Mitutoyo

Mitutoyo Corporation
80th Anniversary
Since 1934

Hardness Testing Machines
HM/HV/MZT/HR/HH Series

Test Equipment and Seismometers

Catalog No. E17001(2)

Mitutoyo

HARDNESS TESTING MACHINES

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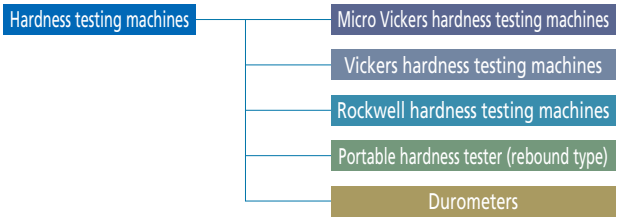
Introduction

Hardness testing machine lineup

Among the many types of material testing equipment, hardness testing machines provide the simplest and most economical testing methods and they play a vital role in research through to production and commercial transactions. Mitutoyo meets diverse needs by offering a broad lineup of efficient machines for testing the hardness of many kinds materials ranging from hard metals to soft plastics and rubber.



CE compliance
The products in this brochure are safe designs conforming to low voltage, EMC and machinery directives of the EU. (Excludes some products.)

CE

Overview of SHT Series standard hardness testing machines

SHT Series standard hardness testing machines possess all the characteristics required to serve as a benchmark for hardness testing machines, namely high accuracy, stability, reproducibility and quality. SHT Series machines are ideal for use as specified sub-primary or secondary standards, for example as specified standard instruments, under the domestic traceability framework currently being reviewed in Japan, as well as verification standards for general users. The SHT Series lineup comprises four standard hardness testing machines supporting the four most important types of hardness measurement in the industrial sector—Rockwell hardness standard testing machine SHT-31, Vickers hardness standard testing machine SHT-41, Brinell hardness standard testing machine SHT-5, and Shore hardness standard testing machine SHT-6. All four models were adopted by Korea's metrology institute, the Korea Research Institute of Standards and Science (KRISS), in 1997. In 2001, Taiwanese metrology institute the Center for Measurement Standards of the Industrial Technology Research Institute (ITRI) adopted the SHT-41. And in 2003, the National Institute of Metrology (Thailand) (NIMT) adopted SHT-31, SHT-41 and SHT-6. In Japan, the SHT-31 delivered to the National Research Laboratory of Metrology of the Agency of Industrial Science and Technology (now the National Institute of Advanced Industrial Science and Technology, or AIST) was made a specified standard instrument in 1998 under Ministry of International Trade and Industry (MITI) Public Notice No. 587. And in March 2001, the Vickers hardness standard testing machine (SHT-41) held by AIST was made a specified standard instrument alongside the Rockwell hardness standard testing machine (SHT-32) under Ministry of Economy, Trade and Industry (METI) Public Notice No. 210. SHT Series models are living up to their name as standard hardness testing machines.

Rockwell hardness standard testing machine SHT-31
(main unit and control panel, shown with optional accessories)

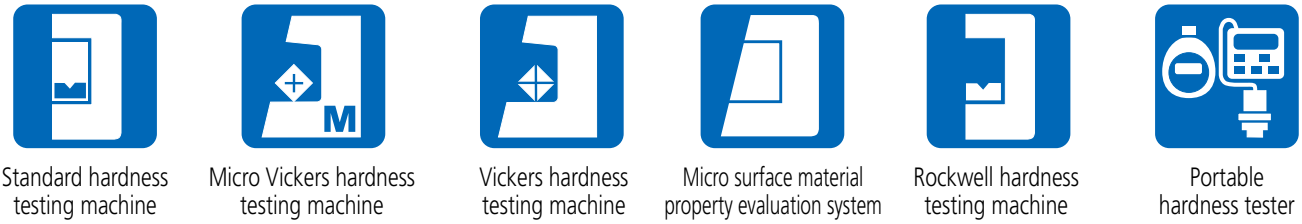
Vickers hardness standard testing machine SHT-41

Brinell hardness standard testing machine SHT-5

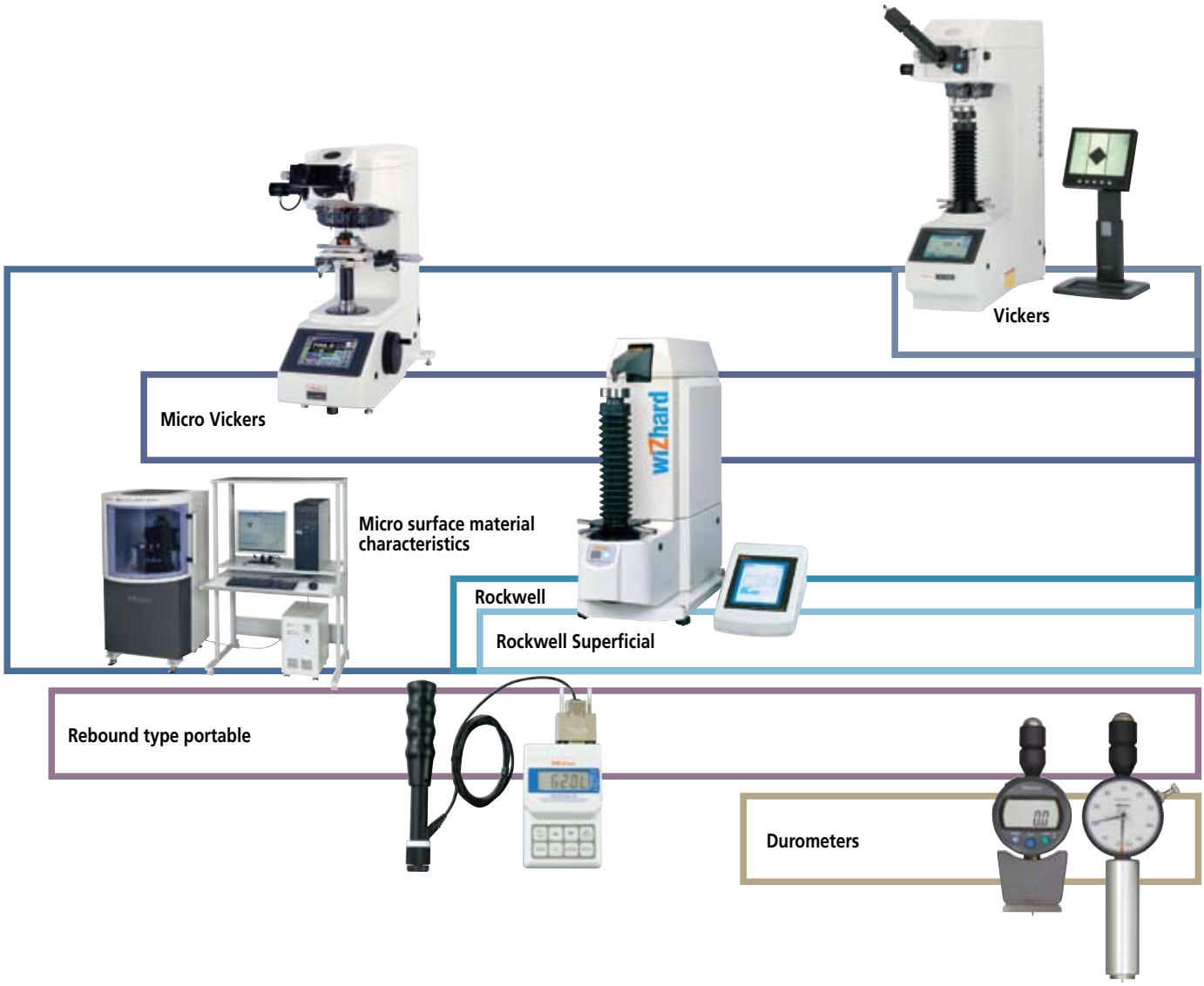
Shore hardness standard testing machine SHT-6

Hardness testing machine lineup

Hardness testing machine icons



Standard hardness testing machine | Micro Vickers hardness testing machine | Vickers hardness testing machine | Micro surface material property evaluation system | Rockwell hardness testing machine | Portable hardness tester



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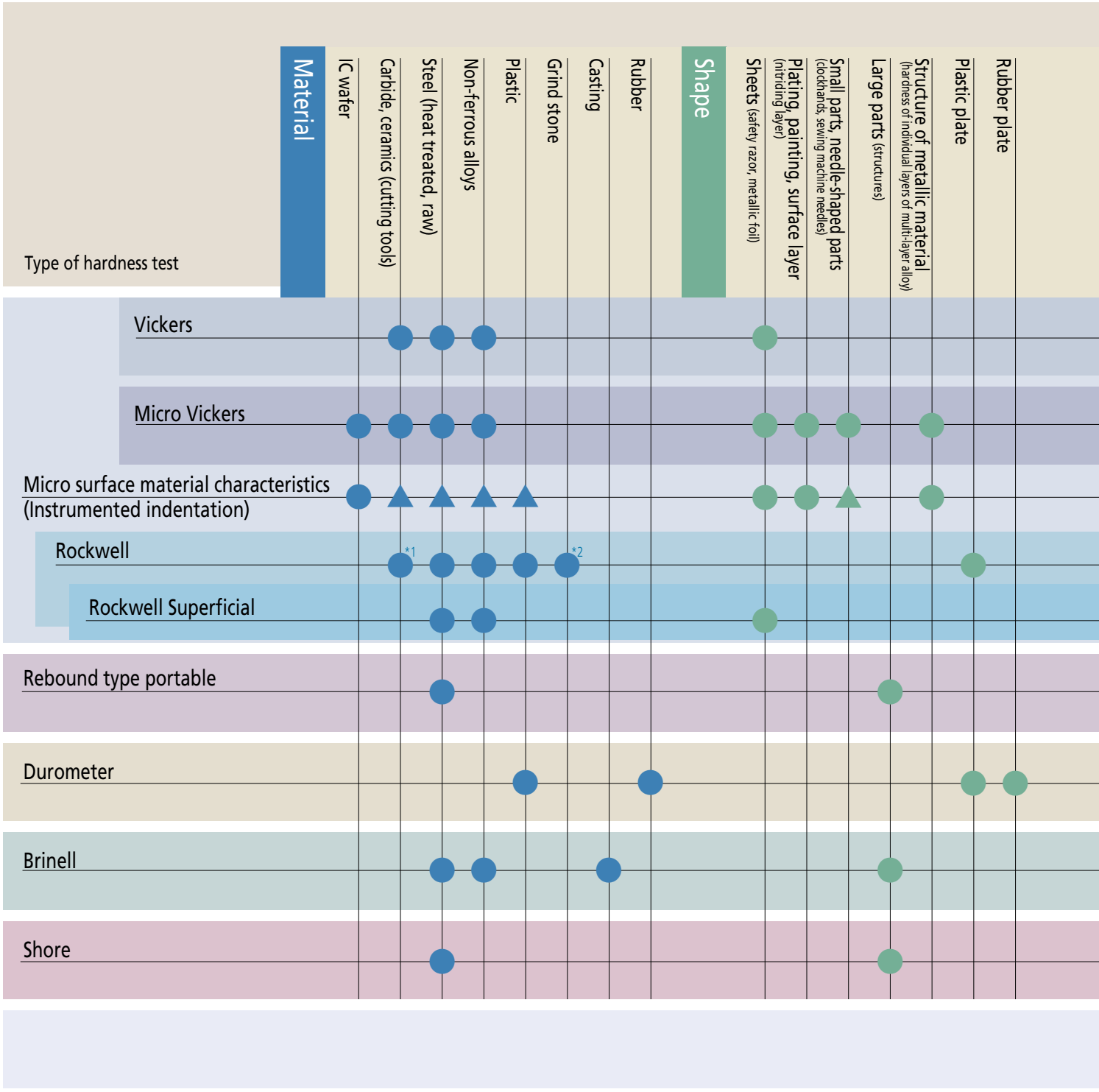
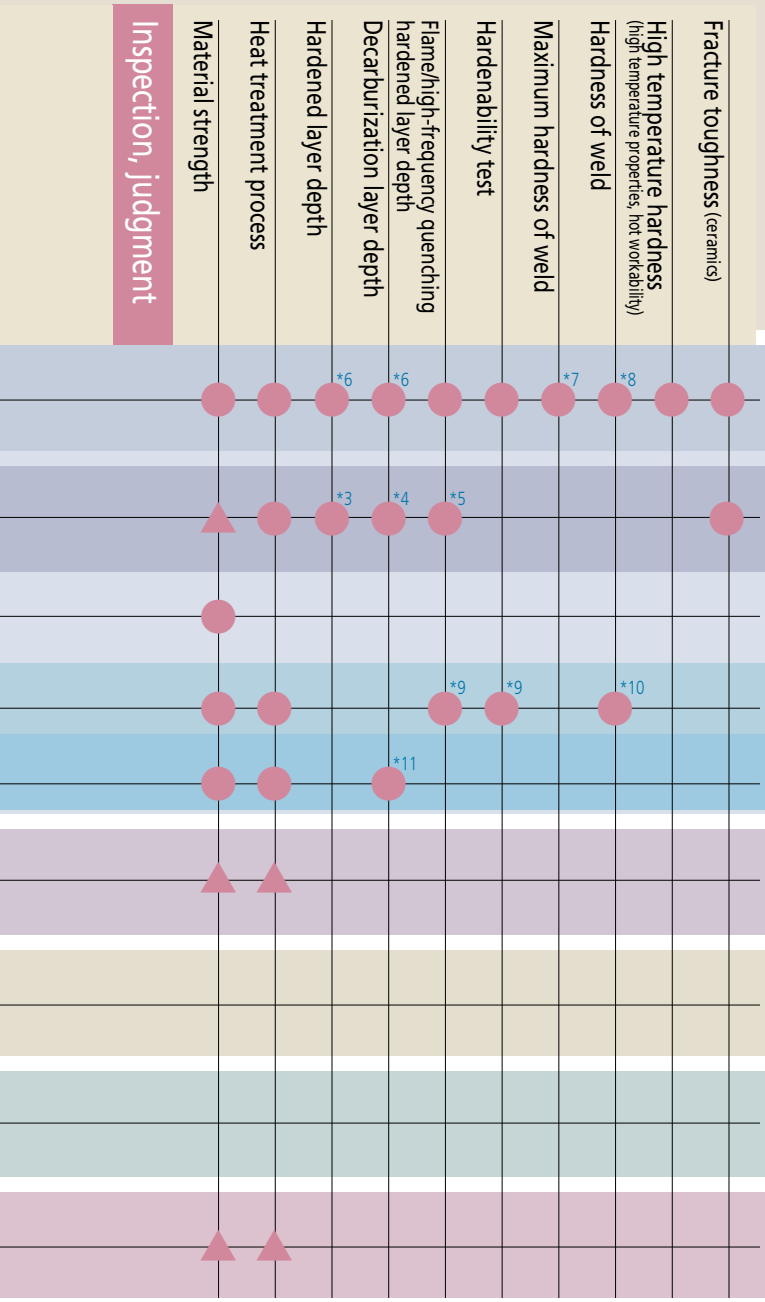
Types of hardness test and selection criteria for hardness testing machines



*● : Suitable ▲ : Fairly suitable *1 : A scale *2 : H scale *3 : Test force 2.942N 9.807N *4 : Test force 0.9807N 9.807N *5 : Test force 2.942N or more



*6 : Test force 9.807N *7 : Test force 98.07N *8 : Test force 294.2N *9 : C scale *10 : B, C scale *11 : 15N, 30N scale

Vickers Hardness Testing Machine Series
Wide range of test force available between

Micro Vickers hardness testing machines

Advanced model HM-200 Series

Test force: **0.4903~19610mN**

Economy model
HM-100 Series

810-124 HM-101

810-125 HM-102

0.4903mN and 490.3N

Vickers hardness testing machines

Advanced model HV-100 Series

Test force: **2.942~490.3N**

Economy model AVK-C0

810-160 AVK-C0

Advanced model provides flexible system configuration suitable

Micro Vickers hardness testing machines

System A

HM-210A/HM-220A

All-in-one model with simple touch-panel operation

Features

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

Camera and monitor are optional accessories.

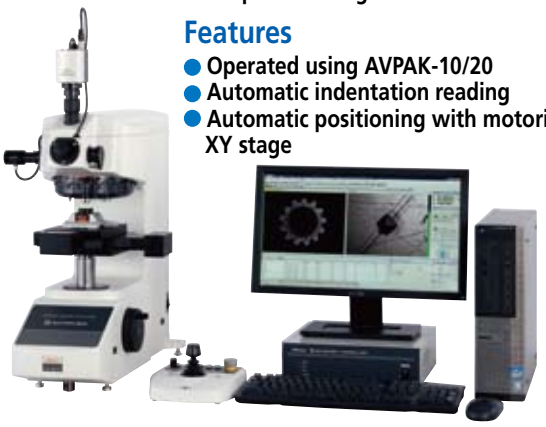
System C

HM-210C/HM-220C

Improves work efficiency for multi-point testing

Features

- **Operated using AVPAK-10/20**
- **Automatic indentation reading**
- **Automatic positioning with motorized XY stage**



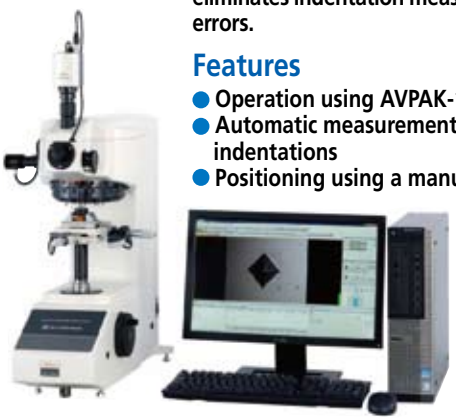
System B

HM-210B/HM-220B

Automatic dimensions by AVPAK-10/20 eliminates indentation measurement errors.

Features

- **Operation using AVPAK-10/20**
- **Automatic measurement of indentations**
- **Positioning using a manual XY stage**



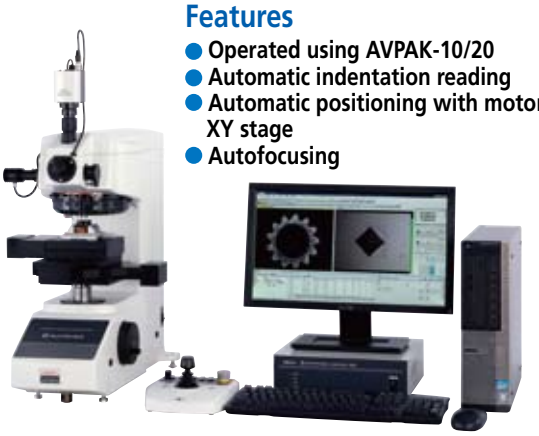
System D

HM-210D/HM-220D

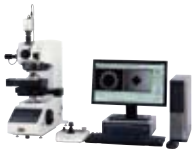
Top-end model with autofocus

Features

- **Operated using AVPAK-10/20**
- **Automatic indentation reading**
- **Automatic positioning with motorized XY stage**
- **Autofocusing**



* With regarding to the AVPAK-20, not for use and/or export to the United States of America.

Functions	System A	System B	System C	System D
				
Focusing	Manual	Manual	Manual	Auto
Testing action	Single point	Single point	Programmed multi-point	Programmed multi-point
Test-point positioning	Manual XY stage	Manual XY stage	Motorized XY stage	Motorized XY stage
Measuring indentations	Measuring microscope	Automatic (AVPAK-10/20)	Automatic (AVPAK-10/20)	Automatic (AVPAK-10/20)
Camera (for observing and measuring indentations)	Monochrome, 300,000 pixels*	Color, 3 million pixels	Color, 3 million pixels	Color, 3 million pixels
Operating the main unit	Touch panel	PC (AVPAK-10/20)	PC (AVPAK-10/20)	PC (AVPAK-10/20)

*When a video camera unit is used (pixel count of the camera itself: 380,000)

for many applications.

Vickers hardness testing machines

System A — HV-110A/HV-120A

All-in-one model with simple touch-panel operation

Features

- Touch-panel operation
- Measurement of indentation dimensions using a measuring microscope

Camera and monitor are optional accessories.

System C — HV-110C/HV-120C

Improves work efficiency for multi-point testing

Features

- Operated using AVPAK-10/20
- Automatic indentation reading
- Automatic positioning with motorized XY stage

System B — HV-110B/HV-120B

Automatic dimensions by AVPAK-10/20 eliminates indentation measurement errors.

Features

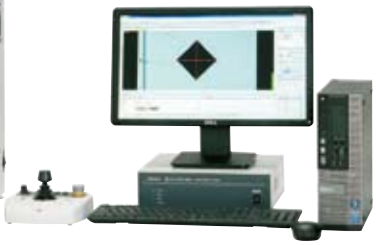
- Operation using AVPAK-10/20
- Automatic measurement of indentations

System D — HV-110D/HV-120D

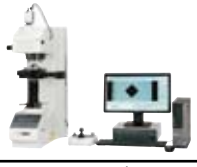
Top-end model with autofocus

Features

- Operated using AVPAK-10/20
- Automatic indentation reading
- Automatic positioning with motorized XY stage
- Autofocusing



* With regarding to the AVPAK-20, not for use and/or export to the United States of America.

Functions	System A	System B	System C	System D
				
Focusing	Manual	Manual	Manual	Auto
Testing action	Single point	Single point	Programmed multi-point	Programmed multi-point
Test-point positioning	Manual XY stage*1	Manual XY stage*1	Motorized XY stage	Motorized XY stage
Measuring indentations	Measuring microscope	Automatic (AVPAK-10/20)	Automatic (AVPAK-10/20)	Automatic (AVPAK-10/20)
Camera (for observing and measuring indentations)	Monochrome, 300,000 pixels*2	Color, 3 million pixels	Color, 3 million pixels	Color, 3 million pixels
Operating the main unit	Touch panel	PC (AVPAK-10/20)	PC (AVPAK-10/20)	PC (AVPAK-10/20)

*1 Manual XY stage (optional accessory) can be supplied.
*2 When a video camera unit is used (pixel count of the camera itself: 380,000)

Advanced model ensures further productivity improvement

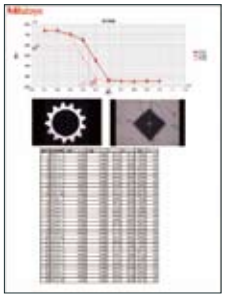
AVPAK-10/20 software for controlling Systems B and C allow seamless handling such as screen layout for control, testing status and result display.

* With regarding to the AVPAK-20, not for use and/or export to the United States of America.
** Systems B and C, some functions have restrictions. For details, contact your local Mitutoyo sales office.
*** For Stitching, Auto trace, and Contour detection are functions only for AVPAK-20.

Introduction of software AVPAK-10/20 function for controlling system B/C/D

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.

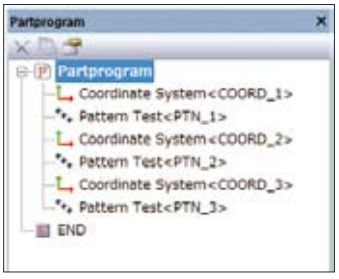


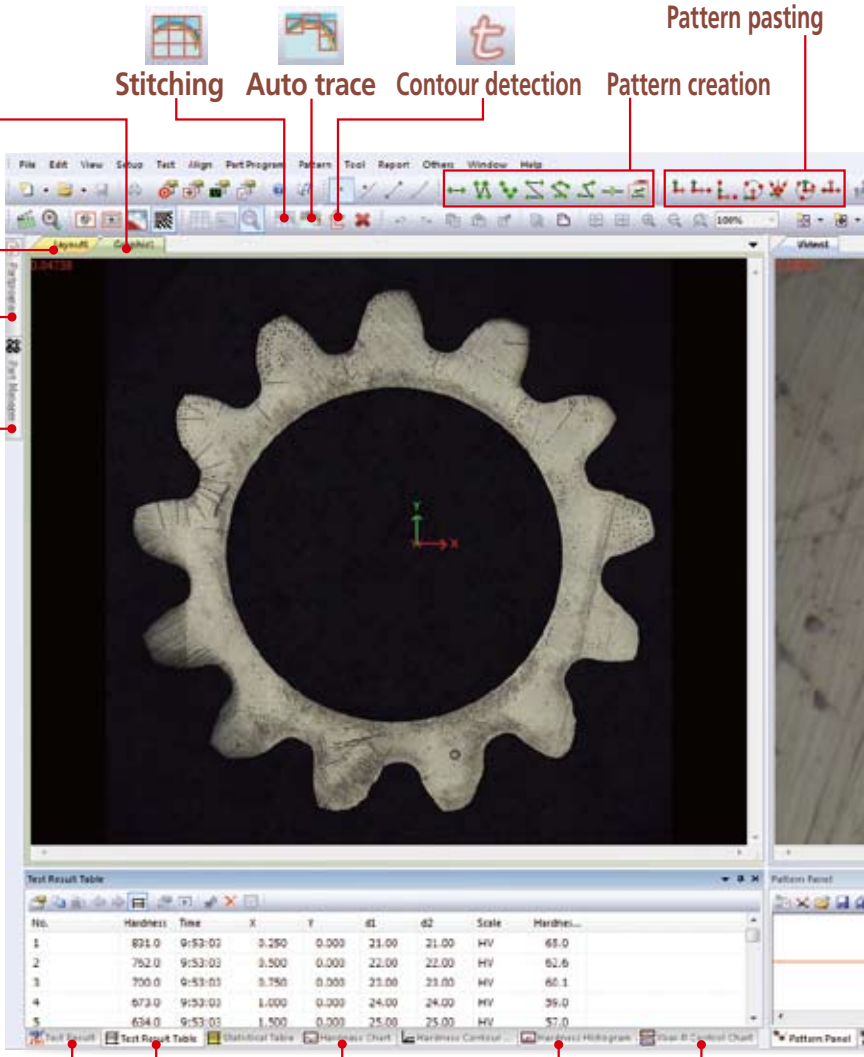
Layout view

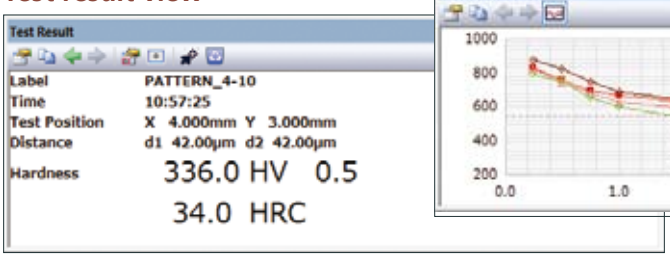
Photos from individual views, graphs, tables, etc., can be laid out freely to help with report creation.

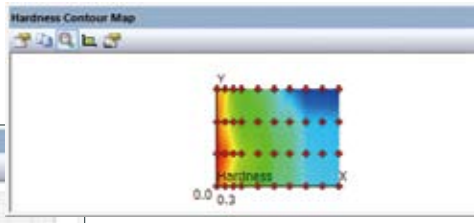
Part program

Automatically records the sequence of operations in a test.
To repeat the same test, the part program can be called up for repeated execution.





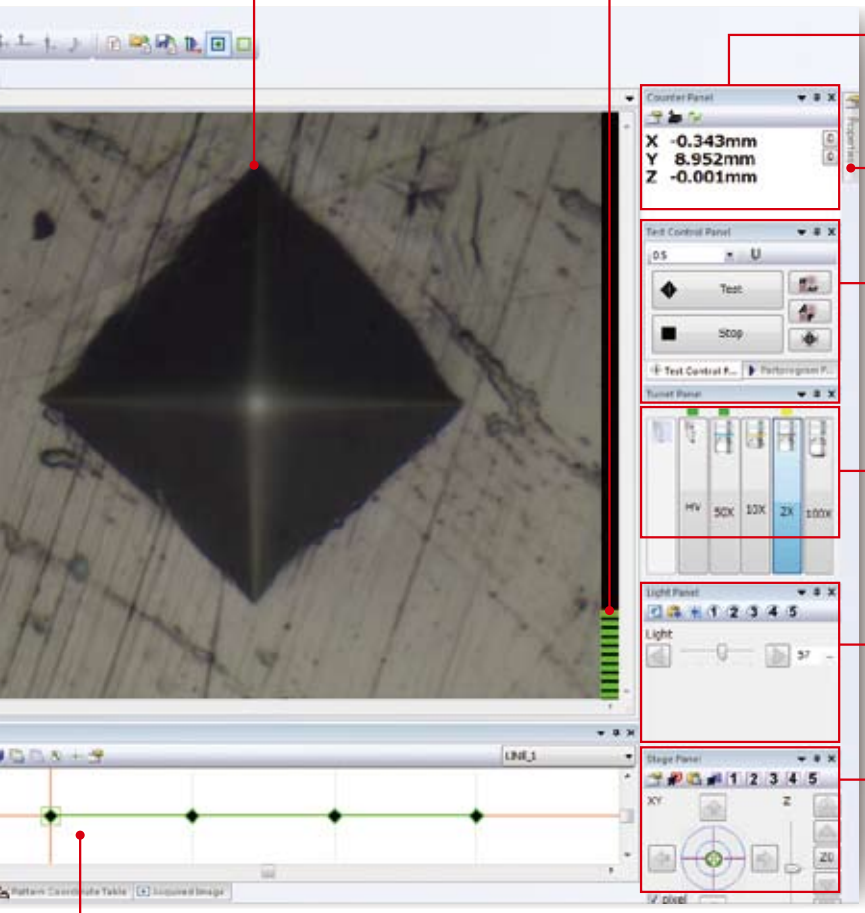




* All the screens shown in this page are for AVPAK-20.

Video view (live image)
Indentation image display
Small indentations can be observed using the digital zoom function.

Contrast level meter
Stable focusing can be easily achieved by anyone.



Counter
Displays the stage's current coordinates.

Property panel

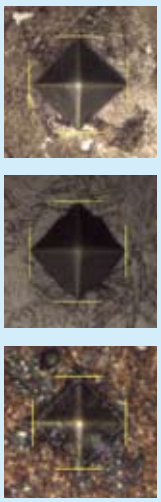
Test control
Controls test actions such as wide- or narrow-range auto-focusing and measurement of indentations.

Turret control
Switches the objective lens and indenter in and out of the test position

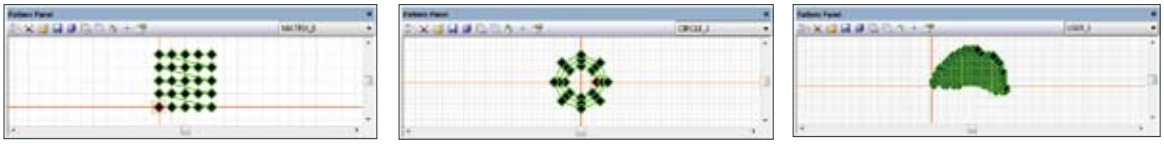
Illumination control
Controls the illumination in 100 steps

Stage control
Used to move the motorized XY stage and AF stage.
(Systems C and D only)

Indentation-reading example



Pattern panel



Frequency distribution graph

* All the screens shown in this page are for AVPAK-20.

Feature of software AVPAK-10/20 function for controlling system B/C/D

* With regarding to the AVPAK-20, not for use and/or export to the United States of America.

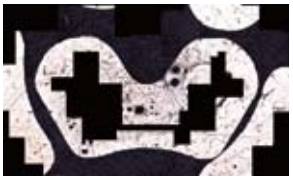
Function related to capture of specimen image and pattern setting of test position

Stitching (Only for AVPAK-20)

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

Auto trace (Only for AVPAK-20)

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



Contour detection (Only for AVPAK-20)

Detects the outline of the workpiece from combined images.

Various kinds of pattern setting

Performs time-consuming pattern setting with ease.

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.

Remote Control Box

Assists operation using AVPAK-10/20. Besides control of the motorized XY stage, the Remote Control Box can be used for turret switching, XY stage speed control and single-point testing.

There are four speeds to choose from for stage control using the joystick—Step, Low, Middle, and High.

Dimensions: 177 x 176 x 49mm (WxDxH)
Mass: 1kg

Handling of multiple specimens

Part program and Parts Manager functions support testing of multiple and irregular specimens.

Multi-specimen testing

Executes different part programs for each irregular specimen

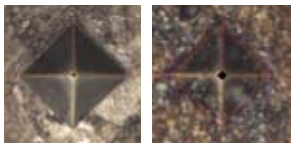
Parts Manager

Executes a common part program for specimens having the same shape

Reading of indentations

Improvement in image-processing performance has improved the indentation measurement function.

*measurement accuracy varies according to conditions.



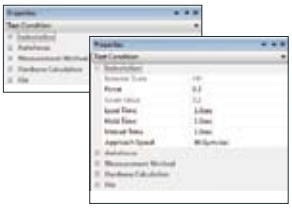
Indentation depth display

Displays the indentation depth of the diamond indenter while the testing force is being applied. (Reference value)

*Only for HM-200 Series.

Property panel

Used for setting the test conditions such as the test force and duration time, as well as the indentation measurement condition.



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)

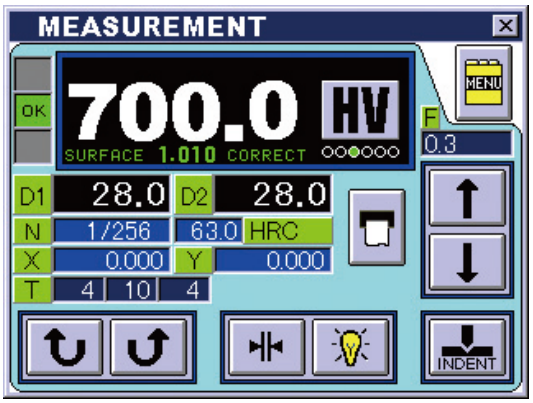
*Only for System B with manual XY stage.

Touch-panel display and function for System A

Touch-panel control screen

Easy-to-understand graphic display enables intuitive operation. Functions for converting values and compensating for curved surfaces, as well as a test condition guiding function are all provided as standard features.
(Installed in the System A main unit)

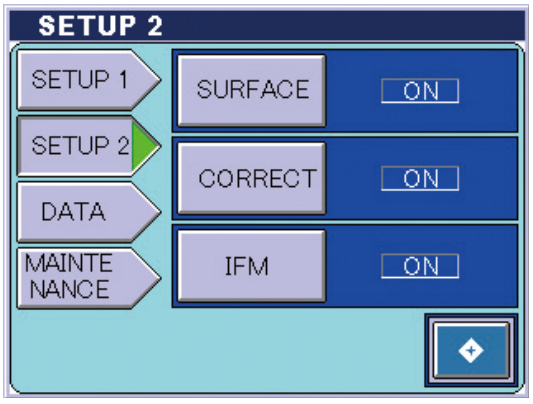
HM-210A/220A Touch-panel



Displays test conditions and test results.

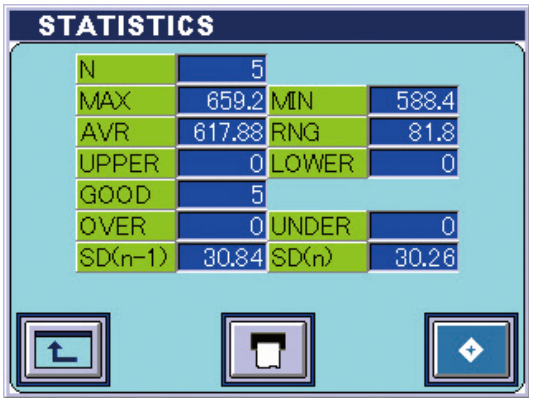
HV-110A/120A Touch-panel

Displays test conditions and test results.



Used for selecting a conversion scale, entering a setting for Pass/Fail determination, and specifying external output.

Used for selecting a conversion scale, entering a setting for Pass/Fail determination, and specifying external output.



You can check the test results in a statistical list.

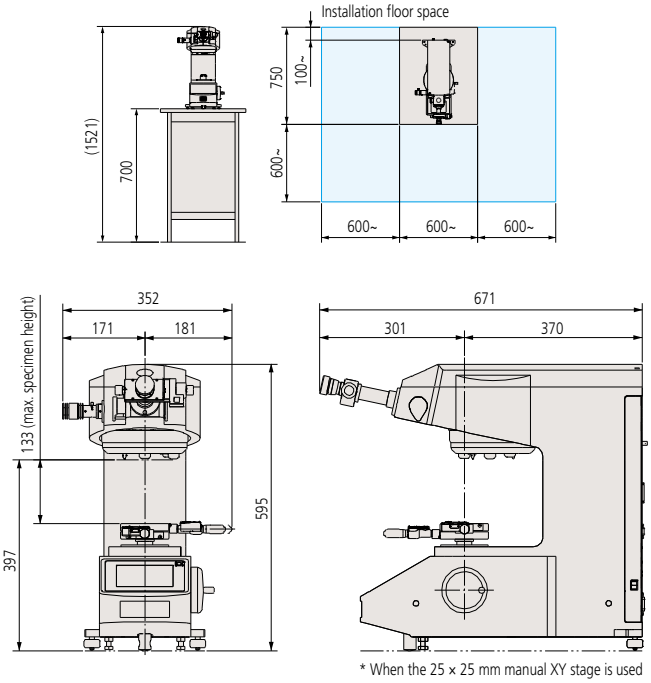
You can check the test results in a statistical list.

Outline drawings

Micro Vickers Hardness Testing Machines

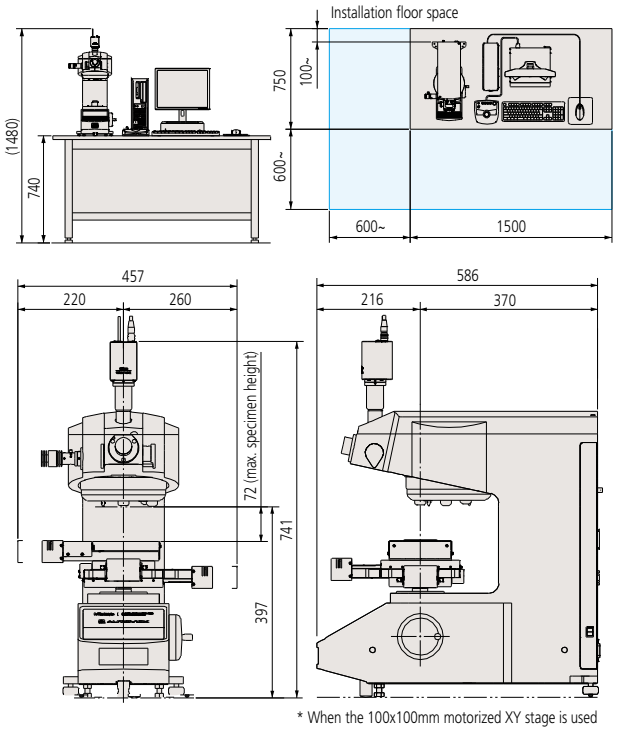
System A

Unit: mm



* When the 25 × 25 mm manual XY stage is used

System D

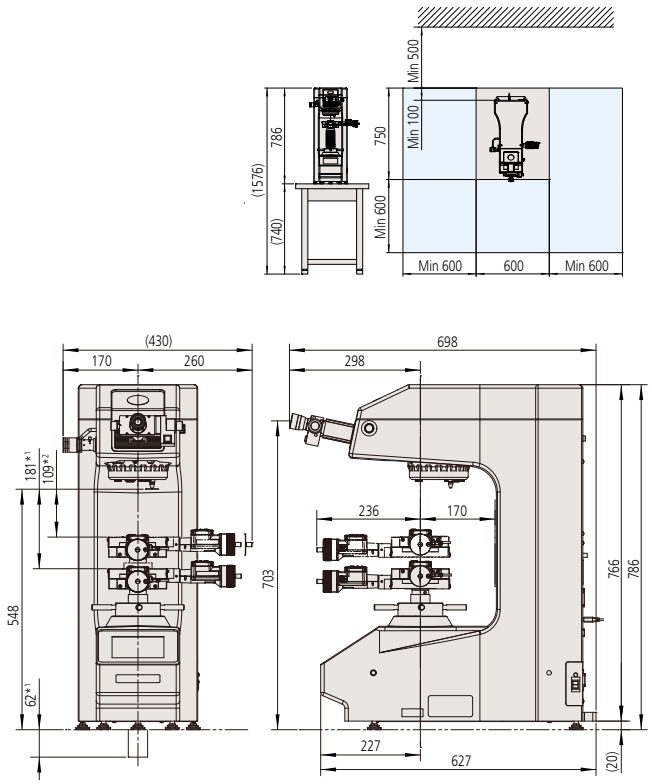


* When the 100x100mm motorized XY stage is used

Vickers Hardness Testing Machines

System A

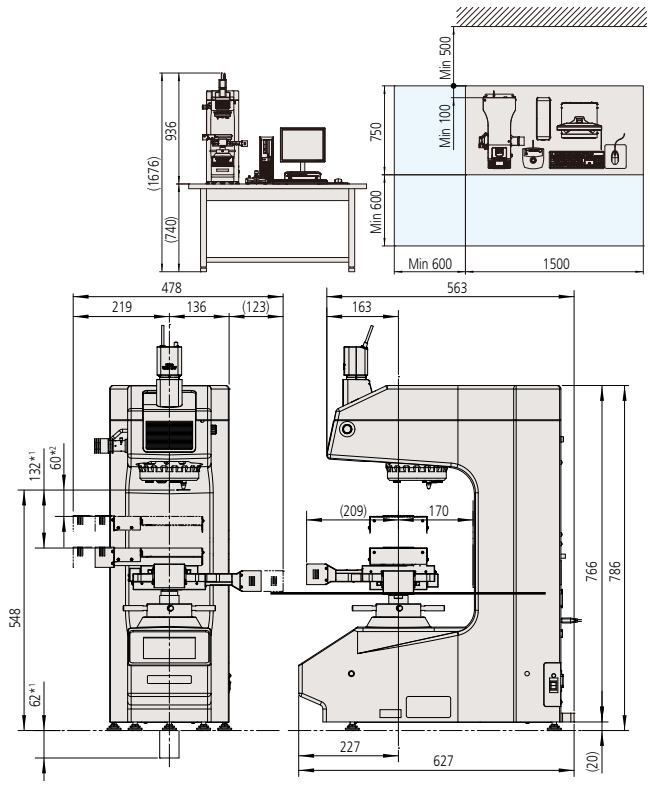
Unit: mm



*1 Maximum height of specimen when an escape hole exists below the main shaft in the machine mounting table that allows the shaft to be lowered to the maximum extent.
*2 Maximum height of specimen when an escape hole does not exist in the machine mounting table.
*3 Dimension when the manual XY stage unit with 50mm stroke (option) is equipped.

System D

Unit: mm



*1 Maximum height of specimen when an escape hole exists below the main shaft in the machine mounting table that allows the shaft to be lowered to the maximum extent.
*2 Maximum height of specimen when an escape hole does not exist in the machine mounting table.

Specifications

System configuration

Parameter	Order No.	Item	System A	System B	System C	System D	Details	Notes
Main unit	**810-400***1	HM-210 manual model main unit	○	×	×	×	Standard test force, microscope with a 50X lens	
	810-405*1	HM-220 manual model main unit	○	×	×	×	Low test force, microscope with a 50X lens	
	810-403*1	HM-210 system model main unit	×	○	○	○	Standard test force, 50X lens	No measuring microscope, No touch panel
	810-408*1	HM-220 system model main unit	×	○	○	○	Low test force, 50X lens	
	810-440*1	HV-110 manual model main unit	○	×	×	×	Standard test force, microscope with a 10X lens	
	810-445*1	HV-120 manual model main unit	○	×	×	×	Low test force, microscope with a 10X lens	
	810-443*1	HV-110 system model main unit	×	○	○	○	Standard test force, 10X lens	No measuring microscope, No touch panel
	810-448*1	HV-120 system model main unit	×	○	○	○	Low test force, 10X lens	
Stage	**810-451***1	Motorized XY stage unit 50x50	×	×	●	●		
	810-452*1	Motorized XY stage unit 100x100	×	×	●	●		
	810-420	Manual XY stage unit 25x25	●*2	●*2	×	×	For HM-210A and HM-220A	
	810-423	Manual XY stage unit 50x50	●*2	●*2	×	×		
	810-424	Manual XY stage unit 1"×1"	●	●	×	×		Not available in Korea and Japan
	810-427	Manual XY stage unit 2"×2"	●	●	×	×		Not available in Korea and Japan
	810-425	AF stage unit	×	×	×	●		
	11AAC316	AVPAK-20 V1*3	×	●	●	●	For HM-210/220 System B/C/D	Except the United States, available overseas (See Notes)
	11AAC666	AVPAK-20 V2*3	×	●	●	●		
	12AAQ777	PC set	△	●	●	●		Available only in Japan. Windows7, 64bit

○: Selectable ●: One of each type must be selected from the choice offered ×: Cannot be selected △: Contact Mitutoyo Sales Dept.
*1: To denote your AC power cable add the following suffixes to the order No.: A for UL/CSA, D for CEE, DC for CCC, E for BS, K for KC, C and No suffix are required for PSE.
*2: Manual XY stage unit 50x50 is a selectable stage in HV-110A and HV-120A (it is not the one must be selected from the choice offered).
Eitherone of the manual XY stage unit 25x25 or 50x50 must be selected for HM-210A, 210B, 220A, and 220B.
*3: With regarding to the AVPAK-20 V1 and AVPAK-20 V2, not for use and/or export to the United States of America.

Individual specifications for HM-210/220

Model name			HM-210A	HM-210B	HM-210C	HM-210D
Main unit	HM-210 manual model main unit	810-400 *	○	–	–	–
	HM-210 system model main unit	810-403 *	–	○	○	○

Specification of basic conditions	Applicable standards	JIS B 7725, ISO 6507-2									
	Test force (Variable test force)	Hardness symbol	HV0.01	HV0.02	HV0.03	HV0.05	HV0.1	HV0.2	HV0.3	HV0.5	HV1
		mN	98.07	196.1	294.2	490.3	980.7	1961	2942	4903	9807
		(gf)	(10)	(20)	(30)	(50)	(100)	(200)	(300)	(500)	(1000)
	Indenter approach speed	Fixed at 60 µm/s									
	Test force setting step	HV0.01 to less than HV0.1: HV0.001 step, HV0.1 to less than HV1: HV0.01 step									

Model name			HM-220A	HM-220B	HM-220C	HM-220D
Main unit	HM-220 manual model main unit	810-405 *	○	–	–	–
	HM-220 system model main unit	810-408 *	–	○	○	○

Specification of basic conditions	Applicable standards	JIS B 7725, ISO 6507-2									
	Test force (Variable test force)	Hardness symbol	HV0.00005	HV0.0001	HV0.0002	HV0.0003	HV0.0005	HV0.001	HV0.002	HV0.003	HV0.005	HV0.01
		mN	0.4903	0.9807	1.961	2.942	4.903	9.807	19.61	29.42	49.03	98.07
		(gf)	(0.05)	(0.1)	(0.2)	(0.3)	(0.5)	(1)	(2)	(3)	(5)	(10)
		Hardness symbol	HV0.02	HV0.03	HV0.05	HV0.1	HV0.2	HV0.3	HV0.5	HV1	HV2	
		mN	196.1	294.2	490.3	980.7	1961	2942	4903	9807	19610	
		(gf)	(20)	(30)	(50)	(100)	(200)	(300)	(500)	(1000)	(2000)	
	Indenter approach speed	Variable between 2 and 60µm/s. Can be set in 1µm/s increments (only for 30 gf or smaller; Fixed at 60 µm/s for 31 gf or greater)									
	Test force setting step	Less than HV0.0001: Only HV0.00005, HV0.0001 to less than HV0.001: HV0.0001 step, HV0.001 to less than HV0.1: HV0.001 step, HV0.1 to less than HV2: HV0.01 step									

* To denote your AC power cable add the following suffixes to the order No.: A for UL/CSA, D for CEE, DC for CCC, E for BS, K for KC, C and No suffix are required for PSE.

Common specifications for HM-210/220

Specimen		Maximum dimensions	Max. depth: 160 mm, Max. height : 133mm (Manual XY stage unit 25x25), 72mm (Motorized XY stage unit 100x100 with AF stage)
		Max. loading capacity	System A,B: 3kg System C: 7kg System D: 3kg
Optical section	Optical system		Infinitely corrected optical system, 4-port objective lens switching method
	Illumination	Light source	White LED
		Aperture diaphragm	Variable
	Standard objective lens	Lens	MH Plan 50X
		Working distance	2.5mm
		Real field of view and imaging range	System A: Real field of view: ø0.14 mm System B, C, D: Imaging range: 0.118 (H) mm x 0.089 (V) mm
	Measuring microscope (Ocular)		System A: Length-measuring microscope with integrated encoder and eyepiece (10X) System B, C, D: Factory-installed options
Mechanism	Test time	Test force loading time	1- 99s Can be set in 1s increments.
		Test force duration time	0-999s Can be set in 1s increments.
		Test force unloading time	1- 99s Can be set in 1s increments.
	Loading device	Test force control	Electromagnetic (voice coil)
		Test force switching	System A: Can be selected from touch panel, System B, C, D: Can be selected by AVPAK-10/20
	Turret	Drive method	Motor drive
		Operation method	System A: Touch panel / Manual, System B: AVPAK-10/20 / Manual, System C, D: AVPAK-10/20 / Remote Control Box, button / manual
		Number of turret ports	Indenter shaft unit: Up to two can be installed (including the standard Vickers indenter shaft unit already installed); Objective lens unit: Up to four can be installed (including the standard 50X objective lens already installed)
Controller	Display/Controller		System A: Integrated touch panel (5.7-inch color LCD), System B, C, D: Data-processing software
	Display content and calculation functions	Indentation value	System A: Max. 5 digits Minimum display unit for objective lenses of 50X or higher: 0.01µm, for lower than 50X: 0.1µm System B, C, D: PC screen display by AVPAK-10/20
		Hardness value	System A: Max. 4 digits Minimum display unit 0.1 Scale: HV/HK/Kc System B, C, D: PC screen display by AVPAK-10/20
		Test condition	XY positional data, turret position display, indenter (HV/HK), test force, loading time, duration time, and unloading time
		Function for guiding measurement condition setup	Enter the indenter, specimen thickness, and presumed hardness to calculate the maximum test force.
		Compensation	Cylinder, sphere, measurement
		Statistical calculation result	Maximum value, minimum value, average, standard deviation (n-1), standard deviation (n), OK/±NG judgment, converted hardness value, etc.
		Language used	Japanese, English, German, French, Italian, Spanish
External connection interface			RS-232C, Digimatic, USB2.0
Main unit power supply			39VA (45VA for HM-220A):100/100-125/200/220-240V AC
Maximum specimen dimensions / Maximum load capacity		System A	Approx. 315 (W)×671 (D)×595 (H)mm
		System B, C, D	Approx. 315 (W)×586 (D)×741 (H)mm
Main unit mass		Common for all system	Approx. 38kg

Individual specifications for HV-110/120

Model name			HV-110A	HV-110B	HV-110C	HV-110D
Main unit	HV-110 manual model main unit	810-440*	○	–	–	–
	HV-110 system model main unit	810-443*	–	○	○	○

Specification of basic conditions	Applicable standards	JIS B 7725, ISO 6507-2								
	Test force	Hardness symbol	HV1	HV2	HV3	HV5	HV10	HV20	HV30	HV50
		N	9.807	19.61	29.42	49.03	98.07	196.1	294.2	490.3
		(kgf)	(1)	(2)	(3)	(5)	(10)	(20)	(30)	(50)
	Indenter approach speed	60µm/s, 150µm/s								

Model name			HV-120A	HV-120B	HV-120C	HV-120D
Main unit	HV-120 manual model main unit	810-445*	○	–	–	–
	HV-120 system model main unit	810-448*	–	○	○	○

Specification of basic conditions	Applicable standards	JIS B 7725, ISO 6507-2								
	Test force	Hardness symbol	HV0.3	HV0.5	HV1	HV2.5	HV5	HV10	HV20	HV30
		N	2.942	4.903	9.807	24.51	49.03	98.07	196.1	294.2
		(kgf)	(0.3)	(0.5)	(1)	(2.5)	(5)	(10)	(20)	(30)
	Indenter approach speed	60µm/s, 150µm/s								

* To denote your AC power cable add the following suffixes to the order No.: A for UL/CSA, D for CEE, DC for CCC, E for BS, K for KC, C and No suffix are required for PSE.

Common specifications for HV-110/120

Specimen		Maximum dimensions	Max. depth: 170 mm, Max. height : 210mm (Manual main unit and flat anvil), 132mm (System main unit, Motorized XY stage 50x50 with AF stage, and stand with escape hole)
		Max. loading capacity	System A,B: 20kg*1 System C: 7kg System D: 3kg
Optical section	Optical system		Infinitely corrected optical system, 3-port objective lens switching method
	Illumination	Light source	White LED
		Aperture diaphragm	Variable
	Standard objective lens	Lens	MH Plan 10X
		Working distance	11.8mm
		Real field of view and imaging range	System A: Real field of view: ø1.4 mm System B, C, D: Imaging range: 0.590 (H) mm x 0.443 (V) mm
	Measuring microscope (Ocular)		System A: Length-measuring microscope with integrated encoder and eyepiece (10X) System B, C, D: Factory-installed options
Mechanism	Test time	Test force duration time	5-999s Can be set in 1s increments.
	Loading device	Test force control	Motor drive (loading/duration/unloading)
		Test force switching	System A: Can be selected from touch panel, System B, C, D: Can be selected by AVPAK-10/20
	Turret	Drive method	Motor drive
		Operation method	System A: Touch panel, System B: AVPAK-10/20, System C, D: AVPAK-10/20 / Remote Control Box,
		Number of turret ports	Indenter shaft unit: One shaft can be installed (the standard Vickers indenter shaft unit already installed); Objective lens unit: Up to three can be installed (including the standard 10X objective lens already installed)
Controller	Display/Controller		System A: Integrated touch panel (5.7-inch color LCD), System B, C, D: Data-processing software
	Display content and calculation functions	Indentation value	System A: Max. 6 digits Minimum display unit for objective lenses of 50X or higher: 0.01µm, for lower than 50X: 0.1µm System B, C, D: PC screen display by AVPAK-10/20
		Hardness value	System A: Max. 6 digits Minimum display unit 0.01 Scale: HV/HK/HB/Kc System B, C, D: PC screen display by AVPAK-10/20
		Test condition	XY positional data (when using stage), turret position display, test force, and duration time
		Compensation	Cylinder, sphere, measurement
		Statistical calculation result	Maximum value, minimum value, average, standard deviation (n-1), standard deviation (n), OK/±NG judgment, converted hardness value, etc.
		Language used	Japanese, English, German, French, Italian, Spanish
External connection interface			RS-232C, Digimatic, USB2.0
Main unit power supply			24VA for Manual main unit and 22VA for System main unit: 100/100-125/200/220-240V AC
Maximum specimen dimensions / Maximum load capacity		System A	Approx. 307 (W)×696 (D)×786 (H)mm
		System B, C, D	Approx. 307 (W)×627 (D)×880 (H)mm
Main unit mass		Common for all system	Approx. 60kg for HV-110 and 58kg for HV-120

*1 Maximum load capacity is 3kg when using the Manual XY stage unit 50x50.

Specifications for AVPAK-20 V2 (common for HM/HV)

Applicable system	System B/C/D	
Display languages (screen messages)	AVPAK-20 V1 (for HM) : Japanese, English, French, Traditional Chinese, Simplified Chinese, Korean, Turkish, and Portuguese.	
	AVPAK-20 V2 (for HV) : Japanese, English, French, Traditional Chinese, Simplified Chinese, Korean, Turkish, and Portuguese, Spanish, German, and Italian	
Functions	Indentation control function	
	Indentation analysis function	
	Focusing function	Only for System D
	Illumination control function	
	Stage control function	Only for System C and D
	Turret control function	
	Test pattern function	
	Coordinate alignment function	
	Wide area image synthesis function	Only for System C and D
	Automatic execution function	
	Multiple specimens testing function	Only for System C and D
	Wizard function	
	Image analysis function	
	Analysis and report making function	
	External output function	
	Security function	Only for AVPAK-20 V2
	Simple dimension function	Only for AVPAK-20 V2
	Other functions	Hardness scale conversion, spherical compensation, judgment, statistical factor

Note: With regarding to the AVPAK-20 V1 and AVPAK-20 V2, not for use and/or export to the United States of America.

Specifications: Video camera unit

System A

Item	Description
TFT screen magnification	Approx. 200X (approx. 260X) at 10X objective lens
	Approx. 1000X (approx. 1300X) at 50X objective lens
	Approx. 2000X (approx. 2600X) at 100X objective lens
CCD camera	Imaging device: 1/3-inch interline CCD
TFT monitor	Power supply: 100-230V AC, 50/60Hz
	Power consumption: 12VA
	External dimensions: 228 (W) x61.5 (D) x195 (H) mm [232 (W) x 227 (D) x 426.5 (H) mm (when installed on the stand)]
	Mass: 1.8 g (4.2 kg including the stand)

Specifications: Manual stage unit

Systems A and B

Item	Specification	
Order No.	810-420	810-423
Type	Manual XY 25x25	Manual XY 50x50
XY range	25×25mm	50×50mm
Table size	100×100mm	130×130mm
Minimum display unit	0.001mm	
Dimensions	221(W)×221(D)×37(H)mm	305(W)×305(D)×49(H)mm
Mass	2.5kg	6.6kg

Specifications: Motorized stage unit

Systems C and D

Item		Specification	
Order No.		810-451*	810-452*
Type		Motorized XY 50x50	Motorized XY 100x100
Motorized XY stage			
	XY range	50mm×50mm	100mm×100mm
	Table size	130mm×130mm	130mm×165mm
	Repeatability	2µm	
	Max. drive speed	25mm/s	
	Dimensions	242.5(W)×242.5(D)×55(H)mm	299.5(W)×299.5(D)×55(H)mm
	Mass	5kg	6.2kg
Control unit			
	Power consumption	57VA	
	Dimensions	300(W)×290(D)×92(H)mm	
	Mass	4.5kg	

*: To denote your AC power cable add the following suffixes to the order No.:
A for UL/CSA, D for CEE, DC for CCC, E for BS, K for KC, C and No suffix are required for PSE.

Specifications: Motorized auto focus stage unit

System D

Item	Specification
Table size	140mm×130mm
Repeatability	0.2µm
Dimensions	245(W)×132(D)×40(H)mm
Mass	4.1kg

Standard accessories

Order No.	Item	Specification/Remarks	Quantity
HV-200 Series			
19BAA058	Diamond indenter*1	Vickers for HM-210	1
19BAA059	Diamond indenter*1	Vickers for HM-220	
–	Hardness testing block*2	700HMV0.3 25 mm (diameter) × 6 mm (thickness)	1
–	Indenter shaft unit*1	With Vickers indenter	1
–	Objective lens unit 50X*1	With objective lens 50X	1
19BAA133	Spacer	Material: Bakelite 11 (W) × 42 (D) × 13 (H) mm	1
11AAB405	Extension shaft	For elevation shaft: 38 mm With two set screws	1
11AAB406	Extension shaft	For elevation shaft: 76 mm With two set screws	1
02DEA471	Dust cover	For the hardness testing machine main unit	1
–	Plastic Phillips screwdriver	No.1300 Phillips 2×100	1
–	Precision flathead screwdriver	No.205 flathead 1.2	1
–	Hex wrench	2.5mm	1
–	Hex wrench	3.0mm	1
–	Cap*1	Cap for the holder	4
–	Cable clamp	Gray	2
–	Cable clamp	Black	2
–	Spiral tube	Black, approx. 2 m	1
HV-100 Series			
19BAA060	Diamond indenter*1		1
–	Objective lens 10X*1		1
–	Hardness testing block*2	700HV10 ø64(diameter) x 15mm (thickness)	1
810-039	Flat anvil	Outside diameter ø64mm	1
383876	Dust cover		1
11BAC212	Precision screwdriver	Flat-blade, 1.2	1
12BAL402	Protective sheet	For manual main unit	1
–	Level		1
–	Hanger bolt (L)		2
Common for HM-200/HV-100			
–	Hex-head screwdriver	1.5mm	2
–	Hex-head screwdriver	2.5mm	HM: 2 HV: 1
–	Wrench for leveling		1
–	Holder	Hanger bolt for the main unit	HM: 4 HV: 2
–	USB camera (system main unit)*1	3 million pixels, 1/2-inch color Systems B, C, D	1
02ZAA000	Power supply code set - PSE	Order No. suffix: C and No suffix	1
02ZAA010	Power supply code set- UL/CSA	Order No. suffix: A	
02ZAA020	Power supply code set- CEE	Order No. suffix: D	
02ZAA030	Power supply code set- BS	Order No. suffix: E	
02ZAA040	Power supply code set- CCC	Order No. suffix: DC	
02ZAA050	Power supply code set- KC	Order No. suffix: K	
–	User's manual (manual model main unit)	For system A	
–	User's manual (system model main unit)	For System B, C, D	1
–	Configuration disc	For System B, C, D	1
–	Accessory case		1
–	Inspection certificate	In both Japanese and English for the tester	1
–	Inspection certificate for test piece	In both Japanese and English for test piece	1
–	Warranty card	In both Japanese and English	1

*1 Already installed in the main unit when it is delivered.
*2 The numeric values shown are nominal; actual values will be slightly above or below the nominal values.

Economy model

Micro Vickers hardness testing machines: HM-100 Series

The ideal series for Vickers hardness testing at the microscopic scale. Basic economy machines with the minimum requirement of functions for hardness testing. Two types are available: an analog model (HM-101) and a digital model (HM-102).

HM-101

HM-102

HM-103

Specifications

Order No.		810-124*	810-125*
Model		HM-101	HM-102
Test force	mN	98.07 245.2 490.3 980.7 1961 2942 4903 9807	
	gf	10 25 50 100 200 300 500 1000	
Test force control		Auto (load, duration, unload)	
Test force duration time		5 to 30s (Arbitrary setting)	5 to 60s
Indenter approach speed		Approx. 60µm/s	
Specimen dimensions		Height: 95mm Depth: 150mm	
Optical path		Measurement path/exposure path (Optical path split method)	
Objective lens		10X (For observation), 50X (For measurement)	10X , 50X (Measurement available with both lenses)
Minimum display		0.2µm	0.1µm
Maximum measurement length		140µm	Objective lens 10X: 700µm Objective lens 50X: 140µm
Manual XY stage		With analog micrometer head, Minimum graduation10µm	
Table size		100×100mm	
Stage XY range		25×25mm	
Measurement magnification calibrator		–	Installed
Data processing function		–	Indentation diagonal length Hardness value Pass/failure decision function
TV device Camera (1/3inch) Monitor (8inch monochrome)		–	Optional accessory
Turret switch		Manual	
External connection interface		–	For printer: Serial interface(compatible with the RS-232C standard), Digimatic interface, Centronics interface For motorized XY stage: I/O interfaces
Service power outlet		100/120V AC specifications only	
External dimensions		Main unit: Approx. 410(W)×600(D)×590(H)mm except operation panel	
Mass		Approx. 42kg	
Power supply		Approx. 60VA or less 120/220/240V AC according to the factory-shipped setting With TV monitor : Approx. 80VA or less	

Notes: (1) An optional Knoop indenter is required for Knoop hardness measurement
(2) HM-102/103 operation panel dimensions: 165(W)×260(D)×150(H)mm, 1.5kg
(3) HM-103 TV unit monitor dimensions: 232(W)×227(D)×426.5(H)mm, mass: 4.4kg

Standard accessories

Vickers indenter	**19BAA114**	1
Objective lenses	10×: **810-617** 50×: **810-619**	1
Fine adjustment table	**810-011**	1
Standard vise	**810-016** Jaw openning:51mm	1
Camera adapter	**19BAA445**	1
Hardness test block	700HV0.3 ø25mm	1
Power supply code set	One of any of the following: **02ZAA000** Order No. suffix: C and No suffix For PSE **02ZAA010** Order No. suffix: A For UL/CSA **02ZAA020** Order No. suffix: D For CEE **02ZAA030** Order No. suffix: E For BS **02ZAA040** Order No. suffix: DC For CCC **02ZAA050** Order No. suffix: K For KC	1
Tool kit	—	1
Accessory box	—	1
User's manual	—	1

Weights and loading shaft are included in the accessory box as standard accessories and need to be attached to the main unit during assembly

System configurations

Order no.	Model no.	Unit	TV unit (camera and monitor)
810-124*	**HM-101**	HM-101	–
810-125*	**HM-102**	HM-102	Optional accessory
810-959*	**HM-103**	HM-102	Standard accessory

*: To denote your AC power cable add the following suffixes to the order No.:A for UL/CSA, D for CEE, DC for CCC, E for BS, K for KC, C and No suffix are required for PSE.

Economy model

Vickers hardness testing machine AVK-C0

A basic Vickers hardness testing machine that is economical and simple.

Specifications

Order No.		810-160*
Model		AVK-C0
Test force	N	9.807 49.03 98.07 196.1 294.2 490.3
	kgf	1 5 10 20 30 50
Test force control		Automatic method (load, duration, unload)
Test force duration time		5, 10, 15, 20, 30S switching method
Test force method		Final test force deceleration method
Specimen maximum dimensions		Height 205mm, depth 165mm (When the flat anvil is used)
Optical path switching		None
Objective lens		10X (For measurement)
Measurement resolution		1µm
Maximum measurement length		Objective lens10X: 700µm
Turret switching		Manual
External connection interface		None
External dimensions		Approx. 200(W)×600(D)×705(H)mm
Mass		50kg
Power supply		AC100V 50/60Hz (switchable between 120, 220, and 240V AC) , approx. 45VA

Note1: An optional Knoop indenter is required for Knoop hardness testing
Note2: A hardness calculation table is supplied with **AVK-C0** as a standard accessory. All other standard accessories, except for objective lens configurations, are almost the same as for the **HV-100** Series. Please refer to the pages described **HV-100** Series.
Note3: With **AVK-C0**, hardness values are obtained from the hardness calculation table based on indentation size measurements and the test force
*: To denote your AC power cable add the following suffixes to the order No.:
A for UL/CSA, D for CEE, DC for CCC, E for BS, K for KC, C and No suffix are required for PSE.

Optional accessories

Measuring microscope

11AAC129 Measuring microscope
*For HM-210 and HM-220 System B, C, and D

Objective lens

Objective lenses (Calibration by Mitutoyo required for replacements/changes)
Please inquire at your nearest Mitutoyo sales office
*Lens unit consists of lens holder and objective lens

For **HM 200 Series**		For **HM 100 Series**	
5X:	**11AAC104**	5X:	**810-616**
10X:	**11AAC105**	10X:	**810-617**
20X:	**11AAC106**	20X:	**810-618**
50X:	**11AAC107**	50X:	**810-619**
100X:	**11AAC108**	100X:	**810-620**

Diamond indenter

19BAA058 Vickers indenter
Applicable model **HHM-210,HM-101,102,103**
19BAA059 Vickers indenter
Applicable model **HM-220**
19BAA061 Knoop indenter
Applicable model **HM-210,HM-101,102,103**
19BAA062 Knoop indenter
Applicable model **HM-220**
11AAC109 Indenter shaft unit (with knoop indenter)
Applicable model **HM-210**
11AAC110 Indenter shaft unit (with knoop indenter)
Applicable model **HM-220**

Hardness standard block (for HM Series)

19BAA010	**40HV**
19BAA001	**100HV**
19BAA002	**200HV**
19BAA003	**300HV**
19BAA004	**400HV**
19BAA005	**500HV**
19BAA006	**600HV**
19BAA007	**700HV***
19BAA008	**800HV**
19BAA009	**900HV**

*Test conditions for hardness test blocks no. 19BAA001 to 009 are HV0.01, HV0.1 and HV1
*The test condition for the hardness test block supplied as a standard accessory with the testing machine is HV0.3

Measuring microscope

11AAC718 Measuring microscope
*For HV-110 and HV-120 System B, C, and D

Objective lens

Objective lenses (Calibration by Mitutoyo required for replacements/changes)
Please inquire at your nearest Mitutoyo sales office
*For HV-110/120
*Lens holder is incorporated in the main unit of the testing machine

2x:	**11AAC712**	50x:	**11AAC715**
5x:	**11AAC713**	100x:	**11AAC716**
20x:	**11AAC714**		

Diamond indenter/Carbide ball indenter/related accessories

19BAA063 Knoop indenter
19BAA277 Carbide ball for Brinell hardness test (with one carbide ball ø1mm)
19BAA279 Carbide ball for Brinell hardness test (with one carbide ball ø1mm)
19BAA280 Carbide ball for Brinell hardness test for 5.0mm
19BAA281 Carbide ball indenter for Brinell hardness test (per piece ø1mm)
19BAA283 Carbide ball indenter for Brinell hardness test (per piece ø2.5mm)
11AAC109 Indenter shaft unit (with knoop indenter)
Applicable model **HM-210**
11AAC110 Indenter shaft unit (with knoop indenter)
Applicable model **HM-220**

Hardness standard block (HV Series)

19BAA011	**200HV***1
19BAA012	**300HV***1
19BAA013	**400HV***1
19BAA014	**500HV***1
19BAA015	**600HV***1
19BAA016	**700HV***1
19BAA017	**800HV***1
19BAA018	**900HV***1
Brinell standard block	
19BAA027	**200HBw**

*1 Test conditions for hardness test blocks are HV1 and HV10.
*2 Test conditions for hardness test blocks are HV1 and HV30.

Brinell weight

11AAC697 Brinell weight (0.5kgf)*3
11AAC698 Brinell weight (1.25kgf)*3
11AAC699 Brinell weight (5.625kgf)*3
11AAC700 Brinell weight (12.5kgf)*3

19BAA087 Brinell weight (1.25kgf)*4
19BAA088 Brinell weight (2.5kgf)*4
19BAA089 Brinell weight (2.8125kgf)*4
19BAA090 Brinell weight (4.0kgf)*4
19BAA091 Brinell weight (5.0kgf)*4
19BAA092 Brinell weight (5.625kgf)*4
19BAA093 Brinell weight (10.0kgf)*4
19BAA094 Brinell weight (12.5kgf)*4

*3 For **HV-110/120**
*4 For **AVK-C0**

External output application

264-504
Digimatic mini processor DP-1VR
Calculation of hardness values, statistical calculation, and control limit values can be performed
For **HM-210A/HM-220A/HV-110A/HV-120A/HM-102/HM-103**
Note that a connection cable is not supplied with the **DP-1VR** and must be ordered separately. (See below.)
Connection cable (1m) **HM-200/HV100: 936937**
HM-100 (except for **HM-103**): **937387**
02AZD810D U-WAVE-R
*For **HM-210A/HM-220A/HV-110A/HV-120A/HM-102/HM-103**
02AZD880D U-WAVE-T buzzer type
*For **HM-210A/HM-220A/HV-110A/HV-120A/HM-102/HM-103**
No.02AZD790D U-WAVE-T dedicated cable
*For **HM-210A/HM-220A/HV-110A/HV-120A/HM-102/HM-103**

02AGD600A
Printer DPU-414
With connection cable
*For **HM-210A/HM-220A/HV-110A/HV-120A**

11AAC236,237
Data processing software
See page 36 for details

Specimen fixtures

*Use the specimen fixtures below under a test force of 1kgf/9.81N only (except for round table, V-anvil, and manual XY stage: 50x50mm).

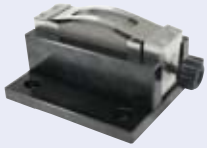
810-013
Sheet specimen table
Prevents variations of hardness results due to flexure and wrinkling during measurement of sheets 0.5mm thick or less (e.g. Scalpel blades, etc.).

810-015-01
Thin specimen table (vertical type)
Clamps pin-shaped specimens of 0.4 to 3mm diameter or less in a chuck (e.g. Wire of steel or copper, etc.).

810-014-01
Thin specimen table (horizontal type)
Holds a thin specimen of 0.3 to 3mm for measuring on a side face (e.g Wire, piano wire, etc.).

810-019
Tilting specimen table
Levels the specimen measurement face to prevent variations of indentation shape, with an opening width of 37mm, tilt angle of ±15°, and rotation angle of ±25°.

810-085
Sheet specimen table
Enables securing of very thin or narrow specimens like foil or fine wire.



Resin mold specimen tables

810-650-1: ø25.4±0.5mm; specimen height: 9-39mm
810-650-2: ø30±0.5mm; specimen height: 9-39mm
810-650-3: ø31.75±0.5mm; specimen height: 9-39mm
810-650-4: ø38.1±0.5mm; specimen height: 9-39mm
810-650-5: ø40±0.5mm; specimen height: 9-39mm

810-012
Manual XY stage (XY range: 50x50mm)
Allows specimen positioning up to 50mm in the X- and Y-directions.
Use it with the test force 50kgf or below.

810-020
Adjustable specimen table
(Specimen thickness of 30mm or less)
Allows proper alignment of the sample surface and the indenter axis when parallelism of the sample is poor. It cannot be used with automatic hardness testing systems.

810-095
Rotary tilting specimen table
In cases where top and bottom surfaces of the specimen are not parallel, the tilting rotary specimen table's adjuster and standard accessory hand press can be used to make adjustments (adjustment range: ±3°) so the top surface of the specimen is perpendicular to the indenter shaft of the hardness testing machine. When attached to the testing machine, the specimen surface can be rotated 360° (in 2° increments).

810-018
Rotary table (Minimum graduation 1°)
The specimen fixed on the table can be rotated for convenient measurement.

810-037 (for HV/AVK)
Round table (Diameter: 180mm)
810-038 (for HV/AVK)
Round table (Diameter: 250mm)

810-040 (for HV/AVK)
V anvil (large) (Outside diameter: ø40mm, Groove width: 30mm)
810-041 (for HV/AVK)
V anvil (small) (Outside diameter: ø40mm, Groove width: 6mm)

810-016
Standard vice (Open width 51mm)

810-017
Special vice (Open width: 100mm)
Can clamp specimens of up to 100mm.

Other optional accessories

937179T (for HV-110/120)
Foot switch
Switch for starting hardness testing.
With a series of test operations such as Ocular*/footswitch/turret switch/vertical handle operation, the test machine can be operated without using touch panel.
*Zero setting of measuring microscope (Ocular) can be performed by pressing and holding the Ocular switch instead of touch panel operation.

810-870 (for HM-200)
Heating specimen table
It allows hardness testing between the room temperature of 10°C and 250.

1AAC702 (for HV Series)
Stand for testing machine

02ATE760 (for HM-210/220/HM-102/HM-103)
Table
*For testing machine and PC (1800W×900D×740Hmm)

998923
System rack (vertical)
*For PC

810-641 (for HM Series)
11AAC719 (for HV Series)
Vibration isolator
Only for the testing machines

810-644
Wing for vibration isolator
*For **810-641** Vibration isolator

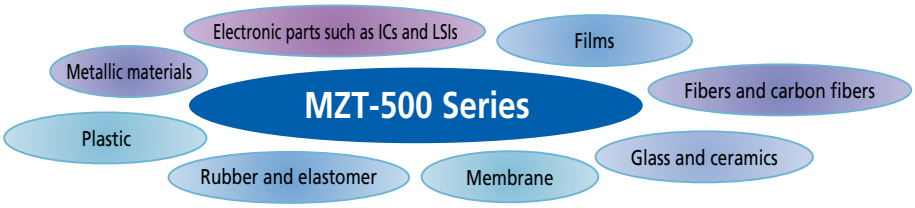
Micro surface material-characteristics evaluation system MZT-500 Series

A remarkably user-friendly micro surface material an automatic multi-point measurement function

This system demonstrates outstanding performance in research and development and quality control of material characteristics in micro surface and submicroscopic areas, such as CVD, PVD, various vapor deposition membranes and generated ultra-thin membranes, as well as hardness, surface adherence properties, and wear resistance properties of a micro cross-section of carbon fibers, glass fibers, and whiskers, which cannot be measured with a conventional micro vickers hardness testing machine.

Indentation by triangular pyramid indenter

For evaluation of various materials



MZT-500

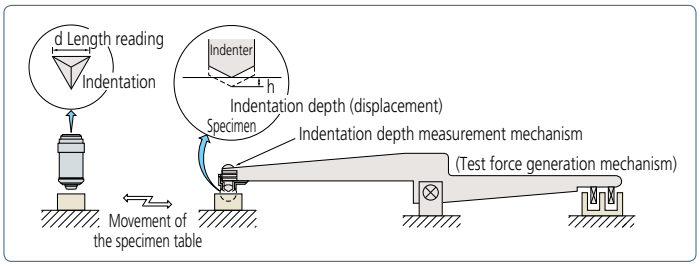
Test data

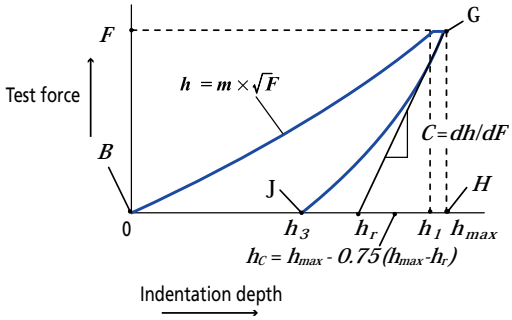
You can obtain the indentation factor, which is related to the hardness value (partially) shown in "Instrumented indentation test for hardness" (ISO14577) and Young's modulus. Deformation characteristics in the load, duration, and unload phases are also obtainable for use in determining properties of the specimen material.

- **Hardness tests such as Vickers and Knoop hardness tests** are supported.
- **The balance lever** vibration isolation mechanism reduces the effect of external vibrations on measurements.
- Indentation depth can be measured up to a **maximum of 20μm** with a measurement resolution of **0.1nm.**
- Test force between **0.1mN** and **1000mN** can be applied electromagnetically for evaluation of material properties in submicroscopic areas.
- **Field-compatible form** with cover for protection against dust and wind.
- **High-temperature testing up to 250°C** High-temperature testing is possible by attaching the optional specimen heater (810-830 HST-250).

Measurement principle

The test force loading mechanism electromagnetically applies a test force to the measurement sample via the non-friction balance lever and indenter. The point of contact of the indenter and specimen is regarded as the zero test force point, and a force is then applied up to the specified test force. During the process in which the indenter is pressed into the specimen, the indentation depth is measured with a displacement gage. By analyzing the 3 factors of test force, displacement (indentation depth) and time, various kinds of information can be obtained for each material.





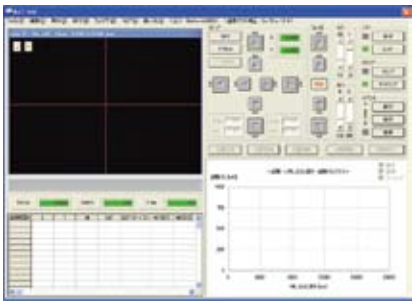
MZT analysis parameter		Definition	Description
Name	ISO notation		
Martens hardness	HM	$HM = \frac{F}{A_S \cdot h_{max}^2} \quad A_S = 26.43$	Hardness to elastic and plastic deformation
Martens hardness	HMs	$HMs = \frac{1}{A_S \cdot m^2}$	Average Martens hardness
Indentation hardness	H_{IT}	$H_{IT} = \frac{F}{A_P \cdot h_c^2} \quad A_P = 23.96$	Hardness of tested area
Indentation creep	C_{IT}	$C_{IT} = \frac{h_{max} - h_1}{h_1} \quad 100$	Ratio of creep to total deformation
Indentation modulus	E_{IT}	$E_{IT} = \frac{1 - \nu_s^2}{\frac{2\sqrt{A_P \cdot C}}{\sqrt{\pi}} - \frac{1 - \nu_i^2}{E_i}}$	Equivalent Young's modulus
Indentation work ratio	η_{IT}	$\eta_{IT} = \frac{\text{Area (J-G-H)}}{\text{Area (B-G-H)}} \times 100$	Ratio between mechanical work and plastic deformation

ν_s: Poisson's ratio of the test piece ν_i: Poisson's ratio of indenter (for daiamond 0.07)
E_i: Modulus of the indenter (for diamond 1.14×10^{-6}N/mm^2)

-characteristics evaluation system with

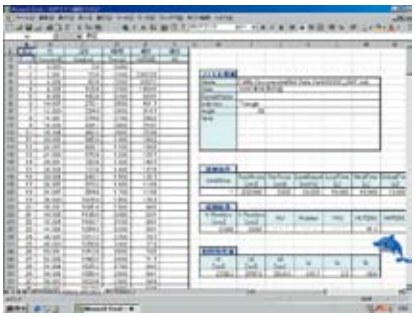
Test condition setting

Required test conditions can be set for each item. If any condition entered is incorrect, an error is displayed to ensure the correct setting. You can also call settings from the data bank.



Data analysis function 1

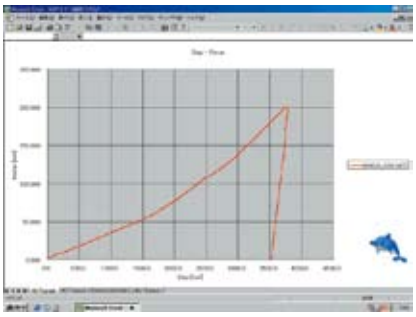
Test results are saved as text files retrievable with Microsoft Excel spreadsheet software. Macros are available for easy retrieval of test results with Excel.



Data analysis function 2

Statistical analysis and graph display of test results retrieved with Excel is easy. Functions such as graph overlay can also be used for visual presentation of the results.

*Excel is either a registered trademark or trademark of Microsoft Corporation in the United States and/or other countries.



Specifications

System

Order No.	Model	Description
810-813	**MZT-500L**	Digimatic specimen table (25×25)
810-814	**MZT-500P**	Automatic XY stage (50×50)

Basic system

Item		Description
Test force loading device	Test force range	0.1-1000mN
	Loading method	Balance lever
	Test force control	Electromagnetic
	Control resolution	0.916μN
	Loading rate	0.01 to 100mN/s
Indenter indentation depth measurement device	Measurement method	Electrostatic linear transducer
	Measurement range	0-20μm
	Resolution	0.1nm
	Linearity	Within ±0.7% of the full scale of 40μm
Indenter	Type	Bercovici triangular pyramid indenter
Sample surface observation device	Camera	1/3 inch black and white (410,000 pixels)
	Objective lens (monitor magnification)	100X (approx. 2500X) 40X (approx. 1000X) 10X (approx. 250X) or, 5X (approx. 125X)
Up/down device	Movable range	0 to 70mm
	Driving method	Coarse adjustment unit: DC motor driven
		Jog unit: Stepping motor driven
	Movement resolution	0.2μm or less (upon jog unit driving)
Vibration isolation function	For low frequencies	Oscillating vibration isolation mechanism
	For high frequencies	Rubber-type vibration isolation mechanism
Dimensions		Approx.700(W)×870(D)×1100(H)mm
Mass		Approx.180kg

Specimen table

Item		Description	
Model		**MZT-500L**	**MZT-500P**
Specimen table		Digimatic fine adjustment table	Automatic XY stage
Specimen fine adjustment table	Travel range	25(X)×25(Y)mm	50(X)×50(Y)mm
	Drive system	Manual	Step motor drive
	Min. drive unit (display)	1μm	0.625μm
	Stage area	100×100mm	130×130m
Specimen dimensions	Max. specimen depth	90mm (from center of indenter shaft)	
	Max. specimen height	500L:90mm, 500P:75mm (from top of specimen table)	

Control unit

Item	Description
Dimensions	Approx. 250(W)×400(D)×450(H)mm
Mass	Approx. 15kg
Power supply	AC100,120,220,240V 50/60Hz
Power consumption	Approx. 100VA

Testing functions (operation unit (PC) software functions)

Function		Specification
Test types		Test A: Indentation test (with preliminary test force) Test B: Indentation test (without preliminary test force) Test C: Test with indentation depth limit Test D: Continuous indentation test Test E: Repeated indentation test
Data analysis	Hardness	Martens hardness (HM) Martens hardness (HMs) Indentation hardness (HIT) Hardness value taken from indentation length reading
	Material properties	Indentation creep (CIT); indentation modulus (EIT); indentation work ratio (ηIT); plastic deformation; creep; elastic deformation
Graphical display	Real-time display	Test force – Indentation depth graph Test sequence graph
	Analysis results display	Test force – Indentation depth graph with test results Integral range during indentation creep calculation Test force – Indentation depth curve fit parameters Unloading curve slope calculation results

Automated testing functions (MZT-500P only)

Function		Specification
Automated testing	Teaching	It is possible to arbitrarily specify a test position on the specimen surface image using the mouse.
	Test position coordinates	It is possible to specify a test position by entering coordinates.
	Predefined patterns	Line, zigzag, 3-point staggered, circle matrix, arc patterns
	Arbitrary patterns	Patterns can be created by entering coordinates.
	Pattern combinations	Multi-point testing with combinations of predefined and arbitrary patterns is possible.

Rockwell hardness testing machine series

Choose from a wide lineup ranging from the Digimatic model featuring an electronically

Rockwell hardness testing machine

Economy model
HR-100/200/300/400 Series

analog economy model to the high-end controlled loading mechanism.

Rockwell hardness testing machine

High-end model HR-500 Series

Rockwell hardness testing machine
HR Series

963-240
HR-430MR

963-241
HR-430MS

- Economy testing machines able to perform both Rockwell and Rockwell Superficial hardness testing. (HR-430MS)
- Economy models with automatic wheel brakes.

810-202 HR-521
810-203 HR-522
810-204 HR-523

- These models use a dolphin-nose indenter to maximize space around the test zone so more specimens of various shapes can be tested without having to section them.

963-231
HR-320MS

- Economy testing machine able to perform both Rockwell and Rockwell Superficial hardness testing.

With additional optional accessories, all **HR Series** models can be used to perform Brinell hardness testing.
Note 1. Requires Brinell ball indenter and measuring microscope (and additional weights).

963-210
HR-110MR

963-220
HR-210MR

- Basic models with analog displays.
  No zero-setting required due to inclusion of an automatic preset gage.

Rockwell hardness testing machine
HR-100/200/300/400 Series

Analog Rockwell hardness testing machines HR-110MR/210MR

HR-110MR
963-210
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
963-220
Rockwell hardness testing machine

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

Digital Rockwell hardness testing machines HR-320MS/430MR/430MS

HR-320MS
963-231
Dual type (Rockwell/ Rockwell superficial) hardness testing machine

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

HR-430MR
963-240
Rockwell hardness testing machine

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

HR-430MS
963-241
Dual type (Rockwell/ Rockwell superficial combined use) hardness testing machine

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

Features

- The newly designed frame provides maximum clearance for positioning the workpiece. A flat table is all that is needed for mounting these testing machines.
- Simple to operate
  With analogue type (HR-110MR, HR-210MR), the gauge presetting operation is rendered unnecessary by the adoption of an automatic presetting dial gauge.

- HR-110MR does not require a power source, and is considered to be environmental friendly.
- Digital types (HR-430MR/430MS), use an automatic steering wheel brake and automatic loading sequencing, making for easy operation.

- Digital types (HR-320MS/430MR/430MS) have digimatic output and our Digimatic Mini-Processor (DP-1VR) for hardcopy output, as well as input tools (USB-ITN-E) to connect to a PC for data transfer.

- Brinell hardness tests can be performed by using the following optional accessories: a Brinell indenter, a weight set and a measurement microscope.

Specifications/Standard accessories/Optional accessories

Specifications

Order No.	963-210	963-220*	963-231*	963-240*	963-241*
Model	HR-110MR	HR-210MR	HR-320MS	HR-430MR	HR-430MS
Supported hardnesses	Rockwell hardness				
	—	—	Rockwell Superficial hardness	—	Rockwell Superficial hardness
Preliminary test force (N)	98.07		29.42 98.07	98.07	29.42 98.07
Test force (N) Superficial	—		147.1 294.2 441.3	—	147.1 294.2 441.3
Rockwell	588.4 980.7 1471				
Standard	JIS B 7726 ISO6508-2 (ASTM E18)				
Hardness display	Analog		Digital		
Resolution	0.5HR graduation		0.1HR indication		
Preliminary test force (handling support)	Automatic pre-setting dial gauge		Loading navigator indication	Automatic steering wheel brake	
Preliminary test force switching	—	—	Dial switching	—	Dial switching
Total test force switching	Weight change			Dial switching	
Total test force load operation	Manual/lever operation	Motor drive, Button start		Motor drive, Automatic start	
Test force duration	Manual	Fixed 3-5.5s or manual		3-60s setting or manual operation	
Maximum specimen height	180mm (100mm if cover is attached)				
Maximum specimen depth	165mm (from indenter axis to the frame)				
Function	—	—	OK/NG judgment function		
	—	—	Compensation function		
	—	—	Hardness conversion function		
Data output interface	—	—	S-232C, SPC (ON/OFF selectable in each output type)		
Power supply	No power required	100-240V AC 1.2A (AC adapter DC12V 3.5A)			
External dimensions	Approx. 296(W) x 512(D) x 780(H)mm	Approx. 235(W) x 512(D) x 780(H)mm	Approx. 235(W) x 516(D) x 780(H)mm		
Mass	Approx. 49kg	Approx. 47kg	Approx. 47kg	Approx. 50kg	

*: To denote your AC power cable add the following suffixes to the order No.:
-10A for UL/CSA, D for CEE, DC for CCC, E for BS, K for KC, C and No suffix are required for PSE.
Note: Please be advised that some plastic materials are not testable with this equipment. Contact Mitutoyo for details if in doubt.

Standard accessories: Brinell hardness tests can be performed by using the following optional accessories: a Brinell indenter, a weight set and a measurement microscope.

Order No.	Item	Description
19BAA072*1	Diamond indenter	For R (for HR-xxxMR)
19BAA073*1	Diamond indenter	For R/S (for HR-xxxMS)
19BAA074	Steel ball indenter	ø1/16" (ø1.5875mm)
19BAA082	Steel ball (spare)	ø1/16" (ø1.5875mm)
810-039	Flat anvil	ø64mm
810-040	V-anvil (large)	ø40mm,120 ° V-groove 30mm wide
—	Hardness test block	60-65HRC
—	Hardness test block	30-35HRC
—	Hardness test block	90-95HRB
—	Hardness test block	65HR30N (only HR-xMS attachment)
—	Hardness test block	70HR30T (only HR-xMS attachment)

*1: It includes either of the two indenters depending on the model.

Order No.	Item	Description
357651	AC adapter	AC100-240V, 1.2A DC12V, 3.5A
Specify one of the following (must match machine Order No. suffix):		
02ZAA000 Order No. suffix: C and No suffix For PSE		
02ZAA010 Order No. suffix: A For UL/CSA		
02ZAA020 Order No. suffix: D For CEE		
02ZAA030 Order No. suffix: E For BS		
02ZAA040 Order No. suffix: DC For CCC		
02ZAA050 Order No. suffix: K For KC		
	User's manual	Depends on destination country
56AAK312	Vinyl cover	
—	Accessory box	
—	Level	

Optional accessories: A weight set for Brinell test, an indenter, and a spare ball

Hardness testing machine	Weight set		Indenters for Brinell test			
	Order No.	Item	**19BAA277**	**19BAA279**	**19BAA280**	**19BAA284**
			ø1mm	ø2.5mm	ø5mm	ø10mm
HR-110MR HR-210MR	**56AAK286**	Brinell weight set for HR110MR, 210MR 62.5 125 187.5	—	HBW2.5/62.5 HBW2.5/187.5	HBW5/62.5 HBW5/125	(HBW10/100*)
HR-320MS	**56AAK287**	Brinell weight set for HR-320MS 31.25 62.5 125 187.5	(HBW1/30*)	HBW2.5/31.25 HBW2.5/62.5 HBW2.5/187.5	HBW5/62.5 HBW5/125	(HBW10/100*)
HR-430MR	**56AAK288**	Brinell weight set for HR-430MR) 62.5 125 187.5	—	HBW2.5/62.5 HBW2.5/187.5	HBW5/62.5 HBW5/125	(HBW10/100*)
HR-430MS	**56AAK289**	Brinell weight set for HR-430MS 31.25 62.5 125 187.5	(HBW1/30*)	HBW2.5/31.25 HBW2.5/62.5 HBW2.5/187.5	HBW5/62.5 HBW5/125	(HBW10/100*)

Measurement microscope for Brinell hardness test

Order No.	Item
19BAA318	Measurement microscope (40X model)
19BAA319	Measurement microscope (100X model)

Spare cemented carbide ball				
Order No.	**19BAA281**	**19BAA283**	**19BAA162**	**19BAA163**
Item	1mm	2.5mm	5mm	10mm
Size (Quantity)	ø1mm (1 pc.)	ø2.5mm (1 pc.)	ø5mm (1 pc.)	ø10mm (1 pc.)

*The built-in weights are used for this range. Only an indenter needs to be selected.

Rockwell hardness testing machine
HR-500 Series wiZhard

The HR-500 Series provides the latest testing machines that can perform 3 types of hardness testing: Rockwell, Rockwell Superficial, and the loading sequence for Brinell hardness tests by the adoption of electronic control.

810-202, -203
HR-521, 522

810-204
HR-523

Hardness testing of internal surfaces, which previously was impossible without sectioning, is now possible. (All models.)
The minimum diameter that can be tested is 34mm as standard. Measurement can be performed down to an inside diameter of 22mm by using the diamond indenter (**19BAA292**-optional).

The operation panel can be installed on top of the machine, which is very helpful when installation space is limited. (All models.)
The operation box installation plate (**19BAA295**-optional) is required for mounting.

Touch screen control panel

Advanced control panel able to perform functions such as statistical analysis and graphical display of test results in addition to basic functions.

Test force auto switch function

The type of the indenter is set in advance. The desired hardness scale can be selected on the operation panel.
The test force can be automatically switched to the level corresponding to the selected hardness scale.

Graphic display of X-R control chart and statistical calculation results

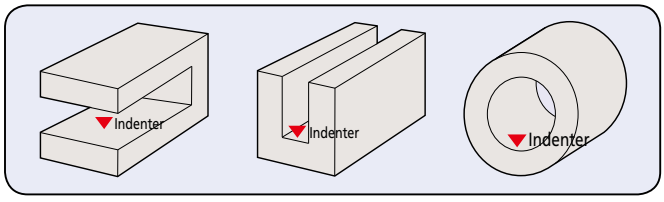
Statistical calculation values such as the maximum, minimum, and mean, X-R control charts, and histograms, which are required for hardness evaluation, can be displayed.

Equipped with the continuous measurement function

An electromagnetic brake means that handle operations are not required for measurement from the 2nd point. All operations can be completed by pressing buttons, which allows continuous, speedy measurement.

Various shapes of specimen can be measured. (Nose-type indenter has been adopted)

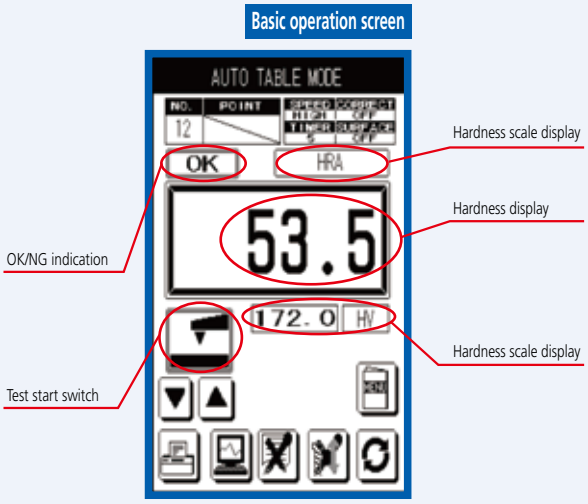
The nose-type indenter allows internal measurement of pipe samples as well as the top surface of a flat sample.



Touch panel display and function

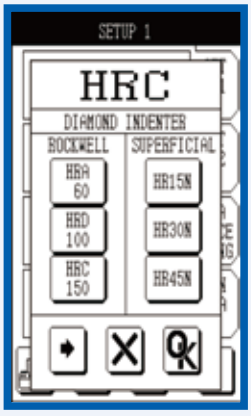
HR-521/522/523 models employ a touch screen control panel with switchable display, enabling both a diverse range of functions and excellent operability.

Basic operation screen



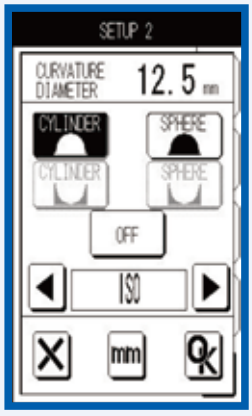
Direct hardness scale selection

The hardness scale, determined according to the test force and indenter combination, can be directly selected on the touch screen. Preliminary test force and test force are set automatically to match the chosen scale, offering great convenience.



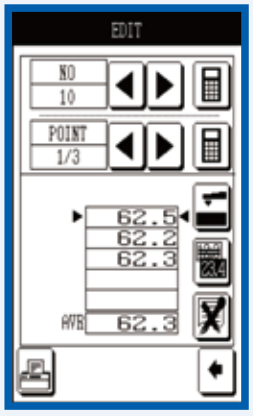
Curved surface compensation and measurement

The curve compensation function supporting specimens with curved surfaces such as round bars and spheres allows hardness testing of specimens of a wide range of shapes, not only flat specimens.



Statistical analysis

Quality control processes involving hardness testing of industrial materials employ judgments based on test results for multiple points. This function performing calculation of statistics such as maximum, minimum and mean values and standard deviations is useful for analysis of multi-point test results.



Specifications/Standard accessories/ Optional accessories

Specifications

Order No.	810-202*1	810-203*1	810-204*1
Model	HR-521	HR-522	HR-523
Supported hardnesses	Rockwell hardness/Rockwell Superficial hardness/Brinell hardness*2		
Preliminary test force (N)	29.42 98.07		
Total test force (N) Superficial	147.1 294.2 441.3		
Rockwell	588.4 980.7 1471		
Brinell	1839	61.29 98.07 153.2 245.2 294.2 306.5 612.9 980.7 1226 1839	
Test force control	Auto (load, duration, unload)		
Table up/down mechanism	Manual (automatic brake for the preliminary test force)		Motor driven (manual operation is also available)
Operation unit	Membrane switch operation panel		
Test force switching	Switch operation		
Test force duration time	0 to 120s (Can be set to any value in units of 1s.)		
Specimen maximum dimensions	Height: 250mm (Long type: 395mm) Depth: 150mm		
Allowable inner diameter of pipe specimen	Minimum hole diameter: 35mm (When the special specification indenter is used: 22mm)		
Display	Hardness value, test condition, OK/NG judgment result, statistical calculation result, $\bar{X}$-R control chart, hardness conversion value		
Function	Conversion function [HV, HK, HR (Rockwell hardness A, B, C, D, F, G / Rockwell Superficial 15T, 30T, 45T, 15N, 30N, 45N), HS, HB, Tensile strength]		
	OK/NG judgement function		
	Continuous measurement function (for specimens of the same thickness)		
	Cylindrical correction, spherical correction, offset correction, multi-point correction functions		
	Statistical calculation function (Maximum value, minimum value, mean value, standard deviation, upper and lower limit values, OK count, range, NG count)		
	Graph generation function ($\bar{X}$-R control charts)		
Language support	6 languages are supported: Japanese, English, German, French, Italian, and Spanish.		
External connection interface	For printer: Serial interface (compatible with the RS-232C standard), Digimatic interface, Centronics interface		
Power supply	100V AC, approx. 40VA or less, (120/220/240V AC set on shipment from factory.)		
External dimensions Mass	Body: Approx. 250(W) x 670(D) x 605(H)mm, (Long types: 750(H)mm), Approx. 65kg (Long types: Approx. 75kg) Operation panel: Approx. 165 (W) x 260 (D) x 105 (H)mm approx. 0.75kg		

Order No. and Models for long types: **810-205***1: HR-521L **810-206***1: HR-522L **810-207***1: HR-523L

*1 To denote your AC power cable add the following suffixes to the order No.:
A for UL/CSA, D for CEE, DC for CCC, E for BS, K for KC, C and No suffix are required for PSE.

*2 For Brinell hardness testing, an indenter (option) and a measurement microscope are required.

Standard accessories

Order No.	Item	Specification	Order No.	Item	Specification	Order No.	Item	Specification
	Connection cable	For connection between the hardness testing machine main unit and display	**19BAA114***	Power cord	For 100V AC	—	Hardness test block	70 to 79HR30T
19BAA073	Diamond indenter	For Rockwell superficial	**419BAA517**	Vinyl cover			Fuse	
19BAA074	Steel ball indenter	1/16" (ø1.5875)	—	Hardness test block	30 to 35HRC		Accessory box	
19BAA082	Spare steel ball	1/16" 10 balls	—	Hardness test block	60 to 65HRC		Operating manual	
810-039	Flat anvil	ø64mm	—	Hardness test block	90 to 95HRB		Warranty card	
810-040	V anvil	ø40mm Groove width : 30mm	—	Hardness test block	64 to 69HR30N			

* Order numbers differ depending on destination.

Additional information

The relation between the test force and indenter for Brinell hardness test is as follows.
For the Brinell hardness test, the following indenter (optional accessory) and measurement microscope are required.

	Brinell									
Test force	61.29	98.07	153.2	245.2	294.2	306.5	612.9	980.7	1226	1839
19BAA277 ø1 Indenter for Brinell test		HBW1/10			HBW1/30					
19BAA279 ø2.5 Indenter for Brinell test	HBW2.5/6.25		HBW2.5/15.625			HBW2.5/31.25	HBW2.5/62.5			HBW2.5/187.5
19BAA280 ø5 Indenter for Brinell test				HBW5/25			HBW5/62.5		HBW5/125	
19BAA284 ø10 Indenter for Brinell test								HBW10/100		

Measurement microscope 40X (**19BAA318**), Measurement microscope 100X (**19BAA319**)

Optional accessories

Item	Order No.	
Hardness standard block 32HRB	**19BAA028**	
Hardness standard block 42HRB	**19BAA029**	
Hardness standard block 52HRB	**19BAA030**	
Hardness standard block 62HRB	**19BAA031**	
Hardness standard block 72HRB	**19BAA032**	
Hardness standard block 82HRB	**19BAA033**	
Hardness standard block 92HRB	**19BAA034**	
Hardness standard block 10HRC	**19BAA035**	
Hardness standard block 20HRC	**19BAA036**	
Hardness standard block 30HRC	**19BAA037**	
Hardness standard block 40HRC	**19BAA038**	
Hardness standard block 50HRC	**19BAA039**	
Hardness standard block 60HRC	**19BAA040**	
Hardness standard block 70HRC	**19BAA041**	
Hardness standard block 41HR30N	**19BAA042**	●
Hardness standard block 50HR30N	**19BAA043**	●
Hardness standard block 60HR30N	**19BAA044**	●
Hardness standard block 73HR30N	**19BAA045**	●
Hardness standard block 83HR30N	**19BAA046**	●
Hardness standard block 75HR15N	**19BAA047**	●
Hardness standard block 85HR15N	**19BAA048**	●
Hardness standard block 90HR15N	**19BAA049**	●
Hardness standard block 32HR30T	**19BAA050**	●
Hardness standard block 42HR30T	**19BAA051**	●
Hardness standard block 52HR30T	**19BAA052**	●
Hardness standard block 62HR30T	**19BAA053**	●
Hardness standard block 72HR30T	**19BAA054**	●
Hardness standard block 78HR15T	**19BAA055**	●
Hardness standard block 82HR15T	**19BAA056**	●
Hardness standard block 87HR15T	**19BAA057**	●
Diamond indenter (R models)	**19BAA072**	
Diamond indenter (R/S models)	**19BAA073**	
Steel ball indenter 1/16" (ø1.5875)	**19BAA074**	
Steel ball indenter 1/8" (ø3.175)	**19BAA075**	
Steel ball indenter 1/4" (ø6.35)	**19BAA076**	
Steel ball indenter 1/2" (ø12.7)	**19BAA077**	
Control box mounting plate	**19BAA295**	▼
5mm diamond indenter	**19BAA292**	▼

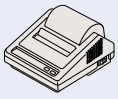
●Except HR-***MR
▼HR-500 Series only

Except HR-110MR/210MR

264-504
Digimatic mini processor
DP-1VR

No connection cable is supplied
(Should be ordered separately)
Connection cable (1m)
HR-300/400/500 Series(937387)

810-622
Printer
DPU-414



No connection cable is supplied
(Should be ordered separately)
Connection cable
(HR-500: 12AAA804)
Not applicable to HR-100 to -400

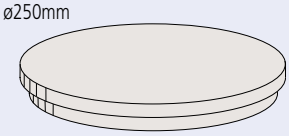
06ADV380E
USB input tool
Direct USB-ITN

For simple data input to PCs

11AAC237
Data processing software

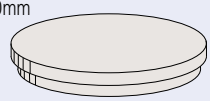
See page 36 for detail.

810-038
Round table Outside ø250mm



For large specimens

810-037
Round table Outside ø180mm



For large specimens

810-040
V-anvil (large)

(Outside ø40mm, groove width 50mm)
For shaft material (max. ø60mm)
Insert diameter: ø19mm

810-043
Spot anvil

(Outside ø12mm)
Insert diameter: ø19mm

810-041
V-anvil (small)

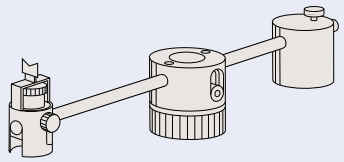
(Outside ø40mm, groove width 6mm)
For shaft material (max. ø8.4mm)
Insert diameter: ø19mm

810-044
Spot anvil

(Outside ø5.5mm)
For sheet specimens
Insert diameter: ø19mm

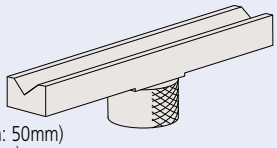
Note: Optional accessories inside this box cannot be used with AR-10, -20 or -600

810-027
VARI-REST



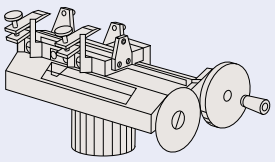
For testing of long samples

810-029
Special V-anvil



(length: 400mm; groove width: 50mm)
For shaft material (max.ø100mm)

810-026
Fine adjustment table for Jominy test

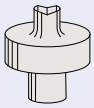


JIS G 0561
For steel hardenability testing

810-030
Diamond-spot anvil

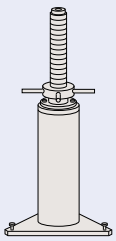
Outside ø10mm
For sheet specimens
Insert diameter: ø19mm
For Rockwell Superficial hardness testing

810-042
Small V-anvil



(Outside ø10mm)
For shafts (max. ø16mm)
Insert diameter: ø19mm

810-028
Jack rest

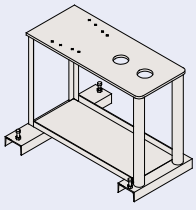


For testing of long samples
(Used with anvil or round table)

810-643
Vibration isolator

Only for mounting hardness testing machines

810-048
Console table

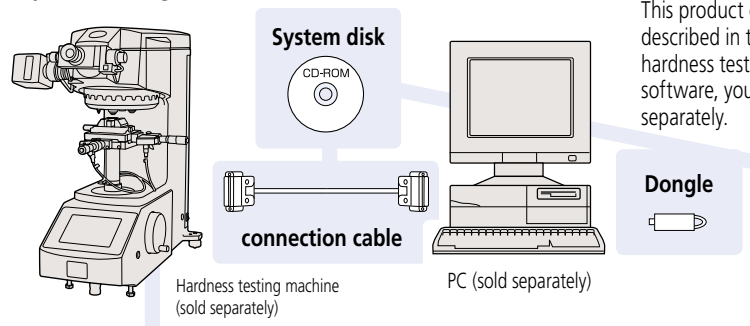


Data processing software for hardness testing machines

As most industrial materials, such as metals, vary in quality, the results of material tests in the property evaluation process and for quality control purposes require accurate statistical analysis. In the case of hardness testing, the results of hardness measurements are processed for statistical calculations, creation of graphs, control charts, and reports for analysis and evaluation for material development and quality control. Such operations and storage of results are performed on PCs. Data processing software connects to a hardness testing machine via a connection cable and transfers the measurement results directly to Excel worksheets on a PC.

This software has the following features:
…It can capture measurement results from the hardness testing machine and display them in Excel worksheets.
…On the worksheets, the measurement results can be easily converted into table format.
…If it is connected to a hardness testing machine that outputs the hardness measurement results and measurement position information together, the hardness distribution on the specimen surface can be displayed graphically. This is very useful in examining the thermal effects of welding, process hardening of the specimen surface, and evaluation of the degree of residual stress.
…A standard file suitable for evaluating the carburization hardened layer, a test often used on steel, is supplied.

System configuration



This product consists of the system disk that contains the software as described in the standard configuration, dongle, cables connecting the hardness testing machine and PC, and operation manual. To use this software, you need to purchase a hardness testing machine and PC separately.

◆Supported models

Vickers hardness testing machine
HM Series (except HM-101)
HV Series (except AVK-C0)

Rockwell hardness testing machine
HR-500 Series
Portable hardness tester
HH-411 Series

Configuration of the data processing software for hardness testing machines

◆Standard configuration

Measurement result list
Statistical calculation (maximum, minimum, standard deviation, variation, mean, coefficient of variation)
Hardness curve
Hardness histogram
2D hardness distribution
3D hardness distribution

◆Cable specifications

This software includes the cable that connects the hardness testing machine and PC as a standard accessory.
Note: the cable specification varies depending on your PC and hardness testing machine.

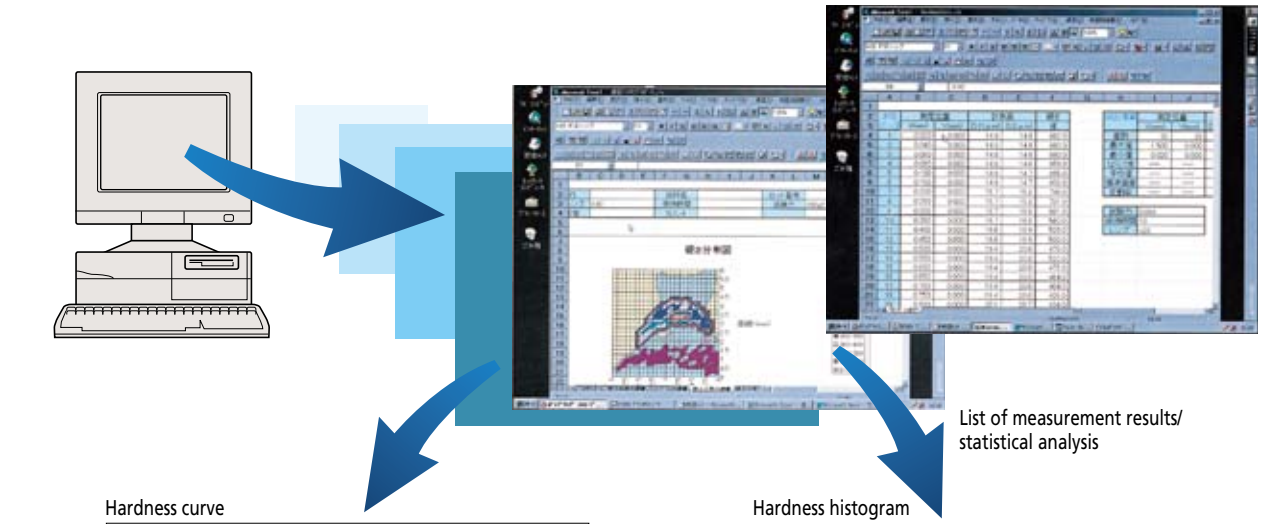
Specifications

Order No.	Model	Standard configuration	Cable connections		Cable specifications
			Hardness testing machine	Operating environment	
11AAC236	**EXPAK-06**	· Software CD-ROM (includes user's manual) · Connection cable · USB security dongle · Quick reference guide	HM-210A HM-220A (Cannot be used with Systems B, C or D)	OS：Windows7　SP1(32bit) Application: Office 2010 (Excel 2010) Language: Japanese or English Recommended hardware CPU: Intel i3-2100 processor (3.1 GHz) Memory: 2GB or more Optical drive: CD-ROM drive Required interfaces and no. of ports: 11AAC236: USB, 2 ports 11AAC237, 238: USB, 1 port and RS-232C*, 1 port	USB cable
11AAC237	**EXPAK-07**		HM-102/103 HR-511/521/522/523 (Can be used for old models as well. See Note2 below the table).		RS-232C reverse cable 9P-9P
11AAC238	**EXPAK-08**		HH-411 (UD-410)		Special connection cable 8P-9P

Note1 Mitutoyo is unable to provide assurance for use of RS-232C with a commercial USB-RS-232C converter as performance has not been tested
Note2 Old models are HM-112/113/114/115/122/123/124/125 and HV-112/113/114/115 (except for system machines such as automatic machines with PC).

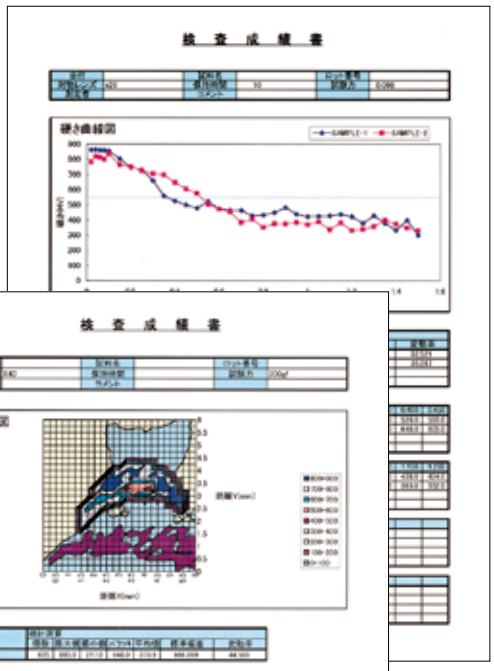
Examples of setting screens

The following are sample screenshots of data processing software for hardness testing machines running within an Excel* worksheet.
* Excel is either a registered trademark or trademark of Microsoft Corporation in the United States and/or other countries

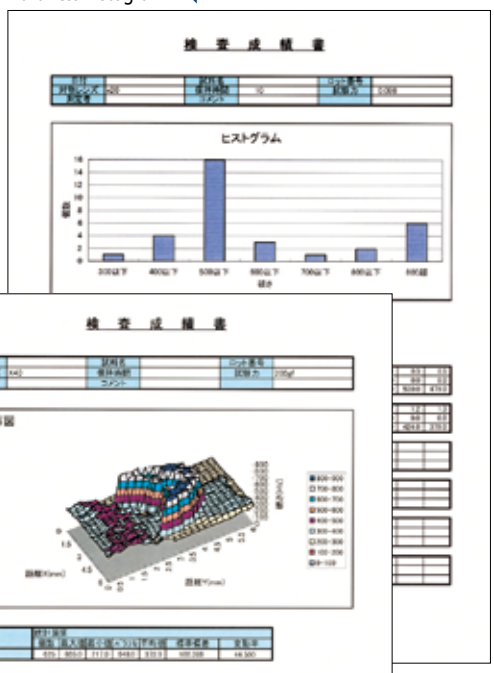


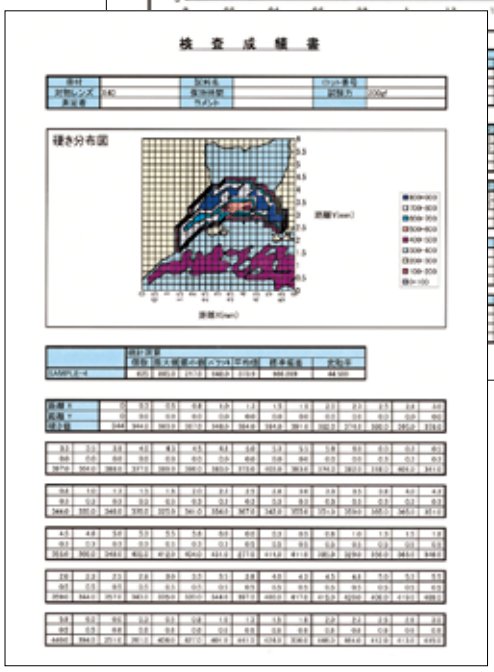
List of measurement results/
statistical analysis

Hardness curve

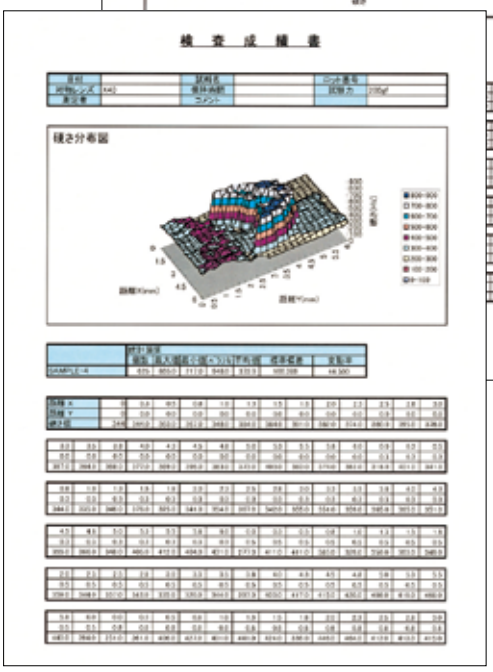


Hardness histogram





2D hardness distribution



3D hardness distribution*

Note: 3D hardness distribution is not a basic function of this product and uses functions of Microsoft Excel software.

Potable hardness tester series of a wide range of materials

Hardmatic HH-411

Rebound type portable hardness tester for metal

helps support testing the hardness from metals to rubbers and plastics.

Hardmatic HH-300 Series

Durometers for sponge, rubber, and plastic

Rebound type portable hardness tester HARDMATIC HH-411

HH-411 is a rebound type portable hardness tester for metal with a compact body and high operability. It allows anyone to perform hardness testing easily at the touch of a key, so it can be used widely on various components in the field.

810-299
HH-411

Rich variety of detectors available

In addition to the general-purpose detector (D type) supplied as standard equipment, the detector lineup includes rich variations (sold separately) to support special applications. The DC type is provided for hardness testing of internal walls of pipes with diameters that cannot be tested with the D type, the D+15 type for bearings and gears, and the DL type for small areas such as the bottom of small gears and weld corners.

Equipped with automatic orientation correction

For the rebound type hardness tester, gravity affects the measurement result depending on the orientation of the detector relative to the vertical when pressed against the specimen surface. The HH-411 is equipped with the latest measurement technology that automatically detects the orientation of the detector to automatically correct for this effect. For this reason, the setting for orientation of the detector is not required.

Hardness testing of small surfaces is possible

Only a small surface (standard D type: ø22mm, separately sold DL type: ø4mm) area is required for hardness testing. Therefore the HH-411 can be used for testing of various specimen shapes such as around grooves and gear teeth.

Equipped with a data save function

Up to 1800 hardness test results can be saved, which is useful for patrol tests in the field.

Hardness scale can be selected for your own individual purpose

Based on the Leeb hardness HL value (L value: according to ASTM A 956), conversion can be performed to Vickers, Brinell, Rockwell C, Rockwell B, and Shore hardness as well as tensile strength.
Conversion can be performed after the test, or hardness value display in the conversion mode is also available.

Great operability

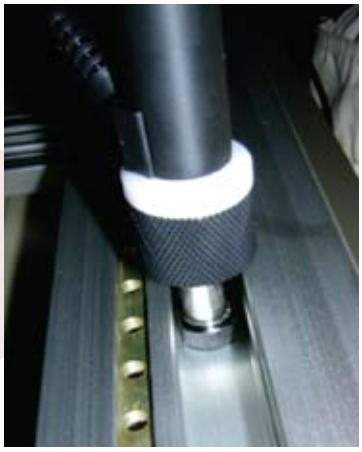
The basic operation is to press the detector against the sample surface and push the detector button by your finger, just like clicking a ballpoint pen, so it is easy for anyone to do.

Application examples for each detector type

DC Type : UD-412

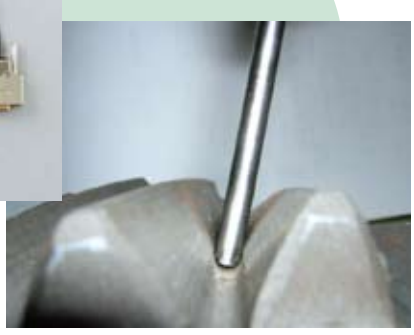
Hardness testing of internal walls of pipes and tight spaces

D+15 Type : UD-413



Hardness testing in gaps and grooves and with slightly uneven surfaces

DL Type : UD-414



Small surfaces such as bottom lands of gears and weld corners

Specifications/Standard accessories/ Optional accessories

Specifications

Order No.	810-298 (ASTM) 810-299 (JIS)
Model	HH-411
Detector	Carbide ball is used at the tip of the impact hammer (D type: ASTM A956 specification)
Display	7 segments, LED display
Hardness display range	Leeb hardness :1 to 999HL
Measuring accuracy	800±12HL For measurements performed using a testing method described in the user's manual with a Mitutoyo-recommended test block firmly mounted on a granite surface base
Display range (The display range varies depending on the conversion table used.)	Vickers hardness :43 to 950HV Brinell hardness :20 to 894HB Rockwell hardness (C scale) :19.3 to 68.2HRC Rockwell hardness (B scale) :13.5 to 101.7HRB Shore hardness :13.2 to 99.3HS Tensile strength :499 to 1996MPa
Function	Automatic angle correction Offset Pass or failure decision function Data save: 1800 Points Conversion (details in display range) Statistical calculation function (mean, maximum, minimum, variation, standard deviation) Auto-sleep Dotting count display
Specimen requirements	Min. thickness: 5mm; mass: 5kg or more (However, specimens with a mass between 0.1 and 5kg can be tested if fixed to a strong support.) Test points: At least 5mm from specimen edges and at intervals of at least 3mm Surface roughness: up to Ra 2µm
External connection interface	RS-232C and SPC (1 each; simultaneous output is available)
Power supply	Two AA alkaline batteries (battery life: Approx. 70 hours in continuous use), AC adapter (special accessory)
Operating environment	Temperature: 0 to 50°C Humidity: 95% (No condensation)
External dimensions	Display: Approx.70(W)×110(D)×35(H)mm Approx. 200g
Mass	Detector: Approx.ø28×175mm 120g

Note: For Shore hardness value measurements in Japan, please use item with order no. 810-299

Standard components

Order No.	Item	Description	Quantity
810-292	Display UD-410	—	1
—	AA alkaline battery	—	2
—	User's manual	—	1
—	Strap	—	1
810-287	Detector UD-411	D type Approx. ø28 x 175mm, Approx. 120g (tip diameter ø22mm)	1
—	Impact hammer	—	1
19BAA457	Carbide ball	Installed in the impact hammer	1
19BAA459	Wrench	For replacement of carbide ball	1
19BAA451	Support ring	ø22mm	1
19BAA452	Support ring (Small)	ø14mm	1
19BAA258	Cleaning brush	—	1
19BAA265	Hardness standard block	800HLD-equivalent (ø90mm、t55mm、2.7kg)	1

Note: The HH411 cannot be used for hardness measurement of elastic materials such as rubber. Stiffness of the measurement target may affect the measurement result. Particularly avoid the measurement of sheets.

Optional accessories

Order No.	Item	Description	
264-504	Digimatic mini processor	Printing of measurement data, various statistical calculations, etc.	1
937387	Connection cable	For connection of DP-1VR and display (1m)	1
09EAA082	Recording paper	For DP-1VR (10 rolls)	1
810-622	Thermal printer DPU-414	Printing, such as the statistical calculation and a variety of measurement data	1
19BAA285	Connection cable (for DPU-414)	With connection cable for display	1
19BAA157	Recording paper	For DPU-414 (TP411-28CL) (10 rolls)	1
19BAA238	Connection cable	For connection of the PC and display RS-232C (For DOS/V PC)	1
526688	AC adapter	For display AD908N	1
19BAA243	Hardness standard block	880HLD (ø115mm, t33mm, 3.7kg)	1
19BAA244	Hardness standard block	830HLD (ø115mm, t33mm, 3.7kg)	1
19BAA245	Hardness standard block	730HLD (ø115mm, t33mm, 3.7kg)	1
19BAA246	Hardness standard block	620HLD (ø115mm, t33mm, 3.7kg)	1
19BAA247	Hardness standard block	520HLD (ø115mm, t33mm, 3.7kg)	1
19BAA248	Support ring cylinder (3)	For measurement of convex surfaces (R10 to 20mm): For D and DC types	1
19BAA249	Support ring hollow cylinder (4)	For measurement of concave surfaces (R14 to 20mm): For D and DC types	1
19BAA250	Support ring sphere (5)	For measurement of convex surfaces (R10 to 27.5mm): For D and DC types	1
19BAA251	Support ring hollow sphere (6)	For measurement of concave surfaces (R13.5 to 20mm): For D and DC types	1
19BAA457	Carbide ball	For D, DC, and D+15 types	1
19BAA458	Replacement ball shaft	For DL type	1
810-287	Detector UD-411	D type Approx. ø28 x 175mm, Approx.120g (tip ø22mm)	1
810-288	Detector UD-412	DC type Approx. ø22 x 85mm, Approx.50g (tip ø22mm)	1
810-289	Detector UD-413	D+15 type Approx. ø28 x 190mm, Approx.130g (tip width ø11mm)	1
810-290	Detector UD-414	DL type Approx. ø28 x 230mm, Approx.140g (tip width ø4mm)	1

Interchangeable detectors (special accessories)

● One display (UD-410) can be used in combination with various detectors.

810-290
UD-414
Application: Suitable for measuring in grooves and crevices such as are found on gears and weld corners.

810-289
UD-413
Application: Suitable for the measurement of concave parts such as and grind parts of ball bearing.

810-288
UD-412
Application: Suitable for the measurement of internal walls of cylinders. The grip is short, which is desirable for maintaining stability in the measurement position.

Durometers for sponge, rubber, and plastic
Hardmatic HH-300 Series

The Hardmatic HH-300 Series includes a slim and easy-to-handle long type and a compact type that fits easily in your hand. Both types have 2 types of display specifications, analog and digital.

Long type

811-333-10,334-10
HH-333, 334
811-337-10,338-10
HH-337, 338

811-333-10,337-10
HH-334, 338

Compact type

811-331-10,332-10
HH-331, 332
811-335-10,336-10
HH-335, 336

811-329-10,330-10
HH-329, 330

HARD

SOFT

Plastics

Hard rubbers

811-019
CTS-101
811-332-10
HH-332

General types of rubber
Elastomers

811-013
CTS-103
811-336-10
HH-336

Hard sponges
Soft foams

DP-1VR

Measuring hardness just requires pressing the hardness tester against the specimen and reading the indicated value.

Various kinds of sample can be tested for hardness, from soft sponge to hard plastic. Also, various measurement locations on the specimen can be used, such as a flat surface, a hole, or the bottom of a groove. The 10 models of hardness testers in the HH-300 Series support various hardness measurement standards.

Long type HH-331, 332, 333, 334

The the long type has a slender cylindrical shape (ø24 x 85mm).
Due to this it can measure hardness at the bottom of grooves or holes as well as exposed surfaces. Also, hardness measurement can be performed while keeping your hands and face away from the specimen surface. This is essential when the surface temperature is high: for example immediately after molding.

Compact type HH-329, 330, 335, 336, 337, 338

The compact body fits snugly into your palm for ease of measurement.

Specifications

Order No.		811-329-10	811-330-10	811-331-10	811-332-10	811-333-10	811-334-10
Model		HH-329	HH-330	HH-331	HH-332	HH-333	HH-334
Type		Compact type		Long type			
Display specification		Analog	Digital	Analog	Digital	Analog	Digital
Measurement target		Soft rubber, sponge, felt, hard foam, winder		General rubber/soft plastic		Hard rubber/hard plastic/ebonite	
Category in standards		Type E		Type A		Type D	
Applicable standard		JIS K 6253		JIS K 6253, JIS K 7215, ASTM D 2240, ISO 868, ISO 7619, DIN 53 505			
Needle shape	Shaft diameter	—		ø1.25mm			
	Tip shape	Semi-sphere		Circular truncated cone		Cone	
	Tip angle	—		35°		30°	
	Tip diameter	ø5mm		ø0.79mm		—	
	Tip curvature	—		—		0.1	
Pressure surface shape		44×18mm		ø18mm			
Protrusion of needle from pressure surface		2.5mm		2.5mm			
Minimum graduation		1° (HH-329, 331, 333, 335, 337) 0.1° (HH-330, 332, 334, 336, 338)					
Loading device W_E, W_A, W_D, spring force (mN) H_E, H_A, H_D hardness		Coil spring method W_E=550+75H_E (10 scale 1300mN, 90 scale 7300mN)		Coil spring method W_A=550+75H_A (HA: 10 to 90) (10 scale 1300mN, 90 scale 7300mN)		Coil spring method W_D=444.5H_D (HD: 20 to 90) (20° 8890mN, 90° 40005mN)	
Accuracy of spring force		±68.6mN		±68.6mN		±392.3mN	
Functions		Peak hold	Hold function Output function: Digimatic interface for printer Tolerance judgment Function lock	Peak hold	Hold function Output function: Digimatic interface for printer Tolerance judgment Function lock	Peak hold	Hold function Output function: Digimatic interface for printer Tolerance judgment Function lock
External dimensions		Approx. 56(W)×33.5(D)×144(H)mm	Approx. 60(W)×28.5(D)×151(H)mm	Analog long Approx.56 (W) ×33.5 (D) ×186 (H) mm Digital long Approx. 60 (W) ×28.5 (D) ×193 (H) mm			
Mass		300g	290g	320g	310g	320g	310g
Power supply		—	Button type silver oxide battery SR44	—	Button type silver oxide battery SR44	—	Button type silver oxide battery SR44

Hold function HH-330/332/334/336/338

Holds the display value at any time during measurement so that you can easily check the measurement result.

Peak hold function HH-329/331/333/335/337

The peak hold indicator attached to the analog display is very useful for peak value measurement.

Output zero set function HH-330/332/334/336/338

A Digimatic output interface is standard, so they can be connected to the DP-1VR (special accessory) and measurement system. By using the ZERO switch, which also serves as the power switch, you can correct any small shift of the zero position due to a quantization error.

Specifications

Order No.		811-335-10	811-336-10	811-337-10	811-338-10
Model		HH-335	HH-336	HH-337	HH-338
Type		Compact type			
Display specification		Analog	Digital	Analog	Digital
Measurement target		General rubber / soft plastic		Hard rubber/hard plastic/ebonite	
Category in standards		Type A		Type D	
Applicable standard		JIS K 6253, JIS K 7215, ASTM D 2240, ISO 868, ISO 7619			
Needle shape	Shaft diameter	ø1.25			
	Tip shape	Circular trancated cone		Cone	
	Tip angle	35°		30°	
	Tip diameter	ø0.79mm		—	
	Tip curvature	—		0.1mm	
Pressure surface shape		44×18mm			
Protrusion of needle from pressure surface		2.5mm			
Minimum graduation		1˚ (HH-331, 333, 335, 337) 0.1˚ (HH-332, 334, 336, 338)			
Loading device W_A, W_D, spring force (mN) H_A, H_D hardness		Coil spring method W_A=550+75H_A (HA: 10 to 90) (10 scale 1300mN, 90 scale 7300mN)		Coil spring method W_D=444.5H_D (HD: 20 to 90) (20 scale 8890mN, 90 scale 40005mN)	
Accuracy of spring force		±68.6mN		±392.3mN	
Functions		Peak hold	Hold function Output function: Digimatic interface for printer Tolerance judgment Function lock	Peak hold	Hold function Output function: Digimatic interface for printer Tolerance judgment Function lock
External dimensions		Analog compact Approx. 56 (W) x 33.5 (D) x 144 (H)mm Digital compact Approx. 60 (W) x 28.5 (D) x 151 (H)mm			
Mass		300g	290g	300g	290g
Power supply		—	Button type silver oxide battery SR44	—	Button type silver oxide battery SR44

One unit for 3 applications

Optional accessories

Measurement/test dual purpose stand CTS Series (all models)

The CTS Series can be combined with the HH-300 Series for (1) hardness measurement, and (2) spring force testing of the HH-300 Series hardness tester main unit. (3) By connecting the attached weight directly to the hardness tester to perform hardness measurement results in better repeatability than can be obtained compared to hardness measurement made by directly pressing the hardness tester against the workpiece by hand. This measurement method with a weight directly connected to the hardness tester is useful for measuring the hardness of large samples for which the stand cannot be used, as well as hardness measurement in the field. The CTS Series includes 3 models for different hardness tester types. All 3 models can be used for (1), (2), and (3) above with one stand by adding a separately available accessory.

Specifications

Order No.		811-019	811-012	811-013
Model		CTS-101	CTS-102	CTS-103
Applicable model		HH-331, 332	HH-333, 334, 337, 338	HH-335, 336
Application	1.Fixed force hardness measurement			
	Measurement force	9.81N	49.05N	9.81N
	Weight used	(1)	(1)+(3)+(4)	(1)
	2.Manual fixed force hardness measurement			
	Measurement force	9.81N	49.05N	9.81N
	Weights used	(1)+(6)	(1)+(3)+(6)	(1)+(6)
	3.Loading test			
	Weight used	L:— / H:(1)	L:(1)+(5) / H:(3)	L:— / H:(1)+(2)
Weights	Weight application	(1)CTS-101, 102, 103 Measurement / testing (2)103 Measurement (3)CTS-102 Measurement / testing (4)CTS-102 Measurement (5)CTS-102 Measurement / testing (6)CTS-101, 102, 103 Measurement		
	Outside diameter (Unit: mm)	(1)ø64×23.5 (6)ø40×13	(1)ø64×23.5 (3)ø78×110 (4)ø20×25 (5)ø40×25 (6)ø40×13	(1)ø64×23.5 (2)ø20×19 (6)ø40×13
	Body mass	(1)580g (2)34.8g (3)3950g (4)50g (5)197.4g (6)130g		
Stand overview	External dimensions	ø148 x Height (Max.) 420mm		
	Up/down stroke	12mm		
	Maximum specimen thickness	Approx. 90mm		
	Specimen table dimension	ø90mm		
	Total mass	Approx. 9kg	Approx. 13kg	Approx. 9kg

Standard configuration

Item	Usage	Quantity	811-019 CTS-101	811-012 CTS-102	811-013 CTS-103
Main unit	—	1	✓	✓	✓
Tool set	—	1	✓	✓	✓
Weight (1)	Measurement / testing	1	✓	✓	✓
Weight (2)	Testing	1	—	—	✓
Weight (3)	Measurement / testing	1	—	✓	—
Weight (4)	Measurement / testing	1	—	✓	—
Weight (5)	Testing	1	—	✓	—
Weight (6)	Testing	2	✓	✓	✓
User's manual	—	1	✓	✓	✓
Warranty card	—	1	✓	✓	✓

(1)Hardness measurement

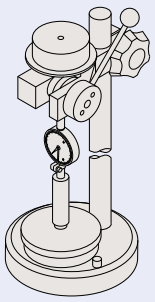
(2)Spring force testing

(3)Direct application of weight

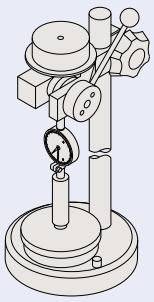
System configuration

The HH-300 Series can be used more effectively by combining them with various special accessories (sold separately).

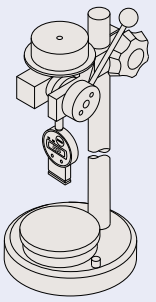
811-019 CTS-101



811-012 CTS-102



811-013 CTS-103



811-331-10
HH-331

Analog type

811-332-10
HH-332

Digital type

811-333-10
HH-333
811-337-10
HH-337

Analog type

811-334-10
HH-334
881-338-10
HH-338

Digital type

811-335-10
HH-335

Analog type

811-336-10
HH-336

Digital type

938882
Battery SR44

Examples of hardness measurement performance in various standards

Standard	Designation	Description
JIS K 6253 ISO 7619	A45/15	Hardness measurement is performed with the Type A hardness tester. It indicates that a hardness measurement of 45 is obtained 15 seconds after starting the measurement.
	D70/10	Hardness measurement is performed with the Type D hardness tester. It indicates that a hardness measurement of 70 is obtained 10 seconds after starting the measurement.
JIS K 7215	HDA83	Hardness measurement is performed with the Type A hardness tester. It indicates that a hardness measurement of 83 is obtained.
	HDD56	Hardness measurement is performed with the Type D hardness tester. It indicates that a hardness measurement of 56 is obtained.
ASTM D 2240	A/45/15	Hardness measurement is performed with the Type A hardness tester. It indicates that a hardness measurement of 45 is obtained 15 seconds after starting the measurement.
	D/60/1	Hardness measurement is performed with the Type D hardness tester. It indicates that a hardness measurement of 60 is obtained 1 second after starting the measurement.
ISO 868	A/15:45	Hardness measurement is performed with the Type A hardness tester. It indicates that a hardness measurement of 45 is obtained 15 seconds after starting the measurement.
	D/1:60	Hardness measurement is performed with the Type D hardness tester. It indicates that a hardness measurement of 60 is obtained 1 second after starting the measurement.
DIN 53 505	75Shore A	Hardness measurement is performed with the Shore A hardness tester. It indicates that a hardness measurement of 75 is obtained.

Domestic and overseas standards

JIS K 6253-3	"Hardness testing methods for rubber, vulcanized or thermoplastic"
JIS K 7215	"Testing Methods for Durometer Hardness of Plastics"
JIS S 6050	"Plastics erasers"
ISO 7619	"Rubber-Determination of indentation hardness by means of pocket hardness meters"
ISO 68	"Plastics and ebonite-Determination of indentation hardness by means of a durometer (Shore hardness)"
ASTM D 2240	"Standard Test Method for Rubber property-Durometer Hardness"
DIN 53 505	"Testing of rubber and plastics; shore A and shore D hardness test"
SRIS 0101	"Physical testing methods for expanded rubber"

Hardness standard block (HH-331,332,335,336)

Hardness standard blocks (based on JIS K 7215/for Type D) are available as useful tools for a daily check of the hardness tester.
To order or for further details, contact the following:

Japanese Chemical Innovation Institute
High Polymer Test & Evaluation Center
2-11-17, Shinonome, Koto-ku, Tokyo 135-0062

Related information and materials

Hardness basics

"Hardness" is a convenient term used broadly in our daily language, but the concept is complicated. Experiencing hard and soft is easy, but it is difficult to express those actual qualities in simple terms. Hardness thus has broad meanings and refers to a measure closely related to one or a number of properties, including resistance to wear, resistance to scratching, elastic modulus, yield point, fracture strength, viscosity, brittleness, and ductility. Hardness testing is localized testing of a material and is therefore easier to perform than testing of other properties like tensile strength, proof stress, spring elastic limit, formability and abrasion resistance. Even after testing, it is often the case that the item can still be used as a product. Therefore testing hardness is often preferred as a practical alternative to testing other characteristics.

Hardness is not a physical quantity like length, time, mass or current, but an industrial quantity or comparison value like other mechanical properties.

The hardness of an object is a measure indicating the level of resistance when the object is subjected to deformation by another object

1. Overview of hardness

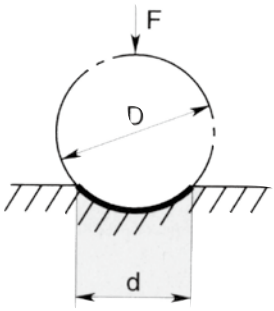
Testing methods used to characterize hardness as a numerical value employ diverse methods of applying deformation and resistance representation devised for, and defined by, each of those testing methods. The hardness testing methods used by industry today can be basically grouped as follows according to variations in standard materials, deformations to be used as the basis for measurement, and hardness calculation methods. Indentation testing methods are the most commonly applied. They involve applying a permanent deformation to the test surface and determining its hardness from the test force required to create the deformation and the size of the deformation.
Rebound hardness (or dynamic hardness) testing measures the behavior when a standard impactor is made to collide with the test surface, and scratch hardness testing measures the behavior when two materials are rubbed together. Portable hardness testing employs a different comparative measurement method for each type of material due to priority being placed on ease of operation and even magnetism and ultrasound are used.
Other typical examples of methods for common hardnesses include Mohs hardness and pencil hardness testing, which have been around for many years.

2. Hardness-related standards

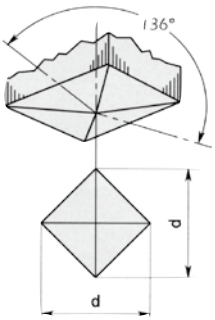
Japanese Industrial Standards (JIS) include a number of standards related to hardness. With the recent trend toward internationalization, JIS standards are being revised so they are consistent with ISO standards. The major categories can be grouped as follows.

- Test methods: Specifying the methods to be used for general hardness testing
- Verification of testing machines: Specifying the testing machines to be used for hardness testing
- Calibration of reference blocks: Specifying the methods of calibration of reference blocks to be used for verification of hardness testing machines
- Application-specific test methods: Specifying the hardness testing methods to be used for specific applications.

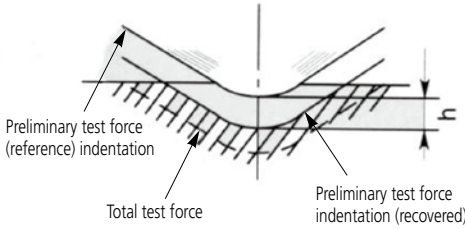
Brinell hardness testing



Vickers hardness testing



Rockwell hardness testing

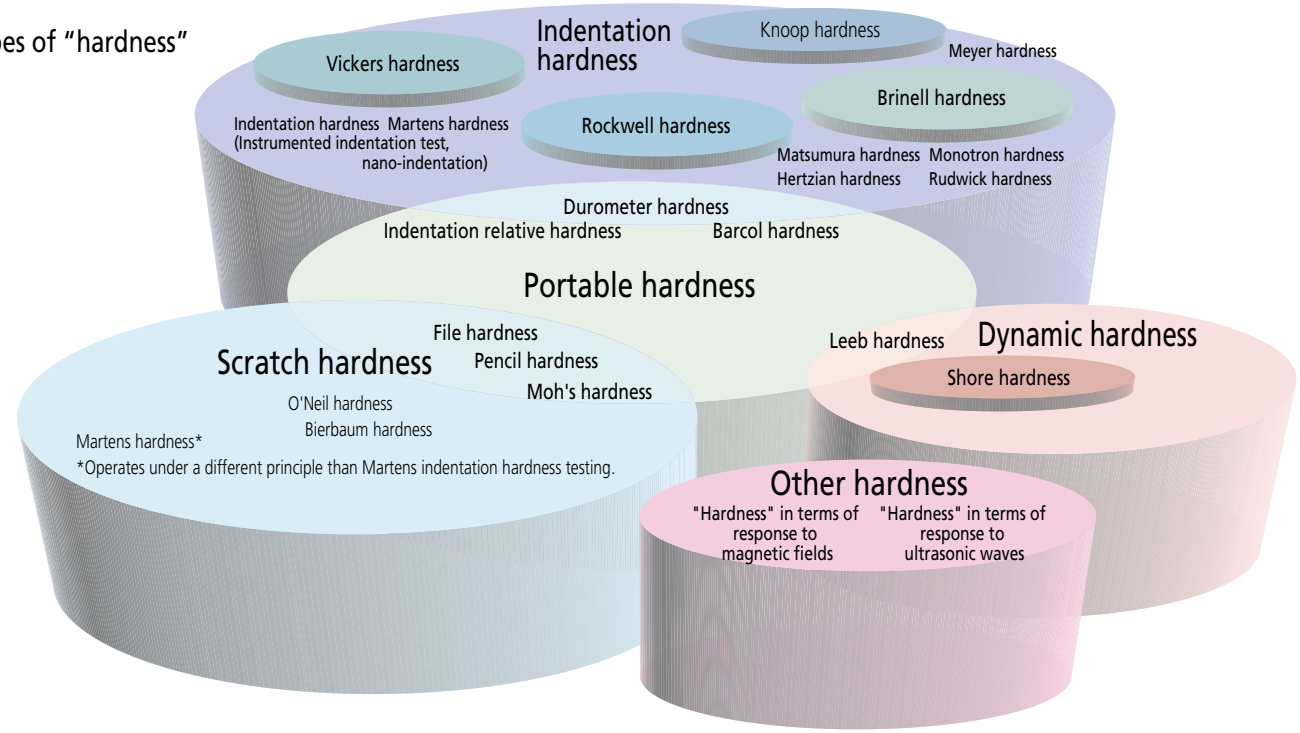


Indentation size for each type of hardness test

Hardness test	Test force	Indentation diameter (mm)	Indentation depth (mm)
Brinell hardness (HB)	29421N	5.5 to 3	1 to 0.5
Rockwell hardness (HRC)	1471N	1 to 0.5	0.06 to 0.015
Rockwell hardness (HRA)	588.4N	0.5 to 0.25	0.04 to 0.01
Rockwell Superficial hardness (HR)	147.1 to 441.3N	0.2 to 0.02	0.02 to 0.001
Vickers hardness (HV)	9.807 to 490.3N	0.7 to 0.05	0.1 to 0.01
	98.07 to 9807mN	0.2 to 0.005	0.03 to 0.001
Shore hardness (HS)		0.3 to 0.6	0.01 to 0.04

Hardness definitions and types

Types of "hardness"



Definition of hardness

(1) Brinell hardness

The Brinell hardness testing method was the first method invented for standardizing hardness, from which other hardness measuring methods have been derived.
Brinell hardness is the test force F divided by the contact area S (mm^2) between the spherical indenter and specimen calculated on the diameter d (mm) of the impression made when the indenter (a steel ball or cemented carbide ball with a diameter D mm) is pressed into the sample by the test force F and then removed. The symbol HBS is used when the indenter is a steel ball, or HBW when it is a cemented carbide ball. k is a constant (1/g = 1/9.80665 = 0.102).

$$HBW = k\frac{F}{S} = 0.102\,\frac{2F}{\pi D\,(D-\sqrt{D^2-d^2})}$$ F:N D:mm d:mm

For the same loading condition (F/D^2), the Brinell hardness obtained is almost the same when different test forces are used for measurement. In many countries, measurement with small test forces is widespread as an application of this fact.
Testing with a test force of 2451N or less can be conducted by using the test force weight and indenter for the Rockwell or Vickers hardness testing machine. For steel, F/D^2 is 30. For other softer materials, an appropriate value is selected from 15, 10, 5, 2.5, 1.25, and 1. In the JIS and ISO standards, the test force is 9.807 to 29420N, and the diameter of the spherical indenter is 1 to 10mm. An error of the Brinell hardness test is obtained by the following formula. $\triangle d^1$ indicates the error of the impression measuring device, $\triangle d^2$ the error in impression measurement.

$$\frac{\triangle HB}{HB} \fallingdotseq -\frac{\triangle F}{F} - (0.03\sim0.18)\frac{\triangle D}{D} - 2\frac{\triangle d_1}{d} - 2\frac{\triangle d_2}{d}$$

(2) Vickers hardness

Vickers hardness is the most versatile test method as it can be used with any test force. More specifically, there are many applications of microhardness below 9.807N.
Vickers hardness is the test force F divided by the area S (mm^2) of the indenter and sample calculated based on the diagonal length d (the average of 2 directions in mm) of the impression made when the pyramid-shaped diamond indentor (θ=136° between opposite faces) is pressed into the sample by the test force F(N) and then removed.

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

An error of the Vickers hardness test is obtained by the following formula. $\triangle d^1$ indicates the measuring error of the microscope, $\triangle d^2$ indicates the error in indentation measurement, "a" indicates the length of the edge line between two opposite faces at the tip of the indenter. $\triangle\theta$ is in degrees.

$$\frac{\triangle HV}{HV} \fallingdotseq -\frac{\triangle F}{F} - 2\frac{\triangle d_1}{d} - 2\frac{\triangle d_2}{d} - \frac{a^2}{d^2} - 3.5\times10^{-3}\triangle\Theta$$

(3) Knoop hardness

Knoop hardness is the test force F divided by the projected area A (mm^2) of the impression calculated based on the longer diagonal length d (mm) of the indentation made when the pyramid-shaped diamond indenter with apical angles of 130° and 172°30′ and rhomboid cross section is pressed into the specimen by the test force F and then removed. Knoop hardness can be measured by replacing the Vickers indenter of the microhardness testing machine with the Knoop indenter.

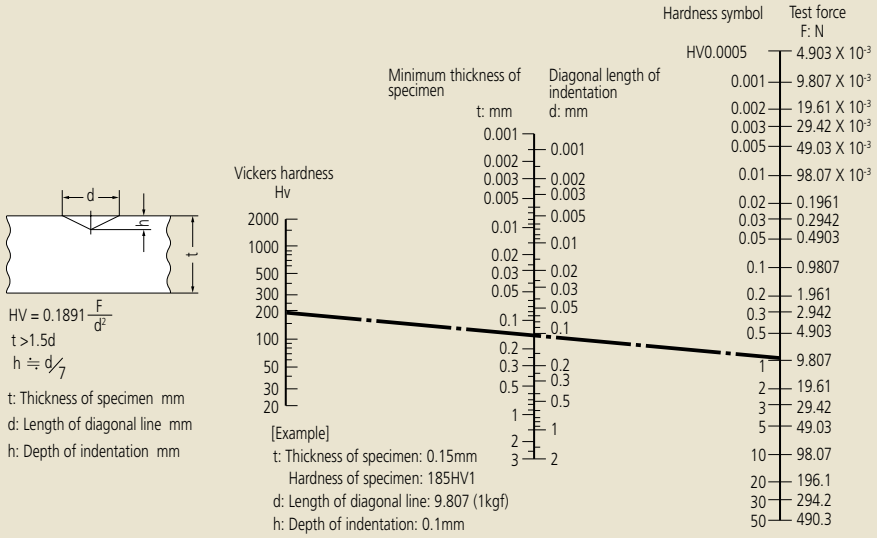
$$HK = k\frac{F}{A} = 0.102\,\frac{F}{A} = 0.102\,\frac{F}{cd^2} = 1.451\,\frac{F}{d^2}$$ F:N d:mm

(4) Rockwell hardness and Rockwell Superficial hardness

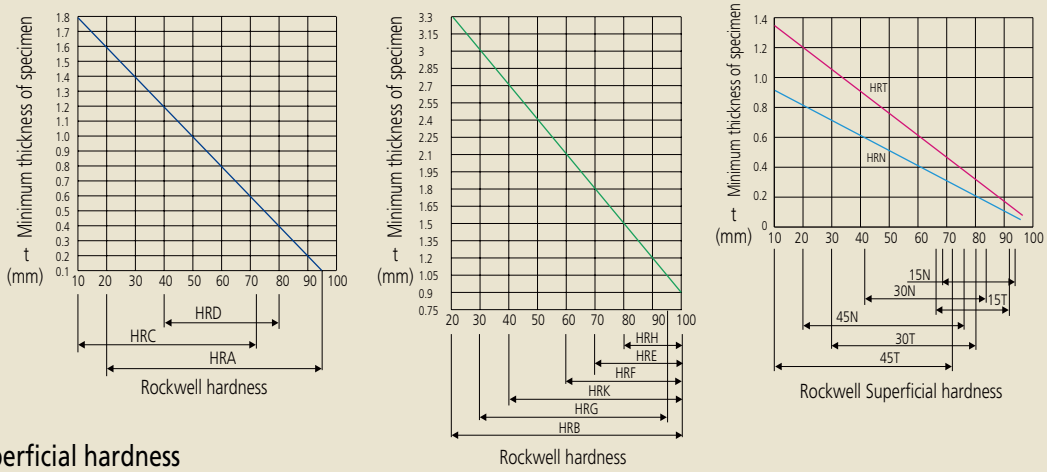
A conical diamond indenter with an angle of 120° and a tip radius of 0.2mm tip or spherical indenter (steel or cemented carbide) is used. The preliminary test force is applied first, the test force is applied, and then the preliminary test force is applied again. Rockwell hardness and Rockwell Superficial hardness can be obtained from the hardness calculation formula based on the difference in depths of impression h (μm) measured at the first and second application of the initial test force.
The hardness is called Rockwell hardness when the preliminary test force is 98.07N, or Rockwell Superficial hardness when it is 29.42N. Unique symbols are assigned to combinations of types of the indenter, test forces, and hardness calculation formula, which comprise a scale. JIS defines scales of hardness.

Relation diagram for specimen hardness and minimum thickness

Vickers



Rockwell
Rockwell Superficial hardness



Types of Rockwell hardness

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

Types of Rockwell Superficial hardness

Scale	Indenter	Test force	Application
15-N	Diamond	147.1N	Thin surface-hardened layer on steel such as carburized or nitrided
30-N		294.2N	
45-N		441.3N	
15-T	Sphere of 1.5875mm diameter	147.1N	Sheet of mild steel, brass, bronze, etc.
30-T		294.2N	
45-T		441.3N	
15-W	Sphere of 3.175mm diameter	147.1N	Plastic, zinc, bearing alloy
30-W		294.2N	
45-W		441.3N	
15-X	Sphere of 6.35mm diameter	147.1N	Plastic, zinc, bearing alloy
30-X		294.2N	
45-X		441.3N	
15-Y	Sphere of 12.7mm diameter	147.1N	Plastic, zinc, bearing alloy
30-Y		294.2N	
45-Y		441.3N	

Hardness conversion table

The table below enables conversion between hardness values for metals, which vary according to the particular standard.
For accurate results, please use values obtained with the respective testing machines as reference.

Steel

Vickers	Rockwell				Rockwell Superficial			Shore
HV	HRA	HRB	HRC	HRD	15N	30N	45N	HS
940	85.6	—	68.0	76.9	93.2	84.4	75.4	98.0
920	85.3	—	67.5	76.5	93.0	84.0	74.8	96.8
900	85.0	—	67.0	76.1	92.9	83.6	74.2	95.6
880	84.7	—	66.4	75.7	92.7	83.1	73.6	94.3
860	84.4	—	65.9	75.3	92.5	82.7	73.1	93.1
840	84.1	—	65.3	74.8	92.3	82.2	72.2	91.7
820	83.8	—	64.7	74.3	92.1	81.7	71.8	90.4
800	83.4	—	64.0	73.8	91.8	81.1	71.0	89.0
780	83.0	—	63.3	73.3	91.5	80.4	70.2	87.6
760	82.6	—	62.5	72.6	91.2	79.7	69.4	86.2
740	82.2	—	61.8	72.1	91.0	79.1	68.6	84.8
720	81.8	—	61.0	71.5	90.7	78.4	67.7	83.3
700	81.3	—	60.1	70.8	90.3	77.6	66.7	81.8
690	81.1	—	59.7	70.5	90.1	77.2	66.2	81.0
680	80.8	—	59.2	70.1	89.8	76.8	65.7	80.2
670	80.6	—	58.8	69.8	89.7	76.4	65.3	79.4
660	80.3	—	58.3	69.4	89.5	75.9	64.7	78.6
650	80.0	—	57.8	69.0	89.2	75.5	64.1	77.8
640	79.8	—	57.3	68.7	89.0	75.1	63.5	77.0
630	79.5	—	56.8	68.3	88.8	74.6	63.0	76.2
620	79.2	—	56.3	67.9	88.5	74.2	62.4	75.4
610	78.9	—	55.7	67.5	88.2	73.6	61.7	74.5
600	78.6	—	55.2	67.0	88.0	73.2	61.2	73.7
590	78.4	—	54.7	66.7	87.8	72.7	60.5	72.8
580	78.0	—	54.1	66.2	87.5	72.1	59.9	72.0
570	77.8	—	53.6	65.8	87.2	71.7	59.3	71.1
560	77.4	—	53.0	65.4	86.9	71.2	58.6	70.2
550	77.0	—	52.3	64.8	86.6	70.5	57.8	69.3
540	76.7	—	51.7	64.4	86.3	70.0	57.0	68.4
530	76.4	—	51.1	63.9	86.0	69.5	56.2	67.5
520	76.1	—	50.5	63.5	85.7	69.0	55.6	66.6
510	75.7	—	49.8	62.9	85.4	68.3	54.7	65.6
500	75.3	—	49.1	62.2	85.0	67.7	53.9	64.7
490	74.9	—	48.4	61.6	84.7	67.1	53.1	63.7
480	74.5	—	47.7	61.3	84.3	66.4	52.2	62.8
470	74.1	—	46.9	60.7	83.9	65.7	51.3	61.8
460	73.6	—	46.1	60.1	83.6	64.9	50.4	60.8
450	73.3	—	45.3	59.4	83.2	64.3	49.4	59.8
440	72.8	—	44.5	58.8	82.8	63.5	48.4	58.8
430	72.3	—	43.6	58.2	82.3	62.7	47.4	57.8
420	71.8	—	42.7	57.5	81.8	61.9	46.4	56.7
410	71.4	—	41.8	56.8	81.4	61.1	45.3	55.7
400	70.8	—	40.8	56.0	81.0	60.2	44.1	54.6
390	70.3	—	39.8	55.2	80.3	59.3	42.9	53.6
380	69.8	(110.0)	38.8	54.4	79.8	58.4	41.7	52.5
370	69.2	—	37.7	53.6	79.2	57.4	40.4	51.4
360	68.7	(109.0)	36.6	52.8	78.6	56.4	39.1	50.3
350	68.1	—	35.5	51.9	78.0	55.4	37.8	49.2
340	67.6	(108.0)	34.4	51.1	77.4	54.4	36.5	48.1
330	67.0	—	33.3	50.2	76.8	53.6	35.2	46.9
320	66.4	(107.0)	32.2	49.4	76.2	52.3	33.9	45.7
310	65.8	—	31.0	48.4	75.6	51.3	32.5	44.6
300	65.2	(105.5)	29.8	47.5	74.9	50.2	31.1	43.4
295	64.8	—	29.2	47.1	74.6	49.7	30.4	42.8
290	64.5	(104.5)	28.5	46.5	74.2	49.0	29.5	42.2
285	64.2	—	27.8	46.0	73.8	48.4	28.7	41.6
280	63.8	(103.5)	27.1	45.3	73.4	47.8	27.9	41.0
275	63.5	—	26.4	44.9	73.0	47.2	27.1	40.4
270	63.1	(102.0)	25.6	44.3	72.6	46.4	26.2	39.7
265	62.7	—	24.8	43.7	72.1	45.7	25.2	39.1
260	62.4	(101.0)	24.0	43.1	71.6	45.0	24.3	38.5
255	62.0	—	23.1	42.2	71.1	44.2	23.2	37.9
250	61.6	99.5	22.2	41.7	70.6	43.4	22.2	37.2
245	61.2	—	21.3	41.1	70.1	42.5	21.1	36.6
240	60.7	98.1	20.3	40.3	69.6	41.7	19.9	36.0
230	—	96.7	(18.0)	—	—	—	—	34.7
220	—	95.0	(15.7)	—	—	—	—	33.4
210	—	93.4	(13.4)	—	—	—	—	32.0
200	—	91.5	(11.0)	—	—	—	—	30.7
190	—	89.5	(8.5)	—	—	—	—	29.4
180	—	87.1	(6.0)	—	—	—	—	28.0
170	—	85.0	(3.0)	—	—	—	—	26.6
160	—	81.7	(0.0)	—	—	—	—	25.2
150	—	78.7	—	—	—	—	—	23.8
140	—	75.0	—	—	—	—	—	22.3
130	—	71.2	—	—	—	—	—	20.8
120	—	66.7	—	—	—	—	—	19.4
110	—	62.3	—	—	—	—	—	17.9
100	—	56.2	—	—	—	—	—	16.3

● This conversion table is compiled based on standard SAE J 417. ● Shore hardness follows JIS B 7731.

Brass

Vickers	Rockwell		Rockwell Superficial	
HV	HRV	HRF	30T	45T
196	93.5	110.0	77.5	66.0
194	—	109.5	—	65.5
192	93.0	—	77.0	65.0
190	92.5	109.0	76.5	64.5
188	92.0	—	—	64.0
186	91.5	108.5	76.0	63.5
184	91.0	—	75.5	63.0
182	90.5	108.0	—	62.5
180	90.0	107.5	75.0	62.0
178	89.0	—	74.5	61.5
176	88.5	107.0	—	61.0
174	88.0	—	74.0	60.5
172	87.5	106.5	73.5	60.0
170	87.0	—	—	59.5
168	86.0	106.0	73.0	59.0
166	85.5	—	72.5	58.5
164	85.0	105.5	72.0	58.0
162	84.0	105.0	—	57.5
160	83.5	—	71.5	56.5
158	83.0	104.5	71.0	56.0
156	82.0	104.0	70.5	55.5
154	81.5	103.5	70.0	54.5
152	80.5	103.0	—	54.0
150	80.0	—	69.5	53.5
148	79.0	102.5	69.0	53.0
146	78.0	102.0	68.5	52.5
144	77.5	101.5	68.0	51.5
142	77.0	101.0	67.5	51.0
140	76.0	100.5	67.0	50.0
138	75.0	100.0	66.5	49.0
136	74.5	99.5	66.0	48.0
134	73.5	99.0	65.5	47.5
132	73.0	98.5	65.0	46.5
130	72.0	98.0	64.5	45.5
128	71.0	97.5	63.5	45.0
126	70.0	97.0	63.0	44.0
124	69.0	96.5	62.5	43.0
122	68.0	96.0	62.0	42.0
120	67.0	95.5	61.0	41.0
118	66.0	95.0	60.5	40.0
116	65.0	94.5	60.0	39.0
114	64.0	94.0	59.5	38.0
112	63.0	93.0	58.5	37.0
110	62.0	92.6	58.0	35.5
108	61.0	92.0	57.0	34.5
106	59.5	91.2	56.0	33.0
104	58.0	90.5	55.0	32.0
102	57.0	89.8	54.5	30.5
100	56.0	89.0	53.5	29.5
98	54.0	88.0	52.5	28.0
96	53.0	87.2	51.5	26.5
94	51.0	86.3	50.5	24.5
92	49.5	85.4	49.0	23.0
90	47.5	84.4	48.0	21.0
88	46.0	83.5	47.0	19.0
86	44.0	82.3	45.5	17.0
84	42.0	81.2	44.0	14.5
82	40.0	80.0	43.0	12.5
80	37.5	78.6	41.0	10.0
78	35.0	77.4	39.5	7.5
76	32.5	76.0	38.0	4.5
74	30.0	74.8	36.0	1.0
72	27.5	73.2	34.0	—
70	24.5	71.8	32.0	—
68	21.5	70.0	30.0	—
66	18.5	68.5	28.0	—
64	15.5	66.8	25.5	—
62	12.5	65.0	23.0	—
60	10.0	63.0	20.5	—
58	—	61.0	18.0	—
56	—	58.8	15.0	—
54	—	56.5	12.0	—
52	—	53.5	—	—
50	—	50.5	—	—
49	—	49.0	—	—
48	—	47.0	—	—
47	—	45.0	—	—
46	—	43.0	—	—
45	—	40.0	—	—

● This conversion table is complied based on standard ASTM E140 TABLE 4.

Related information and materials

Related hardness standards

JIS	Name	Hardness used (scale)
A 1126-07	Method of test for content of soft particles in coarse aggregate by scratching	
B 7724-99	Brinell hardness test – Verification of testing machines	HB
B 7725-10	Vickers hardness test – Verification and calibration of testing machines	HV
B 7726-10	Rockwell hardness test – Verification and calibration of testing machines	HR
B 7727-00	Shore hardness test – Verification of testing machines	HS
B 7730-10	Rockwell hardness test – Calibration of standard blocks	HR
B 7731-00	Shore hardness test – Calibration of standard blocks	HS
B 7734-97	Knoop hardness test – Verification of testing machines	HV, HK
B 7735-10	Vickers hardness test – Calibration of standard blocks	HV
B 7736-99	Brinell hardness test – Calibration of standard blocks	HB
D 4421-96	Hardness test method for brake linings, pads and clutch facings of automobiles	HRM, HRR, BRS, HRV
G 0557-06	Methods of measuring case depth hardened by carburizing treatment for steel	HV
G 0558-07	Steels – Determination of depth of decarburization	HV, 15N, 30N
G 0559-08	Steel – Determination of case depth after flame hardening or induction hardening	HV, HRC
G 0561-11	Method of hardenability test for steel (End quenching method)	HV, HRC
G 0562-93	Method of measuring nitrided case depth for iron and steel	HV, HK
G 0563-93	Method of measuring surface hardness for nitrided iron and steel	HV, HK, HR15N, HS
H 0511-07	Titanium – Sponge titanium – Test methods for Brinell hardness	HB
K 6250-06	Rubber – General procedures for preparing and conditioning test pieces for physical test methods	A, D
K 6253-1-12	Rubber, vulcanized or thermoplastic – Determination of hardness – Part 1: General guidance	A, D
K 6253-3-12	Rubber, vulcanized or thermoplastic – Determination of hardness – Part 3: Durometer method	
K 6253-5-12	Rubber, vulcanized or thermoplastic – Determination of hardness – Part 5: Calibration and verification	
K 7060-95	Testing method for barcol hardness of glass fiber reinforced plastics	
K 7202-2-01	Plastics – Determination of hardness – Part 2: Rockwell hardness	HRR, HRL, HRM, HRE
K 7215-86	Testing Methods for Durometer Hardness of Plastics	HDA, HDD
R 1607-10	Testing methods for fracture toughness of fine ceramics at room temperature	Kc
S 6050-08	Plastics erasers	
Z 2101-09	Methods of test for woods	HB
Z 2243-08	Brinell hardness test – Test method	HB
Z 2244-09	Vickers hardness test – Test method	HV
Z 2245-11	Rockwell hardness test – Test method	HR
Z 2246-00	Shore hardness test – Test method	HS
Z 2251-09	Knoop hardness test – Test method	HV, HK
Z 2252-91	Test methods for Vickers hardness at elevated temperatures	HV
Z 3101-90	Testing Method of Maximum Hardness in Weld Heat - Affected Zone	HV
Z 3114-90	Method of Hardness Test for Deposited Metal	HV, HRB, HRC
Z 3115-73	Method of Taper Hardness Test in Weld Heat - Affected Zone	HV

Note: Standard numbers/names may be different due to revision of the standards.

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