9
97	222	222	236	59.5	...	92.1	81.1	69.9
96	216	216	231	58.9	...	91.8	80.4	68.9
95	210	210	226	58.3	...	91.5	79.8	67.9
94	205	205	221	57.6	...	91.2	79.1	66.9
93	200	200	216	57.0	...	90.8	78.4	65.9
92	195	195	211	56.4	...	90.5	77.8	64.8
91	190	190	206	55.8	...	90.2	77.1	63.8
90	185	185	201	55.2	...	89.9	76.4	62.8
89	180	180	196	54.6	...	89.5	75.8	61.8
88	176	176	192	54.0	...	89.2	75.1	60.8
87	172	172	188	53.4	...	88.9	74.4	59.8
86	169	169	184	52.8	...	88.6	73.8	58.8
85	165	165	180	52.3	...	88.2	73.1	57.8
84	162	162	176	51.7	...	87.9	72.4	56.8
83	159	159	173	51.1	...	87.6	71.8	55.8
82	156	156	170	50.6	...	87.3	71.1	54.8
81	153	153	167	50.0	...	86.9	70.4	53.8
80	150	150	164	49.5	...	86.6	69.7	52.8
79	147	147	161	48.9	...	86.3	69.1	51.8
78	144	144	158	48.4	...	86.0	68.4	50.8
77	141	141	155	47.9	...	85.6	67.7	49.8
76	139	139	152	47.3	...	85.3	67.1	48.8
75	137	137	150	46.8	99.6	85.0	66.4	47.8
74	135	135	147	46.3	99.1	84.7	65.7	46.8
73	132	132	145	45.8	98.5	84.3	65.1	45.8
72	130	130	143	45.3	98.0	84.0	64.4	44.8
71	127	127	141	44.8	97.4	83.7	63.7	43.8
70	125	125	139	44.3	96.8	83.4	63.1	42.8
69	123	123	137	43.8	96.2	83.0	62.4	41.8
68	121	121	135	43.3	95.6	82.7	61.7	40.8
67	119	119	131	42.8	95.1	82.4	61.0	39.8
66	117	117	129	42.3	94.5	82.1	60.4	38.7
65	116	116	127	41.8	93.9	81.8	59.7	37.7
64	114	114	125	40.9	93.4	81.4	59.0	36.7
63	112	112	124	40.4	92.8	81.1	58.4	35.7

Approximate Leeb (Type D) Hardness Conversion for Non-Austenitic Steels (Rockwell C Hardness Range)[A]

Leeb Hardness, Type D Impact Device (HLD)	Rockwell C Hardness 150kgf (HRC)	Vickers Hardness (HV 10)	Brinell Hardness 10mm Steel Ball 3000kgf (HBS)
828	62	762	(721)
819	61	737	(699)
809	60	711	(675)
800	59	688	(654)
791	58	667	634
782	57	645	614
773	56	625	595
764	55	605	577
755	54	586	559
746	53	568	542
737	52	550	526
729	51	534	511
720	50	517	496
712	49	503	482
703	48	487	467
695	47	473	455
687	46	460	442
679	45	447	430
671	44	434	418
663	43	422	407
655	42	410	395
647	41	398	385
640	40	388	375
632	39	377	365
625	38	368	356
618	37	358	347
611	36	349	338
603	35	339	328
596	34	330	320
590	33	323	313
583	32	314	305
576	31	306	297
570	30	299	291
563	29	291	283
557	28	284	276
551	27	277	270
545	26	271	264
539	25	264	258
533	24	258	252
527	23	251	246
521	22	245	240
516	21	240	235
510	20	234	229

Weight - Load - Indentor Chart

Scale Symbol	Indentor Type	Preliminary Force N (kgf)	Total Force N (kgf)	Typical Applications
A	Spheroconical Diamond	98.07 (10)	588.4 (60)	Cemented carbides, thin steel, and shallow case hardened steel
B	1/16" Carbide Ball	98.07 (10)	980.7 (100)	Copper alloys, soft steels, aluminum alloys, malleable iron, etc.
C	Spheroconical Diamond	98.07 (10)	1471 (150)	Steel, hard cast irons, pearlitic malleable iron, titanium, deep case hardened steel, other harder than HRB 100
D	Spheroconical Diamond	98.07 (10)	980.7 (100)	Thin steel and medium case hardened steel, and pearlitic malleable iron
E	1/8" Carbide Ball	98.07 (10)	980.7 (100)	Cast Iron, Aluminum and magnesium alloys, and bearing metals
F	1/16" Carbide Ball	98.07 (10)	588.4 (60)	Annealed copper alloys and thin soft sheet metals
G	1/16" Carbide Ball	98.07 (10)	1471 (150)	Malleable irons, copper-nickel-zinc and cupro-nickel alloys
H	1/8" Carbide Ball	98.07 (10)	588.4 (60)	Aluminum, zinc and lead
K	1/8" Carbide Ball	98.07 (10)	1471 (150)	Bearing Metals and other very soft or thin materials. Use smallest ball and heaviest load that doesn't give anvil effect.
L	¼" Carbide Ball	98.07 (10)	588.4 (60)	
M	¼" Carbide Ball	98.07 (10)	980.7 (100)	
P	¼" Carbide Ball	98.07 (10)	1471 (150)	
R	½" Carbide Ball	98.07 (10)	588.4 (60)	
S	½" Carbide ball	98.07 (10)	980.7 (100)	
V	½" Carbide ball	98.07 (10)	1471 (150)	
15N	Spheroconical Diamond	29.42 (3)	147.1 (15)	Similar to A, C and D scales but for thinner gage material.
30N	Spheroconical Diamond	29.42 (3)	294.2 (30)	
45N	Spheroconical Diamond	29.42 (3)	441.3 (45)	
15T	1/16" Carbide Ball	29.42 (3)	147.1 (15)	Similar to B, F and G scales but for thinner gage material.
30T	1/16" Carbide Ball	29.42 (3)	294.2 (30)	
45T	1/16" Carbide Ball	29.42 (3)	441.3 (45)	
15W	1/8" Carbide Ball	29.42 (3)	147.1 (15)	Very Soft Material
30W	1/8" Carbide Ball	29.42 (3)	294.2 (30)	
45W	1/8" Carbide Ball	29.42 (3)	441.3 (45)	
15X	¼" Carbide Ball	29.42 (3)	147.1 (15)	
30X	¼" Carbide Ball	29.42 (3)	294.2 (30)	
45X	¼" Carbide Ball	29.42 (3)	441.3 (45)	
15Y	½" Carbide Ball	29.42 (3)	147.1 (15)	
30Y	½" Carbide Ball	29.42 (3)	294.2 (30)	
45Y	½" Carbide Ball	29.42 (3)	441.3 (45)	

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

Diameter of Convex Cylindrical Surfaces

Hardness Reading	¼" 6.4mm	3/8" 10mm	½" 13mm	5/8" 16mm	¾" 19mm	7/8" 22mm	1" 25mm	1-1/4" 32mm	1-1/2" 38mm
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

Diameter of Convex Cylindrical Surfaces

Hardness Reading	¼" 6.4mm	3/8" 10mm	½" 13mm	5/8" 16mm	¾" 19mm	7/8" 22mm	1" 25mm
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

Minimum Thickness Requirements

Minimum allowable thickness for a corresponding hardness in the respective scales

Minimum Thickness Inch	Minimum Thickness mm	Rockwell C	Rockwell A	Rockwell B	Superficial 15N	Superficial 30N	Superficial 45N	Superficial 15T	Superficial 30T	Superficial 45T
0.006	0.15	...	...	...	...	...	...	...	...	...
0.008	0.20	...	...	...	92	...	...	...	...	...
0.010	0.25	...	...	...	90	...	...	91	...	...
0.012	0.30	...	...	...	88	82	77	86	...	...
0.014	0.36	...	...	...	83	78.5	74	81	80	...
0.016	0.41	...	86	...	76	74	72	75	72	71
0.018	0.46	...	84	...	68	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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