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Micro-Vickers Hardness Testing Machines HM-210/220

Series 810

This is a high performance hardness testing machine that uses advanced technology and is ideal for quality control.
The HM-210/220 offers you the following benefits:

- Touchscreen and software controlled types
- Its electromagnetic power generation system enables nonstop setup for testing force.
- A high performance optical system provides a visible indenter image.
- A long working distance greatly reduces the possibility of collision.
- You can use it for six objectives: 10X, 20X, 50X and 100X for measuring indentation images, and 2X and 5X for enabling wide-range measurement around indentations.
- LED lighting gives you an observation image in natural colour, with better contrast, as well as longer operation due to lower power consumption.
- You can set different kinds of conditions on a touch panel, and display test results for easy operation.
- Software AVPAK-20 allows automatic measuring.
- It has low testing force **0,4903 x 10^{-3}N** (0,05gf) as well as standard force models.

Specifications

Test force generation	Electromagnetic
Load dwell time	0-999 sec (1 sec increment)
Load control	Automatic (load, dwell, unload)
Indenter / Objective turret	Motor driven and manual operation
Data output	RS-232C, Digimatic, USB 2 interface
XY stage [mm]	**Travel range system A + B**: 25 x 25 / 50 x 50 manual **Travel range system C + D :** 50 x 50 / 100 x 100 motorized
Working distance	50X = 2,5 mm (other objectives available)
Vickers scale	**HM-210A/210B/210C/210D** HV0,01; 0,02; 0,03; 0,05; 0,1; 0,2; 0,3; 0,5; 1 **HM-220A/220B/220C/220D** HV0,00005; 0,0001; 0,0002; 0,0003; 0,0005; 0,001; 0,002; 0,003; 0,005; 0,01; 0,02; 0,03; 0,05; 0,1; 0,2; 0,3; 0,5; 1; 2
Mass	43 kg

Power turret with 2 indenter mounts and 4 objective mounts

Hardness Testing Machines brochure on request

Touchscreen type

Software type

		SYSTEM A		SYSTEM B		SYSTEM C		SYSTEM D	
MAIN UNIT		HM-210	HM-220	HM-210	HM-220	HM-210	HM-220	HM-210	HM-220
CONTROL UNIT		Touch screen		PC		PC		PC	
FORCE		Standard	Low	Standard	Low	Standard	Low	Standard	Low
XY - STAGE		MANUAL		MANUAL		Motorized		Motorized	
	SELECTION	25 x25mm 50 x 50mm		25 x25mm 50 x 50mm		50 x 50mm 100 x 100mm		50 x 50mm 100 x 100mm	
SOFTWARE		-		AVPAK-20		AVPAK-20		AVPAK-20	
FOCUSING		MANUAL		MANUAL		MANUAL		AUTO FOCUS	

Mitutoyo

Micro-Vickers Hardness Testing Machines HM-210/220

Manual or complete automatic measuring

System A

HM-210A/HM-220A

Features:
- Touch-panel operation
- Measurement of indentation dimensions using a measuring microscope
- Positioning using a manual XY stage

System B

HM-210B/HM-220B
Automatic dimensions by AVPAK-20 eliminates identation measurement errors.

Features:
- Operation using AVPAK-20
- Automatic measurement of indentations
- Positioning using a manual XY stage

System C

HM-210C/HM-220C

Features:
- Operated using AVPAK-20
- Automatic indentation reading
- Automatic positioning with motorized XY stage

System D

HM-210D/HM-220D
Top-end model with autofocus

Features:
- Operated using AVPAK-20
- Automatic identation reading
- Automatic positioning with motorized XY stage
- Autofocusing

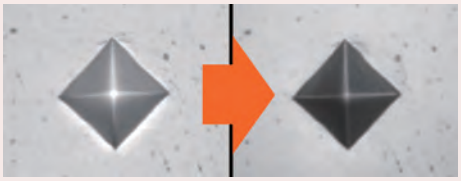
Video camera unit 810-354
(Can be installed in the manual model main unit)
CCD camera and 8.4"/213,4mm TFT monitor Enables observation and measurement of indentations at high magnification, thereby reducing operator error

AVPAK-20 software for automatic hardness testing systems.
Software that supports control, testing and report creation related to hardness testing. Supports parameter setting and automatic measurement.

High-functionality PC and TFT monitor
Compatible with Windows® 7 Professional.
Supports a wide-screen TFT and provides improved operability.

Micro-Vickers Hardness Testing Machines HM-210/220

Configuration



Observation image of the indentation (50X)
Stray light reduction around the indentation

Wide range of lenses available for different magnifications

Objektiv	Vickers-Skala		
	HV 0,00005 - 0,02	HV 0,2 - 1	HV 1-2
2x	Use this objectives only for probe overview		
5x	Use this objectives only for probe overview		
10x			
20x			
50x			
100x			
10x objectiv for easy focus			
Use this table or first orientation			

TOUCH SCREEN MODELS — SYSTEM A

Minimum system configuration			In addition selectable FACTORY OPTIONS		Remarks
HM-210 SYSTEM A	Main unit standard test force	810-400D	Video camera unit	810-354D	
	Manual XY stage 25 x 25mm	810-420	Objective lens 2X	11AAC104	
			Objective lens 5X	11AAC105	
HM-210 SYSTEM A	Main unit standard test force	810-400D	Objective lens 10X	11AAC106	
	Manual XY stage 50 x 50mm	810-423	Objective lens 20X	11AAC107	
			Objective lens 100X	11AAC108	
			Indenter shaft unit	11AAC109	with 19BAA061 Knoop indenter
HM-220 SYSTEM A	Main unit low test force	810-405D	Video camera unit	810-354D	
	Manual XY stage 25 x 25mm	810-420	Objective lens 2X	11AAC104	
			Objective lens 5X	11AAC105	
HM-220 SYSTEM A	Main unit low test force	810-405D	Objective lens 10X	11AAC106	
	Manual XY stage 50 x 50mm	810-423	Objective lens 20X	11AAC107	
			Objective lens 100X	11AAC108	
			Indenter shaft unit	11AAC110	with 19BAA062 Knoop indenter

SOFTWARE MODELS — SYSTEM B

Minimum system configuration			In addition selectable FACTORY OPTIONS		Remarks
HM-210 SYSTEM B	Main unit standard test force	810-403D	Objective lens 2X	11AAC104	
	Manual XY stage 25 x 25mm	810-420	Objective lens 5X	11AAC105	
	AVPAK-20*	11AAC316	Objective lens 10X	11AAC106	
			Objective lens 20X	11AAC107	
HM-210 SYSTEM B	Main unit standard test force	810-403D	Objective lens 100X	11AAC108	
	Manual XY stage 50 x 50mm	810-423	Indenter shaft unit	11AAC109	with 19BAA061 Knoop indenter
	AVPAK-20*	11AAC316	Measuring microscope	11AAC129	Cannot be used simultaneously with the vision unit.
HM-220 SYSTEM B	Main unit low test force	810-408D	Objective lens 2X	11AAC104	
	Manual XY stage 25 x 25mm	810-420	Objective lens 5X	11AAC105	
	AVPAK-20*	11AAC316	Objective lens 10X	11AAC106	
			Objective lens 20X	11AAC107	
HM-220 SYSTEM B	Main unit low test force	810-408D	Objective lens 100X	11AAC108	
	Manual XY stage 50 x 50mm	810-423	Indenter shaft unit	11AAC110	with 19BAA062 Knoop indenter
	AVPAK-20*	11AAC316	Measuring microscope	11AAC129	Cannot be used simultaneously with the vision unit

SOFTWARE MODELS — SYSTEM C

Minimum system configuration			In addition selectable FACTORY OPTIONS		Remarks
HM-210 SYSTEM C	Main unit standard test force	810-403D	Objective lens 2X	11AAC104	
	Motorized XY stage 50 x 50mm	810-421D	Objective lens 5X	11AAC105	
	AVPAK-20*	11AAC316	Objective lens 10X	11AAC106	
			Objective lens 20X	11AAC107	
HM-210 SYSTEM C	Main unit standard test force	810-403D	Objective lens 100X	11AAC108	
	Motorized XY stage 100 x 100mm	810-422D	Indenter shaft unit	11AAC109	with 19BAA061 Knoop indenter
	AVPAK-20*	11AAC316	Measuring microscope	11AAC129	Cannot be used simultaneously with the vision unit
HM-220 SYSTEM C	Main unit low test force	810-408D	Objective lens 2X	11AAC104	
	Motorized XY stage 50 x 50mm	810-421D	Objective lens 5X	11AAC105	
	AVPAK-20*	11AAC316	Objective lens 10X	11AAC106	
			Objective lens 20X	11AAC107	
HM-220 SYSTEM C	Main unit low test force	810-408D	Objective lens 100X	11AAC108	
	Motorized XY stage 100 x 100mm	810-422D	Indenter shaft unit	11AAC110	with 19BAA062 Knoop indenter
	AVPAK-20*	11AAC316	Measuring microscope	11AAC129	Cannot be used simultaneously with the vision unit

SOFTWARE MODELS — SYSTEM D

Minimum system configuration			In addition selectable FACTORY OPTIONS		Remarks
HM-210 SYSTEM D	Main unit standard test force	810-403D	Objective lens 2X	11AAC104	
	Motorized XY stage 50 x 50mm	810-421D	Objective lens 5X	11AAC105	
	Auto Focus stage unit	810-425	Objective lens 10X	11AAC106	
	AVPAK-20*	11AAC316	Objective lens 20X	11AAC107	
			Objective lens 100X	11AAC108	
HM-210 SYSTEM D	Main unit standard test force	810-403D	Indenter shaft unit	11AAC109	with 19BAA061 Knoop indenter
	Motorized XY stage 100 x 100mm	810-422D	Measuring microscope	11AAC129	Cannot be used simultaneously with the vision unit
	Auto Focus stage unit	810-425			
	AVPAK-20*	11AAC316			
HM-220 SYSTEM D	Main unit low test force	810-408D	Objective lens 2X	11AAC104	
	Motorized XY stage 50 x 50mm	810-421D	Objective lens 5X	11AAC105	
	Auto Focus stage unit	810-425	Objective lens 10X	11AAC106	
	AVPAK-20*	11AAC316	Objective lens 20X	11AAC107	
			Objective lens 100X	11AAC108	
HM-220 SYSTEM D	Main unit low test force	810-408D	Indenter shaft unit	11AAC110	with 19BAA062 Knoop indenter
	Motorized XY stage 100 x 100mm	810-422D	Measuring microscope	11AAC129	Cannot be used simultaneously with the vision unit
	Auto Focus stage unit	810-425			
	AVPAK-20*	11AAC316			

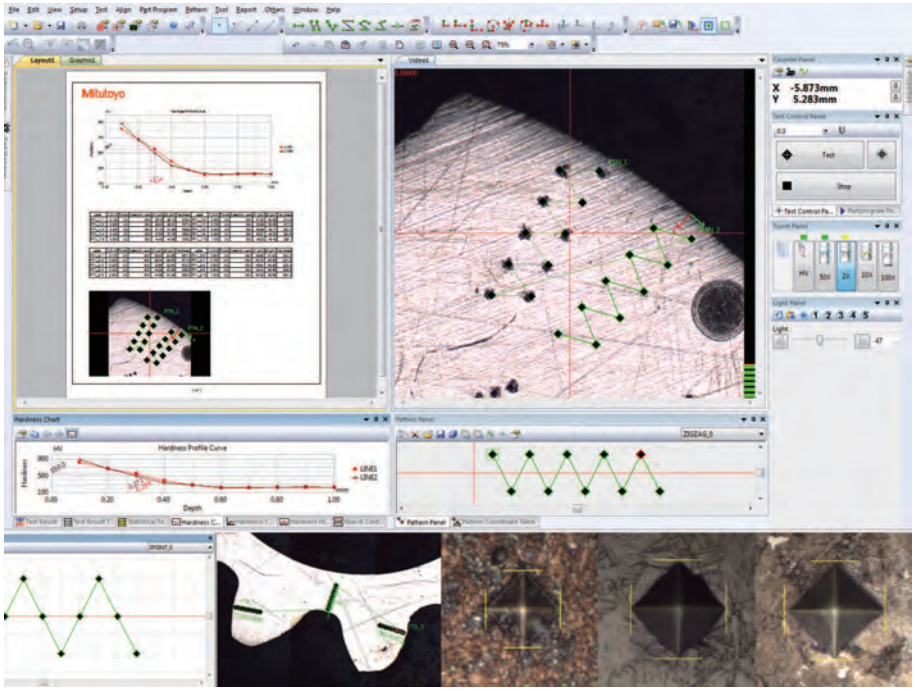
* The above set does not include PC.

For all systems: 50 x objective as standard.

Mitutoyo

Micro-Vickers Hardness Testing Machines HM-210/220

Software AVPAK-20 for system B,C and D



Screen layout for control, testing status, and result display can be changed freely.

Handling of multiple specimens
Part program and Part Manager function support testing of multiple and irregular specimens.

Multi-specimen testing
Executes different part programs for each irregular specimen.

Parts Manager:
Executes a common part program for specimens having the same shape.

Pattern creation:
This tool supports the creation of test patterns such as straight lines, zigzag lines, and teaching patterns.

Pattern pasting :
This tool supports the pasting of created test patterns. It adjusts the origin, direction, etc. to paste a pattern.

Graphic view (of stored images)
For displaying the entire specimen and checking the pattern positioning The digital zoom function can be used to easily magnify and check the indentation site.

FUNCTIONS

Layout view
Photos from individual views, graphs, tables, etc., can be laid out freely to help with report creation.

Stitching
Takes images of an entire rectangular field from the moving stage then combines the images.

Auto trace
Automatically traces the shape of the sample. Take images as the stage moves along the outer contours of the specimen then combines the images.

Navigation function
When the test position is being moved during multi-point testing, this function guides the travel of the XY fine adjustment manual stage to the next position. (System B)

Rockwell HR-100/200/300/400

Series 963

These are five economical Rockwell hardness testing machines to suit practically every application you need.
The Rockwell HR-100/200/300/400 offers you the following benefits:

- The newly designed frame provides maximum clearance for positioning the work piece, all you need is a flat table for mounting these testing machines.
- They are very simple to operate: the analogue types HR-110/HR-210 use an automatic presetting dial gauge.
- HR-110MR does not require a power source, and is considered to be environmentally friendly.
- Digital models HR-430MR/MS use automatic steering wheel braking and load sequencing for easy handling.
- Digital models HR-320MS and HR-430MR/MS can use our Digimatic Mini-processor (DP-1VR) for printing results, and you can use an input tool (USB-ITN-E) to connect to a PC for data transfer, analysis and storage.
- You can perform Brinell hardness tests by using the following optional accessories: a Brinell indenter, a weight set and a measurement microscope.

Specifications

Standards	JIS B 7726, ISO 6508-2 (ASTM E18)
Height	Max. 180 (100 if cover is attached) mm
Measuring depth	Max. 165 mm (from the center of the endenter axis)
Functions	HR-320MS, HR-430MR, HR-430MS : GO/NG, Offset revision, Hardness conversion
Power supply	AC100-240V, 1,2A (HR-110MR : no power required)
Standard accessories	Diamond indenter for R and R/S, Steel ball indenter 1/16"/**1,587mm**, Flat anvil, large V-anvil, Hardness test blocks, AC adapter, cover, Accessory box, level.

Optional accessories

No.	Description	Price €
56AAK286B	Brinell load set weight HR-110MR, 210MR 62.5, 125, 187.5	254,00
56AAK287B	Brinell load set weight HR-320MS 31.25, 62.5, 125, 187.5	318,00
56AAK288B	Brinell load set weight HR-430MR 62.5, 125, 187.5	318,00
56AAK289B	Brinell load set weight HR-430MS 31.25, 62.5, 125, 187.5	254,00
56AAK541B	Brinell microscope 20x	1337,00
810-037	Round table Ø180	626,00
810-038	Round table Ø250	1315,00
Anvils		
810-030	Point anvil (diamond tipped for Rockwell Superficial)	2398,00
810-027	Vari-rest	2631,00
810-029	V-anvil length 400, groove width 50, 120°	2154,00
810-026	Fine adjustment table for jominy test	3767,00
810-028	Jack rest	2631,00
810-040	V-anvil ø40, 120°	239,00
810-043	Point anvil (Ø12)	197,00
810-041	V-anvil ø40, 90°	239,00
810-044	Point anvil (Ø5,5)	197,00
810-042	V-anvil Ø10, 120°	197,00
810-048	Console table	1920,00
Computer accessories (not HR-110, HR-210)		
264-504-5D	Digimatic Mini-Processor	445,00
06ADV380E	USB Input tool Direct cable (2 m)	100,00
937387	Digimatic cable (1 m)	47,00
965013	Digimatic cable (2 m)	58,00

19BAA072 for HR-xxxMR models only
19BAA073 for HR-xxxMS models only
For idenders and Hardness test blocks see chapter Hardness Test Blocks

HR-110MR
Rockwell hardness testing machine

An environmentally friendly energy-saving model.
The basic operation is all manual, including weight-changing (total test force selection).

HR-210MR
Rockwell hardness testing machine

Manual weight changing (with total test force selected) and handling of preload force. Motor drive controls loading sequence.

HR-110MR and HR-210MR gauge

Model	HR-110MR	HR210MR	HR-320MS	HR-430MR	HR-430MS
No.	**963-210-20**	**963-220D**	**963-231D**	**963-240D**	**963-241D**
Price [€]	**4562,00**	**5459,00**	**7777,00**	**8807,00**	**10403,00**
Hardness test	Rockwell	Rockwell	Rockwell Superficial	Rockwell	Rockwell Superficial
Display	Analog	Analog	Digital	Digital	Digital
Display unit	0,5 HR increments	0,5 HR increments	0,1 HR display	0,1 HR display	0,1 HR display
Preload force	Automatic presetting dial guage	Automatc presetting dial gauge	Loading navigator display	Automatic handle brake	Automatic handle brake
Preload force setting	-	-	Dial switching	-	Dial switching
Test force selection	Weight exchange	Weight exchange	Weight exchange	Dial switching	Dial switching
Test force application	Manual	Semi-automatic	Semi-Automatic	Automatic	Automatic
Data output	-	-	Digimatic (SPC), RS-232C	Digimatic (SPC), RS-232C	Digimatic (SPC), RS-232C
Dimensions (WxDxH) mm	296 x 512 x 780	235 x 512 x 780	235 x 516 x 780	235 x 516 x 780	235 x 516 x 780
Mass kg	49	47	47	50	50

Rockwell HR-100/200/300/400

Series 963

Additional product description for HR-100/200/300/400 Series

Optional accessories
For identers and Hardness test blocks see chapter Hardness Test Blocks

HR-320MS

Dual type (Rockwell / Rockwell Superficial) hardness testing machine:

Manually handles test force and preload force selection.
Motor drive controls loading sequence.

HR-430MR

Rockwell hardness testing machine:

Economy type, but supports dial switching, power steering and support of all test standards and is equipped with automatic brake handle auto start feature.
Motor drive controls loading sequence.

HR-430MS

Dual type (Rockwell / Rockwell Superficial) hardness testing machine:

Economy type, but supports dial switching, power steering and support of all test standards and is equipped with automatic brake handle auto start feature.
Motor drive controls loading sequence.

Features preload force selection

Automatic steering wheel brake

SPC Digimatic and RS-232C interface

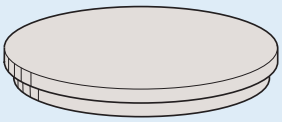
Rockwell HR-100/200/300/400

Series 963

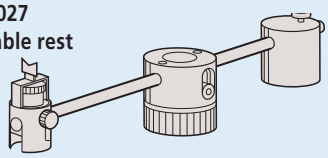
Additional product description and accessories for HR-100/200/300/400 Series

810-038
Round table OD Ø250 mm

For large probes
like profiles



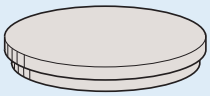
810-027
Variable rest



Test of long object probes (used together with anvil)

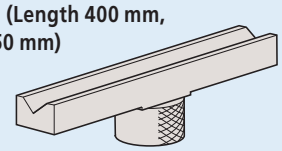
810-037
Round table OD Ø180 mm

For large probes
like profiles



810-029
Special V-anvil (Length 400 mm, groove width 50 mm)

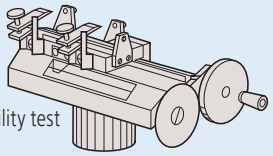
For shaft material
(max. Ø100 mm)



810-040
V-anvil (large)
(OD Ø40 mm, groove width 30 mm)
For shaft material (max Ø60 mm)

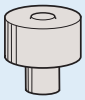
810-026
Micromovement table for Jominy test

JIS G 0561
Steel hardenability test



810-043
Spot anvil

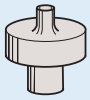
(OD Ø12 mm)



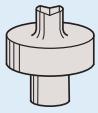
810-030
Diamond spot anvil
(OD Ø10 mm)
For plate material
Exclusive use for Rockwell superficial hardness test

810-041
V-anvil (small)
(OD Ø 40 mm, groove width 6 mm)
For shaft material (max. Ø8.4 mm)

810-044
Spot anvil
(OD Ø5.5 mm)
For plate material

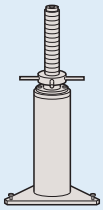


810-042
Small V-anvil
(OD Ø10 mm)
For shaft material (max. Ø16 mm)

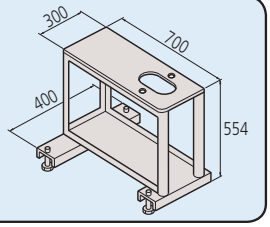


810-028
Jack rest

Testing of long object probes
(used together with anvil
or round table)



810-048
Mount for testing machine



264-504-5
Digimatic miniprocessor DP-1VR
Connecting cable not included (sold separately), please order separately. Connecting cable (1 m), part No. 937387

06ADV380E
USB input tool
Direct USB-ITN

Easy data input to PC

Mitutoyo

Wizhard Rockwell, Rockwell Superficial, Brinell Hardness Testers HR-500 Series

Series 810

These hardness testing machines give you high performance and improved productivity.
The Wizhard Rockwell, Rockwell Superficial, Brinell Hardness Testers HR-500 Series offers you the following benefits:

- Multiple test force generation for Rockwell, Rockwell Superficial and Brinell hardness.
- A dolphin-nose indenter arm gives you easy reach of interior surfaces (min. ø40mm / ø22mm, when using an optional diamond indenter) and exterior surfaces.
- Real-time electronic test force control gives you accurate loading, and completely eliminates load force overshoot.
- An indenter escape function allows you carry out continuous testing at a fixed table position, which eliminates instability caused by table retraction.
- Auto-stop table elevation and automatic preloading provide stable test force generation.
- EXPAK software for simple data collection 11AAC237

HR-521 / HR-522

HR-523

Model	HR-521	HR-522	HR-523
No.	**810-202D**	**810-203D**	**810-204D**
Price [€]	**13049,00**	**14747,00**	**17929,00**
Operation Unit	Touch-screen type	Touch-screen type	Touch-screen type
Table lifting	Manual (with automatic brake)	Manual (with automatic brake)	Power drive
Preload force	29.42 ; 98.07 N	29.42 ; 98.07 N	29.42 ; 98.07 N
Rockwell Superficial	147.1 ; 294.2 , 441.3 N	147.1 ; 294.2 , 441.3 N	147.1 ; 294.2 , 441.3 N
Rockwell	588.4 ; 980.7 ; 1471 N	588.4 ; 980.7 ; 1471 N	588.4 ; 980.7 ; 1471 N
Brinell	1839 N	61.29 ; 98.07 ; 153.2 ; 245.2 ; 294.2 ; 306.5 ; 612.9 ; 980.7 ; 1226 ; 1839 N	61.29 ; 98.07 ; 153.2 ; 245.2 ; 294.2 ; 306.5 ; 612.9 ; 980.7 ; 1226 ; 1839 N

Specifications

Load control	Automatic (load, dwell, unload)
Load dwell time	0-120 s (1 s increments)
Max. specimen height	205 mm (for standard flat anvil)
Max. specimen depth	150 mm (from the center of the indenter shaft)
Measurement Conversions to other hardness scales	HV, HK HRA, HRB, HRC, HRD, HRF, HRG, HR15T, HR30T, HR45T, HR15N, HR30N, HR45N, HS, HB, HBS, tensible strength
Statistics functions	Number of values, Max., Min., Average value, Range, Upper and lower limit, Standard deviation, Number of GO/NG evaluations, Storage of 1024 values, OFFSET, Hardness value, Test condition, Continuous measurement. X-R control card, Editing of 1024 values, Hardness conversion value, Statistical results, Cylindrical, spherical and multipoint correction.
Data output	RS-232C, Digimatic code (SPC) and Centronics
Dimensions (WxDxH)	**Main unit** 250 x 670 x 605 mm **Control unit** 165 x 260 x 105 mm
Power supply	100/120/220/240V AC, 50/60Hz
Optional Accessories	For a detailed list of standard and optional accessories, refer to the following page.
Mass	65 kg

Wizhard Rockwell, Rockwell Superficial, Brinell Hardness Testers HR-500 Series

Series 810

Additional product description and accessories for HR-500 series

Standard accessories

No.	Description
810-039	Flat table Ø64
810-040	V-anvil ø40, 120°
19BAA517	Dust protection cover

Hardness test blocks, Diamond indenter, steel balls and split level are standard accessories.

Optional accessories

No.	Description	Price €
11AAC237	EXPAK data processing program	
Anvils		
810-037	Round table Ø180	626,00
810-038	Round table Ø250	1315,00
810-041	V-anvil ø40, 90°	239,00
810-042	V-anvil Ø10, 120°	197,00
810-029	V-anvil length 400, groove width 50, 120°	2154,00
810-030	Point anvil (diamond tipped for Rockwell Superficial)	2398,00
810-043	Point anvil (Ø12)	197,00
810-044	Point anvil (Ø5,5)	197,00
Computer accessories		
264-504-5D	Digimatic Mini-Processor	445,00
Fixed microscopes for Brinell testing		
19BAA161D	Microscope 20X	573,00
19BAA318D	Microscope 40X	623,00
19BAA319D	Microscope 100X	673,00
Indenters		
19BAA292	For identers and Hardness test blocks see chapter Hardness Test Blocks	
19BAA072	For identers and Hardness test blocks see chapter Hardness Test Blocks	

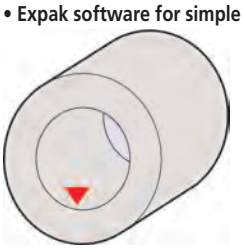
Additional accessories are available for Brinell hardness testing. Refer to the Hardness Testing Machines brochure.
For identers and Hardness test blocks see chapter Hardness Test Blocks

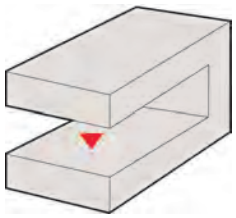
The dolphin-nose indenter arm

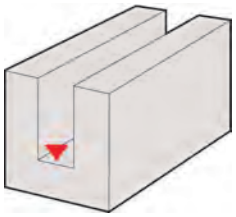
Hardness Testing Machines brochure on request

Control units

Touch-screen type
- **Touch-screen operation with a back-lit LCD graphic display.**
- **Remote selection of the test force linked to the hardness scale selection.**
- **Choice of message language in English, German, French, Spanish, Italian and Japanese for user-friendly operation.**
- **Cylindrical and spherical surface compensation.**
- **Data offset**
- **Conversion to other hardness scales.**
- **Powerful statistical processing with flexible data point editing and 1024 data memory.**
- **Measurement data editing**
- **OK/±NG tolerance judgement.**
- **Statistical processing, histogram and X-R chart**
- **Expak software for simple data collection 11AAC237**







Various shapes of specimen can be tested (a dolphin nose type indenter mechanism has been adopted). The dolphin-nose indenter mechanism allows internal measurement of pipe samples as well as the top surface of a flat sample.

Mitutoyo

Impact Type Hardness Testing Unit HARDMATIC HH-411

Series 810

This is a lightweight, digital-reading portable hardness testing instrument for metal workpieces. The Hardmatic HH-411 offers you the following benefits:

- It operates on the rebound hardness principle (standardised according to ASTM A 956).
- Measurement is conducted with hardness value L (Leeb-value) but you can convert to any desired hardness scale.
- The display automatically shows GO/±NO GO with the tolerance function set and selected.
- It has a memory function for 1800 measured values, and automatic measuring direction angle-compensation.
- Expak software gives you simple data collection 11AAC238

810-298

Sample application

Model	HH-411
No.	**810-298**
Price [€]	**5517,00**
Accuracy	±12 HL (800 HL +/- 1,5%)
	Conversion range / Increment
Vickers	43-950HV / 1 HV
Brinell	20-894 HB / 1 HB
Rockwell C	19,3-68,2 HRC / 0,1 HRC
Rockwell B	13,5-101,7 HRB / 0,1 HRB
Shore	13,2-99,3 HS / 0,1 HS
Tensile strength	499-1996 MPa / 1 MPa
Specimen Thickness	Min. 5 mm
Specimen Mass	5 kg or more
Dimensions	
Measuring/Display unit	ø28 x 175 mm / 70 x 110 x 35 mm
Display unit	7-segment LCD
Resolution	1-999 HL
Mass	320 g

UD-412 Detector
Use for inner walls of cylinders. The grip is short to allow positioning within a cylinder.

UD-413 Detector
Use for concave workpieces such as gear teeth, ball bearings, etc.

UD-414 Detector
Use for gear teeth, welded corners, etc.

Specifications

Impactor	Impact hammer with integrated carbide-ball tip, D type (ASTM A 956)
Functions	Auto angle compensation, Offset, OK/NG judgement, Hardness scale conversion, Data storage (1800 data entries), Statistical analysis (Average value, Max. value, Min. value, Dispersion), Auto sleep function, Impact counter display function
Power supply	Battery LR6 (2 pcs.) or AC adapter (optional)
Data output	RS-232C, SPC

Standard accessories

No.	Description
19BAA457	Carbide ball indenter
19BAA451	Support ring ø22
810-291	Display Unit
19BAA452	Support ring ø14 for HH-411
19BAA460	Cable detector for HH-411
19BAA258	Cleaning brush
19BAA265	Hardness Test Block

Optional accessories

No.	Description	Price €
19BAA458	Impact device for type DL	557,00
06AEG302D	AC Adapter 9V, 500mA	67,00
11AAC238	EXPAK data processing	
Computer accessories		
264-504-5D	Digimatic Mini-Processor	445,00
937387	Digimatic cable (1 m)	47,00
19BAA263	RS-232C cable	206,00
Hardness test blocks (all blocks are 115 mm diameter, 33 mm thick, 3.7 kg mass)		
19BAA243	Hardness test block 880 HLD	1246,00
19BAA244	Hardness test block 830 HLD	1246,00
19BAA245	Hardness test block 730 HLD	1246,00
Indenters		
810-288	UD-412 impactor	3172,00
810-289	UD-413 impactor	3236,00
810-290	UD-414 impactor	3999,00
Support rings		
19BAA248	Cylinder support ring R10-20 (Types D/DC)	44,00
19BAA249	Hollow cylinder support ring R14-20 (Types D/DC)	44,00
19BAA250	Spherical support ring R10-27.5 (Types D/DC)	25,00
19BAA251	Support ring for hollow sphere R13.5-20 (Types D/DC)	25,00

Hardness Testing Machines brochure on request

Digital and Analogue Durometers HARDMATIC HH-300

Series 811

These compact digital/dial durometers can test a range of different materials and offer you the following benefits:

- You can use them for testing the hardness of the materials including natural rubber, neoprene, polyesters, PVC, leather, Thiokol, nitrite rubber, wax, vinyl, cellulose acetates, glass polystyrene, etc.
- Shore hardness „A“ and „D“.

811-332

811-311

Specifications

Resolution	**Dial models** : 1° **Digital models** : 0,5°
Setting standards pcs.	ASTM D 2240 ; ISO 868 ; ISO 7619 ; DIN 83 505 ; JIS K 6253 : JIS K 7215
Indenter diameter	ø1,25 (±0,15 mm)
Pressure foot	ø18 mm
Indenter protrusion	2,5 mm
Functions	**Digital models** : Data hold, Zero-setting, SPC output, ON/OFF **Dial models :** Maximum reading hand

Optional accessories

No.	Description	Price €
Auxiliary weights		
811-017	Auxiliary weights (Shore A)	
811-018	Auxiliary weights (Shore D)	
Computer accessories		
264-504-5D	Digimatic Mini-Processor	445,00
905693	Digimatic cable (1m)	30,00
905694	Digimatic cable (2 m)	36,00
Hardness testing block sets		
64AAA590	Test block set (rubber) Hardness 20, 40, 80 Shore D	260,00
64AAA964	Test block set (rubber) Hardness 30, 60, 90 Shore A	222,00
Measuring stands		
811-012	Measuring stand for 811-333 / 811-334	2218,00
811-019	Measuring stand for 811-331 / 811-332	2218,00
19BAA180	Chuckbar	

Measuring stand

- Workstage dimension : ø90 mm
- Max. specimen height : 90 mm

Testing stand applications
These stands are used to mount Durometers. They allow constant-pressure hardness measurement by ensuring that the Durometer presses vertically on the workpiece surface at all times.
• Anyone can perform repeatable hardness measurement due to fewer possibilities of human error and measurement variations.
• The supplied weights can be attached directly to a Durometer and allow constant-pressure hardness measurement of large samples for which a stand cannot be used.
• The supplied weights are used for calibrating the spring tension of Durometers

Model	HH-331	HH-332	HH-333	HH-334
No.	**811-331**	**811-332**	**811-333**	**811-334**
Price [€]	**577,00**	**1056,00**	**577,00**	**1056,00**
Type	Dial	Digital	Dial	Digital
Scale	0-100 Shore A	0-100 Shore A	0-100 Shore D	0-100 Shore D
Measuring range (inside)	10-90 Shore A	10-90 Shore A	20-90 Shore D	20-90 Shore D
Spring force mN	550 + 75 H (Hardness reading : 10-90)	550 + 75 H (Hardness reading : 10-90)	444,5 H (Hardness reading : 20-90)	444,5 H (hardness reading : 20-90)
Tip form	Cut cone	Cut cone	Cone	Cone
Tip angle	35° (±0,25°)	35° (±0,25°)	35° (±0,25°)	35° (±0,25°)
Tip radius	-	-	0,1 (±0,012 mm)	0,1 (±0,01 mm)
Tip diameter	ø0,79 mm (±0,01 mm)	ø0,79 mm (±0,01 mm)	-	-
Power supply	-	SR44 Battery	-	SR44 Battery
Dimensions (WxDxH)	56 x 33,5 x 144 mm	60 x 28,5 x 193 mm	56 x 33,5 x 186 mm	60 x 28,5 x 193 mm
Mass g	320	310	320	310

64AAA964

Mitutoyo

Digital and Analogue Durometers HARDMATIC HH-300

Series 811

These compact digital/dial durometers can test a range of different materials and offer you the following benefits:

- You can use them for testing the hardness of the materials including natural rubber, neoprene, polyesters, PVC, leather, Thiokol, nitrite rubber, wax, vinyl, cellulose acetates, glass polystyrene, etc.
- Shore hardness „A“ and „D“.

811-336

811-335

Compact digital model

Compact dial model

Model	HH-335	HH-336	HH-337	HH-338
No.	**811-335-01**	**811-336-01**	**811-337-01**	**811-338-01**
Price [€]	**577,00**	**1056,00**	**577,00**	**1056,00**
Type	Dial	Digital	Dial	Digital
Scale	0-100 Shore A	0-100 Shore A	0-100 Shore D	0-100 Shore D
Measuring range (inside)	10-90 Shore A	10-90 Shore A	20-90 Shore D	20-90 Shore D
Spring force mN	550 + 75 H (Hardness reading : 10-90)	550 + 75 H (Hardness reading : 10-90)	444,5 H (Hardness reading : 20-90)	444,5 H (Hardness reading : 20-90)
Tip form	Cut cone	Cut cone	Cone	Cone
Tip angle	35° (±0,25°)	35° (±0,25°)	30° (±0,5°)	30° (±0,5°)
Tip radius	-	-	0,1 (±0,01 mm)	0,1 (±0,01 mm)
Tip diameter	ø0,79 (±0,01 mm)	ø0,79 (±0,01 mm)	-	-
Power supply	-	SR44 Battery	-	SR44 Battery
Dimensions (WxDxH)	56 x 33,5 x 144 mm	60 x 28,5 x 151 mm	56 x 33,5 x 144 mm	60 x 28,5 x 151 mm
Mass g	300	290	300	290

64AAA964

Specifications

Resolution	**Dial models** : 1° **Digital models** : 0,5°
Setting standards pcs.	ASTM D 2240 ; ISO 868 ; ISO 7619 ; DIN 53 505 ; JIS K 6253 : JIS K 7215
Indenter diameter	ø1,25 (±0,15 mm)
Pressure foot	44 x 18 mm
Indenter protrusion	2,5 mm
Functions	**Digital models** : Data hold, Zero-setting, SPC output, ON/OFF **Dial models :** Peak retaining hand

Optional accessories

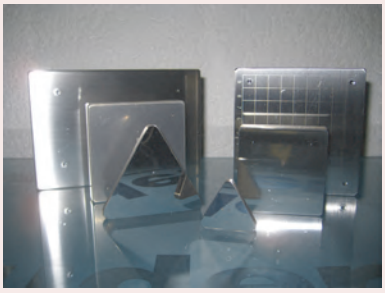
No.	Description	Price €
Auxiliary weights		
811-017	Auxiliary weights (Shore A)	
811-018	Auxiliary weights (Shore D)	
Computer accessories		
264-504-5D	Digimatic Mini-Processor	445,00
905693	Digimatic cable (1m)	30,00
905694	Digimatic cable (2 m)	36,00
Hardness testing block sets		
64AAA590	Test block set (rubber) Hardness 20, 40, 80 Shore D	260,00
64AAA964	Test block set (rubber) Hardness 30, 60, 90 Shore A	222,00
Measuring stands		
811-013	Measuring stand for 811-335-01 / 811-336-01	2218,00
811-014	Measuring stand for 811-337-01 / 811-338-01	2218,00
19BAA180	Chuckbar	

Measuring stand

- Workstage dimension : ø90 mm
- Max. specimen height : 90 mm

Hardness Testing Machines brochure on request

Hardness Test Blocks



Hardness Test Blocks

Today's hardness standards recommend, additional to annual calibration and verification, a daily control of the hardness testing machines. In order to document, calculate and present this for the hardness test blocks distributed by an external manufacturer, an Microsoft® Excel®-sheed has been created, in which calibration values, limiting deviation, repeatability of the hardness testing machine and the uncertainty of measurement of the hardness test block are integrated. The program may be downloaded and additional information may be obtained by taking to the following URL: http://www.mpanrw.de . After inserting MPA NRW number and calibration value, the download can be started by clicking on OK. There are also demo versions as examples available. The program shows in text form, whether the values predetermined by standard, are reached by the machine or not. The program offers two ways to determine the uncertainty of measurement. Firstly, without correction of error according to UNCERT proposal SMT of EU and secondly, with correction of error from nominal value.

How to order: select hardness scale (second column in table) and needed value. Then combine order number from first column with suffix above hardness value like in the following example. For 60HR45N hardness test block order BU107-11. All hardness test blocks are calibrated by German national institute MPA NRW and supplied with a DKD-certificate.

Other hardness test blocks in request.

Brinell (triangle, 70x70x70x6mm 130 g) standard hardness value

No.	Description	01	02	03	05	06	07	08	09	10	11
BU0310-	HBW 2,5/31,25	100									
BU0311-	HBW 2,5/62,5	100	150	200							
BU0312-	HBW 2,5/187,5	100	150	200	250	300	350	400	450	500	600
BU0314-	HBW 2,5/15625	(100)									

Brinell (triangle polished, 70x70x70x6mm 130 g standard hardness value hardness values in brackets are nonstandard values

No.	Description	01	03	05	06	07	08	09	10
BU0404-	HBW 1 / 5	(140)							
BU0405-	HBW 1 / 10	140	(240)						
BU0406-	HBW 1 / 30	140	240	300	350	400	450	540	620

Hardness Test Blocks Steel
Brinell (square, 100x100x16mm 1,3 kg) standard hardness valuesize 150x100x16mm 1,95 kg

No.	Description	02
BU0201-	HBW 5/125	(150*)

Knoop (triangle polished, 35x35x35x6mm 30 g standard hardness value *hardness value 140 HK only available as macro size block (70x70x70x6mm 130 g)

No.	Description	02	04	06	07	08	09	10	11	12	14
BU0701-	HK 0,005	140*	240								
BU0702-	HK 0,01	140*	240								
BU0703-	HK 0,015	140*	240	300	350	400	450	540	620	720	
BU0705-	HK 0,025	140*	240	300	350	400	450	540	620	720	840
BU0707-	HK 0,05	140*	240	300	350	400	450	540	620	720	840
BU0708-	HK 0,1	140*	240	300	350	400	450	540	620	720	840
BU0709-	HK 0,2	140*	240	300	350	400	450	540	620	720	840
BU0710-	HK 0,3	140*	240	300	350	400	450	540	620	720	840
BU0711-	HK 0,5	140*	240	300	350	400	450	540	620	720	840
BU0712-	HK 1	140*	240	300	350	400	450	540	620	720	840
BU0713-	HK 2	140*	240	300	350	400	450	540	620	720	840

Hardness Test Blocks

Rockwell (square, 60x60x16mm 465 g) standard hardness value

No.	Description	01	02	03	04	05	06	07	08	09	10	11	12	13	14
BU0101-	HRA	40	49	55	59,8	62,4	65	67,6	70,2	72,8	75,4	78,1	80,7	82	83,4
BU0102-	HRB (S/W)	60	75	90	100										
BU0103-	HRC				20	25	30	35	40	45	50	55	60	62/63	65
BU0104-	HRF (S/W)	90	95		115										
BU0105-	HR 15 N				67,7	70,5	73,4	76,2	79,1	81,9	84,7	87,5	89,9	90,8	91,3
BU0106-	HR 30 N				41,2	45,6	50,1	54,6	59,1	63,9	68	72,1	76,8	79	81,2
BU0107-	HR 45 N				19,7	25,4	31,2	37	42,8	48,5	54,3	60	65,7	68,5	71,4
BU0108-	HR 15 T (S/W)	80	86,5	91	92,2										
BU0109-	HR 30 T (S/W)	56,5	69,2	77,3	82										
BU0110-	HR 45 T (S/W)	33,5	52,8	64,6	72,1										
BU0115-	HRG (S/W)		62		81	87	94								
BU0116-	HRE (S/W)	95													
BU0117-	HRD				40	44	48	51	55	59	63	67	71	73	75
BU0118-	HRK S/W)	76	97												

Vickers macro (traingle polished , 70 x 70 x 70 x 6 mm 130g) standard hardness

No.	Description	02	04	05	06	08	09	10	11	12	14
BU0601-	HV 1	140	240			400	450	540	620	720	840
BU0602-	HV 5	140	240		300	400	450	540	620	720	840
BU0603-	HV 20	140	240		300	400	450	540	620	720	840
BU0604-	HV 30	140	240		300	400	450	540	620	720	840
BU0605-	HV 50	140	240	300		400	450	540	620	720	840
BU0612-	HV 10	140	240		300	400	450	540	620	720	840
BU0613-	HV 3	140	240		300	400	450	540	620	720	840
BU0614-	HV 2	140	240		300	400	450	540	620	720	840

Vickers micro (triangle polished, 35x35x35x6mm 30 g) standard hardness value hardness values in brackets are nonstandard values, diagonal <20µm

No.	Description	04	06	07	08	09	10	11	12	14
BU0501-	HV 0,01	(240)								
BU0502-	HV 0,015	(240)	(300)							
BU0503-	HV 0,025	(240)	(300)							
BU0505-	HV 0,03	(300)	(300)	(350)	(400)	(450)				
BU0506-	HV 0,5	(240)	(300)	(350)	(400)	(450)	(540)	(620)	(720)	(840)
BU0507-	HV 0,1	240	300	(350)	(400)	(450)	(540)	(620)	(720)	(840)
BU0508-	HV 0,2	240	300	350	400	450	(540)	620	(720)	840
BU0510-	HV 0,3	240	300	350	400	450	540	620	720	840
BU0511-	HV 0,5	240	300	350	400	450	540	620	720	840
BU0512-	HV 1	240	300	350	400	450	540	620	720	840
BU0513-	HV 2	240	300	350	400	450	540	620	720	840
BU0514-	HV 3	240	300	350	400	450	540	620	720	840
BU0515-	HV 5	240	300	350	400	450	540	620	720	840
BU0516-	HV 10	240	300	350	400	450	540	620	720	840

Hardness Test Blocks

Hardness Test Blocks Aluminium

Brinell (150x100x16mm 650 g) standard hardness value

No.	Description	30	31	32	Price [€]
BU1707-	HBW 5/62,5	(60)	(80)		801,00
BU1708-	HBW 5/125	60	80	100	801,00
BU1709-	HBW 5/250	60	80	100	801,00

Brinell (75x75x16mm 250 g) standard hardness value hardness values in brackets are nonstandard values

No.	Description	30	31	32	Price [€]
BU1803-	HBW 2,5/15625	(60)	(80)		801,00
BU1804-	HBW 2,5/31,25	60	80	100	801,00
BU1805-	HBW 2,5/62,5	60	80	100	801,00

Rockwell (75x75x16mm 250 g) standard hardness value

No.	Description	02	04	06	07	08	09	12	14	Price [€]
BU1601-	HRB (S/W				35		37	48	60	801,00
BU1602-	HRE (S/W)	36	67		37		85	49	92	801,00
BU1603-	HRF (S/W)	38	66		39		84	50	90	801,00
BU1604-	HRH (S/W)	40	93							801,00
BU1605-	HRK (S/W)	41	36		42		61	52	72	801,00
BU1606-	HR 15 T (S/W)	43	66		44		76	53	80	801,00
BU1607-	HR 30 T (S/W)	45	27	46		48		54	56,5	801,00
BU1608-	HR 45 T (S/W)				47		20	55	33,5	801,00

Vickers (75x75x16mm 250 g) standard hardness value

No.	Description	30	31	32	Price [€]
BU1900-	HV 1	60	80	100	801,00
BU1901-	HV 2	60	80	100	801,00
BU1902-	HV 3	60	80	100	801,00
BU1903-	HV 5	60	80	100	801,00
BU1904-	HV 10	60	80	100	801,00
BU1905-	HV 20	60	80	100	801,00
BU1906-	HV 30	60	80	100	801,00
BU1907-	HV 50	60	80	100	801,00

Indenters

Brinell

No.	Ball Indenter	Ball only	Form	Machine type	Comment	Price [€]
19BAA162MPA		5mm	hardmetal	HR-100-200-300-400-500 Series Durotwin HV-100 Series	with DKD certificate	75,00
19BAA163MPA		10mm	hardmetal	HR-100-200-300-400-500 Series Durotwin HV-100 Series	with DKD certificate	88,00
19BAA277	1mm		with hardmetal ball	HR-100-200-300-400-500 Series Durotwin HV-100 Series	without certificate	286,00
19BAA279	2,5mm		with hardmetal ball	HR-100-200-300-400-500 Series Durotwin HV-100 Series	without certificate	286,00
19BAA280	5mm		with hardmetal ball	HR-100-200-300-400-500 Series Durotwin HV-100 Series	without certificate	286,00
19BAA281MPA		1mm	hardmetal	HR-100-200-300-400-500 Series Durotwin HV-100 Series	with DKD certificate	75,00
19BAA283MPA		2,5mm	hardmetal	HR-100-200-300-400-500 Series Durotwin HV-100 Series	with DKD certificate	75,00
19BAA284	10mm		with hardmetal ball	HR-100-200-300-400-500 Series Durotwin HV-100 Series	without certificate	399,00

All Mitutoyo indenters and hardmetal balls, marked with MPA, are calibrated by German national Institute MPA NRW and supplied with a DKD certificate

Hardness Test Blocks

Knoop

No.	Diamond Indenter	Form	Machine type	Price [€]
19BAA062MPA	HK 0,01	HM/MVK	HM-100 HM-200 MVK Series with DKD certificate	**729,00**
19BAA063MPA	HK 0,2	HV/AVK	HV-100 AVK Series with DKD certificate	**729,00**

All Mitutoyo indenters and hardmetal balls, marked with MPA, are calibrated by German national Institute MPA NRW and supplied with a DKD certificate

Rockwell

No.	Diamond Indenter	Ball Indenter	Ball only	Form	Machine type	Comment	Price [€]
19BAA072ASTM	Rockwell diamond			standard	all Mitutoyo Rockwell machines	ASTM E-18	**862,00**
19BAA072MPA	Rockwell diamond			standard	all Mitutoyo Rockwell machines	with DKD certificate	**862,00**
19BAA072MPA10	Rockwell diamond			standard	all Mitutoyo Rockwell machines	extended measuring range down to 10HRC	**905,00**
19BAA072MPAL	Rockwell diamond			slim 6mm wide	all Mitutoyo Rockwell machines	with DKD certificate	**774,00**
19BAA073MPA	Rockwell diamond			standard	all Mitutoyo Rockwell machines	DIN EN ISO 6508-3	**1038,00**
19BAA292MPA	Rockwell diamond			short for Ø22mm	HR 500 Series	with DKD certificate	**734,00**
19BAA504		3175 mm		with hardmetal ball	all Mitutoyo Rockwell machines	without certificate	**373,00**
19BAA505		6,35 mm		with hardmetal ball	all Mitutoyo Rockwell machines	without certificate	**373,00**
19BAA506		12,7 mm		with hardmetal ball	all Mitutoyo Rockwell machines	without certificate	**374,00**
19BAA507MPA			1,5875 mm	hardmetal	all Mitutoyo Rockwell machines	with DKD certificate	**77,00**
19BAA508MPA			3175 mm	hardmetal	all Mitutoyo Rockwell machines	with DKD certificate	**77,00**
19BAA509MPA			6,35 mm	hardmetal	all Mitutoyo Rockwell machines	with DKD certificate	**89,00**
19BAA510MPA			12,7 mm	hardmetal	all Mitutoyo Rockwell machines	with DKD certificate	**89,00**
19BAA515		1,5875 mm		with hardmetal ball	all Mitutoyo Rockwell machines	without certificate	**373,00**

All Mitutoyo indenters and hardmetal balls, marked with MPA, are calibrated by German national Institute MPA NRW and supplied with a DKD certificate

Vickers

No.	Diamond Indenter	Form	Machine type	Comment	Price [€]
19BAA059MPA	HV 0,01	HM/MVK	HM-100 HM-200 MVK Series	with DKD certificate	**785,00**
19BAA060MPA	HV 0,2	HV/AVK	HV-100 AVK Series	with DKD certificate	**594,00**

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Quick Guide to Precision Measuring Instruments

Hardness Testing Machines

Hardness Test Methods and Guidelines for Selection of a Hardness Testing Machine

Material \ Test Method	Microhardness (Micro-Vickers)	Micro surface material characteristics	Vickers	Rockwell	Rockwell Superficial	Brinell	Shore	For sponge, rubber, and plastic	Rebound type portable
IC wafer	●	●							
Carbide, ceramics (cutting tool)		▲	●	●					
Steel (heat-treated material, raw material)	●	▲	●	●	●		●		●
Non-ferrous metal	●	▲	●	●	●				●
Plastic		▲		●				●	
Grinding stone				●					
Casting						●			
Sponge, rubber								●	
Form									
Thin metal sheet (safety razor, metal foil)	●	●	●		●				
Thin film, plating, painting, surface layer (nitrided layer)	●	●							
small parts, acicular parts (clock hand, sewing-machine needle)	●	▲							
Large specimen (structure)						●	●		●
Metallic material configuration (hardness for each phase of multilayer alloy)	●	●							
Plastic plate	▲	▲		●				●	
Sponge, rubber plate								●	
Application									
Strength or physical property of materials	●	●	●	●	●	●	●	●	▲
Heat treatment process	●		●	●	●		▲		▲
Carburized case depth	●		●						
Decarburized layer depth	●		●		●				
Flame or high-frequency hardening layer depth	●		●	●					
Hardenability test			●	●					
Maximum hardness of a welded spot			●						
Weld hardness			●	●					
High-temperature hardness (high-temperature characteristics, hot-workability)			●						
Fracture toughness (ceramics)	●		●						

Key: ● Well-suited ▲ Reasonably suited

Methods of Hardness Measurement

(1) Vickers

Vickers hardness is a test method that has the widest application range, allowing hardness inspection with an arbitrary test force. This test has an extremely large number of application fields particularly for hardness tests conducted with a test force less than **9.807N** (1kgf). As shown in the following formula, Vickers hardness is a value determined by dividing test force F (N) by contact area S (mm^2) between a specimen and an indenter, which is calculated from diagonal length d (mm, mean of two directional lengths) of an indentation formed by the indenter (a square pyramidal diamond , opposing face angle θ=136°) in the specimen using a test force F (N). k is a constant ($1/g$=1/9.80665).

$$HV=k\frac{F}{S}=0.102\frac{F}{S}=0.102\frac{2F\sin\frac{\theta}{2}}{d^2}=0.1891\frac{F}{d^2}$$

F:N
d:mm

The error in the calculated Vickers hardness is given by the following formula. Here, Δd1, Δd2, and 'a' represent the measurement error that is due to the microscope, an error in reading an indentation, and the length of an edge line generated by opposing faces of an indenter tip, respectively. The unit of $\Delta\theta$ is degrees.

$$\frac{\Delta HV}{HV}\fallingdotseq\frac{\Delta F}{F}-2\frac{\Delta d1}{d}-2\frac{\Delta d2}{d}-\frac{a^2}{d^2}\,3.5\times10^{-3}\Delta\theta$$

(2) Knoop

As shown in the following formula, Knoop hardness is a value obtained by dividing test force by the projected area A (mm^2) of an indentation, which is calculated from the longer diagonal length d (mm) of the indentation formed by pressing a rhomboidal diamond indenter (opposing edge angles of 172°30' and 130°) into a specimen with test force F applied. Knoop hardness can also be measured by replacing the Vickers indenter of a microhardness testing machine with a Knoop indenter.

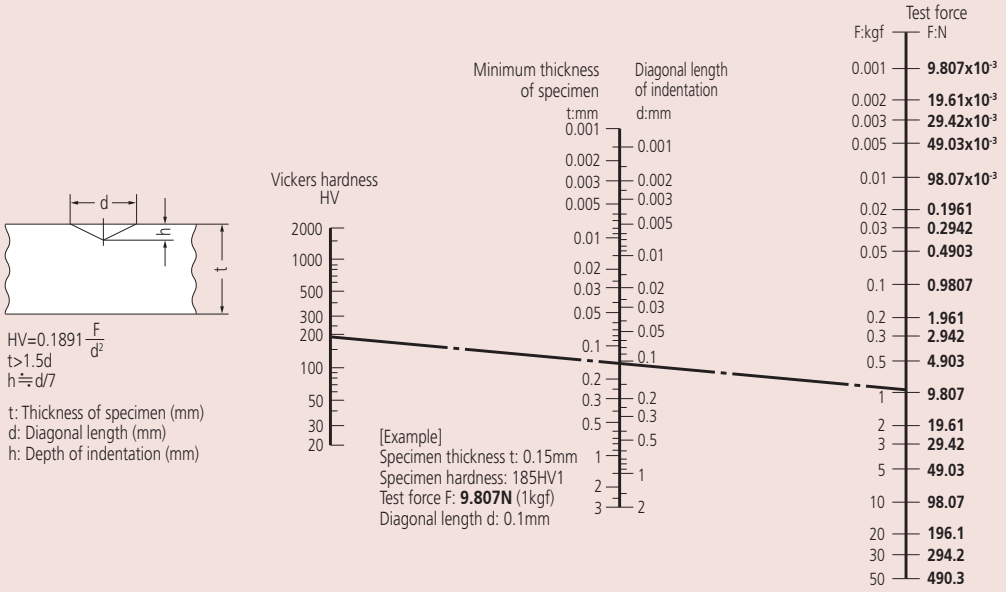
$$HK=k\frac{F}{A}=0.102\frac{F}{A}=0.102\frac{F}{cd^2}=1.451\frac{F}{d^2}$$

F:N
d:mm
c:Constant

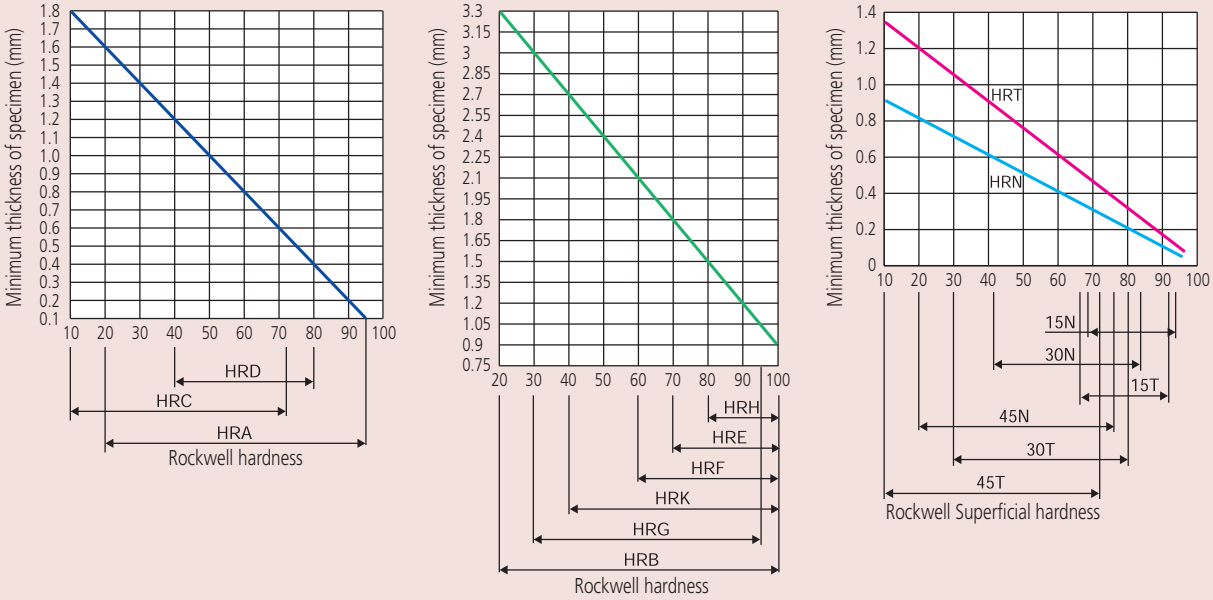
(3) Rockwell and Rockwell Superficial

To measure Rockwell or Rockwell Superficial hardness, first apply a preload force and then the test force to a specimen and return to the preload force using a diamond indenter (tip cone angle: 120°, tip radius: 0.2mm) or a sphere indenter (steel ball or carbide ball). This hardness value is obtained from the hardness formula expressed by the difference in indentation depth h (μm) between the preload and test forces. Rockwell uses a preload force of 98.07N, and Rockwell Superficial 29.42N. A specific symbol provided in combination with a type of indenter, test force, and hardness formula is known as a scale. Japanese Industrial Standards (JIS) define various scales of related hardness.

Relationship between Vickers Hardness and the Minimum Thickness of a Specimen



Relationship between Rockwell/Rockwell Superficial Hardness and the Minimum Thickness of a Specimen



Rockwell Hardness Scales

Scale	Indenter	Test force (N)	Application
A	Diamond	588.4	Carbide, thin steel sheet
D		980.7	Case-hardening steel
C		1471	Steel (greater than 100HRB or less than 70HRC)
F	Ball with a diameter of 1.5875mm	588.4	Bearing metal, annealed copper
B		980.7	Brass
G		1471	Hard aluminum alloy, beryllium copper, phosphor bronze
H	Ball with a diameter of 3.175mm	588.4	Bearing metal, grinding stone
E		980.7	Bearing metal
K		1471	Bearing metal
L	Ball with a diameter of 6.35mm	588.4	Plastic, lead
M		980.7	
P		1471	
R	Ball with a diameter of 12.7mm	588.4	Plastic
S		980.7	
V		1471	

Rockwell Superficial Hardness Scales

Scale	Indenter	Test force (N)	Application
15N	Diamond	147.1	Thin, hard layer on steel such as a carburized or nitrided layer
30N		294.2	
45N		441.3	
15T	Ball with a diameter of 1.5875mm	147.1	Thin metal sheet of soft steel, brass, bronze, etc.
30T		294.2	
45T		441.3	
15W	Ball with a diameter of 3.175mm	147.1	Plastic, zinc, bearing alloy
30W		294.2	
45W		441.3	
15X	Ball with a diameter of 6.35mm	147.1	Plastic, zinc, bearing alloy
30X		294.2	
45X		441.3	
15Y	Ball with a diameter of 12.7mm	147.1	Plastic, zinc, bearing alloy
30Y		294.2	
45Y		441.3	

Calibration Blocks: Test force Rockwell and Rockwell Superficial hardness

No.		Rockwell hardness			Rockwell Superficial hardness		
Preliminary test force	**N**	**98,07**			**29,42**		
	kgf	10			3		
Test force	**N**	**588,4**	**980,7**	**1471**	**147,1**	**294,2**	**441,3**
	kgf	60	100	150	15	30	45
Diamond indenter		A	D	C	15N	30N	45N
Inch ball / mm ball	Ø 1/16" / **1.5875 mm**	F	B	G	15T	30T	45T
	Ø 1/8" / **3.1750 mm**	H	E	K	15W	30W	45W
	Ø 1/4" / **6.3500 mm**	L	M	P	15X	30X	45X
	Ø 1/2" / **12.7000 mm**	R	S	V	15Y	30Y	45Y