

Manual PCE-2000 hardness tester



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1 Introduction

1.1 General

Thank you for purchasing a PCE-2000 hardness tester from PCE Instruments.

This meter serves to quickly test the surface hardness of metallic materials according to the parameters Rockwell B & C, Vickers HV, Brinell HB, Shore HS and Leeb HL. Due to its external digital display showing all the functions and measured values, confusions and faulty measurements can be ruled out. The hardness tester has a statistics function, a data storage function and an R-S232 interface to send data to the computer or laptop (software and cables are included in the delivery). This device can be used in any position, even overhead, with angle selection and adjustment. The impact body fits easily on top of the item to be measured.

1.2 Delivery content

- 1 x PCE-2000 hardness tester (interface RS232)
- 1 x striking instrument type IMPACT-D, 1.5 m cable
- 1 x calibration block
- 1 x software
- 1x data cable
- 1 x cleaning brush
- 1 x retaining ring (plastic, black)
- 1 x case
- 2 x AA battery
- 1 x manual

2 Safety notes

Please read this manual carefully and completely before you use the device for the first time. The device may only be used by qualified personnel and repaired by PCE Instruments personnel. There is no warranty of damages or injuries caused by non-observance of the manual.

- The device may only be used in approved temperature and humidity ranges as set out in the specifications. Extreme temperatures, direct exposure to sunlight, extreme atmospheric humidity or moisture (e. g. wet hands) must be avoided.
- The case should only be opened by qualified personnel of PCE Instruments.
- The instrument must never be placed with the user interface facing an object (e.g. keyboard side on a table).
- You should not make any technical changes to the device.
- The appliance should only be cleaned with a damp cloth / use only pH-neutral cleaner, no abrasives or solvents.
- Only use the device with PCE accessories or equivalent.
- Before using the device, check the case and the test leads for visible damage. If you find damage, do not use the device.
- Do not expose this device to strong magnetic fields, vibration or corrosive media.

This manual is published by PCE Instruments without any guarantee.

We expressly refer to our general guarantee terms, they can be found in our general terms of business.

If you have any questions please contact PCE Instruments.

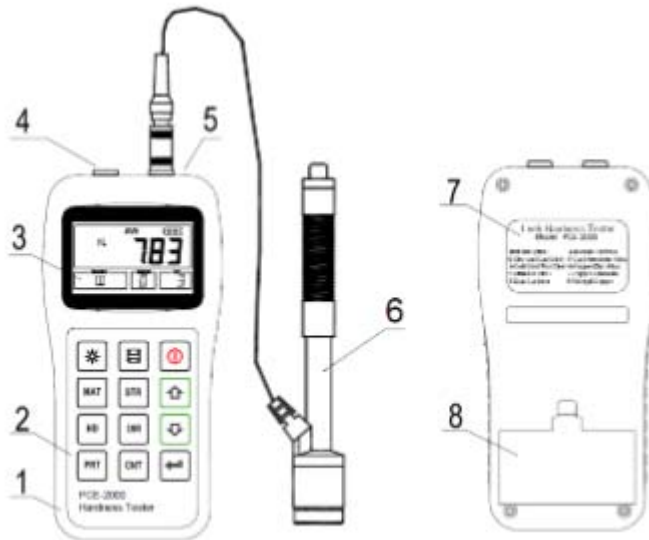
3 Specifications

Measurement range	170 ... 960 HLD
Measuring direction	0 ° ... 260 °
Scales of hardness	HL, HB, HRB, HRC, HRA, HV, HS
Data memory	100 memory groups (measurement value, material, ...)
Computer connection	RS232 interface
Display	LCD with backlight
Power supply	2 x AA batteries (1.5 V)
Battery life	≥ 100 operating hours (without backlight)
Automatic power-off	after 5 minutes of inactivity
Battery level indication	Residual capacity, symbol flashes at low voltage
Operating temperature	0 °C ... 40 °C
Storage temperature	-30 °C ... 60 °C
Atmospheric humidity	≤ 90 % RH
Dimensions	150 x 74x 32 mm
Weight	approx. 245 g

No.	Type of impact device	Hardness value (Leeb standard scale of hardness)	Deviation of the displayed value	Repeatability
1	D	760 ± 30 HLD 530 ± 40 HLD	± 6 HLD ±10 HLD	6 HLD 10 HLD
2	DC	760 ± 30 HLDC 530 ± 40 HLDC	± 6 HLDC ± 10 HLDC	6 HLD 10 HLD
3	DL	878 ± 30 HLDL 736 ± 40 HLDL	± 12 HLDL	12 HLDL
4	D+15	766 ± 30 HLD+15 544 ± 40 HLD+15	±12 HLD + 15	12 HLD + 15
5	G	590 ± 40 HLG 500 ± 40 HLG	± 12 HLG	12 HLG
6	E	715 ± 30 HLE 508 ± 40 HLE	± 12 HLE	12 HLE
7	C	822 ± 30 HLC 590 ±40 HLC	± 12 HLC	12 HLC

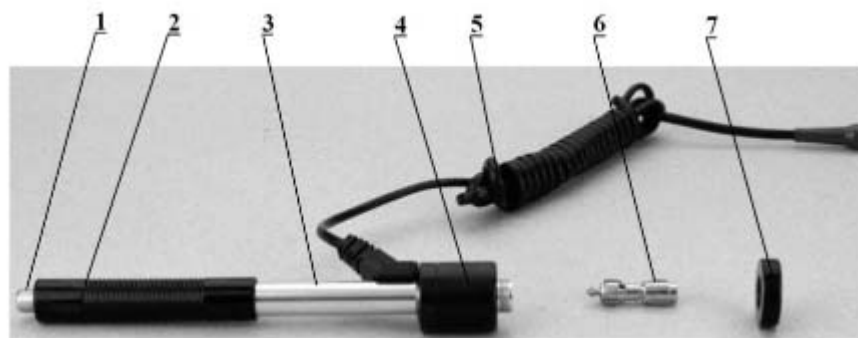
4 System description

4.1 Device



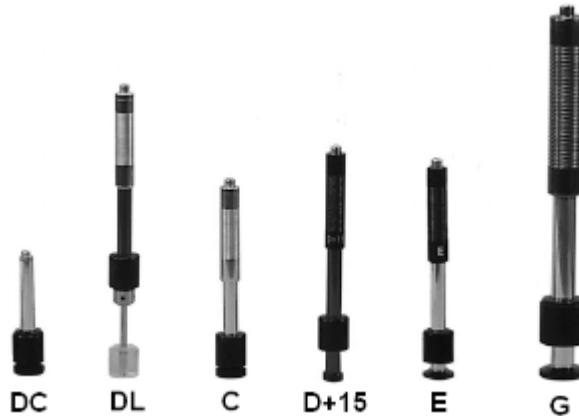
- (1) main device
- (2) keypad
- (3) display
- (4) RS232 interface
- (5) connection for impact device
- (6) impact device
- (7) label
- (8) battery compartment cover

4.2 Impact device IMPACT D

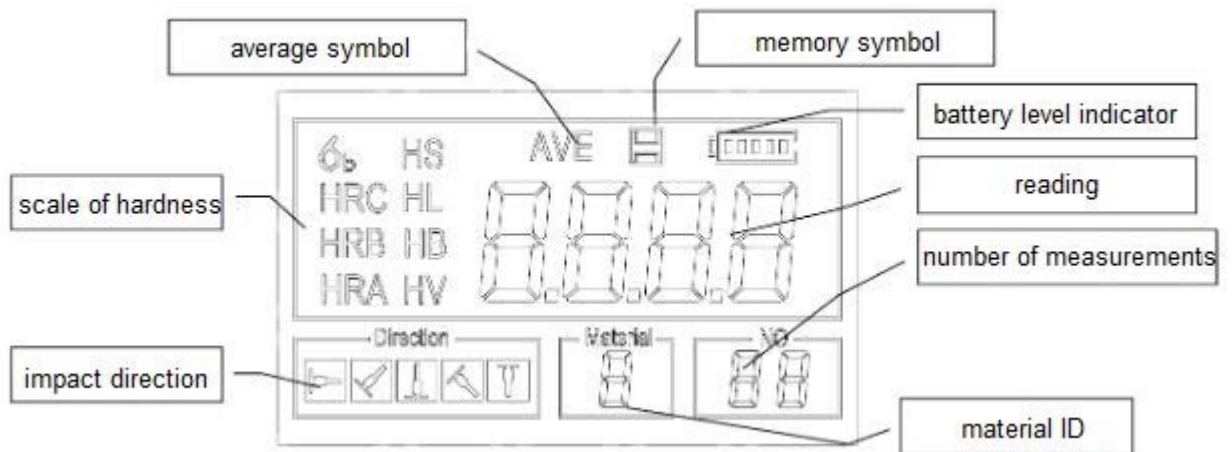


- (1) trigger button
- (2) loading tube
- (3) guide tube
- (4) sensor unit
- (5) connection cable
- (6) impact body
- (7) retaining ring

4.3 Different types of optionally obtainable impact bodies



4.4 Display



Material ID: shows current material default setting.

Impact direction: shows the direction of impact.

Scale of hardness: shows the unit of measurement of the current reading.

Battery level indicator: shows the battery level.

Reading: shows the individual measured value (if no average symbol is displayed) or the calculated average (if the average symbol is displayed).













- "HI" means that the reading exceeds the measuring range or the conversion value.
- "LO" means that the reading is lower than the measuring range or the conversion value.















Number of measurements: shows the number of the hitherto measurements of a series.

Average symbol: appears when the average value is displayed. This will be the case as soon as the preset number of impacts is reached.

Memory symbol: appears when the data memory of the device is retrieved.

4.5 Assignment of keys

	display backlight on / off		save and delete data		on / off
	material selection		switch between hardness and strength		plus or upwards
	selection of hardness scale		change of impact deirection		minus or downwards
	print data		determine number of measurements		save or enter data

- Press  to save the current set of readings. This function can only be carried out after the average value has been displayed.
- Press  and  to show individual readings.
- Press  to switch the display backlight on or off.
- Press  to set the impact direction.
- Press  to change the number of impacts (number of measurements) in a series. The symbol “number of measurements” will flash when  is pressed for the first time. The number is increased when  is pressed and decreased when  is pressed. At the end, press  to leave the number of impacts menu.
- Press  to change the scale of hardness.
- Press  to change the material ID. The hardness scale will automatically change to HL.
- Press  to switch between hardness and strength measurement. A strength measurement can only be carried out with D and DC type impact bodies. When an impact body of another type is connected, this function cannot be activated.
- Press  to print the readings after the measurement.

5 Measurement principle

An impact body of a certain weight is pushed against a test piece at a defined strength. The impact of the impact body results in a minimal deformation of the surface. The spherical impact body is located 1 mm over the test surface. The speed of the impact of the impact body is then measured in relation to the speed of the rebound of the impact body. The calculation formula is:

$HL = 1000 \times VB / VA$, whereas







HL is the Leeb hardness value

VB is the rebound speed of the impact body and

VA is the impact speed of the impact body

6 Instructions

6.1 Preparing and checking the device

When checking the device, use the standard calibration block included in the delivery content. The deviations and the reproducibility of the displayed value should be within the tolerances which you can find in chart 2. The device and the impact device must be calibrated using the standard calibration block before first use, after a longer period of non-use or after a system reset. Press  while holding . The user calibration screen is now shown. Measure five different points on the standard calibration block. The device will show the average value after five measurements. Use  or  to change the nominal value. Press  to confirm the calibration or  to stop the calibration. The adjustment range comprises ± 30 HL. The measurement parameters such as material selection, the scales of hardness and the impact direction cannot be changed during calibration.

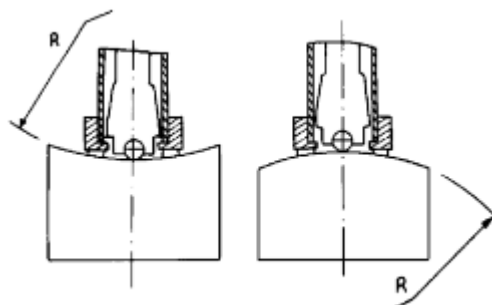
Note: Use a calibrated hardness tester and test the standard calibration block vertically five times. Compare the arithmetic average value to the value of the standard calibration block. In case this value exceeds the standard value, the function “user calibration” can be used to adapt the device.

6.1.1 To select an impact body

Use the charts 1 and 3 in the appendix to select an impact body.

6.1.2 To prepare the surface to be measured

- The preparation of the surface of the material sample to be measured must come up to the requirements laid down in chart 3 in the appendix.
- During the preparation of the surface of the sample, the test surface should not heat up or cool down due to the hardening effect.
- The surface to be measured should not be too uneven or coarse. This could cause deviations. The sample to be measured should have a metallic lustre and be smoothed, polished and free from grease.
- For a heavy material sample, a certain base is not necessary. Medium-heavy parts must be placed on an even and solid base. The sample must stand completely horizontally and flatly.
- Curved surfaces: Even surfaces are easiest to measure. If the radius of curvature R of the test surface is smaller than 30 mm (type of impact device D, DC, D+15, C, E and DL) or smaller than 50 mm (type of impact device G), the small retaining ring or the curved base ring should be used.
- The material sample should have a minimum thickness which you can see in chart 3.
- If the sample has a hardened surface, the thickness of the hardened layer should be the value from chart 3.




- Coupling: Medium-heavy samples must be sufficiently in contact with a heavy ground plate. Both surfaces lying on top of each other must be even and flat and free from coupling gel. The impact direction must be vertical to the base. If the sample is a big plate, a long bar or a flexible part, it can deform and become unstable, even if it is sufficiently heavy and thick. As this may cause faulty measurements, the part to be measured should be supported or strengthened.
- Magnetism of the sample should be avoided.

Type of impact device	Distance from the centre of the two markings	Distance from the centre of the marking to the edge of the sample
	not more than (mm)	not more than (mm)
D, DC	3	5
DL	3	5
D + 15	3	5
G	4	8
E	3	5
C	2	4

6.2 Testing procedure

6.2.1 To switch the device on

- Connect the plug of the impact body to the socket of the device.
- Press  to switch on the device. The device is now in operating mode.

6.2.2 To load the device

- Push the loading tube downwards until you feel a contact. Then let the tube slowly return to its starting position.

6.2.3 To place the impact body

- Push the bearing ring of the impact body firmly against the surface of the sample, bearing in mind that the impact direction should always run vertically to the test surface.

6.2.4 To carry out a measurement

- Push the trigger button of the impact device to make a measurement. The sample, as well as the impact body and the user should now stand still and stable.
- Each part of the sample should be measured 3 to 5 times. The deviations of the values should not be higher than ± 15 HL.
- The distances between the two points of impact and to the edge of the material sample should be in the range of the limit values from charts 1-4.
- If you would like to make an exact conversion of the Leeb measurement value into other hardness measurement values, you need a contrasting test to find out about the conversion relationships of different materials. Use a certified Leeb hardness tester and another corresponding hardness tester to measure the same material sample. For each hardness value, measure the Leeb hardness value at five different points and calculate the resulting average value.

6.2.5 To read the measurement value


After each impact process, the LCD will display the measured value. After further impacts, the device will emit a log sound if the measured value is not within the valid measurement range. As soon as the preset number of measurements has been reached, another long sound will be emitted. After two seconds, the device will emit a short sound and the display will show the average measured value.

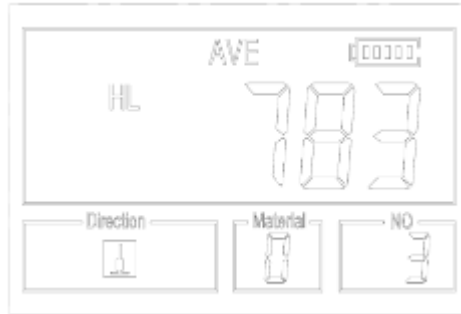
Note


- The impact device may only be changed when the device is switched off. Otherwise the main device cannot recognise the type of impact device, which may cause damage to the main device.
- You cannot save the current measurement value if the impact frequency is lower than the preset value.
- You can only measure the tensile strength with type D and type DC impact devices. You cannot switch to the default setting for testing the tensile strength if another impact device is being used. The setting automatically changes to hardness testing.
- Not all materials can be converted into scale of hardness values. The scale of hardness is automatically reset to HL after the material has been changed. Therefore, you must first choose the material and then the scale of hardness.

6.3 Instruction details


6.3.1 To switch the device on and off

Press  to switch the device on. Make sure that you have connected the impact device before you switch on the device. The system will automatically recognise and display the type of impact device when you switch it on. Pay attention to the probe shown on the display. After a few seconds, the information will disappear and the main display will appear as follows:



You can switch off the device by pressing  while the device is working. It has a special memory which saves all settings, even when the device is switched off.


6.3.2 Material selection

Press  to select the material to be tested. The hardness scale will automatically return to HL after you have changed the material settings. Please select the material first before choosing the scale of hardness. You can choose between the following materials to be tested: steel and cast steel, alloyed tool steel, stainless steel, grey cast iron, spheroidal graphite iron, cast aluminium alloys, red brass, copper-aluminium alloys, wrought copper and wrought steel. The allocation of the material number to the material on the display is as follows:


Material number	Material	Material number	Material
0	steel and cast steel	5	cast aluminium alloys
1	alloyed tool steel	6	red brass
2	stainless steel	7	copper-aluminium alloys
3	grey cast iron	8	wrought copper
4	spheroidal graphite iron	9	wrought steel

For the following materials, a tensile strength measurement is not possible: soft steel, high-carbon steel, chrome steel, Cr-V steel, Cr-Ni steel, Cr-Mo steel, Cr-Ni-Mo steel, Cr-Mn-Si steel, high-tensile steel and stainless steel. The allocation of the material number to the material on the display is as follows:

Material number	Material	Material number	Material
0	soft steel	5	Cr-Mo steel
1	high-carbon steel	6	Cr-Ni-Mo steel
2	chrome steel	7	Cr-Mn-Si steel
3	Cr-V steel	8	high-tensile steel
4	Cr-Ni steel	9	stainless steel

Press  to choose hardness and tensile strength measurement.


Note: You can only measure tensile strength with impact devices of type D and DC. With all other types of impact devices, you can only measure hardness.

When measuring hardness, press  to change the scale of hardness. The supported scales of hardness are: HL, HV, HB, HRC, HS, HRB and HRA.

Note:

- Only the valid scales of hardness for the chosen impact device and material are displayed. Invalid scales of hardness are not displayed.
- Please choose the material first before you choose the scale of hardness.
- The preset scale of hardness changes to HL automatically as soon as the preset material is changed.

6.3.3 To change the impact direction



Press  to change the set impact direction.

6.3.4 To set the number of measurements for average calculations**Error codes**


Error code	Reason	Error code	Reason
E00	battery flat	E05	printing not possible
E01	value outside measurement range	E06	
E02	measurement not finished	E07	
E03	data saved already	E08	
E04	no memory data	E09	

6.3.5 To set the average time

You can determine the average time between 1 and 32 as follows:




- Press  during the testing phase. The impact time symbol starts to flash. Set the desired impact time via the arrow keys.
- Press  again to leave the menu.

6.3.6 To save data

The maximum number of files you can save on the device is one hundred (F00-F99). When you click  once after completion of the measurement, the "AVE" symbol appears and the measurement results are saved. The newly saved file is displayed as the last file in the memory. This function makes it possible to the user to view saved data and to delete files / groups.





6.3.7 To view saved files

To retrieve saved data, take the following steps:

- Press  to call the data log function. The memory symbol appears. The current file name, the test parameters of the group and the main value of the group are displayed. If there is no data in the memory, the display will show <E04> and the device returns to normal mode.
- Use the arrow keys to select the value to be viewed.
- Press  to view the details of these group data.
- Use the arrow keys again to view each single reading of this group.
- By pressing , you can always return to the previous screen.

6.3.8 To delete the selected files

To delete saved data, take the following steps:

- Press  to call the data log function. The memory symbol appears. The current file name, the test parameters of the group and the main value of the group are displayed. If there is no data in the memory, the display will show <E04> and the device returns to normal mode.
- Use the arrow keys to select the value to be viewed.
- Press  to select the value to be deleted.
- Press the  key. The file is automatically deleted and the display will show “-DEL”.
- By means of the  key, you can always return to the previous screen.

Note: Do not switch off the device during the deletion process as this may cause system errors.


6.3.9 Automatic power off

The device is equipped with an automatic power off function to increase battery life. After five minutes of inactivity (no keystroke or measurement), the device switches itself off independently. Before switching off, the display flashed for 20 seconds. During this phase, you can interrupt automatic power off by pressing any key (except on / off key).


6.3.10 Connection to a computer

The device is equipped with an RS232 interface. By means of the software and the data cable included in the delivery contents, the device can be connected to a computer or an external hard disk. Consult the software manual for further information.

6.3.11 To reset the device

Press and hold the  key while switching on the device. The device will be reset to factory defaults. This may help if the parameters of the device are misaligned.



6.3.12 Backlight

In a dark environment, it is easier to work with the backlight on. Press the  anytime the device is switched on to switch the backlight on or off. Since the backlight consumes a lot of energy, only switch it on if necessary.

7 Maintenance and cleaning

7.1 To change the battery

Warning: To avoid faulty measurements, change the batteries at an early stage. Bear the correct polarity in mind.

When the display shows the symbol , this indicates that the battery is low. The more black bars are visible, the more battery voltage is left. If the batteries are almost flat, an empty battery symbol  flashes. You must always replace both batteries (type AA).

7.2 Cleaning

After using the impact device approx. 1000 – 2000 times, please clean the loading tube and the impact body with the nylon brush which is included in the delivery contents. When you want to clean the loading tube, first unscrew the bearing ring, then take the impact body out and turn the nylon brush counterclockwise until you reach the bottom of the loading tube. Pull the brush out about five times. Put the impact body back into the bearing ring and screw the bearing ring back on.

Remove the impact body from the device after use.

Make sure that no lubricants get into the device!

Only clean the meter with a damp cloth and do not use abrasives or solvents.

7.3 Maintenance procedure

If you use the Rockwell calibration block and the deviation is higher than 2 HRC, a possible reason can be wear and tear of the impact body. The spherical probe tip and the impact body should be replaced. If the hardness tester behaves unusually, do not disassemble any fixed parts or try to repair them. Contact PCE Instruments in this case.

8 Disposal

For the disposal of batteries, the 2006/66/EC directive of the European Parliament applies. Due to the contained pollutants, batteries must not be disposed of as household waste. They must be given to collection points designed for that purpose.

In order to comply with the EU directive 2012/19/EU we take our devices back. We either re-use them or give them to a recycling company which disposes of the devices in line with law.

If you have any questions, please contact PCE Instruments.

9 Appendix

9.1 Chart 1

Material	Method	Impact device					
		D / DC	D + 15	C	G	E	DL
steel and cast steel	HRC	20 – 68.5	19.3 – 67.9	20 – 69.5		22.4 – 70.7	20.6 – 68.2
	HRB	38.4 – 99.9			47.7 – 99.9		37 – 99.9
	HRA	59.1 – 85.8				61.7 – 88	
	HB	127 – 651	80 - 638	80 - 638	90 - 646	83 – 663	81 – 646
	HV	83 – 976	80 – 937	80 – 996		84 – 1042	80 – 950
	HS	32.2 – 99.5	33.3 – 99.3	31.8 – 102.1		35.8 – 102.6	30.6 – 96.8
alloyed tool steel	HRC	20.4 – 67.1	19.8 – 68.2	20.7 – 68.2		22.6 – 70.2	
	HV	80 - 898	80 - 935	100 - 941		82 – 1009	
stainless steel	HRB	46.5 – 101.7					
	HB	85 – 655					
	HV	85 – 802					
grey cast iron	HRC						
	HB	93 - 334			92 – 326		
	HV						
spheroidal graphite iron	HRC						
	HB	131 - 387			127 - 364		
	HV						
cast copper-aluminium alloys	HB	19 – 164		23 – 210	32 – 168		
	HRB	23.8 – 84.6		22.7 - 85	23.8 – 85.5		
(red) brass	HB	40 - 173					
	HRB	13.5 – 95.3					
bronze (copper-aluminium alloys)	HB	60 – 290					
processed copper alloys	HB	45 - 315					

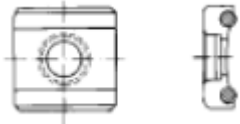
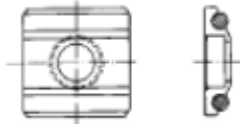


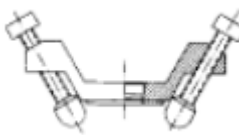
9.2 Chart 2

No.	Material	HLD	Tensile strength σ_b (MPa)
1	soft steel	350 ... 522	374 ... 780
2	high-carbon steel	500 ... 710	737 ... 1670
3	chrome steel	500 ... 730	707 ... 1829
4	Cr-V steel	500 ... 750	704 ... 1980
5	Cr-Ni steel	500 ... 750	763 ... 2007
6	Cr-Mo steel	500 ... 738	721 ... 1875
7	Cr-Ni-Mo steel	540 ... 738	844 ... 1933
8	Cr-Mn-Si steel	500 ... 750	755 ... 1993
9	very high-carbon steel	630 ... 800	1180 ... 2652
10	Stainless steel	500 ... 710	703 ... 1676

9.3 Chart 3

Type of impact device	DC (D) / DL	D+15	C	G	E	
Impact energy	11 mJ	11 mJ	2.7 mJ	90 mJ	11 mJ	
Mass of the impact body	5.5 g / 7.2 g	7.8 g	3.0 g	20.0 g	5.5 g	
Hardness of the probe tip	1600 HV	1600 HV	1600 HV	1600 HV	5000 HV	
Diameter of the probe tip	3 mm	3 mm	3 mm	5 mm	3 mm	
Material of the probe tip	Tungsten carbide	Tungsten carbide	Tungsten carbide	Tungsten carbide	synthetic carbide	
Diameter of the impact device	20 mm	20 mm	20 mm	30 mm	20 mm	
Length of the impact device	86 (147) / 75 mm	162 mm	141 mm	254 mm	155 mm	
Weight of the impact device	50 g	80 g	75 g	250 g	80 g	
Max. hardness of the sample	940 HV	940 HV	1000 HV	650 HV	1200 HV	
Average value of the unevenness of the sample surface Ra	1.6 µm	1.6 µm	0.4 µm	6.3 µm	1.6 µm	
Min. weight of the sample	>5 kg	>5 kg	>1.5 kg	>15 kg	>5 kg	
Direct measurement	2 ... 5 kg	2 ... 5 kg	0.5 ... 1.5 kg	5 ... 15 kg	2 ... 5 kg	
Needs a solid base	0.05 ... 2 kg	0.05 ... 2 kg	0.02 ... 0.5 kg	0.5 ... 5 kg	0.05 ... 2 kg	
Needs a solid connection						
Min. thickness of the sample	5 mm	5 mm	1 mm	10 mm	5 mm	
Needs a solid connection	≥ 0.8 mm	≥ 0.8 mm	≥ 0.2 mm	≥ 1.2 mm	≥ 0.8 mm	
Min. thickness of a surface hardening layer						
Size of the depression						
Hardness 300HV	Diameter of the depression	0.54 mm	0.54 mm	0.38 mm	1.03 mm	0.54 mm
	Depth of the depression	24 µm	24 µm	12 µm	53 µm	24 µm
Hardness 600HV	Diameter of the depression	0.54 mm	0.54 mm	0.32 mm	0.90 mm	0.54 mm
	Depth of the depression	17 µm	17 µm	8 µm	41 µm	17 µm
Hardness 800HV	Diameter of the depression	0.35 mm	0.35 mm	0.35 mm	--	0.35 mm
	Depth of the depression	10 µm	10 µm	7 µm	--	10 µm
Available types of impact devices	DC: for groove-like depressions; DL: tight grooves or holes	D + 15: groove-like depressions	C: small, light, thin parts and hardened surfaces	G: big, thick and heavy steel	F: for extremely hard material	

9.4 Chart 4

No.	Type	Sketch of the non-conventional bearing ring	Comments
1	Z 10-15		to test an outer cylindrical surface R10 ... R15
2	Z 14.5 – 30		to test an outer cylindrical surface R14.5 ... R30
3	Z 25 – 50		to test an outer cylindrical surface R25 ... R50
4	HZ 11 – 13		to test an inner cylindrical surface R11 ... R13
5	HZ 12.5 – 17		to test an inner cylindrical surface R12.5 ... R17
6	HZ 16.5 – 30		to test an inner cylindrical surface R16.5 ... R30
7	K 10 – 15		to test an outer spherical surface SR10 ... SR15
8	K 14.5 – 30		to test an outer spherical surface SR14.5 ... SR30
9	HK 11 – 13		to test an inner spherical surface SR11 ... SR13
10	HK 12.5 – 17		to test an inner spherical surface SR12.5 ... SR17
11	HK 16.5 - 30		to test an inner spherical surface SR16.5 ... SR30
12	UN		To test an outer cylindrical surface, radius adjustable R10 ... ∞

10 Contact

If you have any questions about our range of products or measuring instruments please contact PCE Instruments.

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You can find an overview of our measuring instruments here: <http://www.industrial-needs.com/measuring-instruments.htm>

You can find an overview of our scales here <http://www.industrial-needs.com/balances.htm>

