Micro Hardness Testing Machines

Rockwell Hardness Testing Machines

Micro Zone Test System

Portable Hardness Testing Instruments

Hardmatic HH-411

HM-210D/220D

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HV110 Type B

HH-300 Durometers

Lineup of Hardness Testing Machines

Hardness testing machines provide the simplest and most economical testing methods among many material testing machines, playing an important role in research activities, production activities, and commercial transactions. Mitutoyo offers a choice of standard hardness testing machines that are optimal for hard materials such as metals to soft materials such as plastic and rubber, as well as custom-designed testers such as in line-type automatic machines and labor-saving machines required on the shop floor.

Microhardness
(Micro-Vickers)

Automatic Vickers
Hardness Testing

Vickers

Rockwell

Rockwell Superficial

Rebound type
portable

For rubber
and plastic

Technical Data

Test force range:
HM-210A: 9 steps + arbitrary test force
HM-220A: 19 steps + arbitrary test force
Load dwell time: 0 - 999s
Manual XY stage unit
Stage size: 100x100mm
Travel range: 25x25mm
with Digimatic in/mm micrometer heads
Resolution: 0.001mm
Max. specimen height: 133mm (Stage size: 25 x 25mm)
Max. specimen height: 121mm (Stage size: 50 x 50mm)
Max. specimen depth: 160mm (from the center of indenter)
Optical path: 4-port objectives switching system of Infinity-correction optical system
Resolution: 0.01µm (When using objectives of X40 or more)
Data output: Serial interface (RS-232), Digimatic interface, USB 2.0
Power supply: 39VA 100-125/220-240V AC, 50/60Hz
Dimensions: (W x D x H): 315x671x595mm
Mass: 43kg

Optional Accessories (Factory-installed option)

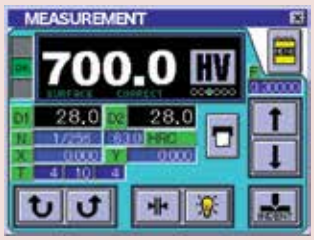
11AAC104: Objective lens unit 2X
11AAC105: Objective lens unit 5X
11AAC106: Objective lens unit 10X
11AAC107: Objective lens unit 20X
11AAC108: Objective lens unit 100X
11AAC129: Measuring microscope (Digital ocular)
11AAC109: Knoop Indenter Assembly (HM-210 Series)
11AAC110: Knoop Indenter Assembly (HM-220 Series)

Optional Accessories

810-454A: TV camera unit (8.4 inch LCD)
19BAA058: Diamond indenter for Vickers (HM210 Series standard test force)
19BAA059: Diamond indenter for Vickers (HM220 Series low test force)
19BAA061: Diamond indenter for Knoop (HM210 Series)
19BAA062: Diamond indenter for Knoop (HM220 Series)
810-013: Specimen (thin plate) holder
810-014-1: Specimen (wire) holder
810-015-1: Specimen (wire or ball) holder
810-016: 50 mm Vise
810-017: 100 mm Vise
810-019: Specimen tilting holder
810-020: Universal specimen holder
810-018: Rotary table
810-084: Rotatable universal specimen holder
810-085: Adjustable specimen (thin plate) holder
810-095: Rotatable specimen stage
375-056: Stage Micrometer (glass) Micro-scale
810-650-1: Resin mold specimen stage ø25.4
810-650-2: Resin mold specimen stage ø30
810-650-3: Resin mold specimen stage ø31.75
810-650-4: Resin mold specimen stage ø38.1
810-650-5: Resin mold specimen stage ø40
810-641: Vibration Isolator
810-870A: Sample Heating Device HST-250
810-420: 25x25mm stage (metric only)
810-423: 50x50mm stage (metric only)
810-424: 1"x1" in/mm stage (standard)
810-427: 2"x2" in/mm stage

Power turret with up to 2 indenter mounts and 4 objective mounts (manual operation possible)

Touch-screen type control panel



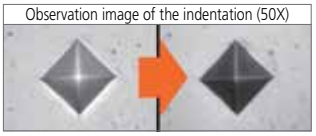
HM-210 / 220 Type A

SERIES 810 — Micro Vickers Hardness Testing Machines

FEATURES

- The electromagnetic force motor used in the loading mechanism enables the test force to be freely selected (see test force specifications) over the wide range of 0.4903mN to 19610mN (0.05gf to 2 kgf). It is also possible to freely set load dwell times. Now your desire for absolute control over the indentation size in Vickers hardness testing can be satisfied. The HM-200 series always offers the test force most appropriate for the specimen material and shape.
- The long working distance objectives used enable a comfortable working distance between the objective and the specimen surface. This greatly reduces the possibility of collision between the specimen and the objective during focusing operations. (e.g. for 50X objectives: 1.1mm for conventional models, 2.5mm for HM-200 series)
- Newly-designed 'MH Plan' objectives are optimized for measuring indentation images. The lineup includes 6 types of long working distance objectives: 10X, 20X, 50X and 100X for measuring indentation images, and 2X and 5X for enabling wide-range measurement around indentations.
- LEDs, which have a longer life, produce less heat, consume less power and are more energy efficient than incandescent bulbs, are employed for the illumination system.
- The motorized turret allows for up to 4 objective lenses and 2 indenter assemblies to be mounted at the same time.

Observation image of the indentation (50X)



Stray light reduction around the indentation

HM-210A

SPECIFICATIONS

TYPE A Digital Hardness Tester

Model No.	HM-210 Type A	HM-210 Type A V/K	HM-220 Type A	HM-220 Type A V/K
Part No.	**64AAB305P**	**64AAB306P**	**64AAB307P**	**64AAB308P**
Fixed test force (mN)	98.07, 196.1, 294.2, 490.3, 980.7, 1961, 2942, 4903, 9807 (10gf-1000gf)		0.4903, 0.9807, 1.961, 2.942, 4.903, 9.807, 19.61, 29.42, 49.03, 98.07, 196.1, 294.2, 490.3, 980.7, 1961, 2942, 4903, 9807, 19610 (0.05 gf-2kgf)	
Arbitrary test force	≤100 gf in 1 gram increments, > 100gf in 10 gram increments		< 1 gf in .1 gf increments, ≤100 gf in 1 gram increments, > 100gf in 10 gram increments	
Test force control	Force generation by electromagnetic and automatic control (load, dwell, unload)			
Control unit	Color LCD Touch Screen			
Loading rate	60 µ/ sec		60µm/s, Variable between 2 and 60µm/s. ≤ 30 gf.	
Load dwell time	0-999 sec			
Indenter	Vickers	Vickers and Knoop	Vickers	Vickers and Knoop
Objective lenses	10x, 50x	10x, 20x, 50x	10x, 50x, 100x	10x, 50x, 100x
Objective turret	Motor driven and manual operation			
Filar eye piece	Dual Line, 10X, .01µ min			

With TV camera unit 810-454A (selectable with HM-210A/220A)

Measurement of indentation dimensions on a TV monitor reduces eye fatigue, which leads to improvement in operation efficiency in multi-point testing.

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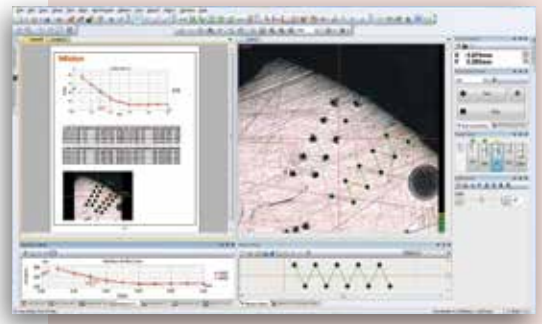
HM-200 Series with AVPAK software

For semi and fully automatic Type B and D Systems

System B (HM-210B/220B)

System B is equipped with **AVPAK-10**, a the software package that automatically measures the diagonal length of an indentation and calculates the corresponding hardness value. This means that measurement error caused by variation in operator interpretation is eliminated, thereby reducing costs.

Automatic measurement of indentation/ manual stage



AVPAK Software

Indentation-reading example

System D (HM-210D/220D)

In addition to the functions of System B, System D is equipped with the autofocus function and motorized x-y stage. This function allows for automatic hardness testing, thereby increasing efficiency and reducing labor costs.

Automatic measurement of indentation / motorized XY stage / Autofocusing

System D Technical Data

Motorized X-Y Stage	Travel Max	50 x 50 mm*
	Travel Min	1µ
	Table Size	130 x 130mm
	Speed Max	25mm/ sec
Motorized Focusing Stage	Max Range	1.4mm
	Min Unit	.1µ
	Max Speed	1mm/ sec
Joystick Controller Functions	Functions	X and Y Lock out
	Axis	X, Y and Z (Focus)
	Speed Control	Adjustable H,M,L
	Tester Control	Indent, Turret Position
	Other	Emergency Stop

*Optional 100 x 100 mm

SPECIFICATIONS

TYPE B PC-Driven Test System **TYPE D** PC-Driven Test System with motorized stage and auto focus

Model No.	HM-210 Type B	HM-210 Type B V/K	HM-220 Type B	HM-220 Type B V/K
Part No.	**64AAB323P**	**64AAB324P**	**64AAB325P**	**64AAB326P**
Model No.	HM-210 Type D	HM-210 Type D V/K	HM-220 Type D	HM-220 Type D V/K
Part No.	**64AAB380P**	**64AAB381P**	**64AAB382P**	**64AAB383P**
Fixed test force (mN)	98.07, 196.1, 294.2, 490.3, 980.7, 1961, 2942, 4903, 9807 (10gf-1000gf)		0.4903, 0.9807, 1.961, 2.942, 4.903, 9.807, 19.61, 29.42, 49.03, 98.07, 196.1, 294.2, 490.3, 980.7, 1961, 2942, 4903, 9807, 19610 (0.05 gf-2kgf)	
Arbitrary test force	≤100 gf in 1 gram increments, > 100gf in 10 gram increments		< 1 gf in .1 gf increments, ≤100 gf in 1 gram increments, > 100gf in 10 gram increments	
Test force control	Force generation by electromagnetic and automatic control (load, dwell, unload)			
Control unit	None, By PC*			
Loading rate	60 µ/ sec		60µm/s, Variable between 2 and 60µm/s. ≤ 30 gf.	
Load dwell time	0-999 sec			
Indenter	Vickers	Vickers and Knoop	Vickers	Vickers and Knoop
Objective lenses	10x, 50x	10x, 20x, 50x	10x, 50x, 100x	10x, 50x, 100x
Objective turret	Motor-driven and manual operation			
Filar eye piece	None			
CCTV camera	3 megapixel, 1/2"		3 megapixel, 1/2"	
Software	AV Pak		AV Pak	

*Must use specified PC

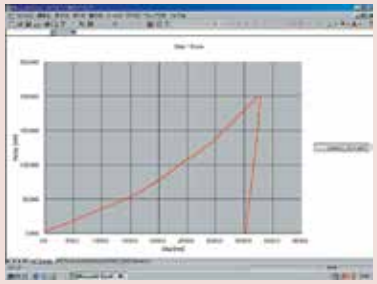
MZT-500

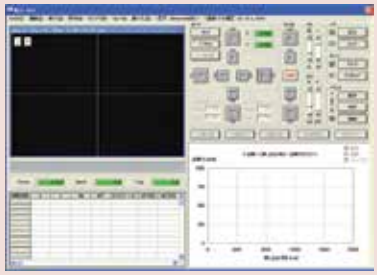
SERIES 810 — Micro Zone Test System

FEATURES

When it comes to evaluating mechanical properties of ultra-small regions of ultra-fine specimens, the MZT-500 Series models are exceptionally powerful tools in the fields of research and development and quality control. The MZT-500 can evaluate mechanical properties, which conventional hardness testing machines for fine specimens cannot measure, such as various CVD and PVD-deposited or generated films, including ion-plated films; hardness of ultra-fine cross-sections; bonding mechanical properties; and mechanical wear properties of carbon fibers, glass fibers, whiskers, etc.

- Test data
  The indentation factor can be obtained, which is related to the hardness value (partially) shown in Martens hardness test (ISO14577) and Young's modulus. Deformation characteristics in the load, dwell, 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.
- Indenter indentation depth can be measured up to a maximum of 20µm with a resolution of 0.1nm.
- Test forces 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.





SPECIFICATIONS

Model No.	MZT-500L	MZT-500P
Order No.	**810-813A**	**810-814A**
Basic system	✔	✔
Data analysis / control device	✔	✔
Manual type XY stage (Travel range 25x25mm)	✔	—
Automatic XY stage (Travel range: 50x50mm)	—	✔

Test force loading device	Test force range: 0.1 to 1000mN
	Control resolution: 0.916µN
	Loading speed: 0.01 to 100mN/s
Indentation depth measurement	Range: 0 to 20µm
	Resolution: 0.1nm
Indenter	Type: Bercovich triangular pyramid indenter
Sample surface observation method	Camera: 1/3 inch black and white (410,000 pixels)
	Objective (monitor magnification): 100X (2500X), Optional: 10X (250X), 40X (1000X)
Specimen dimensions	Maximum height: 90mm
	Maximum depth: 90mm (From the center of the indenter axis)
Test type	Indentation test (with preliminary test force)
	Indentation test (without preliminary test force)
	Indentation depth setting test, continuous indentation test, repeated indentation test

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HV110 / HV120

Series 810—Vickers Hardness Testing Machines – Type A

FEATURES

- Heavy load Vickers testing machines feature motorized force selection from 1-50kgf or .3 to 30kgf. Fully adjustable long-life LED illumination runs cool.
- A dual-line filar eyepiece combines with a color touch-screen LCD to create accurate measurements with the touch of a button.
- The motorized turret can accommodate up to 3 long working distance objective lenses for an even wider range of materials and a wide variety of anvils and x-y stages are also available.

HV120 show with optional **810-454A** CCTV Camera

SPECIFICATIONS

Model	HV110	HV120
Order No.	**810-441A**	**810-446A**
Test force	9.807N (1kgf),19.61N (2kgf),29.42N (3kgf), 49.03N (5kgf), 98.07N (10kgf), 196.1N (20kgf)294.2N (30kgf), 490.3N (50kgf)	2.942N (0.3kgf),4.903N (0.5kgf), 9.807N (1kgf),24.51N (2.5kgf),49.03N (5kgf), 98.07N (10kgf), 196.1N (20kgf)294.2N (30kgf)
Supported test method	HV, HK, HB (Light Force*), Kc	
Test force selection	Motorized	
Loading accuracy	±1%	
Load control	60µ/s, 150µ/s Automatic (loading, duration, unloading)	
Load rate	5~999 sec.	
Objective lens	2X, 5X, 10X (standard), 20X, 50X, 100X	
Measuring microscope	10X Dual-line filar	
Total magnification	20-1000X (100X Standard)	
Field of view	1,400µ (10X Lens) Type A	
Minimum reading	< 50x = 0.1µm, ≥50x = 0.01µm	
Display	Color LCD touch-screen	
Scaled conversion:	8 Types (ASTM, ISO, JIS, SAE and BS)	
Statistics:	N, Max., Min., Average, Range, High, Low, Good, Over, Under, SD(n-1), SD(n-1), SD(n) go/no-go judgment,	
Curvature correction;	0.01 to 200.00mm	
Maximum sample height	210mm Type A	
Maximum sample depth	160mm	
Maximum sample weight	20 Kg Anvil, 10 Kg with x-y Stage	
Optical path	100% Eyetube or Camera	
Output	Rs232, SPC, USB2.0	
Power supply	120 Volt AC/ 60 Hz	
Dimensions main unit (WxDxH)	9.9"x 24.7"x30.7 " (252x627x781mm)	
Mass	110lbs. (50kg)	

* Optional test forces may be required.

Optional Accessories

Lens:
11AAC712 OBJECTIVE LENS 2X
11AAC713 OBJECTIVE LENS 5X
11AAC714 OBJECTIVE LENS 20X
11AAC715 OBJECTIVE LENS 50X
11AAC716 OBJECTIVE LENS 100X

Stage
810-423 MANUAL STAGE 50X50
810-427 MANUAL STAGE 2"X 2"(In/mm)

959149 SPC cable (1m / 40")

Optical
11AAC711 "C" mount CAMERA ADAPTER
810-454A CCTV System

Indenters
19BAA060 DIAMOND INDENTER (VICKERS TYPE)
19BAA063 KNOOP DIAMOND INDENTER
19BAA281 CARBIDE-ALLOY BALL 1MM DIA.
11AAD469 CARBIDE-ALLOY INDENTER, 1MM DIA.
19BAA283 CARBIDE-ALLOY BALL, 2.5MM DIA.
11AAD470 CARBIDE-ALLOY INDENTER, 2.5MM DIA.

Additional Test Force
11AAC697 0.5 kg Brinell Weight
11AAC698 1.25 kg Brinell Weight
11AAC699 5.625 kg Brinell Weight
11AAC700 12.5 kg Brinell Weight

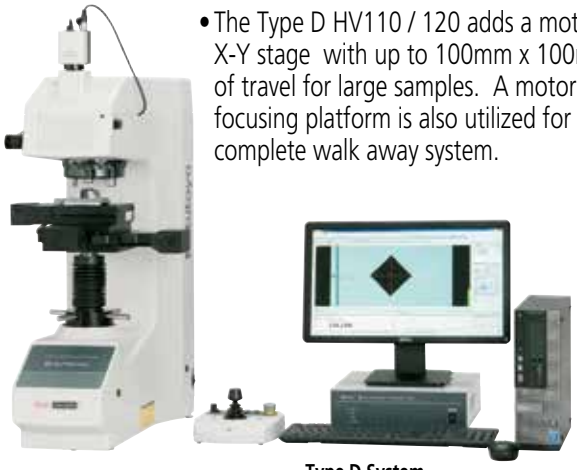
HV110 / HV120

Series 810—Vickers Hardness Testing Machines – Type B / D

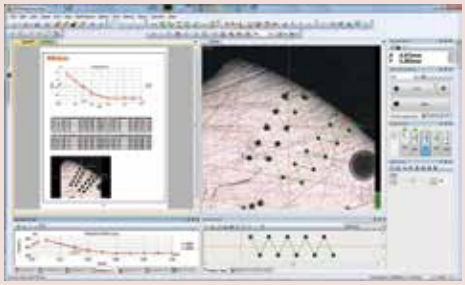
FEATURES

- The Type B HV110/ HV120 Vickers hardness testers add computer control to make measurements even more repeatable.
- A high-resolution 3 mega-pixel camera produces crisp images that are automatically measured in less than .3 seconds.
- Various software functions such as automatic light intensity, simple to use report generator and programming wizards make tedious and repetitive testing requirements more accurate than manual testing and eliminates common operator errors.
- The Type D HV110 / 120 adds a motorized X-Y stage with up to 100mm x 100mm of travel for large samples. A motorized focusing platform is also utilized for a complete walk away system.

Type B System
show with optional PC



Type D System
show with optional PC



SPECIFICATIONS

Model	HV110 Main Unit Only	HV120 Main Unit Only
Order No.	**810-443A**	**810-448A**
Test force	9.807N (1kgf),19.61N (2kgf),29.42N (3kgf), 49.03N (5kgf), 98.07N (10kgf), 196.1N (20kgf)294.2N (30kgf), 490.3N (50kgf)	2.942N (0.3kgf),4.903N (0.5kgf), 9.807N (1kgf),24.51N (2.5kgf),49.03N (5kgf), 98.07N (10kgf), 196.1N (20kgf)294.2N (30kgf)
Supported test method	HV, HK, HB (Light Force**), Kc	
Measuring microscope	Optional	
Field of View w/ 10X Lens	590 x 443 µm	
Display	Via PC	
Curvature correction;	0.01 to 200.00mm	
Maximum sample height	172mm Type B, 132mm Type D	
Maximum sample depth	160mm	
Maximum sample weight	10 Kg Type B, 3 kg Type D	
Optical path	100% Eyetube or Camera	
Output	USB2.0	
Mass	110lbs. (50kg)	

*Other specifications as Type A testers
** Optional test forces may be required

Basic Configuration	Type B	Type D
Main Unit	810-443A or 810-448A	810-443A or 810-448A
AVPak-10 Software	11AAC664	11AAC664
PC***	***	***
Automatic Focus Stage		810-465
Motorized X-Y Stage 50x50		810-461A
Motorized X-Y Stage 100x100		810-462A

*** PC not included

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Optional Accessories

Micro-Vickers/Vickers Hardness Testing Machine

Test Blocks

Order No.	Description	Load
64BAA173	Vickers 100HV Test Block	100gf
64BAA174	Vickers 200HV Test Block	100gf
64BAA175	Vickers 300HV Test Block	100gf
64BAA176	Vickers 400HV Test Block	100gf
64BAA177	Vickers 500HV Test Block	100gf
64BAA178	Vickers 600HV Test Block	100gf
64BAA179	Vickers 700HV Test Block	100gf
64BAA180	Vickers 800HV Test Block	100gf
64BAA181	Vickers 900HV Test Block	100gf
64BAA182	Vickers 100HV Test Block	500gf
64BAA183	Vickers 200HV Test Block	500gf
64BAA184	Vickers 300HV Test Block	500gf
64BAA185	Vickers 400HV Test Block	500gf
64BAA186	Vickers 500HV Test Block	500gf
64BAA187	Vickers 600HV Test Block	500gf
64BAA188	Vickers 700HV Test Block	500gf
64BAA189	Vickers 800HV Test Block	500gf
64BAA190	Vickers 900HV Test Block	500gf
64BAA191	Vickers 100HV Test Block	1000gf
64BAA192	Vickers 200HV Test Block	1000gf
64BAA193	Vickers 300HV Test Block	1000gf
64BAA194	Vickers 400HV Test Block	1000gf
64BAA195	Vickers 500HV Test Block	1000gf
64BAA196	Vickers 600HV Test Block	1000gf
64BAA197	Vickers 700HV Test Block	1000gf
64BAA198	Vickers 800HV Test Block	1000gf
64BAA199	Vickers 900HV Test Block	1000gf
64BAA200	Knoop 200HK Test Block	100gf
64BAA201	Knoop 300HK Test Block	100gf
64BAA202	Knoop 400HK Test Block	100gf
64BAA203	Knoop 500HK Test Block	100gf
64BAA204	Knoop 600HK Test Block	100gf
64BAA205	Knoop 700HK Test Block	100gf
64BAA206	Knoop 800HK Test Block	100gf
64BAA207	Knoop 250HK Test Block	500gf
64BAA208	Knoop 300HK Test Block	500gf
64BAA209	Knoop 400HK Test Block	500gf
64BAA210	Knoop 500HK Test Block	500gf
64BAA211	Knoop 600HK Test Block	500gf
64BAA212	Knoop 700HK Test Block	500gf
64BAA213	Knoop 800HK Test Block	500gf
64BAA214	Knoop 250HK Test Block	1000gf
64BAA215	Knoop 300HK Test Block	1000gf
64BAA216	Knoop 400HK Test Block	1000gf
64BAA217	Knoop 500HK Test Block	1000gf
64BAA218	Knoop 600HK Test Block	1000gf
64BAA219	Knoop 700HK Test Block	1000gf
64BAA220	Knoop 800HK Test Block	1000gf

*Other hardness ranges and test forces available

Indenters

Order No.	Type	Model
19BAA058	Vickers Indenter	H, HM Standard Series
19BAA059	Vickers Indenter	MVK-H2, H3, HM114, HM220
19BAA061	Knoop Indenter	H, HM Standard Series
19BAA062	Knoop Indenter	MVK-H2, H3, HM114, HM220
19BAA060	Vickers Indenter	HV, AVK-C Series
19BAA063	Knoop Indenter	HV, AVK-C Series

Universal Specimen Holder

Used to secure a specimen that has a measuring surface that is hard to stabilize, perpendicular to the indenter axis.

810-020

Mounted Specimen Vise

1.5" (39mm) Max Height	Diameter	
810-650-1	1"	25.4mm
810-650-2		30mm
810-650-3	1.25"	31.75mm
810-650-4	1.5"	38.1mm
810-650-5		40mm

50x50mm travel stage

Manual XY Stage Unit 50 x 50
Manual XY Stage Unit 2"x 2"
810-423 Metric
810-427 Inch/Metric

Bulbs

Order No.	Description
513667	Bulb, 12v/50w, halogen double pin type, HM series with box style illuminators
19BAA219	Bulb, 6v/20w, halogen double pin type, Later H series
19BAA095	Bulb, 6v/15w, halogen bayonet type, all E, G and early H series testers

Clamping devices (Vises)

Vise
Max. opening: 3.94"(100mm)
810-017

Vise
Max. opening: 2"(51mm)
810-016

Rotary Table

Rotary Table
810-018

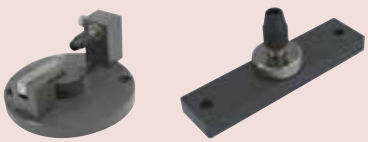
Round Tables

Dimensions: 7.08"(180mm)
810-037

Specimen (thin plate) Holder

Secures a plate with a thickness of .197"(5mm) or less, or foil-like specimens.
810-013

Specimen (wire) Holder



Used to horizontally or vertically secure a wire or needle specimen that has a diameter of .126"(3.2mm) or less.
810-014-1 horizontal
810-015-1 vertical

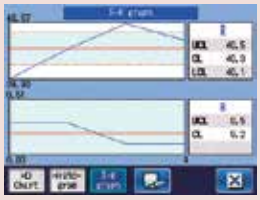
HR-530/530L

SERIES 810 — Rockwell Type Hardness Testing Machines

HR-530
(810-237)

Standard operating display

Graphic display of statistical calculation results and X̄-R control charts



Fine-adjustment table for Jominy testing
810-700

Optional Accessories: See page K-11, 12

Function: Touch-screen type
- Touch-screen operation with a back-lit LCD graphic display.
- Remote selection of the test force linked to the hardness scale selection.
- Choice of message language in English, German, French, Spanish, Italian and Japanese.
- Cylindrical and spherical surface compensation.
- Data offset.
- Conversion to other hardness scales.
- Powerful statistical processing with flexible data point editing and 1024 data memory.
- Measured data editing
- Go/no-go tolerance judgment.
- Statistical processing, histogram and x̄-R chart

FEATURES

- Closed Loop Test Force Control allows for a wide variety of hardness testing including Rockwell, Superficial and Light Force Brinell (6.25 to 187.5 kgf).
- Hardness testing of plastics according to ASTM D785 (Proceedure A and B) and ISO2039-2 are also possible.
- Projected nose type tester allows testing of interior parts down to 40mm or 22mm with optional 19BAA292 indenter
- 5 display formats are possible to show you the information you need. Statistics and graphs can also be displayed on the color touch screen control panel.
- Simple to use automatic brake-start system begins the test automatically when initial force is reached
- The HR-530 is available in 9.8" (250mm) or 15.5" (395mm) height capacity models.
- Complete with a combination diamond indenter, a 1/16" carbide ball indenter, one flat and one V anvil, 2 HRC, 1 HRBW, 1 HR30TW and 1 HR30N test block.

5.7-inch color LCD

SPECIFICATIONS

Order No.		810-237	810-337
Model		HR-530	HR-530L
Hardness testing methods		Rockwell/Rockwell Superficial/Brinell/Plastics hardness	
Initial test force (N)		29.42N (3kgf), 98.07N (10kgf)	
Test force (N)	Rockwell Superficial	147.1N (15kgf), 294.2N (30kgf), 441.3N (45kgf)	
	Rockwell	588.4N (60kgf), 980.7N (100kgf), 1471N (150kgf)	
	Light Force Brinell	61.29 (6.25kgf), 98.07 (10kgf), 153.2 (15.625kgf), 245.2 (25kgf), 294.2 (30kgf), 306.5 (31.25kgf), 612.9 (62.5kgf), 980.7 (100kgf), 1226 (125kgf), 1839 (187.5kgf)	
Test force control		Automatic (load/hold/unload)	
Table up/down mechanism		Manual (automatic braking and load sequencing)	
Control unit		Color touch-panel	
Test force switching		Operated with the display unit	
Test force hold time		1 to 120s (Selectable in units of 1s)	
Maximum specimen size		Height: 9.8" (250 mm) Depth: 5.9" (150 mm)	Height: 15.5" (395 mm) Depth: 5.9" (150 mm)
Permissible inside diameter of a tube specimen		Minimum hole diameter: 1.38" (35 mm) (when using the special indenter: .87" (22 mm))	
Maximum table loading		45 lb (20 kg)	
Ball indenter		Tungsten carbide ball indenter	
Unit (display unit)		inch	
Display		Hardness value, test condition, go/no-go judgment result, statistical calculation result, X-R control chart, hardness conversion value	
		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]	
		Go/no-go judgment function	
		Continuous test function (for specimens with 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 limit value, lower limit value, go count, range, no-go count)	
		Graph generation function (X-R control chart)	
Language support		Japanese, English, German, French, Italian, Spanish, Korean, Chinese (simplified characters/traditional characters), Turkish, Portuguese, Hungarian, Polish, Dutch and Czech	
External data output		RS-232C, SPC, USB2.0	
Power supply		AC120V	
External dimensions	Main unit	9.84" x 26.38" x 23.82" (250(W)×667(D)×621(H) mm)	11.8" x 26.2" x 30.1" (300(W)×667(D)×766(H) mm)
	Touch-panel display	191(W)×147(D)×71(H) mm	
Mass		Approx. 60 kg	Approx. 69 kg

Note: Plastic testing may not be enabled, depending on the material.

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HR-523/523(L)

SERIES 810 — Rockwell Type Hardness Testing Machines

FEATURES

- Multiple test force generation for Rockwell, Rockwell Superficial and Light Force Brinell hardness.
- Dolphin-nose indenter arm for easy reach of interior (min. ø40mm/ø22mm*) and exterior surfaces.
  *When using an optional diamond indenter (**19BAA292**).
- Real-time electronic test force control for accurate loading. This eliminates load force overshooting.
- Indenter escape function for continuous testing at fixed table position. This eliminates instability caused by the table retraction.
- Auto-stop elevation table and automatic preliminary test force loading to provide stable test force generation.
- Complete with one flat and V anvil, diamond and 1/16" carbide ball indenters, 2 HRC and 1 HRBW Rockwell test blocks and an HR30N and HR30TW test block.

HR-523
810-204-03A

SPECIFICATIONS

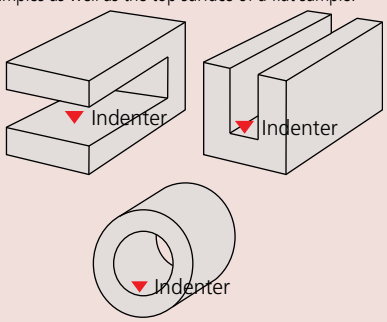
Model		HR-523	HR-523L
Order No.		**810-204-03A**	**810-207-03A**
Preliminary Test Force		29.42N (3kgf), 98.07N (10kgf)	
Test Force	Rockwell	588.4N (60kgf), 980.7N (100kgf), 1471N (150kgf)	
	Rockwell Superficial	147.1N (15kgf), 294.2N (30kgf), 441.3N (45kgf)	
	Light Force Brinell	61.29 (6.25kgf), 98.07 (10kgf), 153.2 (15.625kgf), 245.2 (25kgf), 294.2 (30kgf), 306.5 (31.25kgf), 612.9 (62.5kgf), 980.7 (100kgf), 1226 (125kgf), 1839 (187.5kgf)	
Force Control		Automatic control (unloading/duration/unloading) with closed-loop feed back	
Console/Display Unit		Touch-screen operation with back-lit LCD graphic display	
Test Force Selection		By touch screen	
Table up/down drive		Power-Drive (for full-automatic measurement)	
Load Duration		0 to 120 sec. (1 sec. step)	
Maximum Specimen Height		8.1" (205mm)	15.5" (395mm)
Maximum Specimen Depth		5.9" (150mm)	
Display Indication Functions		Hardness value, Converted hardness value, Test conditions, go/no-go tolerance judgment, statistical processing result Rockwell/Rockwell superficial hardness testing. Continuous testing. Cylindrical/spherical surface compensation, data offset. Hardness conversion (HV, HK, HRA/B/C/D/F/G/15T/30T/45T/15N/30N/45N, HS, HB, HBW, tensile strength) Go/no-go tolerance judgment, measured data editing, data memory (max 1024 data) SPC calculation (No. of data, max/min/mean values, range, upper/lower limit values, standard deviation, No. of passing/defective) Histogram, x̄-R chart	
Data Output		RS-232C, SPC, Centronics	
Dimensions (W x D x H)		9.84" x 26.38" x 23.82" (250 x 670 x 605mm)	
Mass		60kg (133lb)	63kg (139lb)

Technical Data

Preliminary test force:	29.42N, 98.07N
Test force	
Rockwell superficial:	147.1, 294.2, 441.3N
Rockwell:	588.4, 980.7, 1471N
Brinell*:	
Test force setting:	By control unit
Load control:	Automatic (loading, duration, unloading)
Load duration:	0s - 120s (1s increments)
Max. specimen height:	205mm (for standard flat anvil)
Max. specimen depth:	150mm (from the center of indenter shaft)
Stage elevation:	Manual or power drive
Control unit: type	Sheetswitch type or touch-screen
Data output:	RS-232C, Digimatic code (SPC) and Centronics
Power supply:	120V AC, 50/60Hz
Dimensions (W x D x H)	
Main unit:	250 x 670 x 605mm
Control unit:	165 x 260 x 105mm

Optional Accessories: See page K-11, 12

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



Function: Touch-screen type

- Touch-screen operation with a back-lit LCD graphic display.
- Remote selection of the test force linked to the hardness scale selection.
- Choice of message language in English, German, French, Spanish, Italian and Japanese.
- Cylindrical and spherical surface compensation.
- Data offset.
- Conversion to other hardness scales.
- Powerful statistical processing with flexible data point editing and 1024 data memory.
- Measured data editing
- Go/no-go tolerance judgment.
- Statistical processing, histogram and x̄-R chart

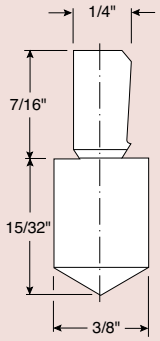
Optional Accessories

For Rockwell/Rockwell Superficial Type Hardness Testing machine

Calibration Set

Order No. 64BAA241 C Scale Set	Order No. 64BAA242 B Scale Set
Test Blocks	Test Blocks
64BAA125	64BAA126
64BAA124	64BAA132
64BAA158	64BAA135
Indenter	Indenter
64BAA072	64BAA078
Order No. 64BAA243 30N Scale Set	**Order No. 64BAA244 30T Scale Set**
Test Blocks	Test Blocks
64BAA128	64BAA129
64BAA165	64BAA140
64BAA167	64BAA130
Indenter	Indenter
64BAA073	64BAA078

Rockwell Type Diamond Indenters



Order No.	Scale
64BAA072	C
64BAA073	N
64BAA086	A
64BAA071	C & N

Order No.	Hardness
64BAA159	HRA81/86 Rockwell Test Block
64BAA160	HRA75/79 Rockwell Test Block
64BAA161	HRA70/73 Rockwell Test Block
64BAA162	HRA65/68 Rockwell Test Block
64BAA163	HRA60/62 Rockwell Test Block
64BAA249	HRBW95/100 Rockwell Test Block
64BAA126	HRBW90/95 Rockwell Test Block
64BAA131	HRBW80/85 Rockwell Test Block
64BAA132	HRBW70/75 Rockwell Test Block
64BAA133	HRBW60/65 Rockwell Test Block
64BAA134	HRBW50/55 Rockwell Test Block
64BAA135	HRBW40/45 Rockwell Test Block
64BAA127	HRBW30/35 Rockwell Test Block
64BAA136	HRBW20/25 Rockwell Test Block
64BAA137	HRBW10/15 Rockwell Test Block
64BAA138	HRBW0/5 Rockwell Test Block
64BAA125	HRC60/65 Rockwell Test Block
64BAA157	HRC50/55 Rockwell Test Block
64BAA124	HRC40/45 Rockwell Test Block
64BAA123	HRC30/35 Rockwell Test Block
64BAA158	HRC20/25 Rockwell Test Block

Order No.	Hardness
64BAA129	HR30T74/79 Rockwell Test Block
64BAA139	HR30T70/73 Rockwell Test Block
64BAA140	HR30T63/67 Rockwell Test Block
64BAA141	HR30T56/60 Rockwell Test Block
64BAA142	HR30T49/53 Rockwell Test Block
64BAA130	HR30T43/47 Rockwell Test Block
64BAA143	HR30T36/39 Rockwell Test Block
64BAA144	HR30T29/33 Rockwell Test Block
64BAA145	HR30T22/26 Rockwell Test Block
64BAA146	HR30T15/18 Rockwell Test Block
64BAA147	HR15T90/92 Rockwell Test Block
64BAA148	HR15T86/69 Rockwell Test Block
64BAA149	HR15T83/85 Rockwell Test Block
64BAA150	HR15T80/82 Rockwell Test Block
64BAA151	HR15T77/79 Rockwell Test Block
64BAA152	HR15T72/74 Rockwell Test Block
64BAA153	HR15T70/72 Rockwell Test Block
64BAA154	HR15T68/69 Rockwell Test Block
64BAA155	HR15T64/66 Rockwell Test Block
64BAA156	HR15T61/63 Rockwell Test Block

Order No.	Hardness
64BAA222	HR45N65/70 Rockwell Test Block
64BAA223	HR45N55/60 Rockwell Test Block
64BAA224	HR45N45/50 Rockwell Test Block
64BAA225	HR45N35/40 Rockwell Test Block
64BAA226	HR45N25/30 Rockwell Test Block
64BAA128	HR30N64/69 Rockwell Test Block
64BAA164	HR30N68/73 Rockwell Test Block
64BAA165	HR30N59/64 Rockwell Test Block
64BAA166	HR30N50/55 Rockwell Test Block
64BAA167	HR30N40/45 Rockwell Test Block
64BAA168	HR15N90/93 Rockwell Test Block
64BAA169	HR15N85/88 Rockwell Test Block
64BAA170	HR15N80/83 Rockwell Test Block
64BAA171	HR15N75/77 Rockwell Test Block
64BAA172	HR15N69/72 Rockwell Test Block

Carbide Ball Indenters

Order No.	Description
11AAD465	1/16″ Carbide ball indenter
11AAD466	1/8″ Carbide ball indenter
11AAD467	1/4″ Carbide ball indenter
11AAD468	1/2″ Carbide ball indenter
19BAA507	1/16″ Carbide ball (1pc.)
19BAA508	1/8″ Carbide ball (1pc.)
19BAA509	1/4″ Carbide ball (1pc.)
19BAA510	1/2″ Carbide ball (1pc.)

Steel Ball Indenters

Order No.	Description
11AAD461	1/16″ diameter steel ball indenter
19BAA078	1/16″ diameter steel ball indenter (auto-discrimination type)
11AAD462	1/8″ diameter steel ball indenter
64BAA079	1/8″ diameter steel ball indenter (auto-discrimination type)
11AAD463	1/4″ diameter steel ball indenter
64BAA080	1/4″ diameter steel ball indenter (auto-discrimination type)
11AAD464	1/2″ diameter steel ball indenter
64BAA081	1/2″ diameter steel ball indenter (auto-discrimination type)
64BAA082	1/16″ diameter spare steel ball (10 pcs)
64BAA083	1/8″ diameter spare steel ball (10 pcs)
64BAA084	1/4″ diameter spare steel ball (10 pcs)
64BAA085	1/2″ diameter spare steel ball (10 pcs)

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Optional Accessories

For Rockwell/Rockwell Superficial Type Hardness Testing machine

Round table
810-038 Outside ø250 mm

For large specimens such as molded items

Round table
810-037 Outside ø180 mm

For large specimens such as molded items

V-anvil (large)
810-040
(Outside ø40 mm,
Groove width 30 mm)

For round specimens (max. ø60 mm)

V-anvil (small)
810-041
(Outside ø40 mm,
Groove width 6 mm)

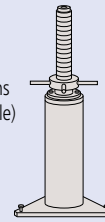
For shaft materials (max. ø8.4 mm)

Spot anvil
810-043
(Outside ø12 mm)

Spot anvil
810-044
(Outside ø5.5 mm)

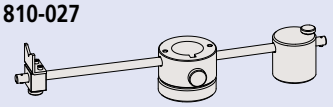
For sheet specimens

Jack rest
810-028
For supporting long specimens
(Used with anvil or round table)



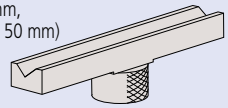
EXPAK Data processing software
11AAC236 HR530 and HM200 Series
11AAC237 HR523 Series

VARI-REST
810-027



For testing long specimens (commonly used for the anvil)

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



For round specimens ø14-98 mm

Diamond-spot anvil
810-030
(Outside ø10 mm)
For sheet specimens

*Dedicated to the Rockwell Superficial hardness test

Small V-anvil
810-042
(Outside ø10 mm)

For round specimens (max. ø16 mm)

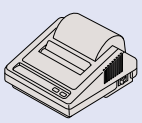
Testing machine table
11AAD186
Supplied with
stability bracket

Testing machine table

Vibration isolator
810-643
Only for mounting hardness testing machines

Foot switch
11AAD537

Printer
DPU-414
02AGD600B
with connection cable



Digimatic mini-processor
DP-1VA
264-505A

Connection cable not supplied. (To be ordered separately.)

937386

936937

Optional Accessories

HR523 and most older models:

06AFM380E: USB input tool – Tester to PC
937386: Tester to DP1-VA Printer

HM200 and HR-530 Series:

06AFM380D: USB input tool – Tester to PC
936937: Tester to DP1-VA Printer

Refer to Bulletin No. (2255) for more details.

Hardmatic HH-411

SERIES 810 — Impact Type Hardness Testing Unit

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.

810-298-10: ASTM standard
Including the display unit, D type impactor (**810-287-10**) and carbide ball (**19BAA457**).

Technical Data

Impactor:	Impact hammer with integrated detector and carbide-ball tip (D type: conforming to ASTM A 956)
Display unit:	7-segment LCD
Functions:	Auto angle compensation, Offset, go/no-go judgment, Hardness scale conversion Data storage (1800 data entries) Statistical analysis (Average, Maximum, Minimum, Dispersion) Auto sleep function Impact counter display function
Testable workpiece	
Thickness:	Minimum 5mm or more
Mass:	5kg or more in mass
Test points:	5mm or more from the edge of the sample, 3mm or more to each of the tested points.
Surface roughness:	Ra 10μm or less
Power supply:	Lithium AA battery 2pcs or optional AC adapter (battery life: 70 hours)

Standard Accessories

19BAA265 Test Block HLD800
810-291-10 Display Unit
810-287-10 Detector
19BAA460 Cable
Battery AA (Lithium) 2pcs.

Optional Accessories

264-505A: Digimatic Mini-Processor DP-1VR
937387: Connecting cable for
09EAA082: Printer paper (10 rolls/set)
810-622A: Thermal printer DUP-414
19BAA285: Thermal printer connecting cable
19BAA157: Thermal printer paper
19BAA238: RS-232C connecting cable for PC
06AEG302JA: AC adapter of display unit
19BAA243: Hardness test block (880HLD)
19BAA244: Hardness test block (830HLD)
19BAA245: Hardness test block (730HLD)
19BAA246: Hardness test block (620HLD)
19BAA247: Hardness test block (520HLD)
19BAA248: Support ring for convex surface of cylinder (R10 - R20)
19BAA249: Support ring for convex surface of cylinder (R14 - R20)
19BAA250: Support ring for convex surface of sphere (R10 - R27.5)
19BAA251: Support ring for concave surface of sphere (R13.5 - R20)
19BAA457: Carbide ball for D, DC, D+15 type impactors
19BAA458: Ball shaft for DL type impactor
810-287-10: D type impactor UD-411
810-288-10: DC type impactor UD-412
810-289-10: D+15 type impactor UD-413
810-290-10: DL type impactor UD-414

SPECIFICATIONS

Model	HH-411		
Order No.	**810-298-10**		
Hardness Range	L-Value (ASTM A956)		
Detector	Input device D (carbide ball)		
Display	**Hardness**	**Range**	**Resolution**
	HL	1-999 HL	1 HL
	HV	43-950 HV	1 HV
	HB	20-894 HB	1 HB
	HRC	19.3-68.2 HRC	0.1 HRC
	HRB	13.5 - 101.7 HRB	0.1 HRB
	HS	13.2 - 99.3 HS	0.1 HS
	HTN	499 - 1996 Mpa	1 Mpa
Functions	Conversions: HL,HV, HB, HRC, HRB, HS, HTN Judgment: go/no go Offsetting Memory: 1,800 data		
Indentation Direction	Any direction		
Output	RS-232C, SPC		
Power supply	Lithium AA Battery 2pcs.		
Dimensions	Detector: (Dia. X H) 1.10" x 6.89" (28 x 175mm) Display: (W x D x H) 2.76" x 4.33" x 1.38" (70 x 110 x 35mm)		
Mass	Detector: .26lbs (120g) Display: .44lbs (200g)		

Impactors (Optional accessories)

Various impactors can be connected to the display unit.

810-288-10
Use for inner walls of cylinders. The grip is short to allow easy positioning within a cylinder.

810-289-10
Use for concave workpieces such as gear teeth, ball bearing races, etc.

810-290-10
Use for gear teeth, welded corners, etc.

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Hardmatic HH-300

SERIES 811 — Durometers for Rubber and Plastics Hardness Testing

FEATURES

Digital / Dial Durometers are suitable for testing the nature of the following materials — natural rubber, neoprene, polyesters, P.V.C., leather, nitrite rubber, wax, vinyl, cellulose acetates, glass polystyrene, etc.

Compact Digital **811-336-10**
Compact Dial **811-335-10**

Long Leg Digital **811-332-10**
Long Leg Dial **811-331-10**

Technical Data

- Designed in accordance with the ASTM D 2240, ISO868, ISO 7619, DIN 53 505, JIS K 6253, and JIS K 7215 specifications.
- Units are available in both Shore A and Shore D scales, and will test a wide variety of applications.
- The Digital Durometer is provided with data hold function, permitting the operator to make an error-free reading on the LCD screen.
- The Dial Durometer is provided with a peak retaining hand for error-free reading.

SPECIFICATIONS

Order No.	Digital	**811-330-10**	**811-336-10**	**811-336-11**	**811-332-10**	**811-338-10**	**811-338-11**	**811-334-10**
	Dial	**811-329-10**	**811-335-10**	**811-335-11**	**811-331-10**	**811-337-10**	**811-337-11**	**811-333-10**
Model No.	Digital	HH-330	HH-336	HH-336	HH-332	HH-338	HH-338	HH-334
	Dial	HH-329	HH-335	HH-335	HH-331	HH-337	HH-337	HH-333
Scale		Shore E	Shore A			Shore D		
Applications		Soft Rubber, Sponge, Felt, Hard Foam	Natural rubber, soft elastomers, etc.			Hard elastomers, plastics, hard rubber, ebonite, etc.		
Resolution		0.1 (digital) or 1 (dial)				0.1 (digital) or 1 (dial)		
Range		HA: 10 - 90				HD: 20 - 90		
Standards	ASTM D 2240	—	✓	✓		✓	✓	
	ISO 868	—	✓	✓		✓	✓	
	ISO 7619	—	✓	✓		✓	✓	
	DIN 53 505	—	—	✓		—	✓	
	JIS K 6253	✓	✓	✓		✓	✓	
	JIS K 7215	—	✓	✓		✓	✓	
Pressure foot		44 x 18mm	44 x 18mm	ø18mm		44 x 18mm	ø18mm	
Spring force (mN)		WE=550+HE	WA=550+75HD (HA:Reading 10-90)			WD=444.5HD (HD:Reading 20-90)		
Indenter		Sphere (Tip diameter: 0.79mm)	Blunt taper (Tip diameter: 0.79mm)			Sharp point (Tip curvature: 0.1±0.01mm)		
Tip angle		—	35°±0.25°			30°±0.5°		
Indenter diameter		5mm	1.25mm					
Indenter protrusion		2.5mm						
Functions		Digital: Data hold, Zero -setting, SPC output, Power ON/OFF (Power supply: SR44 x 1pc.) Analog Durometer: Peak retaining hand						
Type		Compact	Compact		Long-leg	Compact		Long-leg
Dimensions (WxDxH)	Digital	60 x 28.5 x 151	60 x 28.5 x 151mm		60 x 28.5 x 193mm	60 x 28.5 x 151mm		60 x 28.5 x 193mm
	Dial	56 x 33.5 x 144mm	56 x 33.5 x 144mm		56 x 33.5 x 186mm	56 x 33.5 x 144mm		56 x 33.5 x 186mm
Mass	Digital	290g	290g		310g	290g		310g
	Dial	300g	300g		320g	300g		320g

Hardmatic HH-300

Test Block Set

64AAA964

64AAA963

905693

811-332-10

264-505A

Testing stand applications

These stands are used to mount Durometers. They allow constant-pressure hardness measurement by pressing the Durometer vertically on a workpiece.

- Anyone can perform repeatable hardness measurement due to fewer possibilities of human error and measurement variations.
- The supplied weights can be attached directly to a Durometer and allow constant-pressure hardness measurement of large samples for which a stand cannot be used.
- The supplied weights are used for calibrating the spring tension of Durometers.

Item No.	Description
64AAA964	Calibration Set (Shore A Scale) Test Block 30* DURO (Blue) Test Block 60* DURO (Yellow) Test Block 90* DURO (Gray) Mahogany Box
64AAA590	Calibration Set (Shore D Scale) Test Block 20* DURO (Blue) Test Block 40* DURO (Gray) Test Block 80* DURO (Black)
64AAA962	"A" Scale Durometer Stand
64AAA794	"A" Scale Durometer Stand with Air Damper
64AAA796	Combination "D" & "A" Scale Durometer Stand
64AAA963	O-Ring Fixture Set 1/16", 3/32", 1/8", 3/16" and 1/4" O-Ring cross sections
264-505A	Digimatic Miniprocessor with printer
905693	Connecting Cable 40" (1m) for Durometer and Digimatic Miniprocessor

* Values shown are nominal only. Test Block Size 2" x 2" x 1/4"

Mitutoyo

Hardness Testing Machines

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

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

Key: ● Well-suited ▲ Reasonably suited

Methods of Hardness Measurement

(1) Vickers

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

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

F:N
d:mm

The error in the calculated Vickers hardness is given by the following formula. Here, Δd_1, Δd_2, and 'a' represent the measurement error that is due to the microscope, an error in reading an indentation, and the length of an edge line generated by opposing faces of an indenter tip, respectively. The unit of $\Delta\theta$ is degrees.

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

(2) Knoop

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

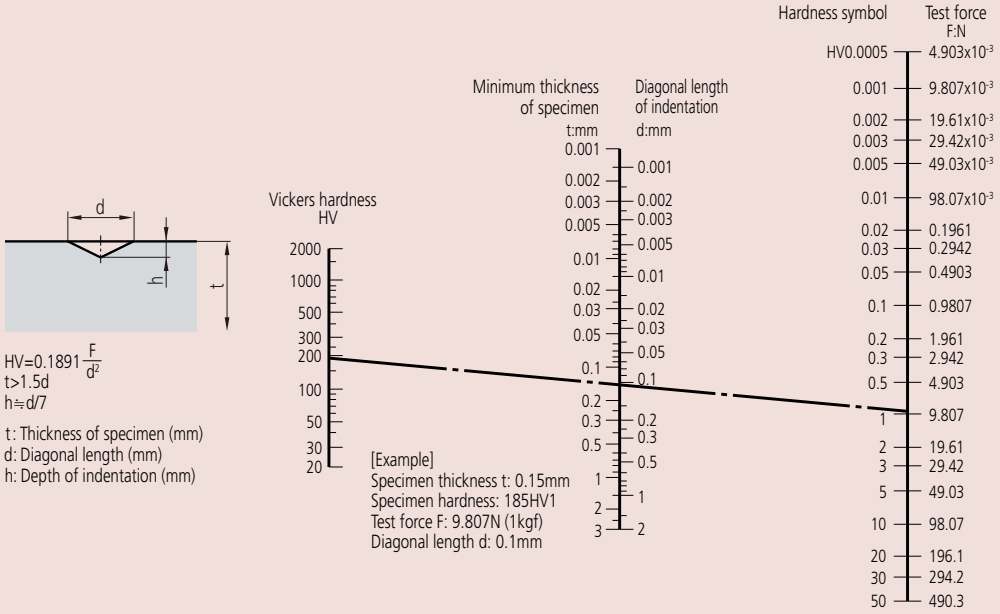
$$HK=k\frac{F}{A}=0.102\frac{F}{A}=0.102\frac{F}{cd^2}=1.451\ \frac{F}{d^2}$$

F:N
d:mm
c:Constant

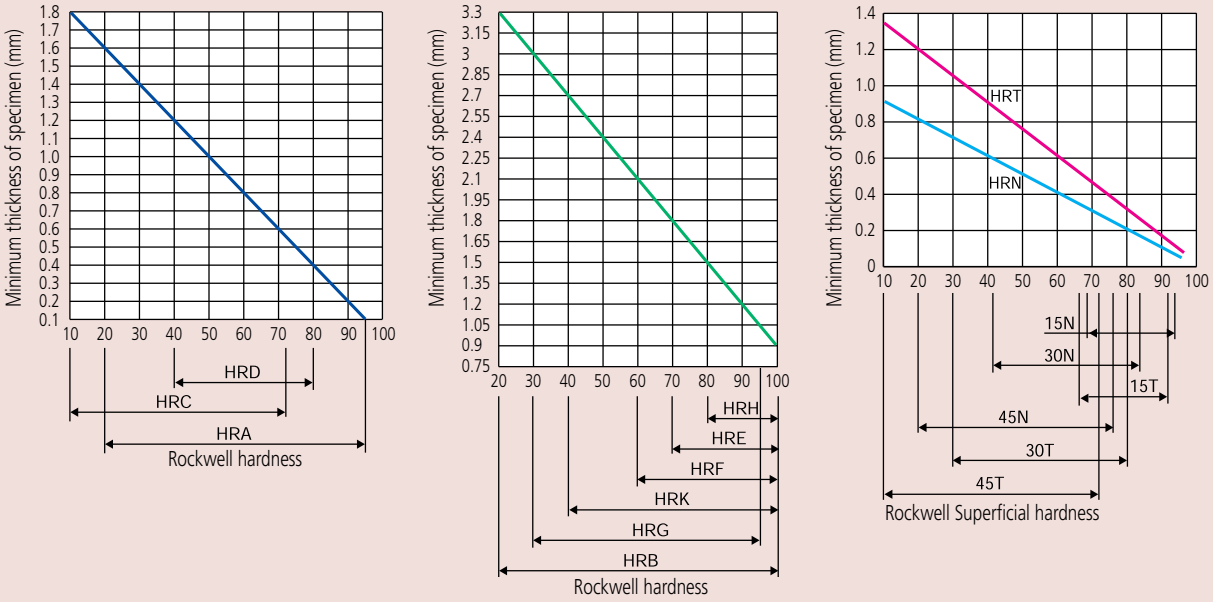
(3) Rockwell and Rockwell Superficial

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

Relationship Between Vickers Hardness and the Minimum Allowable Thickness of a Specimen



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



Rockwell Hardness Scales

Scale	Indenter	Test force	Application
A	Diamond	588.4N	Carbide, sheet steel
D		980.7N	Case-hardened steel
C		1471N	Steel (100HRB or more to 70HRC or less)
F	Sphere of 1.5875mm diameter	588.4N	Bearing metal, annealed copper
B		980.7N	Brass
G		1471N	Hard aluminum alloy, beryllium copper, phosphor bronze
H	Sphere of 3.175mm diameter	588.4N	Bearing metal, grinding wheel
E		980.7N	Bearing metal
K		1471N	Bearing metal
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	

Rockwell Superficial Hardness Scales

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	

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