900-348 Digital Superficial Rockwell Hardness Tester

Instruction Manual

"The Source of Quality"

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Contents

1 General description

The 900-348 Rockwell Superficial hardness tester can be used directly to measure Rockwell Superficial hardness, and has the capabilities to convert those readings into HRB, HB, HV, HK and σ_b values. Loaded with many useful features such as ultra precise results, wide measuring range, automatic test force change according the scale selection, automatic main test force loading/unloading, high resolution digital display, automatic printing, and USB Output to print to PC. The 900-348 is suitable for testing hardness of carbon steel, alloy steel, cast iron, non ferrous metals and engineering plastics.

The tester adheres to the following standards: ASTM E18, ISO 6508-2, and BS EN ISO6508-2.

2 Key performance parameters

- Preload： 3kgf（29.4N）

  Total test force： 15kgf (147.1 N), 30kgf (294.3N), 45kgf (441.3 N)
- Scales： HR15N, HR30N, HR45N, HR15T, HR30T, HR45T, HR15W, HR30W, HR45W, HR15X, HR30X, HR45X, HR15Y, HR30Y, HR45Y
- Load cycle： 3～8s
- Load dwell duration： 2～50s
- Resolution ： 0.1HR
- Display：High definition LCD w/Backlight
- Operation：Menu selectable, Membrane keypad
- Auxiliary functions：Upper/lower limits setting& alarming, Data statistics, Avg., Max., Min., S, R, Scale conversion, HRB, HV, HB, HK, σ_b, Curved surface Auto Correct
- Data output: USB data output to PC, Integrated printer
- Memory: Max 500 items of test results stored automatically
- Testing space：200mm in vertical, 165mm in horizontal
- Dimensions： 550mm×200mm×720mm
- Power supply: single phase, AC, 110V, 50～60Hz, 4A
- Net weight：85kg

Optional Cabinet/Support Stand

3 Basic configuration and structure

3.1 Standard configuration

Base machine	1
1/16″ Carbide ball indenter	1
120° cone diamond indenter	1
Mounting screws for indenter	2
Flat anvil	1
“V ”shape anvil	1
Power supply wire	1
Screwdriver for indenter mounting	1
Screwdriver	1
Dust cover	1
USB cable	1

3.2 Structure schematic diagram

1- screen and keyboard

2- indenter

3- anvil

4- leadscrew and protecting sleeve

5- handwheel

6- weights(in the tester)

7- switch and power panel

8- printer

Figure 3.1

IMPORTANT!

Do Not Discard Shipping Crate as This May be Needed for Future Transportation.

4 Installation and adjustment

4.1 Remove wood crate top by removing 1-each bolt from bottom left and right side of crate and lifting up crate, then remove the three M10 screws from the underside of the base. Lift the machine very carefully from the bottom. Remove the tool kit containing the weights and other accessories.

4.2 The machine should be mounted on a firm bench or table in a clean area, free from vibration or shock, recommended height is 30". A hole must be drilled in the top of the work bench to allow maximum travel of lead screw. Refer to figure 4.1.

4.3 Place the tester on the prepared bench, turn the hand wheel counter-clockwise to lower the anvil, remove the anti vibration pad; then place a flat anvil in the lead screw and place a level with the precision of 0.2mm/m on the anvil, adjust the leveling feet of tester to make it level within +/- 1mm/m, then lock the nuts. **Note: This is very important. The load change will be affected if the machine is not leveled properly**

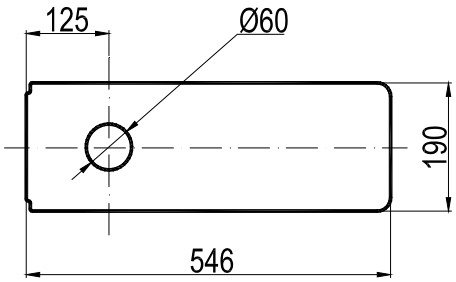
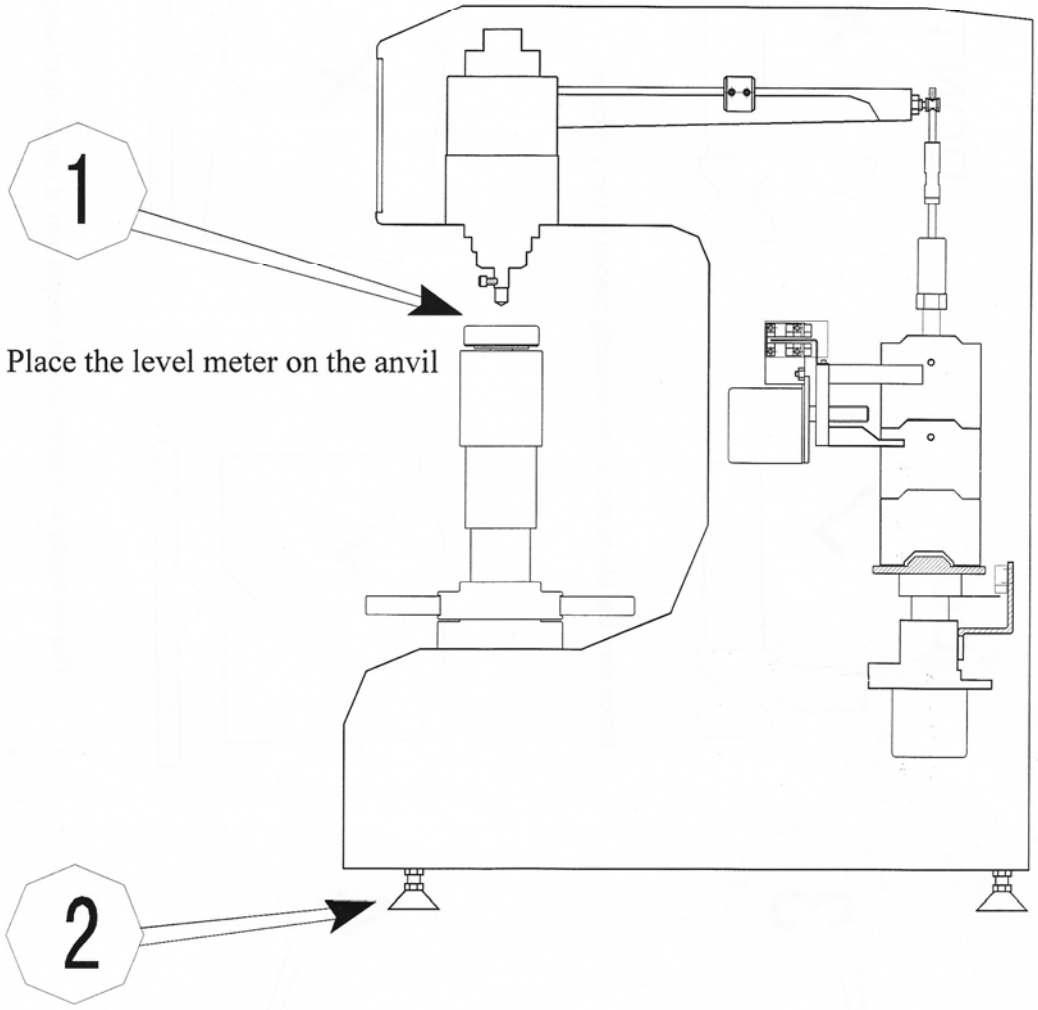


Figure 4.1

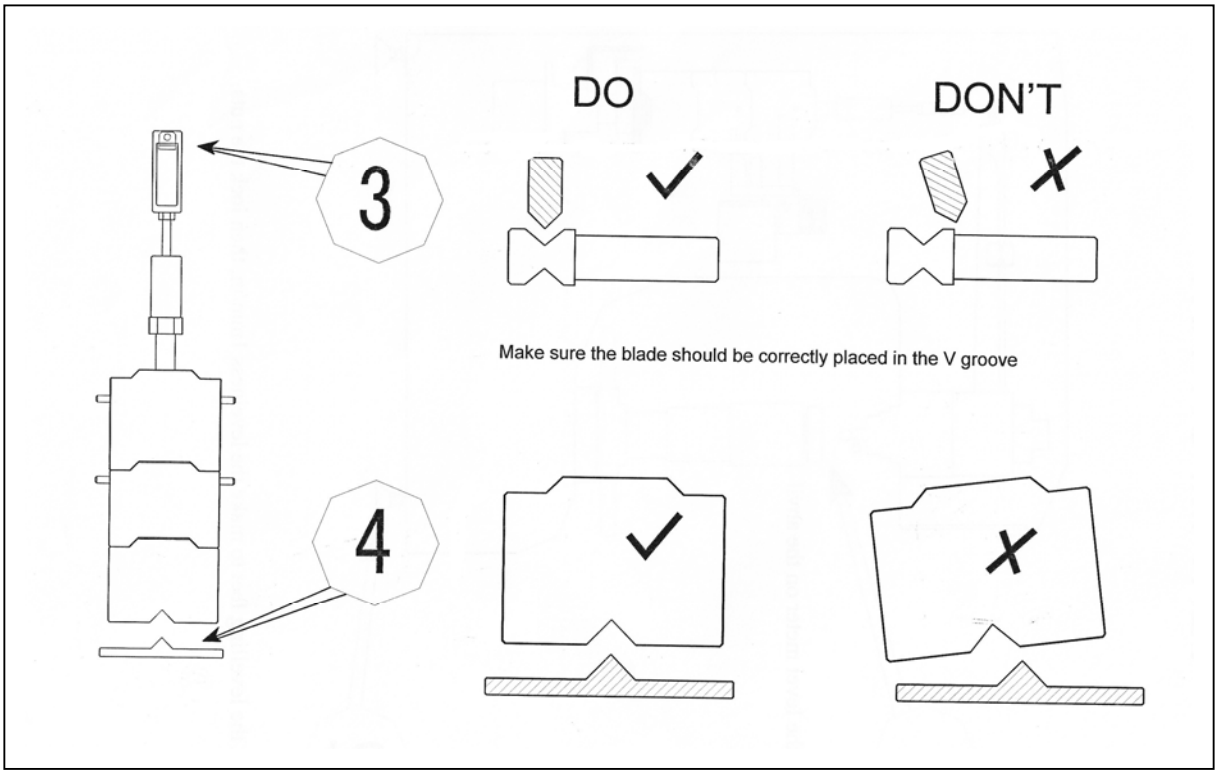
4.4 For installation, open the upper cover and back cover of tester, then remove all the packing materials and suspending weight at the V groove of the lever. Make sure the blade should be correctly placed in the V groove.

4.5 Reinstall the upper and back cover and connecting the power supply wire.

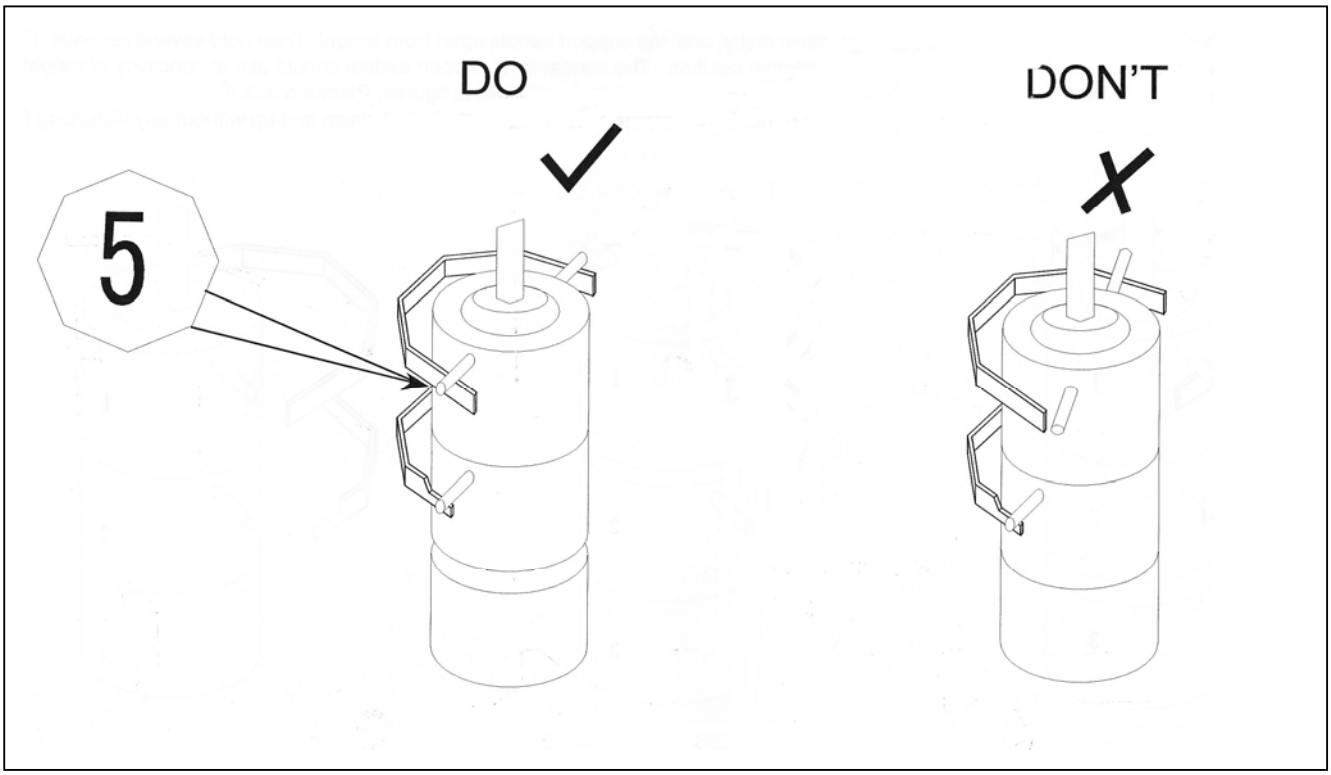
VERY IMPORTANT !



Use adjustable feet to level the machine. Be sure to lock nuts when



The weights must sit flush in the groove of the support saddle



5 Operating methods

5.1 Testing preparation

Power on the machine and then the tester will begin an automatic self check. The relative information such as type, series number, software version will be displayed on screen. Tester will come to main menu after self-checking; current test parameters will be displayed on screen, and the status at the previous test will be automatically stored. Figure 5.1.1 is a typical status of Rockwell testing parameter; showing the current scale, indenter type should be selected according to the current scale, test force, load dwell duration, as well as current time.

Figure 5.1.1

When selecting a particular scale, pay attention to the Indentor that is shown on the display. If the display shows Diamond as above, then you must install the supplied Diamond Indentor in the machine. When installing indenter, make sure the surface of the diamond shank is clean. Install diamond and tighten set screw.

The test force selection is automatically done by the machine once a scale has been chosen.

See details in 5.2.1.

The test can be performed directly according to the procedure 5.3 if all parameters match your requirements; following procedures should be observed if the modification is 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 will move to "HR30N". Press "↑"or"↓"key at this time the optional 15 Rockwell superficial scales HR15N, HR30N, HR45N, HR15T, HR30T, HR45T, HR15W, HR30W, HR45W, HR15X, HR30X, HR45X, HR15Y, HR30Y, HR45Y will appear in sequence. When the desired scale appears, press " ↵ "to confirm. At this time test force will be changed automatically according the confirmed scale accompanying with beeping.

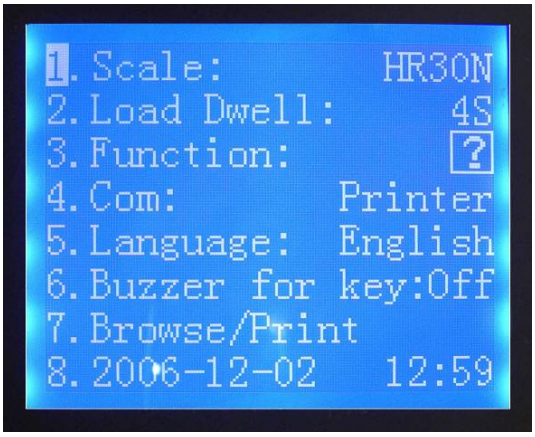


Figure 5.2.1

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 thin and/or soft samples that can be distorted with time after main test force has been loaded, the load dwell is normally set as 2～3s; for thicker, harder samples, the dwell time is normally set as 6～8s;

Press "🡅" or "🡇" key to move cursor to "2" in figure 5.2.1, press " ↵ " key ,then the cursor will move to "4S". 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.

5.2.3 Auxiliary functions: *Limit Setting, Data Stats, Conversions & Curvature Corrections*

The tester has four auxiliary functions, which can be used individually, in multiples 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 " ? ". Press "🡅"or"🡇" key at this time to select the desired auxiliary functions, then press " ↵ "to conform and into next menu as 5.2.2~5.2.7. There four auxiliary functions marked as " ±Δ、Σ、M、Ø ", which represent limit setting, data statistics, scale conversion and curved surface correcting respectively.

5.2.3.1 Limit setting ±Δ

Press "🡅" or "🡇" key to set the value of upper limit and the value of lower limit in the figure5.2.2, then press " ↵ " to confirm.

The upper limit and lower limit will be showed simultaneously with the displaying of measuring result each time after the function setting has been taken into effect. As figure 5.2.3, the testing result is 66.1HR15N, upper limit is reset as 75.0HR15N, lower limit is 60.0HR15N. If the result is beyond the limitation scope, warning on display, buzzing will send out at the same time.

Figure 5.2.2

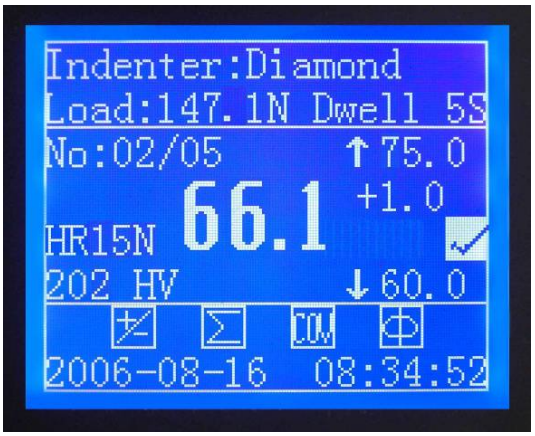


Figure 5.2.3

5.2.3.2 Data statistics

The statistics for one group data is available; press "▲" or "▼" key to determine the value of N (the applicable scope is 2～99) in figure5.2.4; then press" ↵ " to confirm.

The values of serial number n and N will be showed simultaneously with the displaying of measuring result each time after the function setting has been taken into effect. Refer to figure 5.2.3, 5 measurements will be performed totally, 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 5.2.5 showing after the hand wheel had been unloaded by turning in anti direction.

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

Figure 5.2.4

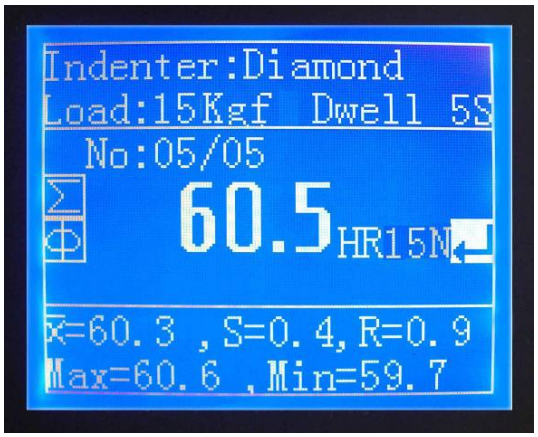


Figure 5.2.5

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

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

$$R=Max\text{-}Min$$

Normally, the serial number will plus 1 after each measurement until the n is equal to N (i.e. all of the N measurements were finished), then begin with statistical calculation. In event of the current measurement required to be cancelled due to some reasons, press "↑" or "↓" key in the figure 5.2.3 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.

5.2.3.3 Scale conversion

This function can convert the measured Rockwell Superficial hardness value to HB, HV, HK and σ_b value.

For instance, if we intend to convert the HR45N value to HV value, press "↑"or"↓"key to move the cursor to "1. HR45N—HV" in figure 5.2.6, and then press "↵" to confirm.

The conversion value will be shown simultaneously with the display of measuring result . As figure 5.2.3, the hardness value measured is 66.1HR15N, conversion value is 202HV. If the conversion entered is not possible then the machine will display "E" alerting you to change to another scale

Figure 5.2.6

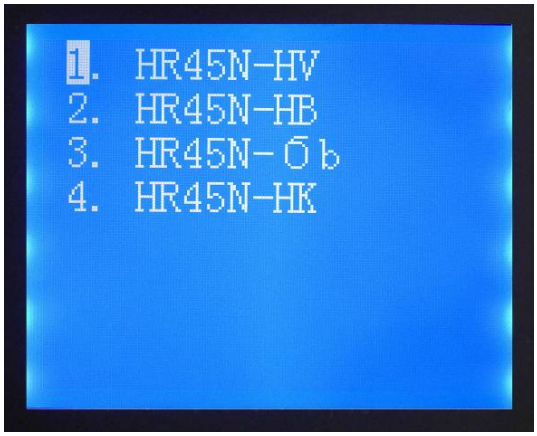
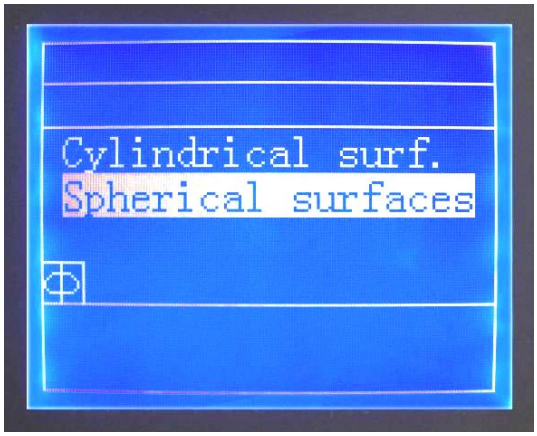


Figure 5.2.7



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 5.2.7.

After that, press "↑"or"↓"key to determine curvature radius or the diameter of sphere, and press "↵" to confirm.

The measuring result as well as correcting value will be given in the course of each measurement after the function setting has been taken into effect. Note: screen will display the testing value (the

direct testing result without correction) along with the corrected value. As figure 5.2.3, the measuring result is 66.1HR15N and the correcting value is "+1.0" HR15N.

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 USB port (transmission rate 9600bps), which can be connected to an external computer. After setting, only the **individual test results** can be sent to your 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 optional "Printer"、"USB"、"Off" will be appear in sequence. When the desired optional appears, press " ↵ "to finish the selection.

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

5.2.5 Buzzer for key

Press "🡅"or"🡇"key to move cursor to "6" in figure 5.2.1, press " ↵ " key, then the cursor move to "Off". 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.

5.2.6 Browse through/print the track record

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 5.2.8. The serial number and time of the test are displayed simultaneously. Memory capacity is 500 test results. Press "🡅"or"🡇" key to scroll thru the items. The highlighted test result can be printed by pressing " ↵ " key.

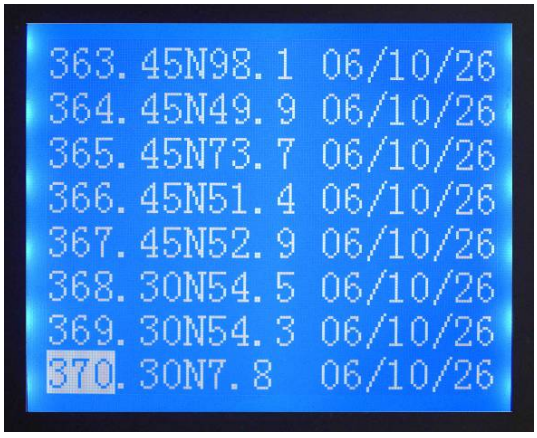


Figure 5.2.8

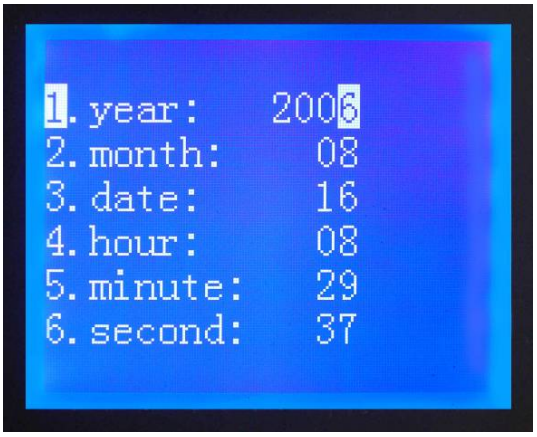


Figure 5.2.9

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

Time/Date Setting:

Press "⇧"or"⇩" key to move cursor to "8" in figure 5.2.1, press " ↵ " key, figure5.2.9 appears. Press "⇧" or "⇩" key to move cursor to "1" in figure 5.2.9, 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.

Seating Your Diamond:

Caution: **To ensure accuracy, mount the indentor by sliding it in the holder as far as possible and then securing the indentor by tightening the set screw finger-tight only.**

Place HRC test block on the small round anvil and begin by turning the handwheel clockwise until the block just touches the diamond. At this point, continue rotating the handwheel until the large needle goes around approx. 3 revolutions. Let the machine sit idle for a few seconds and then loosen the set screw. Wait a few more seconds and then tighten the set screw back up. This will allow the diamond to be "seated" in the shank. Take the load off by turning the handwheel counter-clockwise and you can begin following instructions below.

1. *Prepare the test specimen properly. Be sure that the top and bottom surfaces of the specimen are clean and free of any grease, oil dirt, etc and free of any burrs or debris.*
2. *For small specimens (under 3" maximum length or diameter) use the small round anvil. Use the large anvil for larger specimens. Use the V-shaped anvil for round or curved specimens.*

Warning: Do not test any specimen that cannot be safely and properly positioned on and supported by the tester anvil.

5.3 Testing

5.3.1 The preload loading

Place the sample to be tested on the anvil, and rotate the hand wheel clockwise until your part touches the penetrator. The continue to raise the part and you will see the animated anvil as shown in figure 5.3.1, showing the anvil moving up towards the animated diamond tip. Rotate the hand wheel smoothly until the anvil in figure reaches the tip of the animated diamond tip as shown figure 5.3.2. Once the machine beeps it will immediately begin to put the load on. Be sure not to turn handwheel at this point.

Figure 5.3.1

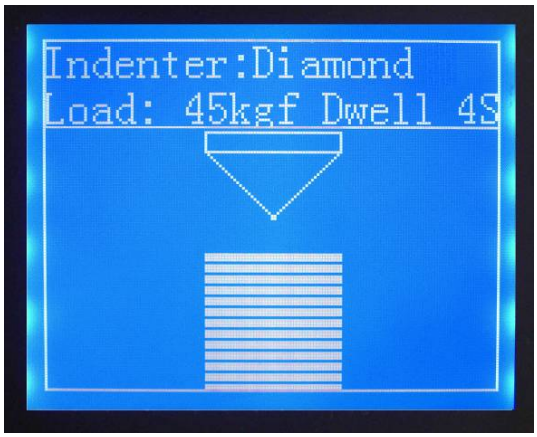
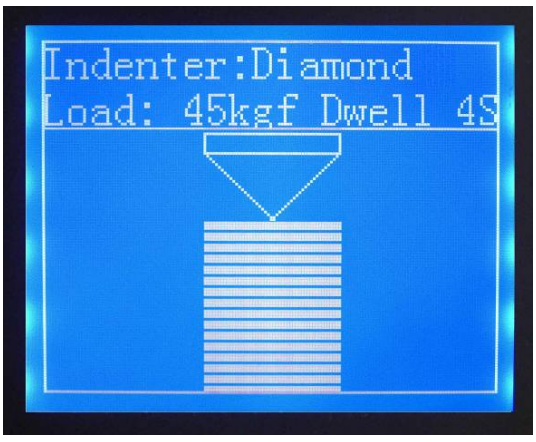


Figure 5.3.2



5.3.2 Automatic testing

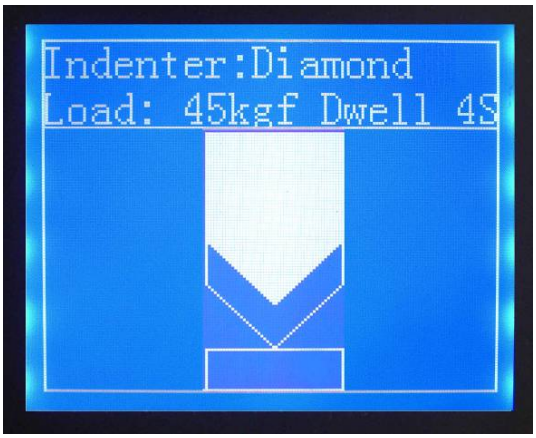


Figure 5.3.3

Figure 5.3.4

After the primary test force loading, test will be performed automatically as follows: loading main test force, as figure 5.3.3; holding for dwell time count down after loading, refer to figure 5.3.4. Finally, unloading is performed immediately when the dwell time has finished. Test results will be shown on screen, refer to figure 5.2.3.

5.3.3 Unloading

Once the test has been completed, you should rotate the hand wheel counter-clockwise to lower the anvil to unload the machine; the screen returns to figure 5.1.1, The machine is now ready to perform the next test. All parameters are saved and should not need to be modified at this time.

5.4 Shut down

Remove the test force completely, and switch off the power supply. Disconnect power cord if not being used for an extended period of time.

6 Maintenance and Service

6.1 When the hardness tester is to be moved or transported, the weights and assembly MUST be removed from the inside of the machine. Serious damage will occur.

Store in supplied tool kit.

6.2 When performing any physical adjustments, the power supply must be disconnected

6.3 Pay careful attention to your indentor. Be sure the shank is clean and free of rust, dirt or metal chips prior to installation.

6.4 The surface of anvil and test blocks should be clean. No oil, dirt, dust, rust or metal chips should be on these surfaces as it will cause erroneous readings.

6.5 Always keep the dust cover on the machine when not in use. Never store in damp area.

6.6 The leadscrew of the anvil should be lubricated periodically. Apply a few drops of light machine oil, then run the leadscrew up and down a few times to distribute the oil.

6.7 Never disassemble any fixed parts as this will automatically void any stated or implied warranties. If you need service, please contact Phase II directly at (201) 962-7373.

Rockwell Superficial Hardness Test

The Rockwell Superficial hardness test method consists of indenting the test material with a diamond cone (N scale) or hardened steel ball indenter. The indenter is forced into the test material under a preliminary minor load *F0* (Fig. 1A) usually 3 kgf. When equilibrium has been reached, an indicating device that follows the movements of the indenter and so responds to changes in depth of penetration of the indenter is set to a datum position. While the preliminary minor load is still applied an additional major load, is applied with resulting increase in penetration (Fig. 1B). When equilibrium has again been reach, the additional major load is removed but the preliminary minor load is still maintained. Removal of the additional major load allows a partial recovery, so reducing the depth of penetration (Fig. 1C). The permanent increase in depth of penetration, *e*, resulting from the application and removal of the additional major load is used to calculate the Rockwell Superficial hardness number.

$$HR = E - e$$

F0 = preliminary minor load in kgf
F1 = additional major load in kgf
F = total load in kgf
e = permanent increase in depth of penetration due to major load *F1*, measured in units of 0.001 mm
E = a constant of 100 units for diamond and ball indenters
HR = Rockwell hardness number
D = diameter of steel ball

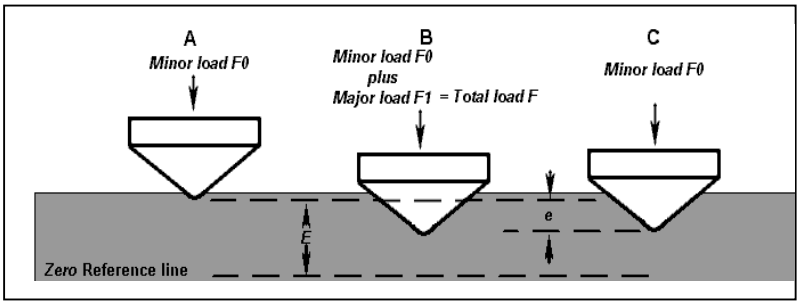


Fig. 1.Rockwell Superficial Principle

Rockwell Superficial Hardness Scales

Scale	Indenter Type	Minor Load *F0* kgf	Major Load *F1* kgf	Total Load *F* kgf	Value of E
HR 15 N	N Diamond cone	3	12	15	100
HR 30 N	N Diamond cone	3	27	30	100
HR 45 N	N Diamond cone	3	42	45	100
HR 15 T	1/16" steel ball	3	12	15	100
HR 30 T	1/16" steel ball	3	27	30	100
HR 45 T	1/16" steel ball	3	42	45	100
HR 15 W	1/8" steel ball	3	12	15	100
HR 30 W	1/8" steel ball	3	27	30	100
HR 45 W	1/8" steel ball	3	42	45	100
HR 15 X	1/4" steel ball	3	12	15	100
HR 30 X	1/4" steel ball	3	27	30	100
HR 45 X	1/4" steel ball	3	42	45	100
HR 15 Y	1/2" steel ball	3	12	15	100
HR 30 Y	1/2" steel ball	3	27	30	100
HR 45 Y	1/2" steel ball	3	42	45	100

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
25	266	253	253	278	62.8	43.8	72.2	45.9	25.5	37.8

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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